

APPENDIX 2

Equipment Manuals

Banner Cloud Data Services



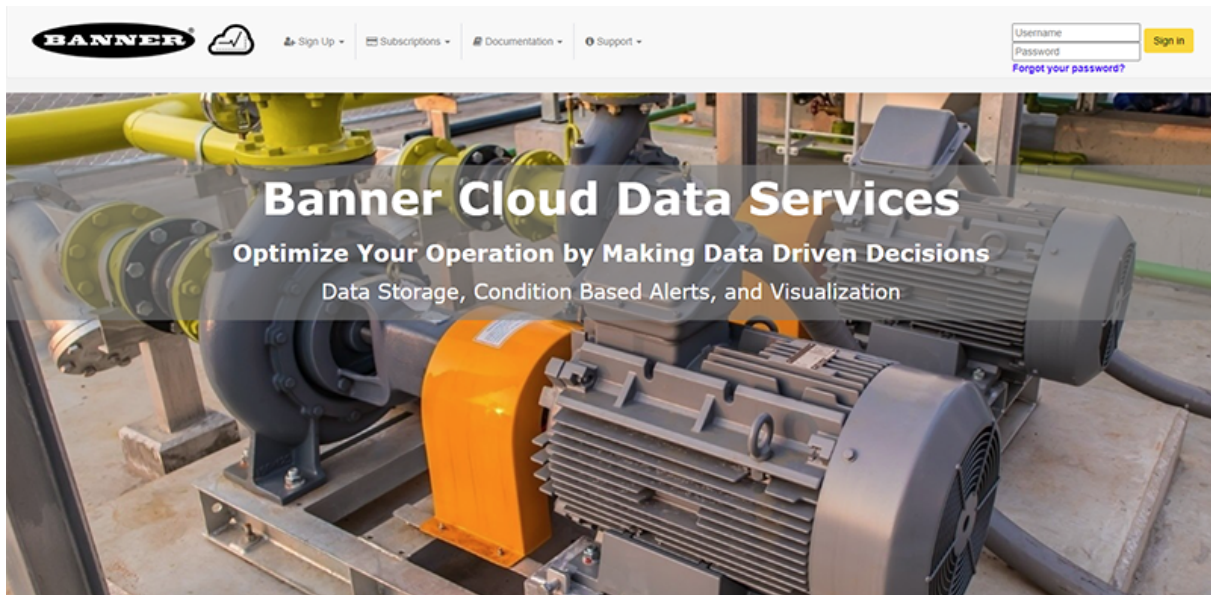
Quick Start Guide

Logging into the Web Service

The web server captures data from the DXM Controller using either a cellular connection or an Ethernet connection. Users collect and view the data or update and manage the DXM Controller using a web browser.

Within a few minutes of your purchase, you will receive an email with your authorization code and details regarding the data subscription service. If the authorization code is not received within 10 minutes, please check your spam folder or contact Banner Engineering at 1-888-373-6767 to obtain the code.

Use both the website and the DXM Configuration Software to set up and configure your data collection. Use the latest version of your browser (Google Chrome is recommended) and enter the URL: <https://bannercds.com>. The login page appears.



Create an Account

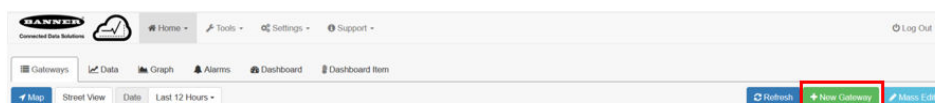
Follow these steps to create an account.

1. Click on **Sign Up**.
2. Click on **Enter Authorization Code and Create Account**.
3. A prompt will appear requesting the **Authorization Code** that was delivered in an email, an **Email** address, **Company** name, **User Name**, and **Password**.
4. Click **Sign Up** and agree to the Terms & Conditions when prompted.

Create a New Gateway

After you log into the Banner Cloud Data Services website, the **Gateway** screen displays. Follow these steps to create a new monitoring site.

1. Click on **+New Gateway**.
Create a new Gateway/site for each device that will be sending data to the web server.



A **Create New Gateway** prompt appears.

2. Verify **Traditional** is selected for the **Configuration**.



3. Enter a site name.
4. Click **Create**.
The Gateway/Site appears in the listing of devices on the Gateways screen.
5. Click **Edit Gateway** (pencil icon) next to your Gateway/Site name.
The Gateway detail window appears.
6. Copy the **Site ID** number located at the top of this window.
The Site ID number created by the web server is a required parameter in the configuration of the DXM Controller. The Site ID is the address the webserver uses to store the data pushed from the DXM Controller.
7. Click **Save**.

Modifying the XML Configuration File

Use the DXM Configuration Software to configure the operation of the DXM Controller.

Launch the DXM Configuration Software software. You can use one of these three screens to modify registers:

- **Local Registers**—Edits individual registers
- **Modify Multiple Registers**—Edits multiple registers at the same time
- **Local Registers in Use**—Edits individual registers

Refer to the [DXM Configuration Software Instruction Manual](#) for more details.

Edit Registers Using the Local Registers in Use Screen

Use this screen to modify the parameters of any local registers being used.

1. Go to the **Local Registers > Local Registers in Use > Edit Register** section of the bottom of the screen.
A list of the local registers being used displays.
2. Under the **Selected Register** box, select the register to define or modify. You may select the register by using the up/down arrows, directly entering a register number into the field, or clicking within the corresponding row in the **Local Registers in Use** table.
Only Local Registers that have already been changed from their default configuration are displayed in the Local Registers In Use table.
3. Using the drop-down lists, assign a name, register group, change the units, or make other configuration changes to this register.
4. To push register values to the web server, set **Cloud Permissions** to read.
If **Cloud Permissions** are set to Read, the web server only views data from the device and cannot write data to the device. If the permissions are set to Write, the web server only writes to the device and cannot read the data. If the permissions are set to Read/Write, the web server can read the data from the device and write to the device from the web.

The changes are automatically applied within the software, not the XML file. To change another register, use the up or down arrows to select another register number. To save these changes to the XML file, go to **File > Save**.

Modify Multiple Registers

Modify a range of registers from the **Local Registers > Local Registers in Use > Modify Multiple Registers** screen.

Select which parameter fields to modify. Most parameters have three selections.

- **Unchanged**—no changes
- **Default**—change to default settings
- **Set**—modify parameter. Other selections will appear based on the parameter.

Figure 1. Modify Multiple Registers screen

Banner Cloud Data Services

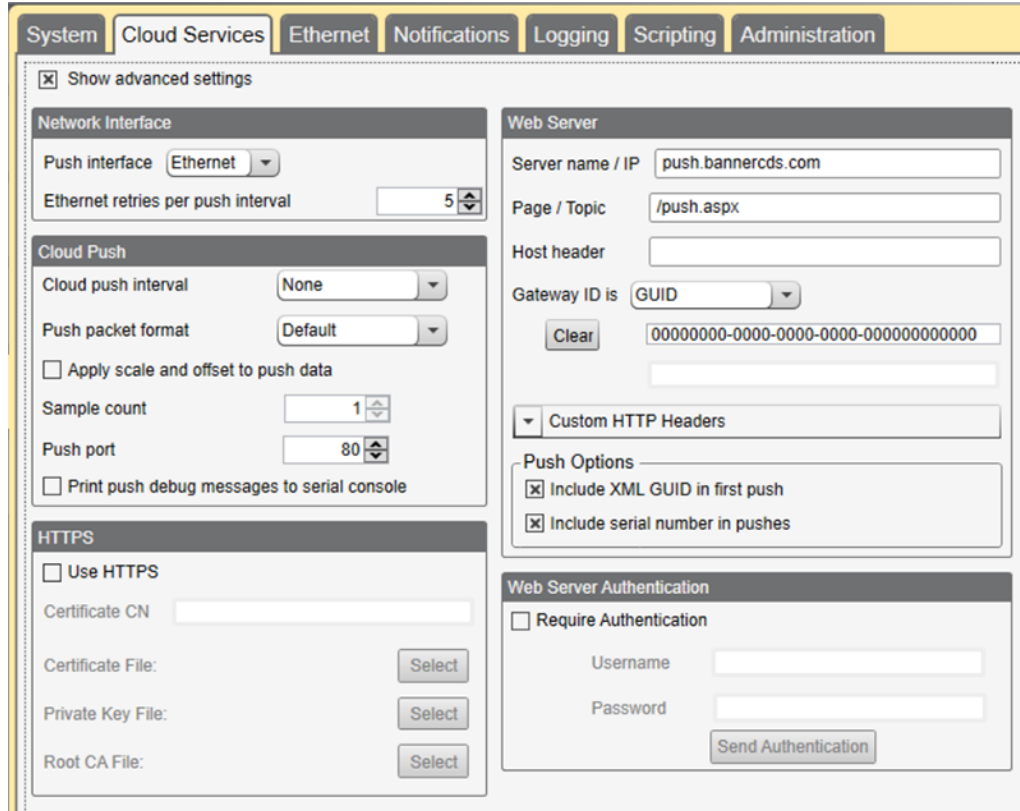
1. Enter the **Starting register** and **Ending register**.
2. Select the value to change using the drop-down list next to each value.
3. Enter the new value in the field provided.
4. To push register values to the web server, set **Cloud Permissions** to read.

If the **Cloud Permissions** are set to Read, the web server only views data from the device and cannot write data to the device. If the permissions are set to Write, the web server only writes to the device and cannot read the data. If the permissions are set to Read/Write, the web server can read the data from the device and write to the device from the web.

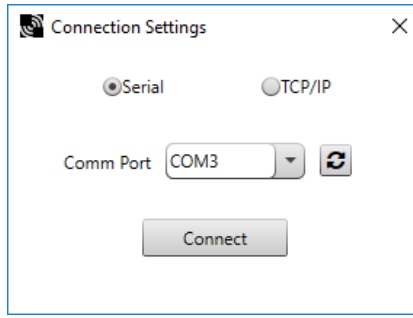
5. Click **Modify Registers** to save and apply the changes.

Configure the Cloud Settings

1. To configure the connection to the web server, go to the **Settings > Cloud Services** screen.



2. Copy and paste the **Site ID**.
The Site ID is that long string of numbers and letters from the Banner Cloud Data Services website.
3. Verify the **Server Name/IP** is set to `push.bannercds.com` and the **Page** is set to `/push.aspx` for sending to the website. To push to the demo website, set the Server Name/IP to `demopush.sensonix.net`.
4. Set the **Cloud Push Interval** to a value appropriate for your application.
The **Cloud Push Interval** determines how often the device pushes the data to the web. The faster the push interval, the more data is sent to the site. Cellular plans can only push at an interval of 5 minutes or longer, while Ethernet connections can push at an interval of 1 minute or longer. The **Sample Count** specifies how many times the data is gathered within the **Cloud Push Interval**.
For example, if the **Cloud Push Interval** is 15 minutes and the **Sample Count** is set to 3, then during each data push (every 15 minutes), 3 samples are sent to the web. This is one sample every 5 minutes.
5. Save the configuration file by going to **File > Save**.
File names must be no more than 30 characters long, and should not contain any spaces or special characters.
6. With a USB cable connected to the device, go to the **Device > Connection Settings** menu.
7. Select the appropriate **Comm Port** and click **Connect**.



- If multiple comm ports are visible, try each one until the software is able to connect to the device.
- Go to **Device > Send Configuration to the Device** to upload the new XML file.

Upload the XML Configuration File to the Website

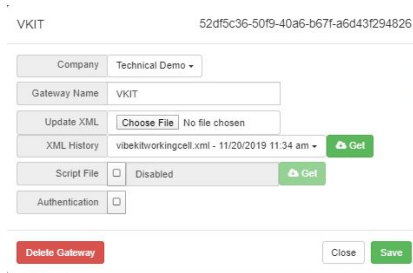
To upload an XML configuration file to the website, follow these instructions.

- At the webserver, select the **Home** screen.



- On the row displaying your new site, click the **Edit Gateway** (pencil) icon.
- Select **Update XML**.
- Click **Choose File** and select the file that was just updated to the DXM and click **Save**.

Figure 2. Example file selection screen that may not represent your specific kit



- After the XML file is loaded into the webserver, the webserver uses the register names and configurations defined in the configuration file.
- Click on the **Site Name** link to go to the configured registers to see the values uploaded by the DXM Controller. The same XML configuration files is now loaded on both the DXM Controller and the Website. After some time, the data should be seen on the website.

Completing these steps creates continuity between the site created on the website with the DXM used in the field. The DXM pushes data to the website, which can be viewed at any time.

Refer to the [Banner Cloud Data Services Instruction Manual](#) to review all the features available for monitoring, comparing data, and establishing warnings/alarms on the website. To access a demo version of the website please contact your local Banner distributor and follow the instructions in the technical note: [Connecting to the Banner Cloud Data Services Demo Site](#) for modified instructions on how to send data to the demo site.

Web Services Features

For more information on each of these features, see the [Banner Cloud Data Services \(CDS\) Instruction Manual](#).

Compare Graphs of Multiple Registers—Compare two or more register values on the same time graph.

Create FTP Backups or Download Data for Backup—Back up registers, upload logs, alarms, updates, and audits to an FTP address that can be accessed with a username and password created by the user.

Create New Companies and Users—This feature is only available with certain subscriptions. Limits may be placed on the number of companies or users a subscription can have.

Create Spreadsheet Tables—Create data tables to view numbers in a spreadsheet-style format.

Set Alarms—Set alarms when a register reaches or is compared to a certain numerical value. Alarms can also be used for connectivity problems, MAC alerts, geofence alerts, or register limits. If an alarm is activated, emails can be sent automatically to preset addresses.

Updating Script or XML via Web—Download an XML file from the DXM or upload a new XML to the DXM without having the device connected to a computer via USB.

Use Log Viewer for Viewing Past Data—Display graphs of data logged to the SD card, backed up previously to an FTP site, or downloaded.

View Graph of Individual Registers—View a graph of register values over time.

Write to Registers via Website—Set Cloud Permissions to Write or Read/Write in the DXM Configuration to write to the DXM from the website. Instead of using the LCD on the DXM or waiting for an input value, users can write certain register values directly to the DXM from the cloud site.

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Sure Cross[®] DXM100-Bx and DXM1000-Bx Wireless Controllers

Instruction Manual

Original Instructions
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2 December 2021
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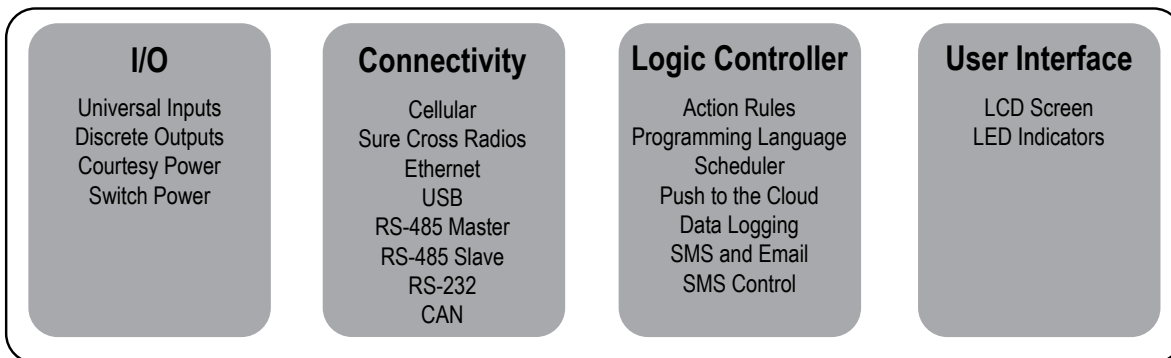
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1 System Overview

1.1 System Overview for the B1 Models

Banner's DXM Logic Controller integrates Banner's wireless radio, cellular connectivity, and local I/O to provide a platform for the Industrial Internet of Things (IIoT).



Inputs/Outputs—On-board universal and programmable I/O ports connect to local sensors, indicators, and control equipment.

- Universal Inputs
- Discrete outputs
- Courtesy power
- Switch power
- Battery backup
- Solar controller

Connectivity—The DXM's wired and wireless connectivity options make it easy to share data between local and remote equipment. The cellular modem option eliminates the need for IT infrastructures to connect remote equipment for sensing and control. The integrated Sure Cross® wireless radio enables Modbus connectivity to remote sensors, indicators, and control equipment.

Wired Connectivity

Ethernet: Modbus TCP or Ethernet/IP
 Field Bus: Modbus RS-485 Master/Slave, RS-232, or Controller Area Network (CAN)

Wireless Connectivity

Sure Cross Wireless Radio: DX80 900 MHz, DX80 2.4 GHz, MultiHop 900 MHz, or MultiHop 2.4 GHz
 Cellular modem: LTE (United States) or GSM (outside the United States)

Logic Controller—Program the DXM's logic controller using action rules and/or ScriptBasic language, which can execute concurrently. The control functions allow freedom when creating custom sensing and control sequences. The logic controller supports the Modbus protocol standards for data management, ensuring seamless integration with existing automation systems.

Action Rules

Supports simple logic, arithmetic and thresholding
 Use for low complexity solutions
 SMS text message Notifications
 E-mail Notifications
 Push data on conditions

Text Programming Language

ScriptBasic
 Use when Action Rules can't supply a solution

Scheduler

Time/calendar-based events
 Astronomical clock

Data Logging

Cyclic Data/Event logging
 E-mail log files

SMS Commanding

Read/Write Local Registers
 Upload data to the cloud-based data service
 Reboot controller

Sure Cross® DXM100-Bx and DXM1000-Bx Wireless Controllers

User Interface—A simple user interface consists of an LCD screen and four LED indicators. Use the LCD to access system status and setup, view user selectable events or data, and to bind and perform site surveys for Sure Cross radios. Configure the user programmable LEDs to indicate the status of the DXM, processes, or equipment.

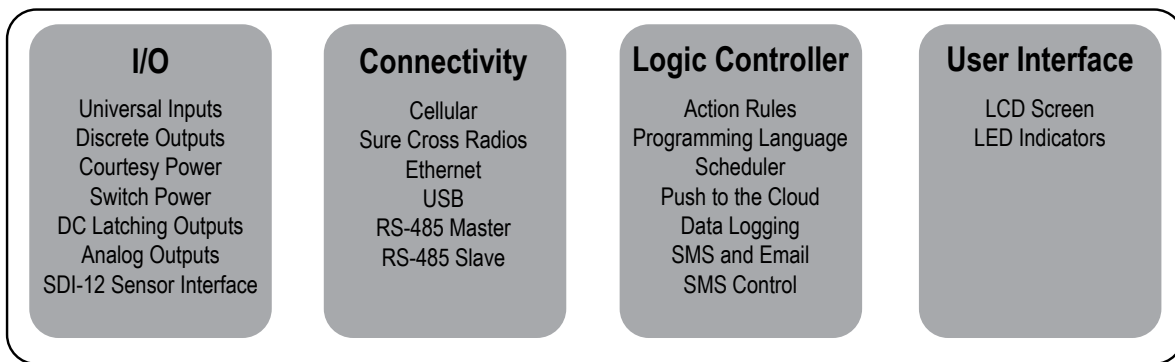
User programmable LCD

- Binding Sure Cross radios
- Conducting a Site Survey
- Viewing sensor information
- Viewing the system's status

User Defined LED indicators

1.2 System Overview for the B2 Models

Banner's DXM Logic Controller integrates Banner's wireless radio, cellular connectivity, and local I/O to provide a platform for the Industrial Internet of Things (IIoT).



Inputs/Outputs—On-board universal and programmable I/O ports connect to local sensors, indicators, and control equipment.

- Universal Inputs
- Discrete outputs
- Courtesy power
- Switch power
- Battery backup
- Solar controller
- DC latching outputs
- SDI-12 sensor interface

Connectivity—The DXM's wired and wireless connectivity options make it easy to share data between local and remote equipment. The cellular modem option eliminates the need for IT infrastructures to connect remote equipment for sensing and control. The integrated Sure Cross® wireless radio enables Modbus connectivity to remote sensors, indicators, and control equipment.

Wired Connectivity

- Ethernet: Modbus/TCP or Ethernet/IP
- Field Bus: Modbus RS-485 Master/Slave

Wireless Connectivity

- Sure Cross Wireless Radio: DX80 900 MHz, DX80 2.4 GHz, MultiHop 900 MHz, or MultiHop 2.4 GHz
- Cellular modem: LTE (United States) or GSM (outside the United States)

Logic Controller—Program the DXM's logic controller using action rules and/or ScriptBasic language, which can execute concurrently. The control functions allow freedom when creating custom sensing and control sequences. The logic controller supports the Modbus protocol standards for data management, ensuring seamless integration with existing automation systems.

Action Rules

- Supports simple logic, arithmetic and thresholding
- Use for low complexity solutions
- SMS text message Notifications
- E-mail Notifications
- Push data on conditions

Text Programming Language

- ScriptBasic
- Use when Action Rules cannot supply a solution

Scheduler

- Time/calendar-based events
- Astronomical clock

Data Logging

- Cyclic Data/Event logging
- E-mail log files

SMS Commanding

- Read/Write Local Registers
- Upload data to the cloud-based data service
- Reboot controller

User Interface—A simple user interface consists of an LCD screen and four LED indicators. Use the LCD to access system status and setup, view user selectable events or data, and to bind and perform site surveys for Sure Cross radios. Configure the user programmable LEDs to indicate the status of the DXM, processes, or equipment.

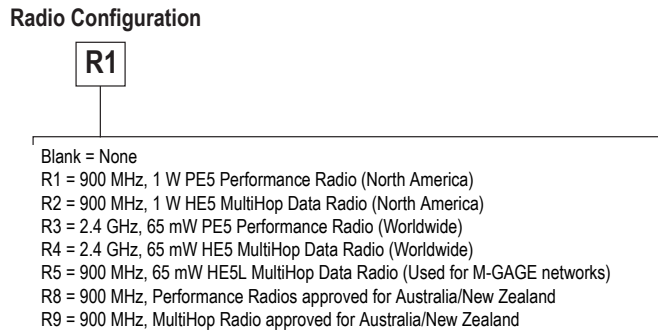
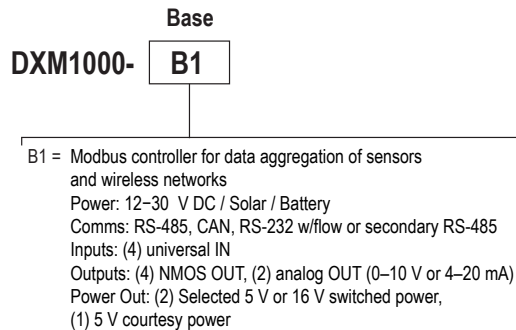
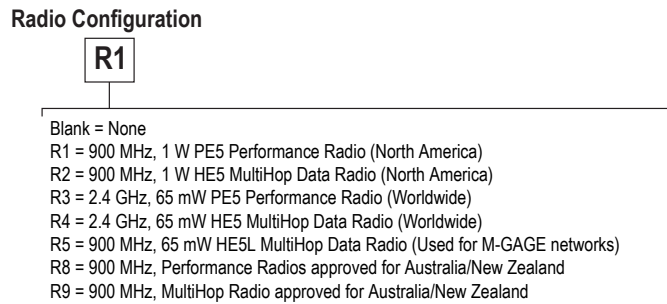
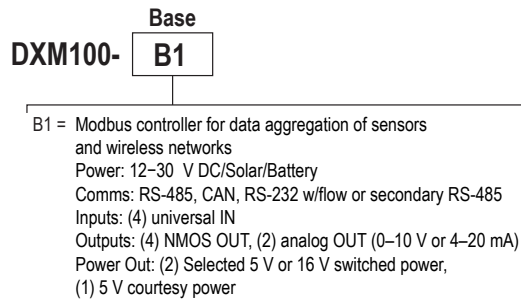
User programmable LCD

- Binding Sure Cross radios
- Conducting a Site Survey
- Viewing sensor Information
- Viewing the system's status

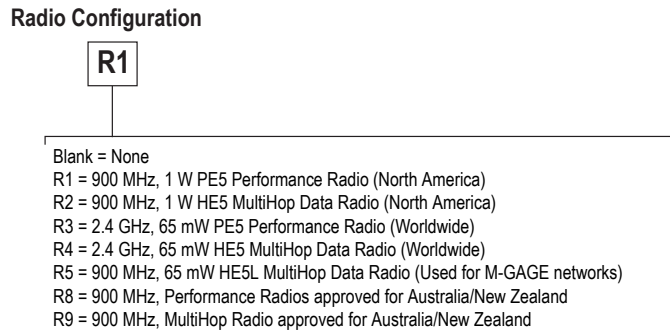
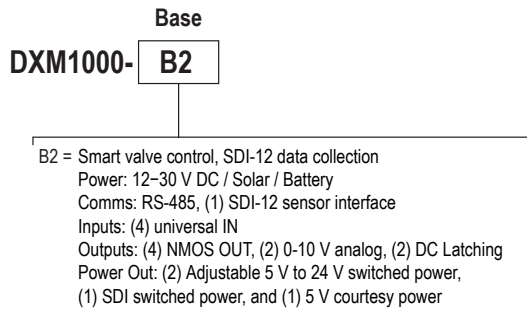
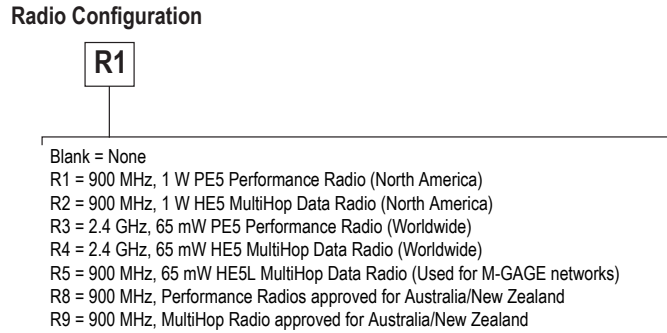
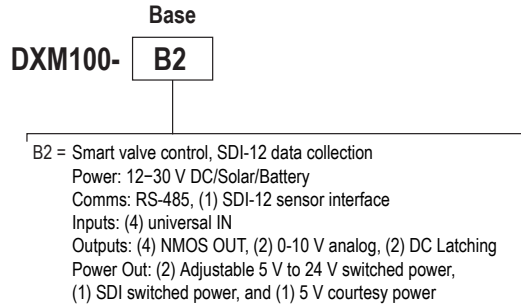
User Defined LED indicators

1.3 Hardware Overview

The DXM can have several different configurations. The DXM has a model number label on the housing. Use the model number and model table to identify which boards are included in the your controller.



Sure Cross® DXM100-Bx and DXM1000-Bx Wireless Controllers

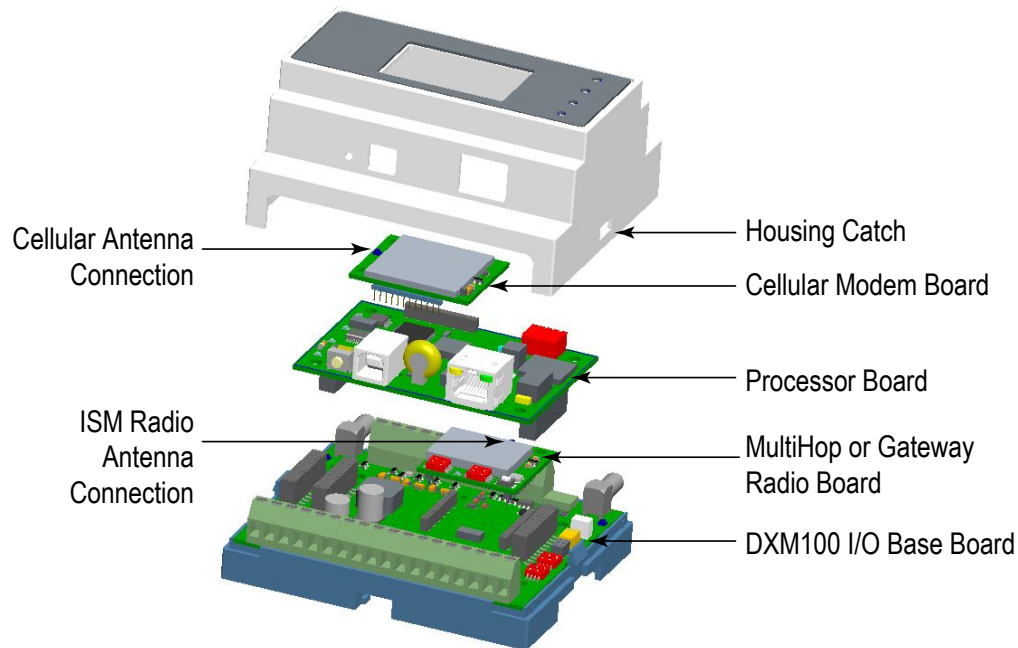


Not all combinations of base boards and radios are supported.



Important:

- **Electrostatic discharge (ESD) sensitive device**
- ESD can damage the device. Damage from inappropriate handling is not covered by warranty.
- Use proper handling procedures to prevent ESD damage. Proper handling procedures include leaving devices in their anti-static packaging until ready for use; wearing anti-static wrist straps; and assembling units on a grounded, static-dissipative surface.



The DXM100 I/O Base Board is shown. The DXM1000 I/O Base Board is similar.

I/O Base Board—The DXM I/O base board provides connections for all inputs, outputs and power. The I/O base board contains a 12 V solar controller that accepts connections to a solar panel and sealed lead acid (SLA) battery. The battery connection can also be used with line power to provide a battery backup in case of line power outages.

ISM Radio—The ISM radio, either a MultiHop or DX80 Gateway, fits on the I/O base board in the parallel sockets. Install the ISM radio so the U.FL antenna connection is to the side with the SMA antenna connectors. Connect the U.FL cable from the ISM radio U.FL to the right side U.FL connector. The ISM radio boards are available with either a 900 MHz radio (North America) or a 2.4 GHz radio (world-wide).

Processor—The processor board plugs into the base board using the two 20 pin socket connectors. The board sits above the ISM radio socket and held by the base board standoffs. Position the processor board so the USB and RJ45 Ethernet connection is to the front, away from the SMA antenna connections.

Cellular Modem (Optional)—The optional cellular modem (purchased separately) board plugs into the processor board with the U.FL antenna connection to the left. Attach the antenna cable from the cellular modem to the left U.FL connection on the base board.

In some DXM models, the cellular modem may be replaced with an ISM radio. In this configuration, position the top ISM radio antenna connection to the left of the SMA antenna connector.

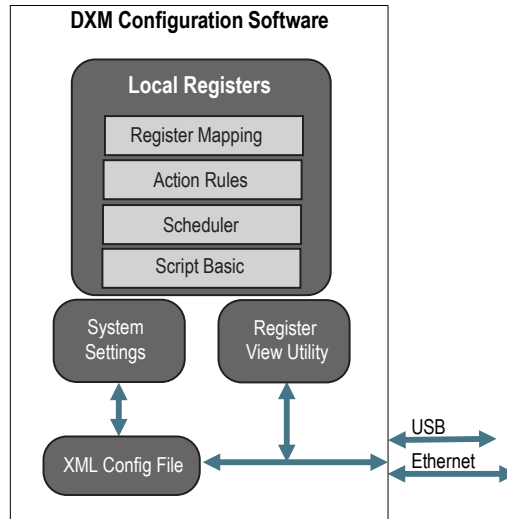
LCD (Display) Board—The top housing contains the LCD board. The display board is connected to the base board using a ribbon cable with a 20 pin connector.

1.4 DXM Configuration Software

Download the latest version of all configuration software from <http://www.bannerengineering.com>. For more information on using the DXM Configuration Software, refer to the instruction manual (p/n 209933).

Sure Cross® DXM100-Bx and DXM1000-Bx Wireless Controllers

Figure 1. Overview of the configuration software features



The configuration software configures the DXM by creating an XML file that is transferred to the DXM using a USB or Ethernet connection. The DXM can also receive the XML configuration file from a Web server using a cellular or Ethernet connection.

This configuration file governs all aspects of the DXM operation.

The wireless network devices are a separate configurable system. Use the DX80 User Configuration Software to configure the internal DX80 wireless Gateway and the attached wireless Nodes. Use the MultiHop Configuration Software if the internal radio is a MultiHop device.

All tools can be connected to the DXM using a USB cable or an Ethernet connection.

1.5 DXM Automation Protocols

The DXM supports the following automation protocols.

Modbus RTU

The DXM manages two separate physical ports running the Modbus RTU protocol. The DXM is the Modbus Master when operating the Modbus master RTU port. The DXM uses the master Modbus RTU bus to communicate with locally connected Modbus devices or uses the Banner wireless radio to communicate with remote Modbus devices.

The other Modbus RTU port is used by a host system to access the DXM as a slave device. The slave Modbus RTU port allows access all the internal registers concurrently with the master RTU port. Set the slave Modbus ID using the LCD menu: **SYSTEM CONFIG > DXM Modbus ID**.

By default, the Modbus RTU ports are active. Configure the port parameters using the configuration software.

Modbus TCP/IP

A host system acting as a Modbus master can access the DXM using the Modbus TCP/IP protocol over Ethernet. Standard Modbus port 502 is used by the DXM for all Modbus TCP/IP requests.

All internal registers are available to the host system concurrently with Modbus RTU.

By default, Modbus TCP/IP is active. Configure the DXM using Modbus TCP rules in the configuration software.

EtherNet/IP™

The Ethernet port is actively running EtherNet/IP. From the factory the DXM is configured to read and write registers on DX80 wireless devices 1 through 16. Custom configurations can be set using the configuration software.

By default, EtherNet/IP is active.

1.6 DXM Modbus Overview

The DXM uses internal 32-bit registers to store information. The processor's internal Local Registers serve as the main global pool of registers and are used as the common data exchange mechanism. External Modbus device registers can be read into the Local Registers or written from the local data registers.

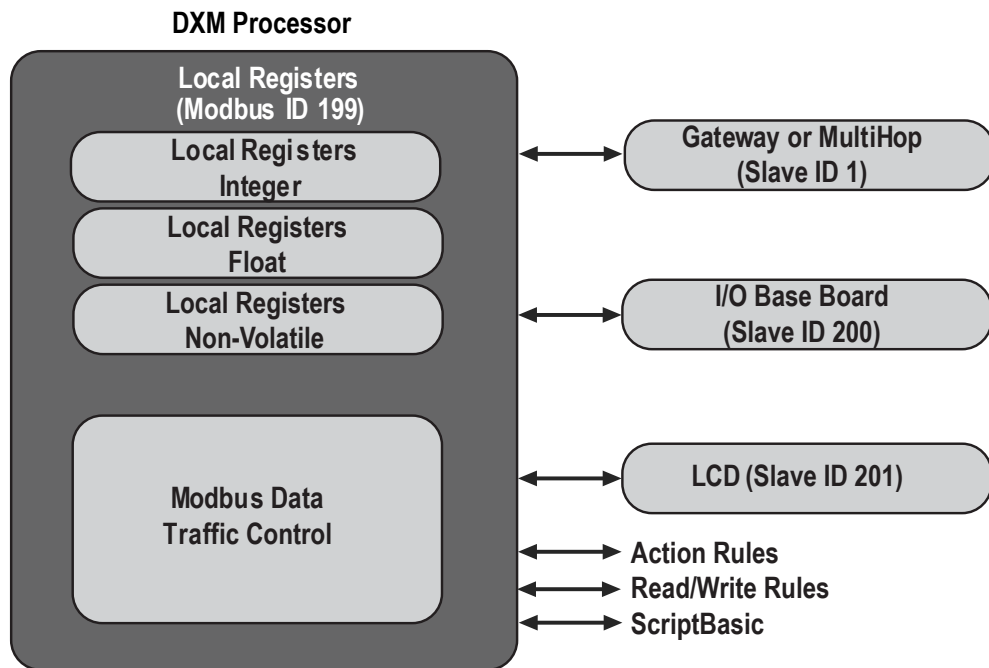
The DXM, as a Modbus master or slave, exchanges data using the Local Registers. Modbus over Ethernet (Modbus/TCP) uses the Local Registers as the accessible register data.

Using Action, Read/Write, and Threshold Rules allows you to manipulate the processor's Local Registers. The ScriptBasic programming capabilities extends the use of Local Registers with variables to create a flexible programming solution for more complex applications.

The processor's Local Registers are divided into three different types: integer, floating point, and non-volatile. When using Local Registers internally, the user can store 32-bit numbers. Using Local Registers with external Modbus devices follows the Modbus standard of a 16-bit holding register. Local Registers are accessible as Modbus ID 199.

Accessing the I/O base board and the LCD follows the same communication as an external Modbus device. Each device has an ID number to uniquely identify itself. The I/O base board is Modbus ID 200 and the LCD is Modbus ID 201.

Figure 2. Overview of the DXM Modbus processor



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2 Quick Start Guide

2.1 Device Setup

2.1.1 Apply Power to the Controller

Follow these instructions to apply 12–30 V DC power to the controller using a wall plug.

Equipment used:

- **DXM Wireless Controller**
- **MQDMC-401** 0.3 m (1 ft) cordset with a 4-pin M12/Euro-style quick disconnect fitting
- **PSW-24-1** Wall plug power supply; 24 V DC, 1 A



Important:

- **Never operate a 1 Watt radio without connecting an antenna**
- Operating 1 Watt radios without an antenna connected will damage the radio circuitry.
- To avoid damaging the radio circuitry, never apply power to a Sure Cross® Performance or Sure Cross MultiHop (1 Watt) radio without an antenna connected.

1. Connect the brown wire from the **MQDMC-401** cordset to the DXM's PW (+ power) terminal.
2. Connect the blue wire from the **MQDMC-401** cordset to the DXM's GD (- ground) terminal.
3. Connect the **PSW-24-1** power supply to the **MQDMC-401** cordset.
4. Plug in the **PSW-24-1** wall plug power supply.

2.1.2 Binding and Conducting a Site Survey with the ISM Radio

Before the ISM radio can communicate, the ISM radio within the DXM must be bound to the other radios in the wireless network.

Use the DXM LCD menu to bind external radios to the internal ISM radio.

If you are having difficulty running binding or site surveys, it may be because of the speed of the XML configuration file or script running on the DXM. To resolve this issue, try one of the following options:

- Disable the XML and script by setting DIP switch 4 on the processor board to ON and cycling the power to the DXM. After binding the devices, turn DIP switch 4 back OFF and cycle power again to return to normal operation of the XML and script.
- Adjust the XML or script to slow down the RTU read or write rules.
- Upload a blank XML, bind all devices, then upload the configured XML file.

Bind a DX80 Node to a DXM and Assign the Node Address

Binding Nodes to a Gateway ensures the Nodes only exchange data with the Gateway they are bound to. After a Gateway enters binding mode, the Gateway automatically generates and transmits a unique extended addressing (XADR), or binding, code to all Nodes within range that are also in binding mode. The extended addressing (binding) code defines the network, and all radios within a network must use the same code.

1. Apply power to all the devices.

Separate radios by two meters when running the binding procedure. Put only one DXM Gateway into binding mode at a time to prevent binding to the wrong Gateway.

2. Enter binding mode on the DXM radio:
 - a) Use the arrow keys to select the **ISM Radio** menu on the LCD and press **ENTER**.
 - b) Highlight the **Binding** menu and press **ENTER**.
3. Assign the Node address to the Node.
 - For Nodes without rotary dials: Use the DXM arrow keys to select the Node address to assign to the DX80 Node about to enter binding mode. The DXM assigns this Node address to the next Node that enters binding mode. Only bind one Node at a time.
 - For Nodes with rotary dials: Use the Node's rotary dials to assign a valid decimal Node Address (between 01 and 47). The left rotary dial represents the tens digit (0 through 4) and the right dial represents the ones digit (0 through 9) of the Node Address. You can leave the DXM "Bind to" address set to 1 because the Node's rotary dials will override that setting.
4. Start binding mode on the DXM radio by pressing **ENTER** on the DXM radio.
5. Enter binding mode on the DX80 Node.
 - For housed radios, triple-click button 2.

- For board-level radios, triple-click the button.
 - For Nodes without buttons, refer to the Node's datasheet for instructions on entering binding mode.
- The left and right LEDs flash alternately and the Node searches for a Gateway in binding mode. After the Node binds, the LEDs stay solid momentarily, then they flash together four times. The Node automatically exits binding mode and reboots.
6. Label the Node with the assigned address number for future reference.
 7. Press **BACK** on the DXM to exit binding mode for that specific Node address.
The Node LEDs continue to flash red until the DXM exits binding mode with that Node address.
 8. Repeat these steps for as many DX80 Nodes as are needed for your network.
 9. When you are finished binding, press **BACK** on the DXM until you return to the main menu.

Bind a MultiHop Radio to a DXM and Assign the Device ID

Before beginning the binding procedure, apply power to all the devices. Separate radios by two (2) meters when running binding procedure. Put only one DXM MultiHop master radio into binding mode at a time to prevent binding the slave radios to the wrong master radio.

Binding MultiHop radios ensures all MultiHop radios within a network communicate only with other radios within the same network. The MultiHop radio master automatically generates a unique binding code when the radio master enters binding mode. This code is then transmitted to all radios within range that are also in binding mode. After a repeater/slave is bound, the repeater/slave radio accepts data only from the master to which it is bound. The binding code defines the network, and all radios within a network must use the same binding code.

1. Enter binding mode on the DXM radio:
 - a) Use the arrow keys select the **ISM Radio** menu on the LCD and press **ENTER**.
 - b) Highlight the **Binding** menu and press **ENTER**.
2. Assign the device address to the repeater or slave radios. Valid device IDs are 11 through 60.
 - For MultiHop radios without rotary dials: Use the DXM arrow keys to select the device ID to assign to the MultiHop radio about to enter binding mode. The DXM assigns this device ID to the next radio that enters binding mode. Only bind one slave radio at a time.
 - For MultiHop radios with rotary dials: Use the MultiHop radio's rotary dials to assign a device ID . The left rotary dial represents the tens digit (1 through 6) and the right dial represents the ones digit (0 through 9) of the device ID. You can leave the DXM "Bind to" address set to 1 because the MultiHop's rotary dials will override that setting.
3. Start binding mode on the DXM radio by pressing **ENTER** on the DXM radio.
4. After entering binding mode on the DXM, put the MultiHop repeater or slave radio into binding mode.
 - For housed radios, triple-click button 2.
 - For board-level radios, triple-click the button.
 - For radios without buttons, refer to the radio's datasheet for instructions on entering binding mode.

After binding is completed, the MultiHop radio automatically exits binding mode and begins operation.
5. Press **BACK** on the DXM to exit binding mode for that specific device address.
The MultiHop radio's LEDs continue to flash red until the DXM exits binding mode with that MultiHop radio.
6. Label the MultiHop radio with the assigned address number for future reference.
7. Repeat these steps, changing the device address, for as many MultiHop radios as are needed for your network.
8. When you are finished binding, press **BACK** on the DXM until you return to the main menu.
All radio devices begin to form the network after the master data radio exits binding mode.

Conduct a Site Survey from the DXM

Conduct a Site Survey to verify the wireless communication between the radios within your wireless network. Conduct the site survey when the Nodes and DXM Controller are at the proposed installation sites to determine each radio's signal strength with the DXM.

For a DX80 network, the Gateway controls the site survey and the results display on the LCD. Running a site survey on a DX80 network does not affect the throughput of the DX80 network. The DX80 Gateway-Node system can run a site survey analysis while the network is operational. For a MultiHop network, the master device passes the site survey request to the intended Modbus slave device. The Site Survey runs and the results display on the LCD. Running a site survey on a MultiHop network stops all network traffic to that device.

1. On the DXM: Use the arrow buttons to select the **ISM Radio** menu and press **ENTER**.
2. Select the **Site Survey** menu and press **ENTER**.
3. Use the Up or Down arrows to select the device ID number and press **ENTER** to run the site survey with that radio.
The site survey results display as green, yellow, red, and missed packets. Green indicates the highest signal strength, then yellow, and red. Missed packets were not received.
4. When you are finished running the Site Survey, press **Back** twice to return to the main menu and exit site survey mode.

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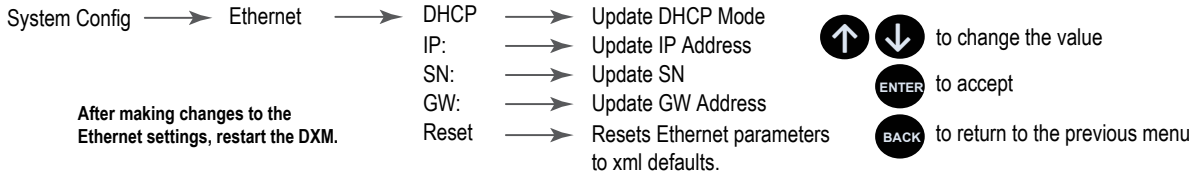
If the Site Survey fails (100 missed packets), verify the radios are at least 10 feet from the DXM and/or rerun the binding procedure. If you find poor signal quality, common solutions include moving the DXM to a more central location relative to the Nodes or using higher-gain antennas on the DXM. Contact your local Banner Engineering representative for assistance.

2.1.3 Set a Static IP Address

Change the IP address of the DXM to connect to a local area network, Modbus TCP/IP host controller, or EtherNet/IP host controller.

There are two ways to set the IP address: using the DXM's LCD menu or using the configuration software to change the XML file. IP addresses entered into the LCD menu system override the IP addresses in the XML configuration files. To use the IP addresses set in the XML configuration file, clear the IP addresses from the menu system.

Figure 3. System Config menu options



1. On the DXM, use the arrows and move to the **System Config** menu. Press **ENTER**.
2. Use the arrow keys to select the **Ethernet** menu. Press **ENTER**.
3. Highlight the **DHCP** selection and press **ENTER**. Set DHCP to OFF.
4. The system will request a restart, press **ENTER** to confirm.
5. Follow steps 1 and 2 to reenter the Ethernet menu. Use the arrow keys to select **IP**. Press **ENTER**. The IP address displays (for example, 192.168.0.1).
6. Use the up and down arrows to change the IP address. Press **ENTER** to move to the next octet.
7. Press **ENTER** on the final octet to accept the changes.
8. Cycle power to the DXM.
The changes are saved on the DXM and the new IP address will be used.

Use this same procedures to set the subnet mask (SN) and default gateway (GW) to match your network requirements. Your IT department can provide these settings if needed.

2.2 Configuration Instructions

2.2.1 Configuring the Controller

Configure the DXM using the configuration [software](#).

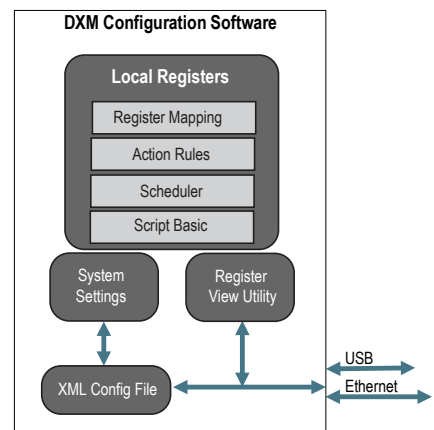
To configure the DXM, connect the DXM's USB or Ethernet port to a computer.

The DXM Configuration Software allows the user to define parameters for the DXM, then saves the configuration in an XML file on the PC.

After the configuration file is saved, upload the XML configuration file to the DXM for operation.

This quick start guide outlines the basic operations to set up a DXM using the configuration software. For a more comprehensive explanation of features, refer to the DXM Configuration Software Instruction Manual (p/n [209933](#)).

Figure 4. DXM Configuration Software



2.2.2 Introduction to Traditional Setup Mode

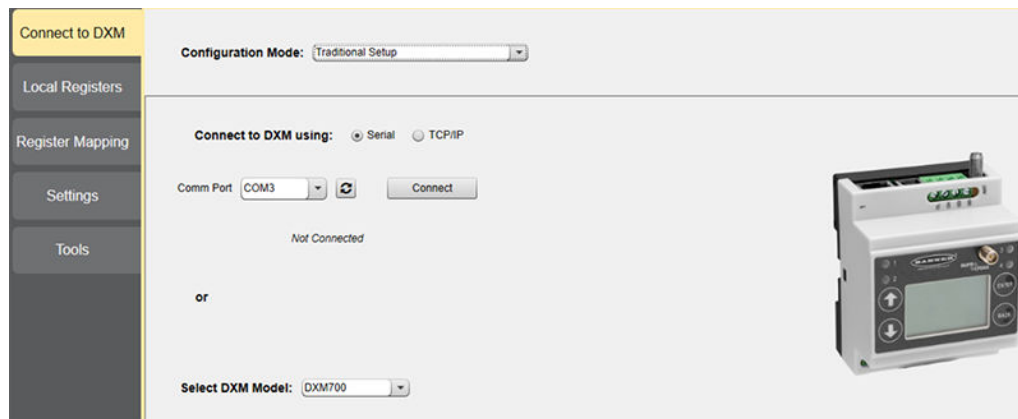
This section will walk you through the traditional method of setting up the DXM Configuration Software and communicating with a connected DXM device. Version 4 of the configuration software supports multiple DXM device models, each of which incorporates different features.

As of DXM Configuration Software v4.10.28, the Simple Setup procedure is only available with the [DXM100](#), [DXM700](#), [DXM1000](#), [DXM1200](#), and [DXM1500](#) models.

As soon as a DXM model is connected to your computer, the software automatically detects the correct model and loads the appropriate screens. You may also manually select which model of DXM you are configuring if you intend to create a configuration file without connecting a device. This ensures that the interface and the configuration file use the correct features.

Not all screens are available for all models. To change to another model of DXM, go to the **Connect to DXM** screen and use the drop-down list to select another model. If the active configuration is incompatible with the selected model, you will be prompted to either proceed and wipe out the active configuration or cancel the model change and preserve the configuration.

Figure 5. Traditional Setup opening screen



Connect via USB or Ethernet. If connecting via Ethernet, set network parameters through the DXM LCD menu in the **System Cfg > Ethernet** menu. Network parameters can also be set within the configuration software. Setting parameters on the LCD menu overrides the parameters stored in the configuration file. To use the network parameters in the configuration file, reset the network parameters on the DXM LCD menu.

Since the DXM-R90x connects only via TCP, its **Connect to DXM** screen differs from the other DXM models. When the **Select DXM Model** drop-down is set to DXM-R90x, a new network discovery table is displayed. Click **Scan Network for DXMs** to detect DXM devices on the host computer's network. Discovered DXMs are listed in the network discovery table. Double-click any row entry to connect to that DXM. If the DXM's IP address is already known, the standard TCP connection option is available below the network discovery table.

Banner recommends disconnecting the COMM port through the **Device** menu before turning off power or disconnecting the USB cable. Use **Device > Reboot** to restart the DXM if needed; the tool automatically disconnects the COMM port, then reconnect it again.



Tip: If connection attempts are failing (Application Status Icon in the footer of the tool is Red), close the configuration software and disconnect the USB cable from the computer. Reconnect the cable, launch the software, and attempt connecting again.

If you cannot connect to your DXM Controller, refer to for more information.



Important: Any model of DXM may connect to the configuration software regardless of which device model is selected in the tool. Compatibility is checked before configuration files are uploaded to the device.

Configuration Example: Reading Registers on a Modbus Slave Device

The local registers are the main global pool of registers that are defined by the user to store data within the DXM. The local registers are listed on the **Local Registers > Local Registers in Use** screen.

The bottom status bar displays the communications status, application status, and the DXM Configuration Software version. In this short example, we will configure the DXM to read six registers on an external Modbus Slave device and save the data into the local registers.

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Important: The software only loads a file to the DXM. Internal parameter settings that are changed in the tool but not saved to the file will not be sent to the device.

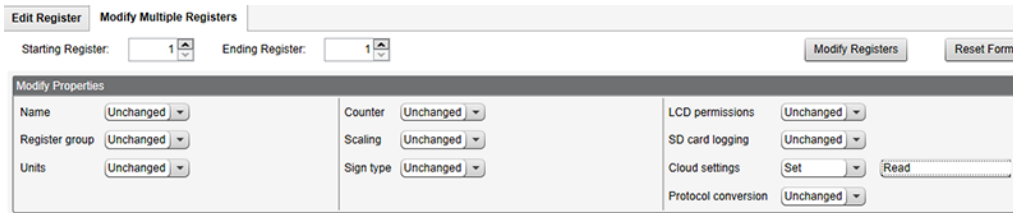
Modify Multiple Registers

Modify a range of registers from the **Local Registers > Local Registers in Use > Modify Multiple Registers** screen.

Select which parameter fields to modify. Most parameters have three selections.

- Unchanged—no changes
- Default—change to default settings
- Set—modify parameter. Other selections will appear based on the parameter.

Figure 6. Modify Multiple Registers screen



1. Enter the **Starting register** and **Ending register**.
2. Select the value to change using the drop-down list next to each value.
3. Enter the new value in the field provided.
4. To push register values to the web server, set **Cloud Permissions** to read.

If the **Cloud Permissions** are set to Read, the web server only views data from the device and cannot write data to the device. If the permissions are set to Write, the web server only writes to the device and cannot read the data. If the permissions are set to Read/Write, the web server can read the data from the device and write to the device from the web.

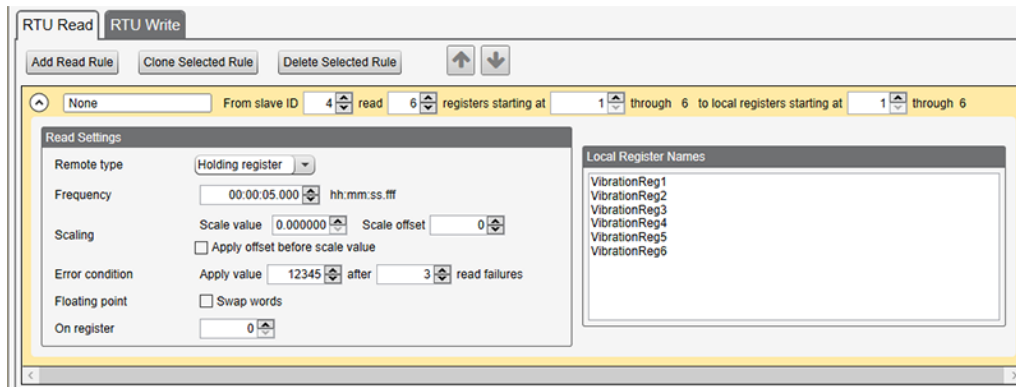
5. Click **Modify Registers** to save and apply the changes.

Define an RTU Read Rule

Follow these steps to create a new read rule.

This example screen shows a read rule created to read six registers (address 1 through 6), from Modbus Slave 4. The results are stored in the Local Registers 1 through 6.

Figure 7. Read Rules - Configuration Example

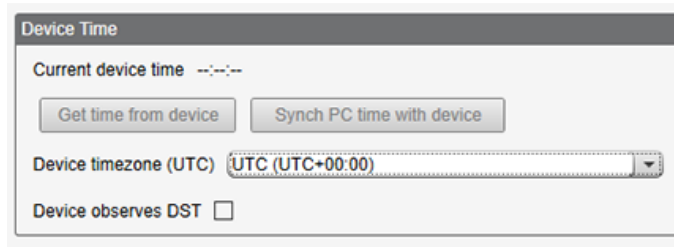


1. From the **Register Mapping > RTU > RTU Read** screen, click **Add Read Rule**.
2. Click the arrow next to the name to display the parameters.
3. Name your rule.
4. Select the slave ID.
5. Select how many registers to read, and the beginning register.
6. Define the register type, how often to read the register, and any other appropriate parameters.
7. If necessary, select the error condition. For this example, if the read function fails after three attempts, the read rule writes 12345 to the DXM local registers. Notice the list of local register names this read rule is using.

Set the Time

Use the **Settings > System** screen to define the time zone and daylight saving option. The time zone and DST options are saved into the configuration file.

Figure 8. Settings > System > Device Time



1. Go to the **Settings > System** screen.
2. If you connect the DXM to a computer, click **Synch PC Time with Device** to set the time on the DXM to match the time of the computer.
3. Set your time zone and select whether or not your device observes daylight saving time (DST).

Save and Upload the Configuration File

After making any changes to the configuration, you must save the configuration files to your computer, then upload it to the device.

Changes to the XML file are not automatically saved. Save your configuration file before exiting the tool and before sending the XML file to the device to avoid losing data. If you select **DXM > Send XML Configuration to DXM** before saving the configuration file, the software will prompt you to choose between saving the file or continuing without saving the file.

1. Save the XML configuration file to your hard drive by going to the **File > Save As** menu.
2. Go to the **DXM > Send XML Configuration to DXM** menu.

Figure 9. Status indicator bar



- If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the cable and reconnect the DXM to the software.
 - If the Application Status indicator is green, the file upload is complete.
 - If the Application Status indicator is yellow, the file transfer is in progress.
- The device reboots and begins running the new configuration.

2.3 Banner Engineering Corp. Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

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For patent information, see www.bannerengineering.com/patents.

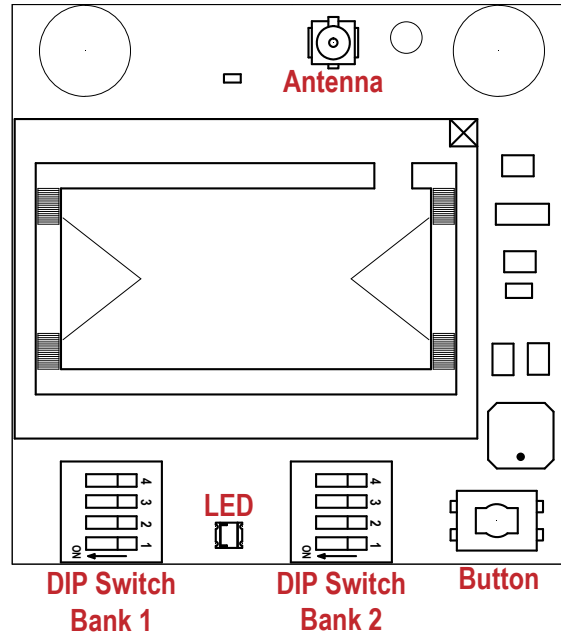
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3 ISM Radio Board (Slave ID 1)

Plug the ISM radio into the I/O base board with the U.FL antenna connector closest to the SMA connectors. Typically, users will not need to adjust the DIP switch settings on the physical radio modules.

For the DXM1200 models, set the radio options using the LCD menu.

Figure 10. ISM radio board



Button Operation

For DXM models without a LCD display, use the button to bind the ISM radio. For models with a LCD display, use the ISM menu to bind the radio.

LED Operation

The LED located on the ISM radio module indicates power and communications traffic. ISM board LED operations also display on the LED on the right side of the I/O base board.

- Solid green DX80 ISM radio LED indicates power.
- Flashing green MultiHop ISM radio LED indicates operation.
- Red and green combined: Communications traffic and binding.

3.1 MultiHop Radio DIP Switches

MultiHop ISM radio devices are defined with R2, R4, and R5 in the model number.

- DXMxxx-xxR2 - MultiHop 900 MHz
- DXMxxx-xxR4 - MultiHop 2.4 GHz
- DXMxxx-xxR5 - MultiHop 900 MHz, 100 mW
- DXMxxx-xxR9 - MultiHop 900 MHz, (Australia)

Making changes to the baud or parity settings requires that you make the same settings to the Modbus Master Communications section within the DXM Configuration Software (**Settings > General**).



Important: Disabling the serial port disables the ISM radio in the DXM. Selecting Transparent mode causes radio communications to be slower and denies access to device I/O register data.

Table 1: DIP switch settings

Device Settings	D1 Switches				D2 Switches			
	1	2	3	4	1	2	3	4
Serial line baud rate 19200 OR User defined receiver slots	OFF*	OFF*						
Serial line baud rate 38400 OR 32 receiver slots	OFF	ON						
Serial line baud rate 9600 OR 128 receiver slots	ON	OFF						
Serial line baud rate Custom OR 4 receiver slots	ON	ON						
Parity: None			OFF*	OFF*				
Parity: Even			OFF	ON				
Parity: Odd			ON	OFF				
Disable serial (low power mode) and enable the receiver slots select for switches 1-2			ON	ON				
Transmit power 900 MHz radios: 1.00 Watt (30 dBm) 2.4 GHz radios: 0.065 Watts (18 dBm) and 60 ms frame					OFF			
Transmit power 900 MHz radios: 0.25 Watts (24 dBm) 2.4 GHz radios: 0.065 Watts (18 dBm) and 40 ms frame					ON *			
Application mode: Modbus						OFF*		
Application mode: Transparent						ON		
MultiHop radio setting: Repeater							OFF	OFF
MultiHop radio setting: Master							OFF	ON
MultiHop radio setting: Slave							ON	OFF
MultiHop radio setting: DXM LCD Menu Control							ON *	ON *

* Default configuration. The default settings for D2 DIP switches 1, 3, and 4 are ON. This allows for forcing the device into Master mode and DXM menu control for the radio power settings.

3.1.1 Application Mode

The MultiHop radio operates in either Modbus mode or transparent mode. Use the internal DIP switches to select the mode of operation. All MultiHop radios within a wireless network must be in the same mode.

Modbus mode uses the Modbus protocol for routing packets. In Modbus mode, a routing table is stored in each parent device to optimize the radio traffic. This allows for point to point communication in a multiple data radio network and acknowledgement/retry of radio packets. To access a radio's I/O, the radios must be running in Modbus mode.

In **transparent** application mode, all incoming packets are stored, then broadcast to all connected data radios. The data communication is packet based and not specific to any protocol. The application layer is responsible for data integrity. For one to one data radios it is possible to enable broadcast acknowledgement of the data packets to provide better throughput. In transparent mode, there is no access to the radio's I/O.

3.1.2 Baud Rate and Parity

The baud rate (bits per second) is the data transmission rate between the device and whatever it is physically wired to. Set the parity to match the parity of the device you are wired to.

3.1.3 Disable Serial

Disable an unused local serial connection to reduce the power consumption of a data radio powered from the solar assembly or from batteries. All radio communications remain operational.

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3.1.4 Transmit Power Levels/Frame Size

The 900 MHz data radios can be operated at 1 watt (30 dBm) or 0.250 watt (24 dBm). For most models, the default transmit power is 1 watt.

For 2.4 GHz radios, the transmit power is fixed at 0.065 watt (18 dBm) and DIP switch 5 is used to set the frame timing. The default position (OFF) sets the frame timing to 60 milliseconds. To increase throughput, set the frame timing to 40 milliseconds. For battery-powered devices, increasing the throughput decreases battery life.



Important: Prior to date code 15341 and radio firmware version 3.6, the frame timing was 40 ms (OFF) or 20 ms (ON).

3.2 DIP Switch Settings for the Performance Gateway Radio Module

The 900 MHz radios transmit at 1 Watt (30 dBm) or 250 mW (24 dBm). The 250 mW mode reduces the radio's range but improves the battery life in short range applications. For 2.4 GHz models, this DIP switch is disabled. The transmit power for 2.4 GHz is fixed at about 65 mW EIRP (18 dBm).

DX80 Performance Gateway ISM radio devices are defined with R1, R3, and R8 in the model number.

- DXMxxx-xxR1 - DX80 Performance 900MHz
- DXMxxx-xxR3 - DX80 Performance 2.4GHz
- DXMxxx-xxR8 - DX80 Performance 900MHz (Australia)



Important: To adjust the transmit power on the Gateway radio, Banner recommends using the LCD menu (**System Conf > ISM Radio > RF CNTRL**).

Figure 11. DIP switch bank 1 and bank 2

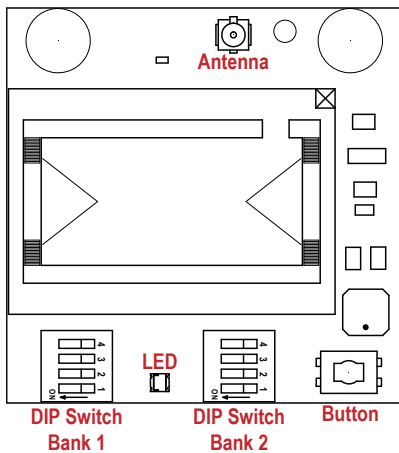


Table 2: DIP switch settings for bank 1 (D1)

DIP Switch 1	
OFF	1 Watt (30 dBm, 900 MHz models only) (default configuration)
ON	250 mW (24 dBm, 900 MHz models only), DX80 compatibility mode

4 Processor Board

4.1 Processor Board for the DXM1x0 Models

Figure 12. Processor board for the DXM

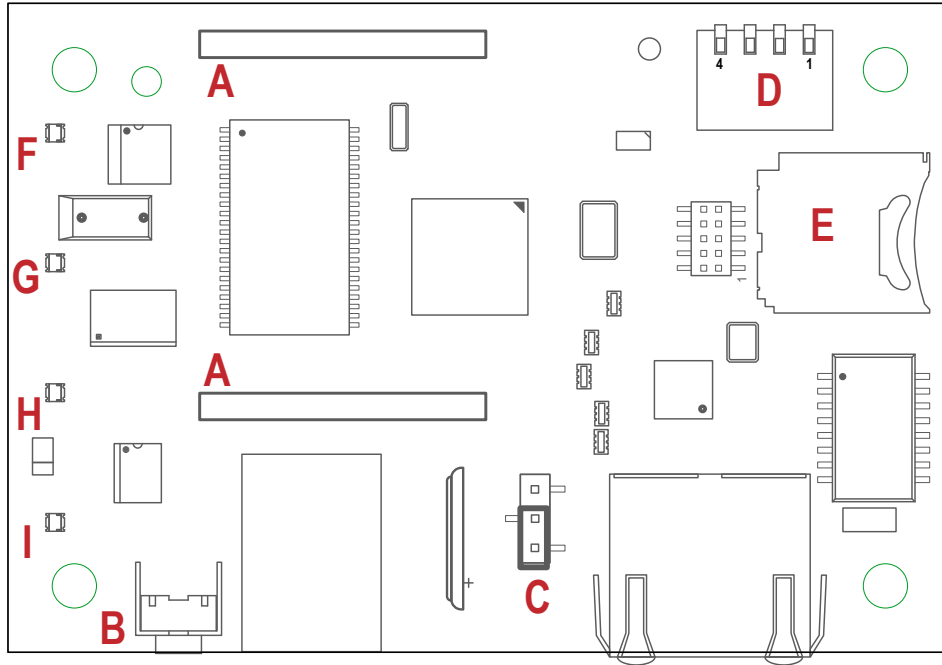
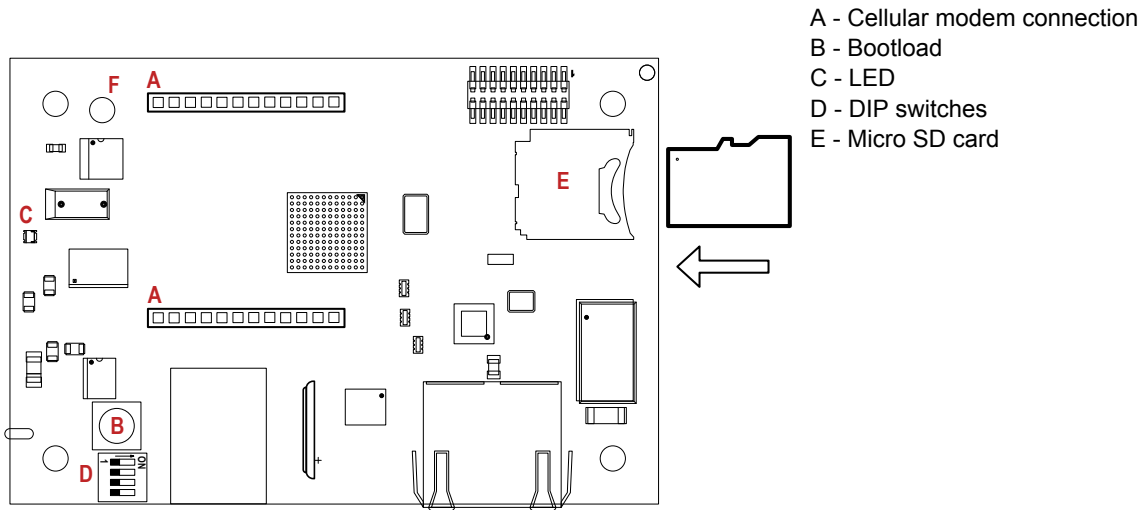


Table 3: Processor board features

Callout	Description	Function
A	Cellular modem connection	Install the cellular modem onto the processor board with the cellular modem's U.FL connector on the left. The antenna cable will go between the cellular U.FL connector and the left I/O base board U.FL connector. Always disconnect the power to the device before installing or removing a cellular modem.
B	Button	Use the processor board button to force a cloud push. To force a push to the cloud, press and hold this button for five (5) seconds to send an immediate push message from the device (if properly configured).
C	Boot load jumpers	
D	DIP switches	
E	Micro SD card	
F	LED 1	Heartbeat, indicates the processor is running
G	LED 2	Indicates the cellular modem power cutoff is active; if the incoming power is less than 11.2 V, the cellular modem is powered down
H	LED 3	XML configuration file was rejected; or file load in process; or the second phase of boot loading is in process (flashing)
I	LED 4	ScriptBasic program failed to load; or the beginning phase of boot loading is in process (flashing = in process, on = complete)

4.2 Processor Board for the DXM1x00 Models



Cellular Modem Connection—Install the cellular modem onto the processor board with the cellular modem's U.FL connector on the left. The antenna cable will go between the cellular U.FL connector and the left I/O base board U.FL connector. Always disconnect the power to the device before installing or removing a cellular modem.

Button Operation—Pressing and holding the button down during power up puts the processor into manual programming mode. Programming requires Microchip SAM-BA programming application. To force a push to the cloud, press and hold this button for five (5) seconds to send an immediate push message from the device (if properly configured)

LED Operation—The single LED indicates the processor is running.

- Flashing green—Processor is running
- Single red flash at power up time—Bootloader is present
- Toggling Red/Orange—Bootloader is examining the new file
- Toggling Red/Green—Bootloader is loading the new image

4.3 DIP Switch Settings for the Processor Board

After making changes to the DIP switch settings, cycle power to the device.

Table 4: DIP switches for the DXM processor board

Settings	DIP Switches			
	1	2	3	4
Disable Ethernet Port	OFF *			
	ON			
Disable LCD Display		OFF *		
		ON		
Not used			OFF *	
Bypass XML				OFF *
				ON

Bypass XML

Turn on to have the XML file ignored at boot time. This is useful for ignoring a corrupt or questionable XML configuration file. After the device is running, a new XML file can be loaded using the DXM configuration tool.

Turn on to stop the processor from executing defined configuration. This is useful if the loaded configuration is using all the processing time and not allowing DXM Configuration Tool operations.

The factory default position is OFF.

Disable Ethernet Port

Set to on to power down the Ethernet interface. Disabling the unused Ethernet port reduces power consumption. The factory default position is OFF.

Disable LCD Display

Set to on to disable the LCD. This DIP switch should be on when the LCD display board is not connected. The factory default position is OFF.

4.4 Ethernet

Before applying power to the DXM, verify the Ethernet cable is connected.

The number of times the processor attempts to connect to the Ethernet network is configured in the DXM Configuration Software (**Settings > Network Ethernet Connection Acquisition**). The default setting is two retries one minute after the device boots up another retry two minutes later.

The Ethernet connection supports the DXM Configuration Software, Modbus/TCP, and EtherNet/IP. ScriptBasic also has access to Ethernet for custom programming. Use the software or LCD menu system to configure the characteristics of the Ethernet connection, including the IP address. Any parameters not changeable from the menu system are configurable from the configuration software.

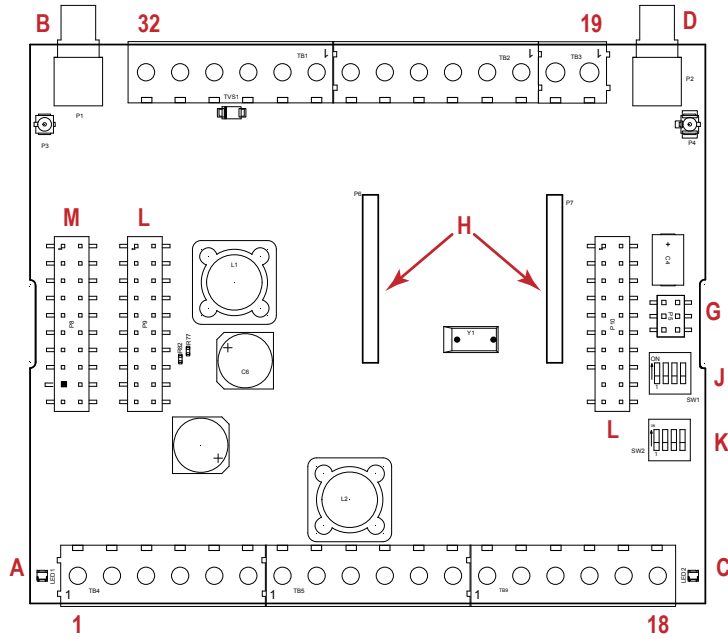
Ethernet parameter changes entered through the LCD menu override the XML configuration parameters. To return to using the network settings in the XML configuration file, remove the Ethernet parameters defined by the LCD menu using the **System Config > Ethernet > Reset** menu.

4.5 USB

The USB port is used with the DXM Configuration Software to program the DXM100/1000-Bx Wireless Controller. The USB port is also used as the console output for the processor and ScriptBasic.

Turn on debug messages to the serial console by selecting **Print push debug messages to serial console** in the DXM Configuration Software **Settings > Cloud Services** screen.

5.2 I/O Base Board for the B2 and S2 Models



1	No connection	12	2B. DLatch 2B	23	N3. NMOS OUT 3
2	PW. 12–30 V DC or solar power in (+)	13	S-. Secondary RS-485 – (not used for the S2)	24	N2. NMOS OUT 2
3	GD. Ground	14	S+. Secondary RS-485 + (not used for the S2)	25	N1. NMOS OUT 1
4	B+. Battery in (< 15 V DC)	15	SP. SDI-12 Courtesy Power	26	GD. Ground
5	GD. Ground	16	SD. SDI-12 Data	27	U4. Universal Input 4
6	M-. Primary RS-485 –	17	GD. GND	28	U3. Universal Input 3
7	M+. Primary RS-485 +	18	P3. Courtesy Power 5 V	29	GD. Ground
8	GD. Ground	19	A2. Analog OUT 2 (0–10 V)	30	P1. Adjustable Courtesy Power (5–24 V)
9	1A. DLatch 1A	20	A1. Analog OUT 1 (0–10 V)	31	U2. Universal Input 2
10	1B. DLatch 1B	21	P2. Adjustable Courtesy Power (5–24 V)	32	U1. Universal Input 1
11	2A. DLatch 2A	22	N4. NMOS OUT 4		

A	Base board LED			J	Modbus Slave ID DIP Switches
B	A1. Cellular or secondary antenna			K	Modbus Slave ID DIP Switches
C	Radio LED	G	Programming header	L	Processor Board Connection
D	A2. ISM Antenna	H	ISM Radio Board Connection	M	Display Connection

5.3 DIP Switches for the I/O Board

The DXM100/1000-Bx Wireless Controller I/O board DIP switches are set from the factory to Modbus Slave ID 200.

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5.4 Setting the Modbus Slave ID on the I/O Base Board

Only DXM100-S1 and -S1R2 Slave models require that the Modbus Slave ID to be adjusted on the I/O base board. The DXM100/1000-Bx Wireless Controller models use DIP switches J and K to set the Modbus Slave ID. This device can use a Modbus register 6804 in the I/O board to access the full range of Modbus Slave IDs.

On the DXM100/1000-Bx Wireless Controller models, use the DIP switches at location K to define the lower digit of the Modbus Slave ID.

DIP Switch location J defines the course group of Modbus Slave IDs. DIP Switch 4 must be set to ON for DXM100-S1, DXM100-S2, DXM100-S1R2, and DXM100-S2R2 models.

Settings	Location J DIP Switches			
	1	2	3	4
Modbus Slave ID set to 11 through 19	OFF	OFF		
Modbus Slave ID set to 20 through 29	ON	OFF		
Modbus Slave ID set to 30 through 39	OFF	ON		
Modbus Slave ID set to 40 through 49	ON	ON		
Not Used			-	
Modbus Slave Configuration (DX100-S1 and -S1R2 models only) ¹				ON
Standard Communication Mode				OFF

DIP Switches J		DIP Switch K, Switches 1, 2, 3, 4 (0 is OFF, 1 is ON)									
1	2	0,0,0,0	1,0,0,0	0,1,0,0	1,1,0,0	0,0,1,0	1,0,1,0	0,1,1,0	1,1,1,0	0,0,0,1	1,0,0,1
OFF	OFF	x ²	11	12	13	14	15	16	17	18	19
ON	OFF	20	21	22	23	24	25	26	27	28	29
OFF	ON	30	31	32	33	34	35	36	37	38	39
ON	ON	40	41	42	43	44	45	46	47	48	49

DXM100/1000-Bx Wireless Controller Example—To set the DXM100/1000-Bx Wireless Controller to a Modbus Slave ID of 34, set the following:

Location J DIP switches set to 1=OFF, 2=ON

Location K DIP switches set to 1=OFF, 2=OFF, 3=ON, 4=OFF

The location J DIP switches set the upper Modbus Slave ID digit to 3 while the location K DIP switches set the lower digit to 4.

Setting the DXM I/O Board Modbus Slave ID using Modbus Registers—Write to the I/O board's Modbus register 6804 to set the Modbus Slave ID to any valid Modbus Slave ID (1 through 245).

- For the DXM100/1000-Bx Wireless Controller model, all switches on DIP switch K should be in the OFF position to use the Modbus register slave ID.

5.5 I/O Board Jumpers for the B1 and S1 Models

Hardware jumpers on the DXM I/O board allow the user to select alternative pin operations. Turn the power off to the device before changing jumper positions.

Jumper	Function	Positions
E	Analog output characteristics for AO2 (pin 19) and AO1 (pin 20)	<p>Defines current (0–20 mA) or voltage (0–10 V) for analog output 1 and 2.</p> <p>By default, current (0–20 mA) is selected using jumpers 1 and 2 and registers 4008 and 4028 contain a value of 2.</p> <p>To select voltage (0–10 V) for output Aout1, set jumper 1 in the voltage position (V) and set Modbus register 4008 on the I/O board (SID 200) to 3.</p> <p>To select voltage (0–10 V) for output Aout2, set jumper 2 in the voltage position (V) and set Modbus register 4028 on the I/O board (SID 200) to 3.</p>

¹ Must be in the ON position for the -S1 and -S1R2 model)

² Uses value in Modbus register 6804.

5.6 Applying Power

Apply power to the DXM100/1000-Bx Wireless Controller using either 12 to 30 V DC or a 12 V DC solar panel and 12 V sealed lead acid battery operating together.

The DXM100 has three power input and three power output options:

- Input Power:
 - 12 to 30 V dc
 - 12 to 30 V dc solar panel
 - 12 V dc sealed lead acid battery with automatic charging
- Courtesy Output Power Supplies:
 - One 5 V dc fixed
 - Two 5 V dc or 16 V dc (DXM100-B1 models) or Two 5 V to 24 V dc (DXM100-B2 models)

The DXM continuously monitors the health of the power inputs. If a power input fault is detected, the DXM automatically switches over to battery with continuous uninterrupted operation.

If the incoming voltage drops below 11.2 V dc, the cellular modem does not turn on and will not turn on until the voltage is above 11.8 V dc. A text file (CmVMon.txt) on the internal micro SD card saves the periodic sampling of the incoming voltage. If cellular operation stops because of voltage, it is logged in this file.

Pin	Description
Pin 1	No connection
Pin 2	12 to 30 V DC input (+) or solar panel connection (+)
Pins 3, 5, 8, 17, 26, 29	Main logic ground for the DXM100/1000-Bx Wireless Controller
Pin 4	Solar or backup battery positive input. Battery voltage must be less than 15 V dc. Use only a sealed lead acid (SLA) battery.

5.6.1 Connecting a Battery

When attaching a battery to the DXM as a backup battery or as a solar battery, verify the charging algorithm is set properly. The factory default setting for the battery charging algorithm assumes you are using 12 to 30 V DC to recharge the battery.

The charging algorithm is designed to work with a sealed lead acid (SLA) battery only.

- When using 12 to 30 V DC, connect the 12 to 30 V DC + to pin 2 and connect the ground to pin 3.
- When using main dc power with a back up battery (default configuration), connect the incoming main power pin 2 (+) and to pin 3 (-). Connect the 12 V sealed lead acid battery to pin 4 (+) and pin 5 (-). The incoming main power must be 15 to 30 V dc to charge the battery.

5.6.2 Supplying Power from a Solar Panel

To power the DXM100/1000-Bx Wireless Controller from a 12 V dc solar panel, connect the solar panel to power pins 2(+) and 3(-). Connect a 12 V dc sealed lead acid (SLA) rechargeable battery to pins 4(+) and 5(-).

The factory default setting for the battery charging configuration assumes you are using 12 to 30 V DC power to recharge the battery. If the incoming power is from a solar panel, you must change the charging configuration.

The battery charging configuration defaults to a battery backup configuration. To change the charging configuration from the menu system:

1. From the DXM LCD menu, navigate to **System Config > I/O Board > Charger**.
2. Select **Solar** for solar panel configurations or **DC** for battery backup configurations.

To change the charging configuration by writing to Modbus register 6071 on the I/O base board (Slave ID 200):

1. Write a 0 to select the solar power charging configuration.

5.7 Connecting the Communication Pins

The base board communications connections to the DXM100-B1 Wireless Controller are RS-485 (primary), RS-485 (secondary) or RS-232. The base board communications connections to the DXM100-B2 Wireless Controller are RS-485 (primary) and RS-485 (secondary).

RS-485. The primary RS-485 bus is a common bus shared with the ISM radio board (Modbus Slave ID 1) or optional cellular board. The DXM100/1000-Bx Wireless Controller is defined as the Modbus Master on this bus. Other internal Modbus slaves include the local processor registers (Modbus Slave ID 199), the base I/O controller (Modbus Slave ID 200), and the display

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board (Modbus Slave ID 201). When assigning Modbus Slave IDs to externally connected devices, only use IDs 2 through 198.

RS-232. The RS-232 bus is not currently defined for the DXM100-B1 models. There is no RS-232 for the DXM100-B2 models.

Pin	Parameter	Description
Pin 6	Primary RS-485 –	Running Modbus protocol at 19.2k baud, use this bus to connect to other Modbus Slave devices. The DXM100/1000-Bx Wireless Controller is a Modbus Master device on this RS-485 port.
Pin 7	Primary RS-485 +	
Pin 9	RS-232 Tx	Serial RS-232 connection. This bus must use a ground connection between devices to operate correctly. (DXM100-B1 models only; not available on the DXM100-B2 models)
Pin 10	RS-232 Rx	
Pin 13	Secondary RS-485 –	The DXM100/1000-Bx Wireless Controller is a Modbus slave on this bus (see I/O Base Board Connections for the B1 Models on page 24).
Pin 14	Secondary RS-485 +	
Pin 15	CANL –	DXM100-B1 models only. Not available on the DXM100-B2 models.
Pin 16	CANH +	

5.8 Modbus RTU Master and Slave Ports

The DXM can be a Modbus RTU master device to other slave devices and can be a Modbus slave device to another Modbus RTU master. The DXM uses the primary RS-485 port (M+/M-) as a Modbus RTU master to control external slave devices. All wired devices connected to the master RS-485 port must be slave devices.

- As a Modbus RTU master device, the DXM controls external slaves connected to the primary RS-485 port, the local ISM radio, local I/O base board, and the local display board.
- As a Modbus RTU slave device, the DXM local registers can be read from or written to by another Modbus RTU master device.

The secondary port (S+/S-) is the Modbus RTU slave connection. The secondary (slave) Modbus RS-485 port (S+/S-) is controlled by another Modbus master device, not the DXM. The slave port is used by an external Modbus master device that will access the DXM as a Modbus slave device.

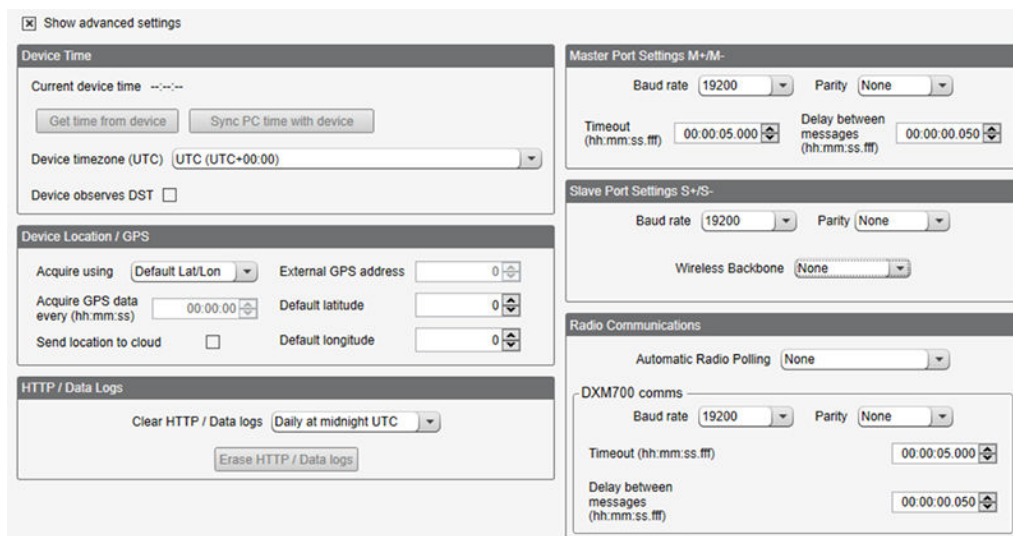
Use the configuration software to define operational settings for both the Modbus RTU master port and the Modbus RTU slave port.

Use the DXM's LCD menu to set the Modbus Slave ID for the secondary RS-485 port.

5.8.1 Set the Master and Slave Port Parameters

The basic communications parameters for the RS-485 ports are set in the DXM Configuration Software and are saved in the XML configuration file.

Figure 13. Settings > General screen



1. In the DXM Configuration Software, go to the **Settings > General** screen.
2. To set the parameters for the Modbus Master, change the settings in the **Master Port Settings M+/M-** section.
3. To set the parameters for the Modbus Slave, change the settings in the **Slave Port Settings S+/S-** section.

Baud Rate

Defined for both the Modbus master and slave

Settings include: 19200 (default), 1200, 2400, 9600, 38400, 57600, and 115200.

Delay between messages

Applies to the Modbus master port

Sets the minimum wait time from the end of a Modbus transaction to the beginning of the next Modbus transaction.

Parity

Defined for both the Modbus master and slave

Settings include: None (default), odd, even, space, and mark

Timeout

Applies to the Modbus master port

Covers the expected time for messages to be sent throughout the wireless network. For the DXM, the **Timeout** parameter is the maximum amount of time the DXM should wait after a request is sent until the response message is received from the Modbus slave device.

Wireless Modbus Backbone

Applies to the Modbus slave port

Define when there is an ISM radio plugged into the processor board. When this is done, the Modbus slave port uses the MultiHop radio as the slave port instead of the terminal block connection on the I/O base board. Settings include: None (default), Modbus, or Ethernet

5.8.2 Set the DXM Modbus Slave Port ID

Set the DXM Modbus slave port ID using the LCD menu system.

1. On the LCD, use the down arrow to highlight **System Config** and click the **Enter** button.
2. Highlight **DXM Modbus ID** and click **Enter**.
3. Use the up and down arrow buttons to change the DXM Modbus Slave Port ID.
4. Press **Enter** to accept the ID change.
5. Use the configuration software to cycle power to the device.

After cycling power to the device, the updated DXM Modbus ID is listed under the **System Config** menu.

5.9 Inputs and Outputs

The I/O base board is a Modbus slave device (Slave ID 200) that communicates to the processor board using Modbus commands. Use the DXM Configuration Software to create a configuration using read/write maps that will access inputs or outputs on the I/O board.

Communication with the I/O board runs at a maximum rate of 10 ms per transaction. The parameter setting for the bus with the I/O board and the processor board are fixed. External Modbus communication runs at a maximum rate of 50 ms per transaction. The parameter settings for the external RS-485 buses are controlled by the DXM Configuration Software.

Refer to [Modbus Register Summary](#) on page 66 for more descriptions of each Modbus register on the DXM100/1000-Bx Wireless Controller.

5.9.1 Universal Inputs

The universal inputs on the DXM100/1000-Bx Wireless Controller can be programmed to accept several different types of inputs:

- Discrete NPN/PNP
- 0 to 20 mA analog
- 0 to 10 V analog
- 10k temperature thermistor
- Potentiometer sense
- Bridge
- NPN raw fast

Any input can be used as a synchronous counter by configuring the input as a discrete NPN/PNP input.

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Use the DXM Configuration Software tool to write to the appropriate Modbus registers in the I/O board to configure the input type. The universal inputs are treated as analog inputs. When the universal inputs are defined as mA, V, or temperature, use Modbus registers to configure the operational characteristics of the inputs. These parameters are temperature conversion type, enable full scale, threshold and hysteresis. Refer to the DXM100 Controller Instruction Manual (p/n 190037) for the parameter definitions.

When a universal input is configured as an NPN or PNP input type, it can be enabled to be a synchronous counter. Enable the counter function by setting Modbus register 'Enable Rising' or 'Enable Falling' to 1. See [Modbus I/O Registers for the B1 I/O Base Board](#) on page 75 for universal input register definitions.

Pin	Universal Input	Modbus Register	Description
27	4	4	Program the universal inputs to accept input types NPN, PNP, 10k thermistor, 0 to 10 V, 0 to 20 mA, or potentiometer. The default setting is 8: NPN raw fast. To set the input type, write the following values to the Input Type Modbus registers defined in Modbus I/O Registers for the B1 I/O Base Board on page 75. 0 = NPN 1 = PNP 2 = 0 to 20 mA 3 = 0 to 10 V dc 4 = 10k Thermistor 5 = Not used 6 = Not used 7 = Bridge 8 = NPN Raw Fast (default)
28	3	3	
31	2	2	
32	1	1	

Thermistor Input

A thermistor input must use a 10k temperature thermistor between ground and the universal input. The thermistor must be a 10k NTC (Banner model number BWA-THERMISTOR-002) or equivalent. Select the temperature conversion of degrees C (default) or degrees F by writing Modbus registers defined in [Modbus I/O Registers for the B1 I/O Base Board](#) on page 75.

Potentiometer Input

A potentiometer input is created from three inputs: a voltage source (pin 30) that supplies 5 V to the potentiometer and two inputs set to voltage inputs to read the voltage across the potentiometer. See Using Universal Inputs to Read a Potentiometer (p/n [b_4462775](#)) for more information.

Bridge Input

The bridge input is not implemented yet.

NPN vs NPN Raw Fast

The difference between NPN and NPN Raw Fast is the amount of settling time given to the input. Switch the input type to NPN if the input is not detecting a transition.

Synchronous Counters

When an input is configured as a counter (inputs set to NPN/PNP), the input counts the input signal transitions. The count value is stored into two 16-bit Modbus registers for a total count of 32-bits (unsigned). To program an input to capture the edge transition counts, follow [Example: Configure Input 1 as a Synchronous Counter](#) on page 30.

Synchronous counter sample the inputs every 10 ms. The input logic does not detect rising or falling edges, but instead samples the input every 10 ms to find level changes. The input signals must be high or low for more than 10 ms or the input will not detect transitions. Because most signals are not perfect, a realistic limit for the synchronous counter would be 30 to 40 Hz.

Example: Configure Input 1 as a Synchronous Counter

1. Connect the DXM to the PC.
2. Launch the DXM Configuration Software software.
3. Connect to the DXM by selecting the **Device > Connection Settings** menu option. You may connect using either USB or Ethernet.
4. Select a COMM port from the drop-down list and click **Connect**.
5. Click on the **Register View** tab on the left part of the page.
6. Change the **Source Register** selection to **I/O Board Registers**.
7. In the **Write Registers** area, write Modbus register 4908 to 1 to enable counting on the rising edge of the input signal.
8. Read Modbus registers 4910 and 4911 to get the 32-bit value of the count.

Example: Change Universal Input 2 to a 0 to 10 V dc Input

1. Connect the DXM to the PC.
2. Launch the DXM Configuration Software software.
3. Connect to the DXM by selecting the **Device > Connection Settings** menu option. You may connect using either USB or Ethernet.
4. Select a COMM port from the drop-down list and click **Connect**.
5. Click on the **Register View** tab on the left part of the page.
6. Change the **Source Register** selection to **I/O Board Registers**.
7. Write a 3 to Modbus register 3326 on Modbus Slave ID 200 (I/O board).
8. Cycle power to the device.
9. Using the **Register View** tab, read register 3326 to verify it is set to 3.

Example: Change Analog Output 1 to a 0 to 10 V dc Output

1. Connect the DXM to the PC.
2. Launch the DXM Configuration Software software.
3. Connect to the DXM by selecting the **Device > Connection Settings** menu option. You may connect using either USB or Ethernet.
4. Select a COMM port from the drop-down list and click **Connect**.
5. Click on the **Register View** tab on the left part of the page.
6. Change the **Source Register** selection to **I/O Board Registers**.
7. Set jumper 1 on the I/O base board to the 0 to 10 V position. Refer to the base board image for the analog output jumper position.
8. Write a 3 to Modbus register 4008 on Modbus Slave ID 200 (I/O board).
9. Cycle power to the device.
10. Using the **Register View** tab, read register 4008 to verify it is set to 3.

5.9.2 NMOS Outputs for the DXM100

Table 5: NMOS output pins for the DXM100 models

Pin	NMOS Discrete Outputs	Modbus Register	Description	Wiring
22	4	504	Less than 1 A maximum current at 30 V DC ON-State Saturation: Less than 0.7 V at 20 mA ON Condition: Less than 0.7 V OFF Condition: Open	
23	3	503		
24	2	502		
35	1	501		

5.9.3 Analog (DAC) Outputs for the B1 and S1 Models

The B1 and S1 analog outputs may be configured as either 0 to 20 mA outputs (default) or 0 to 10 V outputs.

To change the analog (DAC) output type:

1. Remove power to the device.
2. Remove the DXM cover.
3. Change the hardware jumper position (see the table for the pin number and [I/O Base Board Connections for the B1 Models](#) on page 24 for the pin locations).
4. Replace the DXM cover.
5. Restore power to the DXM.
6. Set the Output Type Select Modbus register (on the I/O board, Slave ID 200) to a value of 2 (default) to select 0 to 20 mA or a value of 3 to select 0 to 10 V. For analog output 1 write to Modbus register 4008, for analog output 2 write to Modbus register 4028 (see the table for the values).

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DXM100/1000-B1 and S1 Models			
Pin	Analog Output	Modbus Register	Description
20	1	507	0 to 20 mA or 0 to 10 V dc output (I/O board jumper selectable) Accuracy: 0.1% of full scale +0.01% per °C Resolution: 12-bit
19	2	508	

5.9.4 Analog (DAC) Outputs for the B2 and S2 Models

The B2 and S2 analog outputs are 0 to 10 V dc outputs and cannot be changed.

DXM100/1000-B2 and S2 Models			
Pin	Analog Output	Modbus Register	Description
20	1	509	0 to 10 V dc output Accuracy: 0.1% of full scale +0.01% per °C Resolution: 12-bit
19	2	510	

5.9.5 DC Latching Outputs for the B2 and S2 Models

Pin	DC Latching Outputs	Modbus Register	Description	Wiring
9	D1A	507	Write a 1 to the output register to activate the DC Latching output from A to B.	
10	D1B			
11	D2A	508	Write a 0 to the output register to deactivate the DC Latching output from B to A.	
12	D2B			

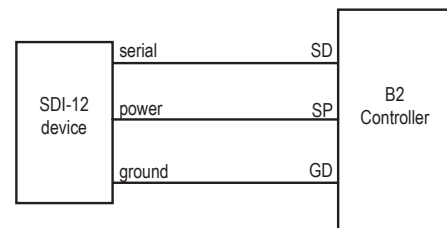
The DXM Configuration Software allows the user to adjust parameters that govern the operation of the DC latch outputs. Most applications will not require any changes for correct operation. Software parameters include:

- **Enable H-Bridge**—Enable or disable the H-bridge output. Default Enabled.
- **Voltage**—The voltage applied to the output when the output is activated. Default 13 V dc.
- **Cap Warmup Time**—The amount of time given to charge the output capacitor. The more time given to charge the output capacitor the more energy will be available to turn on the output. Default 80 ms
- **Switch Time**—The amount of time the output is turned on to be able to change the solenoid output. Default 40 ms

5.9.6 SDI-12 Interface for the B2 and S2 Models

The SDI-12 interface on the B2 Wireless Controllers can support up to five devices with twelve 32-bit register values each. The SDI-12 interface can be configured to increase the number of registers per device address for devices with large register sets. The factory default enables one SDI-12 device using device address 1 with up to nine registers with a SDI-12 command of "M!".

Use the configuration software to adjust the SDI-12 parameters.



Basic SDI-12 Interface Parameters

Up to five devices/commands can be accessed using the SDI-12 interface. There are three parameters for each device/command: Enable, Device Address, Device Command. For more information, refer to the SDI-12 Technical Notes.

Enable. Instructs the DXM device to activate or deactivate the SDI-12 device. Write a 1 to enable, and write a 0 to disable. The factory default for device 1 is enabled; devices 2 through 5 are disabled.

Device Address. Each SDI-12 device must have a unique device address. This parameter is the ASCII code for the device address. Valid device addresses are 0–9 and a–z that map to ASCII codes 48–57 and 97–122, respectively. The factory default addresses are:

- SDI-12 Device 0 uses ASCII code 48
- SDI-12 Device 1 uses ASCII code 49

- SDI-12 Device 2 uses ASCII code 50
- SDI-12 Device 3 uses ASCII code 51
- SDI-12 Device 4 uses ASCII code 52

Device Command The SDI-12 interface supports "M!" or "C!" commands. Use the Device Command parameter to define which command to use for this device. The factory default is "M!" commands for all devices (value of 10 in the Modbus register).

Supported M! Commands		Supported C! Commands	
SDI-12 Command	Register Value	SDI-12 Command	Register Value
xM!	0 or 10	xC!	1 or 20
xM1!	11	xC1!	21
xM2!	12	xC2!	22
xM3!	13	xC3!	23
xM4!	14	xC4!	24
xM5!	15	xC5!	25
xM6!	16	xC6!	26
xM7!	17	xC7!	27
xM8!	18	xC8!	28
xM9!	19	xC9!	29

The Modbus configuration registers are listed. All registers are defined as Modbus holding registers. The factory default values are shown in parentheses. All values are in decimal, unless noted otherwise.

Device/CMD Configuration	Registers (Default Value)		
	Enable	Device Address	Device Command
SDI-12 Device/CMD 1	1751 (1)	11001 (48) ³	11002 (10)
SDI-12 Device/CMD 2	1701 (0)	11201 (49)	11202 (10)
SDI-12 Device/CMD 3	1651 (0)	11401 (50)	11402 (10)
SDI-12 Device/CMD 4	1601 (0)	11601 (51)	11602 (10)
SDI-12 Device/CMD 5	1551 (0)	11801 (52)	11802 (10)

SDI-12 Device Result Registers

The result registers store all information received from the SDI-12 devices.

The registers are 16-bit registers and require two registers to store a 32-bit value. The factory default configuration defines the result registers as 32-bit registers, floating point format, and the first nine result registers are enabled for use. A host system reads the SDI-12 device data from these registers.

Result Registers	Register 1	Register 2	Register 3	Register 4	Register 5	Register 6
SDI-12 Device/CMD 1 Result Upper	11101	11103	11105	11107	11109	11111
SDI-12 Device/CMD 1 Result Lower	11102	11104	11106	11108	11110	11112
SDI-12 Device/CMD 2 Result Upper	11301	11303	11305	11307	11309	11311
SDI-12 Device/CMD 2 Result Lower	11302	11304	11306	11308	11310	11312
SDI-12 Device/CMD 3 Result Upper	11501	11503	11505	11507	11509	11511
SDI-12 Device/CMD 3 Result Lower	11502	11504	11506	11508	11510	11512
SDI-12 Device/CMD 4 Result Upper	11701	11703	11705	11707	11709	11711
SDI-12 Device/CMD 4 Result Lower	11702	11704	11706	11708	11710	11712

³ The default device addresses 48 through 52 are in ASCII.

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Result Registers	Register 1	Register 2	Register 3	Register 4	Register 5	Register 6
SDI-12 Device/CMD 5 Result Upper	11901	11903	11905	11907	11909	11911
SDI-12 Device/CMD 5 Result Lower	11902	11904	11906	11908	11910	11912

Result Registers	Register 7	Register 8	Register 9	Register 10	Register 11	Register 12
SDI-12 Device/CMD 1 Result Upper	11113	11115	11117	11119	11121	11123
SDI-12 Device/CMD 1 Result Lower	11114	11116	11118	11120	11122	11124
SDI-12 Device/CMD 2 Result Upper	11313	11315	11317	11319	11321	11323
SDI-12 Device/CMD 2 Result Lower	11314	11316	11318	11320	11322	11324
SDI-12 Device/CMD 3 Result Upper	11513	11515	11517	11519	11521	11523
SDI-12 Device/CMD 3 Result Lower	11514	11516	11518	11520	11522	11524
SDI-12 Device/CMD 4 Result Upper	11713	11715	11717	11719	11721	11723
SDI-12 Device/CMD 4 Result Lower	11714	11716	11718	11720	11722	11724
SDI-12 Device/CMD 5 Result Upper	11913	11915	11917	11919	11921	11923
SDI-12 Device/CMD 5 Result Lower	11914	11916	11918	11920	11922	11924

SDI-12 Device Settings

The following are generic sampling, power and warmup parameters that should work for all SDI-12 devices. See the tested device table below. In most cases, parameters will not need to be adjusted but if needed there are three common SDI-12 device parameters that control the communications and power of the SDI-12 device. Contact Banner Engineering Corp support for more guidance.

- **Sample Rate.** Formed using two 16-bit parameters, a HI word and a LOW word. The sample rate is how often the SDI-12 device is powered up, then interrogated for data. The value in the registers is the number of 0.010 second counts. For example, the default value is 22,500, which calculates to a sample rate of 22500 × 0.010 seconds. Adjusting this value affects the battery life.
- **Warmup time.** Amount of time to wait, in 0.010 second increments, from powering on the device to the time to send communications to the device. The default value is 50, or 50 × 0.010 seconds. Adjusting this value affects the battery life.
- **Voltage.** The default voltage setting is 6 volts or a register value of 168. Adjusting this value affects the battery life.

Device / Cmd Configuration	Registers (Default Value)							
	Enable	Device Address	Switch Power Enable	Device Command	Sample Hi	Sample Low	Warmup Time	Voltage
SDI-12 Device/CMD 1	1751 (1)	11001 (48) ⁴	1754 (1)	11002 (10)	1752 (0)	1753 (22500)	1755 (50)	1756 (148)
SDI-12 Device/CMD 2	1701 (0)	11201 (49)	1704 (0)	11202 (10)	1702 (0)	1703 (22500)	1705 (50)	1706 (148)
SDI-12 Device/CMD 3	1651 (0)	11401 (50)	1654 (0)	11402 (10)	1652 (0)	1653 (22500)	1655 (50)	1656 (148)
SDI-12 Device/CMD 4	1601 (0)	11601 (51)	1604 (0)	11602 (10)	1602 (0)	1603 (22500)	1605 (50)	1606 (148)
SDI-12 Device/CMD 5	1551 (0)	11801 (52)	1554 (0)	11802 (10)	1552 (0)	1553 (22500)	1555 (50)	1556 (148)

These SDI-12 probes have been tested and are functional with the factory default settings.

MFG	Models	Technical Note
Acclima	SEN-SDI (TDT SDI-12 Soil Moisture Sensor)	SDI-12 and the Acclima TDT SDI-12 Soil Moisture Probe
Adcon Telemetry	HydraProbell	

⁴ The default device addresses 48 through 52 are in ASCII.

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MFG	Models	Technical Note
AquaCheck	Sub-surface Probe	SDI-12 and the AquaCheck Sub-Surface Soil Moisture Probe
Decagon	MPS-2, MPS-6, 5TE, TS1, T8	SDI-12 and the Decagon 5TE Soil Moisture Probe SDI-12 and the Decagon GS3 Soil Moisture Probe SDI-12 and the Decagon MPS-2 Soil Moisture Probe
HSTI	HydraScout	SDI-12 and the HydraScout HSTI Probe
Sentek	EnviroSCAN	SDI-12 and the Sentek EnviroScan Soil Moisture Probe

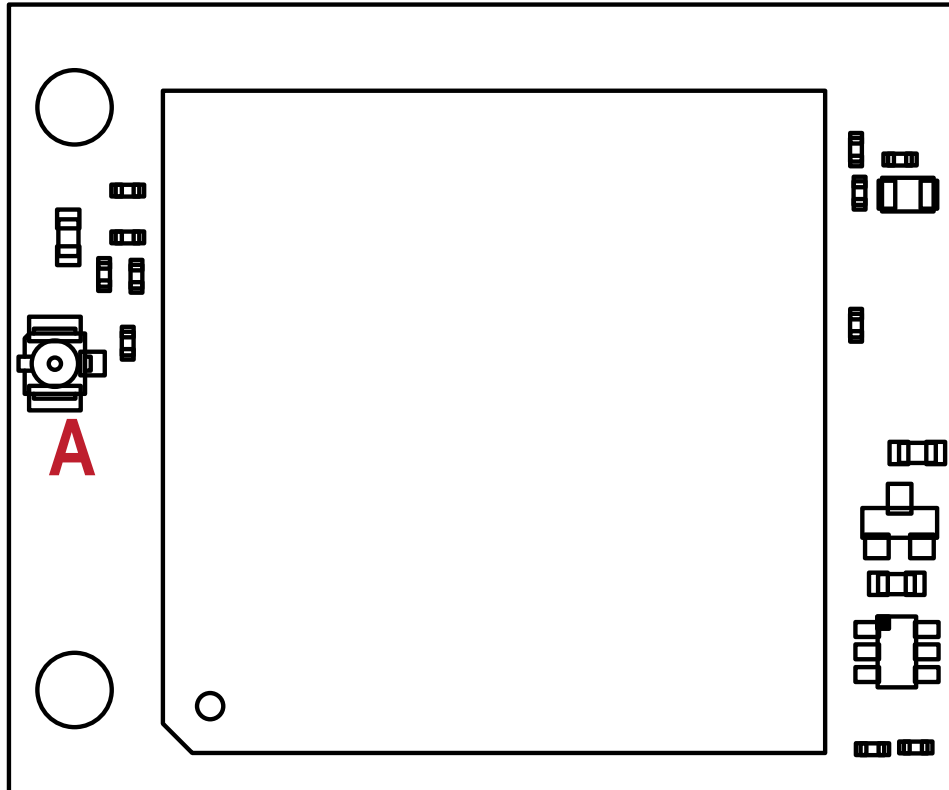
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6 Cellular Modem Boards

6.1 Cellular Modem Board

The LTE (United States) or GSM (outside the United States) cellular modem is an optional accessory that is installed on the processor board on the two 12-pin sockets.

Figure 14. Cellular modem board



A - U.FL antenna connection

The U.FL connector should be to the left, with the antenna cable going to the left antenna U.FL connector. The SIM card slides into the socket on the back of this board.

6.2 Cellular Power Requirements

If the incoming voltage drops below 11.2 V dc, the cellular modem does not turn on and will not turn on until the voltage is above 11.8 V dc. A text file (CmVMon.txt) on the internal micro SD card saves the periodic sampling of the incoming voltage. If cellular operation stops because of voltage, it is logged in this file.

6.3 Using the DXM Cellular Modem

The DXM cellular modem provides a remote network connectivity solution for the DXM.

To use the cellular modem:

1. Verify the cellular modem is installed and the correct antenna is connected to the cellular antenna port.
2. Activate the cellular service.
3. Configure the DXM to use the cellular network as the network interface.

6.4 Activating a Cellular Modem

Follow these basic steps to activate the cellular capabilities of your DXM Controller.

1. Purchase a cellular modem kit from Banner Engineering Corp.
2. Activate a cellular plan to the SIM card, then insert the SIM card into the cellular modem.
3. Install the cellular modem, connect the antenna cable, and connect the cellular antenna.
4. Configure the DXM to use the cellular modem.

Table 6: Cellular modem kit models

Cellular Kit Model	Kit Description
SXI-LTE-001	Verizon LTE cellular modem using Telit LE910 modem kit (Verizon part number SENSX002). Includes a cellular modem, SIM card, antenna, and antenna cable. The SIM card is specific to the LTE technology and cannot be used in other cellular modems. Requires a LTE Verizon cellular wireless plan attached to the ICCID (SIM card) number and IMEI (International Mobile Equipment Identity) number. Cellular plans can be purchased through secure.bannercelldata.com .
SXI-CATM1VZW-001	Verizon CAT M1 cellular modem using Telit ME910 modem kit (Verizon part number SXIM1V). Includes a cellular modem, SIM card, and internal adhesive antenna. The SIM card is specific to the CATM1 technology and cannot be used in other cellular modems. Requires a LTE Verizon cellular wireless plan attached to the ICCID (SIM card) number and IMEI (International Mobile Equipment Identity) number. Cellular plans can be purchased through secure.bannercelldata.com .
SXI-CATM1ATT-001	ATT CAT M1 cellular modem using Telit ME910 model kit. (ATT part number SXIM1A). Includes a cellular modem, SIM card, and internal adhesive antenna. The SIM card is specific to the CATM1 technology and cannot be used in other cellular modems. Requires a LTE AT&T cellular wireless plan attached to the ICCID (SIM card) number and IMEI (International Mobile Equipment Identity) number. Cellular plans can be purchased through secure.bannercelldata.com .

For additional information, refer to the Banner Cloud Data Services support center (support.bannercds.com). The support center includes video tutorials, product documentation, technical notes, and links to download configuration software.



Important: Only the DXM100 and DXM150 models offer SMS/text messaging capabilities directly from the device. SMS/text messaging can be delivered using the BannerCDS web service from any DXM model.

6.4.1 Install the Cellular Modem (DXM100, 150, 700, and 1000 Models)

Follow these steps to install the cellular modem and antenna cable.



Important:

- **Electrostatic discharge (ESD) sensitive device**
- ESD can damage the device. Damage from inappropriate handling is not covered by warranty.
- Use proper handling procedures to prevent ESD damage. Proper handling procedures include leaving devices in their anti-static packaging until ready for use; wearing anti-static wrist straps; and assembling units on a grounded, static-dissipative surface.

Before you activate your cellular plan, verify you have one of the following cellular modem kits.

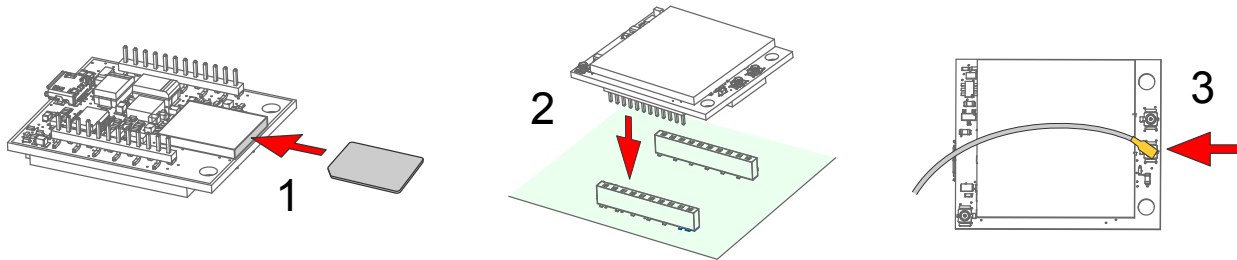
Table 7: Cellular modem kit models

Cellular Kit Model	Kit Description
SXI-LTE-001	Verizon LTE cellular modem using Telit LE910 modem kit (Verizon part number SENSX002). Includes a cellular modem, SIM card, antenna, and antenna cable. The SIM card is specific to the LTE technology and cannot be used in other cellular modems. Requires a LTE Verizon cellular wireless plan attached to the ICCID (SIM card) number and IMEI (International Mobile Equipment Identity) number. Cellular plans can be purchased through secure.bannercelldata.com .
SXI-CATM1VZW-001	Verizon CAT M1 cellular modem using Telit ME910 modem kit (Verizon part number SXIM1V). Includes a cellular modem, SIM card, and internal adhesive antenna. The SIM card is specific to the CATM1 technology and cannot be used in other cellular modems. Requires a LTE Verizon cellular wireless plan attached to the ICCID (SIM card) number and IMEI (International Mobile Equipment Identity) number. Cellular plans can be purchased through secure.bannercelldata.com .

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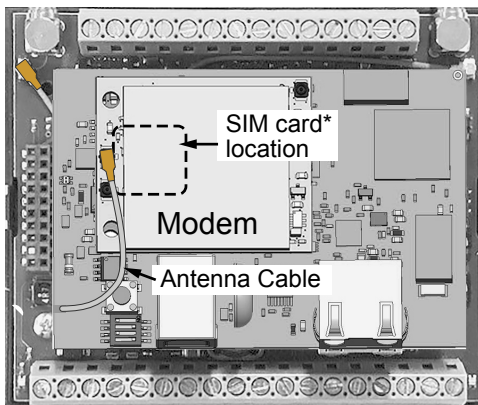
Cellular Kit Model	Kit Description
SXI-CATM1ATT-001	ATT CAT M1 cellular modem using Telit ME910 model kit. (ATT part number SXIM1A). Includes a cellular modem, SIM card, and internal adhesive antenna. The SIM card is specific to the CATM1 technology and cannot be used in other cellular modems. Requires a LTE AT&T cellular wireless plan attached to the ICCID (SIM card) number and IMEI (International Mobile Equipment Identity) number. Cellular plans can be purchased through secure.bannercelldata.com .

Figure 15. Installing the cellular modem



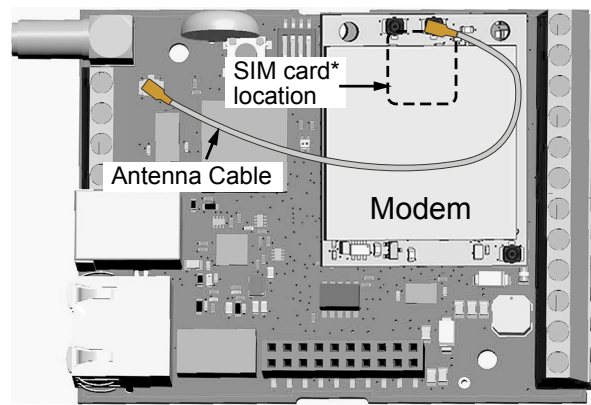
1. Insert the SIM card into the socket on the underside of the cellular modem. SIM cards come in a credit card sized carrier. Snap it out and insert the SIM card into the holder on the cellular modem.
Make note of the IMEI number of the cellular modem and the ICCID number of the SIM card. The numbers can be found on the cellular modem and the SIM card or SIM card carrier. You will need the SIM number to associate a wireless plan to this SIM card.
2. Orient the cellular modem according to the pin layout and verify the pins are properly aligned. Firmly press the modem into the 24-pin socket.
 - For the DXM100, DXM150, and DXM1000 models—Install the cellular modem board onto the processor board as shown. Use the diagram below to verify the orientation is correct.
 - For the DXM700 models—Install the cellular modem board onto the base board as shown. Use the diagram below to verify the orientation is correct.
3. Attach the antenna cable between the cellular modem board to the base board as shown.
4. Install the external cellular antenna on the DXM's SMA connector located next to the antenna cable.

Figure 16. DXM100, 150, and 1000



*SIM card is located on the underside of installed modem

Figure 17. DXM700



*SIM card is located on the underside of installed modem

6.4.2 Install the Cellular Modem (DXM1200 Models)

Follow these steps to install the cellular modem and antenna cable.



Important:

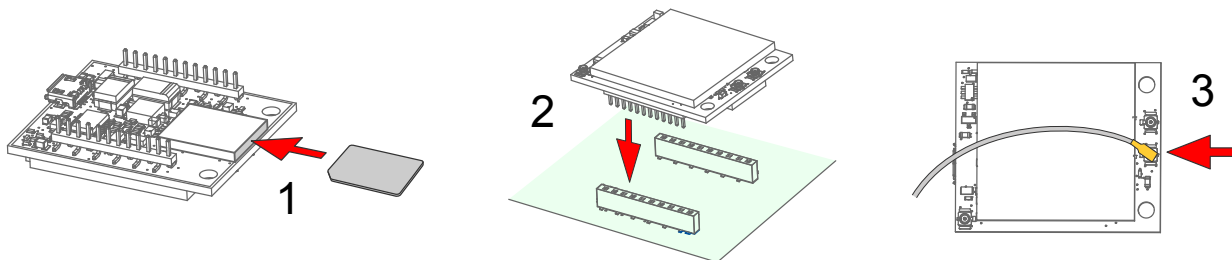
- **Electrostatic discharge (ESD) sensitive device**
- ESD can damage the device. Damage from inappropriate handling is not covered by warranty.
- Use proper handling procedures to prevent ESD damage. Proper handling procedures include leaving devices in their anti-static packaging until ready for use; wearing anti-static wrist straps; and assembling units on a grounded, static-dissipative surface.

Before you activate your cellular plan, verify you have one of the following cellular modem kits.

Table 8: Cellular modem kit models

Cellular Kit Model	Kit Description
SXI-LTE-001	Verizon LTE cellular modem using Telit LE910 modem kit (Verizon part number SENSX002). Includes a cellular modem, SIM card, antenna, and antenna cable. The SIM card is specific to the LTE technology and cannot be used in other cellular modems. Requires a LTE Verizon cellular wireless plan attached to the ICCID (SIM card) number and IMEI (International Mobile Equipment Identity) number. Cellular plans can be purchased through secure.bannercelldata.com .
SXI-CATM1VZW-001	Verizon CAT M1 cellular modem using Telit ME910 modem kit (Verizon part number SXIM1V). Includes a cellular modem, SIM card, and internal adhesive antenna. The SIM card is specific to the CATM1 technology and cannot be used in other cellular modems. Requires a LTE Verizon cellular wireless plan attached to the ICCID (SIM card) number and IMEI (International Mobile Equipment Identity) number. Cellular plans can be purchased through secure.bannercelldata.com .
SXI-CATM1ATT-001	ATT CAT M1 cellular modem using Telit ME910 model kit (ATT part number SXIM1A). Includes a cellular modem, SIM card, and internal adhesive antenna. The SIM card is specific to the CATM1 technology and cannot be used in other cellular modems. Requires a LTE AT&T cellular wireless plan attached to the ICCID (SIM card) number and IMEI (International Mobile Equipment Identity) number. Cellular plans can be purchased through secure.bannercelldata.com .

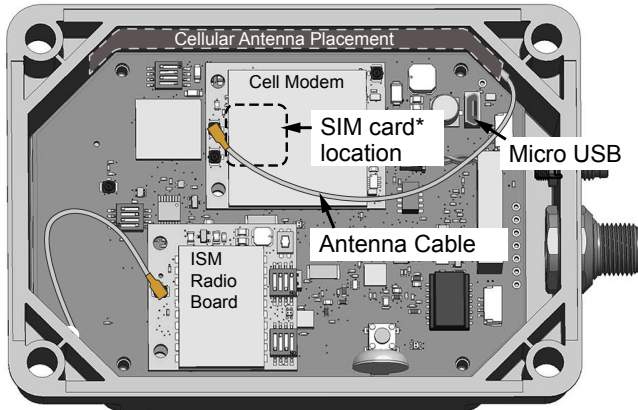
Figure 18. Installing the cellular modem



1. Insert the SIM card into the socket on the underside of the cellular modem. SIM cards come in a credit card sized carrier. Snap it out and insert the SIM card into the holder on the cellular modem.
Make note of the IMEI number of the cellular modem and the ICCID number of the SIM card. The numbers can be found on the cellular modem and the SIM card or SIM card carrier. You will need the SIM number to associate a wireless plan to this SIM card.
2. Apply the internal antenna as shown paying attention to the antenna cable position.
 - a) Pull back the adhesive protective paper from the middle of the antenna, only exposing the middle portion. Antenna application is easier if just a small middle portion of the adhesive is uncovered.
 - b) Center the antenna on the side wall. Use the exposed adhesive in the middle of the antenna to hold the antenna in place while aligning the antenna to the full length of the housing.
 - c) Slowly peel off the paper backing exposing the adhesive and stick to the plastic housing. The antenna should run below the rim of the housing.
 - d) Press firmly.
3. Orient the cellular modem according to the diagram below and verify the pins are properly aligned. Firmly press the modem into the 24-pin socket on the board.
The cellular modem is inserted into the main board with the antenna cable from the applied internal antenna attached to the cellular modem PCB.
4. Attach the antenna cable between the cellular modem board to the base board. The antenna cable uses the top antenna connection.

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Figure 19. Internal view of a DXM1200



*SIM card is located on the underside of installed modem

6.4.3 Activate a 4G LTE or CAT M1 Cellular Plan

Activate a cellular plan for your DXM using the Banner Cloud Data Services website.

1. Go to secure.bannercelldata.com to purchase cellular data plans.
2. If you have previously created an account, click **Login** and enter your username and password to continue.
3. If you are creating a login for the first time:
 - a) Select the region in which the device will operate.
 - b) Select the cellular subscription plan. Please use the calculator and regional coverage information to determine the plan needed for your device (<https://support.bannercds.com/home/pricing/how-to-choose-a-cellular-service-plan>).
 - c) Create a username and password (use an email address for the username).
 - d) Enter your payment information, mailing address, agree to the terms and conditions.
4. Go to the **My Services and Equipment** section.
5. Enter the SIM Number (ICCID) and the Module Number (IMEI).

The **ICCID** is the 20-digit number of the SIM, the bottom barcode number on the SIM card carrier. If the carrier card is not available, the ICCID is also printed on the SIM card, but must be removed from its socket to be read. The **IMEI** is the 15-digit number on top of the 4G LTE device.
6. Click **Activate**.



Note: Although new activations are typically functional in 20 minutes or less, it may take up to 24 hours for the cellular plan to become active on the wireless network.

6.4.4 Configure the DXM Controller for a Cellular Modem

Use the DXM Configuration Software to create a configuration using a cellular connection.



Important: Only the DXM100 and DXM150 models offer SMS/text messaging capabilities directly from the device. SMS/text messaging can be delivered using the BannerCDS web service from any DXM model.

1. Go to the **Settings > Cloud Services** screen.
2. Set the **Push Interface** to **Cell**
All push data, SMS messages, or email alerts will be sent using the cellular modem.
3. Go to the **Settings > Cellular** screen. Under the **Cell Configuration** section, select the **Cell module** from the drop-down list.
 - **For North America**—For Verizon LTE/CATM modems, select **VZW LTE/CATM** and set the **APN** to **vzwinternet**. For ATT LTE/CATM modems, select **ATT LTE/CATM** and set the **APN** to **iot0119.com.attz**. Requires a SIM module to be purchased from a wireless carrier based on the IMEI number of the cellular modem. The wireless carrier will provide the APN parameters. Not all parameters may be required.
4. To send data to the webserver, complete the parameters on the **Settings > Cloud Services** screen. Set the **Cloud push interval** and the **Web Server** settings. (For more information, refer to the DXM Configuration Software Instruction Manual (p/n 201127).

When the DXM is configured to use the cellular modem, the information on the cellular modem is found on the LCD menu under **System Info > Cell**. The menu does not display values until a transaction with the wireless cell tower is complete.

If there are no webserver parameters defined, the user must force a push to retrieve the data from the cellular network. On the LCD menu, select **Push > Trigger Data Push**.

Obtaining LTE service outside of the Banner Cellular Data Plans—Customers have the option of securing a data plan for the Verizon network themselves without using the Banner cellular data portal (secure.bannercelldata.com). Suitable plans would include those available from Verizon directly or from a Mobile Virtual Network Operator (MVNO) licensed to resell Verizon network data plans. (The SXI-LTE-001 will not function on AT&T, T-Mobile, or Sprint networks.) When purchasing a data plan, it is important to refer to the modem by its official Verizon network name (for example, SENSX002) and give the IMEI number (found on the cellular modem) to the plan provider. To use the SIM card that comes with the cellular modem kit, give the SIM card number to the provider. The required SIM card form factor is 3FF - Micro.

6.5 Accessing the DXM Using SMS

The DXM with a cellular modem can be remotely accessed using SMS messages. Simple text messages can:

- Force a push to the cloud
- Reboot the controller
- Read/write local registers

The incoming firewall provides security; only defined phone numbers are permitted to access the controller. Use the DXM Configuration Software to configure the SMS commanding feature. This feature requires firmware version 2.01 or later.

SMS command messages sent from approved phone numbers to the DXM cause the DXM to respond. See the examples below for SMS responses. Responses may take 20 seconds or more, depending upon the network.

A DXM requires a few minutes after powering up before it can accept SMS messages. Initial cellular connection times vary based on the wireless network. A SMS message sent to the controller while a push session is active delays any response or the SMS message may be dropped based on the length of the push session.

Configuring the DXM for SMS Controlling— Configure the DXM for SMS messaging capability using the DXM Configuration Software.

1. On the **Settings > Cloud Services** screen, set the network interface to Cell.
2. On the **Settings > Network** screen, enter the phone numbers that are allowed access to the DXM.
3. Save the configuration file (**File > Save**).
4. Load the XML file to the DXM.
5. After the device has been running for a few minutes, the cellular network should be operational. The phone number (MDN) is visible on the DXM LCD menu (**System Info > Cell**).
6. Send a text message to the DXM from an approved phone number.

HTTP Push

Push triggers a http push to a webserver. The DXM accepts the message, executes the action, and sends an acknowledgment text message back to the user.

Example: Texting `push` forces defined local registers to be sent to a webserver

```
push <send>
```

DXM acknowledgment text message: `Register push requested`

Reboot

Reboot triggers the DXM to reboot. The processor reloads the XML configuration file and zeroes all local register data. This does not affect the other components of the DXM (ISM radio, I/O board, cellular modem). The DXM accepts the message, executes the action, and sends an acknowledgment text message back to the user.

Example: Texting `reboot` forces the processor to reboot.

```
reboot <send>
```

DXM acknowledgment text message: `rebooting...`

Get Register

grN gets register number N (DXM Local Register) and sends a text with the value back to the user. The response text message shows the value in floating point format regardless of register number.

Example: Text `gr1` to retrieve the value for register 1.

```
gr1 <send>
```

DXM acknowledgment text message: `Register 1 is 0`

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Set Register

srN,X sets a register value, where N is the register number and X is the value. The DXM responds with a SMS message indicating the register was set.

Example: Texting `sr1,10` sets register 1 to value of 10

`sr1,10 <send>`

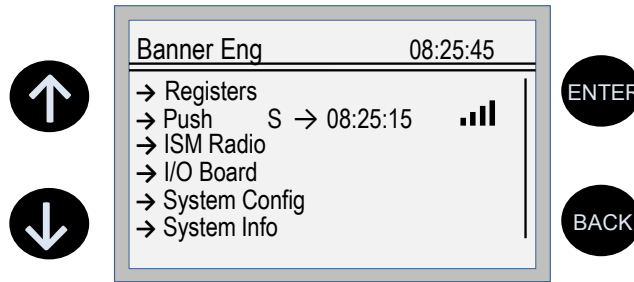
DXM acknowledgment text message: `Register 1 has been set to 10`

Additional information may be available in the DXM Controller API Protocol instruction manual, p/n [186221](#).

7 LCD and Menu System

The LCD has four user-defined LED indicators, four control buttons, and an LCD. The four buttons control the menu system on the LCD menu.

Figure 20. Top-level menu



The top-level menu always displays the time in a 24-hour format.

- The up and down arrows scroll through display items.
- The **ENTER** button selects the highlighted items on the display
- The **BACK** button returns to a previous menu option.

The left display column shows an arrow at the beginning of the line if the menu has submenus. The right column shows a vertical line with an arrow at the bottom if the user can scroll down to see more menu items.

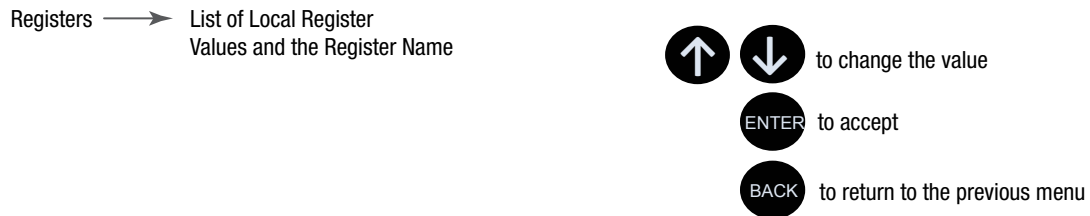
The DXM can be configured to require a passcode be entered before the LCD and Menu system will operate. The passcode configuration is defined in the DXM Configuration Software.

7.1 Registers

The **Registers** submenu displays the processor's local registers that can be configured using the DXM Configuration Software.

To configure these local registers, launch the DXM Configuration Software. Go to **Local Registers** and expand the view for a local register by clicking on the down arrow next to the register number. In the LCD Permissions field, select None, Read, Write, or Read/Write.

Figure 21. Registers menu



Read allows the register to be displayed, and Write or Read/Write allows the register value to be changed using the LCD. The Units and Scaling parameters are optional and affect the LCD.

7.2 Push

The **Push** menu displays information about the last data sent to the Webserver.

Figure 22. Push menu



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The user can force an immediate push to the webserver using Trigger Push. If a current push is in process it may take several minutes to complete over cellular.

- The **Trigger Push** submenu forces an immediate push to the web server.
- The status and time fields indicate success or failure of the last attempted push and time of the last attempted push.

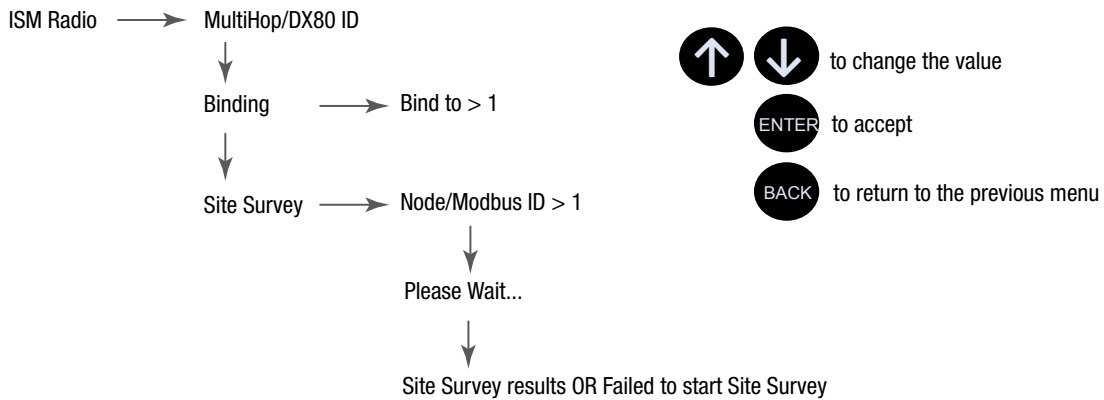
7.3 ISM Radio

The **ISM Radio** menu allows the user to view the Modbus ID of the internal ISM radio, enter binding mode, or run a site survey. This top-level **ISM Radio** menu is different from the **System Config > ISM Radio** submenu.

The first option under the **ISM Radio** menu only displays the type of radio in the DXM (MultiHop or DX80 Star) and the Modbus ID of the radio. To change the ISM Radio Modbus ID refer to the **System** menu.

Select **Binding** to enter binding mode or select **Site Survey** to run a site survey.

Figure 23. ISM Radio menu



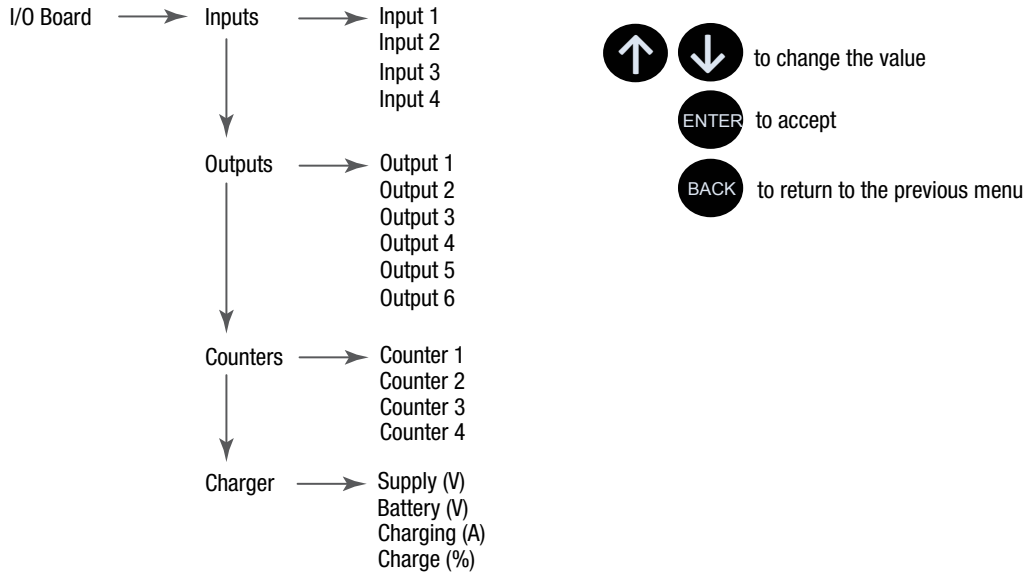
Binding— All ISM radio devices must be bound to the internal Gateway/master device before the DXM can access the wireless devices. The first submenu under binding allows the user to set the wireless address of the device to bind with. This is required to bind with wireless devices that do not have rotary dials (for example: M-GAGEs, ultrasonic sensors, and Q45 devices). See [Binding and Conducting a Site Survey with the ISM Radio](#) on page 12. For more information on binding a particular device, refer to the individual datasheet.

Site Survey—After creating a wireless network using the binding process, run a site survey on each device to see the link quality. See [Conduct a Site Survey from the DXM](#) on page 13.

7.4 I/O Board

Use the **I/O Board** menu to view input values, output values, input counters values, and the charger status on the DXM I/O board. To change the configuration parameters, use the **System Config** menu.

Figure 24. I/O Board menu



The **I/O Board** menu includes the following submenus.

Inputs

Lists the inputs. Depending upon the input type, the value and unit's information will also be displayed.

Outputs

The DXM base configuration can include discrete, current, or voltage outputs. The output values will be displayed based on their configuration settings.

Counters

Counters on the DXM base board are associated to inputs but the count value is stored in different register. Adjust or view the count registers using the LCD menu.

Charger

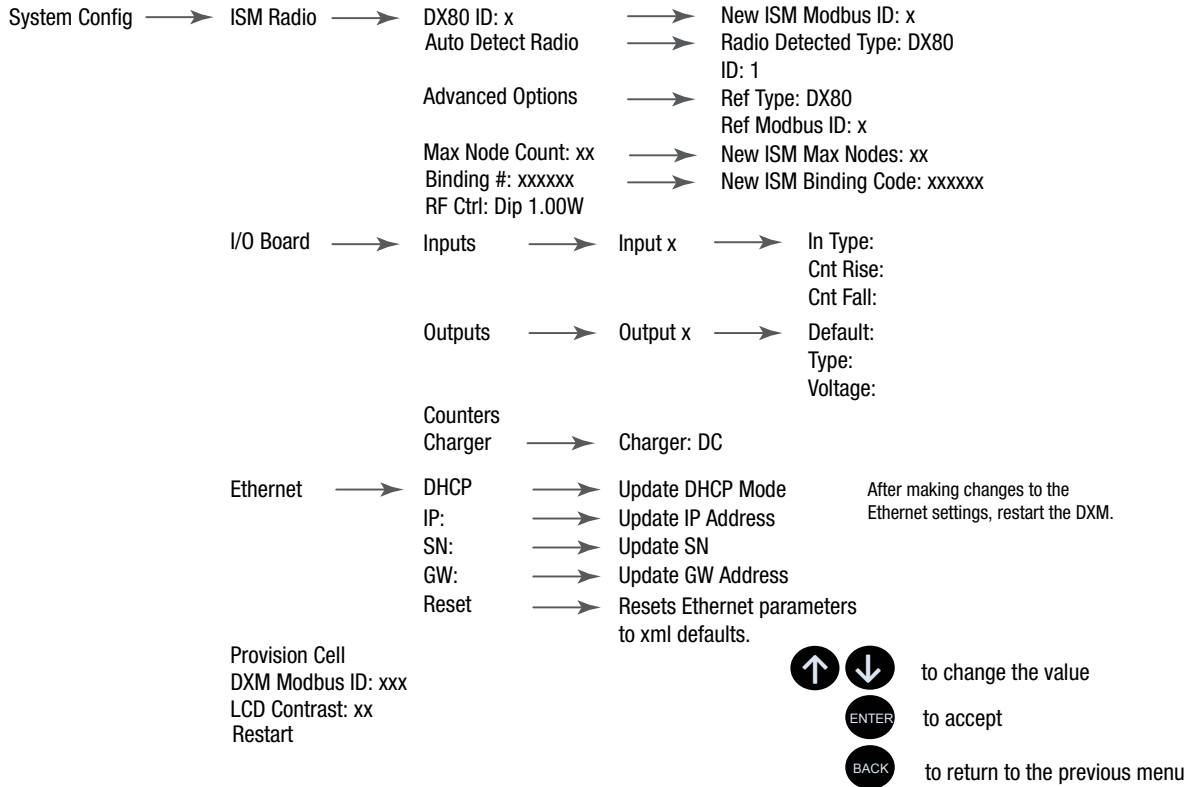
The on-board solar/battery charger of the DXM stores information about the charging circuit in Modbus registers. Use the LCD menu to view information about the incoming voltage, charging current, battery voltage, and battery charge percentage.

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7.5 System Config

Use the **System Config** menu to set DXM system parameters.

Figure 25. System Config menu



7.5.1 ISM Radio

DX80/MultiHop ID—The ISM radio is set at the factory to be Modbus device address 1 (Modbus ID 1). For some applications, you may need to change the Modbus ID. Adjust the Modbus device address using the LCD menu system. Any other method may cause issues with the DXM not knowing which Modbus device address is assigned to the radio, which causes issues with running Binding or Site Survey from the LCD menu.

Set the radio Modbus ID to a valid number (1 through 247) that is not being used by the DXM system. Processor Local Registers allocate ID 199, the I/O board is set to ID 200, and the display board is set to ID 201. With a DX80 Gateway (star network), it's easy to choose a new ID. With a MultiHop network, remember that the master MultiHop radio allocates a range of Modbus IDs for wireless devices, typically 11 through 110.

When setting the new ISM Modbus ID, the system changes the Modbus ID on the internal radio and changes the reference to it on the DXM. The reference Modbus ID is what the DXM uses to access the internal radio when running Binding or Site Survey.

Auto Detect Radio—If the internal Modbus ID of the radio was changed or the internal radio was changed, but not recorded, use Auto Detect Radio to determine the radio ID and radio type. The auto-detect routine broadcasts discovery messages and waits for a response. If other devices are connected to the external RS-485 ports, they may need to be disconnected for this process to work properly.

Advanced Options—The Advanced Options menu is typically not used unless the Modbus ID is changed without the DXM being involved, such as when you write directly to the radio Modbus registers.

- **Reference Type** selects the radio type between DX80 star architecture radios and a MultiHop radio. The DXM uses this reference to determine how to communicate to the internal radio. If set incorrectly, the DXM may not be able to run Site Survey from the LCD menu. Unless you are changing or adding the internal radio device, there should no reason to change the radio type.
- **Reference Modbus ID** defines the Modbus ID the DXM uses when communicating with the internal radio. If this is set incorrectly, the DXM will not be able to run Binding or Site Survey through the LCD menu.

Max Node Count—Defines the maximum number of devices for the DX80 wireless network.

Binding #—This parameter allows the user to define the Binding code within the ISM radio. Typically, you will not have to adjust this number unless you are replacing an existing Gateway or master radio.

RF Ctrl—Displays the status of the ISM radio DIP switch 1 (off or on). The menu doesn't allow the user to change the DIP switch setting through the display.

7.5.2 I/O Board

Use the **System Config > I/O Board** submenu to change the configuration parameters for the inputs, outputs, counters, and charger.

Use the **Inputs** menu to change the input type. The universal inputs on the DXM are defined from the factory as sinking inputs. To change the input type:

1. Go to the **System Config > I/O Board > Inputs** menu.
2. Select which input to change.
3. Select the input type. The available parameters include the Input Type and the Counter Edge Detect.

Table 9: Input parameters

Input Type	Description
Sinking	Discrete input, low active, 0 = ON, 1 = OFF
Sourcing	Discrete input, high active, 1 = ON, 0 = OFF
Current	Analog input, 0–20 mA
Voltage	Analog input, 0–10 V DC
Thermistor 2*	Thermistor input, 10k - J (r-t curve), beta(K) 3890
Thermistor 1*	Thermistor input, 10k - G (r-t curve), beta(K) 3575

Counter	Description
In Type	Sinking or sourcing
Cnt Rise	Increment the count when the input transitions from 0 -> 1
Cnt Fall	Increment the count when the input transitions from 1 -> 0

Use the **Output** menu to change the default condition, output type, and switched power voltage.

Table 10: Output parameters

Output Type	Description
Default	Force output registers to a default condition if the I/O board has not been communicated with for a user-defined time period. The communications timeout parameter must be set to use the Default condition.
Type	Select the output type: NMOS Sinking, Switch Power (Swch Pwr), Analog.
Voltage	Outputs defined as switched power can adjust the voltage: 5 V or 16 V

Use the **Charger** menu to change the charging algorithm for the battery. This parameter can also be set by writing Modbus register 6071 of the I/O board. See [Supplying Power from a Solar Panel](#) on page 27.

Table 11: Charger parameters

Charger Parameters	Description
DC	Used when 12–24 V DC power supplies connected to the DXM power pins and the attached batteries are used as backup batteries. This limits the current during the battery charging process. (factory default setting)
Solar	Select Solar when a solar panel is connected to the power pins of the DXM. Solar panels are current limited by their design and therefore can charge the battery without managing the input power.

7.5.3 Ethernet

Use the **Ethernet** submenu to sets the IP Address, Gateway Address, and Subnet mask of the DXM's Ethernet interface. You may change these settings either from the LCD menu (**System Config > Ethernet**) or from the XML configuration file created by the DXM Configuration Software.

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The network address settings from the LCD menu have the highest priority and override settings in the XML configuration file. To use the parameter settings from the XML configuration file or use DHCP, execute the **Reset** under **System Config > Ethernet** or use the LCD display to set the IP Address, Gateway Address, and Subnet Mask to 255.255.255.255. Reboot the DXM after changing the Ethernet parameters.

The Ethernet cable should be attached before powering up the DXM.

7.5.4 Provision Cell

If the DXM has a cellular modem installed, the modem must be provisioned on the network. This menu provisions the cellular modem on the network. For step by step directions, see [Using the DXM Cellular Modem](#) on page 36.

7.5.5 DXM Modbus ID

Use the secondary Modbus RS-485 port when the DXM is connected to a Modbus RTU network as a Modbus slave device. Set the Modbus ID for the secondary RS-485 port using the LCD display menu **System Config > DXM Modbus ID**.

7.5.6 LCD Contrast

Use the **LCD Contrast** option to adjust the LCD contrast. Adjust the starting number lower to decrease the display contrast. The factory default is 28. Do not set a number less than 15 or the display may not be bright enough to see to change back.

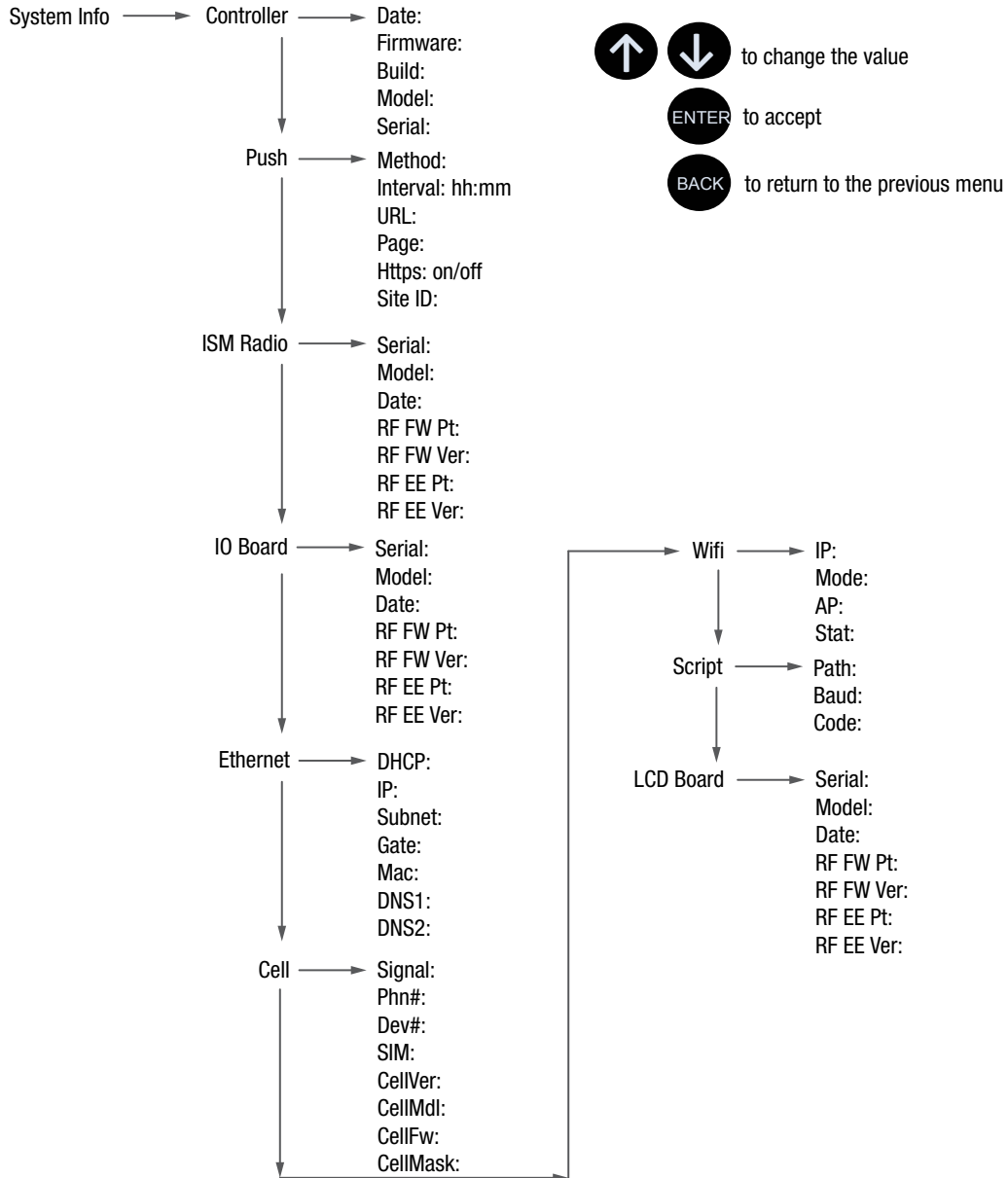
7.5.7 Reset

Use the **Restart** menu to force the main processor to restart. This does not affect the other boards in the system.

7.6 System Info

Various DXM system settings are shown in this menu. The Push, Ethernet, and Cell parameters are helpful for debugging network connections. This is a read only menu.

Figure 26. System Info menu



Cell

Shows the cellular MEID number (Mobil Equipment Identifier), MDN (Mobil Device Number), version, signal, firewall setting, and firewall mask. Some of these parameters are not visible until the cellular network is accessed.

Controller

Displays the date, build, model, and serial number.

Ethernet

Displays the IP address, MAC address, DHCP, Gateway address, and DNS settings.

I/O Board

Displays the serial number, model, date, firmware part numbers, and version numbers.

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ISM Radio

Displays the serial number, model, date, firmware part numbers, and version numbers.

LCD Board

Displays the serial number, model, date, firmware part numbers, and version numbers.

Push

Shows the current parameters loaded from the XML configuration that applies to pushing data to a webserver, including method (Ethernet or cellular), interval, URL, page, HTTPS, and site ID.

Script

Displays the name of the ScriptBasic file running.

Wifi

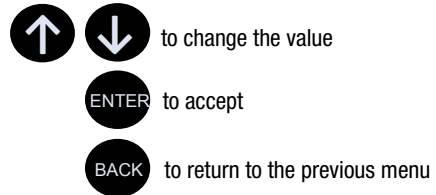
Displays the Wifi IP address and other settings.

7.7 Display Lock

Display Lock protects the DXM LCD menu system from being used until the proper pass code is entered.

Figure 27. Display Lock menu

Display Lock —> Enter password
>> x



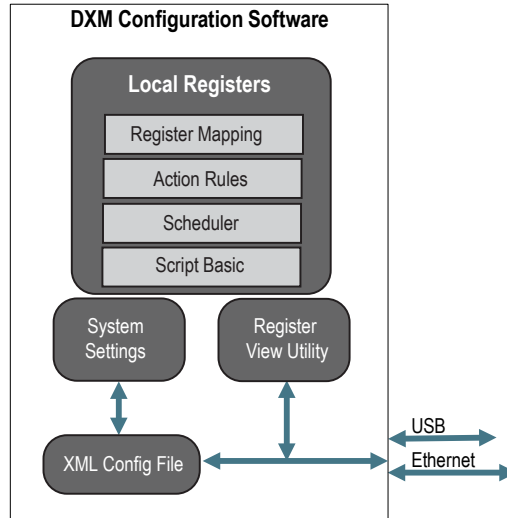
The display lock feature uses the configuration software to set a passcode within the DXM. A valid passcode is 1 to 9 digits long and uses numbers 0 through 9. For example 1234 or 209384754.

8 Configuration Instructions

8.1 DXM Configuration Software

Download the latest version of all configuration software from <http://www.bannerengineering.com>. For more information on using the DXM Configuration Software, refer to the instruction manual (p/n 209933).

Figure 28. Overview of the configuration software features



The configuration software configures the DXM by creating an XML file that is transferred to the DXM using a USB or Ethernet connection. The DXM can also receive the XML configuration file from a Web server using a cellular or Ethernet connection.

This configuration file governs all aspects of the DXM operation.

The wireless network devices are a separate configurable system. Use the DX80 User Configuration Software to configure the internal DX80 wireless Gateway and the attached wireless Nodes. Use the MultiHop Configuration Software if the internal radio is a MultiHop device.

All tools can be connected to the DXM using a USB cable or an Ethernet connection.

8.2 Save and Upload the Configuration File

After making any changes to the configuration, you must save the configuration files to your computer, then upload it to the device.

Changes to the XML file are not automatically saved. Save your configuration file before exiting the tool and before sending the XML file to the device to avoid losing data. If you select **DXM > Send XML Configuration to DXM** before saving the configuration file, the software will prompt you to choose between saving the file or continuing without saving the file.

1. Save the XML configuration file to your hard drive by going to the **File > Save As** menu.
2. Go to the **DXM > Send XML Configuration to DXM** menu.

Figure 29. Status indicator bar



- If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the cable and reconnect the DXM to the software.
- If the Application Status indicator is green, the file upload is complete.
- If the Application Status indicator is yellow, the file transfer is in progress.

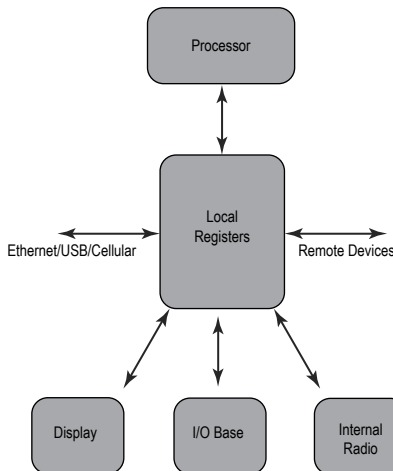
The device reboots and begins running the new configuration.

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8.3 Register Flow and Configuration

The DXM register data flow goes through the Local Registers, which are data storage elements that reside within the processor. Using the DXM Configuration Software, the controller can be programmed to move register data from the Local Register pool to remote devices, the internal radio, or the display.

Figure 30. Register flow



8.3.1 Basic Approach to Configuration

When programming an application in the DXM, first plan the overall data structure of the Local Registers. The Local Registers are the main storage elements in the DXM. Everything goes into or out of the Local Registers.

1. In the DXM Configuration Software, name the Local Registers to provide the beginning structure of the application.
2. Configure the read/write rules to move the data. The Read/Write rules are simple rules that move data between devices (Nodes, Modbus slaves, sensors, etc) and the Local Registers.
3. Most applications require the ability to manipulate the Local Register data, not just move data around. Use the **Action rules** to make decisions or transform the data after the data is in the Local Registers. Action rules can apply many different functions to the Local Register data, including conditional statements, math operations, copy operations, or trending.
4. To perform scheduled events in Local Registers, go to the **Scheduler** screen in the DXM Configuration Software. These rules provide the ability to create register events by days of the week. The scheduler can also create events based on sunrise or sunset.

8.3.2 Troubleshooting a Configuration

View Local Registers using the **Local Registers > Local Registers in Use** screen of the DXM Configuration Software.

When a configuration is running on the DXM, viewing the Local Registers can help you to understand the application's operation. This utility can also access data from remote devices.

To configure the Local Register data to display on the LCD menu, go to the **Local Registers** screen, set the **LCD permissions** to read or read/write.

8.3.3 Saving and Loading Configuration Files

The DXM Configuration Software saves its configuration information in a XML file. Use the **File** menu to Save or Load configuration files.

Save the configuration file before attempting to upload the configuration to the DXM. The DXM Configuration Software uploads the configuration file saved on the PC to the DXM; it will not send the configuration loaded in the tool.

8.3.4 Uploading or Downloading Configuration Files

The DXM requires a XML configuration file to become operational. To upload or download configuration files, connect a computer to the DXM using the USB port or Ethernet port. Then use the **Upload Configuration to Device** or **Download Configuration from Device** under the **Device** menu.

8.4 Scheduler

Use the **Scheduler** screens to create a calendar schedule for local register changes, including defining the days of the week, start time, stop time, and register values.

Schedules are stored in the XML configuration file, which is loaded to the DXM. Reboot the DXM to activate a new schedule. If power is cycled to the DXM in the middle of a schedule, the DXM looks at all events scheduled that day and processes the last event before the current time.

For screens that contain tables with rows, click on any row to select it. Then click **Clone** or **Delete** to copy/paste or remove that row.

8.4.1 Create a Weekly Event

Use the **Scheduler > Weekly Events** screen to define weekly events.

Figure 31. Scheduler > Weekly Events screen

1. Click **Add Weekly Event**.
A new schedule rule is created.
2. Click on the arrow to the left of the new rule to expand the parameters into view.
The user-defined parameters are displayed.
3. Name your new rule.
4. Enter the local register.
5. Select the days of the week this rule applies to.
6. Enter the starting value for the local register.
7. Use the drop-down list to select the type of Start at time: a specific time or a relative time.
8. Enter the starting time.
9. Enter the end time and end value for the local register.

Register updates can be changed up to two times per day for each rule. Each rule can be set for any number of days in the week by clicking the buttons M, T, W, Th, F, S, or Su.

If two register changes are defined for a day, define the start time to be before the end time. Select **End Value** to enable the second event in a 24 hour period. To span across two days (crossing the midnight boundary), set the start value in the first day, without selecting **End Value**. Use the next day to create the final register state.

Start and end times can be specified relative to sunrise and sunset, or set to a specific time within a 24 hour period. When using sunrise or sunset times, set the GPS coordinates on the device so it can calculate sunrise and sunset.

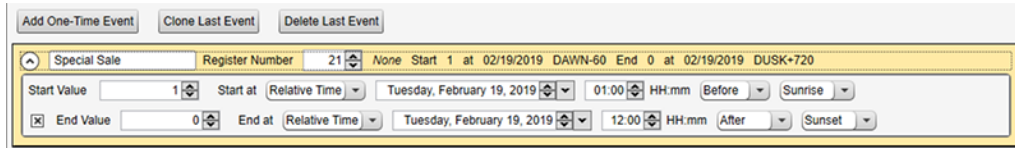
8.4.2 Create a One-Time Event

Define one-time events to update registers at any time within a calendar year.

Similar to Weekly events, the times can be specific or relative to sunrise or sunset. Define one-time events using the **Scheduler > One Time Events** screen.

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Figure 32. Scheduler > One Time Events screen

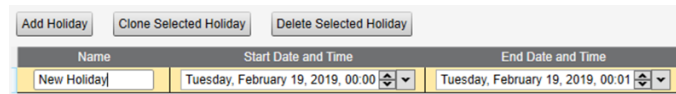


1. Click on **Add One Time Event**.
A new one-time event is created.
2. Click on the arrow to expand the parameters into view.
The user-defined parameters are displayed.
3. Name your one-time event by clicking on the name link and entering a name.
4. Enter the local register.
5. Enter the starting time, date, and starting value for the local register.
6. Enter the ending time, date, and ending value for the local register.

8.4.3 Create a Holiday Event

Use the **Scheduler > Holidays** screen to create date and/or time ranges that interrupt weekly events.

Figure 33. Scheduler > Holidays screen



1. Click on **Add Holiday**.
A new rule is created.
2. Enter a name your new holiday rule.
3. Select the start date and time for the new holiday.
4. Select the stop date and time for the new holiday.

8.5 Authentication Setup

The DXM has three different areas that can be configured to require a login and password authentication.

- Webservice/ Cloud Services Authentication
- Mail Server Authentication
- DXM Configuration Authentication

The webservice and mail server authentication depends upon the service provider.

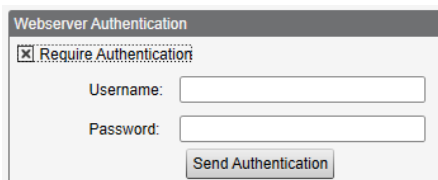
8.5.1 Set the Controller to use Authentication

The DXM can be configured to send login and password credentials for every HTTP packet sent to the webservice. This provides another layer of security for the webservice data.

Configuration requires both the webservice and the DXM to be given the same credentials for the login and password. The webservice authentication username and password are not stored in the XML configuration file and must be stored in the DXM.

1. From within the DXM Configuration Software, go to the **Settings > Cloud Services** screen.
2. In the upper right, select **Show advanced settings**.
3. Define the username and password in the **Web Server Authentication** section of the screen.

Figure 34. Web Server Authentication screen



The first time you select **Require Authentication**, a pop-up box appears with additional instructions. Since the data is not stored in the XML configuration file, it is hidden from view of the DXM Configuration Software.

4. Click on **Send Authentication**.

The controller must be connected to the PC for this operation to succeed.

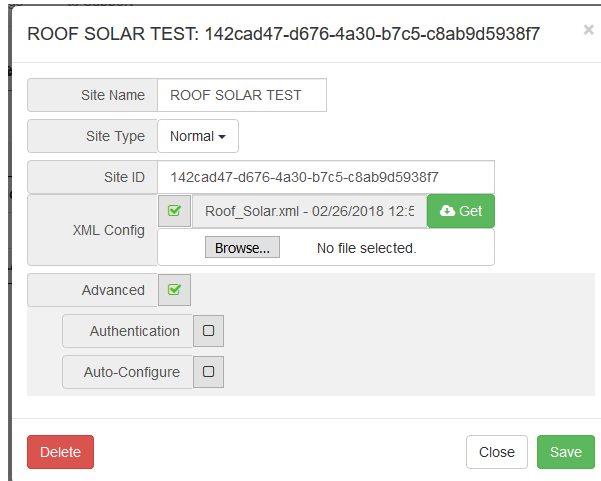
The data transmits directly to the DXM's non-volatile memory. If successful, a pop-up window appears, asking to reboot the device.

5. Select **Yes** to reboot the device.

8.5.2 Set the Web Services to Use Authentication

1. At the Banner Cloud Data Services website, go to **Settings > Sites**.
2. To edit the site settings, click **Edit** on the line of the site name.

Figure 35. Settings > Sites screen of the Banner CDS website



At the bottom of the pop-up window is a checkbox to enable authentication/validation.

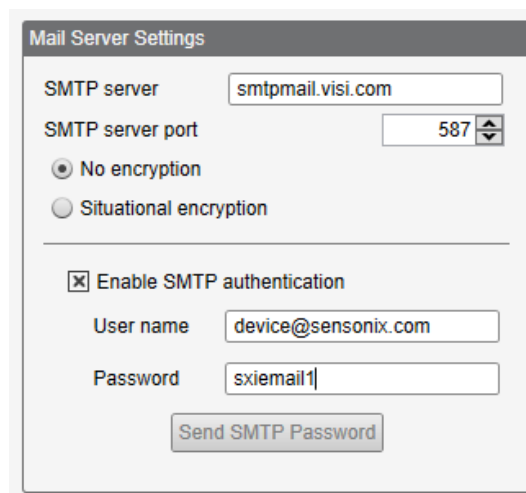
3. Enter the same username and password as used in the DXM Configuration Software. The username and password do not need to be a defined user within the Banner Cloud Data Services website.

8.5.3 Mail Server Authentication

Complete the mail server settings to have the DXM send email alert messages or to email the log files.

The SMTP password is stored in the DXM, not the XML configuration file. Use the **Settings > Notifications** screen to complete this configuration.

Figure 36. Mail server settings



After selecting **Enable SMTP Authentication** for the first time, a pop-up box appears with additional instructions to complete the mail server authentication process.

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After entering the user name and password, click on **Send SMTP Password** to save the user name and password to the DXM. The DXM must be connected to the PC to complete this operation. If successful, a pop-up window appears, asking to reboot the device. Select **Yes** to reboot the device.

8.5.4 Controller Configuration Authentication

The DXM can be programmed to allow changes to the configuration files only with proper authentication by setting up a password on the **Settings > Administration** screen in the DXM Configuration Software.

With the DXM connected to the PC, click **Get Device Status**. The DXM status displays next to the button.

Figure 37. Settings > Administration screen

Use the DXM Configuration Software to:

- Set the Admin Password
- Change the Admin Password
- Remove the Admin Password

To change or remove an admin password, the current password must be supplied. The DXM must be connected to the PC to change the administration password.

The DXM can be unlocked without knowing the administration password, but doing this erases the configuration program, logging files, and any ScriptBasic program on the device. For instruction on how to do this, see the [Additional Information](#) on page 63 section.

8.6 EtherNet/IP™ Configuration

The DXM is defined from the factory to send/receive register data from the Gateway and the first 16 Nodes with an EtherNet/IP™⁵ host.

To expand the number devices going to Ethernet/IP, change the **Devices in system** parameter in the DX80 Gateway (default setting is 8) to 32. To change this value:

1. Launch the the DX80 Configuration Software.
2. In the menu bar, go to **Device > Connection Settings** and select **Serial** or **Ethernet DXM**.
3. In the **Configuration > Device Configuration** screen, click on the arrow next to the Gateway to expand and display the Gateway's parameters.
4. In the **System** section, use the **Devices in system** drop-down list to make your selection.

This allows the user to maximize the use of the EtherNet/IP buffer to 28 devices.

EDS (Electronic Data Sheet) files allow users of the EtherNet/IP protocol to easily add a Banner DXM device to the PLC. Download the EDS files from the Banner website.

- DXM EDS Configuration File (for PLCs) (p/n [b_4205242](#))
- DXM EIP Config File for DXM Controller with Internal Gateway (Models: DXM1xx-BxR1, DXM1xx-BxR3, and DXM1xx-BxCxR1) (p/n [194730](#))

8.6.1 Download an Existing Configuration from the DXM

If you have an existing configuration file, save the XML file locally as a back-up on your computer.

1. Apply power to the DXM.
2. Connect an ethernet or USB cable between your computer and the DXM.
3. Launch the DXM Configuration Software v4 and select your DXM model.

⁵ EtherNet/IP is a trademark of Rockwell Automation.

4. On the **Device > Connection Settings** menu, select one of the following:
 - Select **TCP/IP** as the connection type and enter the **IP Address** of the DXM Controller; or
 - Select **Serial** as the connection type and select the appropriate **Comm port**
5. On the menu bar, select **Device > Get XML configuration from DXM** to download the XML configuration file.
6. Save the XML file locally on your computer.

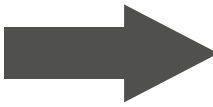
8.6.2 Configuring the Controller

Use the configuration software to define the **Protocol conversion** for each local register to be **EIP Originator > DXM** or **EIP DXM > Originator** from the **Edit Register** or **Modify Multiple Register** screens.


Define a DXM local register as **EIP Originator > DXM** when the host PLC (Originator) will send data to the DXM local register (DXM).

Define a DXM local register as **EIP DXM > Originator** when that register data will be sent from the DXM (DXM) to the host PLC (Originator).

Data from an EIP controller in assembly instance 112 is data destined for the DXM local registers. The PLC is normally configured for INT or UINT data transfer. This allows for a seamless transfer of data.

EIP Assembly Instance 112 (16-bit)			DXM Local Registers	
Adrs	Data		Adrs	Data
0	1122		1	1122
1	3344		2	3344
2	5566		3	5566
3	7788		4	7788
4	9900		5	9900

Data from the DXM local registers is sent to the EIP controller using assembly instance 100. Each local register in the DXM defined as **EIP DXM > Originator** is collected in numerical order and placed into the data buffer destined for assembly instance 100. DXM local registers are capable of 32-bits, but only the lower 2-bytes (16-bits) for each local register are transferred.

EIP Assembly Instance 100 (16-bit)			DXM Local Registers	
Adrs	Data		Adrs	Data
0	1122		11	1122
1	3344		12	3344
2	5566		13	5566
3	7788		14	7788
4	9900		15	9900

Configure the Local Registers to Export Data to a PLC

1. On the DXM Configuration Software: Go to the **Local Registers** screen.
2. Select the register(s) that will be exported to a Host PLC.
A maximum of 228 registers can be read or written with Ethernet/IP.
3. In the **Storage/Connectivity** section, select **EIP DXM -> Originator** from the **Protocol conversion** drop-down list.
To change a block of continuous local registers, use the **Modify Multiple Registers** screen.

Configure the Local Registers to Import Data from a PLC

1. On the DXM Configuration Software: Go to the **Local Registers** screen.
2. Select the register(s) that will be imported from a Host PLC.
A maximum of 228 registers can be read or written with Ethernet/IP.
3. In the **Storage/Connectivity** section, select **EIP Originator -> DXM** from the **Protocol conversion** drop-down list.
To change a block of continuous local registers, use the **Modify Multiple Registers** screen.

To view the EIP Input and Output registers, go to the **Tools > Protocol Conversion** screen. You may also export the register map to a CSV file.

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Save and Upload the Configuration File

After making any changes to the configuration, you must save the configuration files to your computer, then upload it to the device.

Changes to the XML file are not automatically saved. Save your configuration file before exiting the tool and before sending the XML file to the device to avoid losing data. If you select **DXM > Send XML Configuration to DXM** before saving the configuration file, the software will prompt you to choose between saving the file or continuing without saving the file.

1. Save the XML configuration file to your hard drive by going to the **File > Save As** menu.
2. Go to the **DXM > Send XML Configuration to DXM** menu.

Figure 38. Status indicator bar



- If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the cable and reconnect the DXM to the software.
- If the Application Status indicator is green, the file upload is complete.
- If the Application Status indicator is yellow, the file transfer is in progress.

The device reboots and begins running the new configuration.

8.6.3 Configuring the Host PLC

On the host PLC, install the DXM using an EDS file or by using the following parameters:

- Assembly1: Originator to DXM = Instance 112, 456 bytes (228 words)
- Assembly2: DXM to Originator = Instance 100, 456 bytes (228 words)

The Originator is the host PLC system, and the DXM is the DXM. The host system sees the DXM as a generic device with the product name of Banner DXM (ProdType: 43 - Generic Device, ProdName: Banner DXM, Integer Type - INT).



Important: Do not set the Requested Packet Interval (RPI) any faster than 150 ms.

8.7 Setting up Email and Text Messaging

The DXM can be configured to send email or SMS messages based on threshold conditions.



Important: Only the DXM100 and DXM150 models offer SMS/text messaging capabilities.

Cellular-connected systems can use email or SMS. Ethernet-connected systems can only use email, but can send email to cellular phones as a SMS message depending upon the network carrier. To send email to a Verizon phone, use the phone number followed by @vtext.com, for example, 1234567890@vtext.com.

For more information, refer to the DXM Configuration Software Instruction Manual (p/n 209933). Internal log files may be sent using email. Follow these instructions and use the DXM Configuration Software to program the controller for email and/or SMS.

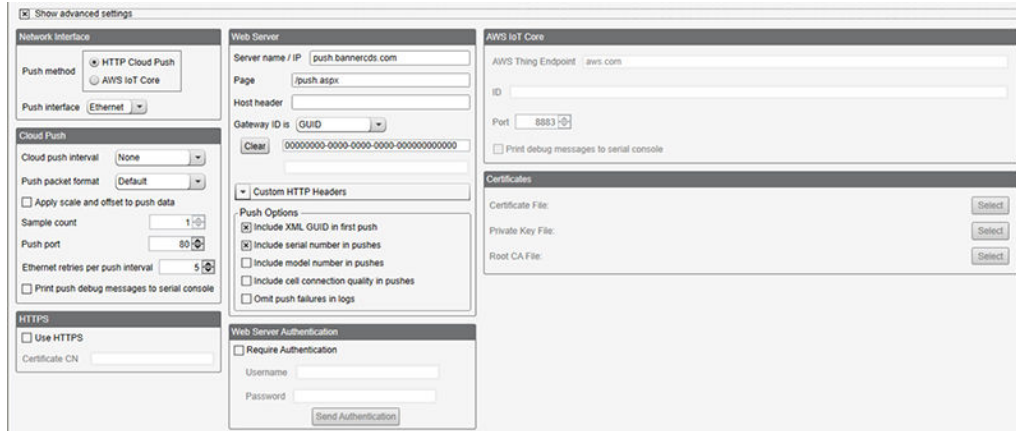
1. On the **Settings > System** screen, set the **Device Time** on the DXM.
2. On the **Settings > Cloud Services** screen, select either Ethernet or Cell for the **Push Interface**.
3. If you selected Ethernet, configure your Ethernet connection by setting the IP settings on the **Ethernet** screen. If you selected a **Push interface** of Cell, use the **Cellular** screen to define parameters.
4. Set the email and message parameters on the **Notifications** screen.
5. To send alert messages, define the threshold rule to use email and/or SMS.
6. To send log files, define the log file parameters.

8.7.1 Define the Network Interface Settings

On the **Cloud Services** screen (shown with **Show advanced settings** selected), define the network connection settings by selecting Ethernet or Cell from the **Network Interface** drop-down list. This determines how the DXM sends data.

If you don't require pushing data to a web server, set the **Cloud Push** interval to zero.

Figure 39. Cloud Services screen

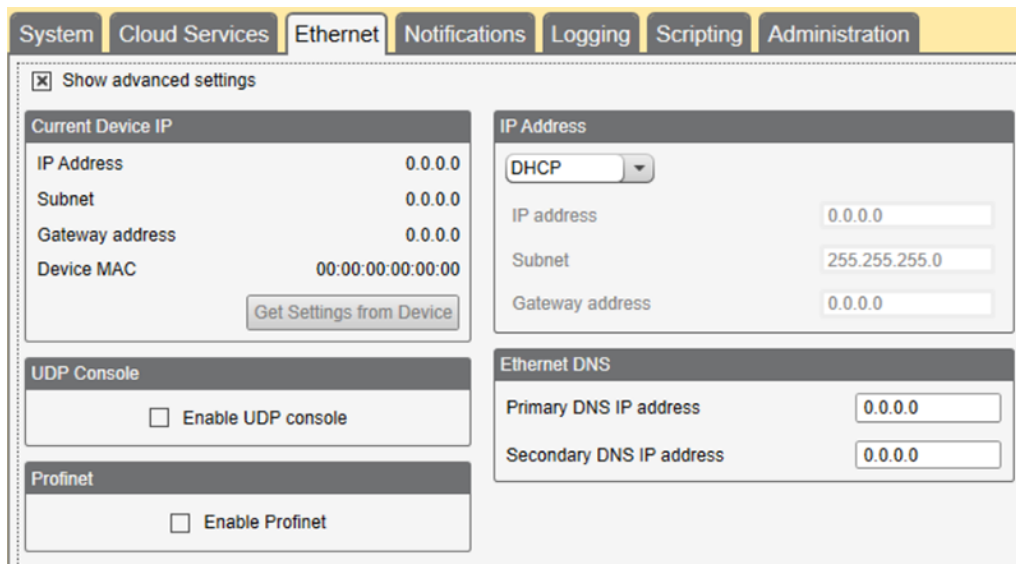


8.7.2 Configure your Ethernet Connection

To send email based on a threshold rule or to email log files, first define the network and email servers. When selecting Ethernet, go to the **Settings > Ethernet** screen.

1. To define the Ethernet IP address, give the DXM a static IP address. In most cases you may select the device to use DHCP and have the IP address automatically assigned.
2. DNS settings are not typically required. The DXM uses a public service to resolve Domain names, but if the network connection does not have Internet access, the DNS settings may be required.

Figure 40. Settings > Ethernet screen



8.7.3 Configure your Cellular Connection

To use a cellular connection, select Cell as the network connection on the **Settings > Cloud Services** screen (see [Configure the DXM Controller for a Cellular Modem](#) on page 40). The **Cellular** screen does not display unless the **Network interface** is set to Cell.

Using a 4G LTE cell module requires a cellular plan; follow the instructions on p/n [205026](#) to activate a cell modem.

1. On the **Settings > Cellular** screen, select your cellular modem from the drop-down list.
2. Set the APN.
 - If you are using a Banner 4G LTE Verizon Module (LE910), set the **APN** to `vzwinternet`.
 - If you are using an Emnify 3G GSM Cellular Radio (HE910), set the **APN** to `EM`. This module does not require an APN username or password.
 - If you are using a third-party SIM card, the APN, APN Username, and Password must be provided by the cellular service provider.

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8.7.4 Set the Email and Messaging Parameters

From the **Settings > Notifications** screen, enter the SMTP definition, login, and password for a mail server.



Important: Only the DXM100 and DXM150 models offer SMS/text messaging capabilities.

To send email, you must supply the SMTP Server, Server Port, and login credentials. When you are only sending SMS messages over cellular, the SMTP Server is not required.

The default SMTP port is 25 but may need to be adjusted for Ethernet-based networks. Note that many facilities block port 25. Port 587 is another common SMTP submission port.

The SMTP password is not stored in the XML configuration file, but on the DXM. After the password is entered, click on **Send SMTP Password** to send it to the DXM. The password is stored in non-volatile memory, so reboot the DXM to recognize the new password.

When using a GMail server, select **Situational encryption** and **Enable SMTP authentication**. The GMail server will not allow you to send email alerts using the cellular interface. GMail may notify you that you must allow access for less secure apps in your email settings.

For other email servers, the parameters may vary and will require information from the provider.

Figure 41. Mail and email settings

At the bottom of the screen, define the recipient to receive emails. These recipients selected in the threshold definition for sending alert messages.

Sending SMS alerts requires that the Cellular Radio chip be installed and configured, regardless of the **Push Interface** used. This setting allows a user to receive SMS alerts directly on their cell phone in the case of critical component changes or failures.

1. On the **Settings > Notifications** screen, add recipients for SMS alerts.
2. In this section, you may change the Name of the recipient, add a phone Number, and insert a Message for the recipient.
3. SMS alerts will be received in the format: Message Active/Inactive or Threshold Rule Name Active/Inactive depending on the configuration.
4. Enter the phone numbers for SMS messages.
 - 4G LTE cellular: Enter phone numbers without dashes. For example, a US phone number of (234) 555-1212 would be entered as 2345551212.
 - Emnify GSM cellular: Enter phone numbers using the country code, area code, and phone number. For example, a US phone number of (234) 555-1212 would be entered as 12345551212. These cellular modems are not certified for use in the US.

8.7.5 Define Threshold Rules for Email

To define a threshold, go to **Local Registers > Action Rules > Thresholds**.

Depending upon which recipients are defined, select the appropriate email or SMS checkbox for the threshold rule (under **Email/SMS on state transition**). When the threshold rules goes active or inactive, an email is generated.

For more information on how to set up threshold rules, refer to the DXM Configuration Software Instruction Manual (p/n 209933).

8.7.6 Define Log File Parameters for Emailing Log Files

The DXM can email log files generated on the device.

Before emailing log files, set the **Mail and Messaging** parameters to provide the login credentials. When using Ethernet, verify the IP address settings are defined on the **Ethernet** screen. Set the DXM time, under **Settings > System**, so that all data is properly time stamped.

Use the **Local Registers > Local Registers in Use > Edit Register** screen to select which registers to log which log file (set the **SD card logging** to the log file). Define the setup of the log file using the **Settings > Logging** screen. Typical settings are shown.

1. Enable the log and timestamp with every entry.
2. Enter the filename, log rate, and the maximum file size to send via email (5 to 10k is an efficient size for a cellular connection). Banner does not recommend setting the log file size larger than 100 kB as this cannot be read through the configuration software and must be read directly from the SD card.
3. Define the email address.

Figure 42. Defining the data log files

4. Define the local register data put into the log file using the **Local Registers > Local Register Configuration** screen, under the **Logging and Protocol Conversion** section. From the **SD Card Logging** drop-down list, select the log file to write to. Log files are written in CSV format.
5. Use the DXM Configuration Software to read back the log files. Under **Settings > Logging**, click **Refresh List**, highlight the file to download, then click **Save Selected**.

8.8 Ethernet and Cellular Push Retries

The DXM can be configured to send register data packets to a webserver. When the Ethernet or cell communications path is not operating, the DXM retries the send procedure. The communications retry process is outlined below for each configuration.

Regardless of the communications type (Ethernet or cellular), a failed attempt results in the register data packet being saved on the local micro SD card⁶. The number of retries will depend upon the network connection type.

When there is bad cellular signal strength or there is no Ethernet connection, the transmission attempts are not counted as failed attempts to send data. Only when there is a good network connection and there are 10 failed attempts will the controller archive the data on the SD card. Data archived on the SD card must be manually retrieved.

⁶ Enable HTTP logging to save data on the SD card; this is the factory default. See SETTINGS -> LOGGING in the DXM Configuration Tool.

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8.8.1 Ethernet Push Retries

With an Ethernet-based network connection, the DXM retries a message five times. The five retry attempts immediately follow each other. After all attempts are exhausted, the register data packet is saved on the micro SD card.

At the next scheduled time, the DXM attempts to send the saved packet as well as the newly created register data packet. If it cannot send the new register data packet, the new register data packet is appended to the saved file on the micro SD card to be sent later. After 10 rounds of retries, the data set is archived on the micro SD card under folder **_sxi**. No additional attempts to resend the data are made; the data file must be manually retrieved.

Using SSL on Ethernet will have no retries, but will save each failed attempt to the micro SD card until 10 failed rounds. At this time, the register data packet is archived.

8.8.2 Cellular Push Retries

In a cellular-connected system there are no retries. Failed transmissions are saved on the micro SD card.

After 10 successive failed attempts, the data is archived in the **_sxi** folder. Send attempts with a low signal quality are not counted against the 10 count limit. For example, if the cellular antenna is disconnected for period that the DXM controller would have sent 20 messages under normal circumstances, all 20 messages would be saved and will be retried when the antenna is reconnected. If the signal quality was good, but the cellular network was not responding, the DXM archives the register data packets after 10 failed attempts.

8.8.3 Event/Action Rule or Log File Push Retries

Event-based pushes caused by Action rules and locally stored log files sent using email follow the same process when failures occur, based on the network connection. The failed Event-based messages are resent with the next cyclical schedule or the next event message that triggers a push message.

8.8.4 Email and Text Message Push Retries

There are no retries for emails or SMS messages that fail to be sent from the DXM.

9 Additional Information

9.1 Working with Modbus Devices

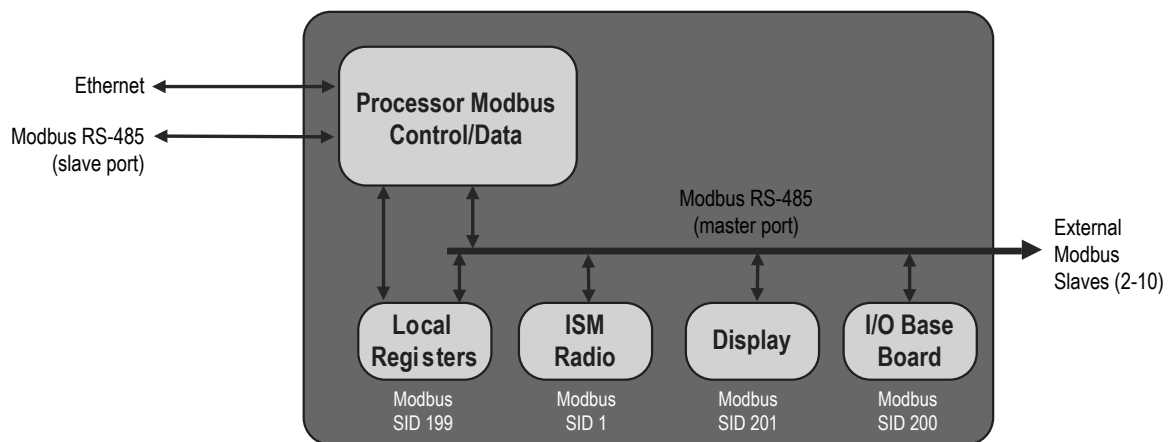
The DXM has two physical RS-485 connections using Modbus RTU protocol.

The DXM can be a Modbus RTU master device to other slave devices and can be a Modbus slave device to another Modbus RTU master. The DXM uses the primary RS-485 port (M+/M-) as a Modbus RTU master to control external slave devices. All wired devices connected to the master RS-485 port must be slave devices.

- As a Modbus RTU master device, the DXM controls external slaves connected to the primary RS-485 port, the local ISM radio, local I/O base board, and the local display board.
- As a Modbus RTU slave device, the DXM local registers can be read from or written to by another Modbus RTU master device.

The secondary port (S+/S-) is the Modbus RTU slave connection. The secondary (slave) Modbus RS-485 port (S+/S-) is controlled by another Modbus master device, not the DXM. The slave port is used by an external Modbus master device that will access the DXM as a Modbus slave device.

Figure 43. Processor Modbus system overview



The DXM has dual Modbus roles: a Modbus slave device and a Modbus master device. These run as separate processes.

The Modbus slave port can only access the DXM local registers. To operate as a Modbus slave device, the DXM needs to be assigned a unique Modbus slave ID as it pertains to the host Modbus network. This slave ID is separate from the internal Modbus slave IDs the DXM uses for its own Modbus network. The DXM Modbus slave ID is defined through the LCD menu. Other Modbus slave port parameters are defined by using the configuration software.

The DXM operates the Modbus master port. Each device on the master port must be assigned a unique slave ID. There are slave IDs that are reserved for internal devices in the DXM.

Table 12: DXM Internal Modbus Slave IDs (factory default)

Modbus Slave ID	Device
1	DX80 Performance Gateway or MultiHop ISM Radio—MultiHop wireless devices connected to the internal MultiHop radio should be assigned Modbus Slave addresses starting at 11.
199	Local Registers—Internal storage registers of the DXM
200	I/O Base Board—All data and parameters for each input or output of the DXM.
201	LCD Display—The user has access to the LED indicators on the DXM.

9.1.1 Assigning Modbus Slave IDs

Assign the DXM Modbus Slave ID only if a Modbus master device is reading or writing the DXM Local Register data through the Modbus RS-485 slave port (S+, S-).

Set the DXM Slave ID from the LCD menu under **System > DXM Slave ID**. The DXM can have any unique slave ID between 1 and 246, depending upon the host Modbus network. Other RS-485 slave port parameters are set in the configuration software under the **Settings > General** tab.

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DXM Master Configuration—When the DXM operates as a Modbus master device, use the configuration software to configure read or write operations of the DXM Modbus network. The DXM communicates with all internal and external peripheral devices using the external Modbus bus RS-485 (M+, M-)

There are four internal Modbus slave devices that are configured from the factory with slave IDs. Assign slave IDs of 2 through 10 to Modbus slave devices that are physically wired to the DXM. Assign slave IDs of 11 through 60 to wireless slaves within the MultiHop network.

Do not assign a slave ID of greater than 10 to Modbus slave devices that are physically wired using the RS-485 port if there is an internal MultiHop ISM radio in the DXM. The MultiHop ISM radio attempts to send any Modbus data intended for slaves 11–60 across the radio network, which conflicts with wired slave devices if the slave IDs overlap. The MultiHop master radio can be changed from the factory default of 11–60 Modbus slave IDs if more hardwired slaves are required.

9.1.2 Wireless and Wired Devices

Wireless DX80 Gateway—The DX80 Gateway architecture is a star architecture in which all Nodes in the system send their data back to the Gateway. The host can access the entire network data from the Gateway, which is Modbus slave ID 1. Because the DXM will not be sending any Modbus messages across the wireless link, the timeout parameter can be set low (less than 1 second) and the device is treated like a directly connected device.

MultiHop Master—The MultiHop master radio forms a wireless tree network using repeaters and slave devices. Each device in a MultiHop network must be assigned a unique Modbus Slave ID and is accessed as a separate device. For the DXM to talk with a MultiHop device in the wireless network, the master MultiHop device interrogates every message on the RS-485 bus. If they are within the wireless devices range (slave IDs 11 though 60), the message is sent across the wireless network. To change this range, the user must adjust the offset and range setting in the MultiHop master radio (Modbus Slave ID 1). Modbus register 6502 holds the Modbus offset, default 11. Modbus register 6503 holds the number of Modbus slaves allowed (maximum of 100).

Table 13: Modbus Slave IDs for wireless and wired devices

Modbus Slave ID	Description
1	Allocated for the internal ISM radio device, either a DX80 Gateway or MultiHop Master
2–10	Slave addresses available for direct connected Modbus slave devices to the master RS485 port (M+ , M-)
11–60	Allocated for wireless MultiHop radio network devices. If there is not an internal MultiHop in the DXM, these slave addresses are available to use for directly connected devices.
61–198	Available to user for direct connected Modbus slave devices or the expansion of the wireless network slave IDs to go past 50 wireless devices.
199	Allocated for internal Local Register
200	Allocated for the I/O base board, will be different for special DXM slave only models.
201	Allocated for the LCD display board, the user can read/write LEDs.

9.1.3 Modbus Communication Timeouts

A Modbus timeout is the amount of time a Modbus slave is given to return an acknowledgment of a message sent by the Modbus master. If the Modbus master waits for the timeout period and no response is seen, the Modbus master considers it a lost message and continues on to the next operation.

The timeout parameter is simple to set for Modbus devices directly connected to the DXM, if there are no MultiHop wireless devices. Special considerations need to be made to set the timeout parameter when a MultiHop network uses the DXM as the master radio.

Configure controllers operating wireless networks to allow for enough time for hardware transmission retries. Set the **Communications Timeout** parameter to cover the expected time for messages to be sent throughout the wireless network. For the DXM, the **Communications Timeout** parameter is the maximum amount of time the DXM should wait after a request is sent until the response message is received from the Modbus slave device. Use the DXM Configuration Software to set the timeout parameter on the **Settings > System** screen (select **Show advanced settings**).

The default setting for the timeout parameter is 5 seconds.

MultiHop Networks vs DX80 Star Networks

The DX80 star Gateway collects all the data from the Nodes, which allows the host system to directly read the data from the Gateway without sending messages across the wireless network. This allows for DX80 Gateway to be treated like any other wired Modbus device.

In a MultiHop network, the data resides at each device, forcing the controller to send messages across the wireless network to access the data. For this reason, carefully consider the value of the wireless timeout parameter.

Calculating the Communications Timeout for Battery-Powered MultiHop Radios

Battery-powered MultiHop radios are configured to run efficiently to maximize battery life. By optimizing battery life, the allowed communications window for receive messages is slow (once per 1.3 seconds) and sending message rates are standard (once per 0.04 seconds).

A MultiHop device is set from the factory with the retry parameter of 8. This means that under worst-case conditions, a message is sent from the DXM to an end device a total of nine times (one initial message and eight retry messages). The end device sends the acknowledgment message back to the DXM a maximum of nine times (one initial message and eight retries). A single Modbus transaction may send up to two messages + 16 retry messages before the transaction is complete. In addition, the radios randomly wait up to one time period before retransmitting a retry message. So to allow for the random wait time, add one extra time period for each in-between time of retries.

To calculate the communication timeout parameter for a Master radio to a slave radio (no repeaters):

Master to Slave Send time = $(9 \times 1.3 \text{ sec}) + (8 \text{ retry wait} \times 1.3 \text{ sec}) = 22 \text{ seconds}$

Slave to Master Send time = $(9 \times 0.04 \text{ sec}) + (8 \text{ retry wait} \times 0.04 \text{ sec}) = 1 \text{ second}$

Total Send/Receive time = 23 seconds

Minimum Timeout period = 23 seconds

If the link quality of the network is poor, the maximum transfer times may happen. Set the timeout parameter to accommodate the maximum number of retries that may happen in your application.

When MultiHop repeaters are added into the wireless network, each additional level of hierarchical network increases the required timeout period. Since MultiHop repeaters are running at the highest communications rate, the overall affect is not as great.

Master to Repeater Send time = $(9 \times 0.04 \text{ sec}) + (8 \text{ retry wait} \times 0.04 \text{ sec}) = 1 \text{ second}$

Repeater to Master Send time = $(9 \times 0.04 \text{ sec}) + (8 \text{ retry wait} \times 0.04 \text{ sec}) = 1 \text{ second}$

Additional Timeout period for a repeater = 2 seconds

Using the timeout calculation above of 23 seconds, if a repeater is added to the network the timeout should be set to 25 seconds. For each additional MultiHop repeater device creating another level of network hierarchy, add an additional two seconds to the timeout period.

Calculating the Communication Timeout for 10–30 VDC MultiHop Radios

Line-powered (10–30 V dc) MultiHop devices operate at the maximum communication rate, resulting in a much lower timeout parameter setting. For each repeater added to the network, increase the timeout parameter 2 seconds.

For a Master radio to a 10–30 V dc powered slave radio (no repeaters):

Master to Slave Send time = $(9 \times 0.04 \text{ sec}) + (8 \text{ retry wait} \times 0.04 \text{ sec}) = 1 \text{ second}$

Slave to Master Send time = $(9 \times 0.04 \text{ sec}) + (8 \text{ retry wait} \times 0.04 \text{ sec}) = 1 \text{ second}$

Total Send/Receive time = 2 seconds

Minimum Timeout period = 2 seconds

Adjusting the Receive Slots and Retry Count Parameters

The number of receive slots governs how often a MultiHop device can communicate on the wireless network.

Battery-powered devices typically have DIP switches that allow the user to set the number of receive slots, which directly affects the battery life of the radio. Adjusting the receive slots changes how often a message can be received. By default, the receive slots are set to 4 (every 1.3 seconds). When the receive slots are set to 32, the radio listens for an incoming message every 0.16 seconds.

Users may also leave the retry mechanism to the application that is accessing the wireless network, in this case the DXM. Adjust the number of retries in the MultiHop devices by writing the number of retries desired to Modbus register 6012. The factory default setting is 8.

Calculating the Communication Timeout for a DX80 Star Network

In the DX80 network, all Node data is automatically collected at the Gateway to be read. The DXM does not use the wireless network to access the data, which allows for much faster messaging and much lower timeout values.

For a DXM with an internal DX80 Gateway, set the timeout value 0.5 seconds. If other Modbus slave devices are connected to the RS-485 lines, the timeout parameter governs all communication transactions and must be set to accommodate all devices on the bus.

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9.1.4 Modbus TCP Client

The DXM can operate as a Modbus TCP client on Ethernet. Users may define up to five socket connections for Modbus TCP server devices to read Modbus register data over Ethernet. Use the DXM Configuration Software to define and configure Modbus TCP client communications with other Modbus TCP servers.

9.2 Modbus Register Summary

9.2.1 DXM Modbus Registers

The DXM may have up to four internal Modbus slave devices.

All Modbus registers are defined as 16-bit Modbus Holding Registers. When connecting external Modbus slave devices, only use Modbus slave IDs 2 through 198. The local registers, the I/O base, and the LCD slave IDs are fixed, but the internal radio slave ID can be changed if needed.

Table 14: DXM Internal Modbus Slave IDs (factory default)

Modbus Slave ID	Device
1	DX80 Performance Gateway or MultiHop ISM Radio—MultiHop wireless devices connected to the internal MultiHop radio should be assigned Modbus Slave addresses starting at 11.
199	Local Registers—Internal storage registers of the DXM
200	I/O Base Board—All data and parameters for each input or output of the DXM.
201	LCD Display—The user has access to the LED indicators on the DXM.

9.2.2 Modbus Registers for the MultiHop Radio Board Module

The DX80 MultiHop master radio is a tree-based architecture device that allows for repeater radios to extend the wireless network. Each device in a MultiHop network is a Modbus device with a unique Modbus ID.

Modbus registers in a MultiHop network are contained within each individual radio device. To obtain Modbus register data from a MultiHop device, configure the DXM to access each device across the wireless network as an individual Modbus slave device.

Table 15: Example MultiHop Modbus registers with generic devices.

Multihop Device	Slave ID	Modbus Registers
DXM Master radio	1	none
Slave radio	11	Modbus register 1–16 are inputs, 501–516 are outputs
Repeater radio	12	Modbus register 1–16 are inputs, 501–516 are outputs
Slave radio	15	Modbus register 1–16 are inputs, 501–516 are outputs

9.2.3 Modbus Registers for the Performance Gateway Radio Module

The DX80 Performance Gateway is a star-based architecture device that contains all the Modbus registers for the wireless network within the Gateway. To access any input or output values within the entire wireless network, read the appropriate Modbus register from Gateway.

There are 16 Modbus registers allocated for each device in the wireless network. The first 16 registers (1–16) are allocated for the Gateway, the next 16 (17–32) are allocated for Node 1, the next 16 (33–48) are allocated for Node 2 and so forth. There are no inputs or outputs on the DXM embedded Gateway but the Modbus registers are still allocated for them.

Although only seven Nodes are listed in the table, the Modbus register numbering continues for as many Nodes as are in the network. For example, the register number for Node 10, I/O point 15, is 175. Calculate the Modbus register number for each device using the equation:

$$\text{Register Number} = \text{I/O\#} + (\text{Node\#} \times 16)$$

Table 16: Modbus holding registers

I/O Point	Gateway	Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7
1	1	17	33	49	65	81	97	113

I/O Point	Gateway	Node 1	Node 2	Node 3	Node 4	Node 5	Node 6	Node 7
2	2	18	34	50	66	82	98	114
3	3	19	35	51	67	83	99	115
4	4	20	36	52	68	84	100	116
5	5	21	37	53	69	85	101	117
6	6	22	38	54	70	86	102	118
7	7	23	39	55	71	87	103	119
8	8	24	40	56	72	88	104	120
9	9	25	41	57	73	89	105	121
10	10	26	42	58	74	90	106	122
11	11	27	43	59	75	91	107	123
12	12	28	44	60	76	92	108	124
13	13	29	45	61	77	93	109	125
14	14	30	46	62	78	94	110	126
15	15	31	47	63	79	95	111	127
16	16	32	48	64	80	96	112	128

Table 17: Access all wireless network registers by reading Modbus slave ID 1

DX80 Device	Slave ID	Modbus Registers
DXM Gateway radio	1	Modbus registers 1–8 are inputs, 9–16 are outputs
Node 1	-	Modbus registers 17–24 are inputs, 25–32 are outputs
Node 2	-	Modbus registers 33–40 are inputs, 41–48 are outputs
Node 3	-	Modbus registers 49–56 are inputs, 57–64 are outputs

Alternative Modbus Register Organization

The Sure Cross DX80 Alternative Modbus Register Organization registers are used for reordering data registers to allow host systems to efficiently access all inputs or outputs using a single Modbus command. The register groups include the input/output registers, bit-packed registers, and analog registers. This feature is only available with the Performance models using version 3 or newer of the LCD firmware code.

Table 18: Alternative Modbus register organization

Name	Modbus Register Address (Decimal)
Inputs and Outputs, in order by device	2201 through 4784
Discrete Bit Packed (Status, Discrete Inputs, Discrete Outputs)	6601 through 6753
Analog Inputs (1–8) and Analog Outputs (1–8)	6801 through 9098

Input Registers and Outputs Registers

Modbus registers 2201 through 2584 are used to organize all inputs together.

In this format, users can sequentially read all input registers using one Modbus message. Modbus registers 4401 through 4784 organize all outputs together to allow users to sequentially write to all outputs registers using one Modbus message.

Table 19: Input and output registers

Inputs (2201–2584)		Outputs (4401–4784)	
Modbus Register Address (Decimal)	16-bit Register Value	Modbus Register Address (Decimal)	16-bit Register Value
2201–2208	Gateway Inputs 1 through 8	4401–4408	Gateway Outputs 1 through 8
2209–2216	Node 1 Inputs 1 through 8	4409–4416	Node 1 Outputs 1 through 8

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Inputs (2201–2584)		Outputs (4401–4784)	
Modbus Register Address (Decimal)	16-bit Register Value	Modbus Register Address (Decimal)	16-bit Register Value
2217–2224	Node 2 Inputs 1 through 8	4417–4424	Node 2 Outputs 1 through 8
...
2577–2584	Node 47 Inputs 1 through 8	4777–4784	Node 47 Outputs 1 through 8

Refer to your device's datasheet for a list of the active inputs and outputs. Not all inputs or outputs listed in this table may be active for your system.

Discrete Bit-Packed Registers

Discrete bit-packed registers include the discrete status registers, discrete inputs, and discrete outputs.

Bit packing involves using a single register, or range of contiguous registers, to represent I/O values.

When networks use similar Nodes to gather data using the same I/O registers for each Node, discrete data from multiple Nodes can be bit packed into a single register on the Gateway. The bit-packed data is arranged by I/O point starting at Modbus register 6601. For example, Discrete IN 1 for all the Nodes in the network is stored in three contiguous 16-bit registers.

The most efficient way to read (or write) discrete data from a Sure Cross® DX80 Gateway is by using these bit-packed registers because users can read or write registers for all devices using one Modbus message. The following registers contain discrete bit-packed I/O values for the Gateway and all Nodes. Values are stored first for the Gateway, then for each Node in order of Node address.

Figure 44. Discrete bit-packed register addresses and bit positions

Bit-Packed Device Status Registers

Register Address	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
6601	Node 15	Node 14	Node 13	Node 12	Node 11	Node 10	Node 9	Node 8	Node 7	Node 6	Node 5	Node 4	Node 3	Node 2	Node 1	Gateway
6602	Node 31	Node 30	Node 29	Node 28	Node 27	Node 26	Node 25	Node 24	Node 23	Node 22	Node 21	Node 20	Node 19	Node 18	Node 17	Node 16
6603	Node 47	Node 46	Node 45	Node 44	Node 43	Node 42	Node 41	Node 40	Node 39	Node 38	Node 37	Node 36	Node 35	Node 34	Node 33	Node 32

Bit-Packed Discrete Input 1

Register Address	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
6611	Node 15	Node 14	Node 13	Node 12	Node 11	Node 10	Node 9	Node 8	Node 7	Node 6	Node 5	Node 4	Node 3	Node 2	Node 1	Gateway
6612	Node 31	Node 30	Node 29	Node 28	Node 27	Node 26	Node 25	Node 24	Node 23	Node 22	Node 21	Node 20	Node 19	Node 18	Node 17	Node 16
6613	Node 47	Node 46	Node 45	Node 44	Node 43	Node 42	Node 41	Node 40	Node 39	Node 38	Node 37	Node 36	Node 35	Node 34	Node 33	Node 32

Bit-Packed Discrete Output 1

Register Address	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
6691	Node 15	Node 14	Node 13	Node 12	Node 11	Node 10	Node 9	Node 8	Node 7	Node 6	Node 5	Node 4	Node 3	Node 2	Node 1	Gateway
6692	Node 31	Node 30	Node 29	Node 28	Node 27	Node 26	Node 25	Node 24	Node 23	Node 22	Node 21	Node 20	Node 19	Node 18	Node 17	Node 16
6693	Node 47	Node 46	Node 45	Node 44	Node 43	Node 42	Node 41	Node 40	Node 39	Node 38	Node 37	Node 36	Node 35	Node 34	Node 33	Node 32

Table 20: Discrete bit-packed registers for inputs and outputs

Inputs		Outputs	
Modbus Register Address (Decimal)	Description (Inputs)	Modbus Register Address (Decimal)	Description (Outputs)
6601–6603	Status for all devices		
6611–6613	Input 1 from all devices	6691–6693	Output 1 from all devices
6621–6623	Input 2 from all devices	6701–6703	Output 2 from all devices
6631–6633	Input 3 from all devices	6711–6713	Output 3 from all devices
6641–6643	Input 4 from all devices	6721–6723	Output 4 from all devices
6651–6653	Input 5 from all devices	6731–6733	Output 5 from all devices
6661–6663	Input 6 from all devices	6741–6743	Output 6 from all devices
6671–6673	Input 7 from all devices	6751–6753	Output 7 from all devices

Inputs		Outputs	
Modbus Register Address (Decimal)	Description (Inputs)	Modbus Register Address (Decimal)	Description (Outputs)
6681–6683	Input 8 from all devices		

Status registers (6601–6603) contain a bit-packed representation defining the devices that are operational in the wireless system. Each bit indicates Node in Sync (1) or Node Not in Sync (0).

Input registers from all devices use Modbus registers 6611 through 6683 to organize the least significant bit into a sequential array of registers. The first register contains the least significant bit from the input values for the Gateway through Node 15. The second register contains the input values for Node 16 through Node 31, and the third register contains the input values for Nodes 32 through 47.

For discrete inputs, only the least significant bit is used. For analog inputs, the least significant bit indicates if the analog value is above or below the selected threshold value (when using the threshold parameter configured in the User Configuration Software). For example, a least significant bit of one (1) indicates the analog value is above the selected threshold value. A least significant bit of zero (0) indicates the analog value is below the threshold value.

Output registers from all devices use Modbus registers 6691 through 6753 to organize the least significant bit into a sequential array of registers. Output 8 (I/O point 16) cannot be written using the discrete format.

Analog 16-Bit Registers (Registers 6801 through 9098)

The most efficient way to read (or write) analog data from a Gateway is by using these 16-bit analog registers. Most networks consist of similar Nodes reporting data using the same I/O registers for each Node. For this reason, the analog data is arranged by I/O point using Modbus registers 6801 through 9098.

For example, Input 1 for Gateway and all Nodes is stored in the first 48 contiguous blocks of 16-bit analog registers, beginning with register 6801.

In this format, users can read a 16-bit holding register for all devices or write to a register for all devices using one Modbus message. Using these registers is the most efficient way to read all status registers, read all analog inputs, or write all analog outputs.

The following registers contain analog I/O values for the Gateway and all Nodes. Values are stored first for the Gateway, then for each Node in order of Node address.

Table 21: Analog input and output registers

Inputs		Outputs	
Modbus Register Address (Decimal)	Description (Inputs)	Modbus Register Address (Decimal)	Description (Outputs)
6801	Input 1 for Gateway	8001	Output 1 for Gateway
6802	Input 1 for Node 1	8002	Output 1 for Node 1
6803	Input 1 for Node 2	8003	Output 1 for Node 2
...
6951	Input 2 for Gateway	8151	Output 2 for Gateway
6952	Input 2 for Node 1	8152	Output 2 for Node 1
6953	Input 2 for Node 2	8153	Output 2 for Node 2
...
7101	Input 3 for Gateway	8301	Output 3 for Gateway
7102	Input 3 for Node 1	8302	Output 3 for Node 1
7103	Input 3 for Node 2	8303	Output 3 for Node 2
...
7851	Input 8 (Status Register) for Gateway	9051	Output 8 for Gateway
7852	Input 8 (Status Register) for Node 1	9052	Output 8 for Node 1
7853	Input 8 (Status Register) for Node 2	9053	Output 8 for Node 2
...

For example, 6801 contains the input 1 value for the Gateway, 6802 contains the input 1 value for Node 1, and 6848 contains the input 1 value for Node 47.

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9.2.4 Internal Local Registers (Slave ID 199) for the DXM100 and DXM150

The main storage elements for the DXM are its Local Registers, which can store 4-byte values that result from register mapping, action rules, or ScriptBasic commands.

- Local Registers 1 through 850 are standard 32-bit unsigned registers.
- Local Registers 851 through 900 are non-volatile registers that are limited to 100,000 write cycles.
- Local Registers 1001 through 1900 are floating point format numbers. Each register address stores half of a floating point number. For example, registers 1001 and 1002 store the first full 32-bit floating point number.
- Local Registers 10001 through 19000 are system, read-only, registers that track DXM data and statistics.

Table 22: Modbus Registers for Internal Local Registers (Modbus Slave 199)

Local Registers	Type	Description
1–845	32-bit unsigned	Internal processor memory
846–849	32-bit unsigned	Reset, Constant, Timer
851–900	32-bit unsigned	Data flash, non-volatile
1001–1900	32-bit IEEE Floating Point	Floating point registers, internal processor memory
> 10000		Read-only virtual registers

Local Registers 1–850 (Internal Processor Memory, 32-bit, Unsigned)—The Local Registers are the main global pool of registers. Local Registers are used as basic storage registers and as the common data exchange mechanism. External Modbus device registers can be read into the Local Registers or written from the Local Registers. The DXM, as a Modbus master device or a Modbus slave device, exchanges data using the Local Registers. Modbus over Ethernet (Modbus/TCP) uses the Local Registers as the accessible register data.

Local Registers 851–900 (Data Flash, Non-volatile, 32-bit, Unsigned)— The top 50 Local Registers are special non-volatile registers. The registers can store constants or calibration type data that must be maintained when power is turned off. This register data is stored in a data flash component that has a limited write capability of 100,000 cycles, so these registers should not be used as common memory registers that change frequently.

Local Registers 1001–1900 (32-bit IEEE Floating Point)— These Local Registers are paired together to store a 32-bit IEEE floating point format number in big endian format. Registers 1001 [31:16], 1002 [15:0] store the first floating point value; registers 1003, 1004 store the second floating point number. There are a total of 500 floating point values; they are addressed as two 16-bit pieces to accommodate the Modbus protocol. Use these registers when reading/writing external devices that require Modbus registers in floating point format. Since Modbus transactions are 16-bits, the protocol requires two registers to form a 32-bit floating point number.

Virtual Registers— The DXM has a small pool of virtual registers that show internal variables of the main processor. Some register values will be dependent upon the configuration settings of the DXM. Do not use **Read Rules** to move Virtual Local Registers data into Local Registers. Use the **Action Rule > Register Copy** function to move Virtual Local Registers into Local Registers space (1-850).

Table 23: Virtual registers

Virtual Registers	Definition	
10001	GPS latitude direction (N, S, E, W)	GPS Coordinate Data if the DXM is configured to read an external GPS unit.
10002	GPS latitude	
10003	GPS longitude direction (N, S, E, W)	
10004	GPS longitude	
10011–10012	Resync timer	Engineering use
10013–10014	Resync timer rollover	Engineering use
10015–10016	Reboot cause (Restart Codes above)	Reboot Type
10017–10018	Watchdog reset count	Counter to track how many resets have been caused by the Watchdog
10021	IO Board Battery Voltage (mV)	mV
10022	IO Board - Incoming Supply Voltage (mV)	mV
10023	Cut-off Feature	0—No successful readings 1—Normal range 2—Cut-off engaged

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Virtual Registers	Definition	
10024	IO Board - Battery Charging Current (mA)	mA
10025–10026	Http Push SSL Acquires	Statistical counts of connections, disconnections and forced disconnects when the DXM creates a connection using SSL/TLS (Encrypted connections)
10027–10028	Http Push SSL Releases	
10029–10030	Http Push SSL Forced Releases	
10031–10032	Http Push Attempts	
10033–10034	Http Push Successes	Statistical counts of connections, disconnections and forced disconnects when the DXM controller creates a connection using HTTP non-encrypted
10035–10036	Http Push Failures	
10037–10038	Http Push Last Status	
10039–10040	Cellular Strength, BER	Cellular signal strength. Value range: 0–31 0 = –113 dBm or less 1 = –111 dBm 2–30 = –109 dBm through –53 dBm in 2 dBm steps 31 = –51 dBm or greater 99 = not known or not detectable; BER not used
10055–10056	Alarms, smtp, attempts	Email attempts
10057–10058	Alarms, smtp, fails	Email failures
10059–10060	Alarms, sms, attempts	SMS text message attempts
10061–10062	Alarms, sms, fails	SMS text message failures
10100	Number of read maps in default	Read Map statistics
10101	Number of read map successes	
10102	Number of read map timeouts	
10103	Number of read map errors	
10104	Read map success streak	
10105	Number of write map successes	Write Map statistics
10106	Number of write map timeouts	
10107	Number of write map errors	
10108	Write map success streak	
10109	Number of passthrough successes	API message passing statistics
10110	Number of passthrough timeouts	
10111	Number of passthrough errors	
10112	Passthrough success streak	
10113	Number of 43 buffer successes	DX80 Gateway automatic messaging buffer statistics
10114	Number of 43 buffer timeouts	
10115	Number of 43 buffer errors	
10116	43 buffer success streak	
11000	Read map success count	Read/Write maps statistics
12000	Write map success count	
13000	Read map timeout count	
14000	Write map timeout count	
15000	Read map error count	

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Virtual Registers	Definition
16000	Write map error count
17000	Read map success streak
18000	Write map success streak
19000	Read map is in default

Table 24: The reset codes are in virtual register 11015 and define the condition of the last restart operation.

Reset Code	Definition
0	Undefined
1	Unknown
2	General
3	Brownout
4	Watchdog
5	User
6	Software
7	Return from backup mode

9.2.5 Internal Local Registers (Slave ID 199) for the DXM700, DXM1000, and DXM1200

The main storage elements for the DXM are its local registers, which can store 4-byte values that result from register mapping, action rules, or ScriptBasic commands.

Local registers updated from Modbus transactions are restricted to a 16-bit data value to follow standard Modbus holding register definition.

The local registers defined in action rules must all be within the same register group. For example, an action rule cannot have inputs from an integer group with the result register defined as a floating point register. To move between integers and floats, use the Register Copy Rule.

- Local registers 1–850 and 5001–7000 are 32-bit integer registers
- Local registers 851–900 and 7001–8000 are non-volatile 32-bit integer registers
- Local registers 901-1000 are reserved for internal use
- Local registers 1001–5000 are floating point format numbers, each address stores half of a floating point number; for example, registers 1001 and 1002 store the first full 32-bit floating point number
- Local registers 10000 and higher are read only virtual registers; virtual registers collect various system-level data

Table 25: Modbus registers for internal local registers (Modbus slave ID 199)

Local Registers	Type	Description
1–845	32-bit integer	Local data registers
846–849	32-bit integer	Reset, Constant, Timer
851–900	32-bit non-volatile integer	Data flash, non-volatile
901–1000		Reserved for internal use
1001–5000	Floating point	Floating point registers, local data registers
5001–7000	32-bit integer	Local data registers
7001–8000	32-bit non-volatile integer	Data flash, non-volatile
> 10000		Read only virtual registers, system-level data

Local registers 1–850 and 5001–7000 (Internal Processor Memory, 32-bit, Unsigned)—The local registers are the main global pool of registers. Local registers are used as basic storage registers and as the common data exchange mechanism. External Modbus device registers can be read into the local registers or written from the local registers. The DXM, as a Modbus master device or a Modbus slave device, exchanges data using the local registers. Modbus over Ethernet (Modbus/TCP) uses the local registers as the accessible register data.

Local registers 851–900 and 7001–8000 (Data Flash, Non-volatile, 32-bit, Unsigned)—The top 50 local registers are special non-volatile registers. The registers can store constants or calibration type data that must be maintained when power is turned off. This register data is stored in a data flash component that has a limited write capability of 100,000 cycles, so these registers should not be used as common memory registers that change frequently.

Local registers 1001–5000— These local registers are paired together to store a 32-bit IEEE floating point format number in big endian format. Registers 1001 [31:16], 1002 [15:0] store the first floating point value; registers 1003, 1004 store the second floating point number. There are a total of 2000 floating point values; they are addressed as two 16-bit pieces to accommodate the Modbus protocol. Use these registers when reading/writing external devices that require Modbus registers in floating point format. Since Modbus transactions are 16-bits, the protocol requires two registers to form a 32-bit floating point number.

Virtual registers—The DXM has a small pool of virtual registers that show internal variables of the main processor. Some register values will be dependent upon the configuration settings of the DXM. Do not use **Read Rules** to move virtual local registers data into local registers. Use the **Action Rule > Register Copy** function to move virtual local registers into local registers space (1–850).

Table 26: Modbus registers for virtual registers

Registers	Definition	
10001	GPS latitude direction (N, S, E, W)	GPS Coordinate Data if the DXM is configured to read an external GPS unit.
10002	GPS latitude	
10003	GPS longitude direction (N, S, E, W)	
10004	GPS longitude	
10011–10012	Resync timer	Engineering use
10013–10014	Resync timer rollover	Engineering use
10015–10016	Reboot cause (Restart Codes above)	Reboot Type
10017–10018	Watchdog reset count	Counter to track how many resets have been caused by the Watchdog
10021	IO Board Battery Voltage (mV)	mV
10022	IO Board - Incoming Supply Voltage (mV)	mV
10023	IO Board Voltage Cut-off Feature	0—No successful readings 1—Normal range 2—Cut-off engaged
10024	IO Board - Battery Charging Current (mA)	mA
10025–10026	Http Push SSL Acquires	Statistical counts of connections, disconnections and forced disconnects when the DXM creates a connection using SSL/TLS (Encrypted connections)
10027–10028	Http Push SSL Releases	
10029–10030	Http Push SSL Forced Releases	
10031–10032	Http Push Attempts	Statistical counts of connections, disconnections and forced disconnects when the DXM controller creates a connection using HTTP non-encrypted
10033–10034	Http Push Successes	
10035–10036	Http Push Failures	
10037–10038	Http Push Last Status	Last DXM push status 0 = Initial state, no push attempt as finished yet 1 = Attempt complete 2 = Attempt aborted
10039–10040	Cellular Strength, BER	Cellular signal strength. Value range: 0–31 0 = –113 dBm or less 1 = –111 dBm 2–30 = –109 dBm through –53 dBm in 2 dBm steps 31 = –51 dBm or greater 99 = not known or not detectable; BER not used
10055–10056	Alarms, smtp, attempts	Email attempts
10057–10058	Alarms, smtp, fails	Email failures
10100	Number of read maps in default	Read Map statistics

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Registers	Definition	
10101	Number of read map successes	
10102	Number of read map timeouts	
10103	Number of read map errors	
10104	Read map success streak	
10105	Number of write map successes	Write Map statistics
10106	Number of write map timeouts	
10107	Number of write map errors	
10108	Write map success streak	
10109	Number of passthrough successes	API message passing statistics
10110	Number of passthrough timeouts	
10111	Number of passthrough errors	
10112	Passthrough success streak	
10113	Number of 43 buffer successes	DX80 Gateway automatic messaging buffer statistics
10114	Number of 43 buffer timeouts	
10115	Number of 43 buffer errors	
10116	43 buffer success streak	
11000	Read map success count	Read/Write maps statistics
12000	Write map success count	
13000	Read map timeout count	
14000	Write map timeout count	
15000	Read map error count	
16000	Write map error count	
17000	Read map success streak	
18000	Write map success streak	
19000	Read map is in default	

TCP Client Stats—The "x" represents the socket 0 through 4. The flex socket is not used. This range repeats for the next socket.

Table 27: TCP client statistics

Register	Definition
2x001	Socket x connection attempts (20001 is the first socket, 21001 is the second socket...)
2x003	Socket x connections
2x005	Socket x disconnections
2x007	Socket x transmits
2x009	Socket x receives
2x011	Socket x resolver attempts (reserved)
2x013	Socket x resolvers (reserved)
2x015–2x020	Reserved
2x021	Socket x Rule 0 transmits
2x023	Socket x Rule 0 receives
2x025	Socket x Rule 0 timeouts

Register	Definition
2x027	Socket x Rule 0 broadcasts
2x029	Reserved
2x031	Socket x Rule 1 transmits
2x033	Socket x Rule 1 receives
2x035	Socket x Rule 1 timeouts
2x037	Socket x Rule 1 broadcasts
2x039	Reserved

Reset Codes—The reset codes are in virtual register 11015 and define the condition of the last restart operation.

Table 28: Reset codes

Reset Code	Definition
0	Undefined
1	Unknown
2	General
3	Brownout
4	Watchdog
5	User
6	Software
7	Return from backup mode

9.2.6 Modbus I/O Registers for the B1 I/O Base Board

The I/O base board stores the input and output values in Modbus holding registers. Since the I/O base board is defined as a separate device, configure the DXM to read or write the values on the I/O base board.

Base Board Input Connection		
Modbus Register	Range	Description
1	0–65535	Universal input 1
2	0–65535	Universal input 2
3	0–65535	Universal input 3
4	0–65535	Universal input 4

Universal Input Register Ranges			
Register Types	Unit	Minimum Value	Maximum Value
Discrete input/output		0	1
Universal input 0 to 10 V	mV	0	10000 *
Universal input 0 to 20 mA	µA	0	20000 *
Universal input temperature (–40 °C to +85 °C)	C or F, signed, in tenths of a degree	–400	850
Universal potentiometer	unsigned	0	65535

* Setting Enable Full Scale to 1 sets the ranges to a linear scale of 0 to 65535.

B1 Controller Base Board Output Connection		
Modbus Register	Range	Description
501	0–1	NMOS Output 1

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B1 Controller Base Board Output Connection		
Modbus Register	Range	Description
502	0–1	NMOS Output 2
503	0–1	NMOS Output 3
504	0–1	NMOS Output 4
505	0–1	Switched Power 1 (5 V or 16 V)
506	0–1	Switched Power 2 (5 V or 16 V)
507	0–20000	Analog Output 1 default (0-20.000 mA)
	0–10000	Analog Output 1 (0-10.000 V)
508	0–20000	Analog Output 2 default (0-20.000 mA)
	0–10000	Analog Output 2 (0-10.000 V)

9.2.7 Modbus I/O Registers for the B2 I/O Base Board

The I/O base board stores the input and output values in Modbus holding registers. Since the I/O base board is defined as a separate device, configure the DXM to read or write the values on the I/O base board.

Base Board Input Connection		
Modbus Register	Range	Description
1	0–65535	Universal input 1
2	0–65535	Universal input 2
3	0–65535	Universal input 3
4	0–65535	Universal input 4

Universal Input Register Ranges			
Register Types	Unit	Minimum Value	Maximum Value
Discrete input/output		0	1
Universal input 0 to 10 V	mV	0	10000 *
Universal input 0 to 20 mA	µA	0	20000 *
Universal input temperature (–40 °C to +85 °C)	C or F, signed, in tenths of a degree	–400	850
Universal potentiometer	unsigned	0	65535

* Setting Enable Full Scale to 1 sets the ranges to a linear scale of 0 to 65535.

B2 Controller Base Board Output Connection		
Modbus Register	Range	Description
501	0–1	NMOS Output 1
502	0–1	NMOS Output 2
503	0–1	NMOS Output 3
504	0–1	NMOS Output 4
505	0–1	Switched Power 1 (5 V to 24 V)
506	0–1	Switched Power 2 (5 V to 24 V)
507	0–1	DC Latching Output 1
508	0–1	DC Latching Output 2
509	0–10000	Analog Output 1 (0-10.000 V)
510	0–10000	Analog Output 2 (0-10.000 V)

9.2.8 Modbus Configuration Registers for the Universal Inputs

Each input or output on the I/O base board has associated Modbus registers that configure its operation.

Universal Input Parameters Registers				
Universal Inputs	1	2	3	4
Enable Full Scale Registers	3303	3323	3343	3363
Temperature °C/°F Registers	3304	3324	3344	3364
Input Type Registers	3306	3326	3346	3366
Threshold Registers	3308	3328	3348	3368
Hysteresis Registers	3309	3329	3349	3369
Enable Rising Registers	4908	4928	4948	4968
Enable Falling Registers	4909	4929	4949	4969
High Register for Counter Registers	4910	4930	4950	4970
Low Register for Counter Registers	4911	4931	4951	4971

9.2.9 Modbus Configuration Registers for the Analog Output

The I/O base board has two analog outputs that are selectable as 0 to 20 mA (factory default) or 0 to 10 V. To change the analog output characteristic, physical jumpers must be change on the I/O board and a parameter Modbus register must be changed.

For step by step instructions on changing the output characteristics see [Analog \(DAC\) Outputs for the B1 and S1 Models](#) on page 31.

Parameters for Analog Output 1 start at 4001 through 4008. Parameters for Analog Output 2 start at 4021 through 4028.

Table 29: Registers for analog output (4xxxx) parameters

Analog output 1	Analog output 2	Description	Values
4001	4021	Maximum Analog Value	
4002	4022	Minimum Analog Value	
4003	4023	Enable Register Full Scale	0 = Store readings in unit-specific data 1 = Linear rate from 0 to 65535
4004	4024	Hold Last State Enable	0 = Disables Hold Last State and uses the Default Output State setting during an error condition 1 = Sets the output to its last known value
4005	4025	Default Output State	
4008	4028	Analog Output Type	0 to 20 mA or 0 to 10 V DC output (I/O board jumper selectable) Accuracy: 0.1% of full scale +0.01% per °C Resolution: 12-bit After changing the jumper position, write the appropriate value to the Modbus registers to define your analog output to match the setting selected by the jumper. 2 = 0 to 20 mA output (default) 3 = 0 to 10 V output
2952		Enable Default Communication Timeout	0 = Disable 1 = Enable
2953		Communication Default I/O Timeout (100 ms/Count)	Number of 100 ms periods
2954		Enable Default on Power Up	0 = Disable 1 = Sends device outputs to their default condition

Analog Output Type—The analog outputs may be configured as either 0 to 20 mA outputs (default) or 0 to 10 V outputs. To change the analog output type change the hardware jumper position and write to the Modbus register that defines the analog output type. For analog output 1, write to Modbus register 4008, for analog output 2 write to Modbus register 4028. Write a value of 2 (default) to select 0 to 20 mA; write a value of 3 to select 0 to 10 V.

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Default Output Conditions—Default output triggers are the conditions that drive outputs to defined states. Example default output conditions include when radios are out of sync, when a device cycles power, or during a host communication timeout.

- **2952 Enable Default Communication Timeout**— A “communication timeout” refers to the communication between any Modbus master host and the DXM baseboard. Set this register to 1 to enable the default condition when the host has not communicated with the DXM baseboard for the period of time defined by the Communication Default IO Timeout.
- **2953 Communication Default I/O Timeout (100 ms/Count)**—This parameter defines the host timeout period in 100 millisecond increments. If a host does not communicate within this timeout period, the device outputs are set to the default values.
- **2954 Enable Default on Power Up**—Setting this parameter to 1 sends the device outputs to their default condition when the DXM baseboard is powered up. Set to 0 to disable this feature.

Default Output State—The Default Output State parameter represents the default condition of the analog output. When an error condition exists, the outputs are set to this 16-bit user-defined output state. To define the error conditions for device outputs, refer to the MultiHop default output parameters 2950–2954.

Enable Register Full Scale—Set to 1 to enable a linear range from 0 to 65535 for specified input range. For a 4 to 20 mA output, a value of 0 represents 4 mA and 65535 represents 20 mA. Set this parameter to 0 to store readings in unit-specific data. For example, the register data representing a 15.53 mA reading is 15530. For units of current (0 to 20 mA outputs), values are stored as μ A (micro Amps) and voltage values are stored as mV (millivolts).

Hold Last State Enable—Set the Hold Last State to 1 to set the output to its last known value before the error occurred. Set this parameter to 0 to disable the Hold Last State and use the Default Output State setting during an error condition.

Maximum Analog Value—The Maximum Analog Value register stores the maximum allowed analog value. The specific units of measure apply to the register value. For example, the register may contain 20000, for 20 mA, or for a voltage output the register may contain 8000, for 8 volts.

Minimum Analog Value—The Minimum Analog Value register stores the minimum allowed analog value. The specific units of measure apply to register value. For example, the register may contain 4000, for 4 mA, or for a voltage output the register may contain 2000, for 2 volts.

9.2.10 Modbus Configuration Registers for the I/O (Definitions)

Enable Full Scale

Set to 1 to enable a linear range from 0 to 65535 for specified input range. For a 4 to 20 mA input, a value of 0 represents 4 mA and 65535 represents 20 mA. Set this parameter to 0 to store input readings in unit-specific data. For example, the register data representing a 15.53 mA reading is 15530. For units of current (0 to 20 mA inputs), values are stored as μ A (micro Amps) and voltage values are stored as mV (millivolts).

Enable Rising/Falling

Use these registers to enable the universal input logic to count on a rising transition or a falling transition. Write a one (1) to enable; write a zero (0) to disable.

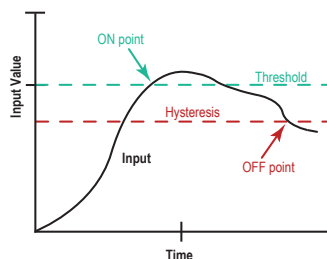
High/Low Register for Counter

The low and high registers for the counter hold the 32-bit counter value. To erase the counter, write zeroes to both registers. To preset a counter value, write that value to the appropriate register.

Hysteresis and Threshold

Threshold and hysteresis work together to establish the ON and OFF points of an analog input. The threshold defines a trigger point or reporting threshold (ON point) for a sensor input. When the input value is higher than the threshold, the input is ON. Hysteresis defines how far below the threshold the analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit’s range.

In the example shown, the input is considered on at 15 mA. To consider the input off at 13 mA, set the hysteresis to 2 mA. The input will be considered off when the value is 2 mA less than the threshold.



Input Type

Program the universal inputs to accept input types NPN, PNP, 10k thermistor, 0 to 10 V, 0 to 20 mA, or potentiometer. The default setting is 8: NPN raw fast. To set the input type, write the following values to the Input Type Modbus registers.

- 0 = NPN
- 1 = PNP
- 2 = 0 to 20 mA
- 3 = 0 to 10 V DC
- 4 = 10k Thermistor
- 5 = Potentiometer Sense (DXM150 only)
- 6 = Not used
- 7 = Bridge
- 8 = NPN Raw Fast (default)

Temperature °C/°F

Set to 1 to represent temperature units in degrees Fahrenheit, and set to 0 (default) to represent temperature units in degrees Celsius.

9.2.11 Modbus Configuration Registers for Power

To monitor the input power characteristics of the DXM, read the following power Modbus registers. The on-board thermistor is not calibrated, but can be used as a non-precision temperature input.

Table 30: Configuration registers for power

Modbus Register	Description
6071	Battery backup charging algorithm. 0 = Battery is recharged from a solar panel 1 = Battery is recharged from 12 to 30 V DC (default)
6081	Battery voltage (mV). If no battery is present, the value in this register is less than 5 V. If the value in this register is greater than the incoming voltage register, the battery is powering the system.
6082	Battery charging current (mA). The charging configuration charges the battery when the incoming voltage register value is greater than the battery voltage register value. This registers shows the charging current in milliamps.
6083	Incoming supply voltage (mV) (solar or power supply). The incoming power can be from a solar panel or from a power supply. The battery is charging when the incoming voltage register value is greater than the battery voltage register value. The battery is powering the system when the incoming voltage register value is less than the battery voltage register value.
6084	On-board thermistor temperature (°C). A thermistor measures the temperature of the solar controller board and its surrounding area and uses the temperature as part of the battery charge calculations. This register stores the thermistor reading in tenths of degrees C. This is not a calibrated input: divide by 10 to calculate the temperature in degrees C. For calibrated temperature inputs, define one of the universal inputs as a temperature input.

9.2.12 Modbus Registers for the LCD Board (Modbus Slave ID 201)

Control the four user-defined LEDs using the display board's Modbus registers. Using write maps or ScriptBasic, write the Modbus registers shown below with 0 (off) or 1 (on). The LCD display is Modbus Slave 201.

Modbus Register	I/O Connection	Modbus Register	I/O Connection
1102 : bit 0	LED 1	1104 : bit 0	LED 3
1103 : bit 0	LED 2	1105 : bit 0	LED 4

Using the Display LEDs

Turn on the DXM LEDs by writing to the LEDs' Modbus registers.

This example shows how to configure the DXM using the configuration software to read four universal inputs and write the state values to the display LEDs.

1. Using the configuration software, go to the **Local Registers > Local Registers in Use** screen.
2. Define the local registers by assigning names to the first four registers and setting the LCD permissions parameter to read/write. The LCD permissions show the register contents on the LCD menu under the **REGISTER** menu. You can also set the value from the LCD menu.

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Figure 45. Local Registers in Use screen

ID	Register Name	Register Group	Units	Signed	Constant or Timer	Cloud Permissions	LCD Permissions	Protocol Conversion	Log Files	Cyclic Push	Read Rules
1	Display LED1		None	No		None	Read/Write	None	None	None	
2	Display LED2		None	No		None	Read/Write	None	None	None	
3	Display LED3		None	No		None	Read/Write	None	None	None	
4	Display LED4		None	No		None	Read/Write	None	None	None	

3. Create a **Read Rule** to read the four universal inputs from the I/O board (Modbus slave 200) and write the values in local registers 1 through 4.

Figure 46. RTU Read rules

4. Create a **Write Rule** to write the four local register values to the DXM display registers 1102 through 1105 (Modbus Slave 201). Define the **Write Rule** to only write the display registers when the inputs change.

Figure 47. RTU Write rules

5. Save the XML configuration from the **File > Save As** menu.
6. Connect to the DXM using a USB cable and select **Device > Connection Settings** from the menu bar.
7. Upload the XML configuration file to the DXM by selecting **Device > Upload Configuration to Device** from the menu bar.

After a configuration file is uploaded, the DXM reboots. The new configuration is now running.

Turning on any one of the universal inputs 1 through 4 on the I/O base board of the DXM now turns on an LED on the display.

9.3 Using Courtesy Power or Switch Power

Pin 18 of the DXM100/1000-Bx Wireless Controller is a constant power source that supplies 5 volts up to 500 mA.

Pins 21 (switch power 2) and 30 (switch power 1) are switched power outputs. Configure the switched power outputs using Modbus registers or by using the DXM Configuration Software's **Settings > I/O Board** screen. The output voltage can be selected and is controlled using a Modbus register on the I/O board (Modbus slave ID 200). The voltage options are:

- 5 volts or 16 volts for DXM100-B1 models; or
- 5 to 24 V dc for DXM100-B2 models.

Turn the switched power on or off using the output register 505 for switch power 1 or 506 for switch power 2. For continuous power, set the Default Output register to 1, then cycle the power.

Switch Power	Enable Register	Enable Register Value	Voltage Register	Voltage Register Value	Default Output Register	Output Register
1 (pin 30)	2201	Write a 0 to turn OFF Write a 1 to turn ON (default)	3601	Write a 0 to select 5 V (default) Write a 1 to select 16 V Write a __ to select 24 V (DXM100-B2 model only)	3602	505
2 (pin 21)	2251		3621		3622	506

Enable Register

Configuration registers that turn on the ability to use the switched power output.
Default setting = ON

Voltage Register

Configuration registers that define the output voltage to the switched power output.
Default setting = 5 V

Default Output Register

Configuration registers that turn on the switched power outputs for continuous power out.
Set register to 1 for continuous power. Cycle power if this register is changed.
Default setting = 0

Modbus Output Register

Turn on or turn off the voltage output. If both outputs 505 and 506 are turned on at the same time but are set to different voltages, the output voltage is 5 V for DXM100-B1 models and set to the lower voltage setting for DXM100-B2 models.

9.4 Associating a Switched Power Output to an Input

Use the DXM Configuration Software to associate a switched power output to a universal input.

Switched power 1 and 2 (pins 30 and 21) can be associated to any Universal input to apply power to a sensor, take a reading, and then remove power from the sensor. This conserves power in battery-operated systems. The switched power supply can be used in one of two different ways: supplying courtesy power to an output pin or associated to an input. (Only one method can be active at a time.)

To manually configure the switched power output using I/O board Modbus registers, write the specified value to the listed register.

Courtesy Power Output Configuration Parameters ⁷	Modbus Registers to Write To	
	Switched Power 1	Switched Power 2
Switched Power Enable	2201	2251
Voltage	3601	3621
Default Output	3602	3622
Output Register	505	506

Default Output

Set the register value to 1 for continuous power. The default setting is 0.
Cycle power if this register value is changed.

Output Register

Write to the Output register to turn on or turn off the voltage output.
If both Output Registers 505 and 506 are turned on at the same time, but are set to different voltages, the output voltage is 5 V for DXM100-B1 models and set to the lower voltage setting for DXM100-B2 models.

⁷ Only used when supply courtesy power to the output pin, not when associating switched power to an input.

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Switched Power Enable

Enables the switched power supply. Set to 1 to enable; set to 0 to disable.

This does not enable the supply output to the actual output pin. To enable the supply output to the output pin, set Modbus register 505 or 506 to 1. Set to 0 when associating the switched power supply to an input.

Voltage

For the B1 and S1 models, set the Modbus register value to 0 for a switched power supply at 5 volts. Set the Modbus register value to 1 for a switched power supply at 16 volts.

For the B2 and S2 models, set one of the following register values to select your switched power output voltage.

- For 5 V, set the Modbus register to 204.
- For 7 V, set the Modbus register to 125.
- For 10 V, set the Modbus register to 69.
- For 15 V, set the Modbus register to 32.
- For 20 V, set the Modbus register to 12.
- For 24 V, set the Modbus register to 3.

When associating a switched power supply to an input, set the **Switch Power Output Enable** register to off (0). Set Modbus register 2201 for switched power 1 and Modbus register 2251 for switched power 2. This allows the input sampling mechanism to control the output.

Use the following configuration parameters to define the switch power associated with an input.

Input Parameter	Universal Input Configuration Parameter Modbus Registers to Write To			
	Universal Input 1	Universal Input 2	Universal Input 3	Universal Input 4
Input Enable	1001	1051	1101	1151
Sample Interval (high)	1002	1052	1102	1152
Sample Interval (low)	1003	1053	1103	1153
Switched Power Enable Mask	1004	1054	1104	1154
Switched Power Warmup	1005	1055	1105	1155
Switched Power Voltage	1006	1056	1106	1156
Extended Input Read	1007	1057	1107	1157
Input Out-of-Sync Enable	1008	1058	1108	1158

Extended Input Read

The Extended Input Read is a bit field parameter that allows multiple inputs to be sampled with the same switch power parameters.

If the bit field is set to 0x000F, the first four inputs are sampled after the switch power parameters are satisfied.

If the Extended Input Read parameter is set in the Universal input 1 configuration registers, set Universal inputs 2 through 4 **Extended Input Read** and **Sample Interval** parameters to zero.

Input Enable

Set to 1 to enable the input. Set to 0 to disable the input.

Out-of-Sync Enable

To enable the input to continue operating when the device is out of sync with the master radio, set to 1.

To disable the input when the device is not synchronized to the master radio, set to 0.

Sample Interval (high), Sample Interval (low)

The sample interval (rate) is a 32-bit value (requires two Modbus registers) that represents how often the I/O board samples the input.

The register value is the number of time units. One time unit is equal to 0.01 seconds.

For example, a Modbus register value of 1000 represents a sample interval of 10 seconds (1000 × 0.010 seconds = 10 seconds).

Switch Power Enable Mask

The Switch Power Enable Mask works with the warm-up and voltage parameters to define the switch power output. The bit mask can select any number of switch powers.

- 0x0 - No switch power enabled
- 0x1 - Enable Switch Power 1
- 0x2 - Enable Switch Power 2
- 0x3 - Enable Switch Power 1 and Switch Power 2

Switch Power Voltage

The Switch Power Voltage parameter defines the output voltage of the switch power output.

This parameter applies only to inputs using switched power. If switch power is not used with an input, use the Courtesy Power Voltage parameter to control the voltage.

See *Voltage* entry for Modbus register values used to select the output voltage.

Switch Power Warm-up

When an input controls power to external sensors, the Switch Power Warm-up parameter defines how long power is applied to the external sensor before the input point is examined for changes.

The register value is the number of time units, and a time unit is 0.01 seconds. For a warm-up time of 1 second, this parameter value is 100 (0.01 seconds × 100 = 1 second).

Associate Universal Input 1 with Switch Power 1

To associate universal input 1 with switched power 1, follow these instructions. Set Input 1 to sample every 60 seconds, with a warmup time of 10 seconds.

1. Verify Switched Power 1 Output Enable is off (0). Set Modbus Register 2201 = 0
2. Set the **Sample Interval** to 1 minute. Modbus Registers 1002 = 0, 1003 = 6000 (0.01 seconds × 6000 = 60 seconds).
3. Set the **Switched Power Enable Mask** to use Switch Power 1. Modbus Register 1004 = 1
4. Set the **Switched Power Warm-up** time to 10 seconds. Modbus Register 1005 = 1000 (0.01 seconds × 1000 = 10 seconds).
5. Set the **Switched Power Voltage** to 16 volts. Modbus Register 1006 = 1.

9.5 Working with Solar Power

A reliable solar system requires careful planning and monitoring to size the components correctly. The recommendations provided are for the DXM system as an autonomous system.

Adding extra components increases the power requirements and likely requires increasing the solar system components. Depending upon the geographical location, the size of the solar panel and battery may vary.

9.5.1 Setting the DXM for Solar Power

By default, the DXM is set from the factory to charge a backup battery from a line power source.

For DXM models with an LCD, use the buttons and menu system to change the charging algorithm to solar power. Go to **System Config > I/O Board > Charger**. Use the up/down arrows to select **Solar**.

For DXM models without an LCD, use the configuration software to adjust the I/O board Modbus register 6071. Set the register to 0 to select battery charging from a solar panel, and set to 1 to select battery charging from incoming 12 to 30 V DC supply.

To minimize the power consumption (may not apply to all models):

- If Ethernet is not being used, save up to 25% of the consumed power by disabling Ethernet. Set DIP switch 1 to the ON position on the processor board then reboot.
- Instead of powering external devices all the time, take advantage of the switched power mechanisms to turn off devices when possible.
- Minimize the number of cellular transactions and the amount of data pushed across the cellular modem.

9.5.2 Solar Components

The components of a solar system include the battery and the solar panel.

Battery

The DXM solar controller is designed to use a 12 V sealed lead acid (SLA) battery. The characteristics of a solar system require the battery to be of a certain type. There are two types of lead acid batteries:

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- SLI batteries (Starting Lights Ignition) designed for quick bursts of energy, like starting engines
- Deep Cycle batteries - greater long-term energy delivery. This is the best choice for a solar battery.

Since a solar system charges and discharges daily, a deep cycle battery is the best choice. There are different versions of a lead acid battery: wet cell (flooded), gel cell, and an absorbed glass mat (AGM).

Wet cell batteries are the original type of rechargeable battery and come in two styles, serviceable and maintenance free. Wet cell batteries typically require special attention to ventilation as well as periodic maintenance but are the lowest cost. The gel cell and AGM battery are sealed batteries that cost more but store very well and do not tend to sulfate or degrade as easily as a wet cell. Gel or AGM batteries are the safest lead acid batteries you can use.

Battery capacity is a function of the ambient temperature and the rate of discharge. Depending upon the specific battery, a battery operating at -30 °C can have as much as 40 percent less capacity than a battery operating at 20 °C. Choose enough battery capacity based on your geographical location.

Table 31: Average voltage readings relative to battery charge

State of Charge (%)	Open Circuit Voltage
100	13.0 or higher
75	12.6
50	12.1
25	11.66
0	11.4 or less

A larger capacity battery typically lasts longer for a given solar application because lead-acid batteries do not like deep cycling (discharging a large percentage of its capacity). Depending upon the battery, a battery discharging only 30 percent of its capacity before recharging will have approximately 1100 charge/discharge cycles. The same battery discharging 50 percent of its capacity will have approximately 500 charge/discharge cycles. Discharging 100 percent leaves the battery with only 200 charge/discharge cycles.

Use this information as a guide to the approximate state of charge and in determining when to apply conservation measures. Batteries degrade over time based on discharge/charge cycles and environmental conditions. Always monitor the battery system to obtain the best performance of the solar powered system.

Solar Panel

Banner solar panels come in two common sizes for the DXM: 5 Watt and 20 Watt. Both panels are designed to work with the DXM but provide different charging characteristics. Use the 5 watt panel for light duty operation and use the 20 watt panel when you require greater charging capabilities.

Solar Panel	Voltage	Current	Typical DXM Configurations
5 Watt	17 V	0.29 A	DXM Controller configured as a slave, ISM radio, I/O base board
20 Watt	21 V	1 A	DXM Controller with ISM radio and Cellular modem

Photovoltaic panels are very sensitive to shading. Unlike solar thermal panels, PV solar panels cannot tolerate shading from a branch of a leafless tree or small amounts of snow in the corners of the panel. Because all cells are connected in a series string, the weakest cell will bring down the other cells' power level.

Good quality solar panels will not degrade much from year to year, typically less than 1 percent .

To capture the maximum amount of solar radiation throughout the year, mount a fixed solar panel to optimize the sun's energy. For the northern hemisphere, face the panel true south. For the southern hemisphere, face the panel true north. If you are using a compass to orientate the panels, compensate for the difference between true north and magnetic north. Magnetic declination varies across the globe.

A solar panel's average tilt from horizontal is at an angle equal to the latitude of the site location. For optimum performance, adjust the tilt by plus 15 degrees in the winter or minus 15 degrees in the summer. For a fixed panel with a consistent power requirement throughout the year, adjust the tilt angle to optimize for the winter months: latitude plus 15 degrees. Although in the summer months the angle may not be the most efficient, there are more hours of solar energy available.

For sites with snow in the winter months, the increased angle helps to shed snow. A solar panel covered in snow produces little or no power.

9.5.3 Recommended Solar Configurations

These solar panel and battery combinations assume direct sunlight for at least two to three hours a day. Solar insolation maps provide approximate sun energy for various locations. The depth of battery discharge is assumed to be 50 percent.

Table 32: Solar panel and battery combinations for a DXM system

Solar Panel Output (W)	Battery Capacity (Ahr)	Days of Autonomy	DXM Current (mA)	DXM Model
5	10	10	25	DXM-Sx models with an ISM radio and I/O base board
20	14	10	30	DXM-Bx models with an ISM radio and no cellular modem
20	20	10	35	DXM-Bx models with an ISM radio and cellular modem

Battery capacity (amp hour) is a standard amp rating taken for 20 hours. Battery capacity should be monitored for reliable system power and may need to be increased for cold weather locations.

9.5.4 Monitoring Solar Operation

The DXM solar controller provides Modbus registers that allow the user to monitor the state of the solar panel input voltage, the battery voltage, the charging current, and the temperature in °C. The DXM can be configured to monitor the health of the charging system as well as send an alert message when the battery is too low.

The charts show a typical charging cycle, with each vertical grid representing about eight hours. The chart shows three days of charging.

Figure 48. Solar Panel Voltage (mV) -- Cloudy First Day

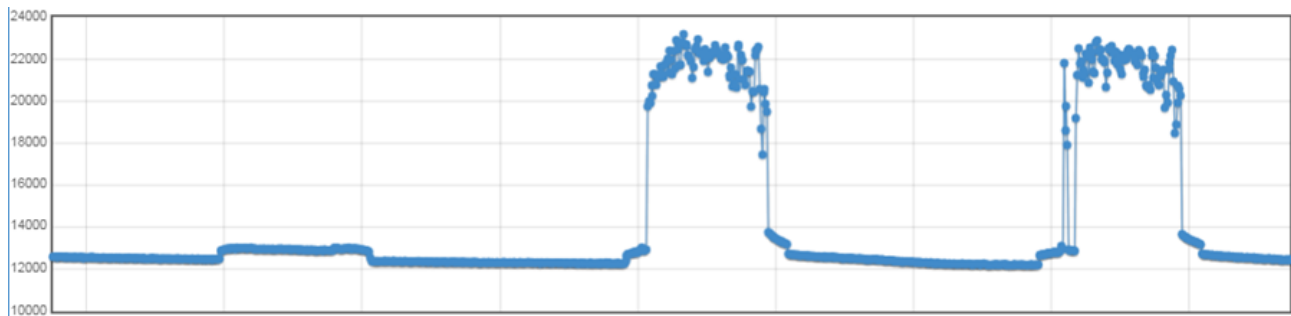
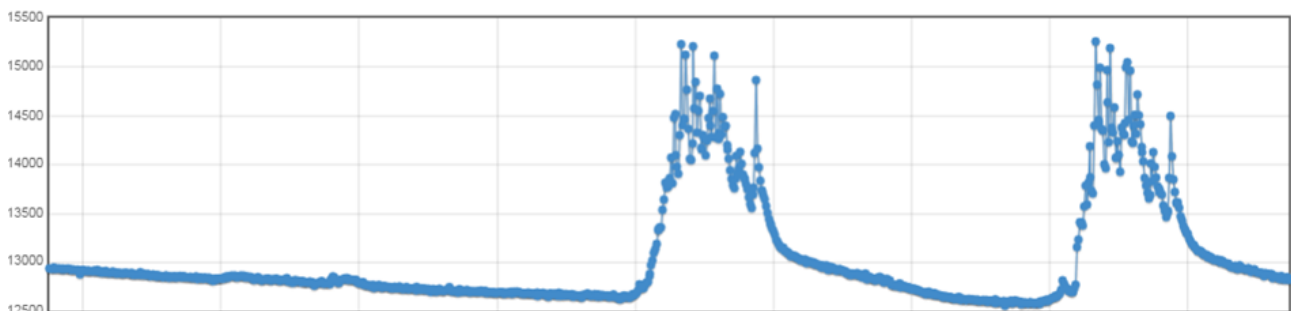


Figure 49. Battery Voltage (mV) - Cloudy First Day



9.6 Clear the Password for the DXM100 and DXM150 Models Only

By default, the DXM Controllers does not require a password to load a configuration file. If a password is defined, the password must be entered before uploading a configuration file. To change the password, you must already know the current password. If you do not know the current password, follow these steps to clear the password.



Important: Clearing the password erases the current configuration and any program files, log files, or history files.

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Important: DO NOT follow these instructions if you have a DXM700, DXM1000, or DXM1500 model. If you attempt to clear the password of a DXM700, DXM1000, or DXM1500 with these instructions, the firmware of your device will be erased and your controller will no longer function.

1. Turn the power OFF to the DXM Controller.
2. Set DIP switch 4 to the ON position.
3. Press and hold the processor button.
4. Turn the power ON to the DXM Controller.
The processor board's LED flashes to indicate the process is complete (about 10-20 seconds).
5. Set DIP switch 4 to the OFF position.
6. Cycle power to the DXM Controller.
7. Reload the configuration file before resuming normal operation.

9.7 Clear the Password on DXM700-Bx, DXM1000-Bx, or DXM1200-Bx Models

By default, the DXM Controllers do not require a password to load a configuration file. If a password is defined, the password must be entered before uploading a configuration file.

To change the password, you must already know the current password. If you do not know the current password, follow these steps to clear the password.



Important: Clearing the password erases the current configuration and any program files, log files, or history files.

1. Turn on the power to the DXM Controller.
2. Set DIP switch 4 to the ON position.
3. Press and hold the processor button until processor board LED flashes.
4. Set DIP switch 4 to the OFF position.
5. Cycle power to the DXM Controller.
6. Reload the configuration file before resuming normal operation.

10 PROFINET®

PROFINET is a data communications protocol for industrial automation and processes. PROFINET IO defines how controllers (IO controllers) and peripheral devices (IO devices) exchange data in real time. PROFINET® is a registered trademark of PROFIBUS Nutzerorganisation e.V. and the standard is maintained by PROFIBUS & PROFINET International (PI), an organization headquartered in Karlsruhe, Germany.

Only the DXMR90, DXM700, DXM1000, and DXM1200 Controller models support PROFINET IO.

10.1 General Station Description Markup Language File

A PROFINET General Station Description (GSD) file is a description of an IO device provided by the device manufacturer in an XML format (GSDML.xml).

The GSD file is a standardized way of describing the device information to engineering tools and the IO controller and can work across a variety of tools as a standard set of device information.

10.2 DXM PROFINET IO Data Model

The PROFINET IO data model is based on the typical, expandable field device that has a backplane with slots. Modules have different functionalities.

Modules are plugged into slots. In the PROFINET IO data model Slot 0, Subslot 1 is reserved for the Device Access Point (DAP) or network interface.

- Inputs Integer Module sends integer data to the PLC
- Inputs Floats Module sends floating point data to the PLC
- Output Integer Module receives integer data from the PLC

10.3 Configure the DXM Controller for a PROFINET IO Connection

To use PROFINET, follow these instructions.

1. Using the DXM Configuration Software, go to the **Settings > Ethernet** screen.
2. Select **Enable PROFINET**.
3. Save the configuration file and upload it to the DXM Controller (see [Save and Upload the Configuration File](#) on page 17).

After PROFINET is enabled, the IP address for the DXM Controller is controlled by the PROFINET host. The LCD display and DXM Configuration Software no longer control the setting of the IP address. The PROFINET IP address settings are invisible to the LCD display and the DXM Configuration Software.

The PROFINET data type and data size to/from the DXM Controller is configurable. The PROFINET data is processed from the Local Register of the DXM Controller.

Configure the Local Registers to match the PROFINET module definitions in the host PLC.

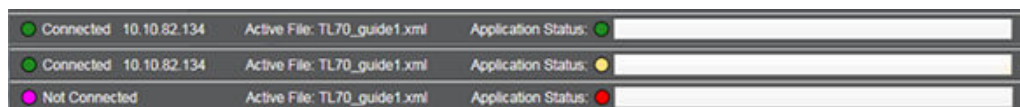
10.3.1 Save and Upload the Configuration File

After making any changes to the configuration, you must save the configuration files to your computer, then upload it to the device.

Changes to the XML file are not automatically saved. Save your configuration file before exiting the tool and before sending the XML file to the device to avoid losing data. If you select **DXM > Send XML Configuration to DXM** before saving the configuration file, the software will prompt you to choose between saving the file or continuing without saving the file.

1. Save the XML configuration file to your hard drive by going to the **File > Save As** menu.
2. Go to the **DXM > Send XML Configuration to DXM** menu.

Figure 50. Status indicator bar



- If the Application Status indicator is red, close and restart the DXM Configuration Tool, unplug and re-plug in the cable and reconnect the DXM to the software.
- If the Application Status indicator is green, the file upload is complete.
- If the Application Status indicator is yellow, the file transfer is in progress.

The device reboots and begins running the new configuration.

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10.4 Slots and Modules

There are nine slots to accommodate the DXM Controller data.

Table 33: Slots for input and output values

Values	Slots	Maximum Data Size
Input values	1–6	1440 bytes
Output values	7–9	1440 bytes

Table 34: Listing of slots for input and output values

Slot	PLC		DXM Local Register		Module Size
	Module Definition		Start	End	512
Slot 1	Inputs Integer	<-	1	256	
Slot 2	Inputs Integer	<-	257	512	
Slot 3	Inputs Integer	<-	513	768	
Slot 4	Inputs Float	<-	1001	1256	
Slot 5	Inputs Float	<-	1257	1512	
Slot 6	Inputs Float	<-	1513	1768	
Slot 7	Output Integer	->	5001	5256	
Slot 8	Output Integer	->	5257	5512	
Slot 9	Output Integer	->	5513	5768	

The DXM Local Register association shown uses a Module size of 512 bytes, which equals 256 Local Registers in the DXM. Module sizes supported are 64, 128, 256 and 512 bytes. Input Integers are data from the DXM to the PLC. Output integers are data from the PLC to the DXM.

Table 35: Slots 1 through 3

Module	Notes
Input Integer 512	Allowed in slots 1-3, Module Identifier= 0x30
Input Integer 256	Allowed in slots 1-3, Module Identifier= 0x31
Input Integer 128	Allowed in slots 1-3, Module Identifier= 0x32
Input Integer 64	Allowed in slots 1-3, Module Identifier= 0x33

Table 36: Slots 4 through 6

Module	Notes
Input Float 512	Allowed in slots 4-6, Module Identifier= 0x34
Input Float 256	Allowed in slots 4-6, Module Identifier= 0x35
Input Float 128	Allowed in slots 4-6, Module Identifier= 0x36
Input Float 64	Allowed in slots 4-6, Module Identifier= 0x37

Table 37: Slots 7 through 9

Module	Notes
Output Integer 512	Allowed in slots 7-9, Module Identifier= 0x40
Output Integer 256	Allowed in slots 7-9, Module Identifier= 0x41
Output Integer 128	Allowed in slots 7-9, Module Identifier= 0x42
Output Integer 64	Allowed in slots 7-9, Module Identifier= 0x43

Example Configuration

Table 38: Example configuration for slots and modules

Slot	Module	Description
Slot 1	Input Integer 512	The two input integer modules have a total of 640 bytes (320 Modbus registers) The data will come from DXM Local Registers 1 through 320
Slot 2	Input Integer 128	
Slot 4	Input Float 128	The input Floating register module has a total of 128 bytes (64 Modbus registers) Since it takes two Modbus registers to make a 32-bit floating value, there will be 32 floating point values coming from Local Registers 1001-1064
Slot 7	Output Integer 64	The output integer 64 module has a total of 64 bytes (32 Modbus registers). The data will come from the PLC and be put into DXM Local Registers 5001 through 5032

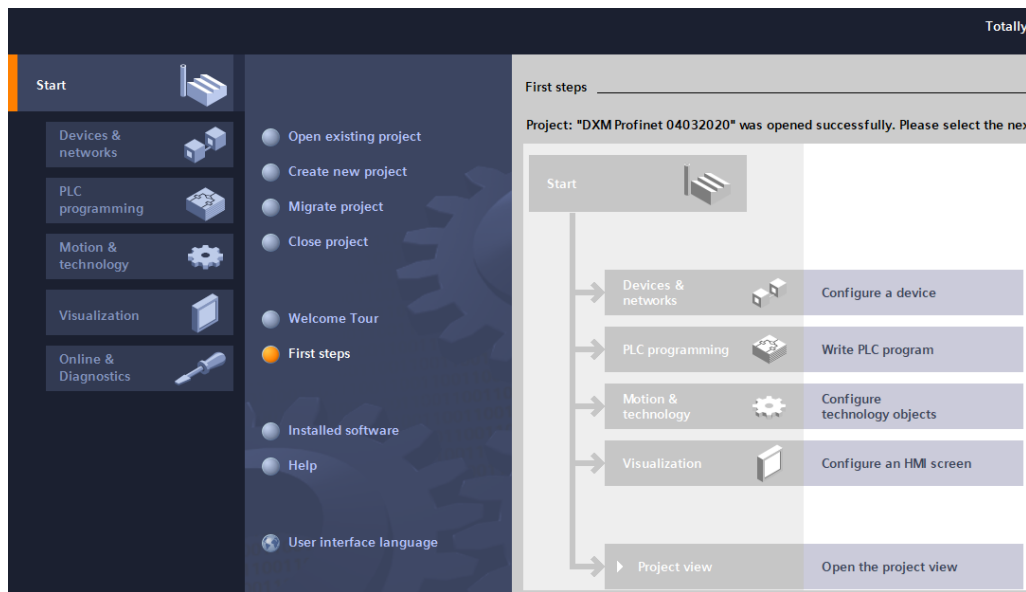
10.5 Configuration Instructions

10.5.1 Install the GSD File

Although these instructions are specific for the Siemens TIA Portal (v14) software, you may use these instructions as a basis for installing the GSD file into another controller.

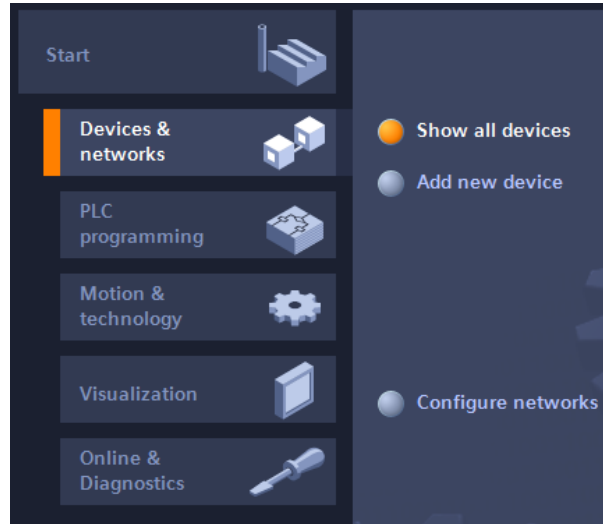
1. Download the GSD file from www.bannerengineering.com.
2. Launch the Siemens TIA Portal (v14) software.
3. Click **Open existing project**.
4. Select a project and open it.
5. After the project is uploaded, click **Devices & networks**.

Figure 51. Devices and networks screen



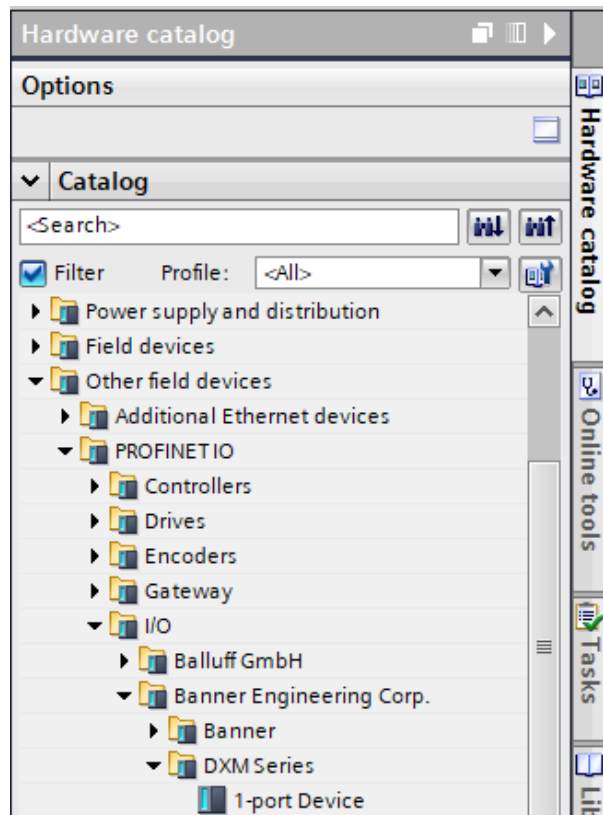
6. Click **Configure networks**.

Figure 52. Configure networks screen



7. Click **Options** and select **Manage general station description file (GSD)**.
The **Install general station description file** window opens.
8. Click the **More options (...)** icon to the right of the **Source path** field and browse to the location the DXM GSD file was downloaded to.
9. Select the DXM GSD file.
10. Click **Install**.

Figure 53. Hardware catalog



The system installs the DXM GSD file and places it in the **Hardware catalog**. In the example, the DXM GSD file is located under **Other field devices > PROFINET IO > Banner Engineering Corp. > Banner**.

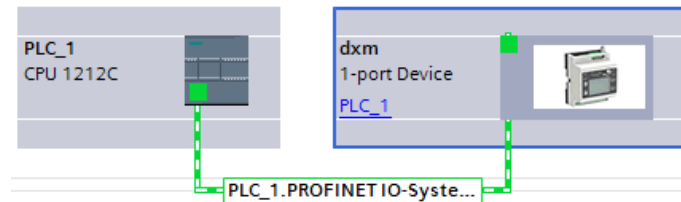
If the DXM GSD file does not install properly, save the log and contact Banner Engineering Corp.

10.5.2 Change the Device IP Address

Follow these instructions to change the IP address of the DXM device using the Siemens TIA Portal (v14) software. Use these instructions as a basis if you are using another controller (PLC).

1. Launch the Siemens TIA Portal (v14) software.
2. Click **Open existing project**.
3. Select a project and open it.
4. Click **Devices & networks**.

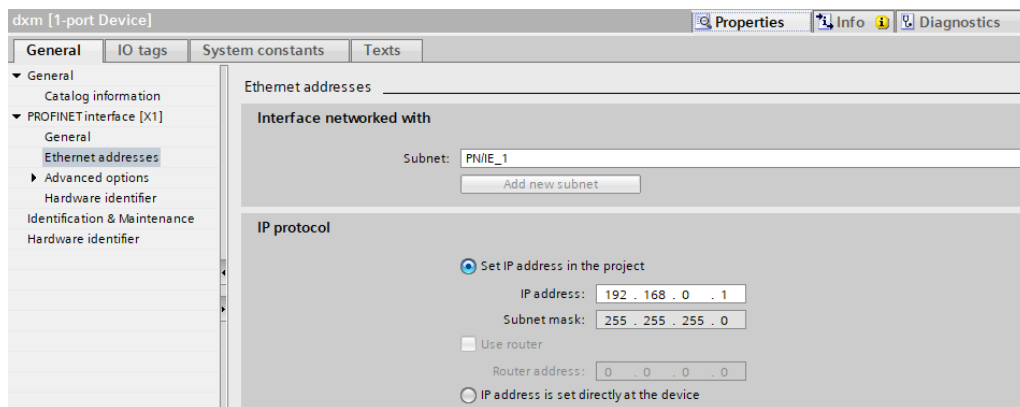
Figure 54. Network view



The **Network view** displays.

5. Double-click on the DXM icon to open the **Device view** screen.
6. Click on the DXM icon in the graphic area of the **Device view** screen. The **Module properties** window displays and the module can now be configured.
7. Click **Properties**.
8. Click **General**.
9. Select **PROFINET Interface > Ethernet addresses**.

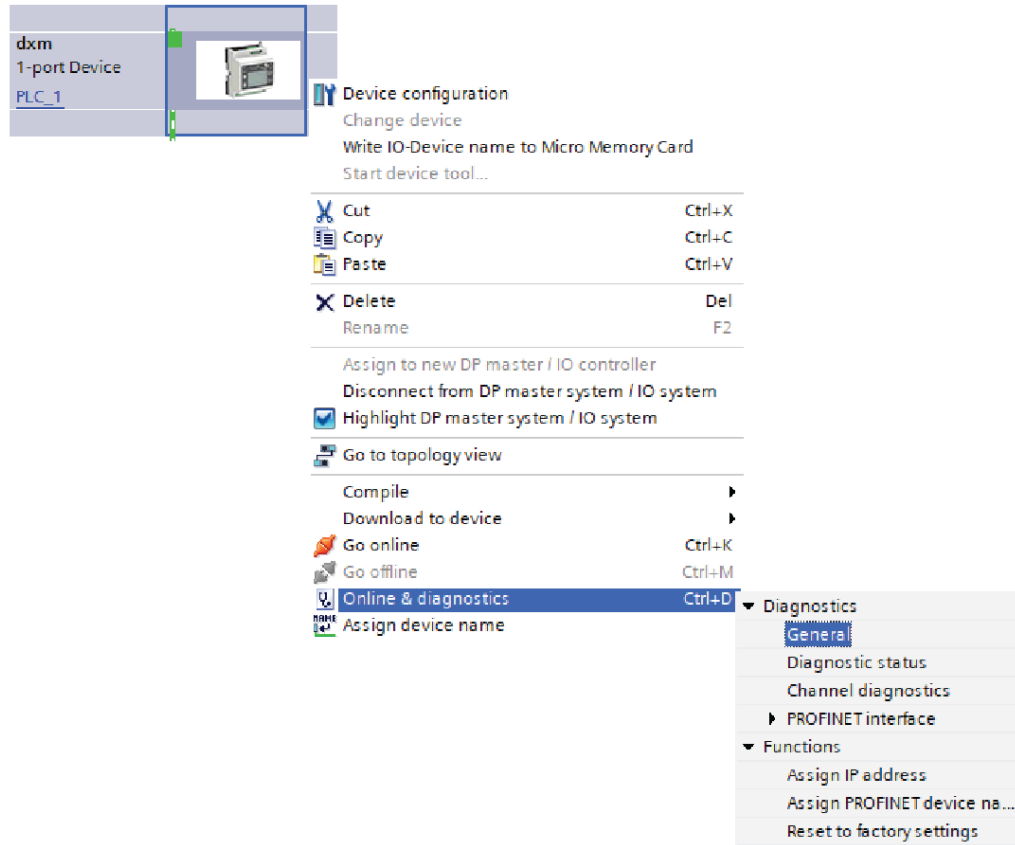
Figure 55. Ethernet addresses



10. Select **Set IP address in the project**.
11. Enter the IP address.
12. Right-click on the device icon and select **Online & diagnostics**.

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Figure 56. Online & diagnostics menu and screen



The **Online & diagnostics** windows displays.

13. Select **Assign IP address** under **Functions**.

14. Click **Accessible devices**.

The Select device window searches the network for available devices.

15. Determine the device to be adjusted via the MAC address and select it.

16. Click **Apply**.

The IP address for the device is updated.

17. Click **Assign IP address** to complete the step.

This step is completed for every device.

By default, each DXM shipped from the factory is assigned the IP address 192.168.0.1.

Immediately after the PROFINET protocol is enabled, the DXM has an IP address of 0.0.0.0. We recommend using the TIA Portal to give the DXM an IP address so that the address is saved in the unit. When the PLC powers up, this IP address is accessible. The PLC can change the IP address if it is configured to do so.

If the PLC assigns the DXM IP address (for example, using the Set IP address in the project option in Siemens TIA Portal), the DXM receives the specified address, but only after the program has been loaded into the PLC and is running. If the DXM is restarted after it was discovered and configured by the PLC, the DXM retains the IP address that was assigned to it using the LCD or software until after the PLC discovers the DXM and assigns it the specified address again. However, if this address is different than what is specified in the PLC, the DXM reverts to the address specified in the PLC after the PLC becomes active again.

These configuration options conform to the PROFINET standard.

10.5.3 Change the Device Name

Follow these instructions to change the name of the DXM using the Siemens TIA Portal (v14) software. Use these instructions as a basis if you are using another controller (PLC).

1. Open a project and click on **Devices & networks**.

The Network view displays.

2. Right-click on the DXM icon and select **Assign device name**.

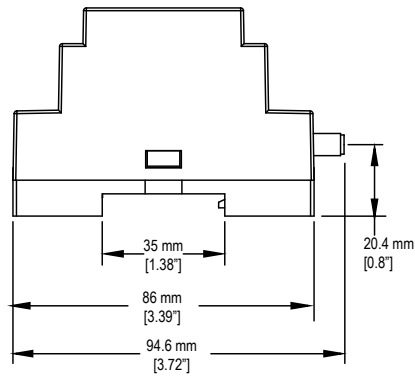
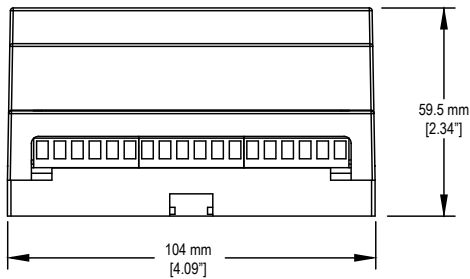
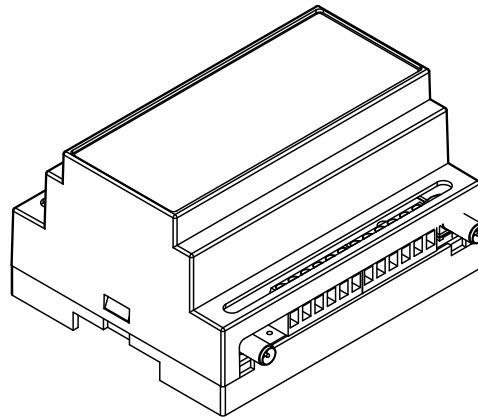
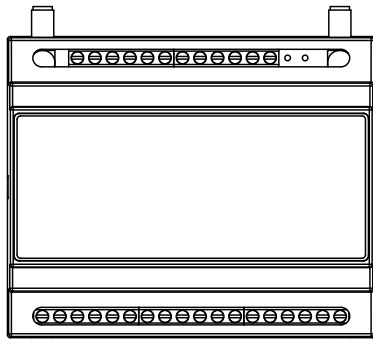
The **Assign PROFINET device name** window displays. The software searches for devices of the same type.

3. Enter the desired name in the **PROFINET device name** field. Note that each name can be used only once.
4. Click **Assign name**.
The device now has a PROFINET name.

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11 DXM100 and DXM1000 Dimensions

All measurements are listed in millimeters, unless noted otherwise.



12 Accessories

For a complete list of all the accessories for the Sure Cross wireless product line, please download the Accessories List (p/n [b_3147091](#)).

Cordsets

MQDC1-506—5-pin M12/Euro-style, straight, single ended, 6 ft
 MQDC1-530—5-pin M12/Euro-style, straight, single ended, 30 ft
 MQDC1-506RA—5-pin M12/Euro-style, right-angle, single ended, 6 ft
 MQDC1-530RA—5-pin M12/Euro-style, right-angle, single ended, 30 ft

Static and Surge Suppressor

BWC-LFNBMN-DC—Surge Suppressor, bulkhead, N-Type, dc Blocking, N-Type Female, N-Type Male

Short-Range Omni Antennas

BWA-2O2-D—Antenna, Dome, 2.4 GHz, 2 dBi, RP-SMA Box Mount
 BWA-9O2-D—Antenna, Dome, 900 MHz, 2 dBi, RP-SMA Box Mount
 BWA-9O2-RA—Antenna, Rubber Fixed Right Angle, 900 MHz, 2 dBi, RP-SMA Male Connector

Medium-Range Omni Antennas

BWA-9O5-C—Antenna, Rubber Swivel, 900 MHz 5 dBi, RP-SMA Male Connector
 BWA-2O5-C—Antenna, Rubber Swivel, 2.4 GHz 5 dBi, RP-SMA Male Connector

Enclosures and DIN Rail Kits

[BWA-AH864](#)—Enclosure, Polycarbonate, with Opaque Cover, 8 × 6 × 4
[BWA-AH1084](#)—Enclosure, Polycarbonate, with Opaque Cover, 10 × 8 × 4
[BWA-AH12106](#)—Enclosure, Polycarbonate, with Opaque Cover, 12 × 10 × 6
 BWA-AH8DR—DIN Rail Kit, 8", 2 trilobular/self-threading screws
 BWA-AH10DR—DIN Rail Kit, 10", 2 trilobular/self-threading screws
 BWA-AH12DR—DIN Rail Kit, 12", 2 trilobular/self-threading screws

Misc Accessories

BWA-CG-5-3X5.6-10—Cable Gland Pack: 1/2-inch NPT, Cordgrip for 3 holes of 2.8 to 5.6 mm diam, 10 pack
 BWA-HW-052— Cable Gland and Vent Plug Pack: includes 1/2-inch NPT gland, 1/2-inch NPT multi-cable gland, and 1/2-inch NPT vent plug, one each

Antenna Cables

BWC-1MRSMN05—LMR200 RP-SMA to N-Type Male, 0.5 m
 BWC-2MRSFRS6—LMR200, RP-SMA Male to RP-SMA Female Bulkhead, 6 m
 BWC-4MNFN6—LMR400 N-Type Male to N-Type Female, 6 m

Long-Range Omni Antennas

BWA-9O8-AS—Antenna, Fiberglass, 3/4 Wave, 900 MHz, 8 dBi, N-Type Female Connector
 BWA-2O8-A—Antenna, Fiberglass, 2.4 GHz, 8 dBi, N-Type Female Connector

Long-Range Yagi Antennas

BWA-9Y10-A—Antenna, 900 MHz, 10 dBd, N-Type Female Connector

Cellular Antenna

BWA-CELLA-002—Cellular multiband, 2 dBi, RP-SMA male connection, 6.3 inch blade style. Datasheet: [b_4475176](#)

Power Supplies

[PSD-24-4](#)—DC Power Supply, Desktop style, 3.9 A, 24 V dc, Class 2, 4-pin M12/Euro-style quick disconnect (QD)
[PSDINP-24-13](#) —DC power supply, 1.3 Amps, 24 V DC, with DIN Rail Mount, Class I Division 2 (Groups A, B, C, D) Rated
[PSDINP-24-25](#) — DC power supply, 2.5 Amps, 24 V DC, with DIN Rail Mount, Class I Division 2 (Groups A, B, C, D) Rated
[BWA-SOLAR PANEL 20W](#)—Solar Panel, 12 V, 20 W, Multicrystalline, 573 × 357 × 30, "L" style mounting bracket included (does not include controller)

13 Product Support and Maintenance

13.1 File System and Archive Process

The DXM file system consists of two physical components: the serial EEPROM that stores non-volatile configuration information and a removable micro SD card that stores file backup data and user created files.

EEPROM Files—The serial EEPROM stores basic data that is required to be non-volatile, including network configuration data, IP address, MAC address, network masks, firewall settings, and authentication information. The controller XML configuration file created by the DXM Configuration Software is stored in EEPROM. The small section of non-volatile local registers is also stored in EEPROM.

Micro SD Card Files—The micro SD card contains most files at the root level. The archive directory contains files kept by the system for history backup. Archive files are stored in the directory **_sxi** and are only accessible by removing the SD card.

- Data Log Files
- HTTP Push Files
- User created ScriptBasic file
- ScriptBasic program file
- CmVMon file
- **_sxi** Archive directory

Data Log files

Users may create up to four data log files using the DXM Configuration Software. The log files are stored in the root directory on the SD card. When the file size limit is reached, the filename is changed to include the date and time and the file is moved into the archive directory **_sxi**. If a finished log file is to be e-mailed, it will be done at this time and then moved into the archive directory. Archived log files are deleted based on the Clear Logs parameter.

HTTP Push File

If the DXM is configured to send data to a webserver or host system, the device creates an HTTP.LOG file on the SD card. The HTTP log is created only if the Logging Interval is non-zero and the HTTP enable log is set. An entry is placed in the HTTP log file at the Logging Interval specified by the user. At the Push Interval time, the HTTP log file is sent to the webserver or host system. If the transmission is successful, the HTTP log file is time stamped and placed into the archive directory (**_sxi**). If the transmission fails, the file remains in the root directory and subsequent Logging Intervals are appended to the file and are sent at the next Push Interval. See [Ethernet and Cellular Push Retries](#) on page 61.

User Created ScriptBasic Files

Users may use ScriptBasic to create files on the SD card by using the FILEOUT function. The filenames are fixed and up to five files can be created in the root directory.

ScriptBasic Program File

The main ScriptBasic program that runs at boot time is stored on the SD card in the root directory.

CmVMon File

The CmVMon.txt file (Cellular milli-Volt Monitor) is created by the system and is used to track power events. Every power-up cycle is date/time stamped with the voltage read from the I/O board. The value 24487 is equal to 24.487 volts. If the voltage drops below 11.2 V, another entry is put in the log file indicating the cellular modem will shut down.

CM	2015-09-22 18:52:43	VMon	Power entered normal range 24487
CM	2015-10-13 20:49:47	VMon	Power entered normal range 24004
CM	2015-10-16 15:00:20	VMon	Power entered normal range 24014
CM	2015-10-19 19:12:26	VMon	Power entered normal range 12845

_sxi Archive Directory

Only two types of files are moved into the archive directory: data log files and HTTP log files. Data log files are date/time stamped and placed into the archive directory when the size limit is reached. HTTP log files are date/time stamped then placed into the archive directory when they are successfully sent to the webserver or host system. If the HTTP log files were not successfully sent after the retries have been exhausted, the files are placed into a root directory called **sav**.

13.2 Troubleshooting

13.2.1 Restoring Factory Default Settings for the I/O Base Board

To reset the I/O base board to factory defaults, write to two Modbus registers in the base board. The default slave ID for the base board is 200.

To reset the DXM I/O base board parameters back to factory defaults:

1. Write a 1 to Modbus register 4152
2. Write a 10 to Modbus register 4151

To reboot (cycle power) the DXM I/O base board:

1. Write a 0 to Modbus register 4152
2. Write a 10 to Modbus register 4151

Table 39: Restoring Factory Defaults for the I/O Base Board

Register	Values	Description
4151	0–255	Reset/restore trigger. This timer is based in 100 millisecond units. Once written, the timer starts to count down to zero. After the timer expires, the restore factory defaults are applied if register 4152 = 1. If register 4152 is zero, the I/O board is reset. Default value: 0 1 = 100 milliseconds, 10 = 1 second.
4152	0–1	0 = Reboots (cycles power) to the I/O base board 1 = Restores factory defaults for I/O parameters

13.2.2 Updating the DXM Processor Firmware

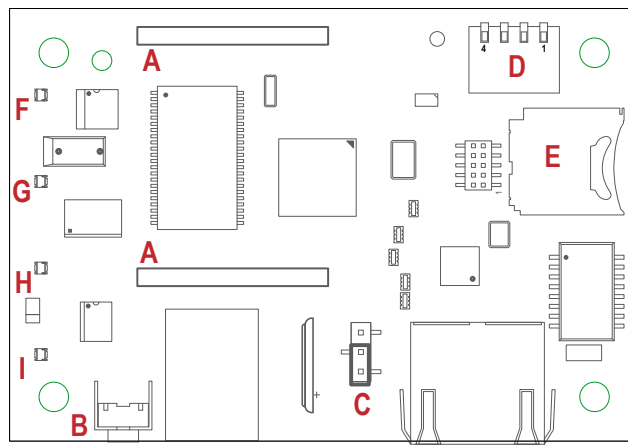
There are two different update procedures, depending on the DXM firmware version of your device.

Update Your DXM Processor Firmware (Prior to Version 2.0)

To update DXM Processor firmware prior to version 2.0, use the SAM-BA program from MicroChip/Atmel. Following these instructions to update the DXM100 or DXM150 processor firmware.

1. Download the SAM-BA software from <http://www.microchip.com/developmenttools/productdetails.aspx?partno=atmel+sam-ba+in-system+programmer>.
2. Install the SAM-BA program.
3. Set the processor board jumper (jumper C, shown below in the "boot load off" position).

Figure 57. Processor board

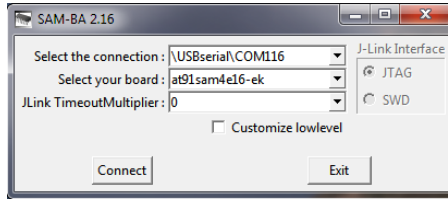


- a) Disconnect the DXM Controller from its power supply.
- b) Open the hardware cover.
- c) Using your fingers or tweezers, move the jumper to the "boot load on" position (jumper on the top two pins).
- d) Connect the DXM back to its power supply.

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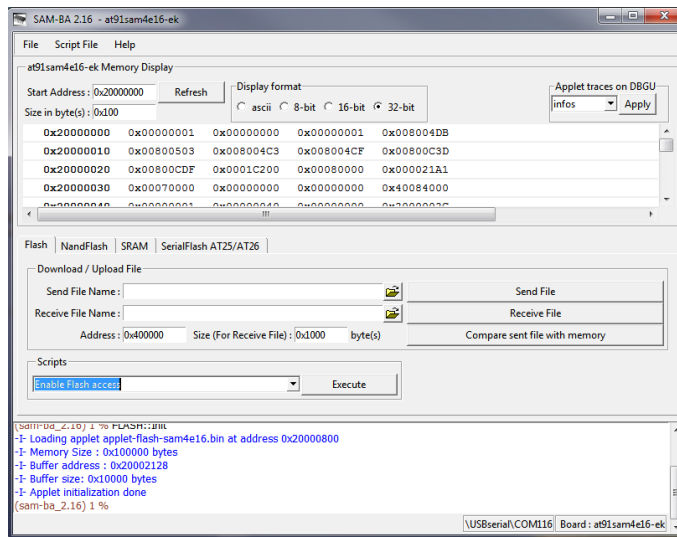
- e) The lower left LED on the I/O base board is solid when power is turned on. After the LED begins flashing, remove power.
 - f) Move the jumper back to its original position.
 - g) Replace the hardware cover.
 - h) Connect the DXM back to its power supply.
4. Launch the SAM-BA program. Select the COM port and correct board. Click **CONNECT**.

Figure 58. Popup screen



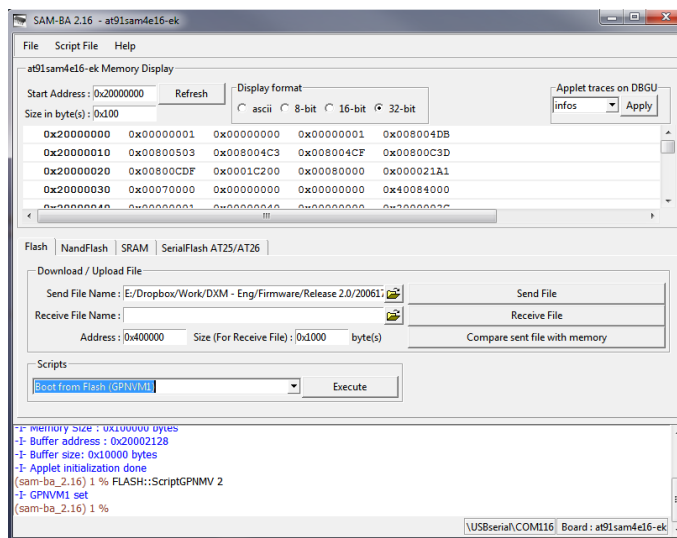
- The SAM-BA program attempts to automatically detect the COM port and the correct device.
5. On the **SCRIPTS** pull-down menu select **ENABLE FLASH ACCESS**. Click **EXECUTE**.

Figure 59. SAM-BA popup window



6. In the **SCRIPTS** pull-down menu, select **BOOT FROM FLASH (GPNVM1)**. Click **EXECUTE**. Click **EXECUTE** again if the message indicates it failed.
7. In the **Flash** tab, click on the folder icon for the **Send File Name** field. Select the boot load file (must be a *.bin file) and click **SEND FILE**. The file is: [DXM PROCESSOR FIRMWARE V2.02](#) or go to the software section of the Wireless Reference Library on www.bannerengineering.com.

Figure 60. SAM-BA popup window



The load process takes a few seconds.

8. After the load is complete, the program asks if you want to lock the flash region. Click **NO**.
9. Close the SAM-BA bootloader program.
10. Cycle the power to the DXM.
The new code should now be running and the LEDs should be on.

Updating Your DXM Processor Firmware (Version 2 or Later)

DXMs with processor firmware version 2.0 or later have a built-in boot loader program to update the firmware. Use the configuration software version 3 or later, the Banner Cloud Data Services webserver, or manually write the files on the SD card to update the firmware.

The new firmware file loads into the **BOOT** directory of the SD card on the DXM. The configuration software or Banner Cloud Data Services website handles the reprogramming process automatically. During the programming process, the internal LEDs on the processor board indicate the status of the programming.

Table 40: Update process overview

Reprogramming Step	Approximate time required	Description
Loading new firmware file (*.HEX)	configuration software: 2 minutes over Ethernet or 15 minutes over USB Banner Cloud Data Services: 2 minutes over Ethernet or 5 minutes over Cellular	Send the new firmware image to the DXM. After the new image is on the device, the controller resets. LED3 is red during the loading process.
Verify the contents of the new firmware file	1 minute	When the DXM finds a file that should be installed, LED4 (amber) flashes at about a 1 second rate while the contents of the file are validated.
New firmware file is valid		After validation successfully completes, LED4 is on (amber).
New firmware file is being loaded	2 minutes; do not remove power to the DXM during the programming process.	LED3 (red) blinks approximately once per second. LED3 continues to blink during the application programming process.
Finished		After programming has completed, the DXM resets and begins running the new firmware

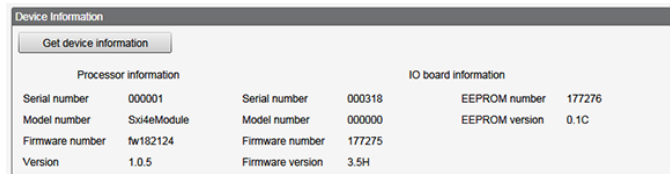
The firmware file names follow an 8.3 filename convention. The first 5 characters are the firmware part number in hexadecimal; the last 3 characters of the part number are the major/minor version number. For example, if 30FA9052.hex is the firmware programming file, 200617 decimal (30FA9 hex) is the firmware part number and 0.5.2 (0502) is the decoded version number.

Update Your DXM Processor Firmware Using the DXM Configuration Tool

To update your processor firmware using the DXM Configuration Software, follow these instructions.

1. Using the DXM Configuration Software version 3 or later, connect to the DXM via USB ⁸ or Ethernet.
File loads to the DXM will take about 15 minutes using USB or approximately 2 minutes using Ethernet.
2. On the DXM Configuration Software, go to **Settings > General > Device Information** to verify the current firmware version.
You must load a different version with the same firmware number for the boot loader to operate. Download firmware files from the Banner website.

Figure 61. Device Information



3. Under **Settings > Reprogram**, click **Select upgrade file** to select the firmware file to program.

After the file load is completed, the DXM restarts and loads the new firmware file. It takes about 2 minutes to complete the programming process. The device reboots when finished. Verify the firmware has been updated, under **Settings > General > Device Information**.

⁸ While the file download is in process over a USB connection, do not use other applications on the PC. After the DXM reboots for a firmware update, the USB port may be unresponsive. Clear the connection by disconnecting the USB cable and restarting the DXM Configuration Software software.

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Update Your Processor Firmware Using the Banner Cloud Data Services Website

To update your processor firmware (version 2.0 or later) using the DXM website, follow these instructions.

To use the website to update the firmware file, first configure the DXM to push data to the website.

1. Go to **Dashboard > Sites** and click **+** to verify the current firmware part number and version on the DXM.

Site Configuration:		Xm1 Configuration:		Site Info:		Initial Push:		Alarm Info:	
Authentication: OFF	Auth Configure: OFF	File Name: FinalTestCel.xml	File Uploads: 1/25/2016 09:02 (241x 5h 26m)	Last Push: 4/23/20m	Last GPS: None	Last Reboot: 05/19/2017 15:03 (44 23h 26m)	Device Firmware: v2.00.00a200917	Connectivity: None	MAC: None
		Push Method: Cellular	Push Interval: 00:30:00	GPS Updated: 4/23/20m	Pending Updates: None	Model: 177271	Serial: 022716	Registers: 0	Geofence: Clear
		Register Estimate per Day: 432		Registers in Last Day: 0		Max: 14:00:23 #9:00-12:00	Cell Number: --		
						Cell MNO: --	Cell Firmware: 20.00.012		

Data collected from the DXM is displayed.

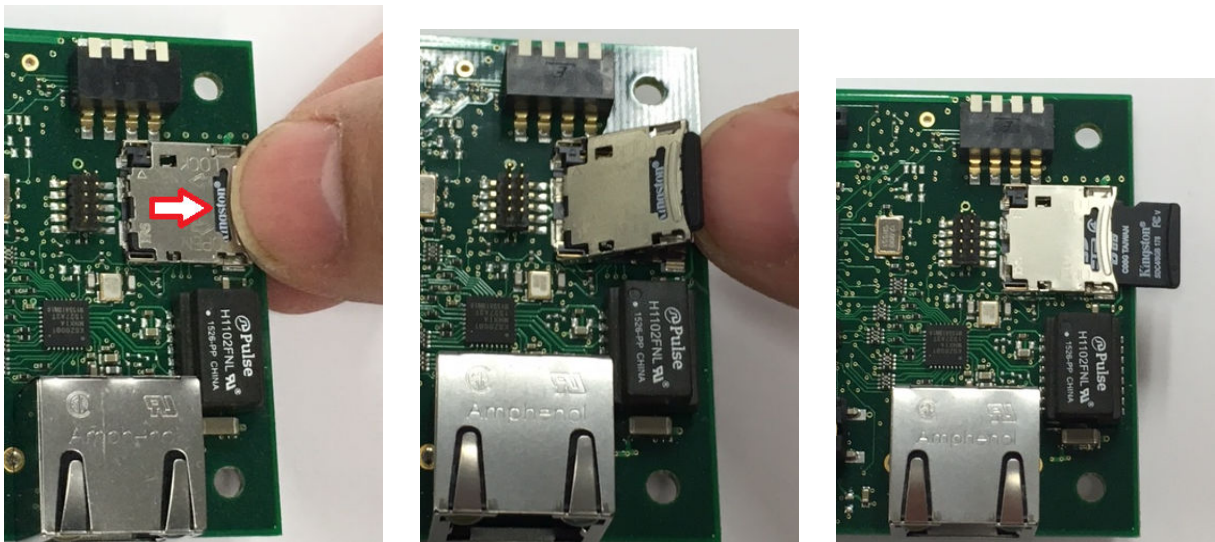
2. From the main **Dashboard > Sites** screen, click on **Update**. A popup box appears.
3. Set the **Communications Type** to **Push Reply**, and set the **Update Type** to **Firmware file**.
4. Choose the appropriate **Upload File (*.HEX)** and click **Queue**. Click **Close**.
At the next scheduled push interval, the DXM retrieves the new firmware file. The new firmware file must be the same part number of firmware that is currently in the DXM.

Update Your Processor Firmware Manually

To manually update your processor firmware (version 2.0 or later) using SD card, follow these instructions.

The firmware file can manually be put on the SD card in the BOOT directory (must have version 2.0 or later on the DXM).

1. Disconnect the DXM from its power supply.
2. Remove the micro SD card from the DXM.



- a) Open the cover housing to the DXM.
 - b) Use your fingernail to slide the top metal portion of SD card holder.
 - c) The metal cover hinges upward, allowing access to the remove the SD card.
 - d) Press down on the SD cover and slide back into position to close the SD card holder.
3. Insert the micro SD card into an SD card reader to access the data from a PC.
 4. Load the new firmware file (*.hex) into the BOOT directory of the micro SD card.
 5. Re-insert the micro SD card into the DXM by sliding the card into the holder.
 6. Reconnect the DXM to its power supply.

The automatic boot process should begin. If the boot process does not begin, verify the firmware file is correct and it is a different version than what is currently installed on the device.

13.2.3 Troubleshooting Issues

Problem	Solution
Communication contention between the LCD and process	The LCD and the processor applications share the external Modbus connection. If the processor is configured to constantly interact with Modbus, it may cause issues with the LCD attempting to use the functions of the ISM radio. To alleviate the contention do one of these things: <ul style="list-style-type: none"> • Load a DXM configuration file that slows down the read/write rules. • Disable the DXM configuration file from loading into the processor by setting DIP switch 4 to ON (on the processor board). Reboot the device. When the processor reboots, it will not load the configuration file and remains idle.
Cellular modem did not turn on	If the incoming voltage drops below 11.2 V dc, the cellular modem does not turn on and will not turn on until the voltage is above 11.8 V dc. A text file (CmVMon.txt) on the internal micro SD card saves the periodic sampling of the incoming voltage. If cellular operation stops because of voltage, it is logged in this file.

13.2.4 Modbus Operation

All Modbus transactions are managed by a central Modbus engine. If there are Modbus messages intended for a Modbus slave that doesn't exist, the Modbus engine waits for a response until the timeout period is expired. This slows down the Modbus polling loop for read and write operations.

For this reason, verify all Modbus read and write operations are intended for Modbus slave devices that are in the network. If a Modbus slave is not in the network, either a wired or wireless device, the operation of the LCD menu system can be compromised. Operations like Binding, Site Survey, or accessing the ISM menu may be slower. This is because all internal devices (such as the ISM radio, LCD, etc) of the DXM are also Modbus slaves.

13.3 DXM100 Documentation

- DXM Wireless Controller Sell Sheet, p/n [194063](#)
- DXM100-B1 Wireless Controller Datasheet, p/n [186724](#)
- DXM100-B2 Wireless Controller Datasheet, p/n [195232](#)
- DXM100-Bx Wireless Controller Instruction Manual, p/n [190037](#)
- DXM100-S1 Modbus Slave Datasheet, p/n [195454](#)
- DXM100-S2 Modbus Slave Datasheet, p/n [195231](#)
- DXM100-Sx Modbus Slave Instruction Manual, p/n [188231](#)
- DXM ScriptBasic Instruction Manual, p/n [191745](#)
- DXM Controller API Protocol, p/n [186221](#)
- DXM Controller Configuration Quick Start, p/n [191247](#)
- SolutionsKit-AG1 Quick Start Guide, p/n [212028](#)
- DXM Configuration Software v4 (p/n [b_4496867](#))
- DXM Configuration Software v4 Instruction Manual, p/n [209933](#)
- DXM EDS Configuration file for Allen-Bradley PLCs, p/n [b_4205242](#)
- EIP Configuration File for DXM 1xx-BxR1 and R3 models, p/n [194730](#)
- Banner CDS Web Service Quick Start Guide, p/n [201126](#)
- Banner CDS Web Service Instruction Manual, p/n [178337](#)
- Activating a Cellular Modem, p/n [b_4419353](#)
- Additional technical notes and videos

For more information about the DXM100 family of products, including technical notes, configuration examples, and ScriptBasic programs, please visit www.bannerengineering.com.

13.4 DXM1000 Documentation

- DXM Wireless Controller Sell Sheet, p/n [194063](#)
- DXM1000-B1 Wireless Controller Datasheet, p/n [210852](#)
- DXM100 and 1000-Bx Wireless Controller Instruction Manual, p/n [190037](#)
- DXM ScriptBasic Instruction Manual, p/n [191745](#)
- DXM Controller Configuration Quick Start, p/n [191247](#)
- DXM Configuration Software (p/n [b_4447978](#))
- DXM Configuration Software Instruction Manual, p/n [158447](#)
- DXM EDS [Configuration file](#) for Allen-Bradley PLCs
- EIP Configuration File for DXM 1xx-BxR1 and R3 models (p/n [194730](#))
- Activating a Cellular Modem (p/n [b_4419353](#))

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- Video tutorials: search "DXM Tutorial" at [youtube.com/bannerengineering](https://www.youtube.com/channel/UCBnnerEngineering).
- Additional technical notes

For more information about the DXM1000 family of products, including technical notes, configuration examples, and ScriptBasic program examples, please refer to the Banner website: www.bannerengineering.com.

13.5 DXM Support Policy

The DXM Wireless Controllers are industrial wireless controllers that facilitate Industrial Internet of Things (IIoT) applications. As a communications gateway, it interfaces local serial ports, local I/O ports, and local ISM radio devices to the Internet using either a cellular connection or a wired Ethernet network connection. In a continuing effort to provide the best operation for the DXM, stay connected with Banner Engineering Corp to hear about the latest updates through the Banner website. Create a login today to stay informed of all Banner product releases.

13.5.1 Firmware Updates

The DXM has been designed to be a robust and secure IOT device. To provide the most reliable and secure device possible, periodic firmware updates are released to enhance and expand the capabilities of the DXM. Firmware updates and description details are found on the Banner website. Customers with critical update requirements will get access to pre-released firmware from the factory.

13.5.2 Website Information

The Banner website is the main method of disseminating DXM information to customers. The data found on the website include:

- DXM instruction manuals
- Configuration manuals
- Firmware downloads
- Firmware release notes
- Errata data, any known issues with a release of firmware
- Possible work-around solutions for known issues
- DXM Solutions Guides

13.5.3 Feature Requests

Our customer is our most valuable resource to improve our DXM. If you have suggestions for improvements to the DXM or configuration tools, please contact Banner Engineering Corp.

13.5.4 Potential DXM Issues

Potential issues with the DXM are collected from Banner's support engineers to provide solutions. Users can get help from the website documentation or by calling Banner Engineering for support help. Solutions are as simple as configuration adjustments, work-around configuration solutions, or potential new firmware updates.

13.5.5 DXM Security

The DXM was designed to collect local wireless sensor data, local sensor data, provide simple control, and send the data to the cloud.

The DXM does not run a Linux or Windows based operating system but an embedded real-time operating system (RTOS) environment. As a proprietary operating system, the security aspects are easier to manage and minimize.

Security updates are released through the Banner Engineering Corp website (www.bannerengineering.com) and New Product Release Announcements ([NPRA](#)).

13.6 Contact Us

Banner Engineering Corp. headquarters is located at:

9714 Tenth Avenue North
Minneapolis, MN 55441, USA
Phone: + 1 888 373 6767

For worldwide locations and local representatives, visit www.bannerengineering.com.

13.7 Mexican Importer

Banner Engineering de México, S. de R.L. de C.V.
David Alfaro Siqueiros 103 Piso 2 Valle oriente
San Pedro Garza García Nuevo León, C. P. 66269

81 8363.2714

13.8 FCC and ISED Certification, 900 MHz, 1 Watt Radios

This equipment contains transmitter module RM1809.

FCC ID: UE3RM1809
IC: 7044A-RM1809
HVIN: RM1809

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device contains licence-exempt transmitters(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada's licence-exempt RSS(s). Operation is subject to the following two conditions: (1) This device may not cause interference, and (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil contient des émetteurs/récepteurs exemptés de licence conformes à la norme Innovation, Sciences, et Développement économique Canada. L'exploitation est autorisée aux deux conditions suivantes: (1) L'appareil ne doit pas produire de brouillage, and (2) L'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

FCC Notices

IMPORTANT: The transmitter modules RM1809 have been certified by the FCC / ISED for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by the manufacturer could void the user's authority to operate the equipment.

IMPORTANT: The transmitter modules RM1809 have been certified for fixed base station and mobile applications. If modules will be used for portable applications, the device must undergo SAR testing.

IMPORTANT: If integrated into another product, the FCC ID label must be visible through a window on the final device or it must be visible when an access panel, door, or cover is easily removed. If not, a second label must be placed on the outside of the final device that contains the following text:

Contains Transmitter Module RM1809

FCC ID: UE3RM1809

IC: 7044A-RM1809

HVIN: RM1809

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna,
- Increase the separation between the equipment and receiving module,
- Connect the equipment into an outlet on a circuit different from that to which the receiving module is connected, and/or
- Consult the dealer or an experienced radio/TV technician for help.

Antenna WARNING: This device has been tested with Reverse Polarity SMA connectors with the antennas listed in [Table 41](#) on page 104. When integrated into OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the tables must be tested to comply with FCC Section 15.203 (unique antenna connectors), FCC Section 15.247 (emissions), and ISED RSS-Gen Section 6.8.

Sure Cross® DXM100-Bx and DXM1000-Bx Wireless Controllers

FCC and ISED Approved Antennas

WARNING: This equipment is approved only for mobile and base station transmitting devices. Antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter.

This radio transmitter module RM1809 have been approved by FCC and ISED Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Table 41: Certified Antennas for 900 MHz 1 Watt

Model Number	Antenna Type	Maximum Gain	Impedance	Minimum Required Cable/ Connector Loss
-	Integral Antenna	Unity gain		0
BWA-901-x	Omni, 1/4 wave dipole	≤2 dBi	50 Ω	0
BWA-902-C	Omni, 1/2 wave dipole, Swivel	≤2 dBi	50 Ω	0
BWA-906-A	Omni Wideband, Fiberglass Radome	≤8.2 dBi	50 Ω	2.2 dB
BWA-905-B	Omni Base Whip	≤7.2 dBi	50 Ω	1.2 dB
BWA-9Y10-A	Yagi	≤10 dBi	50 Ω	4 dB

13.9 FCC and ISED Certification, 2.4GHz

This equipment contains transmitter module DX80-2400 or SX243.

FCC ID:
UE300DX80-2400
IC: 7044A-DX8024
FCC ID: UE3SX243
IC: 7044A-SX243
HVIN: DX80G2 /
DX80N2 / SX243

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

This device contains licence-exempt transmitters(s)/receiver(s) that comply with Innovation, Science and Economic Development Canada’s licence-exempt RSS(s). Operation is subject to the following two conditions: (1) This device may not cause interference, and (2) This device must accept any interference, including interference that may cause undesired operation of the device.

Cet appareil contient des émetteurs/récepteurs exemptés de licence conformes à la norme Innovation, Sciences, et Développement économique Canada. L’exploitation est autorisée aux deux conditions suivantes: (1) L’appareil ne doit pas produire de brouillage, and (2) L’utilisateur de l’appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d’en compromettre le fonctionnement.

FCC Notices

IMPORTANT: The transmitter modules DX80-2400 and SX243 have been certified by the FCC / ISED for use with other products without any further certification (as per FCC section 2.1091). Changes or modifications not expressly approved by the manufacturer could void the user’s authority to operate the equipment.

IMPORTANT: The transmitter modules DX80-2400 and SX243 have been certified for fixed base station and mobile applications. If modules will be used for portable applications, the device must undergo SAR testing.

IMPORTANT: If integrated into another product, the FCC ID/IC label must be visible through a window on the final device or it must be visible when an access panel, door, or cover is easily removed. If not, a second label must be placed on the outside of the final device that contains the following text:

Contains Transmitter Module [DX80-2400 or SX243]
FCC ID: [UE300DX80-2400 or UE3SX243]
IC: [7044A-DX8024 or 7044A-SX243]
HVIN: [DX80G2, DX80N2 or SX243]

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

Note

This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee

that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna,
- Increase the separation between the equipment and receiving module,
- Connect the equipment into an outlet on a circuit different from that to which the receiving module is connected, and/or
- Consult the dealer or an experienced radio/TV technician for help.

Antenna Warning: This device has been tested with Reverse Polarity SMA connectors with the antennas listed in Table 42 on page 105. When integrated into OEM products, fixed antennas require installation preventing end-users from replacing them with non-approved antennas. Antennas not listed in the tables must be tested to comply with FCC Section 15.203 (unique antenna connectors), FCC Section 15.247 (emissions), and ISED RSS-Gen Section 6.8.

FCC and ISED Approved Antennas

WARNING: This equipment is approved only for mobile and base station transmitting devices. Antenna(s) used for this transmitter must be installed to provide a separation distance of at least 20 cm from all persons and must not be collocated or operating in conjunction with any other antenna or transmitter.

The radio transmitter modules DX80-2400 and SX243 have been approved by FCC and ISED Canada to operate with the antenna types listed below, with the maximum permissible gain indicated. Antenna types not included in this list that have a gain greater than the maximum gain indicated for any type listed are strictly prohibited for use with this device.

Table 42: Certified Antennas for 2.4 GHz

Model	Antenna Type	2.4 GHz Radio Module	Maximum Gain	Impedance
	Integral antenna	DX80-2400	Unity gain	
BWA-202-C	Omni, 1/2 wave dipole, Swivel	DX80-2400 or SX243	≤ 2 dBi	50 Ω
BWA-202-D	Omni, Dome, Box Mount	DX80-2400	≤ 2 dBi	50 Ω
BWA-202-E	Omni, 1/4 wave dipole, Swivel	DX80-2400	≤ 2 dBi	50 Ω
BWA-205-C	Omni, Collinear, Swivel	DX80-2400	≤ 5 dBi	50 Ω
BWA-205-MA	Omni, full-wave dipole, NMO	DX80-2400	≤ 4.5 dBi	50 Ω
BWA-206-A	Omni, Dome, Box Mount	DX80-2400	≤ 6 dBi	50 Ω
BWA-207-C	Omni, Coaxial Sleeve, Swivel	DX80-2400	≤ 7 dBi	50 Ω

13.10 ANATEL

Modelo (Model): DX80-2400—Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados. Para maiores informações, consulte o site da ANATEL www.gov.br/anatel/pt-br/



13.11 Warnings

Install and properly ground a qualified surge suppressor when installing a remote antenna system. Remote antenna configurations installed without surge suppressors invalidate the manufacturer's warranty. Keep the ground wire as short as possible and make all ground connections to a single-point ground system to ensure no ground loops are created. No surge suppressor can absorb all lightning strikes; do not touch the Sure Cross® device or any equipment connected to the Sure Cross device during a thunderstorm.

Exporting Sure Cross® Radios. It is our intent to fully comply with all national and regional regulations regarding radio frequency emissions. **Customers who want to re-export this product to a country other than that to which it was sold must ensure the device is approved in the destination country.** The Sure Cross wireless products were certified for use in these countries using the antenna that ships with the product. When using other antennas, verify you are not exceeding the transmit power levels allowed by local governing agencies. This device has been designed to operate with the antennas listed on Banner Engineering's website and having a maximum gain of 9 dBm. Antennas not included in this list or having a gain greater than 9 dBm are strictly prohibited for use with this device. The required antenna impedance is 50 ohms. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen such that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication. Consult with Banner Engineering Corp. if the destination country is not on this list.

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Important: Please download the complete DXM100/1000-Bx Wireless Controller technical documentation, available in multiple languages, from www.bannerengineering.com for details on the proper use, applications, Warnings, and installation instructions of this device.



Important: Por favor descargue desde www.bannerengineering.com toda la documentación técnica de los DXM100/1000-Bx Wireless Controller, disponibles en múltiples idiomas, para detalles del uso adecuado, aplicaciones, advertencias, y las instrucciones de instalación de estos dispositivos.



Important: Veuillez télécharger la documentation technique complète des DXM100/1000-Bx Wireless Controller sur notre site www.bannerengineering.com pour les détails sur leur utilisation correcte, les applications, les notes de sécurité et les instructions de montage.



WARNING:

- **Do not use this device for personnel protection**
- Using this device for personnel protection could result in serious injury or death.
- This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A device failure or malfunction can cause either an energized (on) or de-energized (off) output condition.



Important:

- **Never operate a 1 Watt radio without connecting an antenna**
- Operating 1 Watt radios without an antenna connected will damage the radio circuitry.
- To avoid damaging the radio circuitry, never apply power to a Sure Cross® Performance or Sure Cross MultiHop (1 Watt) radio without an antenna connected.



Important:

- **Electrostatic discharge (ESD) sensitive device**
- ESD can damage the device. Damage from inappropriate handling is not covered by warranty.
- Use proper handling procedures to prevent ESD damage. Proper handling procedures include leaving devices in their anti-static packaging until ready for use; wearing anti-static wrist straps; and assembling units on a grounded, static-dissipative surface.

13.12 Banner Engineering Corp. Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. **IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.**

Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp. Any misuse, abuse, or improper application or installation of this product or use of the product for personal protection applications when the product is identified as not intended for such purposes will void the product warranty. Any modifications to this product without prior express approval by Banner Engineering Corp will void the product warranties. All specifications published in this document are subject to change; Banner reserves the right to modify product specifications or update documentation at any time. Specifications and product information in English supersede that which is provided in any other language. For the most recent version of any documentation, refer to: www.bannerengineering.com.

For patent information, see www.bannerengineering.com/patents.

13.13 Glossary of Wireless Terminology

This definitions list contains a library of common definitions and glossary terms specific to the Wireless products.

EtherNet/IP™ is a trademark of ODVA, Inc.

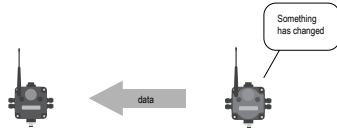
Microsoft and Windows are registered trademarks of Microsoft Corporation in the United States and/or other countries.

Modbus® is a registered trademark of Schneider Electric USA, Inc.

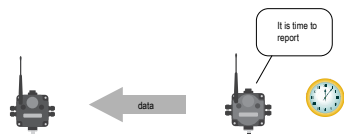
PROFINET® is a registered trademark of PROFIBUS Nutzerorganisation e.V.

active threshold	An active threshold is a trigger point or reporting threshold for an analog input.
a/d converter	An analog to digital converter converts varying sinusoidal signals from instruments into binary code for a computer.
address mode	The Sure Cross® wireless devices may use one of two types of addressing modes: rotary dial addressing or extended addressing. In rotary dial address mode, the left rotary dial establishes the network ID (NID) and the right rotary dial sets the device address. Extended address mode uses a security code to "bind" Nodes to a specific Gateway. Bound Nodes can only send and receive information from the Gateway they are bound to.
antenna	Antennas transmit radio signals by converting radio frequency electrical currents into electromagnetic waves. Antennas receive the signals by converting the electromagnetic waves back into radio frequency electrical currents.
attenuation	Attenuation is the radio signal loss occurring as signals travel through the medium. Radio signal attenuation may also be referred to as free space loss. The higher the frequency, the faster the signal strength decreases. For example, 2.4 GHz signals attenuate faster than 900 MHz signals.
baseline filter (M-GAGE)	Under normal conditions, the ambient magnetic field fluctuates. When the magnetic field readings drift below a threshold setting, the baseline or drift filter uses an algorithm to slowly match the radio device's baseline to the ambient magnetic field.
binding (DX80 star networks)	<p>Binding Nodes to a Gateway ensures the Nodes only exchange data with the Gateway they are bound to. After a Gateway enters binding mode, the Gateway automatically generates and transmits a unique extended addressing (XADR), or binding, code to all Nodes within range that are also in binding mode. The extended addressing (binding) code defines the network, and all radios within a network must use the same code.</p> <p>After binding your Nodes to the Gateway, make note of the binding code displayed under the *DVCFG > XADR menu on the Gateway's LCD. Knowing the binding code prevents having to re-bind all Nodes if the Gateway is ever replaced.</p>
binding (MultiHop networks)	<p>Binding MultiHop radios ensures all MultiHop radios within a network communicate only with other radios within the same network. The MultiHop radio master automatically generates a unique binding code when the radio master enters binding mode. This code is then transmitted to all radios within range that are also in binding mode. After a repeater/slave is bound, the repeater/slave radio accepts data only from the master to which it is bound. The binding code defines the network, and all radios within a network must use the same binding code.</p> <p>After binding your MultiHop radios to the master radio, make note of the binding code displayed under the *DVCFG > -BIND menu on the LCD. Knowing the binding code prevents having to re-bind all radios if the master is ever replaced.</p>
binding (serial data radio networks)	Binding the serial data radios ensures all radios within a network communicate only with the other radios within the same network. The serial data radio master automatically generates a unique binding code when the radio master enters binding mode. This code is transmitted to all radios within range that are also in binding mode. After a repeater/slave is bound, the repeater/slave radio accepts data only from the master to which it is bound. The binding code defines the network, and all radios within a network must use the same binding code.
bit packing i/o	Bit packing uses a single register, or range of contiguous registers, to represent I/O values. This allows you to read or write multiple I/O values with a single Modbus message.
booster (boost voltage)	A booster is an electronic circuit that increases a battery-level voltage input (3.6V) to a sensor operating voltage output (5 to 20 V).
CE	The CE mark on a product or machine establishes its compliance with all relevant European Union (EU) Directives and the associated safety standards.
change of state	Change of state reporting is a report initiated by the Node when a change to the sensor's input state is detected. If the input does not change, nothing is reported to the Gateway.

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- channel** A channel may be either a path for communications or a range of radio frequencies used by a transceiver during communication.
- collision** A collision is a situation in which two or more transmissions are competing to communicate on a system that can only handle one transmission at a time. This may also be referred to as a data collision.
- collocated networks** To prevent interference between collocated wireless networks, assign each wireless network a different Network ID. The Network ID is a unique identifier assigned to each wireless network using the rotary dials on the Gateway.
- contention architecture** Contention architecture is a wireless communication architecture that allows all network devices access to the communications channel at the same time. This may lead to transmission collisions.
- counter - event** The event counter counts the total number of times an input signal changes to the high/ON/1 state. The counter increments on the falling edge of an input signal when the signal level crosses the threshold. Event counters can be used to measure the total operational cycles of a spinning shaft or the total number of items traveling down a conveyor.
- counter - frequency** The frequency counter calculates the frequency of the input signal, in Hz. Frequency counters can be used to measure flow rates, such as measuring the flow rate of items on a conveyor or the speed at which a windmill spins.
- courtesy power outputs** Courtesy power outputs provide continuous power and cannot be turned on or off.
- cyclic reporting** Cyclic reporting is when the Gateway polls the Node at user-defined intervals.



debounce When a signal changes state using a mechanical switch or relay, the signal can oscillate briefly before stabilizing to the new state. The debounce filter examines the signal's transitions to determine the signal's state.



The signal oscillates between states after a mechanical switch or relay activates.



Without a debounce filter, the signal is interpreted to change state multiple times.



With a debounce filter, the signal is interpreted to change state only once.

The factory default setting is to activate the input filtering to compensate for unclean state transitions.

decibel A decibel is a logarithmic ratio between a specific value and a base value of the same unit of measure. With respect to radio power, dBm is a ratio of power relative to 1 milliWatt. According to the following equation, 1 mW corresponds to 0 dBm.

Equation: $PmW = 10^{x/10}$ where x is the transmitted power in dBm, or $dBm = 10 \log(PmW)$

Another decibel rating, dBi, is defined as an antenna's forward gain compared to an idealized isotropic antenna. Typically, $dBm = dBi = dBd + 2.15$ where dBi refers to an isotropic decibel, dBd is a dipole decibel, and dBm is relative to milliwatts.

deep sleep mode

Potted Puck models, potted M-GAGE models: Some battery-powered M-GAGE radios ship in a "deep sleep" mode to conserve battery power. While in "deep sleep" mode, the M-GAGE does not attempt to transmit to a parent radio and remains in "deep sleep" until an LED light at the receiving window wakes it up. M-GAGEs that ship in "deep sleep" mode are typically the potted M-GAGEs that require an LED Optical Commissioning Device to configure the M-GAGE.

Wireless Q45 Sensors: If the Wireless Q45 Sensor fails to communicate with the Gateway for more than 5 minutes, it enters **sleep mode**. The radio continues to search for the Gateway at a slower rate and the LEDs do not blink. To wake up the sensor, press any button. After the Q45 wakes up, it will do a fast rate search for the Gateway for five more minutes.

default output triggers

Default output triggers are the conditions that drive outputs to defined states. Example default output conditions include when radios are out of sync, when a device cycles power, or during a host communication timeout.

Device Power Up—Outputs are set to user-defined states every time the device is powered up.

Out of Sync—Outputs are set to user-defined states when the radio is out of sync with its parent radio.

Host Link Failure—Host link failure is when the defined timeout period has elapsed with no communications between the host system (or Modbus master device) and the DX80 Gateway, typically about four seconds. Outputs are set to user-defined states when a host link failure has been detected.

Node Link Failure—Node link failures are determined by the polling interval or the out-of-sync timing. When a Node detects a communications failure with the Gateway and the Node Link Failure flag is set, the output points are set to the user-defined states and the inputs are frozen.

Gateway Link Failure—Gateway link failures are determined by three global parameters: Polling Interval, Maximum Missed Message Count and Re-link Count. When the Node's Gateway Link Failure flag is set and the Gateway determines a timeout condition exists for a Node, any outputs linked from the failing Node are set to the user-defined default state.

default output value

Default output values are specific values written to output registers. For discrete outputs, this is a 1 (on) or 0 (off) value. For analog outputs the value can be any valid register value. When a default condition occurs, these default output values are written to the output register.

delta

The delta parameter defines the change required between sample points of an analog input before the analog input reports a new value. To turn off this option, set the Delta value to 0.

determinism

A deterministic system defines how network endpoints behave during the loss of communications. The network identifies when the communications link is lost and sets relevant outputs to user-defined conditions. Once the radio signal is re-established, the network returns to normal operation.

device, node, or radio address/ID (DX80 Networks)

The Node address is a unique identifier for each wireless device on a network and is set using the rotary dials. For the DX80 networks, Gateways are identified as device 0. Nodes are assigned addresses (NADR) from 01 to 47 using the rotary dials.

directional antenna

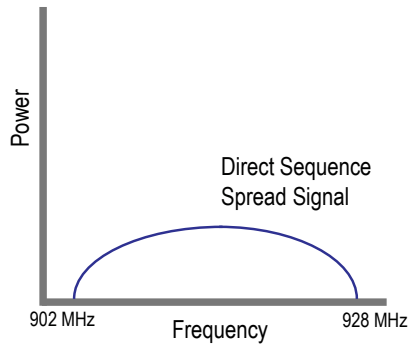
A direction antenna, or Yagi, is an antenna that focuses the majority of the signal energy in one specific direction.



Direct Sequence Spread Spectrum (DSSS)

Direct Sequence Spread Spectrum is a method for generating spread spectrum transmissions where the transmitted signal is sent at a much higher frequency than the original signal, spreading the energy over a much wider band. The receiver is able to de-spread the transmission and filter the original message. DSSS is useful for sending large amounts of data in low to medium interference environments.

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DX83 Ethernet Bridge The Ethernet Bridge acts as a communications bridge between the Modbus RTU network (Gateway) and Modbus/TCP or EtherNet/IP host systems and includes the ability to configure the network using a Web browser interface.

effective isotropic radiated power (EIRP) The EIRP is the effective power found in the main lobe of a transmitter antenna, relative to a 0 dB radiator. EIRP is usually equal to the antenna gain (in dBi) plus the power into that antenna (in dBm).

Ethernet Ethernet is an access method for computer network (Local Area Networks) communications, defined by IEEE as the 802 standard.

EtherNet/IP™ EtherNet/IP is Allen-Bradley’s DeviceNet running over Ethernet hardware.

extended address mode Using extended address mode isolates networks from one another by assigning a unique code, the extended address code, to all devices in a particular network. Only devices sharing the extended address code can exchange data. The extended address code is derived from the Gateway’s serial number, but the code can be customized using the manual binding procedure.

flash pattern Flash patterns are established by selecting timeslots to turn the output on or off. While originally the flash pattern was designed to turn on and off an indicator light, the flash pattern can be set for any discrete output or switch power output.

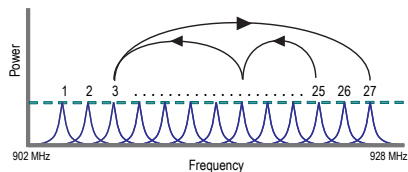
FlexPower Banner’s FlexPower® technology allows for a true wireless solution by allowing the device to operate using either 10 to 30 V DC, 3.6 V lithium D cell batteries, or solar power. This unique power management system can operate a FlexPower Node and an optimized sensing device for up to 5 years on a single lithium D cell.

free space loss (FSL) The radio signal loss occurring as the signal radiates through free space. Free Space Loss = 20 Log (4(3.1416)d/λ) where d is in meters. Remembering that λf = c = 300 x 10⁶ m/s, the equations reduce down to:

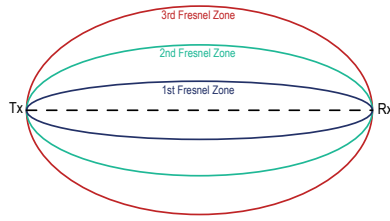
For the 900 MHz radio band: FSL = 31.5 + 20 Log d (where d is in meters).

For the 2.4 GHz radio band: FSL = 40 + 20 Log d (where d is in meters.)

Frequency Hopping Spread Spectrum (FHSS) Frequency Hopping Spread Spectrum (FHSS) is a method for generating spread spectrum transmissions where the signal is switched between different frequency channels in a pseudo-random sequence known by both the transmitter and the receiver. FHSS is useful for sending small packets of data in a high interference environment.



Fresnel zone Fresnel zones are the three-dimensional elliptical zones of radio signals between the transmitter and receiver. Because the signal strength is strongest in the first zone and decreases in each successive zone, obstacles within the first Fresnel zone cause the greatest amount of destructive interference.



gain Gain represents how well the antenna focuses the signal power. A 3 dB gain increase doubles the effective transmitting power while every 6 dB increase doubles the distance the signal travels. Increasing the gain sacrifices the vertical height of the signal for horizontal distance increases. The signal is ‘squashed’ down to concentrate the signal strength along the horizontal plane.

gateway A gateway is a general network device that connects two different networks.

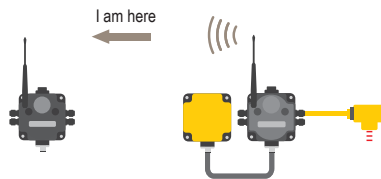
Gateway A Sure Cross® Gateway is the wireless sensor network master device used to control network timing and schedule communication traffic. Similar to how a gateway device on a wired network acts as a "portal" between networks, the Sure Cross Gateway acts as the portal between the wireless network and the central control process. Every wireless I/O sensor network requires one Gateway device. Every Sure Cross device is a transceiver, meaning it can transmit and receive data.

GatewayPro The GatewayPro combines the standard Gateway and the DX83 Ethernet Bridge into one device.

ground loop Ground loops are grounds within a system that are not at the same potential. Ground loops can damage electrical systems.

ground plane A ground plane is an electrically conductive plate that acts as a ‘mirror’ for the antenna, effectively doubling the length of the antenna. When using a 1/4 wave antenna, the ground plane acts to ‘double’ the antenna length to a 1/2 wave antenna.

heartbeat mode In heartbeat mode, the Nodes send "heartbeat" messages to the Gateway at specific intervals to indicate the radio link is active. The heartbeat is always initiated by the Node and is used only to verify radio communications. Using the Nodes to notify the Gateway that the radio link is active instead of having the Gateway "poll" the Nodes saves energy and increases battery life.



hibernation/ storage mode While in **storage mode**, the radio does not operate. To put any integrated battery Sure Cross® radio into storage mode, press and hold button 1 for five seconds. To wake the device, press and hold button 1 for five seconds. The radio is in storage mode when the LEDs stop blinking, but in some models, the LCD remains on for an additional minute after the radio enters storage mode. After a device has entered storage mode, you must wait one minute before waking it.

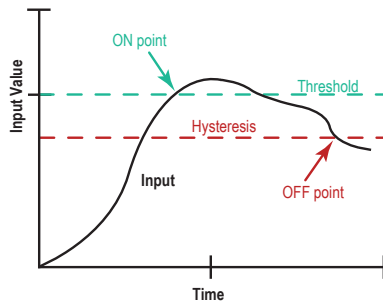
For the Wireless Q45 and Q120 Sensors: While in **storage mode**, the device's radio does not operate, to conserve the battery. To put any device into storage mode, press and hold the binding button for five seconds. The device is in storage mode when the LEDs stop blinking. To wake the device, press and hold the binding button (inside the housing on the radio board) for five seconds.

hop As a verb, hopping is the act of changing from one frequency to another. As a noun, a hop is the device to device transmission link, such as from the Master device to the Slave device.

hop table A hop table is a precalculated, pseudo-random list of frequencies used by both the transmitter and receiver of a radio to create a hopping sequence.

hysteresis Hysteresis defines how far below the active threshold (ON point) an analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit's range. For more specific details, see *Threshold*.

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Industrial, Scientific, and Medical Band (ISM)

The ISM, or Industrial, Scientific, and Medical band, is the part of the radio spectrum that does not require a license for use. The Sure Cross radios operate in the ISM band.

latency

A network's latency is the maximum delay between transmission and reception of a data signal.

lightning arrester

Also called a lightning suppressor, surge suppressor, or coaxial surge protection, lightning arrestors are used in remote antenna installations to protect the radio equipment from damage resulting from a lightning strike. Lightning arrestors are typically mounted close to the ground to minimize the grounding distance.



line of sight

Line of sight is the unobstructed path between radio antennas.

link failures

A **Host Link Failure** occurs when the defined timeout period, typically about four seconds, elapses with no communication between the host system (or Modbus master device) and the DX80 Gateway.
 A **Gateway Link Failure** refers to the radio link between a Node and the Gateway and is determined by three global parameters: Polling Interval, Maximum Missed Message Count, and Re-link Count. When the Node's Gateway Link Failure flag is set and the Gateway determines a timeout condition exists for a Node, any outputs linked from the failing Node are set to the user-defined default state.
 A **Node Link Failure** is determined by the polling interval or the out-of-sync timing. When a Node detects a communications failure with the Gateway and the Node Link Failure flag is selected, the output points are set to the user-defined states and the inputs are frozen.

local and non-local registers

Local registers are registers specific to the device in question. When discussing a Gateway, the Gateway's local registers include the registers specific to the Gateway in addition to all the Nodes' registers that are stored in the Gateway. Non-local, or remote, registers refer to registers on other Modbus slave devices, such as other MultiHop slave radios or third-party Modbus devices.

master/slave relationship

The master/slave relationships is the model for a communication protocol between devices or processes in which one device initiates commands (master) and other devices respond (slave). The Sure Cross network is a master/slave network with the Gateway acting as the master device to the Nodes, which are the slave devices. A PC can also be a master device to a wireless sensor network. See *star networks*.

maximum bad count

The maximum bad count refers to a user-established maximum count of consecutive failed polling attempts before the Gateway considers the radio (RF) link to have failed.

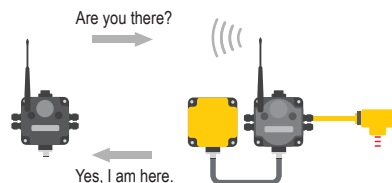
maximum misses

The maximum misses is the number of consecutive polling messages the Node fails to respond to. For more information, see Polling Rate and Maximum Misses.

median filter

When the median filter is turned on, three samples are taken for each analog sensor reading. The high and low values are discarded and the middle value is used as the analog value. Set to zero (0) to turn off the median filter. Set to one (1) to turn on the median filter.

Modbus	Modbus is a master-slave communications protocol typically used for industrial applications.
Modbus/TCP	Modbus/TCP is an open standard protocol very similar to Modbus RTU except that it uses standard Internet communication protocols.
MultiHop	<p>MultiHop networks are made up of one master radio and many repeater and slave radios. The MultiHop networks are self-forming and self-healing networks constructed around a parent-child communication relationship. A MultiHop Radio is either a master radio, a repeater radio, or a slave radio.</p> <p>The master radio controls the overall timing of the network and is always the parent device for other MultiHop radios. The host system connects to this master radio. Repeater radios extend the range of the wireless network and slave radios are the end point of the wireless network.</p> <p>For more information, refer to the Sure Cross MultiHop Radios Instruction Manual (p/n 151317).</p>
multipath fade	Obstructions in the radio path reflect or scatter the transmitted signal, causing multiple copies of a signal to reach the receiver through different paths. Multipath fade is the signal degradation caused by these obstructions.
network ID	The Network ID (NID) is a unique identifier you assign to each wireless network to minimize the chances of two collocated networks interfering with each other. Assigning different NIDs to different networks improves collocation performance in dense installations.
node	A node is any communications point within a network.
Node	Nodes are remote I/O slave devices within Banner's wireless sensor networks. Sensors and other devices connect to the Node's inputs or outputs, allowing the Node to collect sensor data and wirelessly transmit it to the Gateway. Every Sure Cross device is a transceiver, meaning it can transmit and receive data.
noise	Noise is any unwanted electromagnetic disturbances from within the RF equipment, especially the receiver. Noise is more of a concern when signal levels are low.
omni-directional antenna	Omni-directional antennas transmit and receive radio signals equally in all directions.
out of sync/link loss (loss of radio signal)	The Sure Cross wireless devices use a deterministic link time-out method to address RF link interruption or failure. When a radio link fails, all pertinent wired outputs are sent to the selected default value/state until the link is recovered, ensuring that disruptions in the communications link result in predictable system behavior. Following a time-out, all outputs linked to the Node in question are set to 0, 1, or hold the last stable state depending on the value selected.
path loss	Path loss describes attenuation as a function of the wavelength of the operating frequency and the distance between the transmitter and receiver.
path loss (or link loss) calculations	Link loss calculations determine the capabilities of a radio system by calculating the total gain or loss for a system. If the total gain/loss is within a specific range, the radio signal will be received by the radio. Total Gain = Effective output + Free space loss + Total received power . Because the transmitter and receiver gains are positive numbers and the free space loss is a larger negative number, the total gain of a system should be negative. A link loss calculation may also be called a link budget calculation.
peer to peer network	Peer-to-peer is a model for a communication protocol in which any device in the network can send or receive data. Any device can act as a Master to initiate communication.
polling interval/rate	The Gateway communicates with, or polls, each Node to determine if the radio link is active. The polling rate defines how often the Gateway communicates with each Node. Polling is always initiated by the Gateway and only verifies radio signal communications.



polling interval/rate and maximum misses	The Gateway communicates with, or polls, each Node to determine if the radio link is active. The polling rate, or interval, defines how often the Gateway communicates with each Node. Polling is always initiated by the Gateway and only verifies radio signal communications. Nodes that fail to respond are counted against the 'Maximum Misses' for that Node. If the 'Maximum Misses' is exceeded for any
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Node, the Gateway generates an RF timeout error in the Modbus I/O register 8 of the appropriate Node. The 'Maximum Misses' is defined as the number of consecutive polling messages that the Node fails to respond to.

radiation pattern

An antenna's radiation pattern is the area over which the antenna broadcasts an easily received signal. The radiation pattern/shape changes based on the antenna type and gain.

re-link count

The re-link count is the number of completed polling messages the Gateway receives from a Node before a lost RF link is considered re-established and normal operation resumes.

remote antenna

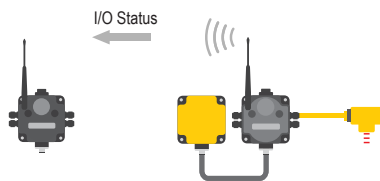
A remote antenna installation is any antenna not mounted directly to the Sure Cross wireless device, especially when coaxial cable is used. Always properly install and ground surge suppressors in remote antenna systems.

repeater radio

A repeater radio extends the transmission range of a wireless network. Repeaters are typically used in long-distance transmission.

report interval/rate

The report rate defines how often the Node communicates the I/O status to the Gateway. For battery-powered applications, setting the report rate to a slower rate extends the battery life.



Change of state reporting sets the system to report only when the value crosses the threshold setting.

rotary dial address mode

See: *address mode*

Received Signal Strength Indicator (RSSI)

An RSSI is the measurement of the strength of received signals in a wireless environment. See *Site Survey*.

resistance temperature detector (RTD)

An RTD is a temperature measurement device that measures the electrical resistance across a pure metal. The most commonly used metal is platinum because of its temperature range, accuracy, and stability.

RTDs are used for higher precision applications or for longer wire runs because RTDs can compensate for wire length. In industrial applications, RTDs are not generally used at temperatures above 660° C. Though RTDs are more accurate, they are slower to respond and have a smaller temperature range than thermocouples.

sample high/sample low (analog I/O)

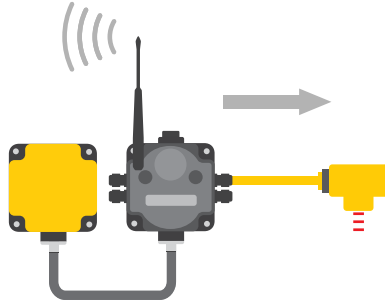
For analog inputs, the sample high parameter defines the number of consecutive samples the input signal must be above the threshold before a signal is considered active. Sample low defines the number of consecutive samples the input signal must be below the threshold minus hysteresis before a signal is considered deactivated. The sample high and sample low parameters are used to avoid unwanted input transitions.

sample high/sample low (discrete I/O)

For discrete inputs, the sample high parameter defines the number of consecutive samples the input signal must be high before a signal is considered active. Sample low defines the number of consecutive samples the input signal must be low before a signal is considered low. The sample high and sample low parameters are used to create a filter to avoid unwanted input transitions. The default value is 0, which disables this feature. The value range is 1 through 255.

sample interval/rate

The sample interval, or rate, defines how often the Sure Cross device samples the input. For battery-powered applications, setting a slower rate extends the battery life.

**sample on demand**

Sample on demand allows a host system to send a Modbus command to a register and require the inputs to immediately sample the sensor and report readings back to the host system and/or Gateway. Sampling on demand can be used between the normal periodic reporting.

The sample on demand feature requires using a host-controlled system capable of sending Modbus commands to the master radio.

signal-to-noise ratio (SNR)

The signal-to-noise ratio is the ratio of the signal to any background noise or noise generated by the medium. In radio terms, it is a ratio of the transmitted radio signal to the noise generated by any electromagnetic equipment, in particular the radio receiver. The weaker the radio signal, the more of an influence noise has on radio performance. Like gain, the signal-to-noise ratio is measured in decibels.

The equations for calculating SNR are:

$SNR = 20 \times \log (V_s/V_n)$ where V_s is the signal voltage and V_n is the noise voltage;

$SNR = 20 \times \log (A_s/A_n)$ where A_s is the signal amplitude and A_n is the noise amplitude; or

$SNR = 10 \times \log (P_s/P_n)$ where P_s is the signal power and P_n is the noise power.

single-point ground

All grounds within a system are made to a single ground to avoid creating ground loops.

site survey

Conducting a site survey, also known as a radio signal strength indication (RSSI), analyzes the radio communications link between the Gateway (or master radio) and any Node (or slave radio) within the network by analyzing the radio signal strength of received data packets and reporting the number of missed packets that required a retry.

slave ID

The slave ID is an identifying number used for devices within a Modbus system. When using more than one Modbus slave, assign each slave a unique ID number.

By default, Gateways are set to Modbus Slave ID 1.

sleep mode

During normal operation, the Sure Cross radio devices enter **sleep mode** after 15 minutes of operation. The radio continues to function, but the LCD goes blank. To wake the device, press any button.

slow scan mode

(All internal battery models) In slow scan mode, the device enters a deeper sleep mode to conserve battery power after the device loses its communication link with its parent or master radio. The device wakes up periodically to search for its parent radio. If a parent or master radio is not found, the device goes back to sleep for another sleep cycle. If the parent or master radio is detected, the device exits slow scan mode. To manually exit slow scan mode, press the binding button.

SMA connector

An SMA connector (SubMiniature version A) is a 50 ohm impedance connector used for coaxial RF connections and developed in the 1960s. An SMA connector is typically used between the radio and the antenna.

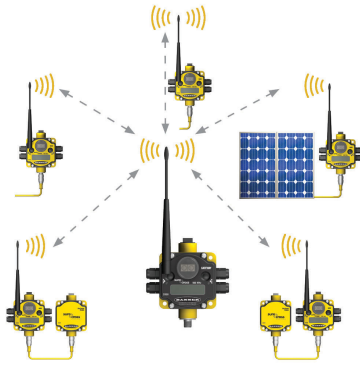
spread spectrum

Spread spectrum is a technique in which the transmitter sends (or spreads) a signal over a wide range of frequencies. The receiver then concentrates the frequencies to recover the information. The Sure Cross radio devices use a version of spread spectrum technology called Frequency Hop Spread Spectrum.

star networks

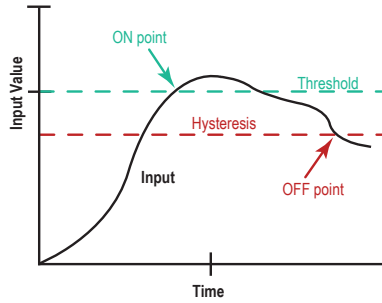
A star topology network is a point to multipoint network that places the network master radio in a center or hub position. Slave radios only transmit messages to the master radio, not to each other. These network layouts can be very flexible and typically operate relatively quickly. Slave radios acknowledge receipt of messages transmitted from the master radio.

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For more information on Banner's star network products, refer to the Sure Cross Performance DX80 Wireless I/O Network Instruction Manual (p/n [132607](#))

- switch power** Efficient power management technology enables some *FlexPower* devices to include an internal power output supply, called switch power (SP), that briefly steps up to power sensors (ideally, 4 to 20 mA loop-powered sensors). The warmup time denotes how long the sensor must be powered before a reliable reading can be taken. After the warmup time has passed, the input reads the sensor, then the switched power shuts off to prolong battery life.
- system operating margin (fade margin)** The system operating margin, or fade margin, is the difference between the received signal level (in dBm) and the receiver sensitivity (also in dBm) required for reliable reception. It is recommended that the receiver sensitivity be more than 10 dBm less than the received signal level. For example, if the signal is about -65 dB after traveling through the air and the radio receiver is rated for -85 dB, the operating margin is 20 dB — an excellent margin.
- tau filter** Set to zero (0) to turn off the tau filter. Set to 1 (weakest filter) through 6 (strongest filter) to turn on the tau filter. (In the DX80 products, the Low Pass Filter is a combination of the median filter and the tau filter.)
- TCP/IP** TCP/IP stands for Transfer Control Protocol / Internet Protocol and describe several layers in the OSI model that control the transfer and addressing of information.
- time-division multiple access (TDMA)** TDMA is a wireless network communication architecture that provides a given slot of time for each device on the network, providing a guaranteed opportunity for each device to transmit to the wireless network master device.
- thermistor** A thermistor is a temperature-sensitive resistor that changes resistance based on temperature fluctuation.
- thermocouple** A thermocouple is a temperature measuring device consisting of two dissimilar metals joined together so that the difference in voltage can be measured. Voltage changes in proportion to temperature, therefore the voltage difference indicates a temperature difference.
 The different “types” of thermocouples use different metal pairs for accuracy over different temperature ranges. Thermocouples are inexpensive, relatively interchangeable, have standard connectors, and have a wide temperature range of operation. They can be susceptible to noise, with the wire length affecting accuracy. Thermocouples are best suited for applications with large temperature ranges, not for measuring small temperature changes over small ranges.
- threshold and hysteresis** Threshold and hysteresis work together to establish the ON and OFF points of an analog input. The threshold defines a trigger point or reporting threshold (ON point) for a sensor input. When the input value is higher than the threshold, the input is ON. Hysteresis defines how far below the threshold the analog input is required to be before the input is considered OFF. A typical hysteresis value is 10% to 20% of the unit's range.



In the example shown, the input is considered on at 15 mA. To consider the input off at 13 mA, set the hysteresis to 2 mA. The input will be considered off when the value is 2 mA less than the threshold.

Setting threshold and hysteresis points prevents inputs from oscillating between 'on' and 'off' when the input remains close to the threshold point.

- timeout interval** The Timeout Interval is the total elapsed time before the system flags an error condition. This is a calculated value from Polling Interval (sec) × Maximum Misses.
- topology** Topology is the pattern of interconnection between devices in a communication network. Some examples include point to point, bus, ring, tree, mesh, and star configurations.
- transceiver** A transceiver includes both a transmitter and receiver in one housing and shares circuitry; abbreviated as RxDx.
- wireless sensor network (WSN)** A wireless sensor network is a network of low-power electronic devices that combine sensing and processing ability. The devices use radio waves to communicate to a gateway device, connecting remote areas to the central control process.
- Yagi** Yagi is the name commonly given to directional antennas. The full name of the antenna is a Yagi-Uda antenna, named for the developers Shintaro Uda and Hidetsugu Yagi, both of Tohoku Imperial University in Sendai, Japan. Yagi antennas may also be called beam antennas or directional antennas.



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Sure Cross® Performance PB2 Gateway Board Module



Datasheet

Sure Cross® Performance embeddable board modules provide connectivity where traditional wired connections are not possible or are cost prohibitive. Wireless networks are formed around a Gateway, which acts as the wireless network master device, and one or more Nodes. Sure Cross Performance embeddable board modules communicate with all Sure Cross Performance radios.



- Wireless industrial I/O device with two PNP discrete inputs, two PNP discrete outputs, two 0–20 mA analog inputs, and two 0–20 mA analog outputs
- Selectable transmit power levels of 250 mW or 1 Watt for 900 MHz models and 65 mW for 2.4 GHz models
- 10 V DC to 30 V DC power input
- DIP switches for user configuration
- Modbus serial interface
- Frequency Hopping Spread Spectrum (FHSS) technology ensures reliable data delivery
- Transceivers provide bidirectional communication between the Gateway and Node, including fully acknowledged data transmission
- Lost RF links are detected and relevant outputs set to user-defined conditions

Refer to document number [164886](#), packed with your PB2 Gateway, for a quick start guide to forming PB2 to PB2 networks.

Models

Models	Frequency	Inputs and Outputs
DX80G2M6S-PB2	2.4 GHz ISM Band	Inputs: Two PNP discrete, two 0–20 mA analog Outputs: Two PNP discrete, two 0–20 mA analog
DX80G9M6S-PB2	900 MHz ISM Band	Automatically maps I/O from a Node to the Gateway via DIP switches on the Gateway

Configuration Instructions

Mixing Performance and Non-Performance (150 mW) Radios in the Same Network

To comply with federal regulations, the 150 mW radios and 1 Watt radios communicate differently. All Performance models offer the ability to select between 250 mW and 1 Watt operation using the DIP switches.

To mix Performance radios with non-Performance radios, refer to the product datasheet and:

- Operate Performance radios in 250 mW mode, not 1 Watt mode
- Set non-Performance (150 mW) radios to use Extended Address Mode

The 150 mW, 250 mW, and 1 Watt networks operate when collocated, but verify the antenna separation distance between a Gateway and Node or between two Gateways is at least 10 feet apart. For more detailed instructions about setting up your wireless network, refer to the following documents:

- DX80 Performance Quick Start Guide (p/n [128185](#))
- DX80 Performance Wireless I/O Network Instruction Manual (p/n [132607](#))

Setting Up Your Wireless Network

To set up and install your wireless network, follow these steps.

For complete instructions, including binding, configuration, installation, weatherproofing, device menu maps, troubleshooting, and a list of accessories, refer to Sure Cross® Wireless I/O Network Instruction Manual (p/n [132607](#))

1. Disconnect the power from your Sure Cross devices.
2. Configure the DIP switches of all devices. DIP switch configurations are always listed in the product's datasheet.
3. If your device has I/O, connect the sensors to the Sure Cross devices. Available I/O is always listed in the product's datasheet. If your device does not have I/O, skip this step.
4. Refer to the wiring diagrams to apply power to all devices.
 - For housed models, the Gateway's LED 1 is solid green and the Node's LED 2 flashes red to indicate there is no radio link to the Gateway.
 - For board-level models, the Gateway's LED is solid green and the Node's LED flashes red to indicate there is no radio link to the Gateway.



5. Form the wireless network by binding the Nodes to the Gateway.
6. Observe the LED behavior to verify the devices are communicating with each other.
 - For housed models, the Gateway's LED 1 is solid green and the Node's LED 1 flashes green to indicate it is communicating with the Gateway.
 - For board-level models, the Gateway's LED is solid green and the Node's LED flashes green to indicate it is communicating with the Gateway.
7. Configure any I/O points to use the sensors connected to the Sure Cross devices.
8. Conduct a site survey between the Gateway and Nodes.
9. Install your wireless sensor network components.

Configure the DIP Switches

Before changing DIP switch positions, disconnect the power. Any changes made to the DIP switches are not recognized until after power is cycled to the device.

For devices powered by batteries integrated into the housing, triple-click button 2, then double-click button 2 to reset the device without removing the battery.

For parameters not set using the DIP switches, use the configuration software to make configuration changes. For parameters set using the DIP switches, the DIP switch positions override any changes made using the configuration software.

DIP Switch Settings

Transmit Power

The 900 MHz radios transmit at 1 Watt (30 dBm) or 250 mW (24 dBm). The 250 mW mode reduces the radio's range but improves the battery life in short range applications. For 2.4 GHz models, this DIP switch is disabled. The transmit power for 2.4 GHz is fixed at about 65 mW EIRP (18 dBm).

DIP Switch 1	
OFF *	1 Watt (30 dBm, 900 MHz models only)
ON	250 mW (24 dBm, 900 MHz models only), DX80 compatibility mode

Modbus/Software Configured or DIP Switch Configured

In Modbus/Software Configured mode, use the DX80 Performance Configuration Software or a Modbus command to change the device parameters. DIP switch positions 3 through 8 are ignored. In DIP Switch Configured mode, use the DIP switches to configure the parameters listed in the table. By default, this Gateway uses Modbus commands or the DX80 Performance Configuration Software to configure the device.

DIP Switch 2	
OFF *	Modbus or software configured (DIP switches 3-8 are ignored)
ON	DIP switch configured

DIP Switch 3

DIP switch 3 must remain in the OFF position.

Link Loss Output State

The Sure Cross® wireless devices use a deterministic radio link time-out method to address RF link interruption or failure. When a radio link fails, all pertinent wired outputs are set to defined states until the link is recovered, ensuring that disruptions in the communications link result in predictable system behavior. Select the state the outputs are changed to during a link loss.

DIP Switches		
4	5	
OFF *	OFF *	Off (discrete) or 0 mA (analog)
OFF	ON	On (discrete) or 20 mA (analog)
ON	OFF	Hold last stable state
ON	ON	Reserved

* Default configuration

Sure Cross® Performance PB2 Gateway Board Module

Analog Scale

Use the DIP switch to select which current scale to use for all the device's analog inputs and outputs: 0 to 20 mA or 4 to 20 mA. When using a 4-20 mA sensor with a 0-20 mA input, the sensor uses the 4-20 mA section of the total range. Using a 4-20 mA with a 0-20 mA input allows you to determine when you have an error condition with the sensor. A normal input reading between 4 and 20 mA indicates a functioning sensor whereas a value below 4 mA indicates an error condition, such as a broken wire or loose connection. This DIP switch is used only on the 0 to 20 mA models, not the 0 to 10V models.


DIP Switch 6	
OFF *	0–20 mA scale
ON	4–20 mA scale


* Default configuration

I/O Mapping

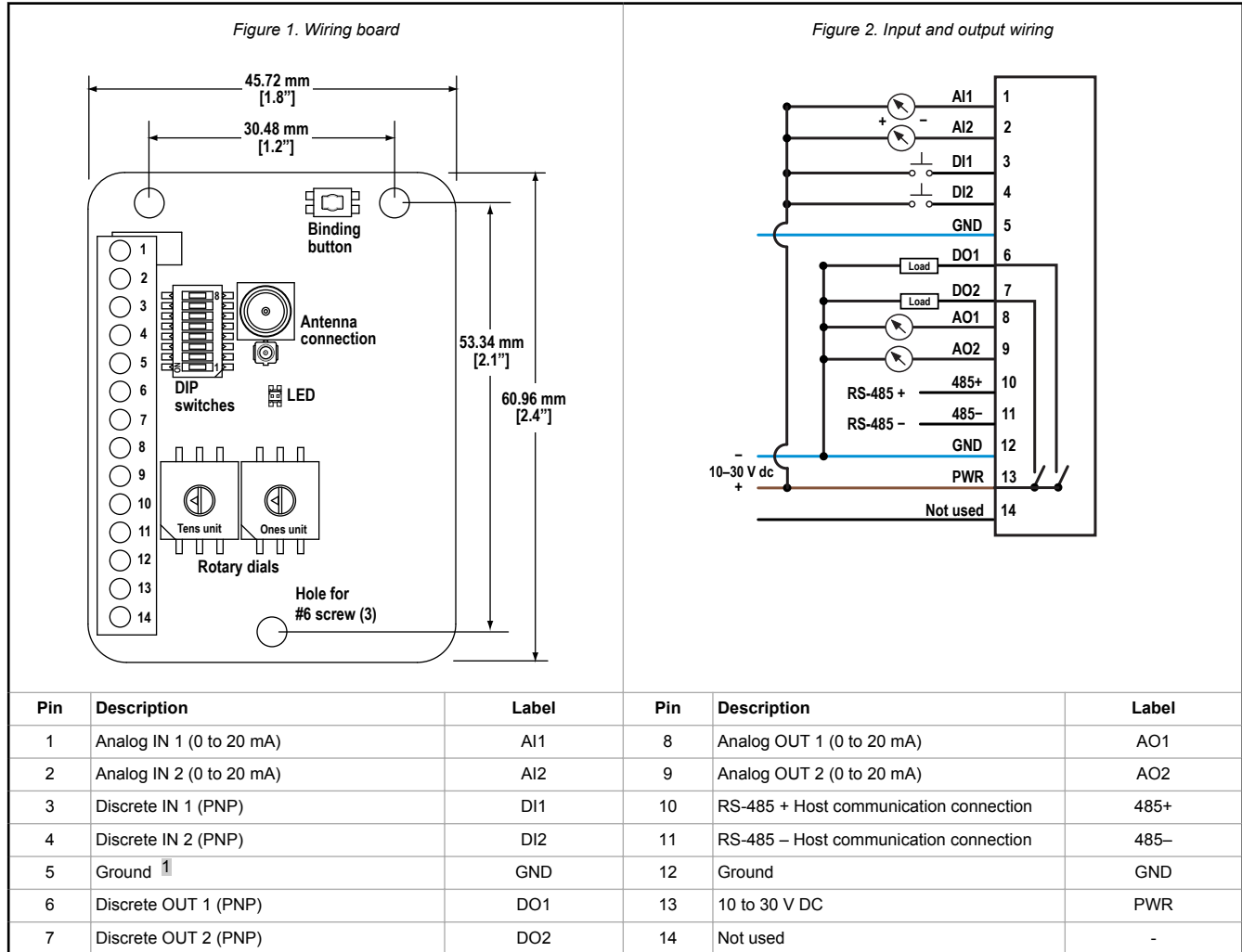
When using these DIP switches to set the I/O mapping, you must change the Node's rotary dials to 01 or 02, depending on which mapping sequence you are using. By default, the Nodes ship from the factory set to 11.

		DIP Switches	
		7 = OFF	8 = OFF
		No I/O mapping via the DIP switches. Use the DX80 Performance Configuration Software to configure the I/O.	

One PB2 Node to a PB2 Gateway		DIP Switches	
		7 = OFF	8 = ON
		Node 01 Discrete IN 1 → Gateway Discrete OUT 1 Node 01 Discrete IN 2 → Gateway Discrete OUT 2 Node 01 Analog IN 1 → Gateway Analog OUT 1 Node 01 Analog IN 2 → Gateway Analog OUT 2 Gateway Discrete IN 1 → Node 01 Discrete OUT 1 Gateway Discrete IN 2 → Node 01 Discrete OUT 2 Gateway Analog IN 1 → Node 01 Analog OUT 1 Gateway Analog IN 2 → Node 01 Analog OUT 2	

Two PB2 Nodes to a PB2 Gateway		DIP Switches	
		7 = ON	8 = OFF
		Node 01 Discrete IN 1 → Gateway Discrete OUT 1 Node 02 Discrete IN 1 → Gateway Discrete OUT 2 Node 01 Analog IN 1 → Gateway Analog OUT 1 Node 02 Analog IN 1 → Gateway Analog OUT 2 Gateway Discrete IN 1 → Node 01 Discrete OUT 1 Gateway Discrete IN 2 → Node 02 Discrete OUT 1 Gateway Analog IN 1 → Node 01 Analog OUT 1 Gateway Analog IN 2 → Node 02 Analog OUT 1	

Wire the I/O and Apply Power



Refer to the Class I Division 2/Zone 2 control drawings (p/n [143086](#)) for wiring specifications and limitations.

Bind Radios to Form Networks

Binding Nodes to a Gateway ensures the Nodes only exchange data with the Gateway they are bound to. For a more detailed definition of binding mode, refer to the *Advanced Setup* section of the *SureCross Wireless I/O Networks* instruction manual.

Apply power to the board module Gateway and all Nodes.



Note: If you are binding a Gateway board module to a Wireless Q45 Sensor, refer to the binding instructions in the Wireless Q45 Sensor's datasheet.

1. Enter binding mode on the Gateway by triple-clicking the binding button. The green and red LED flashes. Any Node entering binding mode will bind to this Gateway.
2. Enter binding mode on the Node.
 - If you have a two-button Node, triple-click button 2.
 - If you have a one-button (board module) Node, triple-click the binding button.

¹ The three ground connections are tied together internally.



- The Node enters binding mode and locates the Gateway in binding mode.
- For two LED models, the red LEDs flash alternately. After binding is complete, both LEDs are both solid red for a few seconds.
 - For one-LED models, the red and green LED flashes alternately while the Node searches for the Gateway. After binding is complete, the LED is red and green for four seconds (looks amber), then the red and green flash simultaneously (looks amber) four times.
 - The Node automatically exits binding mode, cycles its power, then enters RUN mode.
3. Use the Node's rotary dials to assign a valid decimal Node Address (between 01 and 47). The left rotary dial represents the tens digit (0 through 4) and the right dial represents the ones digit (0 through 9) of the Node Address.
 4. Repeat steps 2 and 3 for all Nodes that will communicate to this Gateway.
 5. Exit binding mode on the Gateway by single-clicking the binding button.

LED Behavior for the Gateways

Verify all devices are communicating properly. The radios and antennas must be a minimum distance apart to function properly. Recommended minimum distances are:

- 900 MHz 150 mW and 250 mW radios: 6 feet
- 900 MHz 1 Watt radios: 15 feet
- 2.4 GHz 65 mW radios: 1 foot

LED (Bi-color)	Gateway Status
Solid green	Power ON
Green and red flashing alternately	Binding mode
Flashing red	Device Error
Green and red flashing together, looks amber	Modbus Communication Active
Flashing red	Modbus Communication Error
Solid red	Gateway is trying to conduct a Site Survey with a Node that doesn't exist
Green and red solid together, looks amber)	No radio communication detected

For Gateway and Ethernet Bridge systems, active Modbus communication refers to the communication between the Gateway and the Ethernet Bridge. For Gateway-only systems, the Modbus communication LEDs refer to the communication between the Gateway and its host system (if applicable).

Conduct a Site Survey from a Gateway Board Model

Conducting a Site Survey, also known as an RSSI (Radio Signal Strength Indication), analyzes the radio communications link between the Gateway and any Node within the network by analyzing the radio signal strength of received data packets and reporting the number of missed packets that required a retry.

Perform a Site Survey before permanently installing the radio network to ensure reliable communication. Only the Gateway can initiate a Site Survey, and the Site Survey analyzes the radio communications link with one Node at a time. Follow these steps to conduct a Site Survey from the board module Gateway.

1. Set the Gateway's rotary dials to the Node address you'd like to conduct a Site Survey with.
 For example, to analyze the signal strength between this Gateway and Node 02, rotate the left rotary dial to 0 and the right rotary dial to 2.
 The Site Survey automatically begins running. If there is no device at address 02, the LED is solid red. If there is a device at address 02, the LED flashes amber.
2. Evaluate the signal strength. The amber LED flashes at specific rates to indicate the Site Survey results. Each signal strength represents the majority of the data packets being received at that signal strength. For example, a strong signal

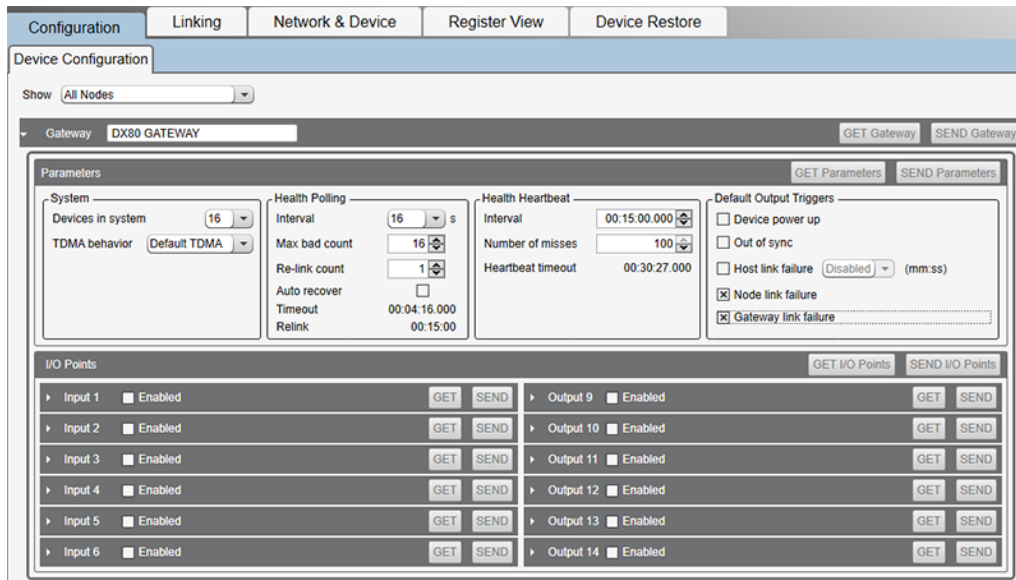
strength indicates the majority of the data packets were received at a strong signal, but a few may have been received at a good or weak signal strength.

- Eight flashes per second: Very strong signal strength
 - Four flashes per second: Strong signal strength
 - Two flashes per second: Good signal strength
 - One flash per second: Weak signal strength
 - Solid amber LED: No radio communication detected
3. To exit the Site Survey, set the Gateway's rotary dials to 00. Otherwise, after 15 minutes the Gateway automatically exits Site Survey mode.
The LED flashes green to indicate the Gateway is in standard operating mode.

Sure Cross® DX80 Performance Configuration Software

The configuration software offers an easy way to link I/O points in your wireless network, view I/O register values, and set system communication parameters when a host system is not part of the wireless network. The software runs on any computer with the Windows Vista, Windows 7, Windows 8, or Windows 10 operating system.

Figure 3. Device Configuration screen



Use a USB to RS-485 adapter cable to connect a standalone DX80 Gateway to the computer. For DXM Controllers with an internal DX80 radio, connect a computer to the DXM Controller using the supplied USB or Ethernet connection. Download the most recent revisions of the configuration software from Banner Engineering's website: <https://www.bannerengineering.com/us/en/products/wireless-sensor-networks/reference-library/software.html>.

The USB to RS-485 adapter cable is not required for the DXM Controller. For standalone DX80 Gateway devices use:

- USB to RS-485 adapter cable model **BWA-UCT-900** for 1 Watt radios
- USB to RS-485 adapter cable model **BWA-HW-006** for all other radios

Installing the Board Modules

Sure Cross® board modules must be mounted inside a panel or OEM enclosure.

Holding Registers

Modbus Registers		EIP Registers		I/O Type	I/O Range		Holding Register Representation (Dec)	
Gateway	Node	Node			Min.	Max.	Min.	Max.
1	1 + (Node# × 16)	0 + (Node# × 8)	Instance 100 / N7	Discrete IN 1	0	1	0	1
2	2 + (Node# × 16)	1 + (Node# × 8)		Discrete IN 2	0	1	0	1
3	3 + (Node# × 16)	2 + (Node# × 8)		Analog IN 1 (mA)	0.0	20.0	0	65535
4	4 + (Node# × 16)	3 + (Node# × 8)		Analog IN 2 (mA)	0.0	20.0	0	65535
...						
7	7 + (Node# × 16)	6 + (Node# × 8)		Reserved				
8	8 + (Node# × 16)	7 + (Node# × 8)		Device Message				
9	9 + (Node# × 16)	0 + (Node# × 8)	Instance 112 / N14	Discrete OUT 1	0	1	0	1
10	10 + (Node# × 16)	1 + (Node# × 8)		Discrete OUT 2	0	1	0	1

Sure Cross® Performance PB2 Gateway Board Module

Modbus Registers		EIP Registers		I/O Type	I/O Range		Holding Register Representation (Dec)	
Gateway	Node	Node			Min.	Max.	Min.	Max.
11	11 + (Node# × 16)	2 + (Node# × 8)		Analog OUT 1 (mA)	0.0	20.0	0	65535
12	12 + (Node# × 16)	3 + (Node# × 8)		Analog OUT 2 (mA)	0.0	20.0	0	65535
	...							
15	15 + (Node# × 16)	6 + (Node# × 8)		Control Message				
16	16 + (Node# × 16)	7 + (Node# × 8)		Reserved				

Discrete Bit-Packed Registers

Discrete bit-packed registers include the discrete status registers, discrete inputs, and discrete outputs.

Bit packing involves using a single register, or range of contiguous registers, to represent I/O values.

When networks use similar Nodes to gather data using the same I/O registers for each Node, discrete data from multiple Nodes can be bit packed into a single register on the Gateway. The bit-packed data is arranged by I/O point starting at Modbus register 6601. For example, Discrete IN 1 for all the Nodes in the network is stored in three contiguous 16-bit registers.

The most efficient way to read (or write) discrete data from a Sure Cross® DX80 Gateway is by using these bit-packed registers because users can read or write registers for all devices using one Modbus message. The following registers contain discrete bit-packed I/O values for the Gateway and all Nodes. Values are stored first for the Gateway, then for each Range Node in order of Node address.

Figure 4. Discrete bit-packed register addresses and bit positions

Bit-Packed Device Status Registers

Register Address	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
6601	Node 15	Node 14	Node 13	Node 12	Node 11	Node 10	Node 9	Node 8	Node 7	Node 6	Node 5	Node 4	Node 3	Node 2	Node 1	Gateway
6602	Node 31	Node 30	Node 29	Node 28	Node 27	Node 26	Node 25	Node 24	Node 23	Node 22	Node 21	Node 20	Node 19	Node 18	Node 17	Node 16
6603	Node 47	Node 46	Node 45	Node 44	Node 43	Node 42	Node 41	Node 40	Node 39	Node 38	Node 37	Node 36	Node 35	Node 34	Node 33	Node 32

Bit-Packed Discrete Input 1

Register Address	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
6611	Node 15	Node 14	Node 13	Node 12	Node 11	Node 10	Node 9	Node 8	Node 7	Node 6	Node 5	Node 4	Node 3	Node 2	Node 1	Gateway
6612	Node 31	Node 30	Node 29	Node 28	Node 27	Node 26	Node 25	Node 24	Node 23	Node 22	Node 21	Node 20	Node 19	Node 18	Node 17	Node 16
6613	Node 47	Node 46	Node 45	Node 44	Node 43	Node 42	Node 41	Node 40	Node 39	Node 38	Node 37	Node 36	Node 35	Node 34	Node 33	Node 32

Bit-Packed Discrete Output 1

Register Address	Bit Position															
	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
6691	Node 15	Node 14	Node 13	Node 12	Node 11	Node 10	Node 9	Node 8	Node 7	Node 6	Node 5	Node 4	Node 3	Node 2	Node 1	Gateway
6692	Node 31	Node 30	Node 29	Node 28	Node 27	Node 26	Node 25	Node 24	Node 23	Node 22	Node 21	Node 20	Node 19	Node 18	Node 17	Node 16
6693	Node 47	Node 46	Node 45	Node 44	Node 43	Node 42	Node 41	Node 40	Node 39	Node 38	Node 37	Node 36	Node 35	Node 34	Node 33	Node 32

Table 1: Discrete bit-packed registers for inputs and outputs

Inputs		Outputs	
Modbus Register Address (Decimal)	Description (Inputs)	Modbus Register Address (Decimal)	Description (Outputs)
6601–6603	Status for all devices		
6611–6613	Input 1 from all devices	6691–6693	Output 1 from all devices
6621–6623	Input 2 from all devices	6701–6703	Output 2 from all devices
6631–6633	Input 3 from all devices	6711–6713	Output 3 from all devices
6641–6643	Input 4 from all devices	6721–6723	Output 4 from all devices
6651–6653	Input 5 from all devices	6731–6733	Output 5 from all devices
6661–6663	Input 6 from all devices	6741–6743	Output 6 from all devices
6671–6673	Input 7 from all devices	6751–6753	Output 7 from all devices
6681–6683	Input 8 from all devices		

Status registers (6601–6603) contain a bit-packed representation defining the devices that are operational in the wireless system. Each bit indicates Node in Sync (1) or Node Not in Sync (0).

Input registers from all devices use Modbus registers 6611 through 6683 to organize the least significant bit into a sequential array of registers. The first register contains the least significant bit from the input values for the Gateway through Node 15. The second register contains the input values for Node 16 through Node 31, and the third register contains the input values for Nodes 32 through 47.

For discrete inputs, only the least significant bit is used. For analog inputs, the least significant bit indicates if the analog value is above or below the selected threshold value (when using the threshold parameter configured in the User Configuration Software). For example, a least significant bit of one (1) indicates the analog value is above the selected threshold value. A least significant bit of zero (0) indicates the analog value is below the threshold value.

Output registers from all devices use Modbus registers 6691 through 6753 to organize the least significant bit into a sequential array of registers. Output 8 (I/O point 16) cannot be written using the discrete format.

Analog 16-Bit Registers (Registers 6801 through 9098)

The most efficient way to read (or write) analog data from a Gateway is by using these 16-bit analog registers. Most networks consist of similar Nodes reporting data using the same I/O registers for each Node. For this reason, the analog data is arranged by I/O point using Modbus registers 6801 through 9098.

For example, Input 1 for Gateway and all Nodes is stored in the first 48 contiguous blocks of 16-bit analog registers, beginning with register 6801.

In this format, users can read a 16-bit holding register for all devices or write to a register for all devices using one Modbus message. Using these registers is the most efficient way to read all status registers, read all analog inputs, or write all analog outputs.

The following registers contain analog I/O values for the Gateway and all Nodes. Values are stored first for the Gateway, then for each Node in order of Node address.

Table 2: Analog input and output registers

Inputs		Outputs	
Modbus Register Address (Decimal)	Description (Inputs)	Modbus Register Address (Decimal)	Description (Outputs)
6801	Input 1 for Gateway	8001	Output 1 for Gateway
6802	Input 1 for Node 1	8002	Output 1 for Node 1
6803	Input 1 for Node 2	8003	Output 1 for Node 2
...
6951	Input 2 for Gateway	8151	Output 2 for Gateway
6952	Input 2 for Node 1	8152	Output 2 for Node 1
6953	Input 2 for Node 2	8153	Output 2 for Node 2
...
7101	Input 3 for Gateway	8301	Output 3 for Gateway
7102	Input 3 for Node 1	8302	Output 3 for Node 1
7103	Input 3 for Node 2	8303	Output 3 for Node 2
...
7851	Input 8 (Status Register) for Gateway	9051	Output 8 for Gateway
7852	Input 8 (Status Register) for Node 1	9052	Output 8 for Node 1
7853	Input 8 (Status Register) for Node 2	9053	Output 8 for Node 2
...

For example, 6801 contains the input 1 value for the Gateway, 6802 contains the input 1 value for Node 1, and 6848 contains the input 1 value for Node 47.

Sure Cross® Performance PB2 Gateway Board Module

Specifications

Performance Radio Specifications

Radio Range²

900 MHz, 1 Watt: Up to 9.6 km (6 miles)
2.4 GHz, 65 mW: Up to 3.2 km (2 miles)

Antenna Minimum Separation Distance

900 MHz, 1 Watt: 4.57 m (15 ft)
2.4 GHz, 65 mW: 0.3 m (1 ft)

Radio Transmit Power

900 MHz, 1 Watt: 30 dBm (1 W) conducted (up to 36 dBm EIRP)
2.4 GHz, 65 mW: 18 dBm (65 mW) conducted, less than or equal to 20 dBm (100 mW) EIRP

Spread Spectrum Technology

FHSS (Frequency Hopping Spread Spectrum)

Link Timeout (Performance)

Gateway: Configurable via User Configuration Software
Node: Defined by Gateway

Antenna Connection

Ext. Reverse Polarity SMA, 50 Ohms
Max Tightening Torque: 0.45 N-m (4 lbf-in)

900 MHz Compliance (1 Watt)

FCC ID UE3RM1809: FCC Part 15, Subpart C, 15.247
IC: 7044A-RM1809
IFT: RCPBARM13-2283



(NOM approval only applies to 900 MHz models)

2.4 GHz Compliance

FCC ID UE300DX80-2400: FCC Part 15, Subpart C, 15.247
Radio Equipment Directive (RED) 2014/53/EU
IC: 7044A-DX8024

ANATEL: 15966-21-04042 Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados. Para maiores informações, consulte o site da ANATEL www.gov.br/anatel/pt-br/

Specifications for the PB2 Gateway

Supply Voltage

10 V DC to 30 V DC; Outside the USA: 12 V DC to 24 V DC, ± 10% (For European applications, power this device from a Limited Power Source as defined in EN 60950-1.)

Wiring Access

Terminal block

Discrete Inputs

Two, PNP
Rating: 3 mA max current at 30 V DC
Sample Rate: 62.5 milliseconds
Report Rate: On change of state
ON Condition: Greater than 8 V
OFF Condition: Less than 5 V

Analog Inputs

Two, 0–20 mA
Rating: 24 mA
Impedance: Approximately 100 Ohms; To verify the analog input's impedance, use an Ohm meter to measure the resistance between the analog input terminal (AIx) and the ground (GND) terminal.
Sample Rate: 62.5 milliseconds
Accuracy: 0.1% of full scale +0.01% per °C
Resolution: 12-bit

Discrete Output

Two, PNP
Update Rate: 1 second
ON Condition (PNP): Supply minus 2 V
OFF Condition (PNP): Less than 2 V
Output State Following Timeout: De-energized (OFF)

Discrete Output Rating (PNP)

100 mA max current at 30 V DC
ON-State Saturation: Less than 3 V at 100 mA
OFF-state Leakage: Less than 10 µA

Analog Outputs

Two, 0–20 mA
Rating: 24 mA
Update Rate: 125 milliseconds
Accuracy: 0.1% of full scale +0.01% per °C
Resolution: 12-bit

Current Draw (at 24 V DC)

900 MHz, 1 Watt: Approx. 30 mA
900 MHz, 250 mW: Approx. 25 mA
2.4 GHz, 65 mW: Approx. 20 mA

Interface

One bi-color LED indicator; One button

Operating Conditions

–40 °C to +85 °C (–40 °F to +185 °F)³
95% maximum relative humidity (non-condensing)

Certifications



Banner Engineering Europe
Park Lane,
Culliganlaan 2F bus 3, 1831
Diegem, BELGIUM

(CE approval only applies to 2.4 GHz models)



CSA: Class I Division 2 Groups ABCD, Class I Zone 2 AEx/Ex nA II T4 — Certificate: 1921239



ATEX: II 3 G Ex nA IIC T4 Gc (Group IIC Zone 2) — Certificate LCIE 10 ATEX 1012 X

Refer to the Class I Division 2/Zone 2 control drawings (p/n 143086) for wiring specifications and limitations. Install the device in a suitable enclosure with provision for connection of Division 2 / Zone 2 wiring methods in accordance with local codes, as acceptable to the local inspection authority having jurisdiction. All battery-powered devices must only use the lithium battery manufactured by Xeno, model XL-205F (Banner model number **BWA-BATT-001**).

RS-485 Communication Specifications

Communication Hardware (RS-485)

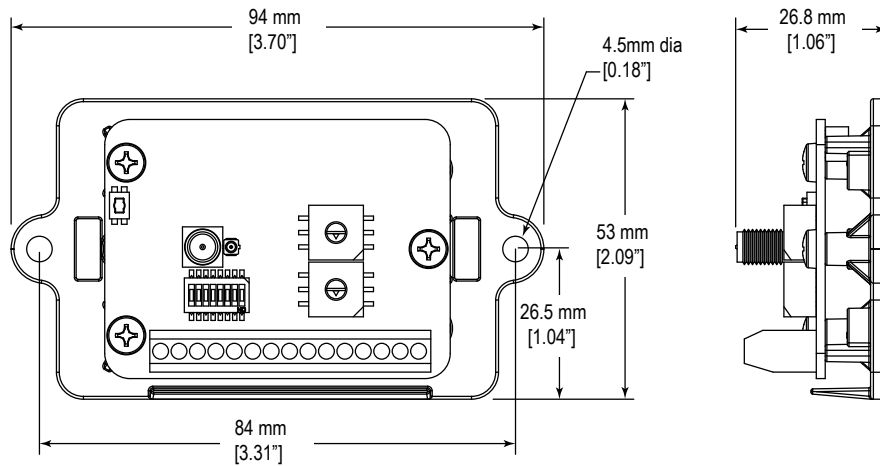
Interface: 2-wire half-duplex RS-485
Baud rates: 9.6k, 19.2k (default), or 38.4k
Data format: 8 data bits, no parity, 1 stop bit

² Radio range is with the 2 dB antenna that ships with the product. High-gain antennas are available, but the range depends on the environment and line of sight. Always verify your wireless network's range by performing a Site Survey.

³ Operating the devices at the maximum operating conditions for extended periods can shorten the life of the device.

MultiHop M-HBx and Performance PBx Models Mounted on the Base

Figure 5. Most MultiHop M-HBx and Performance PBx models ship from the factory mounted on a plastic base.



Accessories for the Board Models

BWA-HW-034

- DIN rail clip, black plastic



Warnings

Install and properly ground a qualified surge suppressor when installing a remote antenna system. Remote antenna configurations installed without surge suppressors invalidate the manufacturer's warranty. Keep the ground wire as short as possible and make all ground connections to a single-point ground system to ensure no ground loops are created. No surge suppressor can absorb all lightning strikes; do not touch the Sure Cross® device or any equipment connected to the Sure Cross device during a thunderstorm.

Exporting Sure Cross® Radios. It is our intent to fully comply with all national and regional regulations regarding radio frequency emissions. **Customers who want to re-export this product to a country other than that to which it was sold must ensure the device is approved in the destination country.** The Sure Cross wireless products were certified for use in these countries using the antenna that ships with the product. When using other antennas, verify you are not exceeding the transmit power levels allowed by local governing agencies. This device has been designed to operate with the antennas listed on Banner Engineering's website and having a maximum gain of 9 dBm. Antennas not included in this list or having a gain greater than 9 dBm are strictly prohibited for use with this device. The required antenna impedance is 50 ohms. To reduce potential radio interference to other users, the antenna type and its gain should be so chosen such that the equivalent isotropically radiated power (EIRP) is not more than that permitted for successful communication. Consult with Banner Engineering Corp. if the destination country is not on this list.



Important: Please download the complete Performance Gateway or Node technical documentation, available in multiple languages, from www.bannerengineering.com for details on the proper use, applications, Warnings, and installation instructions of this device.



Important: Por favor descargue desde www.bannerengineering.com toda la documentación técnica de los Performance Gateway or Node, disponibles en múltiples idiomas, para detalles del uso adecuado, aplicaciones, advertencias, y las instrucciones de instalación de estos dispositivos.



Important: Veuillez télécharger la documentation technique complète des Performance Gateway or Node sur notre site www.bannerengineering.com pour les détails sur leur utilisation correcte, les applications, les notes de sécurité et les instructions de montage.



WARNING:

- **Do not use this device for personnel protection**
- Using this device for personnel protection could result in serious injury or death.
- This device does not include the self-checking redundant circuitry necessary to allow its use in personnel safety applications. A device failure or malfunction can cause either an energized (on) or de-energized (off) output condition.



Important:

- **Never operate a 1 Watt radio without connecting an antenna**
- Operating 1 Watt radios without an antenna connected will damage the radio circuitry.
- To avoid damaging the radio circuitry, never apply power to a Sure Cross® Performance or Sure Cross MultiHop (1 Watt) radio without an antenna connected.



Important:

- **Electrostatic discharge (ESD) sensitive device**
- ESD can damage the device. Damage from inappropriate handling is not covered by warranty.
- Use proper handling procedures to prevent ESD damage. Proper handling procedures include leaving devices in their anti-static packaging until ready for use; wearing anti-static wrist straps; and assembling units on a grounded, static-dissipative surface.

Banner Engineering Corp. Limited Warranty

Banner Engineering Corp. warrants its products to be free from defects in material and workmanship for one year following the date of shipment. Banner Engineering Corp. will repair or replace, free of charge, any product of its manufacture which, at the time it is returned to the factory, is found to have been defective during the warranty period. This warranty does not cover damage or liability for misuse, abuse, or the improper application or installation of the Banner product.

THIS LIMITED WARRANTY IS EXCLUSIVE AND IN LIEU OF ALL OTHER WARRANTIES WHETHER EXPRESS OR IMPLIED (INCLUDING, WITHOUT LIMITATION, ANY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE), AND WHETHER ARISING UNDER COURSE OF PERFORMANCE, COURSE OF DEALING OR TRADE USAGE.

This Warranty is exclusive and limited to repair or, at the discretion of Banner Engineering Corp., replacement. **IN NO EVENT SHALL BANNER ENGINEERING CORP. BE LIABLE TO BUYER OR ANY OTHER PERSON OR ENTITY FOR ANY EXTRA COSTS, EXPENSES, LOSSES, LOSS OF PROFITS, OR ANY INCIDENTAL, CONSEQUENTIAL OR SPECIAL DAMAGES RESULTING FROM ANY PRODUCT DEFECT OR FROM THE USE OR INABILITY TO USE THE PRODUCT, WHETHER ARISING IN CONTRACT OR WARRANTY, STATUTE, TORT, STRICT LIABILITY, NEGLIGENCE, OR OTHERWISE.**

Banner Engineering Corp. reserves the right to change, modify or improve the design of the product without assuming any obligations or liabilities relating to any product previously manufactured by Banner Engineering Corp. Any misuse, abuse, or improper application or installation of this product or use of the product for personal protection applications when the product is identified as not intended for such purposes will void the product warranty. Any modifications to this product without prior express approval by Banner Engineering Corp will void the product warranties. All specifications published in this document are subject to change; Banner reserves the right to modify product specifications or update documentation at any time. Specifications and product information in English supersedes that which is provided in any other language. For the most recent version of any documentation, refer to: www.bannerengineering.com.

For patent information, see www.bannerengineering.com/patents.

Notas Adicionales

Información México: La operación de este equipo está sujeta a las siguientes dos condiciones: 1) es posible que este equipo o dispositivo no cause interferencia perjudicial y 2) este equipo debe aceptar cualquier interferencia, incluyendo la que pueda causar su operación no deseada.

Banner es una marca registrada de Banner Engineering Corp. y podrán ser utilizadas de manera indistinta para referirse al fabricante. "Este equipo ha sido diseñado para operar con las antenas tipo Omnidireccional para una ganancia máxima de antena de 6 dBd y Yagi para una ganancia máxima de antena 10 dBd que en seguida se enlistan. También se incluyen aquellas con aprobación ATEX tipo Omnidireccional siempre que no excedan una ganancia máxima de antena de 6dBd. El uso con este equipo de antenas no incluidas en esta lista o que tengan una ganancia mayor que 6 dBd en tipo omnidireccional y 10 dBd en tipo Yagi, quedan prohibidas. La impedancia requerida de la antena es de 50 ohms."

Antenas SMA	Modelo	Antenas Tipo-N	Modelo
Antena, Omni 902-928 MHz, 2 dBd, junta de caucho, RP-SMA Macho	BWA-902-C	Antena, Omni 902-928 MHz, 6 dBd, fibra de vidrio, 1800mm, N Hembra	BWA-906-A
Antena, Omni 902-928 MHz, 5 dBd, junta de caucho, RP-SMA Macho	BWA-905-C	Antena, Yagi, 900 MHz, 10 dBd, N Hembra	BWA-9Y10-A

Mexican Importer

Banner Engineering de México, S. de R.L. de C.V.
 David Alfaro Siqueiros 103 Piso 2 Valle oriente
 San Pedro Garza Garcia Nuevo León, C. P. 66269
 81 8363.2714

ANATEL

Modelo (Model): DX80-2400—Este equipamento não tem direito à proteção contra interferência prejudicial e não pode causar interferência em sistemas devidamente autorizados. Para maiores informações, consulte o site da ANATEL www.gov.br/anatel/pt-br/



Level Measurement

Continuous level measurement - Ultrasonic transducers

EchoMax XRS-5

Overview



EchoMax XRS-5 ultrasonic transducer provides reliable, continuous level monitoring of liquids and slurries in narrow lift stations/wet wells, flumes, weirs and filter beds using a beam angle of just 10° and a CSM rubber face.

Benefits

- Narrow beam angle of only 10°
- Chemically resistant PVDF copolymer enclosure and CSM rubber face
- Measuring range: 8 m (26 ft) for measurement of liquids and slurries
- Fully submersible: IP68 degree of protection
- Easy installation with 1" NPT or R 1" BSPT connection

Application

The XRS-5 is non-contacting with a measuring range from 0.3 to 8 m (1 to 26 ft). Advanced echo processing ensures reliable data even in conditions with obstructions, turbulence, and foam.

The hermetically sealed CSM rubber face and the PVDF copolymer enclosure are designed for maximum resistance to methane, salt water, caustics, and harsh chemicals common to wastewater installations. With an IP68 degree of protection, this rugged sensor is fully submersible in the event of flood conditions. Use a submergence shield if full submergence is possible in the application. A submergence shield will maintain a high level reading output during submerged conditions.

The low-cost XRS-5 transducer is compatible with a full range of Siemens controllers, from a basic system for high/low alarm or simple pump control, up to advanced control systems with communications, telemetry and SCADA integration capabilities.

- Key Applications: wet wells, flumes, weirs, filter beds

Technical specifications

Mode of operation	
Measuring principle	Ultrasonic transducer
Input	
Measuring range	0.3 ... 8 m (1 ... 26 ft), dependent on application
Output	
Frequency	44 kHz
Beam angle	10°
Accuracy	
Temperature error	Compensated by integral temperature sensor
Rated operating conditions	
Vessel pressure	Normal atmospheric pressure
Ambient Conditions	
• Ambient temperature	-20 ... +65 °C (-4 ... +149 ° F)
Design	
Weight (approximate shipping weight of sensor with standard cable length)	1.2 kg (2.6 lb)
Material (enclosure)	PVDF copolymer enclosure and CSM face
Process connection	1" NPT [(Taper), ANSI/ASME B1.20.1] or R 1" [(BSPT), EN 10226]
Degree of protection	IP65/IP68
Cable connection	2-core shielded/twisted, 0.5 mm ² (20 AWG), PVC sheath
Cable (max. length)	<ul style="list-style-type: none"> • 365 m (1 200 ft) with RG 62 A/U coaxial cable • 365 m (1 200 ft) with 2-core twisted pair, foil shield, 0.5 mm² (20 AWG), PVC sheath, only for MultiRanger 100/200
Options	
Flange version	Factory flange with PTFE face for ASME, EN or JIS configuration
Submergence shield	For applications with flooding possible
Certificates and approvals	
CE, RCM, KCC	
CSA Class I, Div. 2, Groups A, B, C, D, Class II, Div. 1 Groups E, F, G	
FM Class I, Zone 1, AEx m IIC, T6 Class II, III, Div. 1, Groups E, F, G T6	
ATEX II 2GD / IECEx / INMETRO Ex mb IIC T6 Gb, Ex tb IIC T85 °C Db	

Level Measurement

Continuous level measurement - Ultrasonic transducers

EchoMax XRS-5

Selection and Ordering data	Article No.	Selection and Ordering data	Order code
<p>EchoMax XRS-5 transducer</p> <p>With a beam angle of 10°, the XRS-5 provides reliable, continuous level monitoring of liquids and slurries in narrow lift stations/wet wells, flumes, weirs and filter beds. Measuring range: min. 0.3 m (1 ft), max. 8 m (26 ft)</p> <p>➤ Click on the Article No. for the online configuration in the PIA Life Cycle Portal.</p>	<p>7ML1106-</p> <p>0 - 0</p>	<p>Further designs</p> <p>Please add "-Z" to Article No. and specify Order code(s).</p> <p>Acrylic coated, stainless steel tag [13 x 45 mm (0.5 x 1.75 inch)]: Measuring-point number/identification (max. 16 characters) specify in plain text</p>	<p>Y17</p>
<p>Process connection</p> <p>1" NPT [(Taper), ANSI/ASME B1.20.1] ➤ 1</p> <p>R 1" [(BSPT), EN 10226] ➤ 2</p>		<p>Accessories</p> <p>Tag, stainless steel with hole, 12 x 45 mm (0.47 x 1.77 inch), one text line for fastening on sensors</p> <p>Submergence shield kit</p> <p>Easy Aimer 2, aluminum, NPT with 3/4" x 1" PVC coupling</p> <p>Easy Aimer 2, aluminum with M20 adapter and 1" and 1 1/2" BSPT aluminum couplings</p> <p>Easy Aimer 304, NPT with 1" stainless steel coupling</p> <p>Easy Aimer 304, with M20 adapter and 1" and 1 1/2" BSPT 304 stainless steel couplings</p> <p>FMS-200 universal box bracket, mounting kit</p> <p>FMS-210 channel bracket, wall mount</p> <p>FMS-220 extended channel bracket, wall mount</p> <p>FMS-310 channel bracket, floor mount</p> <p>FMS-320 extended channel bracket, floor mount</p> <p>FMS-350 bridge channel bracket, floor mount (see Mounting Brackets on page 4/179 for more information)</p> <p>1" NPT locknut, plastic</p> <p>1" BSPT locknut, plastic</p> <p>Plastic adapter 1" BSP - 20 mm</p> <p>Plastic adapter 1" NPT</p> <p>Plastic adapter 1" NPT/M20</p>	<p>Article No.</p> <p>7ML1930-1BJ</p> <p>7ML1830-1BH</p> <p>7ML1830-1AQ</p> <p>7ML1830-1AX</p> <p>7ML1830-1AU</p> <p>7ML1830-1GN</p> <p>7ML1830-1BK</p> <p>7ML1830-1BL</p> <p>7ML1830-1BM</p> <p>7ML1830-1BN</p> <p>7ML1830-1BP</p> <p>7ML1830-1BQ</p> <p>7ML1830-1DS</p> <p>7ML1830-1DR</p> <p>7ML1830-1EA</p> <p>7ML1930-1FX</p> <p>7ML1830-1EF</p>
<p>Cable length</p> <p>5 m (16.40 ft) ➤ A</p> <p>10 m (32.81 ft) ➤ B</p> <p>30 m (98.43 ft) ➤ C</p>			
<p>Facing</p> <p>Standard (CSM rubber) ➤ A</p> <p>PTFE (flange versions) ➤ B</p>			
<p>Approvals</p> <p>CE, RCM, KCC, CSA Class I, Div. 2, Groups A, B, C, D, Class II, Div. 1, Groups E, F, G FM Class I, Zone 1, AEx m IIC, T6 Class II, III, Div. 1, Groups E, F, G T6 ATEX II 2GD / IECEx / INMETRO Ex mb IIC T6 Gb, Ex tb IIIC T85 °C Db</p>	2		
<p>Mounting flange (flush mount)</p> <p>None ➤ A</p> <p>3" ASME, 150 lb, flat faced ➤ B</p> <p>4" ASME, 150 lb, flat faced ➤ C</p> <p>6" ASME, 150 lb, flat faced ➤ D</p> <p>DN 80, PN 10/16, Type A, flat faced ➤ J</p> <p>DN 100, PN 10/16, Type A, flat faced ➤ K</p> <p>DN 150, PN 10/16, Type A, flat faced ➤ L</p> <p>JIS10K 3B style ➤ Q</p> <p>JIS10K 4B style ➤ R</p> <p>JIS10K 6B style ➤ S</p> <p>Note: flange bolting patterns and facings dimensionally correspond to the applicable ASME B16.5 or EN 1092-1, or JIS B 2220 standard.</p>			
<p>Operating Instructions</p> <p>All literature is available to download for free, in a range of languages, at http://www.siemens.com/processinstrumentation/documentation</p>			

➤ We can offer shorter delivery times for configurations designated with the Quick Ship Symbol ➤. For details see page 10/11 in the appendix.

Level Measurement

Continuous level measurement - Ultrasonic transducers

EchoMax XRS-5

Selection and Ordering data	Article No.
EchoMax XRS-5C transducer With a beam angle of 10°, the XRS-5 provides reliable, continuous level monitoring of liquids and slurries in narrow lift stations/wet wells, flumes, weirs and filter beds. Measuring range: min. 0.3 m (1 ft), max. 8 m (26 ft) ↗ Click on the Article No. for the online configuration in the PIA Life Cycle Portal.	7ML1105-
Process connection 1" NPT [(Taper), ANSI/ASME B1.20.1]	
Cable length 5 m (16.40 ft) 10 m (32.81 ft) 30 m (98.43 ft)	
Facing Standard (CSM rubber) PTFE (flange versions)	
Approvals CSA Class I Div. 1, Groups A, B, C, D; Class II Div. 1, Groups E, F, G; Class III	
Mounting flange (flush mount) None 3" ASME, 150 lb, flat faced 4" ASME, 150 lb, flat faced 6" ASME, 150 lb, flat faced Note: flange bolting patterns and facings dimensionally correspond to the applicable ASME B16.5 or EN 1092-1, or JIS B 2220 standard.	
Operating Instructions All literature is available to download for free, in a range of languages, at http://www.siemens.com/processinstrumentation/documentation	

◆ We can offer shorter delivery times for configurations designated with the Quick Ship Symbol ◆. For details see page 10/11 in the appendix.

Selection and Ordering data	Order code
Further designs Please add "-Z" to Article No. and specify Order code(s). Acrylic coated, stainless steel tag [13 x 45 mm (0.5 x 1.75 inch)]: Measuring-point number/identification (max. 16 characters) specify in plain text	
Accessories Submergence shield kit Easy Aimer 2, aluminum, NPT with 3/4" x 1" PVC coupling Easy Aimer 304, NPT with 1" stainless steel coupling FMS-200 universal box bracket, mounting kit FMS-210 channel bracket, wall mount FMS-220 extended channel bracket, wall mount FMS-310 channel bracket, floor mount FMS-320 extended channel bracket, floor mount FMS-350 bridge channel bracket, floor mount (see Mounting Brackets on page 4/179 for more information)	Article No. 7ML1830-1BH 7ML1830-1AQ 7ML1830-1AU 7ML1830-1BK 7ML1830-1BL 7ML1830-1BM 7ML1830-1BN 7ML1830-1BP 7ML1830-1BQ

◆ We can offer shorter delivery times for configurations designated with the Quick Ship Symbol ◆. For details see page 10/11 in the appendix.

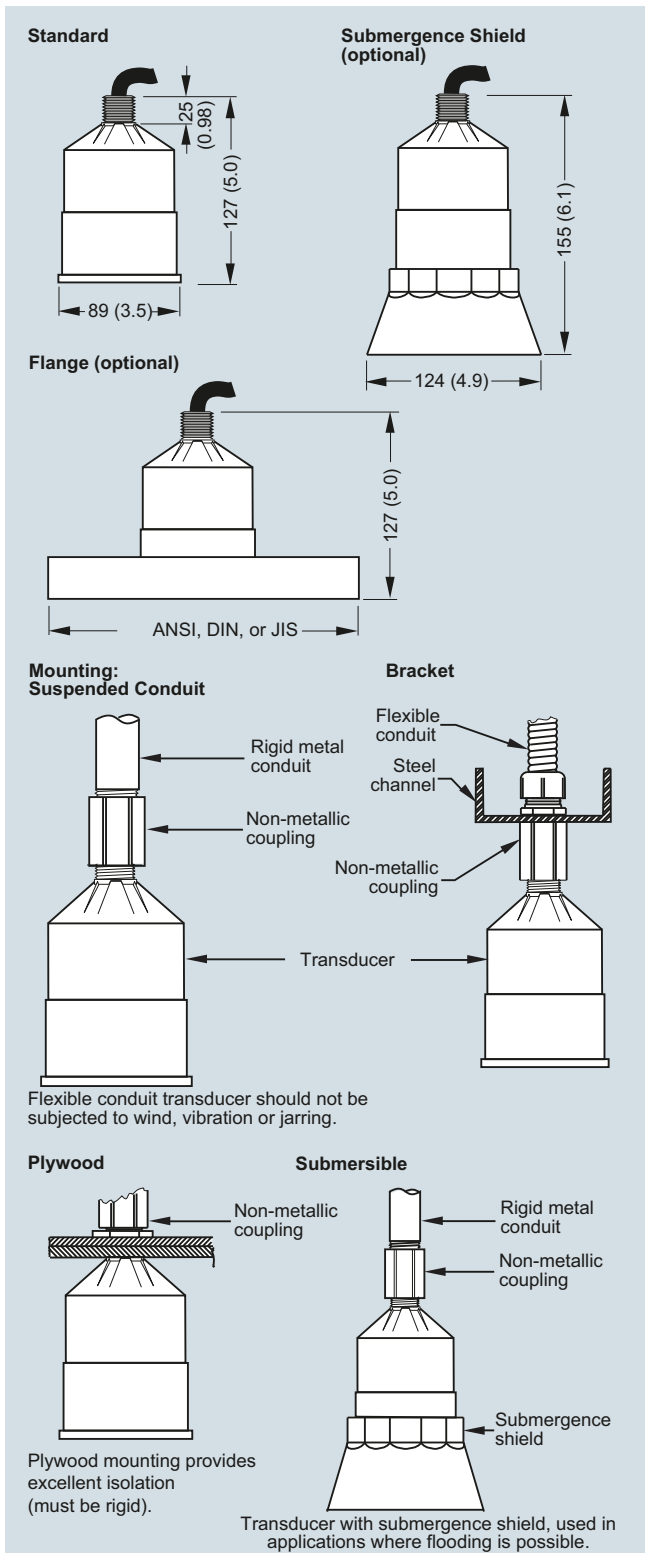
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Level Measurement

Continuous level measurement - Ultrasonic transducers

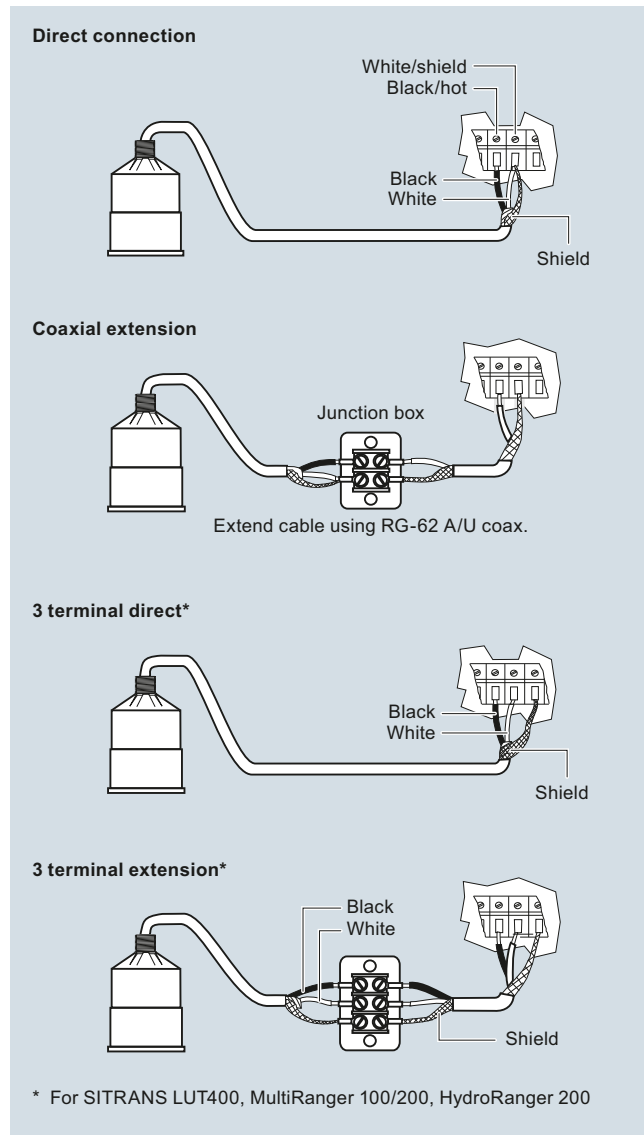
EchoMax XRS-5

Dimensional drawings



XRS-5 ultrasonic transducer, dimensions in mm (inch)

Schematics



XRS-5 ultrasonic transducer connections

4

Level Measurement

Continuous level measurement - Ultrasonic controllers

SITRANS LUT400 series

Overview

The SITRANS LUT400 series controllers are compact, single point, long-range ultrasonic controllers for continuous level or volume measurement of liquids, slurries, solids, and high accuracy monitoring of open channel flow.

Benefits

- Small 1/2 DIN enclosure [144 h x 144 d x 146 w mm (5.7 x 5.7 x 5.75 inch)] with standard universal mounting bracket for wall, pipe, and DIN rail, plus an optional panel mount
- Easy to use HMI display with local four-button programming, menu-driven parameters, and Wizard support for key applications
- English, German, French, Spanish, Chinese, Italian, Portuguese, and Russian texts on the HMI.
- Level, Volume, OCM Flow monitoring
- Three relays combined with a suite of pump, alarm, and relay control features
- HART Communications
- EDDs for SIMATIC PDM, AMS Device Manager, and Field Communicator 375/475, plus DTMs for FDTs (Field Device Tools)
- Web browser for local programming from an intuitive web-based interface
- Two discrete inputs for backup level override and pump interlock functions
- Echo profile and trend views from the local display
- Patented digital receiver for improved performance in electrically noisy applications (close proximity to VSDs)
- Real time clock with daylight savings time, supporting an integrated datalogger and energy saving algorithms for minimizing pump operation during high cost energy periods
- Removable terminal blocks for ease of wiring
- MCERTS Certified for Open Channel Flow

Application

The SITRANS LUT400 comes in three different models, depending on the application, level of performance and functionality required:

- SITRANS LUT420 Level Controller: Level or volume measurement of liquids, slurries, and solids, as well as basic pump control functions, and basic data logging capability
- SITRANS LUT430 Level, Pump and Flow Controller: Includes all features of the LUT420 plus a full suite of advanced pump control and alarm functionality, open channel flow monitoring, and basic flow data logging capability
- SITRANS LUT440 High Accuracy OCM: Our most featured, highest accuracy model. Includes all features of the LUT430, plus the industry's best accuracy (± 1 mm within 3 m), full suite of advanced control functionality, and enhanced flow logging capability
- Key Applications: wet wells, reservoirs, flumes/weirs, chemical storage, liquid storage, hoppers, crusher bins, dry solids storage

Level Measurement

Continuous level measurement - Ultrasonic controllers

SITRANS LUT400 series

Technical specifications

Mode of Operation	Ultrasonic level, volume, pump, and open channel flow
Measuring range	0.3 ... 60 m (1 ... 196 ft), transducer dependent
Input	
Discrete	0 ... 50 V DC switching level Logical 0 ≤ 10 V DC Logical 1 = 10 ... 50 V DC Max. 3 mA
Output	
Transducer frequency	10 ... 52 kHz
Ultrasonic transducer	Compatible transducers: All Echo-Max and ST-H series transducers
Relays	<ul style="list-style-type: none"> • 1 SPDT Form C, NO or NC relay, rated 1A at 250 V AC, non-inductive and 3A at 30 V DC • 2 SPST Form A, NO relays, rated 5A at 250 V AC, non-inductive and 3 A at 30 V DC
mA output	4 ... 20 mA, isolated
Max. load	600 Ω max. in ACTIVE mode, 750 Ω max. in PASSIVE mode
Resolution	0.1 % of range
Accuracy	
Error in measurement	<ul style="list-style-type: none"> • Standard operation: ± 1 mm (0.04 inch) plus 0.17 % of measured distance • High accuracy OCM: ± 1 mm (0.04 inch), within 3 m (9.84 ft) range
Resolution	<ul style="list-style-type: none"> • Standard operation: 0.1 % of range or 2 mm (0.08 inch), whichever is greater • High accuracy OCM: 0.6 mm (0.02 inch), within 3 m (9.84 ft) range
Temperature compensation	<ul style="list-style-type: none"> • -40 ... +150 °C (-40 ... +300 °F) • Integral temperature sensor in transducer • External TS-3 temperature sensor (optional) • Programmable fixed temperature values
Rated operating conditions	
Installation conditions	
• Location	Indoor/outdoor
• Installation category	II
• Pollution degree	4
Ambient conditions	
• Ambient temperature (enclosure)	-20 ... +50 °C (-4 ... +122 °F)

Design	
Weight	
• Enclosure with display lid	1.3 kg (2.87 lb)
• Enclosure with blank lid	1.2 kg (2.65 lb)
Material (enclosure)	Polycarbonate
Degree of protection	
• Enclosure with display or blank lid	IP65/Type 4X/NEMA 4X
• Enclosure with blank lid and knock-out removed	IP20
Remote display lid	IP65/Type 3/NEMA 3
Cable	
Transducer and mA output signal	<ul style="list-style-type: none"> • Transducer, mA output: 2 copper conductors, twisted, with foil shield/drain wire, 300 V 0.5 ... 0.75 mm² (22 ... 18 AWG) • Relay/power to be copper conductors per local requirements to meet 250 V 5 A contact rating
Max. separation between transducer and transceiver	365 m (1 200 ft)
Displays and controls	60 x 40 mm (2.36 x 1.57 inch) removable LCD, 240 x 160 pixels resolution, operational up to 5 m from enclosure base
Programming	
• Primary	4 Local push buttons
• Secondary	<ul style="list-style-type: none"> • PC running SIMATIC PDM • PC running Emerson AMS Device Manager • PC running a web browser • PC running a Field Device Tool (FDT) • Field Communicator 375/475 (FC375/FC475)
Memory	<ul style="list-style-type: none"> • 512 kB flash EPROM • 1.5 MB flash for data logging
Power supply	
AC version	100 ... 230 V AC ± 15 %, 50/60 Hz, 36 VA Fuse: 5 x 20 mm, Slow Blow, 0.25 A, 250 V
DC version	10 ... 32 V DC, 10 W Fuse: 5 x 20 mm, Slow Blow, 1.6 A, 125 V
Certificates and approvals	
General	CSA _{US/CA} , CE, FM, UL listed, RCM, MCERTS certified for Open Channel Flow
Hazardous	
• Non-incendive (Canada)	CSA Class I, Div. 2, Groups A, B, C, D; Class II, Div. 2, Groups F, G; Class III
• Shipping	Lloyd's Register, ABS
Communication	HART 7.0, USB

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Level Measurement

Continuous level measurement - Ultrasonic controllers

SITRANS LUT400 series

		SITRANS LUT420	SITRANS LUT430	SITRANS LUT440
Category	Feature	Level Controller	Level, pump and flow controller	High accuracy OCM controller
Operations	Level, space, and distance measurement	✓	✓	✓
	Open channel flow measurement		✓	✓
	Volume conversion	✓	✓	✓
Specifications	Compatible with EchoMax and ST-H transducers	✓	✓	✓
	Standard accuracy: ± 1 mm + 0.17 % of measured distance	✓	✓	✓
	High accuracy: ± 1 mm within 3 meters			✓
	Mounting options: wall or panel, pipe, DIN-rail	✓	✓	✓
Data logging and communications	HART communications	✓	✓	✓
	4 ... 20 mA output (active and passive)	✓	✓	✓
	Integrated datalogger for measurement value and alarms	✓	✓	✓
	Integrated datalogger for fixed rate flow logging		✓	✓
	Integrated datalogger for variable rate flow logging triggered by changes in flow condition			✓
	Daily data logging for maximum, minimum and average flow, daily totalized volume, and minimum and maximum temperature		✓	✓
Flow monitoring	High accuracy open channel flow measurement			✓
	9 digit daily and running flow totalizers		✓	✓
	High and low flowrate alarms		✓	✓
	External totalizer and sampler control		✓	✓
	MCERTS Class 1 Certification			✓
	MCERTS Class 2 Certification		✓	
Pump control	Energy saving algorithms for pump control		✓	✓
	Wall cling reduction	✓	✓	✓
	Pump run-on functionality		✓	✓
	Pump start and power resumption delays		✓	✓
	Alternate duty pump routines	✓	✓	✓
	Fixed duty and service ratio pump routines		✓	✓
	Pumped volume totalizer		✓	✓
	Submergence detection	✓	✓	✓
	Discrete input pump interlocks		✓	✓
	Time to spill calculation		✓	✓

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Level Measurement

Continuous level measurement - Ultrasonic controllers

SITRANS LUT400 series

Selection and Ordering data	Article No.
SITRANS LUT420 and LUT430 Compact ultrasonic level controllers for continuous short to long-range level or volume measurement of liquids, slurries, and solids. Both units include basic relay functions for pumps, alarms, and other controls, plus onboard data logging. LUT430 offers additional advanced pump control and alarm functionality, open channel flow monitoring, and basic flow data logging capability. Functionality varies by model. ↗ Click on the Article No. for the online configuration in the PIA Life Cycle Portal.	7ML5050-
Model SITRANS LUT420 - Level controller ● A SITRANS LUT430 - Level, Pump & Flow controller ● B	
Enclosure display options With display ● A With remote panel mount display [Includes panel mount cable extension, 2.5 m (8.2 ft)] ● B No display (blank lid provided) ● C Note: Enclosure includes back-plate for wall and pipe mounting, and an integrated clip for DIN-rail mounting. DIN-rail mounting for standard TS35 x 7.5 and TS35 x 15 mm DIN-rail to IEC 60715, EN 60715	
Input voltage 100 ... 230 V AC ± 15 % ● 1 10 ... 32 V DC ● 2	
Cable inlet 3 cable inlets, cable glands not supplied ● 1 3 cable inlets, 3 M20 plastic cable glands supplied ● 2	
Number of measurement points Single point system (includes one transducer input, one mA output, and one external temperature sensor input) ● 1	
Communications and I/O HART, 2 discrete inputs, 3 relays ● D	
Approvals General purpose CE, FM, CSA _{US/CA} , UL, RCM Hazardous locations CSA Class I, II, III, Div. 2, Groups A, B, C, D, F, G ● A ● C	

● We can offer shorter delivery times for configurations designated with the Quick Ship Symbol ●. For details see page 10/11 in the appendix.

Selection and Ordering data	Order code
Further designs Please add "-Z" to Article No. and specify Order code(s).	
Manufacturer's test certificate M to DIN 55350, Part 18 and to ISO 9000 ● C11	
Stainless steel tag [69 x 50 mm (2.71 x 1.97 inch)]: Measuring-point number/identification (max. 27 characters) specify in plain text ● Y15	
Namur NE43 failsafe setting - device preset to failsafe < 3.6 mA ● N07	
Operating Instructions English German Note: The Operating Instructions should be ordered as a separate line item on the order. All literature is available to download for free, in a range of languages, at http://www.siemens.com/processinstrumentation/documentation	Article No. A5E33329501 A5E35690863

Selection and Ordering data	Article No.
Accessories Tag, stainless steel, 12 x 45 mm (0.47 x 1.77 inch), one text line, suitable for enclosure 7ML1930-1AC TS-3 Temperature Sensor - see TS-3 on page 4/181 7ML1813-... Panel mount cable extension, 2.5 m (8.2 ft) 7ML1930-1GF Qty 3 cable glands and retaining nuts 7ML1930-1GB USB cable, 2 m (6.56 ft) - Standard USB-A to USB-mini B 7ML1930-1GD Hart modem/USB (for use with a PC and SIMATIC PDM) 7MF4997-1DB Sunshield, 304 stainless steel 7ML1930-1GE SITRANS RD100, loop powered display - see Chapter 7 7ML5741-... SITRANS RD200, universal input display with Modbus conversion - see Chapter 7 7ML5740-... SITRANS RD300, dual line display with totalizer and linearization curve and Modbus conversion - see Chapter 7 7ML5744-... SITRANS RD500 web, universal remote monitoring solution for instrumentation - see Chapter 7 7ML5750-...	
Spare parts Panel mount retrofit kit (convert standard unit with display to panel mount version) 7ML1830-1PA Terminal block replacement kit (5 piece kit with one of each removable terminal) 7ML1830-1PB Wall/Pipe mount plate 7ML1830-1PC Enclosure (include blank label) 7ML1830-1PD SITRANS LUT400 Lid (with Display) 7ML1830-1PE SITRANS LUT400 Lid (blank) 7ML1830-1PF Fuse - AC (0.25 A, 250 V, Slow Blow) 7ML1830-1PG Fuse - DC (1.6 A, 125 V, Slow Blow) 7ML1830-1PH Panel mount gasket and fastener kit 7ML1830-1PK DIN-rail clip 7ML1830-1PL	

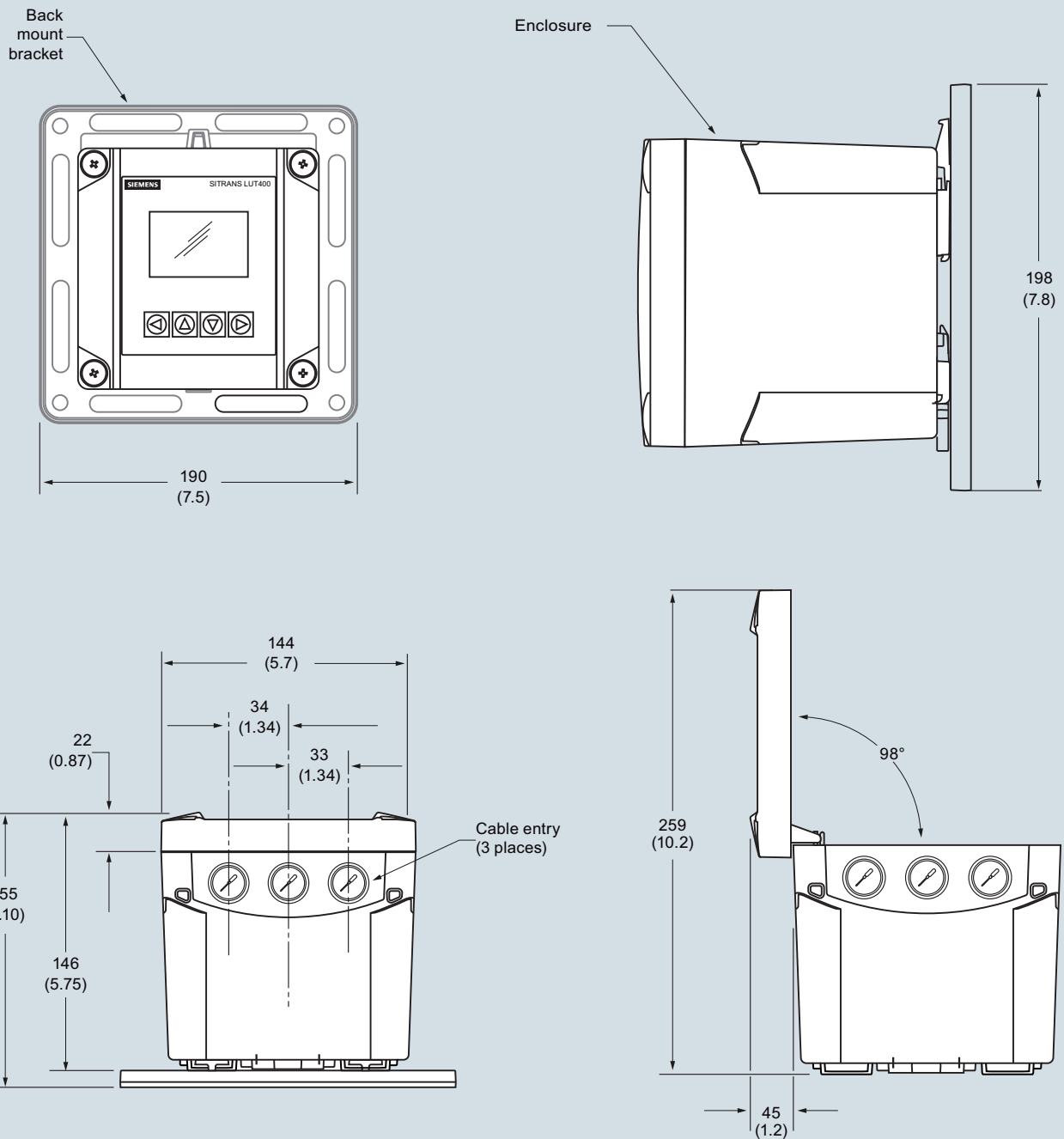
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Level Measurement

Continuous level measurement - Ultrasonic controllers

SITRANS LUT400 series

Dimensional drawings

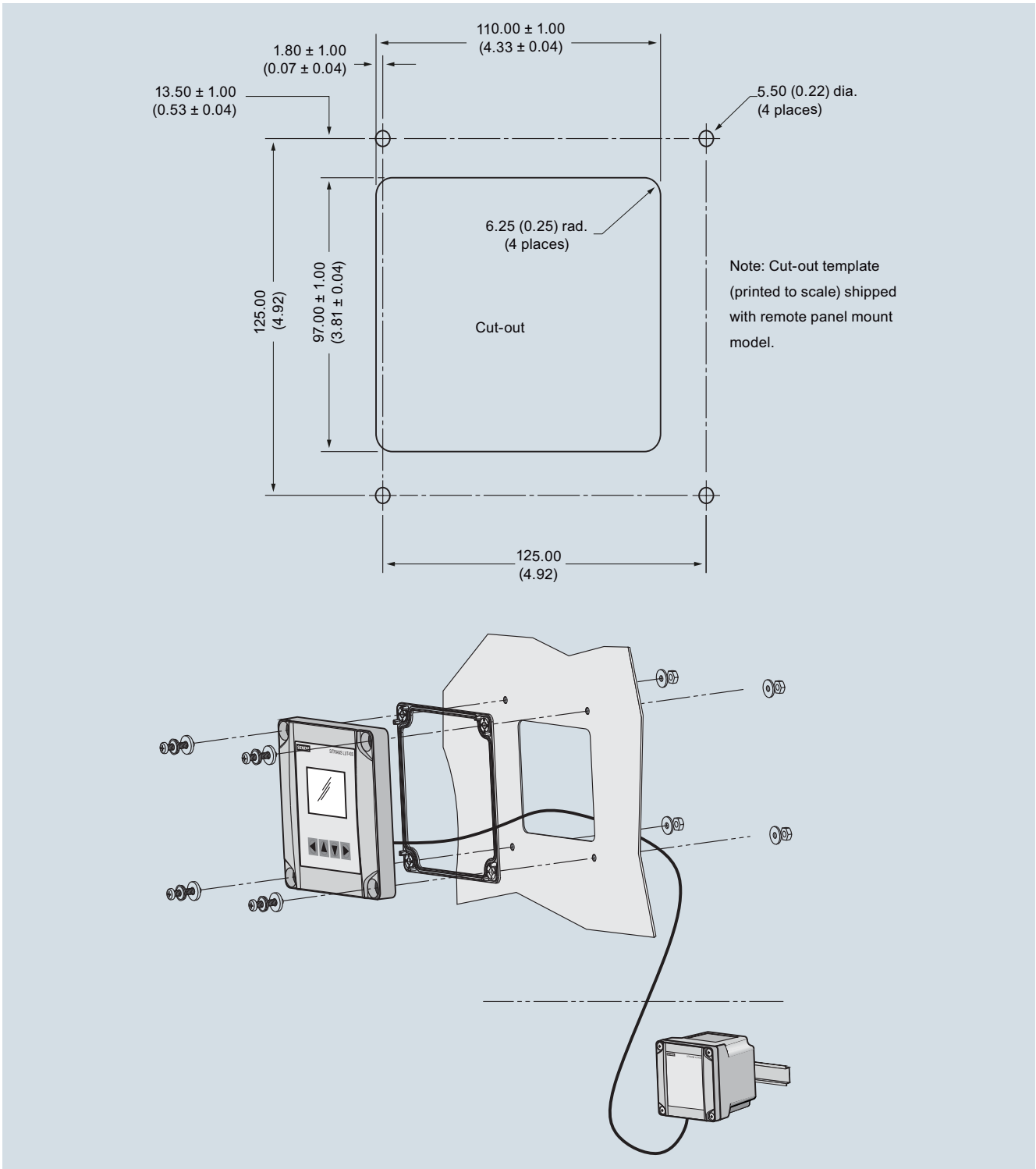


SITRANS LUT400, dimensions in mm (inch)

Level Measurement

Continuous level measurement - Ultrasonic controllers

SITRANS LUT400 series



SITRANS LUT400, dimensions in mm (inch)

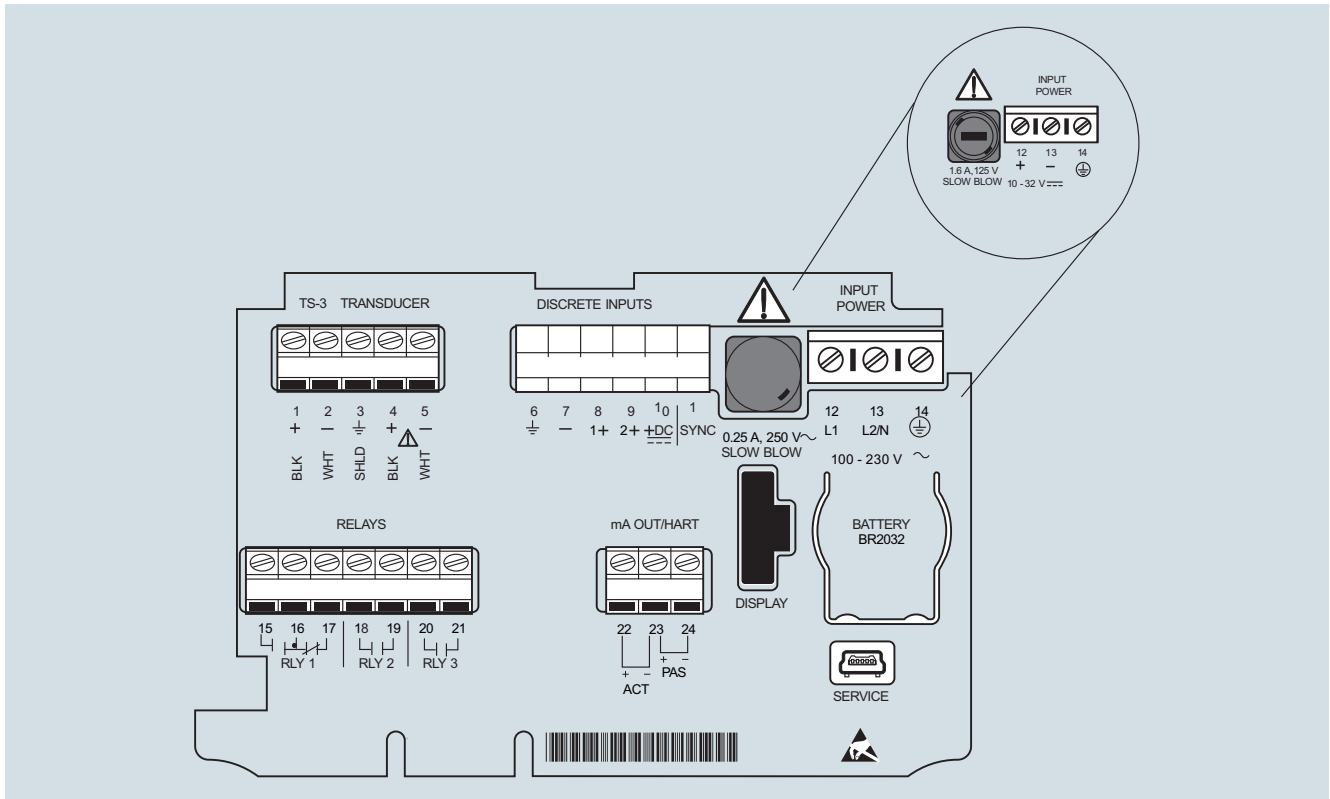
Level Measurement

Continuous level measurement - Ultrasonic controllers

SITRANS LUT400 series

Schematics

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SITRANS LUT400 connections

Ultrasonic Controllers

SITRANS LUT400 (HART)

Operating Instructions · 02/2014



SITRANS

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Safety Guidelines: Warning notices must be observed to ensure personal safety as well as that of others, and to protect the product and the connected equipment. These warning notices are accompanied by a clarification of the level of caution to be observed.

Qualified Personnel: This device/system may only be set up and operated in conjunction with this manual. Qualified personnel are only authorized to install and operate this equipment in accordance with established safety practices and standards.

Unit Repair and Excluded Liability:

- The user is responsible for all changes and repairs made to the device by the user or the user's agent.
- All new components are to be provided by Siemens Milltronics Process Instruments.
- Restrict repair to faulty components only.
- Do not reuse faulty components.

Warning: Cardboard shipping package provides limited humidity and moisture protection. This product can only function properly and safely if it is correctly transported, stored, installed, set up, operated, and maintained.

This product is intended for use in industrial areas. Operation of this equipment in a residential area may cause interference to several frequency based communications.

Note: Always use product in accordance with specifications.

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While we have verified the contents of this manual for agreement with the instrumentation described, variations remain possible. Thus we cannot guarantee full agreement. The contents of this manual are regularly reviewed and corrections are included in subsequent editions. We welcome all suggestions for improvement.

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Introduction

The Manual

Notes:







- This product is intended for use in industrial areas. Operation of this equipment in a residential area may cause interference to several frequency based communications.
- Please follow the installation and operating procedures for a quick, trouble-free installation and to ensure the maximum accuracy and reliability of your SITRANS LUT400.
- This manual applies to the SITRANS LUT400 series only.

This manual will help you set up your SITRANS LUT400 for optimum performance. We always welcome suggestions and comments about manual content, design, and accessibility. Please direct your comments to techpubs.smpi@siemens.com.

For other Siemens level measurement manuals, go to: www.siemens.com/level, and look under **Level Measurement**.

Manual symbols

Please note their use carefully.

	Alternating Current
	Direct Current
	Earth (ground) Terminal
	Protective Conductor Terminal
	Caution (refer to instructions)
	No co-axial cable connections

Application examples

The application examples used in this manual illustrate typical installations using SITRANS LUT400. As there is often a range of ways to approach an application, other configurations may also apply.

In all examples, substitute your own application details. If the examples do not apply to your application, check the applicable parameter reference for the available options.

Change History

Sensor node

Firmware Rev.	PDM EDD Rev.	Date	Changes
1.00.00	1.00.00	August 3, 2012	<ul style="list-style-type: none"> Initial release.

LUI

Firmware Rev.	Date	Changes
1.00.00	August 3, 2012	<ul style="list-style-type: none"> Initial release.

SITRANS LUT400

Safety Notes

Special attention must be paid to warnings and notes highlighted from the rest of the text by grey boxes.



WARNING: relates to a caution symbol on the product, and means that failure to observe the necessary precautions can result in death, serious injury, and/or considerable material damage.



WARNING¹: means that failure to observe the necessary precautions can result in death, serious injury, and/or considerable material damage.

Note: means important information about the product or that part of the operating manual.

Safety marking symbols

In manual	On product	Description
		Earth (ground) Terminal (shield)
		Protective Conductor Terminal
		Dispose of in an environmentally safe manner, and according to local regulations.
		WARNING: refer to accompanying documents (manual) for details.
		CAUTION: Observe electrostatic discharge precautions prior to handling electronic components within the wiring compartment.

¹ This symbol is used when there is no corresponding caution symbol on the product.

FCC Conformity

US Installations only: Federal Communications Commission (FCC) rules

! WARNING: Changes or modifications not expressly approved by Siemens could void the user's authority to operate the equipment.

Notes:

- This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment.
- This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference to radio communications, in which case the user will be required to correct the interference at his own expense.

CE Electromagnetic Compatibility (EMC) Conformity

This equipment has been tested and found to comply with the following EMC Standards:

EMC Standard	Title
CISPR 11:2004/EN 55011: 2009, CLASS A	Limits and methods of measurements of radio disturbance characteristics of industrial, scientific, and medical (ISM) radio-frequency equipment.
EN 61326-1: 2006 IEC 61326-1: 2005	Electrical Equipment for Measurement, Control and Laboratory Use – Electromagnetic Compatibility.
EN61000-3-2: 2006	Electromagnetic Compatibility (EMC) Part 3-2: Limits for harmonic current emissions (equipment input current \leq 16A per phase).
EN61000-3-3: 2008 A1: 2001 + A2: 2005	Electromagnetic Compatibility (EMC) Part 3-3: Limitation of voltage changes, voltage fluctuations, and flicker in public low voltage supply systems, for equipment with rated current \leq 16A per phase and not subject to conditional connection.
EN61000-4-2:2009	Electromagnetic Compatibility (EMC) Part 4-2: Testing and measurement techniques – Electrostatic discharge immunity test.
EN61000-4-3:2006	Electromagnetic Compatibility (EMC) Part 4-3: Testing and measurement techniques – Radiated, radio-frequency, electromagnetic field immunity test.
EN61000-4-4:2004	Electromagnetic Compatibility (EMC) Part 4-4: Testing and measurement techniques – Electrical fast transient/burst immunity test.
EN61000-4-5:2006	Electromagnetic Compatibility (EMC) Part 4-5: Testing and measurement techniques – Surge immunity test.

Appendix 2F

EMC Standard	Title
EN61000-4-6:2009	Electromagnetic Compatibility (EMC) Part 4-6: Testing and measurement techniques – Immunity to conducted disturbances, induced by radio-frequency fields.
EN61000-4-8:2010	Electromagnetic Compatibility (EMC) Part 4-8: Testing and measurement techniques – Power frequency magnetic field immunity test.
EN61000-4-11: 2004	Electromagnetic Compatibility (EMC) Part 4-11: Testing and measurement techniques - voltage clips, short interruptions and voltage variations immunity tests.

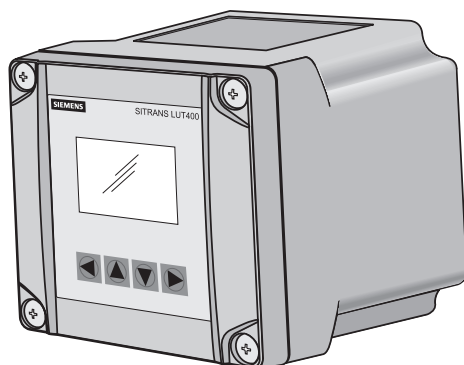
Notes

Description

Overview

The Siemens SITRANS LUT400 series controllers are compact, single point, long-range ultrasonic controllers for continuous level measurement of liquids, slurries, and solids, and high accuracy monitoring of open channel flow.

The series is compatible with Siemens full line of EchoMax[®] Transducers, allowing an operating range of 0.3 to 60 meters (dependent on transducer). The SITRANS LUT400 has been coupled with a backlit Local User Interface (LUI) display featuring menu driven programming and a host of wizards for plug and play performance. The LUT400 also features our next generation of Sonic Intelligence[®], further strengthening our industry leading measurement performance while improving ease of use. With a number of advanced pump, alarm, and flow control features, plus a real time clock and an integrated datalogger, the LUT400 is a powerful and comprehensive solution for your Ultrasonic applications.



Features

- Small 1/2 DIN enclosure footprint with standard universal mounting bracket for wall, pipe, and DIN rail, plus an optional panel mount
- Easy to use LUI display with local four-button programming, menu-driven parameters, and Wizard support for key applications
- Level, Volume, High Accuracy OCM Flow monitoring
- Three relays combined with a suite of pump, alarm, and relay control features
- HART Communications
- EDDs for SIMATIC PDM, AMS Device Manager, and Field Communicator 375/475, plus DTMs for FDTs (Field Device Tools)
- Integrated web browser for local programming from an intuitive web-based interface
- Two discrete inputs for backup level override and pump interlock functions
- Echo profile and trend views from the local display
- Patented digital receiver for improved performance in electrically noisy applications (close proximity to VSDs)
- Real time clock with daylight savings time supporting an integrated datalogger and energy saving algorithms for minimizing pump operation during high cost energy periods
- Removable terminal blocks for ease of wiring

Models

The SITRANS LUT400 comes in three different models, depending on the application, level of performance and functionality required:

- SITRANS LUT420 Level Controller - Level or volume measurement, basic pump control functions, and basic data logging capability
- SITRANS LUT430 Pump and Flow Controller - Full suite of advanced control functionality, open channel flow monitoring, and basic data logging capability
- SITRANS LUT440 High Accuracy OCM - Best performance (rated at 1 mm accuracy up to 3 meters), full suite of advanced control functionality, and enhanced data logging capability

Applications

- Liquids, solids and slurry monitoring in small to large process and storage vessels or outdoor applications (open air)
- Environmental, Mining/Aggregates/Cement, Food & Beverage, and Chemical market applications primarily
- Key sample applications include: wet wells, reservoirs, flumes/weirs, chemical storage, liquid storage, hoppers, crusher bins, dry solids storage

Approvals and Certificates

The SITRANS LUT400 is available with General Purpose and Hazardous Area approvals. It also has a number of approvals for specialized applications. For details, see chart below.

Note: The device nameplate lists the approvals that apply to your device.

Application Type		Approval Rating	Valid for:
Non-hazardous	General Purpose	CSA _{US/C} , CE, FM, UL listed, C-TICK	N. America, Europe, Australia
Hazardous	Non-incendive	CSA Class I, Div. 2, Groups A, B, C, D; Class II, Div 2, Groups F, G; Class III ^a	Canada


- a. Not available for devices with remote display.

Installing and Mounting


Installing

Notes:

- Installation must only be performed by qualified personnel, and in accordance with local governing regulations.
- This product is susceptible to electrostatic shock. Follow proper grounding procedures.

 **All field wiring must have insulation suitable for at least 250V.**

 **Hazardous voltages present on transducer terminals during operation.**

 **DC input terminals shall be supplied from a source providing electrical isolation between the input and output, in order to meet applicable safety requirements of IEC 61010-1.**

- Relay contact terminals are for use with equipment that has no accessible live parts and wiring that has insulation suitable for at least 250 V. The maximum allowable working voltage between adjacent relay contacts shall be 250 V.
- The non-metallic enclosure does not provide grounding between conduit connections. Use grounding type bushings and jumpers.

Mounting locations

Recommended

- Ambient temperature is always within -20 to +50 °C (-4 to +122 °F)
- SITRANS LUT400 display window is at shoulder level, unless most interaction is through a SCADA system
- Easy access to local push buttons is provided
- Cable length requirements are minimized
- Mounting surface is free from vibration
- Sufficient room to swing device lid open and have clear access.
- A place for a laptop computer is provided for on-site configuration (optional, as laptop not required for configuration).

Avoid

- Exposure to direct sunlight. (Provide a sun shield to avoid direct sunlight.)
- Proximity to high voltage/current runs, contactors, SCR or variable frequency motor speed controllers

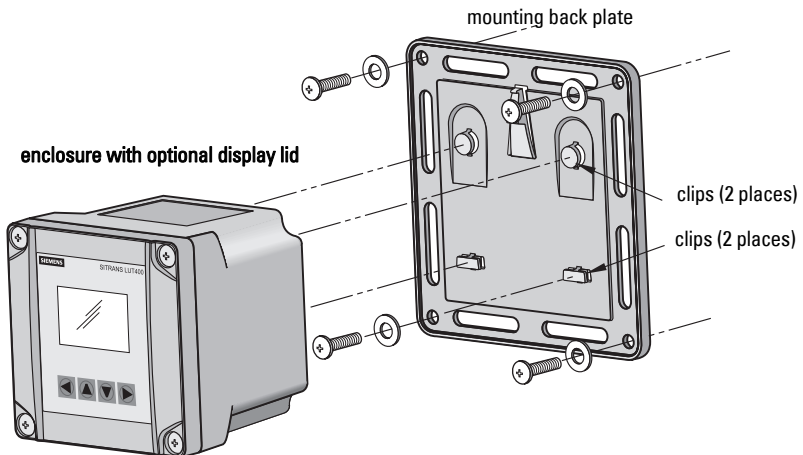
Mounting instructions

Mounting instructions differ for wall, pipe, DIN-rail, and remote display panel mount devices. Please follow the specific instructions for your device.

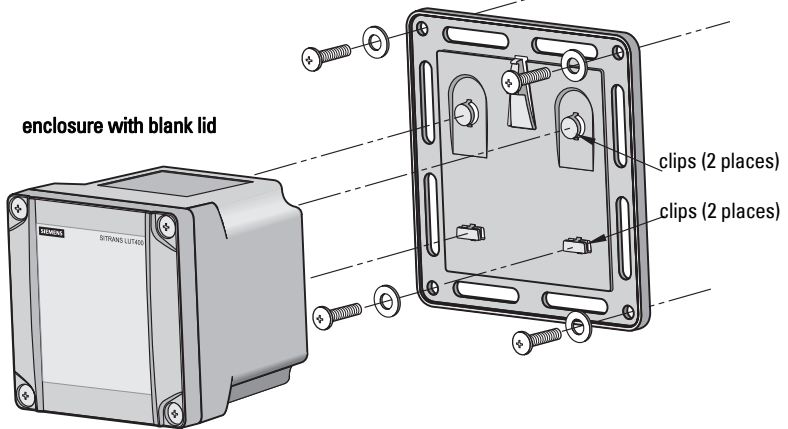
Note: Some electrical codes require use of metal conduit. When routing cable through a conduit, please follow the Cable Routing instructions on page 11 before mounting the SITRANS LUT400.

Wall or panel mount

All configurations of the SITRANS LUT400 are shipped with a mounting back plate. SITRANS LUT400 has the option of a lid with a Local User Interface (LUI) display, a remote display for panel mount configuration, or a blank lid. The panel mount model comes with both a LUI display and a blank lid.

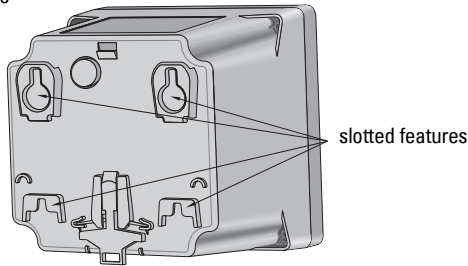


Note: Wall mount fasteners not included.



Note: Wall mount fasteners not included.

back of enclosure



For a more detailed dimension drawing, see *SITRANS LUT400 Dimensions* on page 119.

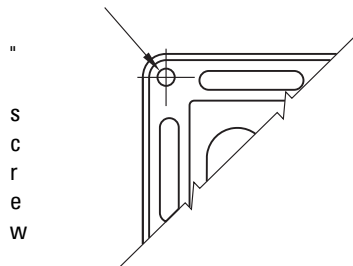
Wall mounting of the enclosure

1. Mark and drill four holes in the mounting surface for the four screws (customer supplied).
2. Fasten with a screwdriver.
3. Line up slotted features on back of device with clips on mounting back plate. Press the LUT400 flush against the back plate and slide downward to fasten in place.

Please note:

- Recommended fastener size: M8 or 5/16

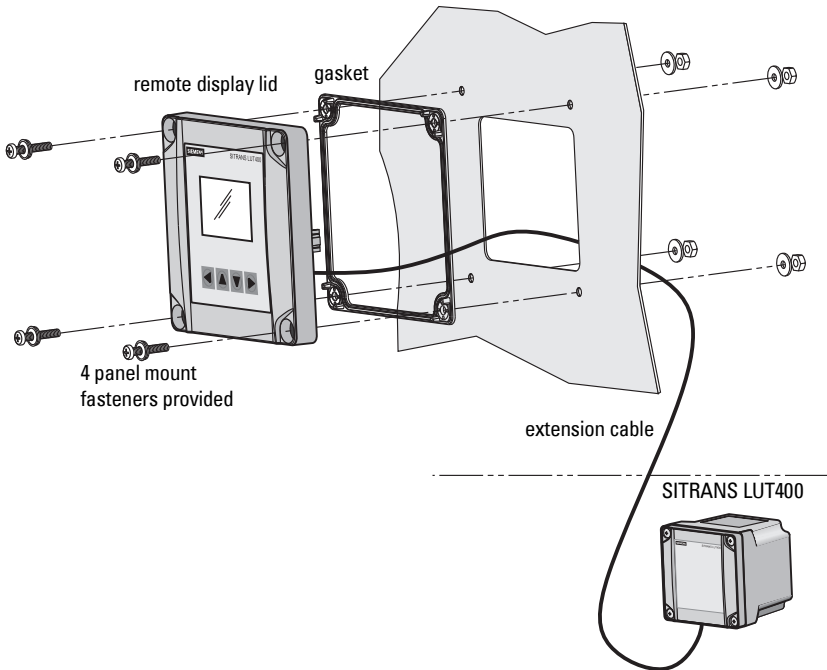
mounting screw holes on back plate



System Redesign and Construction
with washer of maximum 17 mm or
5/8" outside diameter

Recommended mounting: mount directly
to wall. If alternate mounting surface is
used, it **MUST** be able to support four
times the weight of the device.

Remote mounted lid



For a more detailed dimension drawing, see *SITRANS LUT400 Dimensions* on page 119 and *Cutout Dimensions (for Remote Panel Mount)* on page 120.

Mounting the remote lid

Note: Remote mounted lid can be mounted up to 5 m from the device using two optional cable extensions (each 2.5 m in length). For instructions on how to connect an extension cable, see *Remote mounted lid with extension cable* on page 29.

- Using the template provided, cut out the necessary hole for the remote LUI display lid. Place the gasket inside the lid, aligning the mounting holes. Align the back of the remote display lid with the panel hole cut-out. Mark and drill four holes in the mounting surface for the four screws (provided).

2. Fasten with a screwdriver and wrench.

Note: Recommended torque on fastening screws for good seal:

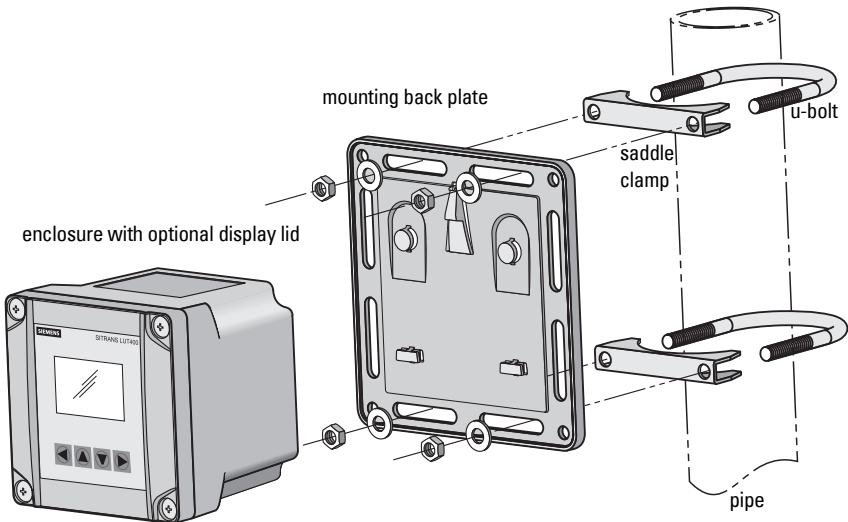
- 1.1 N m
- 10 in-lbs

Please note:

- Recommended mounting: mount to panel, up to 5 m from the device. If alternate mounting surface is used, it **MUST** be able to support four times the weight of the device.

Note: Fasteners included: M5 screw, seal washer, M5 flat washer and nut. These fasteners are required to maintain IP65 rating on remote lid.

Pipe mount



Note: Pipe mount fasteners not included.

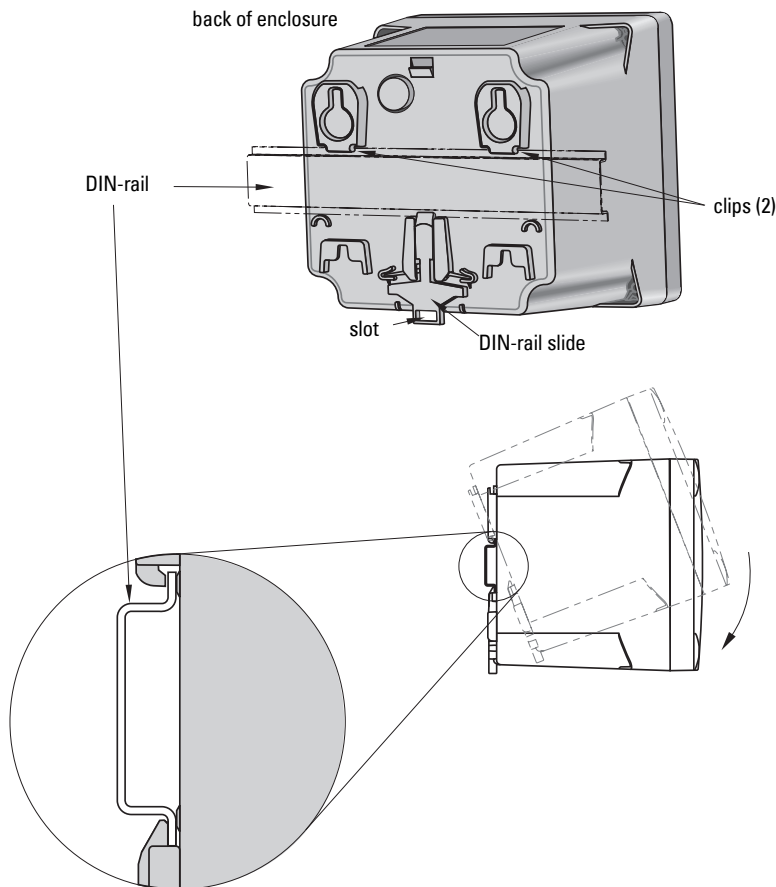
For a more detailed dimension drawing, see *SITRANS LUT400 Dimensions* on page 119.

Mounting the enclosure

1. Fasten the mounting back plate to the pipe using u-bolts, saddle clamps, (customer supplied) suitable to pipe diameter.
2. Fasten bolts with a wrench. Do not over-tighten so that plate becomes twisted or bent. This may hinder ability to clip the LUT400 to the back plate.
3. Fasten device to mounting back plate (as described in step 3 of *Wall mounting of the enclosure* on page 7).

Please note:

- Recommended mounting: directly to horizontal or vertical pipe. If alternate mounting surface is used, it **MUST** be able to support four times the weight of the device.
- Recommended pipe dimensions: maximum: 3" pipe, minimum: 3/4" pipe
- Recommended fastener sizes:
 - U-Bolts:
 - maximum: 3" pipe size with M8 or 3/8" thread
 - minimum: 3/4" pipe size with M6 or 1/4" thread
 - Hex Nuts:
 - M6 or 1/4" to M8 or 3/8"
 - Washer:
 - maximum: 16 mm or 13/16" outside diameter.

DIN-rail mount

For a more detailed dimension drawing, see *SITRANS LUT400 Dimensions* on page 119.

Mounting the enclosure

1. Angle top of enclosure toward DIN-rail, and position slightly above top of rail.

2. Move enclosure downward against DIN-rail to hook clips on back of enclosure to top of DIN-rail.
3. Press device flush against DIN-rail to engage DIN-rail slide, which will fasten enclosure securely to DIN-rail.

Please note:

- Recommended mounting: directly to horizontal DIN-rail.
- Required DIN-rail dimensions: TH 35-7.5 or TH 35-15 per standard IEC 60715.
- The DIN-rail **MUST** be able to support four times the weight of the SITRANS LUT400.

Removing the enclosure

1. From the front of the device, place screwdriver in slot at bottom of DIN-rail slide and pry downward. This will unclip slide from bottom of DIN-rail.
2. While holding slide down, push upward on enclosure to release clips from top of DIN-rail.

Preparation for cable entry

Cables can be routed through conduit or enter the enclosure through cable glands. Follow steps 1 to 5 below to first uncover cable entry holes, then complete steps for use with conduit, or with cable glands.

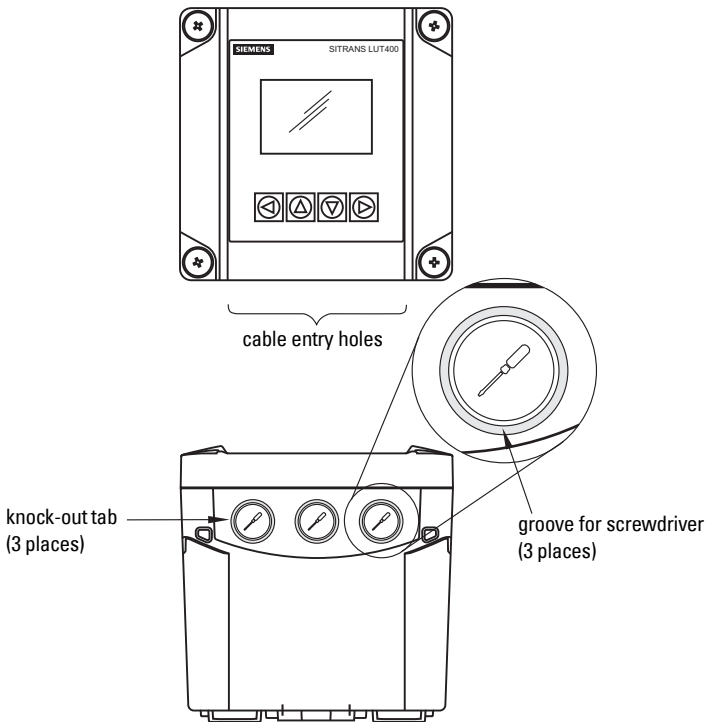
1. Ensure enclosure lid is closed and fastener screws are locked.
2. Place tip of screwdriver into groove on the outer diameter of the knock-out tab (see illustration that follows).
3. Hit the end of the screwdriver with palm of hand to knock out entry hole.
4. Loosen screws and remove enclosure lid.
5. Remove plastic piece(s) that covered entry holes from enclosure. Be careful not to damage the electronics with static electricity, or the tools used to knock out entry holes.

Cable routed through conduit

(continued from steps 1 to 5 above)

6. After preparing for cable entry in steps 1 to 5 above, attach the conduit to the enclosure using only suitable size fittings approved for water-tight applications. (Conduit size is 1/2" NPT.)

7. Replace enclosure lid and tighten screws.



For a more detailed dimension drawing, see *SITRANS LUT400 Dimensions* on page 119.

Cable exposed and entering through the cable glands

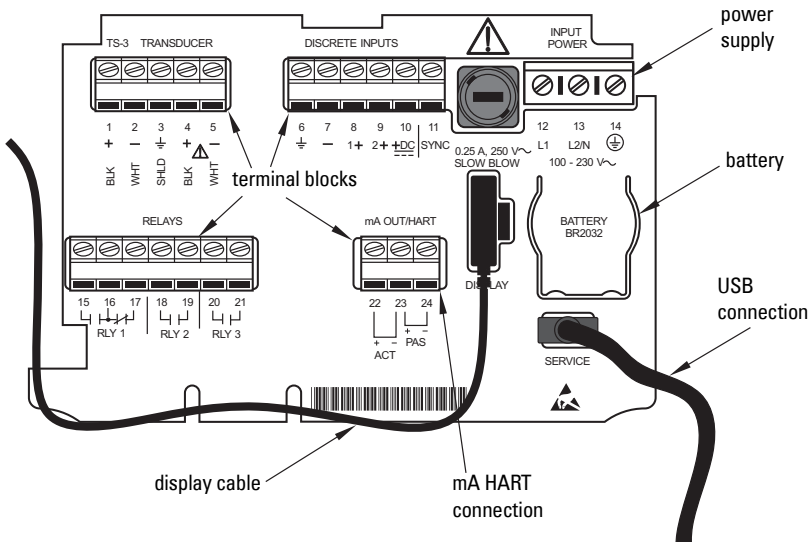
(continued from steps 1 to 5 on previous page)

6. After preparing for cable entry in steps 1 to 5 above, unscrew the glands and attach them firmly to the enclosure.
7. Thread the cables through the glands. Ensure the power cable is kept separated from the signal cables and then wire the cables to the terminal blocks.
8. Tighten the glands to form a good seal.
9. Replace enclosure lid and tighten screws.

Notes:

- When cable entry hole knock-out tabs have been removed, the entry hole is 21.4 mm to 21.6 mm in diameter.
- M20 cable glands (20 mm in diameter), and 1/2" NPT conduit (21.3 mm in diameter) fit this entry hole.
- Caution should be taken when selecting appropriate seal for entry holes. Flat gasket is recommended (instead of O-ring). If alternate cable glands are used, it is the customer's responsibility to maintain IP65 rating of entry holes.

SITRANS LUT400 wiring compartment



The Battery

The SITRANS LUT400 is supplied with one battery installed. The battery (BR2032) has a life expectancy of ten years, and is affected by ambient temperature. If the LUT400 loses input power, the battery will maintain operation of the device’s real time clock until power has been restored.

When the battery reaches its end of life, refer to *Replacing the Battery* on page 116.



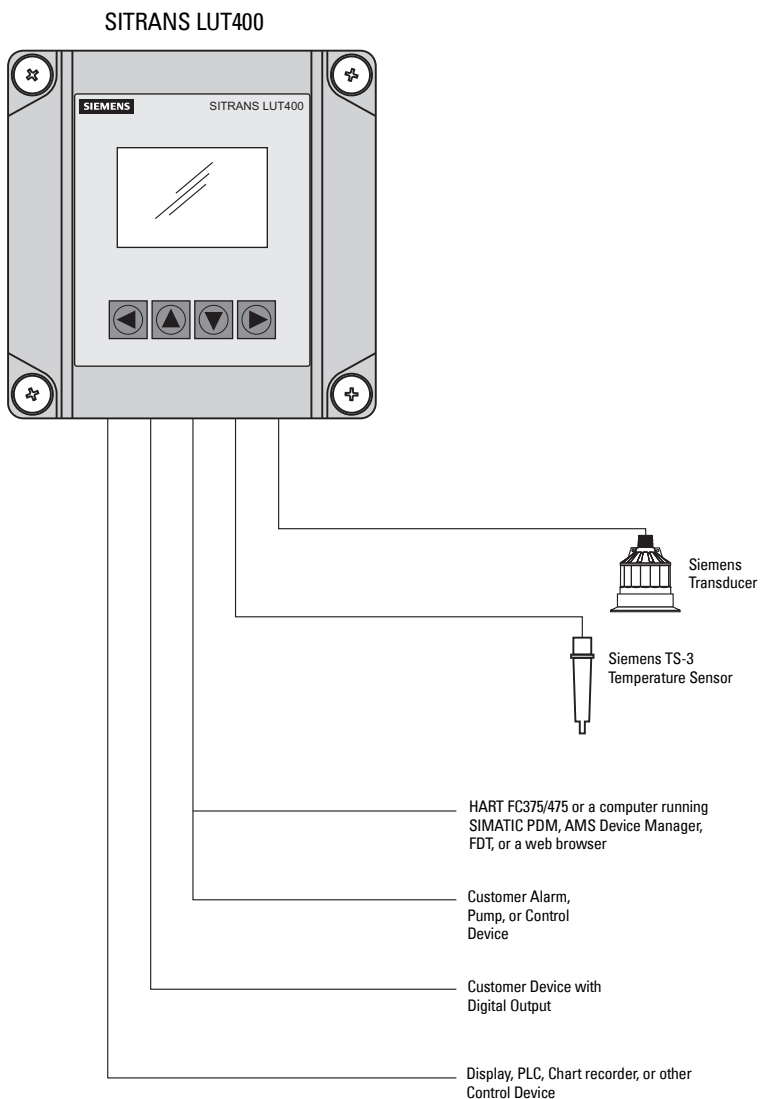
Disconnect power before replacing the battery.

Notes

Connecting

Safety notes for connection

- Verify that all system components are installed in accordance with instructions.
- Connect all cable shields to the LUT400 shield terminals (denoted on device with symbol \perp). To avoid differential ground potentials ensure cable shields are properly connected to ground.
- Keep exposed conductors on shielded cables as short as possible to reduce noise on the line caused by stray transmissions and noise pickup.



Connecting SITRANS LUT400



WARNINGS:

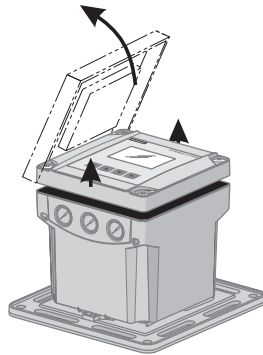
- Check the device label on your instrument, to verify the approval rating.
- Use appropriate conduit seals to maintain IP or NEMA rating.

Notes:

- Separate cables and conduits may be required to conform to standard instrumentation wiring practices or electrical codes.

To access the wiring compartment:

1. Loosen 1/4 turn locking screws.
2. Lift lid up and to the left on its hinges.
3. The lid can remain open connected by hinges, or it can be unclipped from the hinges and set to one side, to access wiring compartment.



4. Make all connections as per instructions that follow.
5. When wiring complete, replace device lid.
6. Tighten locking screws.

Wiring compartment

The terminal board on the LUT400 allows all inputs and outputs to be connected simultaneously. Terminal strips can be removed to improve ease of wiring.

CAUTION: Ensure the terminal strips are terminated to the correct location during re-installation. Failure to do so may result in damage to the device, or external equipment that is attached.

Note: Recommended torque on terminal clamping screws.

- 0.56 - 0.79 N m
- 5 - 7 in-lbs

Please do not overtighten the screws.

Power

WARNINGS:



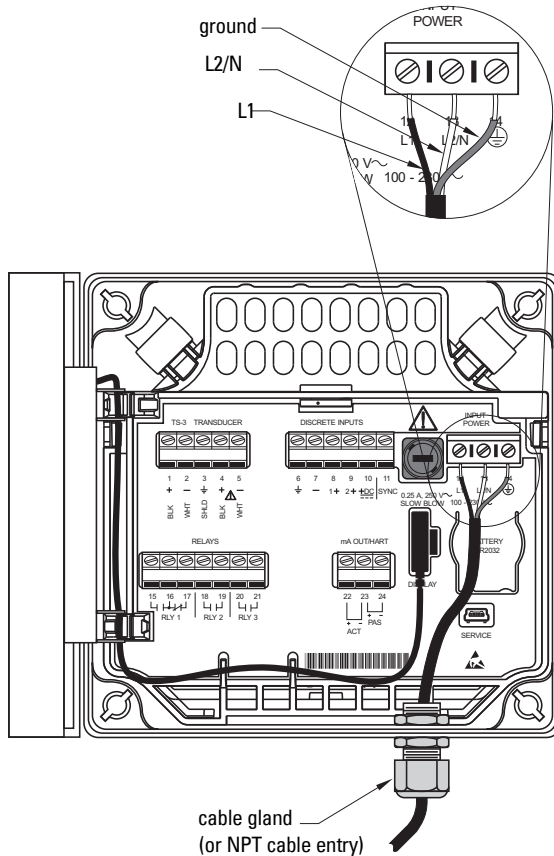
The DC input terminals shall be supplied from a source providing electrical isolation between the input and output, in order to meet the applicable safety requirements of IEC 61010-1.



All field wiring must have insulation ratings suitable for the application.

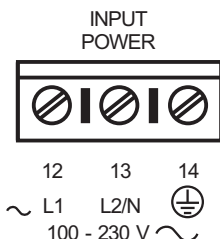
Important!

Before applying power to the SITRANS LUT400 for the first time, ensure any connected alarm/control equipment is disabled until satisfactory system operation and performance is verified.

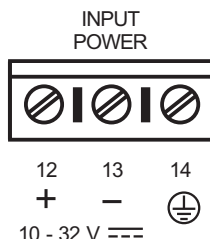


The SITRANS LUT400 is available in AC or DC power models.

AC Power



DC Power



AC: 100-230 V AC ±15%, 50/60 Hz, 36 VA (10W) **DC:** 10-32 V DC, 10W

Note: Make sure device is connected to a reliable ground.



1. To wire for power, strip the cable jacket for approximately 70 mm (2.75") from the end of the cable, and thread the wires through the gland¹.
2. Connect the wires to the terminals as shown: the polarity is identified below the terminal block.
3. Ground the device according to local regulations.

Notes for AC power connections:

- The equipment must be protected by a 15 A fuse, or circuit breaker on all current-carrying conductors in the building installation.
- A circuit breaker or switch in the building installation, marked as the disconnect switch, must be in close proximity to the equipment and within easy reach of the operator, and must disconnect all current-carrying conductors.

Cables

The SITRANS LUT400 is designed to work with two conductor shielded transducer cables.

Connection	Cable Type
mA output, sync, Temperature sensor, discrete input	2 copper conductors, twisted, with shield ^a /drain wire, 300V 0.324 - 0.823 mm ² (22 - 18 AWG). Maximum length: 365 m
Transducer	Shielded two-wire. Maximum length: 365 m
	 Warning: Do not use a coaxial transducer cable extension with the SITRANS LUT400. High voltage transmitted on shield of coaxial cable could result in personal injury, damage to equipment, or poor device performance.
Relay output AC input	Copper conductors per local requirements.

a. Preferred shielding is braided shield.

1. If cable is routed through conduit, use only approved suitable-size hubs for waterproof applications.

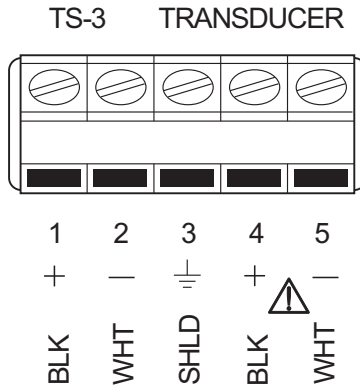
Transducers



Warning: Hazardous voltage present on transducer terminals during operation.

Notes:

- Do not connect coaxial cable directly to SITRANS LUT400 due to high voltage transmitted on shield of coaxial cable
- Do not connect the LUT400 shield and white transducer wires together; wire to separate terminals
- Disregard older transducer manuals that recommend these practices



Temperature sensor

The speed of sound changes as temperature changes. To ensure accurate level measurement, the SITRANS LUT400 compensates via an external temperature input. All Siemens EchoMax transducers have an internal temperature sensor for this purpose, and for the fastest temperature response, Siemens also offers a dedicated temperature sensor, the TS-3.

If the following conditions apply, a separate TS-3 temperature sensor will ensure optimum accuracy:

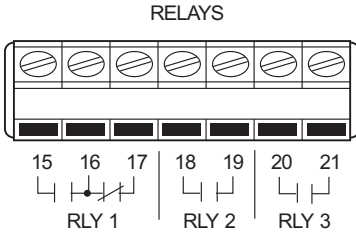
- the transducer is exposed to direct sunlight (or other radiant heat source)
- the temperature of the atmosphere between the transducer face and monitored surface differs from the temperature of the transducer
- faster response to temperature changes is required.

To achieve the best performance of temperature measurement in a typical open channel flow application, the temperature sensor should be shielded from direct sunlight and mounted half way between the ultrasonic transducer face and the maximum head achievable in the application. Care should be taken to not obstruct the direct sound path of the ultrasonic transducer.

Note: Use a TS-3 Temperature Sensor only. Leave terminals open (unused) if TS-3 is not deployed.

Relays

Relay contacts are shown in the de-energized position. All relays can be configured as positive or negative logic (see 2.8.11. Relay Logic).



Relay Ratings

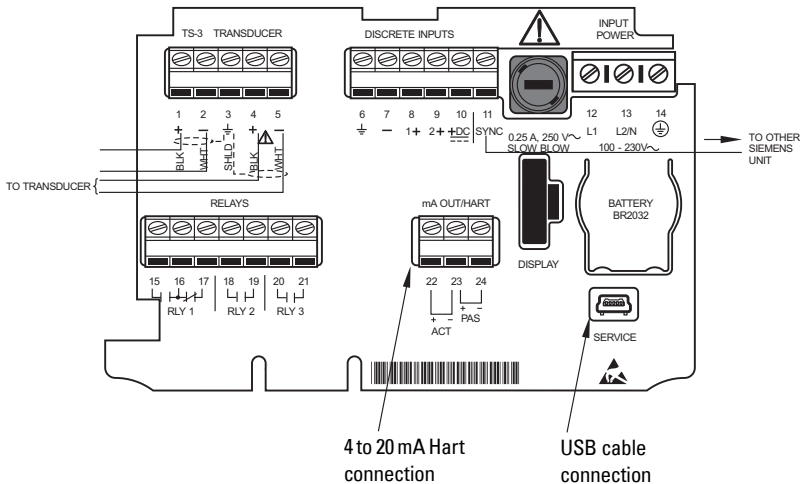
- one Form **C** (NO or NC) relay (relay 1), 1A at 250 V AC, non-inductive, 3A at 30 V DC
- two Form **A** (NO) relays (relays 2,3), 5A at 250 V AC, non-inductive, 3A at 30 V DC

Power Failure

Relays 2, 3 are normally open.
Relay 1 can be wired either normally open or normally closed.
In the event of loss of input power, relays will revert to their normal states.

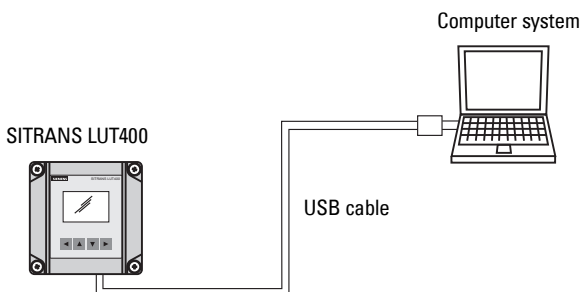
Communications

The USB port and the 4 to 20 mA HART terminal block (terminal numbers 22, 23, and 24) are located inside the enclosure of the device.

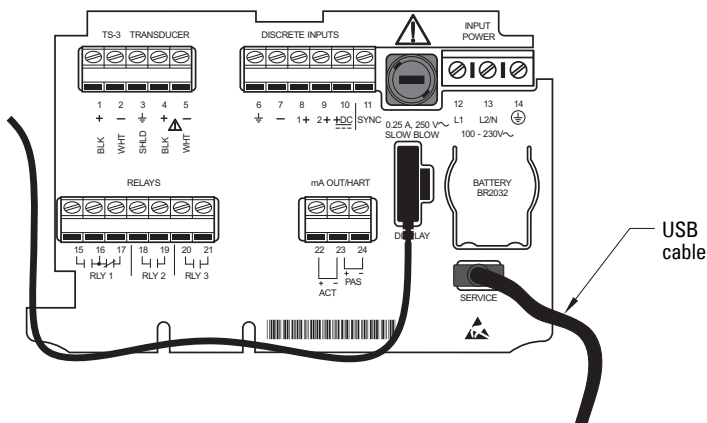


Connecting via USB

Typical USB configuration



USB connection



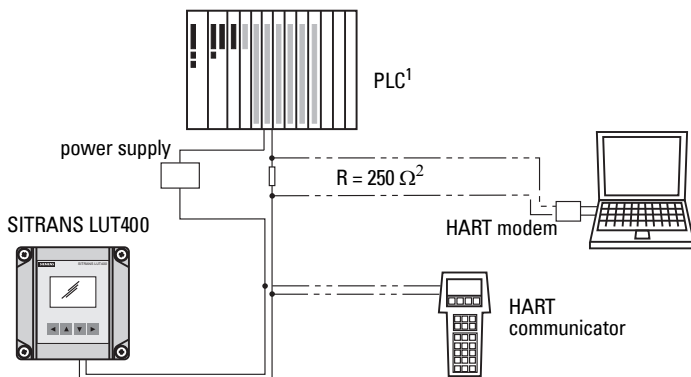
Use 5-pin USB Mini-B cable. The cable should not exceed 3 m (9.8 ft.).

Notes:

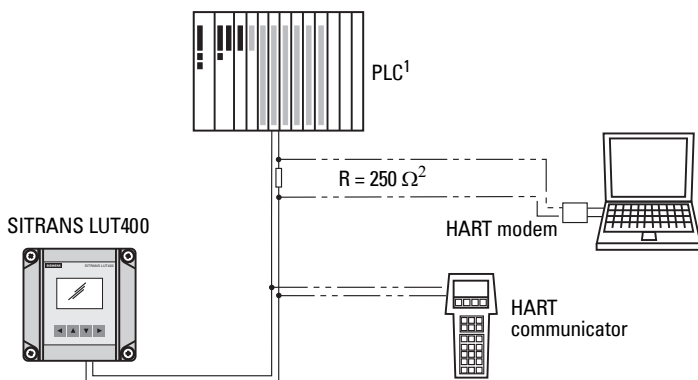
- No data logs are written while device is connected to a PC via USB. (See 2.10. **Data Logging** on page 173 and 3.2.6. **View Logs** on page 201.) Connect USB cable for device configuration, and when configuration is complete, disconnect the USB cable to allow Data Logging to occur. (It is good practice to use MS Windows *Safely Remove Hardware* feature before unplugging any USB cable from your computer.)
- Do not use a USB *extension* cable with the LUT400. Data Logging may not occur, even after extension cable has been disconnected. (If a USB extension cable has been used in error, a power reset of the device is required to restart Data Logging.)

Connecting HART

Typical PLC/mA configuration with Passive HART connection

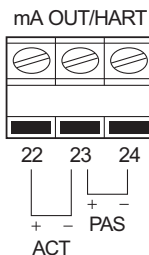


Typical PLC/mA configuration with Active HART connection



mA Output (HART)

For **ACTIVE** HART connection (using LUT400 integral power supply), connect terminals 22 and 23.



For **PASSIVE** HART connection (using external power supply), connect terminals 23 and 24.

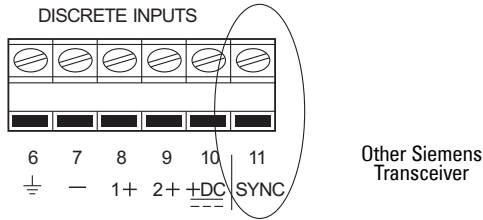
For more information, consult the mA output parameters (2.5. Current Output) in the parameter reference section.

1. Depending on the system design, the power supply may be separate from the PLC, or integral to it.
2. The nominal value for the HART resistor is 250 Ohm. For more information see application guide *Working with HART*, which can be downloaded from the product page of our website. Go to: www.siemens.com/sitransLUT400 under **Support** and click on **Application Guides**.

Level system synchronization

Note: The SITRANS LUT400 CANNOT be synchronized with the MultiRanger Plus, the original HydroRanger, or the OCMIII.

When transducer cables are run parallel with each other, synchronize the level monitors so that no device transmits while another is waiting for echo reception. If more than one ultrasonic device is being installed in the same application, the devices must be synchronized to prevent cross-talk. Optionally, the transducer cables can be run in separate grounded metal conduits.



Synchronizing with another SITRANS LUT400, or other Siemens devices

Other Siemens devices that can be synchronized with the SITRANS LUT400:

DPL+, SPL, XPL+, LU01, LU02, LU10, LUC500, DPS300, HydroRanger 200, HydroRanger Plus, EnviroRanger, MiniRanger, MultiRanger 100/200

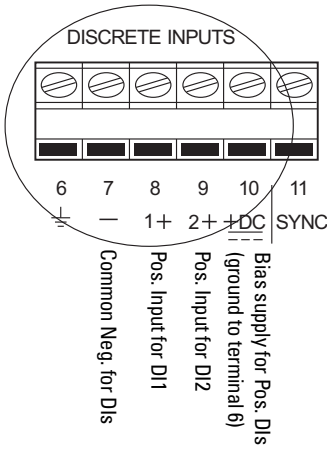
- Mount the level monitors together in one cabinet
- Use a common power (mains) supply and ground (earth) for all devices
- Interconnect the SYNC terminals of all level monitors.
- Up to 16 Siemens devices can be synchronized together.

For more information or assistance, contact Siemens or your local distributor. Go to:

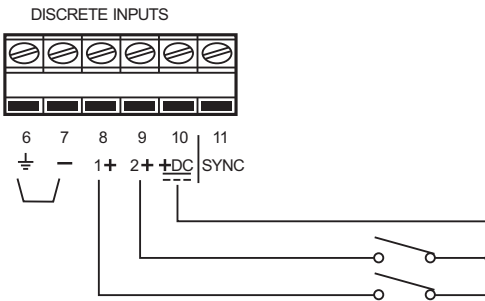
www.siemens.com/processautomation.

Discrete inputs

The SITRANS LUT400 has a 24V power bias (terminal 10) for use with the discrete inputs, or the discrete inputs can be wired using external power.

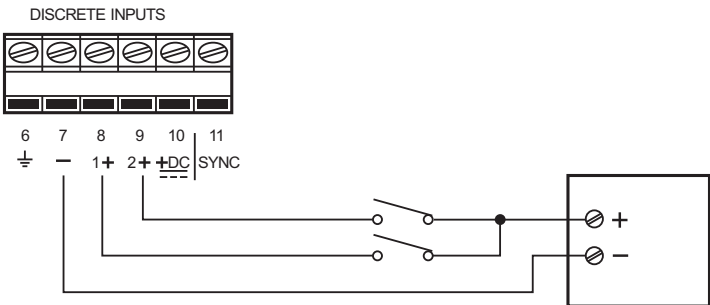


Discrete Inputs used with internal bias supply



Note: terminals 6 and 7 must be connected together.

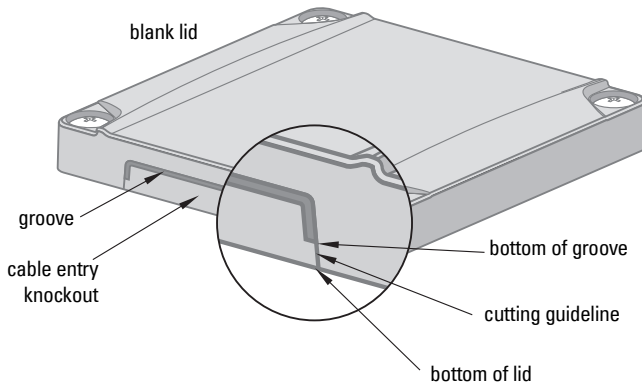
Discrete Inputs used with external bias voltage



Remote mounted lid with extension cable

The optional display lid can be mounted remotely up to 5 m from the device. The optional extension cable can be used for such an installation.

1. Remove display lid from the enclosure.
2. Carefully disconnect the existing display cable from the terminal board.
3. Separate from the device, knock out cable entry tab on blank lid:
 - a. With gasket in place, use snips to cut into lid on both sides of the cable entry knockout. Use cutting guideline to cut from bottom of lid, up to bottom of groove (as shown below).
 - b. Once both sides of knockout have been cut through all layers of the lid (including the gasket), pry upward with pliers on knockout to snap off plastic and uncover cable entry hole.



- c. Use sand paper if necessary to smooth any sharp edges.
- d. Replace the blank lid on the enclosure.

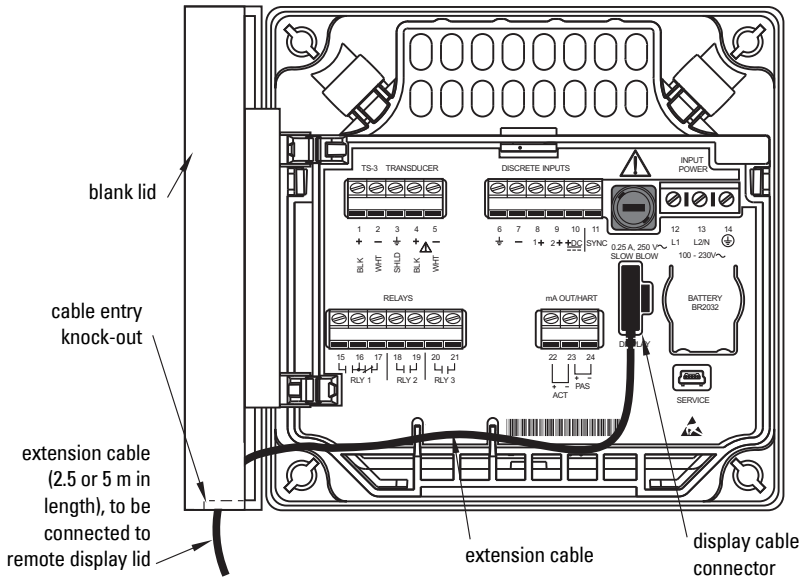


WARNINGS:

- Ingress protection of the enclosure is reduced to IP20, and Type 4X / NEMA 4X rating is void when cable entry knock-out in the blank lid is removed.
- An enclosure reduced to an IP20 rating and intended for use in non-hazardous locations must be installed in an indoor location free of dust and moisture, or be installed in a suitably rated field enclosure IP54 or better.

4. Connect the extension cable to the display connector on the terminal board. (If desired, attach second extension cable to the other end of the first extension cable.)
5. Feed the free end of the extension cable through cable entry hole on blank lid.
6. Connect extension cable to display cable on remote lid.

- Secure blank lid on device and mount display lid remotely. See *Remote mounted lid* on page 8 for mounting instructions.



Extension cable

Optional extension cables (2.5 m cables) are available to be used with remote mounted lid. Two cables can be connected together for an extension of up to 5 meters.

Note: It is recommended that the exposed extension cable be secured along a wall, or run through conduit to prevent damage to device, should cable be accidentally subjected to stress.

Connecting in hazardous area installations



Wiring setups for hazardous area installations



The following wiring options are available for hazardous area installations:



- Non-incendive wiring (Canada)



In all cases, check the device label on your instrument, and confirm the approval rating.



1. Non-incendive wiring (Canada)



SIEMENS	
SITRANS LUT420 7ML0000-xxxxxx-xxxx Serial No.: GYZ / B1034567 Power Rating: 100 – 230V ~ ± 15% 50/60 Hz, 36 VA (10 W) Contact Rating: 1A/5A @ 250V ~, Non-Inductive Operating Temperature: – 20°C to 50°C Enclosure: IP65 / TYPE 4X / NEMA 4X	
 Class I, Div.2, Gr. A, B, C & D T3C Class II, Div.2, Gr. F & G Class III Per Drawing A5E03936871	
Siemens Milltronics Process Instruments, Peterborough Assembled in Canada with domestic and imported parts	

SIEMENS	
SITRANS LUT430 7ML0000-xxxxxx-xxxx Serial No.: GYZ / B1034567 Power Rating: 100 – 230V ~ ± 15% 50/60 Hz, 36 VA (10 W) Contact Rating: 1A/5A @ 250V ~, Non-Inductive Operating Temperature: – 20°C to 50°C Enclosure: IP65 / TYPE 4X / NEMA 4X	
 Class I, Div.2, Gr. A, B, C & D T3C Class II, Div.2, Gr. F & G Class III Per Drawing A5E03936871	
Siemens Milltronics Process Instruments, Peterborough Assembled in Canada with domestic and imported parts	

SIEMENS	
SITRANS LUT440 7ML0000-xxxxxx-xxxx Serial No.: GYZ / B1034567 Power Rating: 100 – 230V ~ ± 15% 50/60 Hz, 36 VA (10 W) Contact Rating: 1A/5A @ 250V ~, Non-Inductive Operating Temperature: – 20°C to 50°C Enclosure: IP65 / TYPE 4X / NEMA 4X	
 Class I, Div.2, Gr. A, B, C & D T3C Class II, Div.2, Gr. F & G Class III Per Drawing A5E03936871	
Siemens Milltronics Process Instruments, Peterborough Assembled in Canada with domestic and imported parts	

SIEMENS	
SITRANS LUT420 7ML0000-xxxxxx-xxxx Serial No.: GYZ / B1034567 Power Rating: 10 – 32V ~, 10W Contact Rating: 1A/5A @ 250V ~, Non-Inductive Operating Temperature: – 20°C to 50°C Enclosure: IP65 / TYPE 4X / NEMA 4X	
 Class I, Div.2, Gr. A, B, C & D T3C Class II, Div.2, Gr. F & G Class III Per DWG. A5E03936871	
Siemens Milltronics Process Instruments, Peterborough Assembled in Canada with domestic and imported parts	

SIEMENS	
SITRANS LUT430 7ML0000-xxxxxx-xxxx Serial No.: GYZ / B1034567 Power Rating: 10 – 32V ~, 10W Contact Rating: 1A/5A @ 250V ~, Non-Inductive Operating Temperature: – 20°C to 50°C Enclosure: IP65 / TYPE 4X / NEMA 4X	
 Class I, Div.2, Gr. A, B, C & D T3C Class II, Div.2, Gr. F & G Class III Per DWG. A5E03936871	
Siemens Milltronics Process Instruments, Peterborough Assembled in Canada with domestic and imported parts	

SIEMENS	
SITRANS LUT440 7ML0000-xxxxxx-xxxx Serial No.: GYZ / B1034567 Power Rating: 10 – 32V ~, 10W Contact Rating: 1A/5A @ 250V ~, Non-Inductive Operating Temperature: – 20°C to 50°C Enclosure: IP65 / TYPE 4X / NEMA 4X	
 Class I, Div.2, Gr. A, B, C & D T3C Class II, Div.2, Gr. F & G Class III Per DWG. A5E03936871	
Siemens Milltronics Process Instruments, Peterborough Assembled in Canada with domestic and imported parts	

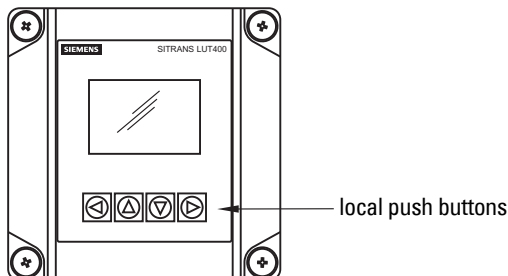
CSA Class I, Div 2 connection drawing number A5E03936871 can be downloaded from the product page of our website at www.siemens.com/sitransLUT400.

Notes

Commissioning

Local Commissioning

SITRANS LUT400 is an easy to use, and quick to commission device, with its numerous wizards, and menu driven parameters. The parameters can be modified locally using the LCD and the local push buttons, also known as the Local User Interface (LUI).



A Quick Start Wizard provides an easy step-by-step procedure to help you configure the device for a simple application. We recommend that you configure your application in the following order:

- First, run the appropriate Quick Start Wizard for your application (Level, Volume, Flow).
- Next, setup pumps via the Pump Control Wizard (if applicable).
- Lastly, configure alarms, or other controls, totalizers and samplers, referencing the respective parameters [see *Parameter reference (LUI)* on page 137]. It is important that alarms, and other controls are configured last to avoid pump relay assignments being overridden by the Quick Start Wizard.

There are two ways to access the Quick Start wizards:

- locally (see *Quick Start Wizards via LUI* on page 38)
- from a remote location (see *Other Quick Start Wizards (QSW)*: on page 38)

See *Level Application Example* on page 58, or *Flow application example* on page 59 for illustrations, and for the complete range of parameters, see *Parameter reference (LUI)* on page 137.

Activating SITRANS LUT400

Notes:

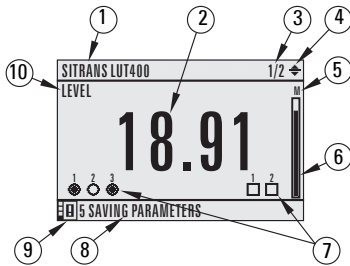
- Program Mode and Measurement mode refer to the display only. While the device is in Program mode, the output remains active and continues to respond to changes in the device.
- To enter Program mode using the device local push buttons, press ►. Press ◀ to return to Measurement mode.
- The display will return to Measurement mode after ten minutes of inactivity (from last button press), when in Program Mode and from within a Wizard. Pressing ► will then take you to the main navigation menu. (It will not return to the screen from which the timeout occurred.)

1. Power up the device. SITRANS LUT400 automatically starts up in Measurement mode. A transition screen showing first the Siemens logo and then the current firmware revision of the LUI is displayed while the first measurement is being processed.
2. The first time the device is configured, you will be prompted to select a language (English, German, French, Spanish, Chinese, Italian, Portuguese, or Russian). To change the language again (after initial setup), see *Language* on page 217.
3. Device time is set to Eastern Standard Time (EST) at the factory. To modify, see *Date and Time* on page 187. The correct date and time should be set prior to configuring the device.

The LCD Display

Measurement mode display: Normal operation

Level



1 – tag

2 – measured value (level, space, distance, volume, flow, or head)

3 – value being displayed [Primary Variable (PV)=1 of 2, Secondary Variable (SV)=2 of 2]

4 – toggle indicator¹ for PV or SV

5 – units

6 – bar graph indicates level

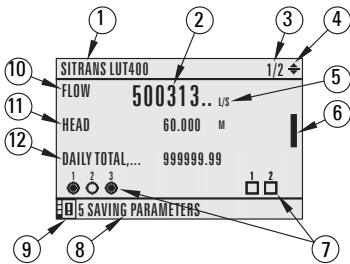
7 – secondary region indicates configured relays (left) and discrete inputs (right)

8 – text area displays status messages

9 – device status indicator

10 – selected (primary) sensor mode: level, space, distance, volume, head, or flow

Flow



11 – secondary sensor mode = head when primary sensor mode = flow

12 – totalizer values: display alternates between daily totalizer and running totalizer

Fault present



8 – text area displays a fault code and an error message

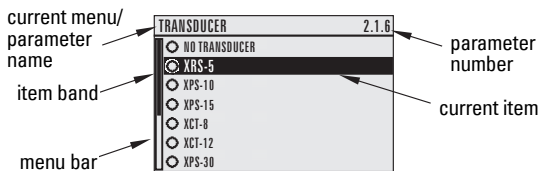
9 – service required icon appears

1. Press UP or DOWN arrow to switch

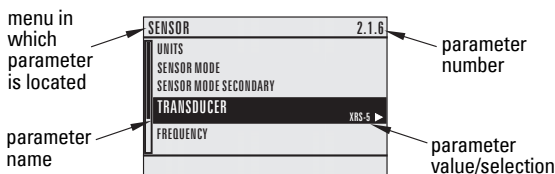
PROGRAM mode display

Navigation view

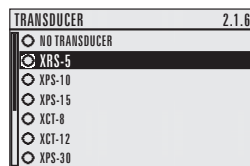
- A visible menu bar indicates the menu list is too long to display all items.
- The depth of the item band on the menu bar indicates the length of the menu list: a deeper band indicates fewer items.
- The position of the item band indicates the approximate position of the current item in the list. A band filled halfway down the menu bar indicates the current item is halfway down the list.



Parameter view



Edit view



Key functions in Measurement mode

Key	Function	Result
	RIGHT arrow opens PROGRAM mode.	Opens the top level menu.
	UP or DOWN arrow toggles between PV and SV.	LCD displays primary or secondary value.

Programming SITRANS LUT400

Notes:

- To enter Program mode using the device local push buttons, press . Press to return to Measurement mode.
- While the device is in Program mode, the output remains active and continues to respond to changes in the device.

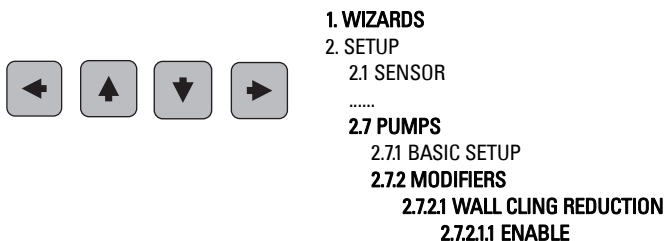
Change parameter settings and set operating conditions to suit your specific application. (For remote operation, see *Operation via SIMATIC PDM 6 (HART)* on page 15 or *Operation via AMS Device Manager (HART)* on page 19.)

Commissioning

Parameter menus

Note: For the complete list of parameters with instructions, see .

Parameters are identified by name and organized into function groups, then arranged in a 5-level menu structure, as in the example below. (For full menu see *LCD Menu Structure* on page 125.)



1. Enter PROGRAM mode





Using local push buttons:

- **RIGHT arrow** ► activates PROGRAM mode and opens menu level 1.

2. Navigating: key functions in Navigation view

Notes:

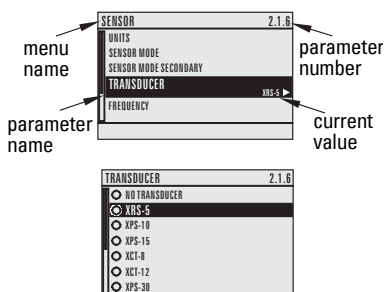
- In Navigation view, **ARROW keys** move to the next menu item in the direction of the arrow.
- Press and hold any arrow key to scroll through a list of options or menus (in the direction of the arrow).

Key	Name	Menu level	Function
 	UP or DOWN arrow	menu or parameter	Scroll to previous or next menu or parameter.
	RIGHT arrow	menu	Go to first parameter in the selected menu, or open next menu.
		parameter	Open Edit mode.
	LEFT arrow	menu or parameter	Open parent menu.

3. Editing in PROGRAM mode

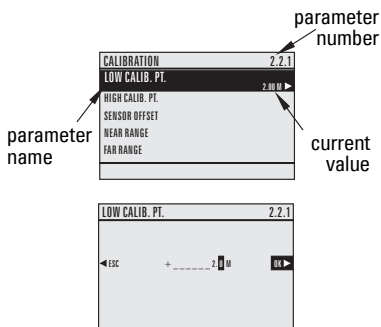
Selecting a listed option

- Navigate to the desired parameter.
- Press **RIGHT arrow** ► to open **Edit** mode. The current selection is highlighted.
- Scroll to a new selection.
- Press **RIGHT arrow** ► to accept it. The LCD returns to parameter view and displays the new selection.







Changing a numeric value

- Navigate to the desired parameter.
 - When selected, the current value is displayed.
 - Press **RIGHT arrow** ► to open **Edit** mode. The cursor position is highlighted.
 - Use **LEFT** ◀ and **RIGHT arrow** ► to move cursor to digit position you wish to change.
 - As each digit is highlighted (selected), use the **UP** ▲ and **DOWN arrow** ▼ to increase or decrease the digit respectively.
 - While decimal point is selected, use **UP** ▲ and **DOWN arrow** ▼ to shift decimal position.
 - To escape without saving your changes, press **LEFT arrow** ◀ continually until **ESC** is highlighted. Press **LEFT arrow** ◀ again to escape without saving changes.
- Otherwise, when new parameter value is correct, press **RIGHT arrow** ► continually until **OK** is highlighted.
- Press **RIGHT arrow** ► to accept the new value. The LCD returns to parameter view and displays the new selection. Review for accuracy.



Key functions in Edit mode

Key	Name	Function
 	UP or DOWN arrow	Selecting options
		Alpha-numeric editing
		Scrolls to item. - Increments or decrements digits - Toggles plus and minus sign

Key	Name	Function (Continued)	
	RIGHT arrow	Selecting options	- Accepts the data (writes the parameter) - Changes from Edit to Navigation mode
		Numeric editing	- Moves cursor one space to the right - or with selection highlighted, accepts the data and changes from Edit to Navigation mode
	LEFT arrow:	Selecting options	Cancels Edit mode without changing the parameter
		Numeric editing	- Moves cursor to plus/minus sign if this is the first key pressed - or moves cursor one space to the left. - or with cursor on Enter sign, cancels the entry

Quick Start Wizards

A Wizard provides an easy step-by-step Quick Start (QS) procedure that configures the device for a simple application. To configure the SITRANS LUT400 for applications of level, volume (standard vessel shapes), or flow, use the *Quick Start Wizards via LUI* on page 38 of this chapter.

Wizards for applications employing more complex vessel shapes are available via SIMATIC PDM. See *Quick Start (Volume - Linearization)* in the LUT400 Communications manual¹.


Other Quick Start Wizards (QSW):

Other Quick Start Wizards using various software packages are also available:

- SIMATIC PDM (HART) (see page 15)
- AMS (HART) (see page 19)
- FC375/475 (HART) (see page 21)
- FDTs (HART) (see page 23)

Before initiating a Quick Start Wizard to configure the device, you may wish to gather the necessary parameter values. Parameter Configuration Charts that list all parameters and available options for each application type are available on our website. Go to www.siemens.com/sitransLUT400 > **Support** > **Application Guides**. You can record data and select from options on the chart that apply to your application, then with this data on hand, complete the *Quick Start Wizards via LUI* below, or via another Quick Start Wizard, as referenced above.

Quick Start Wizards via LUI

- 1) Press  to enter Program mode.

Note: Device continues to measure while in Program Mode. If you wish to disable the device while it is configured, see *3.3.1. Transducer Enable* on page 204.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01). (See DVD shipped with device or download manual from our website.)

- 2) Choose **Wizards (1.)**, **Quick Start (1.1)**, and then the **appropriate quick start**:
QS Level (1.1.1.), **QS Volume (1.1.2.)**, or **QS Flow (1.1.3.)**.
 [The QS Flow wizard will display on LUI for LUT430 (Pump and Flow), and LUT440 (OCM) configured models only.]
- 3) Follow the steps then choose **Finish** to save Quick Start parameter changes and return to Program menu, then press **◀** three times to return to Measurement mode.

Notes:

- The Quick Start Wizard settings are inter-related and changes apply only after you choose Finish in the final step.
- Perform customization for your application only after the Quick Start has been completed.

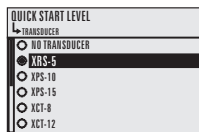
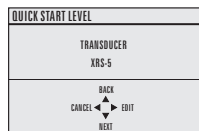
1. Wizards

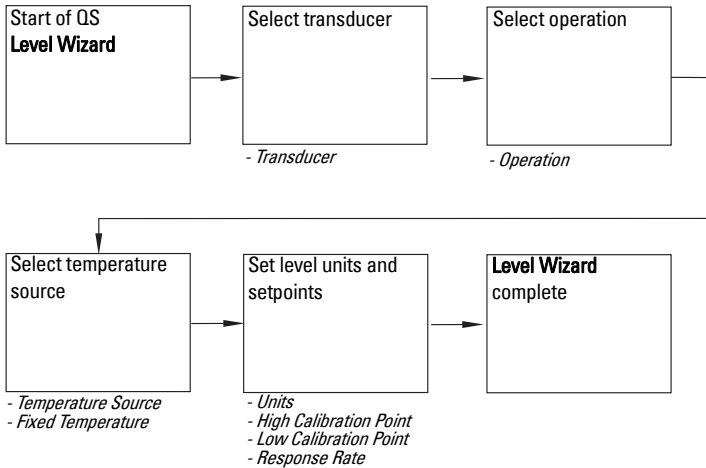
1.1. Quick Start

1.1.1. QS Level

Use this wizard to configure simple level applications.

- a. Press **RIGHT arrow ▶** to activate PROGRAM mode and open menu level 1: MAIN MENU.
- b. Press **RIGHT arrow ▶** two times to navigate to menu item 1.1.1.
- c. Press **RIGHT arrow ▶** to open QS Level.
- d. At each step, press **DOWN arrow ▼** to accept default values and move directly to the next item,
 or **RIGHT arrow ▶** to open Edit mode: the current selection is highlighted.
- e. Scroll to desired item and press **RIGHT arrow ▶** to store the change, then press **DOWN arrow ▼** to continue.
- f. At any time, you can press **UP arrow ▲** to go back, or **LEFT arrow ◀** to cancel the wizard.





Start of QS Level Wizard

Note: The introduction screen is displayed only on the device when using the local push buttons. This screen is not part of the Quick Start when using SIMATIC PDM.

Shows the type of Wizard to be executed.

Options	CANCEL, START
----------------	---------------

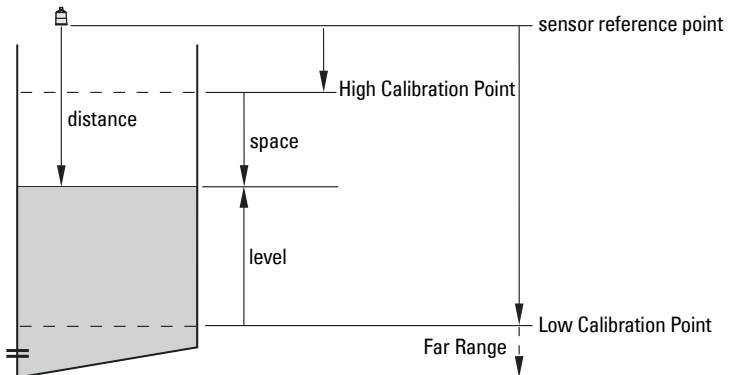
Transducer

Specifies the Siemens transducer connected to the device.

Options	NO TRANSDUCER, XRS-5, XPS-10, XPS-15, XCT-8, XCT-12, XPS-30, XPS-40, XLT-30, XLT-60, STH
	Default: NO TRANSDUCER

Operation

Sets the type of measurement (and the corresponding mA output) required for the application.



Mode		Description	Reference point
LEVEL	*	Height of material	Low Calibration Point (process empty level)
SPACE		Distance to material surface	High Calibration Point (process full level)
DISTANCE			Sensor Reference Point
OTHER		Do NOT select. If Operation value displays as OTHER, the device is configured as a level controller, but has been set previously to a mode other than LEVEL, SPACE, or DISTANCE. The operation mode must be set to LEVEL, SPACE, or DISTANCE to proceed with the QS Level Wizard.	

Temperature Source

Source of the temperature reading used to adjust the speed of sound.

Options	TRANSDUCER, FIXED TEMPERATURE, EXTERNAL TS-3, AVERAGE OF SENSORS
	Default: TRANSDUCER

See *Temperature Source* on page 180 for more details.

Fixed Temperature

Use this feature if a temperature sensing device is not used.

Value	Range: -100.0 to +150.0 °C
	Default: +20.0 °C

This parameter is only displayed if **FIXED TEMPERATURE** selected for Temperature Source.

Units

Sensor measurement units.

Options	M, CM, MM, FT, IN
	Default: M

Note: For the purpose of this example, all values are assumed to be in meters (m).

High Calibration Point

Distance from Sensor Reference Point to High Calibration Point: usually process full level.

Value	Range: 0.000 to 60.000
	Default: 0.000

Low Calibration Point

Distance from Sensor Reference Point to Low Calibration Point: usually process empty level.

Value	Range: 0.000 to 60.000
	Default: 60.000

Response Rate

Sets the reaction speed of the device to measurement changes in the target range.

Notes:

- Response Rate can only be set through the Quick Start Wizard, and any changes made to Fill Rate per Minute (2.3.1.), Empty Rate per Minute (2.3.2.), or Damping Filter (2.3.3.) parameters following the completion of the wizard will supersede the Response Rate setting.
- **Response Rate** always displays in m/minute.

Options	SLOW (0.1 M/MIN)
	MEDIUM (1.0 M/MIN)
	FAST (10 M/MIN)
	Default: SLOW (0.1 M/MIN)

Use a setting just faster than the maximum filling or emptying rate (whichever is greater). Slower settings provide higher accuracy, faster settings allow for more rapid level fluctuations.

End of QS Level Wizard

For QS to be successful, all changes must be applied.

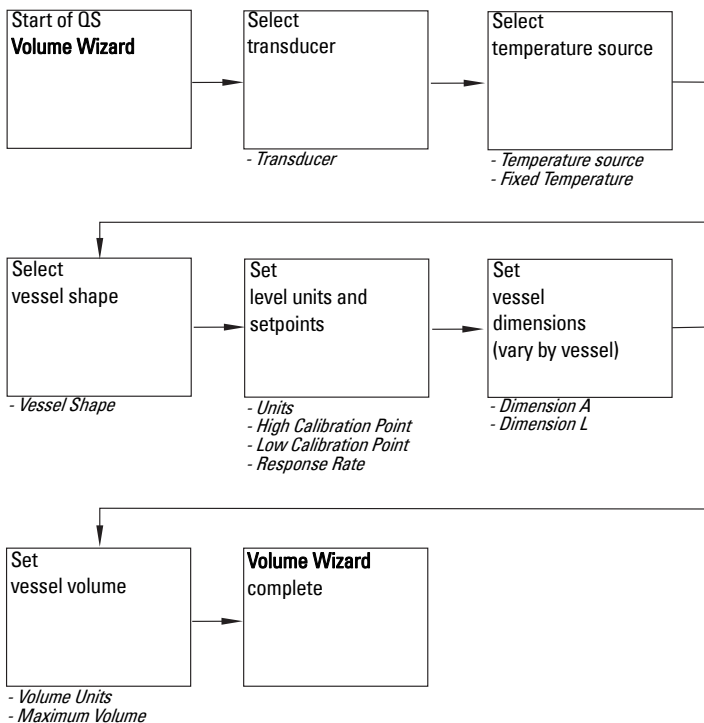
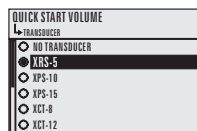
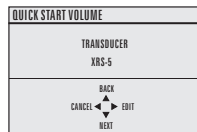
Options	BACK, CANCEL, FINISH (Display returns to 1.1 Quick Start menu when Quick Start is successfully completed or cancelled. If CANCEL is selected, no changes are written to the device.)
----------------	---

To transfer Quick Start values to the device and return to Program menu, press **DOWN arrow ▼ (Finish)**. Then press **LEFT arrow ◀** three times to return to Measurement mode.

1.1.2. QS Volume

Use this wizard to configure volume applications employing standard vessel shapes.

- Press **RIGHT arrow** ► to activate PROGRAM mode and open menu level 1: MAIN MENU.
- Press **RIGHT arrow** ► two times to navigate to menu item 1.1.1.
- Press **DOWN arrow** ▼ and **RIGHT arrow** ► to open QS Volume.
- At each step, press **DOWN arrow** ▼ to accept default values and move directly to the next item, or **RIGHT arrow** ► to open Edit mode: the current selection is highlighted.
- Scroll to desired item and press **RIGHT arrow** ► to store the change, then press **DOWN arrow** ▼ to continue.
- At any time, you can press **UP arrow** ▲ to go back, or **LEFT arrow** ◀ to cancel the wizard.



Commissioning

Start of QS Volume Wizard

Note: The introduction screen is displayed only on the device when using the local push buttons. This screen is not part of the Quick Start when using SIMATIC PDM.

Shows the type of Wizard to be executed.

Options	CANCEL, START
----------------	---------------

Transducer

Specifies the Siemens transducer connected to the device.

Options	NO TRANSDUCER, XRS-5, XPS-10, XPS-15, XCT-8, XCT-12, XPS-30, XPS-40, XLT-30, XLT-60, STH
	Default: NO TRANSDUCER

Temperature Source

Source of the temperature reading used to adjust the speed of sound.

Options	TRANSDUCER, FIXED TEMPERATURE, EXTERNAL TS-3, AVGERAGE OF SENSORS
	Default: TRANSDUCER

See *Temperature Source* on page 180 for more details.

Fixed Temperature

Use this feature if a temperature sensing device is not used.

Value	Range: -100.0 to +150.0 °C
	Default: +20.0 °C

This parameter is only displayed if **FIXED TEMPERATURE** selected for Temperature Source.

Vessel Shape

*Defines the vessel shape and allows the SITRANS LUT400 to calculate volume instead of level. If **NONE** is selected, no volume conversion is performed. Select the vessel shape matching the monitored vessel or reservoir.*

Options	NONE, LINEAR, CYLINDER, PARABOLIC BOTTOM, HALF SPHERE BOTTOM, FLAT SLOPED BOTTOM, PARABOLIC ENDS, SPHERE, CONICAL BOTTOM, CURVE TABLE, LINEAR TABLE
	Default: LINEAR

See *Vessel Shape* on page 147 for illustration. If CURVE TABLE or LINEAR TABLE selected, enter values for level and volume breakpoints after completing the wizard (see 2.6.7. Table 1-8 on page 150).

Units

Sensor measurement units.

Options	M, CM, MM, FT, IN
	Default: M

Note: For the purpose of this example, all values are assumed to be in meters (m).

High Calibration Point

Distance from Sensor Reference Point to High Calibration Point: usually process full level.

Value	Range: 0.000 to 60.000
	Default: 0.000

Low Calibration Point

Distance from Sensor Reference Point to Low Calibration Point: usually process empty level.

Value	Range: 0.000 to 60.000
	Default: 60.000

Response Rate

Sets the reaction speed of the device to measurement changes in the target range.

Notes:

- Response Rate can only be set through the Quick Start Wizard, and any changes made to Fill Rate per Minute (2.3.1.) or Empty Rate per Minute (2.3.2.) parameters following the completion of the wizard will supersede the Response Rate setting.
- **Response Rate** always displays in m/minute.

Options	SLOW (0.1 M/MIN)
	MEDIUM (1.0 M/MIN)
	FAST (10 M/MIN)
	Default: SLOW (0.1 M/MIN)

Use a setting just faster than the maximum filling or emptying rate (whichever is greater). Slower settings provide higher accuracy, faster settings allow for more level fluctuations.

Dimension A

The height of the vessel bottom when the bottom is conical, pyramidal, parabolic, spherical, or flat -sloped..

Value	Range: 0.000 to 99.999
	Default: 0.000

Dimension L

Length of the cylindrical section of a horizontal parabolic end vessel.

Value	Range: 0.000 to 99.999
	Default: 0.000

Volume Units

Determines volume measurement units.

Options	L, USGAL, IMPGAL, CUM, USER DEFINED *
	Default: L

* If **USER DEFINED** option selected, the value must be set after completing the wizard. See 2.6.6. *User Defined Unit* on page 149.

Maximum Volume

The maximum volume of the vessel. Enter the vessel volume corresponding to the High Calibration Point. For example, if your maximum vessel volume is 8000 L, enter a value of 8000.

Value	Range: 0.0 to 9999999
	Default: 100.0

End of QS Volume Wizard

For QS to be successful, all changes must be applied.

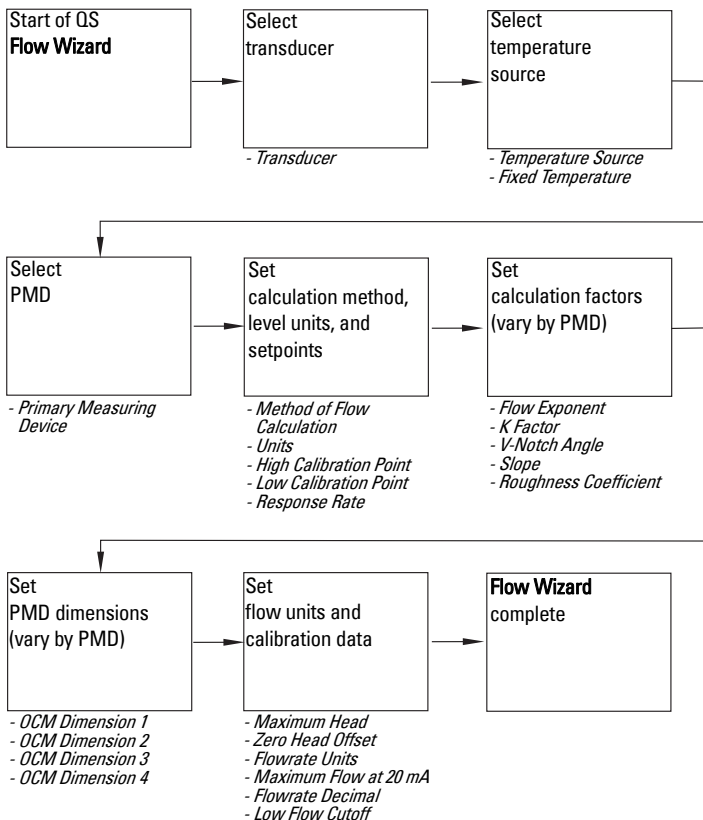
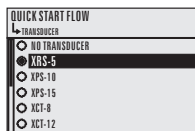
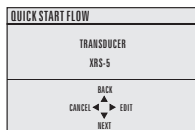
Options	BACK, CANCEL, FINISH (Display returns to 1.1 Quick Start menu when Quick Start is successfully completed or cancelled. If CANCEL is selected, no changes are written to the device.)
----------------	--

To transfer Quick Start values to the device and return to Program menu, press **DOWN arrow ▼ (Finish)**. Then press **LEFT arrow ◀** three times to return to Measurement mode.

1.1.3. QS Flow

Use this wizard to configure simple flow applications.
(Visible on LUT430 (Pump and Flow), and LUT440 (OCM) configured models only.

- Press **RIGHT arrow** ► to activate PROGRAM mode and open menu level 1: MAIN MENU.
- Press **RIGHT arrow** ► two times to navigate to menu item 1.1.1.
- Press **DOWN arrow** ▼ two times and **RIGHT arrow** ► to open QS Flow.
- At each step, press **DOWN arrow** ▼ to accept default values and move directly to the next item,
or **RIGHT arrow** ► to open Edit mode: the current selection is highlighted.
- Scroll to desired item and press **RIGHT arrow** ► to store the change, then press **DOWN arrow** ▼ to continue.
- At any time, you can press **UP arrow** ▲ to go back, or **LEFT arrow** ◀ to cancel the wizard.



Commissioning

Start of QS Flow Wizard

Note: The introduction screen is displayed only on the device when using the local push buttons. This screen is not part of the Quick Start when using SIMATIC PDM.

Shows the type of Wizard to be executed.

Options	CANCEL, START
----------------	---------------

Transducer

Specifies the Siemens transducer connected to the device.

Options	NO TRANSDUCER, XRS-5, XPS-10, XPS-15, XCT-8, XCT-12, XPS-30, XPS-40, XLT-30, XLT-60, STH
	Default: NO TRANSDUCER

Temperature Source

Source of the temperature reading used to adjust the speed of sound.

Options	TRANSDUCER, FIXED TEMPERATURE, EXTERNAL TS-3, AVGERAGE OF SENSORS
	Default: TRANSDUCER

See *Temperature Source* on page 180 for more details.

Fixed Temperature

Source of the temperature reading used to adjust the speed of sound.

Value	Range: -100.0 to +150.0 °C
	Default: +20.0 °C

This parameter is only displayed if **FIXED TEMPERATURE** selected for Temperature Source.

Primary Measuring Device

Defines the primary measuring device (PMD) to be used in the application.

Options	EXPONENTIAL DEVICES, RECTANGULAR FLUME BS-3680, ROUND NOSE HORIZONTAL CR. BS-3680, TRAPEZOIDAL FLUME BS-3680, U-FLUME BS-3680, FINITE CREST WEIR BS-3680, THIN PLATE RECT. WEIR BS-3680, THIN PLATE V-NOTCH WEIR BS-3680, RECT. WEIR CONTRACTED, ROUND PIPE, PALMER BOWLUS FLUME, H-FLUME, OTHER*
	Default: EXPONENTIAL DEVICES

* Option will be set to **OTHER** if the wizard was run previously via HART software tool (such as SIMATIC PDM), and the device was set to **OFF** or **UNIVERSAL HEAD VS. FLOW**. If this is initial configuration, the PMD can only be set for no calculation (OFF), or for linearization (UNIVERSAL HEAD VS. FLOW) via HART software tools (SIMATIC PDM, AMS, FC375/475).

Method of Flow Calculation

Sets the method of flow calculation.

Options	ABSOLUTE, RATIOMETRIC
	Default: ABSOLUTE

Units

Sensor measurement units.

Options	M, CM, MM, FT, IN
	Default: M

Note: For the purpose of this example, all values are assumed to be in meters (m).

High Calibration Point

Distance from Sensor Reference Point to High Calibration Point: usually process full level.

Value	Range: 0.000 to 60.000
	Default: 0.000

Low Calibration Point

Distance from Sensor Reference Point to Low Calibration Point: usually process empty level.

Value	Range: 0.000 to 60.000
	Default: 60.000

Response Rate

Sets the reaction speed of the device to measurement changes in the target range.

Notes:

- Response Rate can only be set through the Quick Start Wizard, and any changes made to Fill Rate per Minute (2.3.1.) or Empty Rate per Minute (2.3.2.) parameters following the completion of the wizard will supersede the Response Rate setting.
- **Response Rate** always displays in m/minute.

Options	SLOW (0.1 M/MIN)
	MEDIUM (1.0 M/MIN)
	FAST (10 M/MIN)
	Default: SLOW (0.1 M/MIN)

Use a setting just faster than the maximum filling or emptying rate (whichever is greater). Slower settings provide higher accuracy, faster settings allow for more level fluctuations.

Calculation factors:**Notes:**

- The following five parameters will display in the wizard based on the PMD selected above.
- These parameters are used in the flow calculation formula (see *Method of Flow Calculation* on page 266).

Flow Exponent**(PMD = EXPONENTIAL DEVICES)**

The exponent for the flow calculation formula. (See Method of Flow Calculation on page 266.)

Value	Range: -999.000 to 9999.000
	Default: 1.550

K Factor**(PMD = EXPONENTIAL DEVICES)**

The constant used in the flow calculation formula for absolute calculation of an exponential device only.

Value	Range: -999.000 to 9999.000
	Default: 1.000

V-Notch Angle**(PMD = THIN PLATE V-NOTCH WEIR)**

The V-Notch angle used in the flow calculation formula.

Value	Range: 25.000 to 95.000
	Default: 25.000

Slope**(PMD = TRAPEZOIDAL FLUME or ROUND PIPE)**

The Flow Slope used in the flow calculation formula.

Value	Range: -999.000 to 9999.000
	Default: 0.000

Roughness Coefficient**(PMD = ROUND PIPE)**

The Flow Roughness Coefficient used in the flow calculation formula.

Value	Range: -999.000 to 9999.000
	Default: 0.000

PMD Dimensions

Notes:

- For each PMD excluding *Exponential Devices*, and *Other*, you must enter up to four dimensions.
- In the wizard, you will be prompted for each dimension required for the PMD selected, and the respective PMD dimension name will be displayed.

PMD selected	Wizard dimension name (parameter menu reference)
Rectangular Flume BS-3680	
	APPROACH WIDTH B (2.15.4.5. OCM Dimension 1)
	THROAT WIDTH B (2.15.4.6. OCM Dimension 2)
	HUMP HEIGHT P (2.15.4.7. OCM Dimension 3)
	THROAT LENGTH L (2.15.4.8. OCM Dimension 4)
Round Nose Horizontal Crest Weir BS-3680	
	CREST WIDTH B (2.15.4.5. OCM Dimension 1)
	CREST HEIGHT P (2.15.4.6. OCM Dimension 2)
	CREST LENGTH L (2.15.4.7. OCM Dimension 3)
Trapezoidal Flume BS-3680	
	APPROACH WIDTH B (2.15.4.5. OCM Dimension 1)
	THROAT WIDTH B (2.15.4.6. OCM Dimension 2)
	HUMP HEIGHT P (2.15.4.7. OCM Dimension 3)
	THROAT LENGTH L (2.15.4.8. OCM Dimension 4)
U-Flume BS-3680	
	APPROACH DIAMETER DA (2.15.4.5. OCM Dimension 1)
	THROAT DIAMETER D (2.15.4.6. OCM Dimension 2)
	HUMP HEIGHT P (2.15.4.7. OCM Dimension 3)
	THROAT LENGTH L (2.15.4.8. OCM Dimension 4)
Finite Crest Weir BS-3680	
	CREST WIDTH B (2.15.4.5. OCM Dimension 1)
	CREST HEIGHT P (2.15.4.6. OCM Dimension 2)
	CREST LENGTH L (2.15.4.7. OCM Dimension 3)
Thin Plate Rectangular Weir BS-3680	
	APPROACH WIDTH B (2.15.4.5. OCM Dimension 1)
	CREST WIDTH B (2.15.4.6. OCM Dimension 2)
	CREST HEIGHT P (2.15.4.7. OCM Dimension 3)
Rectangular Weir Contracted	
	CREST WIDTH B (2.15.4.5. OCM Dimension 1)
Round Pipe	
	PIPE INSIDE DIAMETER D (2.15.4.5. OCM Dimension 1)

PMD selected (cont'd)	Wizard dimension name (parameter menu reference)
Palmer Bowlus Flume	
	MAXIMUM FLUME WIDTH HMAX (2.15.4.5. OCM Dimension 1)
H-Flume	
	MAXIMUM LISTED HEAD HMAX (2.15.4.5. OCM Dimension 1)

Maximum Head

The maximum level value associated with the PMD.

Value	Range: 0.000 to 60.000
	Default: 60.000

Zero Head Offset

The difference (positive or negative) between Low Calibration Point and zero head (level at zero flow).

Value	Range: -60.000 to 60.000
	Default: 0.000

Flowrate Units

The volume units used to display total flow.

Options	L/S, L/MIN, CUFT/S, CUFT/D, GAL/MIN, GAL/D, IMPGAL/MIN, IMPGAL/D, CUM/H, CUM/D, MMGAL/D, USER DEFINED *
	Default: L/S

* If **USER DEFINED** option selected, the value must be set after completing the wizard. See 2.15.3.8. *User Defined Unit* on page 194.

Maximum Flow at 20 mA

The maximum flowrate.

Value	Range: -999 to 9999999
	Default: 100

Flowrate Decimal

The maximum number of decimal units to be displayed.

Options	NO DIGITS, 1 DIGIT, 2 DIGITS, 3 DIGITS
	Default: NO DIGITS

Low Flow Cutoff

Eliminates totalizer activity for head levels at or below the cutoff value.

Value	Range: 0.000 to 60.000
	Default: 0.000

End of QS Flow Wizard

For QS to be successful, all changes must be applied.

Options	BACK, CANCEL, FINISH (Display returns to 1.1.1 Quick Start menu when Quick Start is successfully completed or cancelled. If CANCEL is selected, no changes are written to the device.)
----------------	--

To transfer Quick Start values to the device and return to Program menu, press **DOWN arrow ▼ (Finish)**. Then press **LEFT arrow ◀** three times to return to Measurement mode.

Note: It is strongly recommended that an *Auto Zero Head* be performed after completion of the wizard to ensure best accuracy. See *2.15.2. Auto Zero Head* on page 190.

1.2. Pump Control

Use this wizard to configure pumps if they will be used in your application. Be sure to first complete the applicable Quick Start Wizard.

- Press **RIGHT arrow** ► to activate PROGRAM mode and open menu level 1: MAIN MENU.
- Press **RIGHT arrow** ► to navigate to menu item 1.1.
- Press **DOWN arrow** ▼ and **RIGHT arrow** ► to open Pump Control.
- At each step, press **DOWN arrow** ▼ to accept default values and move directly to the next item,
or **RIGHT arrow** ► to open Edit mode: the current selection is highlighted.
- Scroll to desired item and press **RIGHT arrow** ► to store the change, then press **DOWN arrow** ▼ to continue.
- At any time, you can press **UP arrow** ▲ to go back, or **LEFT arrow** ◀ to cancel the wizard.

Start of Wizard - Pump Control

Note: The introduction screen is displayed only on the device when using the local push buttons. This screen is not part of the Quick Start when using SIMATIC PDM.

Shows the type of Wizard to be executed.

Options	CANCEL, START
----------------	---------------

Number of Pumps

Select the number of pumps to be used with pump control.

Options	NONE, 2
	Default: NONE

If set to NONE, pump control is disabled.

Relay Pump 1

Selects the relay assigned to Pump 1.

Options	RELAY 2, RELAY 3
	Default: RELAY 2

Relay Pump 2

View only. Automatically sets the relay assigned to Pump 2 based on relay selected for Pump 1 in previous step.

Options (view only)	If Relay Pump 1 = RELAY 2, then Relay Pump 2 = RELAY 3
	If Relay Pump 1 = RELAY 3, then Relay Pump 2 = RELAY 2

Pump Control Mode

Sets the control algorithm used to trip the relay.

Options supported per model	LUT420 Level Controller: ALTERNATE DUTY ASSIST, ALTERNATE DUTY BACKUP
	LUT430 Pump and Flow Controller: ALTERNATE DUTY ASSIST, ALTERNATE DUTY BACKUP, SERVICE RATIO DUTY ASSIST, SERVICE RATIO DUTY BACKUP, FIXED DUTY ASSIST, FIXED DUTY BACKUP
	LUT440 High Accuracy OCM: ALTERNATE DUTY ASSIST, ALTERNATE DUTY BACKUP, SERVICE RATIO DUTY ASSIST, SERVICE RATIO DUTY BACKUP, FIXED DUTY ASSIST, FIXED DUTY BACKUP
	Default (all models): ALTERNATE DUTY ASSIST

See *Pump Control Mode 2.7.1.4* on page 151 for descriptions of each.

Service Ratio Pump 1

Selects pump usage based on the RUN time ratio rather than last used.

Value	Range: 0 to 255
	Default: 1

This parameter displays only if a Service Ratio algorithm is selected for **Pump Control Mode**.

Service Ratio Pump 2

Selects pump usage based on the RUN time ratio rather than last used.

Value	Range: 0 to 255
	Default: 1

This parameter displays only if a Service Ratio algorithm is selected for **Pump Control Mode**.

Run Time Relay 2

Set the amount of time that pump Relay 2 has run, defined in hours.

Value	Range: 0 to 999999
	Default: 0

Use the default value for new pumps, or set this value for existing pumps with accumulated run time. (This parameter displays only if a Service Ratio algorithm is selected for **Pump Control Mode**.)

Run Time Relay 3

Set the amount of time that pump Relay 3 has run, defined in hours.

Value	Range: 0 to 999999
	Default: 0

Use the default value for new pumps, or set this value for existing pumps with accumulated run time. (This parameter displays only if a Service Ratio algorithm is selected for **Pump Control Mode**.)

Commissioning

ON Setpoint Pump 1*The level at which Pump 1 turns ON, defined in 2.1.1. Units.*

Value	Range: 0.000 to 99999.000
	Default: 0.000

ON Setpoint Pump 2*The level at which Pump 2 turns ON, defined in 2.1.1. Units.*

Value	Range: 0.000 to 99999.000
	Default: 0.000

OFF Setpoint Pump 1*The level at which Pump 1 turns OFF, defined in 2.1.1. Units.*

Value	Range: 0.000 to 99999.000
	Default: 0.000

OFF Setpoint Pump 2*The level at which Pump 2 turns OFF, defined in 2.1.1. Units.*

Value	Range: 0.000 to 99999.000
	Default: 0.000

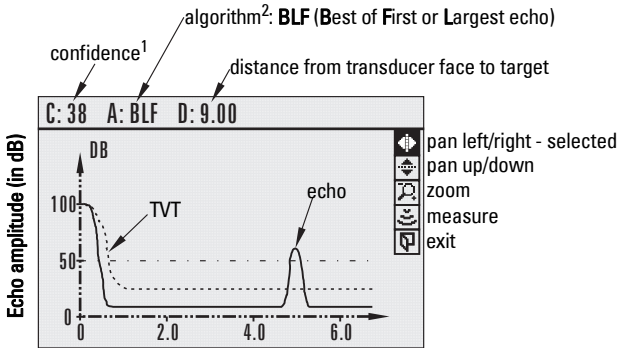
End of Wizard - Pump Control*For Wizard to be successful, all changes must be applied.*

Options	BACK, CANCEL, FINISH (Display returns to Pump Control menu when Wizard is successfully completed or cancelled. If CANCEL is selected, no changes are written to the device.)
----------------	--

To transfer values to the device and return to Program menu, press **DOWN arrow** ▼ (Finish). Then press **LEFT arrow** ◀ two times to return to Measurement mode.

Requesting an Echo Profile

- In PROGRAM mode, navigate to: **Main Menu > Diagnostics (3.2.) > Echo Profile (3.2.1.)**.
- Press **RIGHT arrow** ► to request a profile.



1. See Confidence (3.2.9.2.) on page 203.
2. See Algorithm (2.12.2.1.) on page 181.

- Use **UP** ▲ or **DOWN arrow** ▼ to scroll to an icon. When an icon is highlighted, that feature becomes active.
- To move a cross-hair, press **RIGHT arrow** ► to increase the value, **LEFT arrow** ◀ to decrease.
- To Zoom into an area, position the intersection of the cross-hairs at the center of that area, select **Zoom**, and press **RIGHT arrow** ►. Press **LEFT arrow** ◀ to Zoom out.
- To update the profile, select **Measure** and press **RIGHT arrow** ►.
- To return to the previous menu, select **Exit** then press **RIGHT arrow** ►.

Device Address

Setting a device address is not necessary for local operation, but must be set if configuring the SITRANS LUT400 for use on a HART network. See *Device Address 4.1* on page 216.

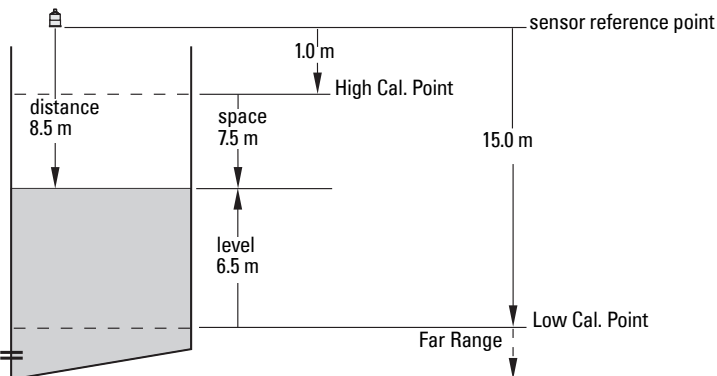
Testing the configuration

After programming the device, it is recommended that you test the device to ensure that it performs to your specifications. This test can be run in simulation mode or by varying the actual level in the application. The latter is preferred as it more accurately represents running conditions. However, if it is not possible to do a physical test, a simulation will ensure that control programming is correct. For further details, see *Simulation* on page 120, and *Application test* on page 123.

Application examples

In the examples that follow, substitute your own application details. If the examples do not apply to your application, check the applicable parameter reference for the available options.

Level Application Example



Quick Start Parameter	Setting	Description
Transducer	XPS-15	Transducer to be used with the LUT400.
Operation	LEVEL	Material level referenced from Low Cal. Point.
Temperature Source	TS-3	Temperature source.
Units	M	Sensor measurement units.
High Calibration Point	1.0	Process full level.
Low Calibration Point	15.0	Process empty level.
Response Rate	SLOW	Sets Fill Rate ^a / Empty Rate to 0.1 m/minute.

^a See *Fill Rate per Minute 2.3.1* on page 142.

The application is a vessel that takes an average 3 hours (180 minutes) to fill and 3 weeks to empty.

$$\begin{aligned} \text{Fill rate} &= (\text{Low Cal Pt.} - \text{High Cal Pt.}) / \text{fastest of fill or empty time} \\ &= (15.5 \text{ m} - 1 \text{ m}) / 180 \text{ min.} \\ &= 14.5 \text{ m} / 180 \text{ min.} = 0.08 \text{ m/min.} \end{aligned}$$

Flow application example

Parshall Flume

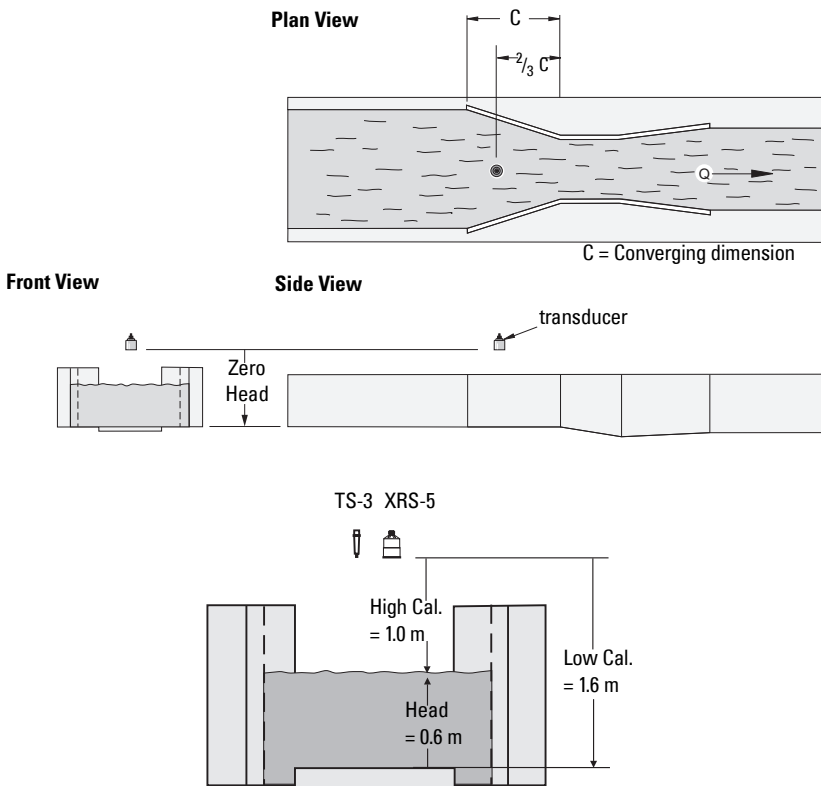
In this example, a 12 inch (0.305 m) Parshall Flume has been installed in an open channel. As per the supplier's data sheet, the device has been rated for a maximum flow of 1143 m³ per hour at a maximum head of 0.6 m.

The Parshall Flume is considered an exponential device, therefore the supplier's data sheet includes a flow exponent value of 1.522.

The SITRANS LUT400, and the XRS-5 transducer have been installed 1.6 m above the channel beside the TS-3 external temperature sensor.

During intermittent peak flow times, the head level can be expected to rise at a rate of approximately 0.12 m/minute. The application also calls for a flow sampler to be activated every 1000 m³, or 24 hours (whichever comes first), and for a fail-safe alarm to activate in the event of a loss of echo or cable fault.

Commissioning



Initial device setup

Quick Start Parameter	Setting/ Value	Description
Transducer	XRS-5	For best accuracy, an XRS-5 transducer should be used in conjunction with the High Accuracy SITRANS LUT440.
Temperature Source	TS-3	For best accuracy, a TS-3 external temperature sensor is required.
Primary Measuring Device (PMD)	Exponential	Parshall Flumes are a type of exponential device.
Flow Exponent	1.522	Available from the PMD supplier data sheet.
Units	m	Units corresponding to the head measurement.
Low Calibration Point	1.6	The distance to the empty point or bottom of the flume. This sets the 4 mA setpoint.
High Calibration Point	1.0	The distance to the Max. Head. This sets the 20 mA setpoint.
Response Rate	Medium (1.0 m/min)	Response rate is set to be faster than the fastest rise in material level under typical operating conditions. In this example, the rate is faster than the Peak Time rate provided by the end user.
Method of Flow Calculation	Ratiometric	Used when the Max. Head and Max. Flow values are provided.
Maximum Head	0.6 m	Available from the PMD supplier data sheet.
Flowrate Units	Cum/hr	Set per end user requirements.
Maximum Flow at 20 mA	1143	Available from the PMD supplier data sheet.
Flowrate Decimal	No Digits	For the purpose of this example, decimals are not required.
Low Flow Cutoff	0.00	This parameter stops the LUT440 from totalizing if the head value corresponding to low flow is reached. This prevents flow from being totalized when the head level reaches the ineffective point of the PMD. Refer to the PMD data sheets for ratings.

Continue with alarm setup below.

Fail-safe Alarm setup

Parameter	Setting/ Value	Description
Enable (2.8.8.1)	Enabled	By selecting Enabled, the fail-safe alarm is now activated.
Assigned Relay (2.8.8.2)	Relay 1	Select relay to be used for fail-safe alarm. Relay 1 is the dedicated alarm relay for the LUT400.

Continue with sampler setup on next page.

External Sampler setup

Parameter	Setting/ Value	Description
Enable (2.11.4.1.)	Enabled	By selecting Enabled, the external sampler is now activated.
Multiplier (2.11.4.2.)	1000	In this example, the LUT440 will activate the external sampler every 1000 flow units (<i>Flowrate Units</i> defined above during initial application setup).
Interval (2.11.4.3.)	24	In low flow conditions where the sampler may not activate for extended periods of time, a relay interval can be programmed to allow for sampler activation after a defined number of hours. In this example, activation should occur every 24 hours.
Relay Duration (2.11.4.4.)	0.2	Duration of time in seconds that the relay will energize or "tick".
Assigned Relay (2.11.4.5.)	Relay 2	Relay 2 has been selected for control in this example as relay 1 has been allocated to the Fail-safe alarm.
Relay Logic (2.11.4.6.)	Normally Open	Default for control relay functions is Normally Open. In this example, relay 2's coil will be Normally Open, and will close for 0.2 seconds.

Notes

General Operation

This chapter provides details on the general operation and functionality of the SITRANS LUT400. For instructions on the use of the device LCD and local push buttons, refer to *The LCD Display* on page 34.

Starting measurement

The SITRANS LUT400 is a single point device. The device starts in LEVEL mode with a preset of no transducer and a low calibration point of 60 meters. Change the following common parameters to reflect your application.

Parameter	Sample Value
2.1.2. <i>Sensor Mode</i>	LEVEL
<i>Response Rate</i> (set via <i>QS Level</i> on page 39)	MEDIUM
2.1.6. <i>Transducer</i>	XPS-15
2.1.1. <i>Units</i>	M
2.2.1. <i>Low Calibration Point</i>	12
2.2.2. <i>High Calibration Point</i>	2

Measurement conditions

The following information will help you configure your SITRANS LUT400 for optimal performance and reliability.

Response Rate

The response rate of the device influences the measurement reliability. Use the slowest rate possible with the application requirements.

Note: Changes to fill and empty rate parameters can override Response Rate setting. See “Response Rate” on page 42.

Dimensions

Dimensions of the vessel, wet well, or reservoir (other than low and high calibration points) are only important if you require volume readings. In this case, all dimensions are used to calculate the volume value in terms of level. They are also used to calculate pumped volume.

Fail-safe

The fail-safe parameters ensure that the devices controlled by the SITRANS LUT400 default to an appropriate state when a valid level reading is not available. (See list of faults that result in fail-safe in *General Fault Codes* on page 231.)

- **2.4.2. LOE Timer** activates if an error condition is detected. Upon expiration of the timer, the mA output value and the relay status default to values based on **2.4.1. Material Level**.
- The fail-safe **2.4.1. Material Level** determines the mA output if the **2.4.2. LOE Timer** expires and the device is still in an error condition.

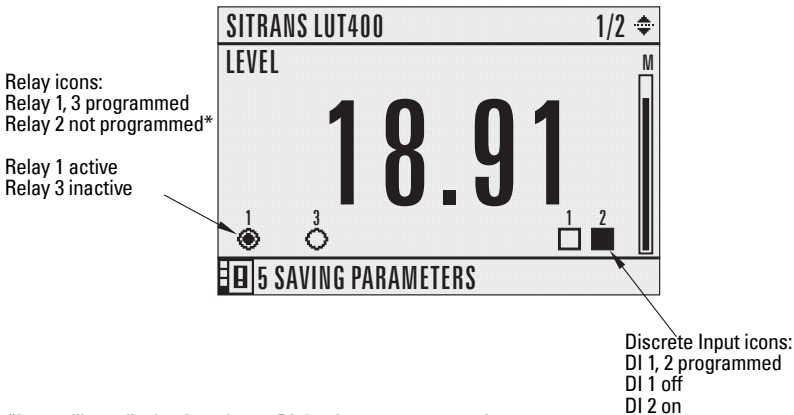
If fail-safe operation activates frequently, see *Diagnosing and Troubleshooting* on page 229.

Relays

Relays are the primary controls of external devices such as pumps or alarms. The SITRANS LUT400 comes with extensive control and alarm functions described below.

General introduction

Three relays are provided on the SITRANS LUT400. Each relay may be independently assigned to one function (one or more functions for alarms), and has a corresponding status icon on the LCD.



*Icon will not display for relay or DI that is not programmed.

Mode	Function (in normal state)
alarm	alarm ON = LCD icon ON = relay coil de-energized
pump	pump ON = LCD icon ON = relay coil energized
miscellaneous	contact closed = LCD icon ON = relay coil energized

Relay contact operation is **NORMALLY CLOSED** for alarms and **NORMALLY OPEN** for controls.

Options	Default	Alarm Contact	Pump or Control Contact
	*	Normally Closed	Normally Open
	Normally Open	Normally Closed	

In software, all relays are programmed the same way, with ON setpoints indicating when to change the relay contact state (open or closed). Some parameters allow the reversal of the operation so that relay contacts can be **NORMALLY CLOSED** or **NORMALLY OPEN** (for example, when assigned to an alarm).

Relay function

Alarm

Level

In high alarm, the alarm state becomes active when the level rises to High Level Value ON and inactive when it falls below High Level Value OFF. In low alarm, the alarm state becomes active when the level falls to Low Level Value ON and inactive when the level rises above Low Level Value OFF.

In-bounds

The relay alarm becomes active if the level is inside a user-defined range.

Out-of-bounds

The relay alarm becomes active if the level is outside a user-defined range.

Temperature

In high alarm, the alarm state becomes active when the temperature rises to High Temperature Value ON and inactive when the temperature falls below High Temperature Value OFF. In low alarm, the alarm state becomes active when the temperature falls to Low Temperature Value ON and inactive when the temperature rises above Low Temperature Value OFF.

Switch (Discrete Input)

The relay alarm state associated with the discrete input becomes active when the discrete input is in a user-defined state.

Fail-safe fault

The relay alarm state becomes active when a fault that has caused a fail-safe condition is present. The relay alarm state becomes inactive when no faults that cause fail-safe are present.

Flowrate

Available for LUT440 (OCM) model only.

In high alarm, the alarm state becomes active when the flowrate exceeds High Flowrate Value ON and inactive when the flowrate falls below High Flowrate Value OFF. In low alarm, the alarm state becomes active when the flowrate falls below Low Flowrate Value ON and inactive when the flowrate rises above Low Flowrate Value OFF.

Pump

Setpoint - ON / OFF

If the ON setpoint is higher than the OFF setpoint, the relay operates as:

- pump down control

If the ON setpoint is lower than the OFF setpoint, the relay operates as:

- pump up control

Miscellaneous

Totalizer and samplers

Refer to *Other Pump Controls* on page 87. Relays are normally de-energized, contact closure is approximately 200 ms duration.

Relay behaviour under fail-safe conditions

A fail-safe condition generally indicates that the level reading is not reliable or is unknown. In such a situation, pumps will not run and alarms (that are based on level or a derivative reading) will not activate. The following describes this behaviour in detail, by relay function.

Alarm relays

Any alarm that is based on level, or a reading derived from level such as flow rate, will not activate if there is a fail-safe condition. If the fail-safe condition occurs and the alarm is already active, the alarm will de-activate.

The following alarm types will de-activate during a fail-safe condition:

- *High Level*
- *Low Level*
- *In-bounds Level*
- *Out-of-bounds Level*
- *High Flow Rate*
- *Low Flow Rate*.

Note: A dedicated alarm exists for fail-safe condition as described above. See *Fail-safe fault* on page 65.

Pump relays

If a pump cycle is in progress at the time the fail-safe condition occurs, then the pump cycle will end prematurely (as if the 'off' setpoints were reached). This has the effect of turning off all pumps immediately. If a pump run-on occurrence was scheduled for the pump cycle, *it will not occur*. However, if a pump run-on occurrence has already begun at the time the fail-safe condition occurs, then the run-on will complete.

If no pump cycle is in progress at the time the fail-safe condition occurs, then subsequent pump cycles will not occur (the fail-safe condition will prevent pumps from starting), until the fail-safe condition is cleared.

Miscellaneous relays

External Totalizer relay

If the external totalizer is in the process of recording volume (i.e. the relay is clicking) when a fail-safe condition occurs, then the current series of clicks will be allowed to complete.

When totalizing volume:

Since pumps do not run when in fail-safe, then the external totalizer will in general not operate either. If a fail-safe condition occurs during a pump cycle then the volume pumped for that cycle will *not* be totalized.

When totalizing OCM flow:

The flow totalizers continue to operate during a fail-safe condition, thus the external totalizer relay will also continue to operate.

External Sampler relay

The External Sampler relay operates the same as the External Totalizer relay described above. The periodic timeout-click will also continue to occur in fail-safe.

Communications relays

Relays controlled by communications (HART) are not affected by a fail-safe condition.

Relay states

The relays on the SITRANS LUT400 are programmable, allowing for many control schemes.

Relay Types
Relay 1 – NO / NC (Form C)
Relay 2,3 – NO (Form A)

Relay output logic

Affects relay reaction. Reverses the logic (normally-open to normally-closed or vice versa). Relay logic can be modified separately for alarms, and controls. (Logic for pumps cannot be reversed.)

Function	Parameter
<i>2.8.11. Relay Logic for 2.8. Alarms</i>	<i>2.8.11.1. Relay 1 Logic</i> <i>2.8.11.2. Relay 2 Logic</i> <i>2.8.11.3. Relay 3 Logic</i>
<i>2.11. Other Control</i>	<i>2.11.1. Elapsed Time Relay</i> <i>2.11.1.5. Relay Logic</i>
	<i>2.11.2. Time of Day Relay</i> <i>2.11.2.5. Relay Logic</i>
	<i>2.11.3. External Totalizer</i> <i>2.11.3.5. Relay Logic</i>
	<i>2.11.4. External Sampler</i> <i>2.11.4.6. Relay Logic</i>

General Operation

Relay related parameters

Some parameters affect how relays react during normal conditions:

Setpoints

When a setpoint is reached, the corresponding action is taken. The setpoint can be an ON or OFF setpoint related to a process variable, or a timed setpoint based on interval and duration.

1. ON and OFF Setpoints

Sets the process point at which the relay is activated (ON setpoint) then reset (OFF setpoint). These setpoints are set separately for each pump within each pump control, and for each alarm type:

Function		Parameter
2.7. Pumps	2.7.1. Basic Setup	2.7.1.6. ON Setpoint Pump 1
		2.7.1.7. OFF Setpoint Pump 1
		2.7.1.8. ON Setpoint Pump 2
		2.7.1.9. OFF Setpoint Pump 2
2.7.2. Modifiers (for 2.7. Pumps)	2.7.2.2. Energy Savings	2.7.2.2.13. Peak ON Setpoint Pump 1
		2.7.2.2.14. Peak OFF Setpoint Pump 1
		2.7.2.2.15. Peak ON Setpoint Pump 2
		2.7.2.2.16. Peak OFF Setpoint Pump 2
2.8. Alarms	2.8.1. High Level Alarm	2.8.1.2. High Level Value ON
		2.8.1.3. High Level Value OFF
	2.8.2. Low Level Alarm	2.8.2.2. Low Level Value ON
		2.8.2.3. Low Level Value OFF
	2.8.4. In-bounds Level Alarm	2.8.4.2. High Level Value
		2.8.4.3. Low Level Value
	2.8.5. Out-of-bounds Level Alarm	2.8.5.2. High Level Value
		2.8.5.3. Low Level Value
	2.8.6. Low Temperature Alarm	2.8.6.2. Low Temperature Value ON
		2.8.6.3. Low Temperature Value OFF
2.8.7. High Temperature Alarm	2.8.7.2. High Temperature Value ON	
	2.8.7.3. High Temperature Value OFF	
2.8.9. High Flowrate Alarm	2.8.9.2. High Flowrate Value ON	
	2.8.9.3. High Flowrate Value OFF	
2.8.10. Low Flowrate Alarm	2.8.10.2. Low Flowrate Value ON	
	2.8.10.3. Low Flowrate Value OFF	

2. Timed Setpoints

Timed setpoints are based on interval, duration, or time of day. These setpoints are set separately for each pump within each pump control, and for each non-pump control function:

Function		Parameter
2.7.2. Modifiers (for 2.7. Pumps)	2.7.2.3. Pump Run-On	2.7.2.3.2. Run-On Interval
		2.7.2.3.3. Run-On Duration Pump 1
		2.7.2.3.4. Run-On Duration Pump 2
2.11. Other Control	2.7.2.4. Pump Start Delays	2.7.2.4.1. Delay Between Starts
		2.7.2.4.2. Power Resumption Delay
	2.11.1. Elapsed Time Relay	2.11.1.2. Interval
		2.11.1.3. Relay Duration
	2.11.2. Time of Day Relay	2.11.2.2. Activation Time
		2.11.2.3. Relay Duration
	2.11.3. External Totalizer	2.11.3.3. Relay Duration
	2.11.4. External Sampler	2.11.4.3. Interval
2.11.4.4. Relay Duration		

Relays controlled by HART Communications

A relay can be controlled directly by a remote system through communications. HART commands can be used for this purpose. An expert knowledge of HART, and the use of HART commands is recommended. For further details on configuring relays controlled by HART, contact your Siemens representative.

Discrete Inputs

SITRANS LUT400 has two discrete inputs to trigger or alter the way SITRANS LUT400 controls devices. A Backup Level Override, Pump Interlock, or a Switch (DI) Alarm can be configured using discrete inputs, and discrete input logic can be reversed if necessary for the application.

Backup Level Override

Backup level override provides the option of overriding the ultrasonic input (signal from a transducer) with another contacting point level device, such as the Pointek CLS200, to determine the level output.

The material reading is fixed at the programmed switch level until the discrete input is released. The LUT400 makes its decisions based on the override value.

Note: A backup level override will prevent a fail-safe condition from occurring.

Backup Level Override functionality is particularly useful in wet-wells and reservoirs that use pumps:

- place a backup level switch high in a vessel to indicate when it is about to overflow
- place a backup level switch low in a vessel, to indicate when it is almost empty.

Basic operation

Configuring Backup Level Override involves three steps (see *2.9.1. Backup Level Override*).

1. Select a level override value. This will be the Level output produced by the instrument when the backup level override condition is present.
2. Select the discrete input that is connected to the point-level device.
3. Enable the Backup Level Override function.

It may also be necessary to invert the logic of the discrete input, which is possible through the LUT400 discrete input logic parameters (see *2.9.2. Discrete Input Logic*).

Backup Level Override parameters

Example:

SITRANS LUT400 is configured for a level measurement. In the same application, Discrete Input 2 is connected to a Hi Level Backup switch at a level value of 4.3 m.

Settings

Parameter	Sample Value
2.9.1.2. Level Override Value	4.3
2.9.1.3. Discrete Input Number	DISCRETE INPUT 2
2.9.1.1. Enable	ENABLED

When the level rises to 4.3 m and the switch is activated, the reading is forced to 4.3 m where it stays until the switch is de-activated.

Level Override conditions

When the discrete input activates, the level output will immediately take on the value chosen in step 1 above. The LUT400 LCD will indicate that the discrete input has been activated.

When a Backup Level Override condition clears (the discrete input is deactivated), the level will return to the value determined from the ultrasonic transducer or, if no echo is available, the device will enter the fail-safe condition.

Affect of Backup Level Override

The level produced by a Backup Level Override condition completely replaces the level that would otherwise be produced by normal echo processing algorithms. This means that the Backup Level will:

- drive all readings that depend on Level (for example: space, distance, and flow)
- drive level alarms
- appear in system logs
- affect pump control
- affect totalizers (OCM and Pumped Volume)

Additional considerations

A Backup Level Override condition will prevent a fail-safe condition from occurring: when a backup level override condition is present, a fail-safe response will never occur. This allows pumps and other controls such as level alarms to be active even during the backup level override condition.

Pump Interlocks

Discrete inputs can be used to supply pump information to the SITRANS LUT400 to set actions that will occur when a pump is determined to be in a failed state.

For an example of how to configure a pump interlock, see *Pump Control Interlocks* on page 87.

Switch (DI) Alarm

An alarm can be set to activate based on the state of a discrete input. See *Switch (DI) Alarm* on page 70 for an example.

Discrete Input Logic

Discrete input logic affects the reaction of the discrete input. Normal state is standard operation, with the SITRANS LUT400 sensing the material level and controlling the pumps.

The contacts of the signalling device connected to the discrete inputs may be **normally-open** or **normally closed**.

Example:

Normal state for a backup high level switch is **open**, and the contacts on the discrete input are wired as **normally open**.

This logic can also be reversed (NORMALLY OPEN to NORMALLY CLOSED or vice versa). Use the Discrete Input logic parameters to set the state of each discrete input.

Function	Parameter	
2.9. Discrete Inputs	2.9.2. Discrete Input Logic	2.9.2.1. Discrete Input 1 Logic
		2.9.2.3. Discrete Input 2 Logic

Read the current state of discrete input 1 in *2.9.2.2. Discrete Input 1 Scaled State* and the current state of discrete input 2 in *2.9.2.4. Discrete Input 2 Scaled State*.

See *Discrete inputs* on page 28 for complete details on wiring the discrete inputs. To override a level using a discrete input, see *2.9.1. Backup Level Override* on page 171.

mA Control

mA output

The SITRANS LUT400 has one mA output, used for communications with other devices.

Example:

Configuring the mA output to send a 4 to 20 mA signal corresponding to a scaled value of 10% to 90% of maximum process level on a 60 m transducer:

Parameter	Sample Value	Description
<i>2.5.1. Current Output Function or 2.5.2. Current Output Function</i>	LEVEL	send mA proportional to level reading
<i>2.5.3. 4 mA Setpoint</i>	6	set 4 mA at process level equal to 10% of maximum (Low Cal minus High Cal) ^a
<i>2.5.4. 20 mA Setpoint</i>	54	set 20 mA at process level equal to 90% of maximum (Low Cal minus High Cal) ^b
<i>2.5.5. Minimum mA Limit</i>	3.5	set minimum mA level below 4 mA
<i>2.5.6. Maximum mA Limit</i>	22.8	set maximum mA level above 20 mA

a. If the level reading drops below 6 m, the mA output drops below 4 mA.

b. If the level reading rises above 54 m, the mA output rises above 20 mA.

Note: If default values (4 and 20 mA) are used for the minimum and maximum mA limits, the mA output (shown in *2.5.8. Current Output Value*) will remain at the set mA limit, even if the level reading falls below/rises above the mA setpoints.

Verifying the mA range

Checks that the external device can track the entire 4 to 20 mA range sent by the SITRANS LUT400. Follow the steps below if actual mA readings differ between the LUT400 (shown in *2.5.8. Current Output Value*) and an external device (such as a PLC).

- To test the loop current, set *2.5.1. Current Output Function* to **Manual**, then set the value to use in *2.5.7. Manual Value*.
- Check that the external device displays the same mA reading as the mA value set above.
- If external device reading differs from the set manual value on the LUT400, adjust the reading on the external device to match the reading on the LUT400.

Volume

Volume is used in two situations:

1. Calculate and display volume instead of level.
2. Calculate pumped volume to accomplish the following:
 - Totalize the volume of material that is pumped out of the wet well

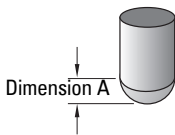
Readings

When using volume, readings are given in units specified in *2.6.2. Volume Units*.

Vessel Shape and Dimensions

There are many common vessel shapes to select from. (See *2.6.1. Vessel Shape*. If possible, use one of these.) Each vessel shape uses the *2.2.1. Low Calibration Point* in its calculations of volume.

Some vessel shapes also require extra dimensions to calculate the volume. Do not estimate these values. They must be correct to ensure the accuracy of your volume calculations.



Example:

To configure volume for a vessel with a half-sphere bottom, set the following:

Parameter	Sample Value	Description
<i>2.6.1. Vessel Shape</i>	HALF SPHERE BOTTOM	selects the correct vessel shape
<i>2.6.3. Maximum Volume</i>	100	sets maximum volume at 100 (defined in <i>2.6.2. Volume Units</i>)
<i>2.6.4. Dimension A</i>	1.3	sets dimension A to 1.3 m

Notes:

- The default reading changes to a range from 0 to 100
- The process empty value is still measured to the bottom of the vessel (*2.2.1. Low Calibration Point* plus any *2.2.5. Far Range* value), not the top of **Dimension A**.

Characterization chart

If you cannot use a pre-defined vessel, then use one of the universal vessel shapes and program the characterization curve.

1. Plot a volume to height chart. Usually a vessel supplier will provide this chart. However, if you have a custom-built vessel, then you will need access to complete drawings of the well or accurate measurements.

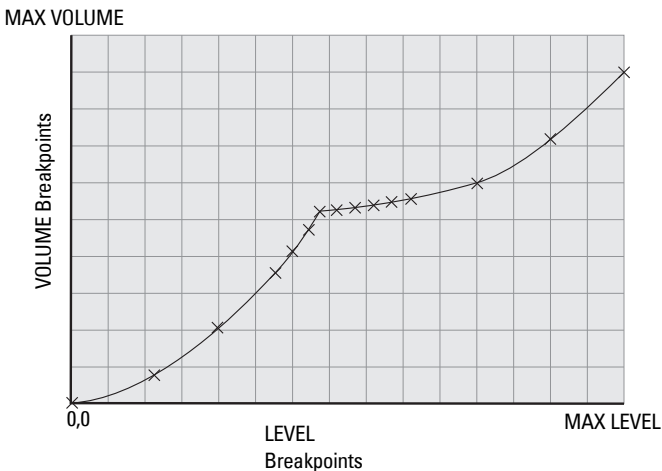
2. Enter the curve values from this chart into level and volume breakpoint tables (see 2.6.7. Table 1-8).

Note: If breakpoints are entered via LUI, then an upload is performed via PDM, a second upload via PDM may be necessary to transfer the breakpoint values.

3. Ensure extra points are added around sharp transitions in the vessel volume (e.g. steps in a well wall).

Note: The end points in the curve are 0,0 (fixed) and the point defined by Maximum Level and Maximum Volume.

Example chart (with 15 of possible 32 Level and Volume breakpoints defined):



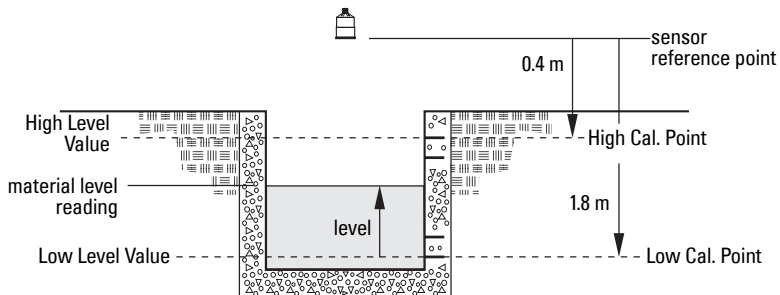
Parameter	Value	Description
2.6.7.1. Level 1	0.0	Determines the Level breakpoints at which the volumes are known.
Level 2	0.8	
Level 3	2.0	
Level 4	3.5	
Level 5	4.1	
Level 6	4.7	
Level 7	5.1	
Level 8	5.2	
Level 9	5.3	
Level 10	5.4	
Level 11	5.5	
Level 12	5.6	
Level 13	6.0	
Level 14	7.2	
Level 15	9.0	

Appendix 2F

Parameter	Value	Description
<i>2.6.7.2. Volume 1</i>	0.0	<p>Determines the volumes which correspond to the level breakpoints. The universal calculations interpret between the breakpoints to produce an accurate model of the volume at all level readings.</p> <p>Settings <i>2.6.1. Vessel Shape</i> = LINEAR TABLE for linear approximation <i>2.6.1. Vessel Shape</i> = CURVE TABLE for curved approximation</p> <p>Linear approximation uses a linear algorithm; curved approximation uses a cubic spline algorithm.</p>
Volume 2	2.1	
Volume 3	4.0	
Volume 4	5.6	
Volume 5	5.9	
Volume 6	6.3	
Volume 7	6.7	
Volume 8	7.1	
Volume 9	7.8	
Volume 10	8.2	
Volume 11	8.8	
Volume 12	9.2	
Volume 13	10.9	
Volume 14	13.0	
Volume 15	15.0	

Alarms

Set the common parameters



Prerequisite: You must know the details of your application and substitute the values for the sample values provided. If you are bench testing the device, then set your test values to be the same as the sample values.

Parameter	Sample Value
2.1.2. <i>Sensor Mode</i> (for Level)	LEVEL
or	FLOW
2.1.3. <i>Sensor Mode</i> (for Flow)	
<i>Response Rate</i>	MEDIUM
2.1.6. <i>Transducer</i>	XPS-10
2.1.1. <i>Units</i> (for Level Alarms)	M
2.15.3.7. <i>Flowrate Units</i> (for Flowrate Alarms)	L/S
2.2.1. <i>Low Calibration Point</i>	1.8
2.2.2. <i>High Calibration Point</i>	0.4

Note: When configuring alarms, more than one alarm can be assigned to the same relay.

Level

The level alarm is the most common. Use this alarm to warn you when your process is in danger of being upset due to high or low levels.

High level and low level alarms can be set to activate when the material level rises above or falls below a set level. (See 2.8.1. *High Level Alarm*, 2.8.2. *Low Level Alarm*.)

Example: Setting a High Level Alarm

To assign Relay 3 to a high level alarm that activates when the level rises above 10 m:

1. Enable the High Level Alarm (set 2.8.1.1. *Enable* = **Enabled**)
2. Set 2.8.1.2. *High Level Value ON* = **10 m**

3. Set 2.8.1.3. *High Level Value OFF* = 9 m
4. Set 2.8.1.4. *Assigned Relay* to **Relay 3**

Use the High Level alarm in conjunction with 2.8.12. *Time To Spill* feature. See page 170.

Example: Setting a Low Level Alarm

To assign Relay 3 to a low level alarm that activates when the level falls below 2 m:

1. Enable the Low Level Alarm (set 2.8.2.1. *Enable* = **Enabled**)
2. Set 2.8.2.2. *Low Level Value ON* = 2
3. Set 2.8.2.3. *Low Level Value OFF* = 3
4. Set 2.8.2.4. *Assigned Relay* to **Relay 3**

In-bounds/ Out-of-bounds Range

Use the bounded range alarms to detect when the level is inside or outside of the range.

Example: Setting an In-bounds Level Alarm

To assign Relay 3 to an in-bounds level alarm do the following:

1. Enable the In-bounds Level Alarm (set 2.8.4.1. *Enable* = **Enabled**)
2. Set 2.8.4.2. *High Level Value* = 1.30 m
3. Set 2.8.4.3. *Low Level Value* = 0.30 m
4. Set 2.8.4.4. *Assigned Relay* to **Relay 3**.

Results:

- Activates alarm assigned to relay 3 when level is within range 0.3 to 1.3 m
- Resets alarm above 1.3 m or below 0.3 m

Use 2.8.4.5. *Alarm State* to view the current state of the In-bounds Level Alarm.

Example: Setting an Out-of-bounds Level Alarm

To assign Relay 3 to an out-of-bounds level alarm do the following:

1. Enable the Out-of-bounds Level Alarm (set 2.8.5.1. *Enable* = **Enabled**)
2. Set 2.8.5.2. *High Level Value* = 1.30 m
3. Set 2.8.5.3. *Low Level Value* = 0.30 m
4. Set 2.8.5.4. *Assigned Relay* to **Relay 3**.

Results:

- Activates alarm assigned to relay 3 when level is outside range 0.3 to 1.3 m
- Resets alarm below 1.30 m or above 0.30 m

Use 2.8.5.5. *Alarm State* to view the current state of the Out-of-bounds Level Alarm.

Temperature

Activates an alarm when the process temperature reaches a certain value (Low Temperature Value ON for Low Temperature Alarm or High Temperature Value ON for a High Temperature Alarm).

The temperature source can be the temperature sensor built into the transducer or an external TS-3, as set by *Temperature Source*. (Temperature Source is set in the Quick Start Wizard, see page 39.)

Example: Setting a High Temperature Alarm

To assign Relay 3 to a high temperature alarm that activates when the temperature goes above 30 °C do the following:

1. Enable the High Temperature Alarm (set *2.8.7.1. Enable* = **Enabled**)
2. Set *2.8.7.2. High Temperature Value ON* = **30**
3. Set *2.8.7.3. High Temperature Value OFF* = **28**
4. Set *2.8.7.4. Assigned Relay* to **Relay 3**.

The high temperature alarm will not de-activate until the temperature falls to 28 °C.

Use *2.8.7.5. Alarm State* to view the current state of the High Temperature Alarm.

Example: Setting a Low Temperature Alarm

To assign Relay 3 to a low level alarm that activates when the temperature falls below -10 °C do the following:

1. Enable the Low Level Alarm (set *2.8.6.1. Enable* = **Enabled**)
2. Set *2.8.6.2. Low Temperature Value ON* = **-10**
3. Set *2.8.6.3. Low Temperature Value OFF* = **- 8**
4. Set *2.8.6.4. Assigned Relay* to **Relay 3**.

Use *2.8.6.5. Alarm State* to view the current state of the Low Temperature Alarm.

Switch (Discrete Input) Alarm

Activates an alarm when a discrete input is in a pre-defined state.

Example: Setting a Switch Alarm

To assign Relay 3 to a switch alarm that is activated when DI 1 turns ON do the following:

1. Enable the Switch (Discrete Input) Alarm (set *2.8.3.1. Enable* = **Enabled**)
2. Set the *2.8.3.2. Discrete Input Number* = **1**
3. Set *2.8.3.3. Discrete Input State* to **ON**.
4. Set *2.8.3.4. Assigned Relay* to **Relay 3**.

Use *2.8.3.5. Alarm State* to view the current state of the Switch Alarm.

Fail-safe Fault Alarm

Activates an alarm when a fault that has caused a fail-safe condition is present.

Example: Setting a Fail-safe Fault Alarm

To assign a fail-safe fault alarm to Relay 3 do the following:

1. Enable the Fail-safe Fault Alarm (set *2.8.8.1. Enable* = **Enabled**)
 2. Set *2.8.8.2. Assigned Relay* to **Relay 3**.
- Use *2.8.8.3. Alarm State* to view the current state of the Fail-safe Alarm.

Flowrate

Flowrate alarms are available on LUT440 (OCM) model only. They can activate an alarm if the OCM flowrate is above or below a given setpoint.

Example: Setting a High Flowrate Alarm

To assign Relay 3 to a high flowrate alarm that activates when the flowrate rises above 10 l/s:

1. Enable the High Flowrate Alarm (set *2.8.9.1. Enable* = **Enabled**).
2. Set *2.8.9.2. High Flowrate Value ON* = **10**
3. Set *2.8.9.3. High Flowrate Value OFF* = **8**
4. Set *2.8.9.4. Assigned Relay* to **Relay 3**

Example: Setting a Low Flowrate Alarm

To assign Relay 3 to a low level alarm that activates when the flowrate falls below 2 l/s:

1. Enable the Low Flowrate Alarm (set *2.8.10.1. Enable* = **Enabled**)
2. Set *2.8.10.2. Low Flowrate Value ON* = **2**
3. Set *2.8.10.3. Low Flowrate Value OFF* = **4**
4. Set *2.8.10.4. Assigned Relay* to **Relay 3**

Pump Control

The SITRANS LUT400 has the pump control functionality to solve nearly any water / wastewater application.

To set up pump control for simple applications, see *Pump Control Wizard* in LUT400 Communications manual¹.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

Pump Control options

Methods of pump control are dependent on two variables:

Pump start method indicates in what sequence pumps are started; using Fixed, Alternate, or Service Ratio setpoints.

Pump duty indicates whether new pumps start and run with any currently running pumps (most common) or whether new pumps start and shut off currently running pumps; using Assist or Backup duty.

Pump Control algorithms

Algorithms are used to provide six modes of pump control. They can be used to start multiple pumps (assist) or one pump at a time (backup). These six modes can be grouped into three main methods of pump control used by the SITRANS LUT400: Fixed, Alternate, and Service Ratio. The LUT420 (Level) model operates with Alternate pump control only.

Fixed: Starts pumps based on individual setpoints and always starts the same pumps in the same sequence [Fixed Duty Assist (FDA), and Fixed Duty Backup (FDB)].

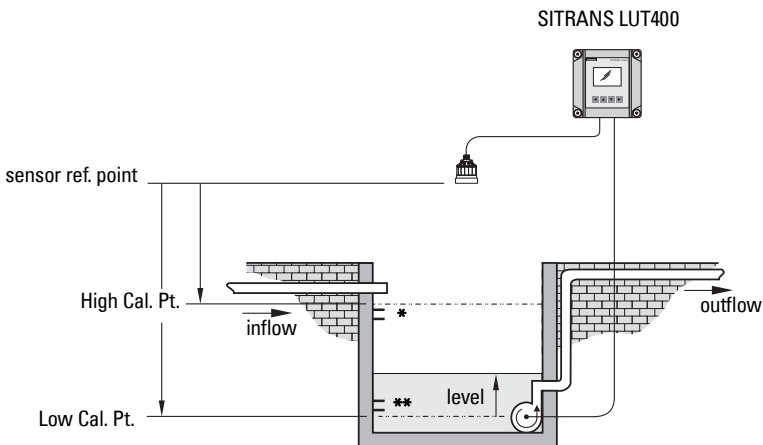
Alternate: Starts pumps based on the duty schedule and always leads with a new pump [Alternate Duty Assist (ADA), and Alternate Duty Backup (ADB)].

Service Ratio: Starts pumps based on user-defined ratio of running time [Service Ratio Duty Assist (SRA), and Service Ratio Duty Backup (SRB)].

Alternate Duty Assist (ADA) is set as the default.

Setting a pump down (wet well) group

Setting a group of two pumps to pump down a wet well.



Setpoint sample values: * ON Setpoint Pump 1 / Pump 2
(see tables below) ** OFF Setpoint Pump 1 / Pump 2

Set the common parameters

Prerequisite: Substitute the details of your application in place of the sample values provided. If you are bench testing the device, set your test values to be the same as the sample values.

Parameter	Sample Value
2.1.2. <i>Sensor Mode</i>	Level
<i>Response Rate</i>	Medium
2.1.6. <i>Transducer</i>	XPS-10
2.1.1. <i>Units</i>	M
2.2.1. <i>Low Calibration Point</i>	1.8
2.2.2. <i>High Calibration Point</i>	0.4

Set Relays to ALTERNATE DUTY ASSIST (ADA)

Parameter	Value	Description
2.7.1.4. <i>Pump Control Mode</i> or 2.7.1.5. <i>Pump Control Mode</i>	ADA	Sets the control algorithm used to trip the pump relay to ALTERNATE DUTY ASSIST . Multiple pumps can run simultaneously.

Set the ON Setpoints

Parameter	Sample Value ^a	Description
2.7.1.6. <i>ON Setpoint Pump 1</i>	1.0 m *	Sets the level at which pump 1 turns on. The first cycle will use this setpoint. Subsequent cycles rotate the setpoint among the pumps. For example: In cycle 1, pump 1 turns on at 1 m. In the next cycle, pump 2 will turn on at 1 m.
2.7.1.8. <i>ON Setpoint Pump 2</i>	1.1 m *	Sets the level at which pump 2 turns on.

a. Sample values denoted by asterisks in illustration on page 80.

Set the OFF Setpoints

Parameter	Sample Value ^a	Description
2.7.1.7. <i>OFF Setpoint Pump 1</i>	0.5 m **	Sets the level at which pump 1 turns off. The first cycle will use this setpoint. Subsequent cycles rotate the setpoint among the pumps. For example: In cycle 1, pump 1 turns off at 0.5 m. In the next cycle, pump 2 will turn off at 0.5 m.
2.7.1.9. <i>OFF Setpoint Pump 2</i>	0.6 m **	Sets the level at which pump 2 turns off.

a. Sample values denoted by asterisks in illustration on page 80.

Other Pump Control algorithms

Set Relays to ALTERNATE DUTY BACKUP (ADB)

Parameter	Value	Description
2.71.4. Pump Control Mode or 2.71.5. Pump Control Mode	ADB	Sets the control algorithm used to trip the pump relay to ALTERNATE DUTY BACKUP . Only one pump can run at a time.

Set the ON Setpoints

Parameter	Sample Value	Description
2.71.6. ON Setpoint Pump 1	1.3 m	Sets the level at which pump 1 turns on. The first cycle will use this setpoint. Subsequent cycles rotate the setpoint among the pumps.
2.71.8. ON Setpoint Pump 2	1.2 m	Sets the level at which pump 2 turns on.

Set the OFF Setpoints

Parameter	Sample Value	Description
2.71.7. OFF Setpoint Pump 1	0.4 m	Sets the level at which pump 1 turns off. The first cycle will use this setpoint. Subsequent cycles rotate the setpoint among the pumps.
2.71.9. OFF Setpoint Pump 2	0.3 m	Sets the level at which pump 2 turns off.

Set Relays to FIXED DUTY ASSIST (FDA)

Parameter	Value	Description
2.71.5. Pump Control Mode	FDA	Sets the control algorithm used to trip the pump relay to FIXED DUTY ASSIST . Multiple pumps can run simultaneously.

Set the ON Setpoints

Parameter	Sample Value	Description
2.71.6. ON Setpoint Pump 1	1.3 m	Sets the level at which pump 1 turns on.
2.71.8. ON Setpoint Pump 2	1.2 m	Sets the level at which pump 2 turns on.

Set the OFF Setpoints

Parameter	Sample Value	Description
2.71.7. OFF Setpoint Pump 1	0.4 m	Sets the level at which pump 1 turns off.
2.71.9. OFF Setpoint Pump 2	0.3 m	Sets the level at which pump 2 turns off.

Set Relays to FIXED DUTY BACKUP (FDB)

Parameter	Value	Description
2.71.5. Pump Control Mode	FDB	Sets the control algorithm used to trip the pump relay to FIXED DUTY BACKUP . Only one pump can run at a time.

Set the ON Setpoints

Parameter	Sample Value	Description
2.71.6. ON Setpoint Pump 1	1.3 m	Sets the level at which pump 1 turns on.
2.71.8. ON Setpoint Pump 2	1.2 m	Sets the level at which pump 2 turns on.

Set the OFF Setpoints

Parameter	Sample Value	Description
2.71.7. OFF Setpoint Pump 1	0.4 m	Sets the level at which pump 1 turns off.
2.71.9. OFF Setpoint Pump 2	0.3 m	Sets the level at which pump 2 turns off.

Set Relays to SERVICE RATIO DUTY ASSIST (SRA)

Parameter	Value	Description
2.71.5. Pump Control Mode	SRA	Sets the control algorithm used to trip the pump relay to SERVICE RATIO DUTY ASSIST . Multiple pumps can run simultaneously. Pump usage is based on RUN time rather than last used.
2.71.10. Service Ratio Pump 1	25	Sets the ratio to: 25% for pump 1, i.e. pump 1 will run 25% of the time.
2.71.11. Service Ratio Pump 2	75	Sets the ratio to: 75% for pump 2, i.e. pump 2 will run 75% of the time

Set the ON Setpoints

Parameter	Sample Value	Description
2.71.6. ON Setpoint Pump 1	1.3 m	Sets the level at which the first pump turns on.
2.71.8. ON Setpoint Pump 2	1.2 m	Sets the level at which the second pump turns on.

Set the OFF Setpoints

Parameter	Sample Value	Description
2.71.7. OFF Setpoint Pump 1	0.4 m	Sets the level at which the first pump turns off.
2.71.9. OFF Setpoint Pump 2	0.3 m	Sets the level at which the second pump turns off.

Set Relays to SERVICE RATIO DUTY BACKUP (SRB)

Parameter	Value	Description
2.71.5. Pump Control Mode	SRB	Sets the control algorithm used to trip the pump relay to SERVICE RATIO DUTY BACKUP . Only one pump can run at a time. Pump usage is based on RUN time rather than last used.

Set the Service Ratio for each pump

Parameter	Sample Value	Description
2.71.10. Service Ratio Pump 1	25	Sets the ratio to: 25% for pump 1, i.e. pump 1 will run 25% of the time.
2.71.11. Service Ratio Pump 2	75	Sets the ratio to: 75% for pump 2, i.e pump 2 will run 75% of the time

Set the ON Setpoints

Parameter	Sample Value	Description
2.71.6. ON Setpoint Pump 1	1.3 m	Sets the level at which the first pump turns on.
2.71.8. ON Setpoint Pump 2	1.2 m	Sets the level at which the second pump turns on.

Set the OFF Setpoints

Parameter	Sample Value	Description
2.71.7. OFF Setpoint Pump 1	0.4 m	Sets the level at which the first pump turns off.
2.71.9. OFF Setpoint Pump 2	0.3 m	Sets the level at which the second pump turns off.

Notes:

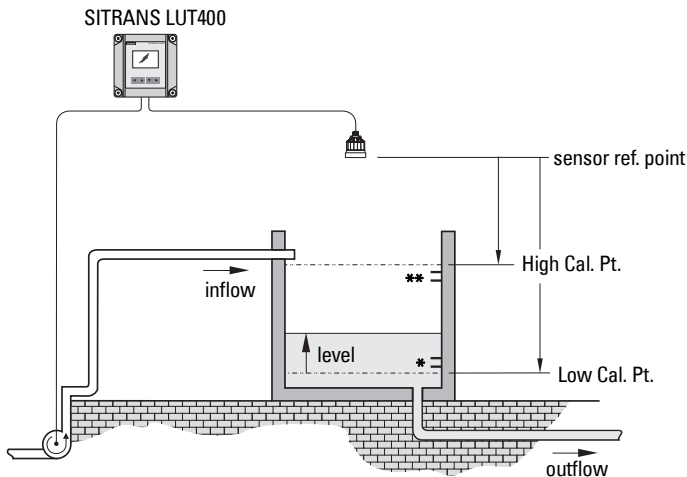
- The SITRANS LUT400 will not sacrifice other pumping strategies to ensure that the service ratio is held true
- If the pump ratios are set to the same value, then the ratio equals 1:1 and all pumps are used equally (default)

When a pump start is required (ON Setpoint), the pump with the fewest running hours (with respect to the assigned ratio values) starts.

Conversely, when a pump stop is required (OFF Setpoint), if multiple pumps are running simultaneously, the pump with the most running hours (as compared to the assigned ratio values) stops.

Setting a pump up (reservoir) group

Sets a group of two pumps to pump up a reservoir.



Setpoint sample values: * ON Setpoint Pump 1 / Pump 2
(see tables below) ** OFF Setpoint Pump 1 / Pump 2

Set the common parameters

Prerequisite: Substitute the details of your application in place of the sample values provided. If you are bench testing the device, set your test values to be the same as the sample values.

Parameter	Sample Value
2.1.2. Sensor Mode or 2.1.3. Sensor Mode	Level
Response Rate	Medium
2.1.6. Transducer	XPS-10
2.1.1. Units	M
2.2.1. Low Calibration Point	1.8
2.2.2. High Calibration Point	0.4

Set Relays to ALTERNATE DUTY ASSIST (ADA)

Parameter	Value	Description
2.7.1.4. Pump Control Mode or 2.7.1.5. Pump Control Mode	ADA	Sets the control algorithm used to trip the pump relay to ALTERNATE DUTY ASSIST .

General Operation

Set the ON Setpoints

Parameter	Sample Value^a	Description
<i>2.71.6. ON Setpoint Pump 1</i>	0.4 m*	Sets the level at which pump 1 turns on. The first cycle will use this setpoint. Subsequent cycles rotate the setpoint among the pumps. For example: In cycle 1, pump 1 turns on at 0.4 m. In the next cycle, pump 2 will turn on at 0.4 m.
<i>2.71.8. ON Setpoint Pump 2</i>	0.3 m*	Sets the level at which pump 2 turns on.

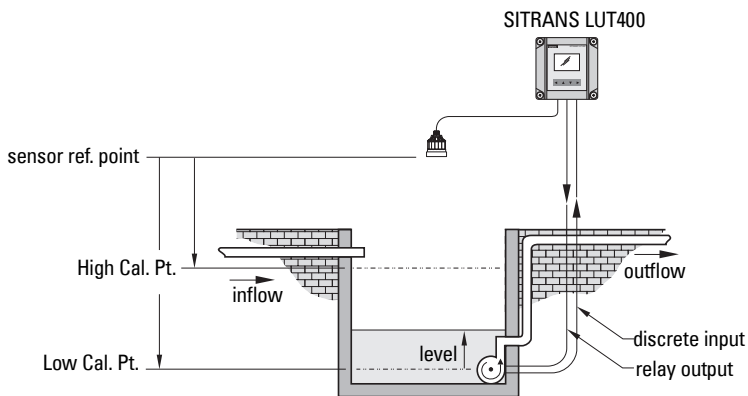
^a. Sample values denoted by asterisks in illustration on page 85.

Set the OFF Setpoints

Parameter	Sample Value^a	Description
<i>2.71.7. OFF Setpoint Pump 1</i>	1.3 m**	Sets the level at which pump 1 turns off. The first cycle will use this setpoint. Subsequent cycles rotate the setpoint among the pumps. For example: In cycle 1, pump 1 turns off at 1.3 m. In the next cycle, pump 2 will turn off at 1.3 m.
<i>2.71.9. OFF Setpoint Pump 2</i>	1.2 m**	Sets the level at which pump 2 turns off.

^a. Sample values denoted by asterisks in illustration on page 85.

Pump Control Interlocks



Parameter	Sample Value	Description
2.71.4. Pump Control Mode or 2.71.5. Pump Control Mode	ADA	Sets the control algorithm used to trip the pump relay to ALTERNATE DUTY ASSIST.
2.9.3.1. Enable Pump 1	ON	Enables pump start interlock for Pump 1.
2.9.3.2. Pump 1 Discrete Input	Discrete Input 1	Sets the discrete input to use for pump start interlock on Pump 1.
2.9.3.3. Enable Pump 2	ON	Enables pump start interlock for Pump 2.
2.9.3.4. Pump 2 Discrete Input	Discrete Input 2	Sets the discrete input to use for pump start interlock on Pump 2.
2.9.2.1. Discrete Input 1 Logic	Normally Closed	Use if necessary to reverse logic for Discrete Input 1.
2.9.2.3. Discrete Input 2 Logic	Normally Closed	Use if necessary to reverse logic for Discrete Input 2.

These values will ensure that any pump reporting a failure is removed from the pumping rotation. For more information on pump interlocks and discrete inputs, see *Discrete Inputs* on page 69.

Other Pump Controls

Prerequisite: Common parameters must first be set for each pump control below:

Parameter	Sample Value
2.1.2. Sensor Mode or 2.1.3. Sensor Mode Response Rate	Volume Medium
2.1.6. Transducer	XPS-10
2.1.1. Units	M
2.2.1. Low Calibration Point	1.8
2.2.2. High Calibration Point	0.4

General Operation

Totalizing pumped volume

Available only on LUT430 (Pump and Flow model), and LUT440 (OCM model).

Prerequisite: The volume of the vessel must be known.

Parameter	Sample Value	Description
2.6.1. Vessel Shape	LINEAR	Vessel shape is linear (flat bottom)
2.6.3. Maximum Volume	17.6	Max volume is 17.6m ³ or 17,600 liters.
2.7.1.4. Pump Control Mode or 2.7.1.5. Pump Control Mode	ADA	Sets the control algorithm used to trip the pump relay to ALTERNATE DUTY ASSIST .
2.7.1.6. ON Setpoint Pump 1	1.0 m	Sets the level at which pump 1 turns on. The first cycle will use this setpoint. Subsequent cycles rotate the setpoint among the pumps.
2.7.1.8. ON Setpoint Pump 2	1.2 m	Sets the level at which pump 2 turns on.
2.7.1.7. OFF Setpoint Pump 1	0.2 m	Sets the level at which pump 1 turns off. The first cycle will use this setpoint. Subsequent cycles rotate the setpoint among the pumps.
2.7.1.9. OFF Setpoint Pump 2	0.3 m	Sets the level at which pump 2 turns off.
2.7.3.2. Totalizer Decimal Position	2 DIGITS	Sets the totalizer display to 2 digits.
2.7.3.3. Totalizer Multiplier	1000	Actual volume is divided by 1000, prior to display on LCD.
2.7.3.4. Inflow/Discharge Adjust	RATE ESTIMATE	The inflow rate measured just prior to the start of the pump cycle is used to estimate the inflow for the duration of the cycle.

1. Display vessel volume on the LCD (set parameter 2.1.2. *Sensor Mode* to **VOLUME**).
2. Toggle to SV on LCD to display current level (set parameter 2.1.4. *Sensor Mode Secondary* to **LEVEL**).
3. See 2.7.3.1. *Running Totalizer* to view pumped volume.

Setting a pump to run-on

This functionality is used to reduce sludge and sediment from building up at the bottom of a wet well, thereby reducing maintenance. This is achieved by running the pumps below the normal OFF setpoint and requires you to set a run-on duration and interval to control this event.

Example:

Pump 1 is set to pump for an extra 60 seconds every 5 hours, pump 2 should not run-on.

Parameter	Sample Value	Description
<i>2.72.3.2. Run-On Interval</i>	5	Five hours between pump run-on occurrences.
<i>2.72.3.3. Run-On Duration</i>	60	The pump will run-on for 60 seconds.
<i>Pump 1</i>		
<i>2.72.3.4. Run-On Duration</i>	0	Pump 2 will never run-on.
<i>Pump 2</i>		

Setting the pump start delays

In the event that power to the SITRANS LUT400 has been lost, the pump start delay ensures that all of the pumps do not start at once to avoid power surges. There are two parameters used here: Pump Start Delay and Power Resumption Delay.

Example:

The delay between pumps is set to 20 seconds and the delay of the first pump is set to 30 seconds.

Parameter	Sample Value	Description
<i>2.72.4.1. Delay Between Starts</i>	20	Wait at least 20 seconds between pump starts.
<i>2.72.4.2. Power Resumption Delay</i>	60	Wait for 60 seconds when power is restored for the first pump to activate.

Reducing wall cling

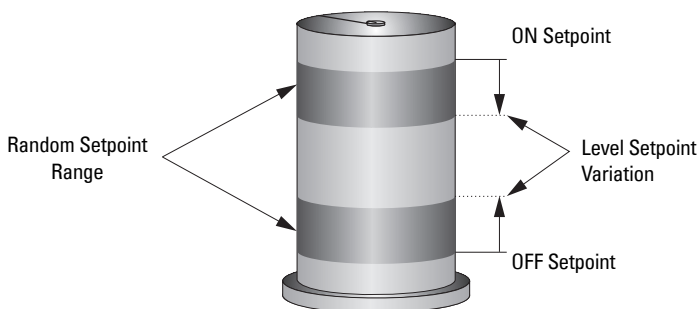
Use the Wall Cling Reduction function to randomly alter the ON and OFF setpoints over a range. This eliminates the ridge of material that builds up at the setpoint that can give false echoes.

This setting may increase the number of days between trips to clean the wet well.

Enable Wall Cling Reduction by setting *2.7.2.1.1. Enable* = **Enabled**. Then set the range in *2.7.2.1.2. Level Setpoint Variation*. The pump ON and OFF setpoints are randomly varied inside this range so the material level does not stop at the same point each time.

Example:

A range of 0.5 meters is used to vary the setpoint. The randomly-selected setpoints are always **inside** the ON and OFF setpoints.

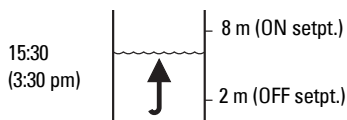


Saving energy

Pumps can use different setpoints at different times of the day to account for variable energy costs.

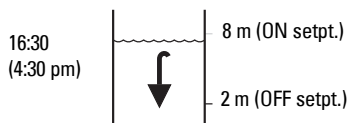
The following example illustrates high energy cost usage reduction and/or elimination by using the SITRANS LUT400 Energy Savings function on a wet well (pump down application) using pump 1.

Pre-requisite: enable Energy Savings function (set 2.7.2.2.1. *Enable* = **Enabled**)



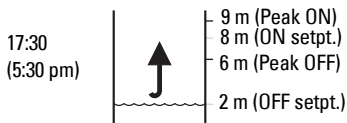
Normal Operation

Uses the standard ON and OFF setpoints (2.7.1.6. *ON Setpoint Pump 1* | 2.7.1.7. *OFF Setpoint Pump 1*). Energy cost is at minimum.



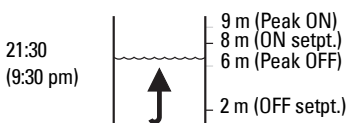
2.7.2.2.2. *Peak Lead Time* = 60 minutes.

Pumps down the wet well regardless of the pump ON Setpoints. This ensures that the wet well starts the high cost period at the 2.7.1.7. *OFF Setpoint Pump 1*. Energy cost is at minimum.



2.7.2.2.3. *Peak 1 Start Time* = 17:30.

Starts using the energy savings setpoints (2.7.2.2.13. *Peak ON Setpoint Pump 1* and 2.7.2.2.14. *Peak OFF Setpoint Pump 1*). Energy cost is at maximum.



2.7.2.2.4. *Peak 1 End Time* = 21:30.

Returns to normal setpoints (2.7.1.6. *ON Setpoint Pump 1* | 2.7.1.7. *OFF Setpoint Pump 1*). Energy cost returns to minimum.

Generally, you would cascade the timing of the pump downs so that the wells farthest from the treatment facility would begin first and the entire system would push material through during the low cost period.

Note: When the Peak ON Setpoint is not reached, no energy is used during the **high cost** period. If the Peak ON Setpoint is reached, the Wet Well is only pumped down to 6 m, thereby minimizing **high cost** energy usage.

Parameter	Value	Description
2.7.2.2.1. <i>Enable</i>	Enabled	Enables Energy Savings function
2.7.2.2.3. <i>Peak 1 Start Time</i>	17:30	Starts the first high cost period at 5:30 pm
2.7.2.2.4. <i>Peak 1 End Time</i>	21:30	Ends the first high cost period at 9:30 pm
2.7.2.2.2. <i>Peak Lead Time</i>	00:60	Sets the pump down to happen 60 minutes before the high cost period
2.7.2.2.13. <i>Peak ON Setpoint Pump 1</i>	9	Sets the high cost ON setpoint at process level of 9 m
2.7.2.2.14. <i>Peak OFF Setpoint Pump 1</i>	6	Sets the high cost OFF setpoint at process level of 6 m

Tracking pump usage

You can find out how much an individual pump has been used by viewing the pump record parameters.

Information Available	Parameter Access
Total running hours for a relay assigned to a pump.	3.2.7.1. <i>Run Time Relay 2</i> 3.2.7.2. <i>Run Time Relay 3</i>

Other controls

Relays controlled by time

A relay can be controlled by time setpoints using Time of Day or Elapsed Time.

Set Time of Day Relay

Parameter	Value	Description
2.11.2.1. <i>Enable</i>	Enabled	Enables Time of Day Relay
2.11.2.2. <i>Activation Time</i>	17:30	Activates the relay at 5:30 pm
2.11.2.3. <i>Relay Duration</i>	60	Activates the relay for 60 seconds
2.11.2.4. <i>Assigned Relay</i>	Relay 1	Sets relay 1 to be controlled by time of day
2.11.2.5. <i>Relay Logic</i>	Normally Closed	Use (if necessary) to change the behaviour of the relay assigned to the time of day control. Default: Normally Open

Set Elapsed Time Relay

Parameter	Value	Description
2.11.1.1. <i>Enable</i>	Enabled	Enables elapsed time relay
2.11.1.2. <i>Interval</i>	24	Activates the relay every 24 hours
2.11.1.3. <i>Relay Duration</i>	60	Activates the relay for 60 seconds
2.11.1.4. <i>Assigned Relay</i>	Relay 1	Sets relay 1 to be controlled by elapsed time
2.11.1.5. <i>Relay Logic</i>	Normally Closed	Use (if necessary) to change the behaviour of the relay assigned to the elapsed time control. Default: Normally Open

Flow

Flow calculation

The SITRANS LUT400 provides numerous open channel flow calculation features (see *2.15. Flow*).

The device can be configured to select the flow calculation specific to the primary measuring device (PMD), such as a flume or weir. If the PMD does not match any of the eleven preset PMD calculations, a universal flow calculation can be used (PMD = Universal Head Flow). See *Flow Calculation* on page 265 for more details.

The SITRANS LUT400 converts the head measurement into flow rate. The flow rate is totalized and stored in a comprehensive data log to facilitate detailed flow analysis.

Totalizing flow

Totalizing of the calculated flow is ongoing. Daily and running totalizers can be viewed in *2.16. Totalizers*. The daily totalizer resets automatically every 24 hours at 23:59:59, and both can be reset by the user.

In order to adjust the rate of filling of the totalizer, the *2.7.3.3. Totalizer Multiplier* can be set to an appropriate value. Totalizing that is specific to a time and date can be viewed under View Logs for flow (see *3.2.6.2. OCM* on page 202).

The SITRANS LUT400 can be programmed to operate a remote totalizer by assigning any of the relays to act as a totalizer contact. Under this function, the maximum rate of contact closure is 5/s with a closure duration of 100 ms.¹

External Totalizers and Flow Samplers

External totalizers are simple counters which count the number of relay clicks produced by the SITRANS LUT400. This is generally used to keep track of OCM or pumped volume totals. Note that both of these values are also stored in the SITRANS LUT400 and are available through communications.

Flow samplers are devices which take a sample of liquid when triggered by a relay click. These samples are used to monitor water quality over time. Flow samplers can be driven by OCM volume, pumped volume, or by time depending on the application requirements.

¹ Typically the totalizer should be set for 300 to 3000 counts per day at maximum flow.

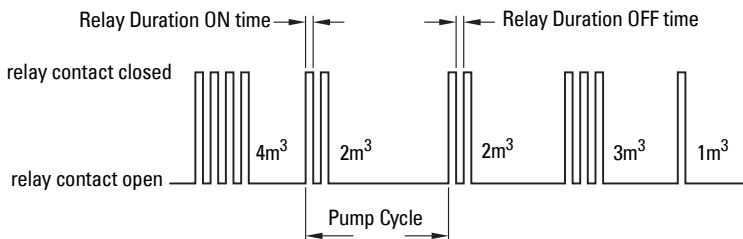
Relay contacts

Pumped volume is calculated at the end of the pump cycle. Totalized volume when *External Totalizer* function is enabled will be given in bursts at the end of the pump cycle, not throughout the pump cycle.

Use 2.11.3.3. *Relay Duration* to set the time in seconds from one change of state in the relay to the next. This parameter sets both the open and closed times for the relay contact and is preset to 0.2 seconds. Partial units are added to the next pump cycle.

Example:

Shows a relay set up to make one contact for every cubic metre (m³) of liquid.



The following parameters describe how to setup a Totalizer or Sampler.

General Operation

Totalizer

Use the *2.11.3. External Totalizer* function to set the totalizer to provide relay contact to an external counter.

Counter Formula

1 contact every x units, where $x = \text{value set in } 2.11.3.2. \textit{Multiplier}$ is preset to **1** so the default number of contacts is one contact per unit of volume.
 Example:
 To click once every 4310 units, set *2.11.3.2. Multiplier* to 4310.

The totalizer source, and units depend on the volume configuration:

Volume Configuration	Totalizer Source	Units Source
<i>2.6.1. Vessel Shape</i> = NONE	<i>2.16. Totalizers</i> (OCM flow totalizer)	<i>2.15.3.7. Flowrate Units</i>
<i>2.6.1. Vessel Shape</i> = any setting other than NONE	<i>2.7.3. Totalizers</i> (pumped volume totalizer)	<i>2.6.2. Volume Units</i>

Parameter	Sample Value	Description
<i>2.11.3.1. Enable</i>	Enabled	Enables External Totalizer Relay
<i>2.11.3.2. Multiplier</i>	4310	Click once every 4310 units
<i>2.11.3.3. Relay Duration</i>	0.2	Activates the relay for 0.2 seconds
<i>2.11.3.4. Assigned Relay</i>	Relay 1	Sets relay 1 to be controlled by external totalizer
<i>2.11.3.5. Relay Logic</i>	Normally Closed	Use (if necessary) to change the behaviour of the relay assigned to the totalizer. Default: Normally Open

General Operation

Flow Sampler

Use the *2.11.4. External Sampler* function to activate the flow sampler relay based on volume and time.

Counter Formula

<p>1 contact every x units, where x = value set in <i>2.11.4.2. Multiplier</i></p> <p>Example: To click once every 4310 units, set <i>2.11.4.2. Multiplier</i> to 4310.</p>	<p><i>2.11.4.2. Multiplier</i> is preset to 1 so the default number of contacts for a pumped volume cycle is one contact per unit of volume.</p>
---	---

The totalizer source, and units depend on the volume configuration:

Volume Configuration	Totalizer Source	Units Source
<i>2.6.1. Vessel Shape</i> = NONE	<i>2.16. Totalizers</i> (OCM flow totalizer)	<i>2.15.3.7. Flowrate Units</i>
<i>2.6.1. Vessel Shape</i> = any setting other than NONE	<i>2.7.3. Totalizers</i> (pumped volume totalizer)	<i>2.6.2. Volume Units</i>

By using *2.11.4.2. Multiplier*, the relay contacts can be based on a volume other than a multiple of ten.

Parameter	Sample Value	Description
<i>2.11.4.1. Enable</i>	Enabled	Enables Flow Sampler Relay
<i>2.11.4.2. Multiplier</i>	4310	Click once every 4310 units
<i>2.11.4.3. Interval</i>	2	Sets the INTERVAL (in hours) of the relay contact, usually long.
<i>2.11.4.4. Relay Duration</i>	0.2	Sets the DURATION (in seconds) of the relay contact, usually short.
<i>2.11.4.5. Assigned Relay</i>	Relay 1	Sets relay 1 to be controlled by flow sampler
<i>2.11.4.6. Relay Logic</i>	Normally Closed	Use (if necessary) to change the behaviour of the relay assigned to the sampler. Default: Normally Open

During the periods of low flow, the sampler may be idle for lengths of time. Program *2.11.4.3. Interval* time in hours to drive the sampler. The sampler will operate based on the volume of flow or the time interval, whichever comes first.

General Operation

Open Channel Monitoring (OCM)

An OCM installation is defined one of three ways, based on the Primary Measuring Device (PMD):

1. Dimensional

For some common weir and flume types. PMD dimensions (*2.15.4. PMD Dimensions*) are entered directly.

Vessel Type	See page:
<i>BS- 3680 Rectangular Flume</i>	105
<i>BS- 3680 Round Nose Horizontal Crest Weir</i>	106
<i>BS- 3680 Trapezoidal Flume</i>	107
<i>BS- 3680 U-Flume</i>	108
<i>BS- 3680 Finite Crest Weir</i>	109
<i>BS- 3680 Thin Plate Rectangular Weir</i>	110
<i>BS- 3680 Thin Plate V-Notch Weir</i>	111
<i>Rectangular Weir Contracted</i>	112
<i>Round Pipe</i>	113
<i>Palmer Bowlus Flume</i>	114
<i>H-Flume</i>	115

2. Exponential

For most other weir and flume types. PMD exponents provided by the manufacturer are entered. Flow is calculated using the exponent (*2.15.3.2. Flow Exponent*) and the maximum values (*2.15.3.3. Maximum Head* and *2.15.3.4. Maximum Flow at 20 mA*).

Vessel Type	See page:
<i>Standard Weirs</i>	116
<i>Parshall Flume</i>	101
<i>Leopold Lagco Flume</i>	102
<i>Cut Throat Flume</i>	103

3. Universal

For all other PMDs, the head-to-flow curve can be plotted based on known breakpoints, usually supplied by the PMD manufacturer.

Vessel Type	See page:
<i>Typical flow characterization</i>	116
<i>Example flumes</i>	117
<i>Example weirs</i>	118

Method of Flow Calculation

When using the SITRANS LUT400 in a flow application, the **Method of Flow Calculation (215.3.1)** must be selected. There are two possible methods for calculating flow with the SITRANS LUT400: absolute or ratiometric, and different information must be entered for the device to carry out the calculation. For more details, and an example, see *Method of Flow Calculation* on page 266.

Common parameters

These common parameters are required for all installations.

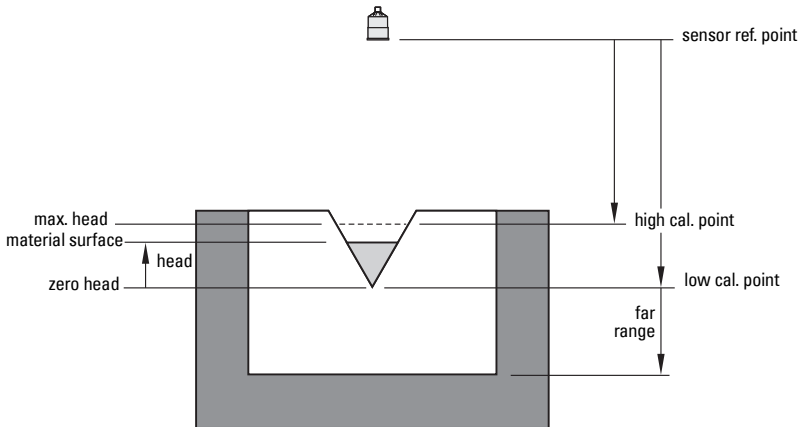
Parameter	Sample Value
	Flow
<i>Response Rate</i>	MEDIUM
<i>2.1.6. Transducer</i>	XRS-5
<i>2.1.1. Units</i>	M
<i>2.2.1. Low Calibration Point</i>	1.8
<i>2.2.2. High Calibration Point</i>	0.4
<i>2.2.5. Far Range</i>	0.8

Setting Zero Head

Many PMDs start flowing higher than the traditional empty distance of the application. You can account for the flow in one of two ways:

1. Use *2.15.3.5. Zero Head Offset* to have OCM calculations ignore levels below that value. Possible head = *2.2.1. Low Calibration Point* minus *2.2.2. High Calibration Point*.

Note: *2.15.3.3. Maximum Head* is preset to *2.2.1. Low Calibration Point* minus *2.2.2. High Calibration Point* and is not updated when *2.15.3.5. Zero Head Offset* is used. Make sure you set *2.15.3.3. Maximum Head* to the correct value when using *2.15.3.5. Zero Head Offset*. (Refer to PMD supplier documentation for Maximum Head.)



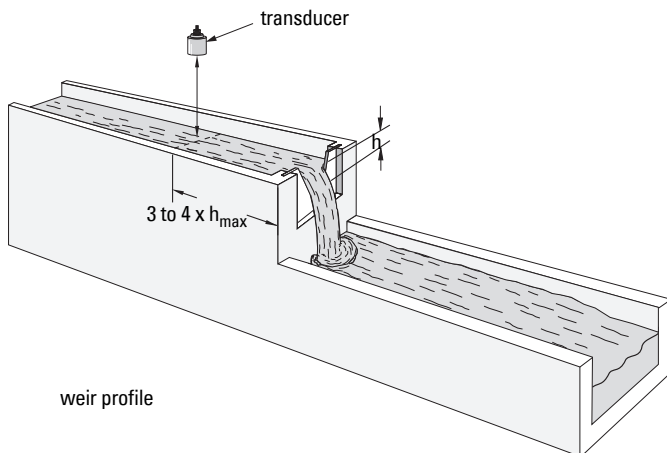
2. Use *2.2.5. Far Range* where the empty level is set to the bottom of the weir, and above the bottom of the channel. It should be used if the surface monitored can fall past the *2.2.1. Low Calibration Point* level in normal operation without reporting an LOE. The value is added to *2.2.1. Low Calibration Point* and can be greater than the range of the transducer.

The examples on the following pages show both methods.

PMDs with Exponential Flow to Head function

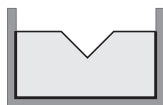
For Primary Measuring Devices (PMDs) that measure flow by an exponential equation, use these parameters. Ensure that you use the correct exponent for your PMD; the values below are samples only.

Standard Weirs



weir profile

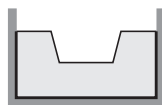
Applicable weir profiles



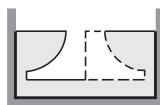
V-notch or
triangular



suppressed
rectangular



Cipolletti or
trapezoidal



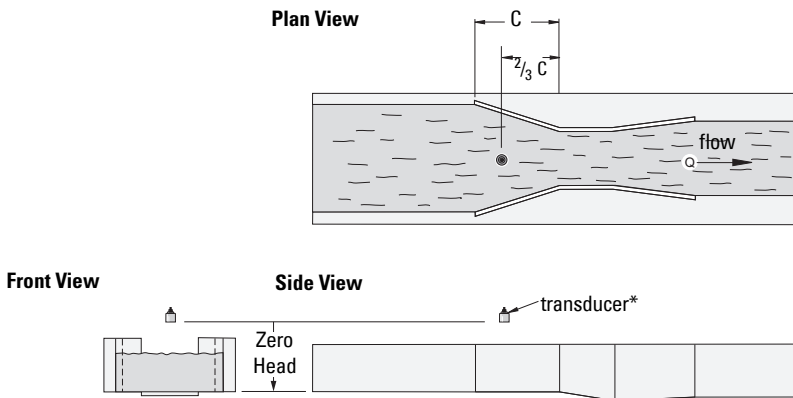
Sutro or
proportional

Parameter	Value										
2.15.1. Primary Measuring Device (PMD)	Exponential Devices										
2.15.3.2. Flow Exponent	<table border="1"> <thead> <tr> <th>Weir Type</th> <th>Value^a</th> </tr> </thead> <tbody> <tr> <td>V-notch</td> <td>2.50</td> </tr> <tr> <td>Suppressed rectangular</td> <td>1.50</td> </tr> <tr> <td>Cipolletti or trapezoidal</td> <td>1.50</td> </tr> <tr> <td>Sutro or proportional</td> <td>1.00</td> </tr> </tbody> </table>	Weir Type	Value ^a	V-notch	2.50	Suppressed rectangular	1.50	Cipolletti or trapezoidal	1.50	Sutro or proportional	1.00
Weir Type	Value ^a										
V-notch	2.50										
Suppressed rectangular	1.50										
Cipolletti or trapezoidal	1.50										
Sutro or proportional	1.00										
2.15.3.3. Maximum Head											
2.15.3.4. Maximum Flow at 20 mA											
2.15.3.7. Flowrate Units											
2.2.5. Far Range											
2.15.4.1. K Factor ^b											

- a. Values are samples only. Consult weir manufacturer’s documentation for correct flow exponent.
- b. Required for exponential device absolute calculation only.

Parshall Flume

Note: C = Converging Dimension.



* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. Near Range).

Application information

- Sized by throat width
- Set on solid foundation
- For rated flows under free flow conditions, the head is measured at $\frac{2}{3}$ the length of the converging section from the beginning of the throat section

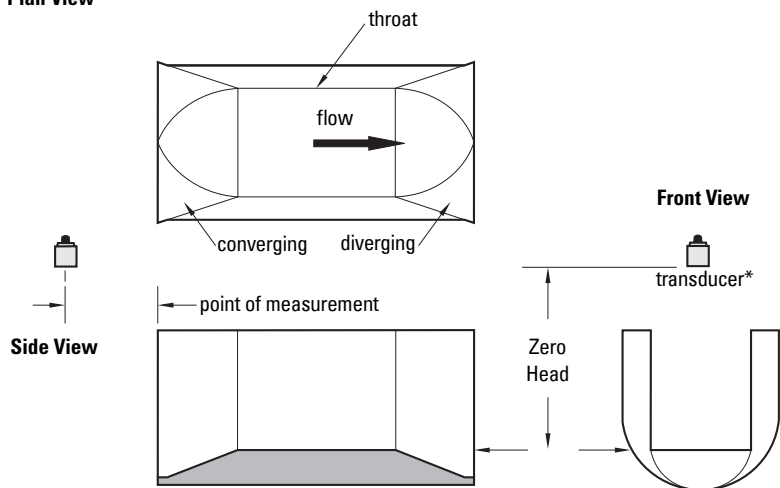
Parameter	Value
2.15.1. Primary Measuring Device (PMD)	Exponential Devices
2.15.3.2. Flow Exponent	1.522–1.607 ^a
2.15.3.3. Maximum Head	
2.15.3.4. Maximum Flow at 20 mA	
2.15.4.1. K Factor ^b	

- Typical Flow Exponent range for Parshall Flume; consult your flume documentation.
- Required for exponential device absolute calculation only.

General Operation

Leopold Lagco Flume

Plan View



* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. *Near Range*).

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	Exponential Devices
2.15.3.2. Flow Exponent	1.547 ^a
2.15.3.3. Maximum Head	
2.15.3.4. Maximum Flow at 20 mA	
2.15.3.5. Zero Head Offset	
2.15.3.7. Flowrate Units	
2.15.4.1. K Factor ^b	

- a. Typical Flow Exponent for Leopold Lagco Flume; consult your flume documentation.
- b. Required for exponential device absolute calculation only.

Application information

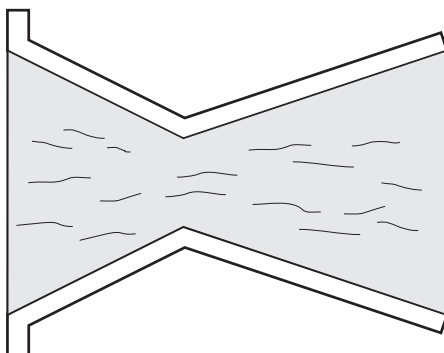
- Designed to be installed directly into pipelines and manholes
- Leopold Lagco may be classed as a rectangular Palmer-Bowlus flume
- Sized by pipe (sewer) diameter
- For rated flows under free flow conditions, the head is measured at a point upstream referenced to the beginning of the converging section. Refer to the following table:

Flume Size (pipe diameter in inches)	Point of Measurement	
	cm	inches
4-12	2.5	1
15	3.2	1.25
18	4.4	1.75
21	5.1	2

Flume Size (pipe diameter in inches)	Point of Measurement	
	cm	inches
24	6.4	2.5
30	7.6	3
42	8.9	3.5
48	10.2	4
54	11.4	4.5
60	12.7	5
66	14.0	5.5
72	15.2	6

Cut Throat Flume

Plan View



Application information

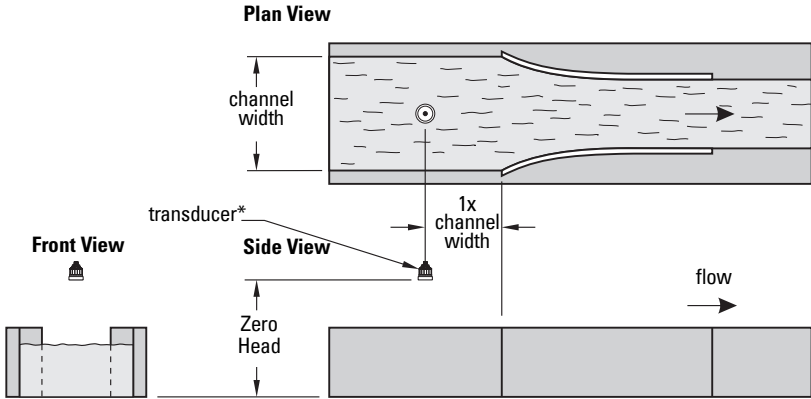
- Similar to Parshall flume except that the floor is flat bottomed and throat has no virtual length.
- Refer to manufacturer's specifications for flow equation and point of head measurement.

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	Exponential Devices
2.15.3.2. Flow Exponent	1.56 - 2.00 ^a
2.15.3.3. Maximum Head	
2.15.3.4. Maximum Flow at 20 mA	
2.15.3.7. Flowrate Units	
2.15.4.1. K Factor ^b	

- Typical Flow Exponent range for Cut Throat Flume; consult your flume documentation.
- Required for exponential device absolute calculation only.

General Operation

Khafagi Venturi



* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. *Near Range*).

Application information

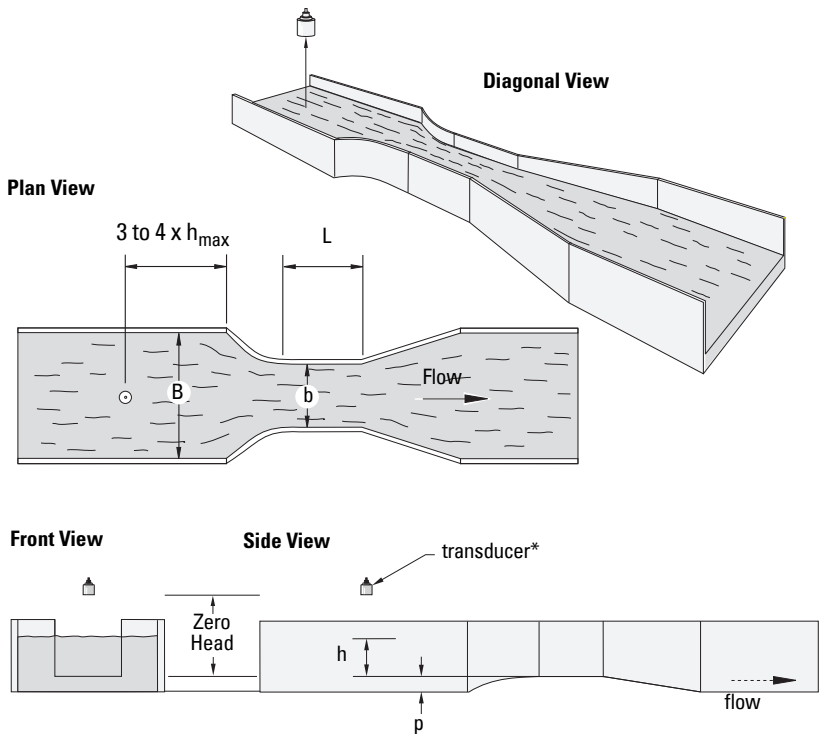
- Similar to Parshall flume except that the floor is flat bottomed and the sidewalls are curved.
- For rated flows under free flow conditions, the head is measured 1 x (channel width) upstream from the beginning of the converging section.

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	Exponential Devices
2.15.3.2. Flow Exponent	1.55 (Consult your flume documentation.)
2.15.3.3. Maximum Head	
2.15.3.4. Maximum Flow at 20 mA	
2.15.3.7. Flowrate Units	
2.15.4.1. K Factor ^a	

- a. Required for exponential device absolute calculation only.

Applications supported by SITRANS LUT400

BS- 3680 Rectangular Flume



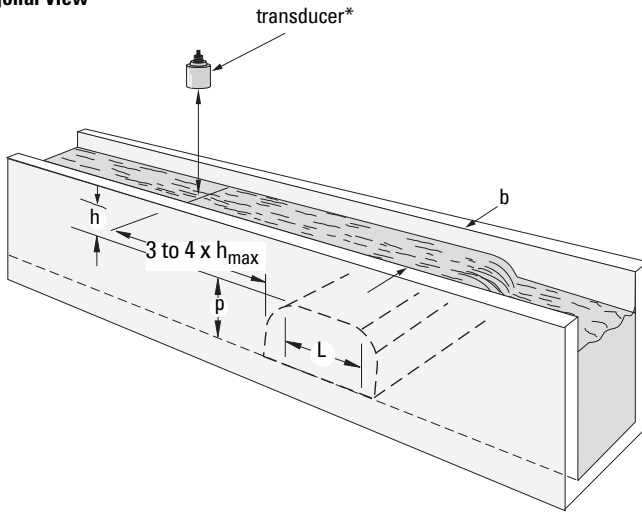
* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. Near Range).

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	BS-3680 Rectangular Flume
2.15.4. PMD Dimensions	Approach width (B)
	Throat width (b)
	Hump Height (p)
	Throat length (L)
2.15.3.5. Zero Head Offset	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	
2.15.3.4. Maximum Flow at 20 mA	

General Operation

BS- 3680 Round Nose Horizontal Crest Weir

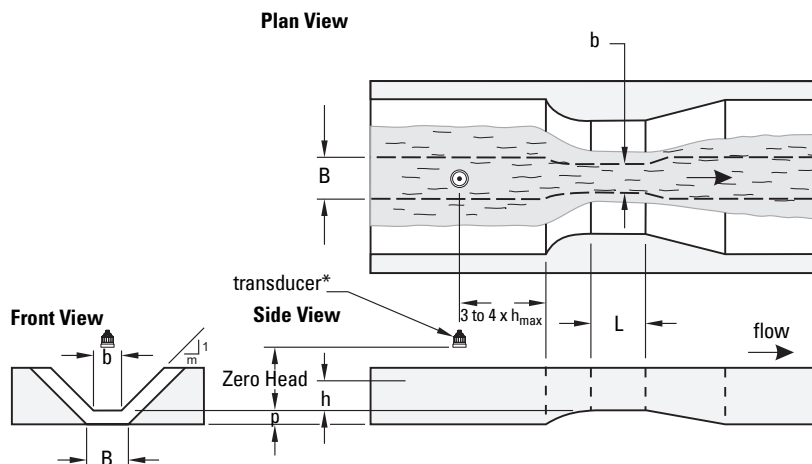
Diagonal View



* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. *Near Range*).

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	BS-3680 Round Nose Horizontal Crest Weir
2.15.4. PMD Dimensions	Crest Width b
	Crest Height p
	Crest Length L
2.15.3.3. Maximum Head	
2.2.5. Far Range	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	
2.15.3.4. Maximum Flow at 20 mA	

BS- 3680 Trapezoidal Flume



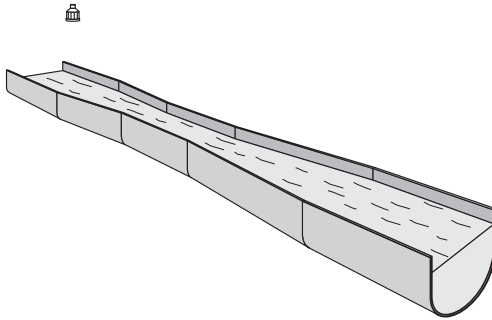
* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. Near Range).

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	BS-3680 Trapezoidal Flume
2.15.4. PMD Dimensions	Slope m
	Approach Width B
	Throat Width b
	Hump Height p
	Throat length L
2.15.3.3. Maximum Head	
2.2.5. Far Range	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	
2.15.3.4. Maximum Flow at 20 mA	

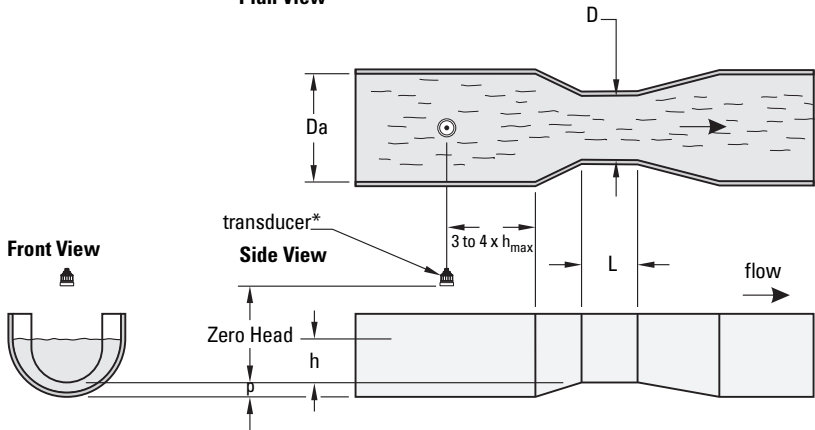
General Operation

BS- 3680 U-Flume

Diagonal View



Plan View

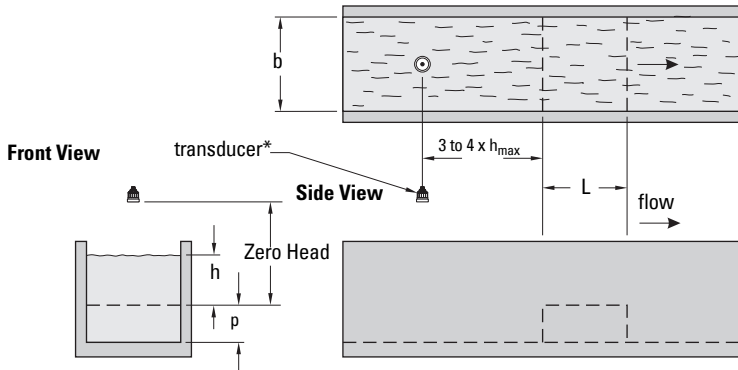
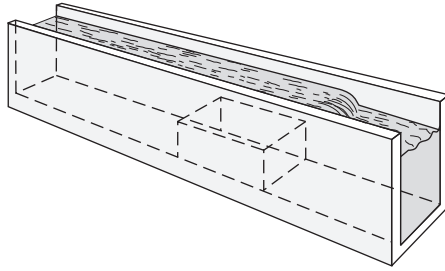


* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. *Near Range*).

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	BS-3680 U-Flume
2.15.4. PMD Dimensions	Approach Diameter D_a
	Throat Diameter D
	Hump Height p
	Throat Length L
2.15.3.3. Maximum Head	
2.2.5. Far Range	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	
2.15.3.4. Maximum Flow at 20 mA	

BS- 3680 Finite Crest Weir

Diagonal View



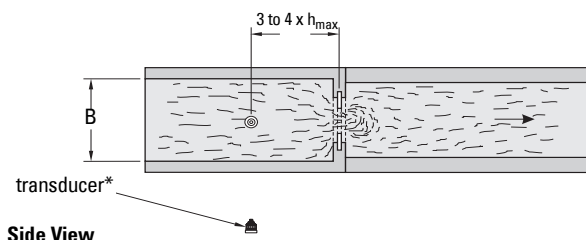
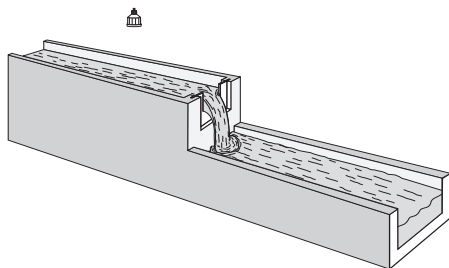
* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. Near Range).

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	BS-3680 Finite Crest Weir
2.15.4. PMD Dimensions	Crest Width b
	Crest Height p
	Crest Length L
2.15.3.3. Maximum Head	
2.2.5. Far Range	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	
2.15.3.4. Maximum Flow at 20 mA	

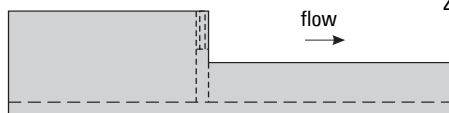
General Operation

BS- 3680 Thin Plate Rectangular Weir

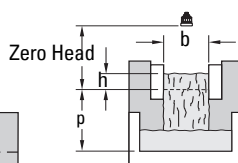
Diagonal View



Side View



Front View



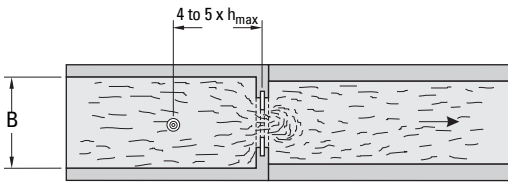
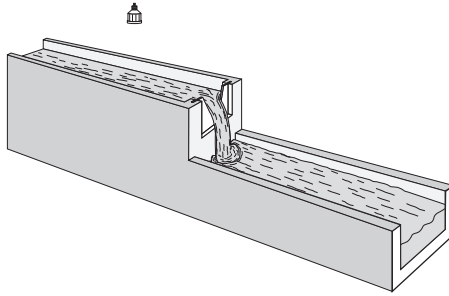
* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. *Near Range*).

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	BS-3680 Thin Plate Rectangular Weir
2.15.4. PMD Dimensions	Approach Width B
	Crest Width b
	Crest Height p
2.15.3.3. Maximum Head	
2.2.5. Far Range	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	
2.15.3.4. Maximum Flow at 20 mA	

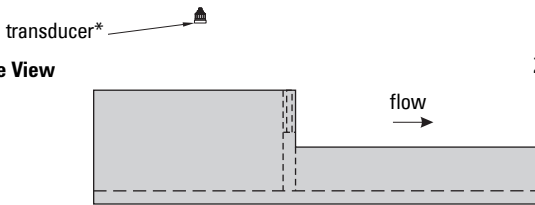
General Operation

BS- 3680 Thin Plate V-Notch Weir

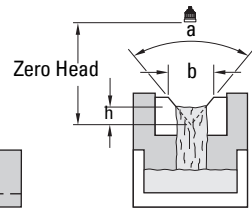
Diagonal View



Side View



Front View



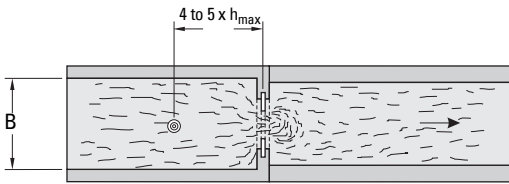
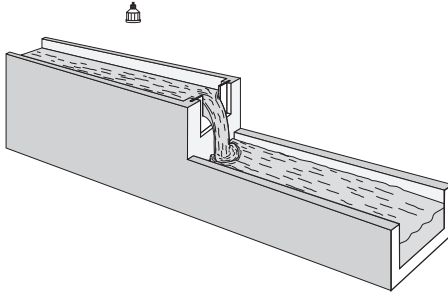
* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. Near Range).

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	BS-3680 Thin Plate V-Notch Weir
2.15.4. PMD Dimensions	Notch angle (a)
2.15.3.3. Maximum Head	
2.2.5. Far Range	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	
2.15.3.4. Maximum Flow at 20 mA	

General Operation

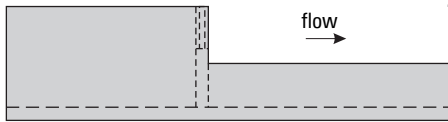
Rectangular Weir Contracted

Diagonal View

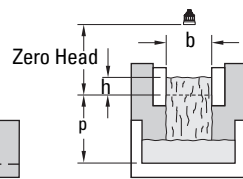


transducer*

Side View



Front View

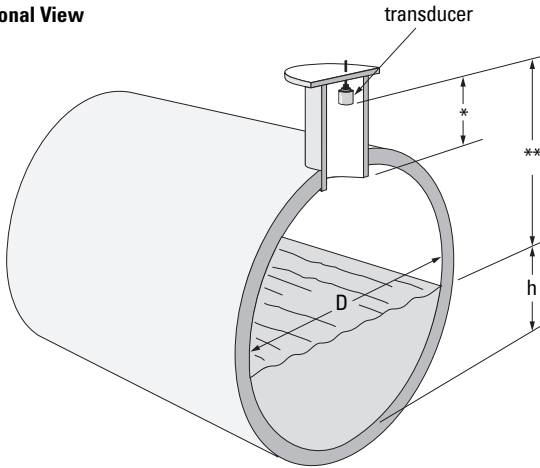


* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. *Near Range*).

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	Rectangular Weir Contracted
2.15.4. PMD Dimensions	Crest Width b
2.15.3.3. Maximum Head	
2.2.5. Far Range	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	
2.15.3.4. Maximum Flow at 20 mA	

Round Pipe

Diagonal View



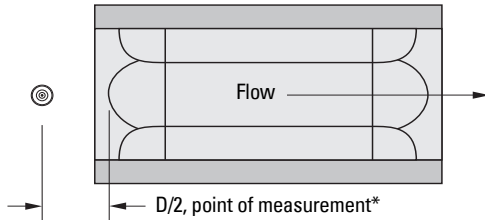
* This dimension should be at least 15 cm (6") shorter than the blanking value (see 2.2.4. *Near Range*).

** The transducer must be above the maximum head by at least the blanking value.

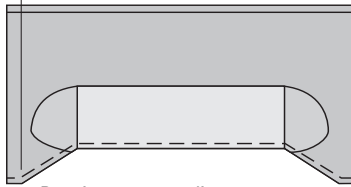
Parameter	Value
2.15.1. Primary Measuring Device (PMD)	Round Pipe
2.15.4. PMD Dimensions	Pipe Inside Diameter D
	Slope (fall/run) s
	Roughness Coefficient n
2.15.3.3. Maximum Head	
2.2.5. Far Range	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	
2.15.3.4. Maximum Flow at 20 mA	

Palmer Bowlus Flume

Plan View

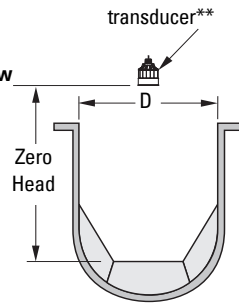


Side View



D = pipe or sewer diameter

Front View



* for rated flows under free flow conditions

** The transducer must be above the maximum head by at least the blanking value (see 2.2.4. Near Range).

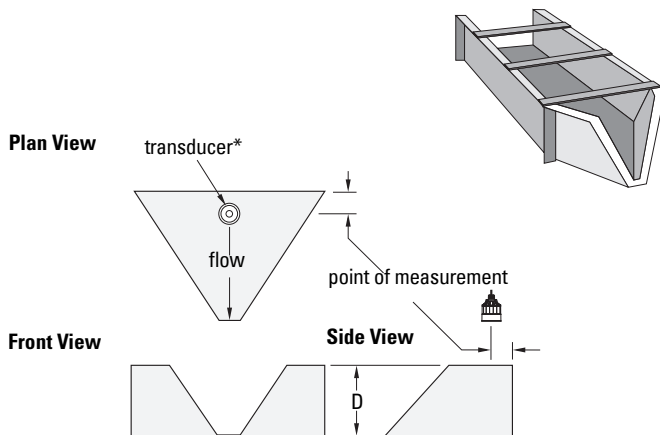
Parameter	Value
2.15.1. Primary Measuring Device (PMD)	Palmer Bowlus Flume
2.15.4. PMD Dimensions	Maximum Flume width h_{max}
2.15.3.3. Maximum Head	
2.15.3.4. Maximum Flow at 20 mA	
2.15.3.5. Zero Head Offset	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	Ratiometric

Note: Palmer Bowlus Flume can only be setup using ratiometric calculations

Application information

- Sized by pipe diameter D
- Flume relief is trapezoidal
- Designed to install directly into pipelines and manholes
- Head is referenced to bottom of the throat, not bottom of the pipe
- For rated flows under free flow conditions, the head is measured at a distance of D/2 upstream from the beginning of the converging section

H-Flume



* The transducer must be above the maximum head by at least the blanking value (see 2.2.4. Near Range).

Parameter	Value
2.15.1. Primary Measuring Device (PMD)	H-Flume
2.15.4. PMD Dimensions	Flume height (D)
2.15.3.3. Maximum Head	
2.15.3.4. Maximum Flow at 20 mA	
2.15.3.7. Flowrate Units	
2.15.3.1. Method of Flow Calculation	Ratiometric

Note: H-Flume can only be setup using ratiometric calculations

- Sized by maximum depth of flume
- Approach is preferably rectangular, matching width and depth for distance 3 to 5 times the depth of the flume
- May be installed in channels under partial submergence (ratio of downstream level to head). Typical errors are:
 - 1% @ 30% submergence
 - 3% @ 50% submergence
- For rated flows under free flow conditions, the head is measured at a point downstream from the flume entrance. Refer to the following table.

Flume Size (Diameter in feet)	Point of Measurement	
	cm	inches
0.5	5	1.75
0.75	7	2.75
1.0	9	3.75
1.5	14	5.5

continued on next page

General Operation

Flume Size (Diameter in feet)	Point of Measurement	
	cm	inches
2.0	18	7.25
2.5	23	9
3.0	28	10.75
4.5	41	16.25

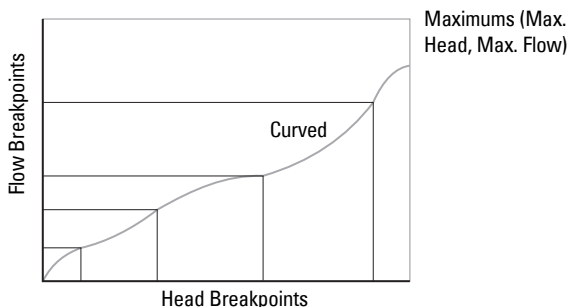
- H-flumes come with a flat or sloping floor. The same flow table can be used because error is less than 1%.

Universal calculation support

When the primary measuring device (PMD) doesn't fit one of the standard types, it can be programmed using a universal characterization. When Universal is selected as the PMD type [2.15.1. *Primary Measuring Device (PMD)*], then both head and flow breakpoints (2.15.5. *Universal Head vs. Flow*) must be entered to define the flow.

SITRANS LUT400 supports Universal curved (cubic spline) flow calculation shown in the following chart. (The 2.15.3.1. *Method of Flow Calculation* for universal support can be Ratiometric or Absolute. Refer to your PMD manufacturer's documentation.)

Typical flow characterization

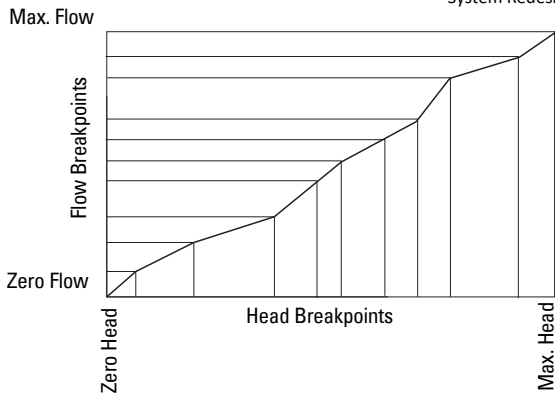


Characterization is achieved by entering the head and corresponding flow breakpoints, either from empirical measurement or from the manufacturer's specification. Increasing the number of defined breakpoints will increase the accuracy of the flow measurement.

Breakpoints should be concentrated in areas exhibiting the higher degrees of non linear flow. A maximum of 32 breakpoints can be defined, with a minimum of four required. The curve's end point is always specified by the parameters 2.15.3.3. *Maximum Head* and 2.15.3.4. *Maximum Flow at 20 mA*. These two parameter values are in addition to the 32 breakpoints available for definition.

Use as many breakpoints as required by the complexity of your PMD.

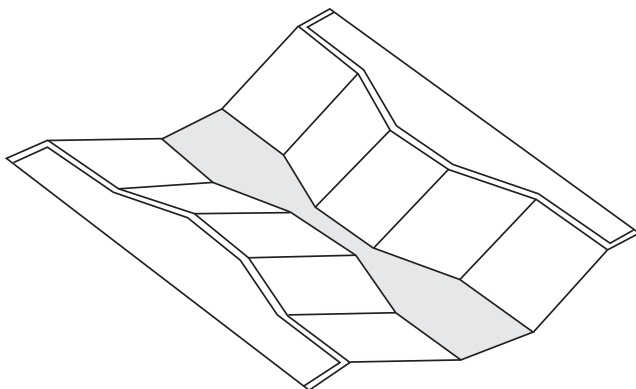
See *Volume* on page 73 for more information and parameter 2.15.5. *Universal Head vs. Flow* for characterization.



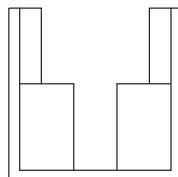
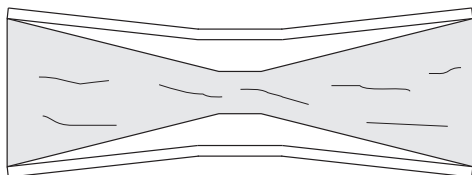
Example flumes

These example flumes would both require a universal calculation.

Trapezoidal

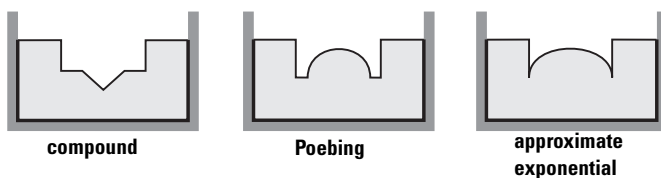


Dual Range (nested) Parshall



Example weirs

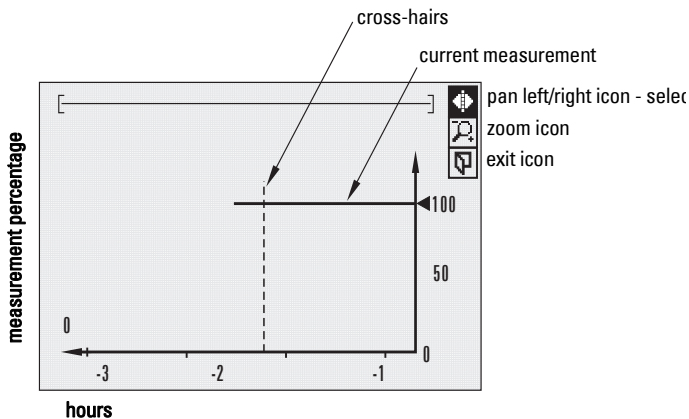
These weirs could require universal calculation.



Trends

To view trend lines, navigate to **3. Maintenance and Diagnostics > 3.2. Diagnostics > 3.2.2. Trend**. The PV (in percentage) is logged at five minute intervals and trend displays up to 3000 data points since last power up.

- Press **RIGHT arrow** ► to request a trend.



- Use **UP** ▲ or **DOWN arrow** ▼ to scroll to an icon. When an icon is highlighted, that feature becomes active.
- To move the cross-hair, press **RIGHT arrow** ► to increase the value, **LEFT arrow** ◀ to decrease.
- To Zoom into an area, position the cross-hairs at the center of that area, select **Zoom** icon, and press **RIGHT arrow** ►. Press **LEFT arrow** ◀ to Zoom out.
- To return to the previous menu, select **Exit** icon then press **RIGHT arrow** ►.

Notes:

- When a fail-safe condition has occurred, it will appear as a gap in the Trend line.
- Trend view will *not* timeout. This view will display on LUI until the exit icon is selected.

Data logging

The SITRANS LUT400 provides an extensive logging feature which can be viewed on the local display or retrieved via USB port.

Enable data logging for a Process Value, an Alarm, or for Flow (see *2.10. Data Logging* on page 173).

For flow, the logging rate can be fixed or variable. The latter being useful in conserving logging space. The condition for variable logging is determined when selecting the logging rate.

Variable logging rate conditions are categorized as: percent change of flow per minute, percent change of maximum flow or percent change of maximum head. Logging occurs at the normal (slower) rate while the condition is less than the setpoint (*2.10.3.6. Rapid Flow Log Setpoint*). If the condition exceeds the rapid flow log setpoint, the rapid rate of logging takes effect until the condition falls below the standard flow log setpoint (*2.10.3.4. Standard Flow Log Setpoint*).

The setpoints represent the absolute value of the rate of change; that is, for either increasing or decreasing flowrate. The SITRANS LUT400 does not recognize negative entries for standard or rapid flow log setpoints.

Flow data is logged in flowrate units (with full resolution of flow measurement value) from 0 to 110% of maximum flow. Flows above 110% are logged at the 110% value (in flowrate units). Truncation of flows to 110% does not apply to daily totalization.

Viewing the Data Log

To view the data log, navigate to **3. Maintenance and Diagnostics > 3.2. Diagnostics > 3.2.6. View Logs** and select the desired log; Alarms, OCM, PV, or Daily Totals.

The log can be examined locally via LUI, or via USB. On LUI, viewing of the log is done by task and by method. The viewing tasks are: Alarms, OCM, Daily Totals, or Primary Variable (PV). The viewing methods are: by first entry, by last entry and by specified date. The scrolling keys are used to maneuver through the tasks, methods and time of day.

Log Capacity vs. Rates

Note: No data logs are written while the device is connected to a PC via USB.

Rate	Capacity
1 min.	7 days
5	1 month
15	3.5 months
30	7 months
60	1.2 years
24 hr	27.8 years

e.g. rate = 15 / 5, capacity = 3.5 months max / 1 month min

Log files copied to a local computer drive via USB, are comma-delimited files. For a list of field names, see *Data Logging* on page 267.

Fault code 129 is displayed on the device when the data log memory becomes full. To clear entries when memory is full:

1. Disable all logging functions that are active (PV log: *2.10.1.1*, Alarm log: *2.10.2.1*, Flow log: *2.10.3.1* or *2.10.3.2*)
2. Browse to the USB drive on your computer and delete log files (or *move* files from the USB drive to another local computer drive). (If a file is deleted or moved without first disabling the associated logging function, the fault code will not clear.)
3. Re-enable logging functions that were disabled in step 1.

Simulation

The SITRANS LUT400 supports simulation from the LUI. Level and discrete inputs can be simulated, separately or concurrently.

Level simulation

In level simulation, the LCD reacts to the simulated level changes, and activates relays based on the setpoints programmed. The material level can be set to continuously sweep through the measurement range, from Low Calibration Point to High Calibration Point and back again (using *3.4.1.3. Ramp*, *3.4.1.4. Ramp Rate*), or the material level can be held at a specific value (using *3.4.1.2. Level Value*).

Discrete Input simulation

When discrete inputs are simulated, the DI icon on the LCD will show the simulated states of the discrete inputs. Any programming that uses the discrete inputs, such as the backup level override, will use the simulated values.

In simulation mode, some of the LUT400's configured functionality will respond to the simulated value, including:

- **Readings that are based on Level** - The LUT400 supports simulation of Level values only. Other simulated values cannot be entered, however, these values will be calculated correctly when Level is simulated. Space, Distance, Volume, Flow, and Head will be calculated [see Sensor Mode (2.1.2.) on page 138].
- **The milliamp output** - The current loop output will also track the corresponding reading (Level, Space, Distance, Volume, Flow, or Head depending on which of these it is configured to track). [See Current Output Function (2.5.1.) on page 144.]
- **Alarms** - Any alarms that have been configured, including any relays configured for alarms, will activate based on the simulated value. [See Alarms (2.8.) on page 162.]
- **Relays configured for pumps** - If the device is configured for a pump application then the corresponding relay indicators on the LCD will also show when the pumps would activate. By default the relay contacts themselves will not activate in simulation mode, but this behaviour can be changed if desired (see *Pump relay behaviour during simulation* on page 121).
- **Logging** - Log files will reflect the simulated values. This includes logging simulated high-flow/low-flow conditions, and any alarms.

The following functions will not respond to the simulated value when in simulation mode:

- **Fault Conditions** - The LUT400 will never enter the Fail-safe state when in simulation mode. For further details see *Fail-safe and Simulation* on page 122.
- **Backup Level Override** - If a Backup Level Override switch is configured and it lies within the simulated Level range, it will not be simulated. To simulate a Backup Level Override, simulate the discrete input. See *Simulating Discrete Inputs* on page 123.
- **Totalizing of OCM Flow** - Totalizing of flow (OCM applications) does not occur during simulation. The OCM Daily Totalizer (2.16.1) and Running Totalizer (2.16.2) will not increase in value during simulation.
- **Totalizing of Pumped Volume** - Totalizing of pumped volume does not occur during simulation if 3.4.3. *Pump Activations* is set to **Disabled**. If pumps are set to run during simulation, the material pumped will be totalized (2.7.31. *Running Totalizer*).
- **External Sampler** - The external sampler, if configured, will click at its timeout interval when in simulation mode (see 2.11.4.3. *Interval*).

Pump relay behaviour during simulation

The 3.4.3. *Pump Activations* parameter allows you to choose how the physical relays that are assigned to pumps will behave when in simulation mode.

This parameter has two possible values:

Disabled: Pump relays are not activated in simulation (default value)

Enabled: Pump relays are activated in simulation

If 3.4.3. *Pump Activations* is **Disabled**, only the LCD indicators are affected (the corresponding relay icons will turn ON, but the relays will not energize). If 3.4.3. *Pump Activations* is **Enabled**, the relay icons will turn ON, and the relays will energize.

! **WARNING:** Select **Enabled** only when there is no possibility of the pumps being damaged during simulation, or if the pumps have been locally disabled through some other means.

Notes:

- If the pump relays are configured to physically activate in simulation mode, then any time activated will be recorded in the pump Run Time parameter (see *Pump Records* on page 202.).
- If a pump start delay has been programmed for the device (2.7.2.4.1. *Delay Between Starts*), it will be respected in Simulation mode.

Fail-safe and Simulation

When simulating Level or Discrete Inputs, the LUT400 will never enter the Fail-safe state. Faults that would normally cause a fail-safe condition (such as a broken cable or LOE) may still occur, but a fail-safe condition will not be reported on the device during simulation.

Note: As fail-safe will not be reported during simulation, a bench simulation of the LUT400 can be run without a transducer connected.

HART status

When using HART communications via software tools such as PDM, AMS, FDT, and FC375/475, the Level value and the readings derived from level will display simulated values (when level or discrete input simulation is enabled on LUI). (See *Process Variables* within PDM, AMS, FDT, and FC375/475.) Device status conditions within each tool will also indicate that the device is in simulation mode (see *Diagnostics*).

Simulation process

Simulation is an iterative process whereby parameters are adjusted and corresponding results are viewed in Measurement Mode. Level and Discrete Inputs can be simulated separately, or concurrently. When either simulation is enabled, the LCD displays *Simulation Enabled* in the text area for status messages (see *Measurement mode display: Normal operation* on page 34).

Note: *Simulation Enabled* status will display on LCD even if other faults are present.

To stop simulation at any time, set the parameter for the function being simulated (3.4.1.1. *Level Simulation Enable*, 3.4.2.1. *Discrete Input 1*, 3.4.2.2. *Discrete Input 2*) to **Disabled**.

In general, to run a simulation:

1. Select the function to be simulated: Level or Discrete Input (can be simulated concurrently).
2. Set simulation parameters if performing a Level simulation.
3. Decide if pumps will be active during simulation (see *Pump relay behaviour during simulation* on page 121).
4. Start simulation.

Simulating a fixed level

1. Set the desired fixed level value in 3.4.1.2. *Level Value*.
2. Set 3.4.1.3. *Ramp* to **Disabled**.
3. **Enable** 3.4.3. *Pump Activations* if desired (see *Pump relay behaviour during simulation* on page 121).
4. Set 3.4.1.1. *Level Simulation Enable* to **Enabled** to start level simulation.

Set 3.4.1.1. *Level Simulation Enable* to **Disabled** when you wish to stop level simulation.

Simulating a changing level

1. Set the desired starting level value in *3.4.1.2. Level Value*.
2. Set *3.4.1.3. Ramp* to **Enabled**.
3. Set *3.4.1.4. Ramp Rate* to the desired speed, e.g. **Medium**.
4. **Enable 3.4.3. Pump Activations** if desired (see *Pump relay behaviour during simulation* on page 121).
5. Set *3.4.1.1. Level Simulation Enable* to **Enabled** to start level simulation.

The simulated level will initially begin ramping up from *Level Value* (increasing level). When the level rises to 100% or falls to 0%, it reverses direction at the same rate.

Set *3.4.1.1. Level Simulation Enable* to **Disabled** when you wish to stop level simulation.

Simulating Discrete Inputs

1. Enable *3.4.3. Pump Activations* if desired (see *Pump relay behaviour during simulation* on page 121).
2. Set the discrete input to be simulated (*3.4.2.1. Discrete Input 1*, *3.4.2.2. Discrete Input 2* or both) to one of the following:
 - **ON**: the discrete input is simulated to be on
 - **OFF**: the discrete input is simulated to be off.

Set parameter(s) for DI to be simulated (*3.4.2.1. Discrete Input 1* and/or *3.4.2.2. Discrete Input 2*) to **Disabled** if you do not wish to simulate a discrete input, or to stop DI simulation that is currently running.

Simulation timeout

Simulation will automatically be disabled and the LUT400 will return to normal measurement and control ten minutes after changing (editing) any simulation parameter (except *Level Value*). When the timeout occurs, parameters used to enable simulation (*Level Simulation Enable*, *Discrete Input 1*, *Discrete Input 2*), as well as *Pump Activations* will switch to **Disabled**, and the message **Simulation Enabled** will no longer display on the LCD. (Device status conditions will also reset in PDM, AMS, FDT, and FC375/475.)

Application test

You can test the application by varying the actual material level (the preferred test method), or by simulating level changes.

If you are testing the application via simulation mode, decide if control devices, such as pumps, are to be operational during simulation by setting the *Pump Activations* parameter (see *Pump relay behaviour during simulation* on page 121).



WARNING: Only enable *Pump Activations* when there is no possibility of the pumps being damaged during simulation, or if the pumps have been locally disabled through some other means.

While the level is being cycled, check the results of the discrete inputs either by closing the circuit externally (preferred), or by setting DI simulation parameter to force the input **ON** or **OFF**. Try all possible combinations to thoroughly test the setup. When simulating a

changing level, run a complete cycle (from Low Calibration Point to High Calibration Point and back again) to verify that the relays operate as expected.

Monitor system performance carefully, under all anticipated operating conditions.

1. When the LUT400 performs exactly as required, programming is complete.
2. If alternate reading units, fail-safe action, or relay operation is desired, update the parameters for the new functionality.
3. If you experience problems with system performance, see *Diagnosing and Troubleshooting* on page 229.

If you cannot observe all possible operating conditions by varying the material level, use *Simulation process* on page 122 to verify programming.

Retest the system each time you adjust any control parameters.

SITRANS LUT400 Communication Systems

The SITRANS LUT400 is an integrated level controller capable of communicating process information to a Supervisory Control and Data Acquisition (SCADA) system, via a HART modem.



Connection via HART modem.

LUT400 Communications (HART)

Highway Addressable Remote Transducer, HART, is an industrial protocol that is superimposed on the 4-20 mA signal. It is an open standard, and full details about HART can be obtained from the HART Communication Foundation at www.hartcomm.org

SITRANS LUT400 can be configured over the HART network using the HART Communicator 375/475 by Emerson (see *Operation via Field Communicator 375/475 (FC375/FC475) (HART)* on page 21), or a software package. The recommended software package is the SIMATIC Process Device Manager (PDM) by Siemens.

HART Version

SITRANS LUT400 conforms to HART rev. 7.2.

Burst mode

SITRANS LUT400 does not support burst mode.

HART multi-drop mode

HART Multi-drop Mode allows the connection of multiple field devices via HART. To setup a device in Multi-drop Mode, see *Device Address* on page 126. Details on the use of Multi-drop Mode are outlined in an application guide *Working with HART*, which can be downloaded from the product page of our website. Go to:

www.siemens.com/sitransLUT400 under **Support** and click on **Application Guides**.

SIMATIC PDM

This software package is designed to permit easy configuration, monitoring, and troubleshooting of HART devices. The HART EDD for SITRANS LUT400 was written with SIMATIC PDM in mind and has been extensively tested with this software.

For more information, see *Operation via SIMATIC PDM 6 (HART)* on page 15.

HART Electronic Device Description (EDD)

In order to configure a HART device, the configuration software requires the HART Electronic Device Description for the instrument in question.

You can download the HART EDD for SITRANS LUT400 from the product page of our website. Go to: www.siemens.com/sitransLUT400 and click on **Support** > **Software Downloads**.

Older versions of the library will have to be updated in order to use all the features of SITRANS LUT400.

HART Status

Information on HART Status is outlined in an application guide *Working with HART*, which can be downloaded from the product page of our website. Go to: www.siemens.com/sitransLUT400 under **Support** and click on **Application Guides**.

LUT400 Communication connections

The SITRANS LUT400 can be connected to a computer system via a HART modem (connected to the mA OUT/HART terminal block), or directly connected via a Universal Serial Bus (USB) cable (for use with the Web Browser interface). A HART network requires a device address be configured. For communications via USB, connect SITRANS LUT400 to your computer via the USB cable.

Configuring communication ports

HART modem

Note: It is recommended that only HCF registered modems be used.

Device Address

The unique identifier of the SITRANS LUT400 on a HART network.

Values	Range: 0 to 63 (Set within range of 0 to 15 if HART 5 master used.)
	Default: 0

Set the device address or poll ID on a HART network.

Prior to HART 6, the device address was set to 0 for point to point operation. For HART Multi-drop mode, the device was set to any value other than 0 within the range. (Setting a non-zero address forced the device into fixed current mode.)

With HART 6 and above (version 7.2 supported by LUT400), Multi-drop mode no longer depends on the device address. (However, it is recommended that a non-zero address be set to avoid confusion based on previous HART requirements).

To set the LUT400 in Multi-drop mode, **disable** *Loop current mode* via one of the HART communication software tools (such as SIMATIC PDM). When *Loop current mode* is disabled, a low fixed current is used, allowing for multiple devices to be connected.

Note: Loop current mode can not be disabled via LUI or Web Browser.

See *4.1. Device Address* on page 216.

USB cable

See *Communications* on page 24 for typical setup via USB, then follow instructions under *Installing the USB driver* in the LUT400 Communications manual¹.

Communication troubleshooting

See *Communication Troubleshooting* on page 229 of *Diagnosing and Troubleshooting*.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01).

Remote operation

SITRANS LUT400 supports several software tools for operation via remote communications:

- PC running SIMATIC PDM
- PC running Emerson AMS Device Manager
- PC running a web browser
- PC running a Field Device Tool (FDT)
- Field Communicator 375/475 (FC375/FC475).

This section of the manual covers basic information required to use these tools with your SITRANS LUT400. Further details for each are available in the Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01). (See DVD shipped with device or download manual from product page of our website: Go to www.siemens.com/sitransLUT400 > **Technical Info > Manuals/Operating instructions.**)

Note: Italian, Portuguese and Russian are not supported in the software tools for remote operation. If the device is set to one of these languages, it may be necessary to switch the device to English, German, French, Spanish or Chinese.

Operation via SIMATIC PDM 6 (HART)

(SITRANS LUT400 compatible with PDM version 6.1)

Features and Functions

SIMATIC PDM is a software package used to commission and maintain SITRANS LUT400 and other process devices. PDM monitors the process values, alarms and status signals of the device. It allows you to display, compare, adjust, verify, and simulate process device data; also to set schedules for calibration and maintenance. Please consult the LUT400 online help for details on using SIMATIC PDM. (You can find more information at: www.siemens.com/simatic-pdm.)

SIMATIC PDM features four Quick Start Wizards (Level, Volume, Volume-Linearization, and Flow) to easily configure the SITRANS LUT400. A Pump Control Wizard is also available. Other features include Echo Profile Utilities, Manual TVT Shaper adjustment, Auto False Echo Suppression screening, Process Variables monitoring, and Maintenance scheduling.

Parameters are identified by name and organized into function groups. The menu structure for SIMATIC PDM is almost identical to that of the LCD. See *LCD Menu Structure* on page 125 for a chart. For a complete list of parameters, see *Parameter reference (LUI)* on page 137.

Startup and Configuration

To startup the SITRANS LUT400 using SIMATIC PDM, check that you have the latest version of PDM installed (update your installation if necessary - see *SIMATIC PDM version* below), then install the EDD. Next, configure the device using the Quick Start Wizards in PDM.

For more information on SIMATIC PDM functions, and details on how to configure the device using PDM, refer to the LUT400 Communications manual¹.

SIMATIC PDM version

Check the support page of our website to make sure you have the latest version of SIMATIC PDM, the most recent Service Pack (SP) and the most recent hot fix (HF). Go to:

<http://support.automation.siemens.com/WWW/>

[llisapi.dll?func=cslib.csinfo&lang=en&objID=10806857&subtype=133100](http://lisapi.dll?func=cslib.csinfo&lang=en&objID=10806857&subtype=133100)

Electronic Device Description (EDD)

You can locate the EDD in Device Catalog, under **Sensors/Level/Echo/Siemens AG/ SITRANS LUT400**. (The EDD is written for forward compatibility.)

As a guideline to locate the correct EDD, the major and minor numbers should match between the EDD revision and the Firmware revision in the device (e.g. major and minor numbers in bold text: **1.00.00-04**).

To check it in PDM, go to **SITRANS LUT400 HART > Identification > Device**.

Parameter	Value
Device	
Manufacturer	Siemens
Product Name	SITRANS LUT400
Product	SITRANS LUT440 (OCM)
Order Number	7ML5050-0CA10-1DA0
Serial Number	DP2-40
Final Assembly Number	0
Hardware Revision	1.00.00-00
Firmware Revision	1.00.00-04
Loader Revision	2.00.00-??
EDD Version	1.00.00-10
Date of Manufacturing	20110907
Order Option	Standard

matching Firmware and EDD revisions

Installing a new version of SIMATIC PDM requires the most recent Service Pack (SP) and the most recent hot fix (HF).

To install a new EDD

- Go to www.siemens.com/sitransLUT400 > **Support > Software Downloads** to download the most up-to-date EDD from the product page of our website.
- Save the files to your computer and extract the zipped file to an easily accessed location.
- Launch **SIMATIC PDM – Manage Device Catalog**, browse to and select the folder which contains the unzipped EDD file.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01).

Operation via Web Browser (USB)

Features and Functions

The web browser interface in SITRANS LUT400, designed to work with Windows XP, makes monitoring and adjustments easy. Internet Explorer installed on a computer can be used to configure the SITRANS LUT400, and the Web Server *Abyss* is supplied for your convenience. The web browser is available in English only.

SITRANS LUT400 parameters, organized into six main function groups, allow you to configure and monitor the device:

- Identification
- Setup
- Maintenance and Diagnostics
- Communication
- Security
- Language

Startup and Configuration

To start up the SITRANS LUT400 using the Web Browser, you must first install the USB driver and web browser interface. On the small DVD shipped with the device you will find the driver and installation software¹. Once installed, the communication port (COMPORT) must be set, then you can configure the device via the browser menu parameters.

The menu structure for the web browser interface is almost identical to that of the LCD. See *Browser Menu Parameter Function Groups* in the LUT400 Communications manual² for a complete list of parameters that can be configured via the web browser.

For installation instructions and details on how to configure the device via the Web Browser, refer to the LUT400 Communications manual¹.

1. Also available from the product page of our website. Go to:
www.siemens.com/sitransLUT400 and click on **Support>Software Downloads**.

2. Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01).

Notes

Operation via AMS Device Manager (HART)

(SITRANS LUT400 compatible with AMS version 10.5 and higher)

Features and Functions

AMS Device Manager is a software package used to commission and maintain SITRANS LUT400 and other process devices. AMS Device Manager monitors the process values, alarms and status signals of the device. It allows you to display, compare, adjust, verify, and simulate process device data. The graphic interface in SITRANS LUT400 makes monitoring and adjustments easy. Please consult the operating instructions or online help for details on using AMS Device Manager. (You can find more information at: <http://www.emersonprocess.com/AMS/>.)

AMS Device Manager features four Quick Start Wizards (Level, Volume, Volume-Linearization, and Flow) to easily configure the SITRANS LUT400. A Pump Control Wizard is also available. Other features include Echo Profile viewing, TVT setup, Process Variables monitoring, and Security.

Parameters organized into three main function groups allow you to configure and monitor the device:

- Configure/Setup
- Device Diagnostics (read only)
- Process Variables (read only)

For a chart¹ of the *AMS Menu Structure*, see LUT400 Communications manual².

Startup and Configuration

To startup the SITRANS LUT400 using AMS Device Manager, you must first install the EDD (see below). You can then configure the device using the Quick Start Wizards in AMS.

For more information on AMS functions, and details on how to configure the device using AMS, refer to the LUT400 Communications manual².

Electronic Device Description (EDD)

SITRANS LUT400 requires the EDD for AMS Device Manager version 10.5.

You can locate the EDD in Device Catalog, under **Sensors/Level/Echo/Siemens/SITRANS LUT400**. Check the product page of our website at www.siemens.com/sitransLUT400, under **Support->Software Downloads**, to make sure you have the latest version of the EDD for AMS Device Manager.

¹ The menu structure for AMS Device Manager is almost identical to that of the LCD.

² Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01).

Notes

Operation via Field Communicator 375/475 (FC375/ FC475) (HART)

Features and Functions

The FC375/FC475 HART Communicator is a handheld communication device that is easy to use, and provides universal support for other HART devices, such as the SITRANS LUT400.

For a list of parameters available with the Field Communicator, see *HART FC375/FC475 Menu Structure* in the LUT400 Communications manual¹. This menu structure is very similar to that of AMS Device Manager.

Startup and Configuration

In order to configure this HART device, just as with AMS, the configuration software requires the HART Electronic Device Description (EDD) for the instrument. Once the EDD is installed, you can configure the device using the Quick Start Wizards within FC375/475.

For instructions on how to install the EDD, and how to configure a new device using FC375/475, refer to the LUT400 Communications manual².

¹. Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01).

Notes

Operation - FC375

Operation via FDT (Field Device Tool)

Features and Functions

FDT is a standard used in several software packages designed to commission and maintain field devices such as SITRANS LUT400. Two commercially available FDTs are PACTware and Fieldcare.

FDT is very similar to PDM [see *Operation via SIMATIC PDM 6 (HART)* in the LUT400 Communications manual¹ for more detail].

- To configure a field device via FDT, you need the DTM (Device Type Manager) for the device.
- To configure a field device via SIMATIC PDM, you need the EDD (Electronic Data Description) for the device.

Startup and Configuration

To startup the SITRANS LUT400 using an FDT, you must first install the DTM (see below). You can then configure the device using the parameters available with the FDT.

The full process to configure a field device via FDT is outlined in an application guide for *SITRANS DTM*, which can be downloaded from the product page of our website. Go to: www.siemens.com/sitransLUT400 under **Support** and click on **Application Guides**.

Device Type Manager (DTM)

A DTM is a type of software that 'plugs into' FDT. It contains the same information as an EDD but an EDD is independent of the operating system.

SITRANS DTM version 3.1

- SITRANS DTM is an EDDL interpreter developed by Siemens to interpret the EDD for that device.
- To use SITRANS DTM to connect to a device, you must first install SITRANS DTM on your system and then install the instrument EDD written for SITRANS DTM.
- You can download SITRANS DTM from our website at: <http://www.siemens.com/sitransdtm>.
Click on **Support** then go to **Software downloads**.

Electronic Device Description (EDD)

The SITRANS LUT400 HART EDD for SITRANS DTM can be downloaded from the product page of our website.

Go to www.siemens.com/sitransLUT400 under **Support** and click on **Software Downloads**.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01).

Notes

Parameter reference (LUI)

Notes:

- Parameter names and menu structure are almost identical for SIMATIC PDM and the local user interface (LUI). Access is described below for some parameters that do not appear in the SIMATIC PDM menu structure. **(For further details on using these parameters within SIMATIC PDM, see the LUT400 Communications manual^a.)**
- Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.
- Parameter range values are displayed in the default of the defined unit of measure. For example, if a parameter description states that it is *defined in Units (2.1.1.)*, the range for that parameter will be shown in meters [as meters (M) is the default for Units (2.1.1.)].
- The number of decimals displayed for a parameter value will depend on the unit of measure, unless decimal places can be set by the user (e.g. Totalizers - *2.7.3.2.Totalizer Decimal Position*).
For example:
Values defined in default *2.1.1.Units* will display 3 decimal places; default *2.6.2.Volume Units* - 1 decimal place, default *2.15.3.7.Flowrate Units* - 0 decimal places.
- To enter Program mode using the local push buttons, press ►. Press ◀ to return to Measurement mode.

- a. Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

Parameters are identified by name and organized into function groups. See **LCD Menu Structure** on page 125 for a chart.

Parameters accessible via the local push buttons are preceded by a number. Parameters not preceded by a number are accessible only via remote operation.

Based on model configuration (LUT420, LUT430, LUT440), some parameters will not appear on LUI. Exceptions are noted by parameter.

Where the same parameter exists for more than one model, but is represented by a different menu number, both parameters are listed together (separated by "OR"), and the details are noted under the second of the two parameters.

For more details see:

- Operation via SIMATIC PDM 6 (HART)** on page 15
- Operation via AMS Device Manager (HART)** on page 19

1. Wizards

Several Wizards are available with the SITRANS LUT400. Wizards group together all the settings needed for a particular feature. All Wizards are available via the local push buttons, and many are also available via SIMATIC PDM under the Device menu.

For details on the Wizards listed below, see **Quick Start Wizards** on page 38 of *Commissioning*.

1.1. Quick Start

1.1.1. QS Level

1.1.2. QS Volume

1.1.3. QS Flow

Available only on LUT430 (Pump and Flow), and LUT440 (OCM) configured models.

1.2. Pump Control

2. Setup

Notes:

- See *Local Commissioning* on page 33 or *Operation via SIMATIC PDM 6 (HART)* on page 15 for instructions.
- Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.
- Values shown in the following tables can be entered via the local push buttons.

2.1. Sensor

2.1.1. Units

Determines sensor measurement units used when 2.1.2.Sensor Mode set to Level, Space, Distance, or Head.

Options	M, CM, MM, FT, IN
	Default: M

2.1.2. Sensor Mode

Menu number 2.1.2 visible on LUT420 (Level model).

OR

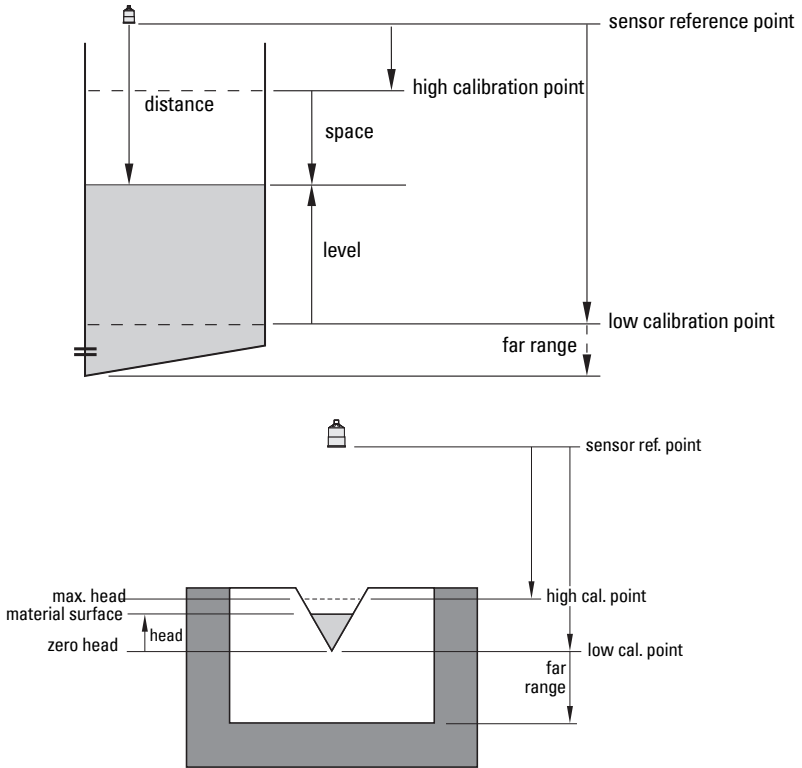
2.1.3. Sensor Mode

Menu number 2.1.3 visible on LUT430 (Pump and Flow model), and LUT440 (OCM model).

Sets the type of measurement required for the application.

Options (Mode)		Description	Reference point
*	LEVEL	Distance to material surface	Low Calibration Point (process empty level)
	SPACE		High Calibration Point (process full level)
	DISTANCE		Sensor Reference Point
	VOLUME	Volume of material in volumetric units (based on level)	Low Calibration Point
	HEAD ^a	Distance to material surface	Zero Head
	FLOW ^a	Flowrate in an open channel in Flowrate Units	Zero Head (zero flow level)

^a. Option available only on LUT430, LUT440.



2.1.4. Sensor Mode Secondary

Menu number *2.1.4* visible on LUT420 (Level model).

OR

2.1.5. Sensor Mode Secondary

Menu number *2.1.5* visible on LUT430 (Pump and Flow model), and LUT440 (OCM model).

Sets the secondary measurement type to be used in the application.

See **Sensor Mode (2.1.3.)** for illustration.

2.1.6. Transducer

Specifies the Siemens transducer connected to the device.

Options	*	NO TRANSDUCER
		XRS-5
		XPS-10
		XPS-15
		XCT-8
		XCT-12
		XPS-30
		XPS-40
		XLT-30
		XLT-60
		STH

Notes:

- When **Transducer (2.1.6.)** is set to NO TRANSDUCER, the LOE fault will display immediately.
- An **Echo Profile (3.2.1.)** cannot be requested from LUI when **Transducer (2.1.6.)** is set to NO TRANSDUCER. The local push button will not operate.

2.1.7. Frequency

Adjust the shot transmit pulse frequency (in kHz).

Values	Range: 10.000 to 52.000
	Default: Depends on transducer selected in Transducer (2.1.6.).

2.1.8. Long Shot Duration

Adjust the duration of the long shot transmit pulse (in μ s).

Values	Range: 100.000 to 2000.000
	Default: Depends on transducer selected in Transducer (2.1.6.).

2.1.9. Short Shot Duration

Adjust the duration of the short shot transmit pulse (in μ s).

Values	Range: 100.000 to 2000.000
	Default: Depends on transducer selected in Transducer (2.1.6.).

2.2. Calibration

2.2.1. Low Calibration Point

*Distance from sensor reference point¹ to Low Calibration Point defined in **Units (2.1.1.)**.*

Values	Range: 0.000 to 60.000
	Default: 60.000

¹ The point from which level measurement is referenced (see **Sensor Mode on page 138** for illustration).

2.2.2. High Calibration Point

*Distance from sensor reference point¹ to High Calibration Point defined in **Units (2.1.1).***

Values	Range: 0.000 to 60.000
	Default: 0.000

When setting the High Calibration Point value, note that echoes are ignored within **2.2.4.Near Range**.

2.2.3. Sensor Offset

*The value altered when an **Auto Sensor Offset (2.2.6.)** is performed, defined in **Units (2.1.1).***

Values	Range: -99.999 to 99.999
	Default: 0.000

Alternatively, if amount of Sensor Offset is known, enter the constant that can be added to or subtracted from sensor value¹ to compensate if the sensor reference point has shifted.

2.2.4. Near Range

*The range in front of the device (measured from the sensor reference point) within which any echoes will be ignored. This is sometimes referred to as blanking or a dead zone. Defined in **Units (2.1.1).***

Values	Range: 0.000 to 60.000
	Default: 0.300

2.2.5. Far Range

Note: Far Range can extend beyond the bottom of the vessel.

*Allows the material level to drop below Low Calibration Point without generating a Loss of Echo (LOE) state. See **Sensor Mode (2.1.2)** on page 138 for an illustration. Defined in **Units (2.1.1).***

Values	Range: Min. = Low Calibration Point Max. = 61.000 M (200.13 FT)
	Default: Value for Low Calibration Pt. + 1 m (3.281 ft.)

Use this feature if the measured surface can drop below the Low Calibration Point in normal operation.

¹ The value produced by the echo processing which represents the distance from sensor reference point to the target (see **Sensor Mode on page 138** for illustration).

2.2.6. Auto Sensor Offset

Note: Auto Sensor Offset supports adjustments to distance value only.

*Calibrates actual distance if reported value is consistently high or low by a fixed amount. (Adjusts distance measurement by a fixed amount.) Defined in **Units (2.1.1.)**.*

Values	Range: 0.000 to 60.000
---------------	-------------------------------

Before using this feature, verify the following parameters are correct:

- *2.2.1.Low Calibration Point* (or *2.15.3.5.Zero Head Offset*, if using OCM)
- *2.12.1.2.Process Temperature*
- *2.2.3.Sensor Offset*

A correction to any one of these parameters may resolve the issue and an Auto Sensor Offset calibration may not be necessary.

Using Auto Sensor Offset:

Begin with a steady distance at a known low distance value (low distance value equates to a high level value).

1. Review the distance measurement via LUI for approximately 30 seconds to verify repeatability.
2. Measure the actual distance (for example, with a tape measure).
3. Enter the actual distance, defined in **Units (2.1.1.)**

The deviation between the calculated and the actual distance value is stored in *2.2.3.Sensor Offset*.

2.3. Rate

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

Notes:

- The following three rate parameters work in conjunction, and are affected by **Response Rate** (set in the Quick Start wizard).
- **Fill Rate per Minute**, **Empty Rate per Minute**, and **Damping Filter** automatically update when **Response Rate** is altered, but any change to these parameters will supersede a Response Rate set previously through the wizard.
- For more information, see **Measurement Response** on page 260.

2.3.1. Fill Rate per Minute

Defines the maximum rate at which the reported level is allowed to increase. Allows you to adjust the SITRANS LUT400 response to increases in the actual material level.

Values	Range: 0.000 to 99999.000 m/min
	Default: 0.100 m/min

Enter a value slightly greater than the vessel's maximum filling rate, in units per minute.

2.3.2. Empty Rate per Minute

Defines the maximum rate at which the reported level is allowed to decrease. Adjusts the SITRANS LUT400 response to decreases in the actual material level.

Values	Range: 0.000 to 99999.000 m/min
	Default: 0.100 m/min

Enter a value slightly greater than the vessel's maximum emptying rate, in units per minute.

2.3.3. Damping Filter

Use this to stabilize the reported level (displayed and analog output), due to level fluctuations (such as a rippling or splashing liquid surface), defined in seconds.

Values	Range: 0.0 to 7200.0
	Default: 100.0

2.4. Fail-Safe

*The fail-safe parameters ensure that the devices controlled by the SITRANS LUT400 default to an appropriate state when a valid level reading is not available. The PV region on LUI will display dashes (-----) until the fail-safe fault has been cleared. (See **General Fault Codes** on page 231 for a list of faults that will cause fail-safe.)*

Note: When a Loss of Echo occurs **Material Level (2.4.1)** determines the material level to be reported when the Fail-safe timer expires. See **Loss of Echo (LOE)** on page 261 for more detail.

2.4.1. Material Level

Note: The default is a factory setting and depends whether or not your device was ordered as NAMUR NE43-compliant for Fail-safe.

*Defines the mA output to use (shown in **Current Output Value**) when the Fail-safe Timer expires and the device is still in an error condition.*

Options	HI	20.0 mA (max. mA Limit)
	LO	4.0 mA (min. mA Limit)
	HOLD	Last valid reading
	VALUE	User-selected value [defined in Fail-Safe mA Value (2.4.3) : default 3.58 mA]
Default	VALUE (if ordered with NAMUR NE43 compliant fail-safe preset) HOLD (if ordered without NAMUR NE43 compliant fail-safe preset)	

2.4.2. LOE Timer

Sets the time to elapse since the last valid reading, before the Fail-safe Material Level is reported (defined in seconds).

Values	Range: 0 to 7200
	Default: 100

2.4.3. Fail-Safe mA Value

Note: Material Level (2.4.1.) must be set to **Value** for the **Material Level** value to be reported.

Allows the user to define the mA value to be reported when the Fail-safe timer expires.

Values	Range	3.50 to 22.80 mA
	Default	3.58

2.5. Current Output

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.5.1. Current Output Function

Menu number *2.5.1.* visible on LUT420 (Level model).

OR

2.5.2. Current Output Function

Menu number *2.5.2.* visible on LUT430 (Pump and Flow model), and LUT440 (OCM model).

Alters the mA output/measurement relationship.

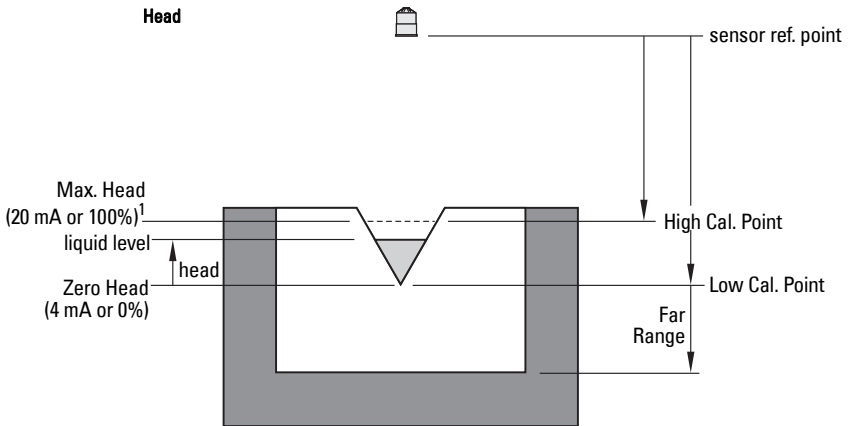
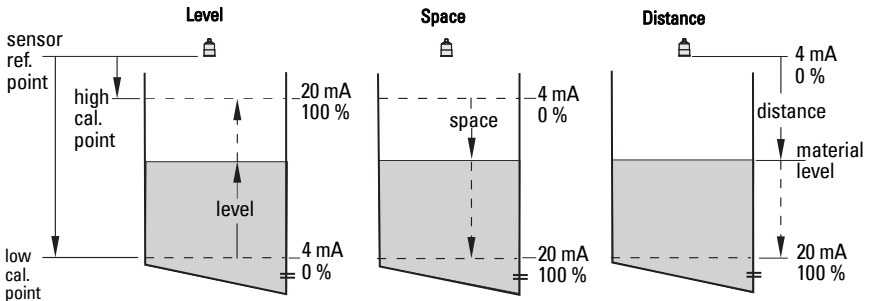
Notes:

- The various options have different reference points.
- Use caution when changing Current Output Function while the device is connected to a HART network. Current Output Function controls the primary value and the loop current for the device.

Options		Reference point	Description
	MANUAL ^a	n/a	user can enter mA value for loop current.
*	LEVEL	Low Calibration Point	measured as difference between the material level and <i>2.2.1.Low Calibration Point</i> , defined in <i>2.1.1.Units</i>
	SPACE	High Calibration Point	measured as difference between the material level and <i>2.2.2.High Calibration Point</i> , defined in <i>2.1.1.Units</i>
	DISTANCE	Sensor reference point	measured as difference between the material level and sensor reference point, defined in <i>2.1.1.Units</i>

VOLUME	Low Calibration Point	converted from Level, defined in <i>Length of the cylindrical section of a horizontal parabolic end vessel. See Vessel Shape (2.6.1.) for an illustration.</i>
HEAD ^b	Zero Head	measured as difference between the liquid level and Zero Head, defined in 2.1.1.Units
FLOW ^b	Zero Head	converted from Head, defined in 2.15.3.7.Flowrate Units

- a. When Current Output Function is set to **Manual**, a power cycle will reset this parameter to its previous value.
- b. Option available only on LUT430, LUT440.



¹. Refer to PMD supplier documentation for maximum head.

To modify Current Output Function via SIMATIC PDM:

Open the menu **Device – Select Analog Output.**

Parameters

2.5.3. 4 mA Setpoint

*Sets the process level corresponding to the 4 mA value. 4 mA always defaults to 0 m, and **Current Output Function (2.5.1.)** determines the type of measurement. [See **Current Output Function (2.5.1.)** for an illustration.]*

Values	Range: Level, Space, Distance, Head: 0.000 to 60.000 m Volume: 0.0 to Max. Volume Flow: 0 to Max. Flow
	Default: 0 (set to value corresponding to 0% as defined by Current Output Function and associated units)

- Enter the reading that is to correspond to a 4 mA output.
- Units are defined in **Units (2.1.1)** for Level, Space, Distance, or Head, and in **Flowrate Units (2.15.3.7)** for Flow. Volume units are converted from a level value.

2.5.4. 20 mA Setpoint

*Sets the process level corresponding to the 20 mA value. 20 mA always defaults to 60 m, and **Current Output Function (2.5.1.)** determines the type of measurement. [See **Current Output Function (2.5.1.)** for an illustration.]*

Values	Range: Level, Space, Distance, Head: 0.000 to 60.000 m Volume: 0.0 to Max. Volume Flow: 0 to Max. Flow
	Default: Level, Space, Distance, Head: 60.000 Volume: Max. Volume Flow: Max Flow (set to value corresponding to 100% as defined by Current Output Function and associated units)

- Enter the reading that is to correspond to a 20 mA output.
- Units are defined in **Units (2.1.1)** for Level, Space, or Distance, or Head, and in **Flowrate Units (2.15.3.7)** for Flow. Volume units are converted from a level value.

2.5.5. Minimum mA Limit

Prevents the mA output from dropping below this minimum level for a measurement value. This does not restrict the Fail-safe or Manual settings.

Values	Range: 3.5 to 22.8 mA
	Default: 4.0

2.5.6. Maximum mA Limit

Prevents the mA output from rising above this maximum level for a measurement value. This does not restrict the Fail-safe or Manual settings

Values	Range: 3.5 to 22.8 mA
	Default: 20.0

2.5.7. Manual Value

The mA value to use when **Current Output Function (2.5.1.)** is set to **Manual**. Allows you to use a simulated value to test the functioning of the loop. You can enter 4 mA, 20 mA, or any other user-defined value within the range.

Values	Range: 3.5 to 22.8 mA
	Default: 3.58

- First set **Current Output Function (2.5.1.)** to **Manual**.
- Set this parameter to the desired mA value.
- After completing the test, remember to reset **Current Output Function (2.5.1.)** to the previous setting.

Via AMS Device Manager or FC375/475:

Open the menu **Configure/Setup > Operation > Select Analog Output**.

Via SIMATIC PDM:

Open the menu **Device – Loop Test**.

2.5.8. Current Output Value

Read only. Displays the current mA value, including a simulated value entered to test the functioning of the loop.

Values	Range: 3.5 to 22.8 mA
---------------	------------------------------

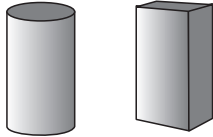

2.6. Volume

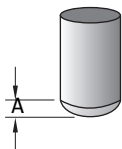
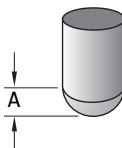
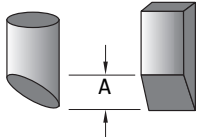
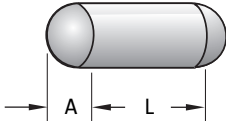

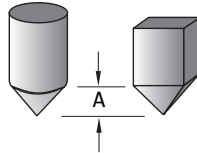
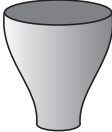
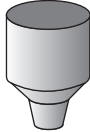
Carries out a volume conversion from a level value.

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.6.1. Vessel Shape

89Defines the vessel shape and allows the LUT400 to calculate volume instead of level. If **None** is selected, no volume conversion is performed. Select the vessel shape matching the monitored vessel or reservoir.

	Vessel Shape	LCD DISPLAY/ Description	Also required
*	None	NONE/ No volume calculation required	N/A
		LINEAR/ Upright, linear (flat bottom)	maximum volume
		CYLINDER/ Flat end horizontal cylinder	maximum volume

	Vessel Shape (cont'd)	LCD DISPLAY/ Description	Also required
		PARABOLIC BOTTOM	maximum volume, dimension A
		HALF SPHERE BOTTOM	maximum volume, dimension A
		FLAT SLOPED BOTTOM	maximum volume, dimension A
		PARABOLIC ENDS/ Parabolic end horizontal cylinder	maximum volume, dimension A, dimension L
		SPHERE	maximum volume
		CONICAL BOTTOM/ Conical or pyramidal bottom	maximum volume, dimension A
		CURVE TABLE ^a / Linearization table (level/volume breakpoints)	maximum volume, tables 1-32 level and volume breakpoints
		LINEAR TABLE ^a / Linearization table (level/volume breakpoints)	maximum volume, tables 1-32 level and volume breakpoints

a. Linearization Table must be selected in order for level/volume values [see **Table 1-8 (2.6.7.)**] to be transferred.

2.6.2. Volume Units

Determines volume measurement units used when 2.1.2.Sensor Mode set to VOLUME.

Options	*	L (Litres)
		USGAL (US Gallons)
		IMPGAL (Imperial Gallons)
		CUM (Cubic Meters)
		USER DEFINED (units defined in 2.6.6.User Defined Unit)

2.6.3. Maximum Volume

The maximum volume of the vessel. Enter the vessel volume corresponding to High Calibration Point. For example, if your maximum vessel volume is 8000 L, enter a value of 8000.

Values	Range: 0.0 to 9999999
	Default: 100.0

2.6.4. Dimension A

*The height of the vessel bottom when the bottom is conical, pyramidal, parabolic, spherical, or flat -sloped. If the vessel is horizontal with parabolic ends, the depth of the end. See **Vessel Shape (2.6.1.)** for an illustration.*

Values	Range: 0.000 to 99.999
	Default: 0.000

Defined in 2.1.1.Units.

2.6.5. Dimension L

*Length of the cylindrical section of a horizontal parabolic end vessel. See **Vessel Shape (2.6.1.)** for an illustration.*

Values	Range: 0.000 to 99.999
	Default: 0.000

Defined in 2.1.1.Units.

2.6.6. User Defined Unit

*Set the unit text to display for current volume when 2.6.2.Volume Units set to **user-defined**. Limited to 16 ASCII characters.*

Note: The text entered is simply for display purposes. No unit conversion occurs.

2.6.7. Table 1-8

*If your vessel shape is more complex than any of the preconfigured shapes, you can define the shape as a series of segments. A value is assigned to each level breakpoint and a corresponding value is assigned to each volume breakpoint. Level values are defined in **Units (2.1.1.)**. Volume values are defined in **Volume Units (2.6.2.)**.*

Level Values	Range: 0.000 to 60.000
	Default: 0.000
Volume Values	Range: 0.0 to 9999999.0
	Default: 0.0

Enter up to 32 level breakpoints, where the corresponding volume is known. The values corresponding to 0% and 100% levels must be entered, and breakpoints can be ordered from top to bottom, or the reverse.

Breakpoints are grouped into four tables: Table 1-8, Table 9-16, Table 17-24, and Table 25-32.

Entering breakpoints via SIMATIC PDM:

- See *Using Linearization via the Quick Start wizard* in the LUT400 Communications manual¹.

Entering breakpoints via the local push buttons:

- The default unit for level values is **m**: to change it navigate to **Setup (2.) > Sensor (2.1.) > Units (2.1.1.)**, and select the desired unit.
- Navigate to **Setup (2.) > Volume (2.6.) > Table 1-8 (2.6.7.)**, and enter the value.
- Go to the appropriate table for the particular breakpoint you wish to adjust: for example, go to Table 1-8 for breakpoint 1.
- Under Table 1-8, go to **Level 1 (2.6.7.1.)** to enter the level value for the breakpoint 1.
- Under Table 1-8, go to **Volume 1 (2.6.7.2.)** to enter the volume value for the breakpoint 1.
- Repeat steps c) to e), until values have been entered for all required breakpoints.

2.6.7.1. Level 1

- Press **RIGHT arrow** to open Edit mode.
- Enter level value and press **RIGHT arrow** to accept it.
- Press **Down ARROW** to move to corresponding volume breakpoint.

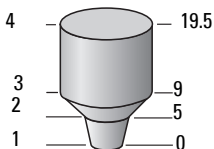
2.6.7.2. Volume 1

- Press **RIGHT arrow** to open Edit mode.
- Enter volume value and press **RIGHT arrow** to accept it.
- Press **Down ARROW** to move to next level breakpoint.

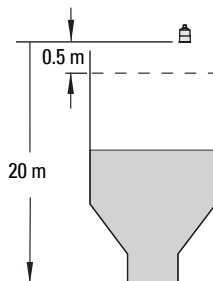
¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

Example (values are for example purposes only)

Breakpoint number Level value



Breakpoint Number	Level value (m)	Volume value (l)
1	0	0
2	5	500
3	9	3000
4	19.5	8000



2.6.8. Table 9-16

2.6.9. Table 17-24

2.6.10. Table 25-32

2.7. Pumps

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

For details on relay behaviour under fail-safe conditions, see **Pump relays** on page 66.

2.7.1. Basic Setup

2.7.1.1. Pump Control Enable

Enables/disables pump control.

Options		ENABLED
	*	DISABLED

2.7.1.2. Relay Pump 1

Selects the relay assigned to Pump 1.

Options	*	RELAY 2
		RELAY 3

2.7.1.3. Relay Pump 2

Selects the relay assigned to Pump 2.

Options		RELAY 2
	*	RELAY 3

2.7.1.4. Pump Control Mode

Menu number 2.7.1.4. visible on LUT420 (Level model).

OR

2.7.1.5. Pump Control Mode

Menu number 2.7.1.5. visible on LUT430 (Pump and Flow model), and LUT440 (OCM model).

Parameters

Sets the control algorithm used to trip the relay.

Options	*	ALTERNATE DUTY ASSIST (ADA)	At rotating ON and OFF setpoints and allows multiple pumps to run
		ALTERNATE DUTY BACKUP (ADB)	At rotating ON and OFF setpoints and allows only one pump to run
		SERVICE RATIO DUTY ASSIST (SRA) ^a	On service ratio at ON and OFF setpoints and allows multiple pumps to run
		SERVICE RATIO DUTY BACKUP (SRB) ^a	On service ratio at ON and OFF setpoints and allows only one pump to run
		FIXED DUTY ASSIST (FDA) ^a	At fixed ON and OFF setpoints and allows multiple pumps to run
		FIXED DUTY BACKUP (FDB) ^a	At fixed ON and OFF setpoints and allows only one pump to run

^a. Option available only on LUT430, LUT440.

Each algorithm defines a pump duty and pump start method.

2.7.1.6. ON Setpoint Pump 1

The level at which Pump 1 turns ON, defined in 2.1.1. Units.

Values	Range: 0.000 to 99999.000
	Default: 0.000

This parameter is set according to level even when another reading, such as volume, is shown on the LCD.

2.7.1.7. OFF Setpoint Pump 1

The level at which Pump 1 turns OFF, defined in 2.1.1. Units.

Values	Range: 0.000 to 99999.000
	Default: 0.000

This parameter is set according to level even when another reading, such as volume, is shown on the LCD.

2.7.1.8. ON Setpoint Pump 2

The level at which Pump 2 turns ON, defined in 2.1.1. Units.

Values	Range: 0.000 to 99999.000
	Default: 0.000

This parameter is set according to level even when another reading, such as volume, is shown on the LCD.

2.7.1.9. OFF Setpoint Pump 2

The level at which Pump 2 turns OFF, defined in 2.1.1. Units.

Values	Range: 0.000 to 99999.000
	Default: 0.000

This parameter is set according to level even when another reading, such as volume, is shown on the LCD.

2.7.1.10. Service Ratio Pump 1

Selects pump usage based on the RUN time ratio rather than last used. (See 3.2.7.1.Run Time Relay 2.)

Values	Range: 0 to 255
	Default: 1

This parameter only relates to relays with **Pump Control Mode (2.7.1.4.)** set to Service Ratio Duty Assist or Service Ratio Duty Backup.

The number assigned to each pump relay represents the ratio applied to decide the next pump to start or stop.

Notes:

- The SITRANS LUT400 will not sacrifice other pumping strategies to ensure that the ratio is held true.
- If the pump relays are set to the same value then the ratio equals 1:1 and all pumps are used equally (default).

2.7.1.11. Service Ratio Pump 2

Selects pump usage based on the RUN time ratio rather than last used. (See 3.2.7.2.Run Time Relay 3.)

Values	Range: 0 to 255
	Default: 1

This parameter only relates to relays with **Pump Control Mode (2.7.1.4.)** set to Service Ratio Duty Assist or Service Ratio Duty Backup.

The number assigned to each pump relay represents the ratio applied to decide the next pump to start or stop.

Notes:

- The SITRANS LUT400 will not sacrifice other pumping strategies to ensure that the ratio is held true.
- If the pump relays are set to the same value then the ratio equals 1:1 and all pumps are used equally (default).

2.7.2. Modifiers

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.7.2.1. Wall Cling Reduction

2.7.2.1.1. Enable

Enables/disables 2.7.2.1.2.Level Setpoint Variation.

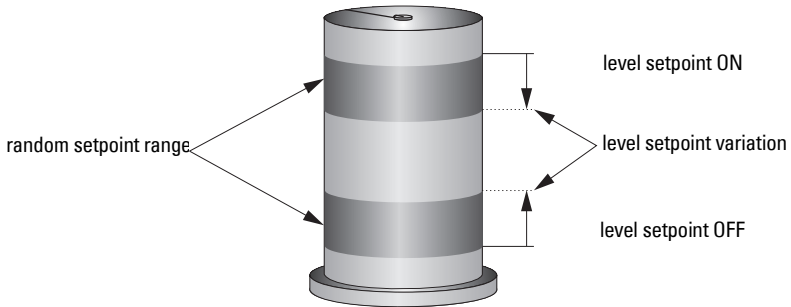
Options		ENABLED
	*	DISABLED

2.7.2.1.2. Level Setpoint Variation

Varies the ON and OFF setpoints to reduce material buildup on the walls (defined in 2.1.1. Units).

Values	Range: 0.000 to 99999.000
	Default: 0.000

This value is the range in which the setpoints are allowed to deviate. The pump ON and OFF Setpoint values are randomly varied inside the range to ensure that the material level does not consistently stop at the same point.



2.7.2.2. Energy Savings

Available only on LUT430 (Pump and Flow model), and LUT440 (OCM model).

Use these parameters to maximize your device's operation during periods of low energy cost and minimize its operation during periods of high cost.

The methods used to achieve this are:

- Emptying the wet well just prior to the high cost period, regardless of material level (2.7.2.2.2. *Peak Lead Time*).
- Changing setpoints for high cost and low cost periods (2.7.2.2.13. *Peak ON Setpoint Pump 1*, 2.7.2.2.14. *Peak OFF Setpoint Pump 1*, 2.7.2.2.3. *Peak 1 Start Time*, 2.7.2.2.4. *Peak 1 End Time*).

One peak lead time is shared by all five peak zones. When one zone's peak time interval (difference between peak start time and peak end time) overlaps another zone's peak lead time, the lead time is chosen over the interval. If a zone's start time matches its end time, the zone is treated as not configured.

2.7.2.2.1. Enable

Enables/disables the Energy Savings feature. The Energy Savings feature is used to minimize the pumping that occurs during periods of high energy cost.

Options	*	DISABLED
		ENABLED

2.7.2.2.2. Peak Lead Time

The time in minutes before the Peak Start Time that the SITRANS LUT400 will begin pumping.

Values	Range: 0 to 65535
	Default: 60

This value determines when pumping should start to ensure the level is as far as possible from the 2.7.1.6. *ON Setpoint Pump 1* level. If level is already within 5% of 2.7.1.7. *OFF Setpoint Pump 1*, no action occurs. If multiple pump stations are series linked, ensure the Peak Lead Time entered is sufficient to attain the desired level in all stations before the high-energy cost period occurs.

2.7.2.2.3. Peak 1 Start Time

Sets the start time of the high energy cost period 1.

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30pm, set parameter to 17:30)
	Default: 00:00

Used in conjunction with 2.7.2.2.4. *Peak 1 End Time* to define the high cost period.

For instructions on how to edit parameters with a string editor, see *Using the string editor:* on page 187.

2.7.2.2.4. Peak 1 End Time*Sets the end time of the high energy cost period 1.*

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30pm, set parameter to 17:30)
	Default: 00:00

Used in conjunction with *2.7.2.2.3.Peak 1 Start Time* to define the high cost period.

For instructions on how to edit parameters with a string editor, see *Using the string editor:* on page 187.

2.7.2.2.5. Peak 2 Start Time*Sets the start time of the high energy cost period 2.*

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30pm, set parameter to 17:30)
	Default: 00:00

Used in conjunction with *2.7.2.2.6.Peak 2 End Time* to define the high cost period.

2.7.2.2.6. Peak 2 End Time*Sets the end time of the high energy cost period 2.*

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30pm, set parameter to 17:30)
	Default: 00:00

Used in conjunction with *2.7.2.2.5.Peak 2 Start Time* to define the high cost period.

2.7.2.2.7. Peak 3 Start Time*Sets the start time of the high energy cost period 3.*

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30pm, set parameter to 17:30)
	Default: 00:00

Used in conjunction with *2.7.2.2.8.Peak 3 End Time* to define the high cost period.

2.7.2.2.8. Peak 3 End Time*Sets the end time of the high energy cost period 3.*

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30pm, set parameter to 17:30)
	Default: 00:00

Used in conjunction with *2.7.2.2.7.Peak 3 Start Time* to define the high cost period.

2.7.2.2.9. Peak 4 Start Time*Sets the start time of the high energy cost period 4.*

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30pm, set parameter to 17:30)
	Default: 00:00

Used in conjunction with *2.7.2.2.10.Peak 4 End Time* to define the high cost period.

2.7.2.2.10. Peak 4 End Time*Sets the end time of the high energy cost period 4.*

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30pm, set parameter to 17:30)
	Default: 00:00

Used in conjunction with *2.7.2.2.9.Peak 4 Start Time* to define the high cost period.

2.7.2.2.11. Peak 5 Start Time*Sets the start time of the high energy cost period 5.*

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30pm, set parameter to 17:30)
	Default: 00:00

Used in conjunction with *2.7.2.2.12.Peak 5 End Time* to define the high cost period.

2.7.2.2.12. Peak 5 End Time*Sets the end time of the high energy cost period 5.*

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30pm, set parameter to 17:30)
	Default: 00:00

Used in conjunction with *2.7.2.2.11.Peak 5 Start Time* to define the high cost period.

2.7.2.2.13. Peak ON Setpoint Pump 1

Sets the process point at which Pump 1 will turn on when in a peak period.

Values	Range: 0.000 to 99999.000
	Default: 0.000

To allow the level to go beyond the normal Relay ON Setpoint before a pump is started, enter the value to be used for the high-energy cost period.

2.7.2.2.14. Peak OFF Setpoint Pump 1

Sets the process point at which Pump 1 will turn off when in a peak period.

Values	Range: 0.000 to 99999.000
	Default: 0.000

To stop the pump(s) before the normal relay OFF Setpoint and reduce pump-running time. Enter the value to be used for the high cost period.

2.7.2.2.15. Peak ON Setpoint Pump 2

Sets the process point at which Pump 2 will turn on when in a peak period.

Values	Range: 0.000 to 99999.000
	Default: 0.000

To allow the level to go beyond the normal Relay ON Setpoint before a pump is started, enter the value to be used for the high-energy cost period.

2.7.2.2.16. Peak OFF Setpoint Pump 2

Sets the process point at which Pump 2 will turn off when in a peak period.

Values	Range: 0.000 to 99999.000
	Default: 0.000

To stop the pump(s) before the normal relay OFF Setpoint and reduce pump-running time. Enter the value to be used for the high cost period.

2.7.2.3. Pump Run-On

Available only on LUT430 (Pump and Flow model) and LUT440 (OCM model).

*For details on relay behaviour under fail-safe conditions, see **Pump relays** on page 66.*

2.7.2.3.1. Enable

Enables/disables Pump Run-On.

Options		ENABLED
	*	DISABLED

2.7.2.3.2. Run-On Interval

The number of hours between pump run-on occurrences.

Values	Range: 0.00 to 1000.00
	Default: 0.00

To clear sediment in a pump-down wet well, run the pump after the normal OFF setpoint is reached to force some solid material through. This parameter sets the time between such events. Only the last pump running can run-on.

2.7.2.3.3. Run-On Duration Pump 1

The number of seconds that the pump will run-on.

Values	Range: 0 to 65535
	Default: 0

Each pump capacity will determine the amount of material that can be removed. Choose a value long enough to clean out the vessel bottom, yet short enough not to run the pump dry. Also be sure that this value does not overlap with **Run-On Interval (2.7.2.3.2.)**.

2.7.2.3.4. Run-On Duration Pump 2

The number of seconds that the pump will run-on.

Values	Range: 0 to 65535
	Default: 0

Each pump capacity will determine the amount of material that can be removed. Choose a value long enough to clean out the vessel bottom, yet short enough not to run the pump dry. Also be sure that this value does not overlap with **Run-On Interval (2.7.2.3.2.)**.

2.7.2.4. Pump Start Delays

Available only on LUT430 (Pump and Flow model), and LUT440 (OCM model).

2.7.2.4.1. Delay Between Starts

The minimum delay (in seconds) between pump starts.

Values	Range: 0 to 65535
	Default: 10

Use this feature to reduce a power surge from all pumps starting at the same time. This delay determines when the next pump is permitted to start.

Note: If a delay is configured, it will be respected when in simulation mode (see *Pump relay behaviour during simulation* on page 121).

2.7.2.4.2. Power Resumption Delay

The minimum delay (in seconds) before the first pump restart after a power failure.

Values	Range: 0 to 65535
	Default: 60

This reduces the power surge from multiple instruments starting their pumps immediately on power resumption. When this delay expires, other pumps will start as per 2.7.2.4.1. *Delay Between Starts*.

2.7.3. Totalizers

Available only on LUT430 (Pump and Flow model), and LUT440 (OCM model).

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.7.3.1. Running Totalizer

Current pumped volume totalizer value in 2.6.2. Volume Units.

Values	Range: 0.00 to 999999999
	Default: 0.00

Pumped volume is automatically calculated whenever both Volume and Pumps are configured.

2.7.3.2. Totalizer Decimal Position

Sets the maximum number of decimal places to be displayed on the LCD.

Options		NO DIGITS	No digits after the decimal position
		1 DIGIT	1 digit after the decimal point
	*	2 DIGITS	2 digits after the decimal point
		3 DIGITS	3 digits after the decimal point

2.7.3.3. Totalizer Multiplier

Use this feature if the LCD Total increments by an amount that is too large (or too small).

Options		.001
		.01
		.1
	*	1
		10
		100
		1000
		10,000
		100,000
		1,000,000
	10,000,000	

Enter the factor by which actual volume is divided, prior to display on LCD. Use a value such that the nine-digit totalizer doesn't roll over between readings.

Example:

For an LCD Total display in 1000s of volume units, enter **1000**. In this example, **10,000** volume units would display as **10**.

2.7.3.4. Inflow/Discharge Adjust

Determines how inflow (or discharge) adjustment is made.

Options	*	BASED ON RATE ESTIMATION	The inflow rate measured just prior to the start of the pump cycle is used to estimate the inflow for the duration of the cycle.
		BASED ON PUMP CYCLE	The inflow is calculated using the change of volume between the end of the last pump cycle and the start of the next one, and the time period between the last cycle and the current one.
		NO ADJUSTMENT	No inflow adjustment is made (assumes an inflow of zero).

For an illustration, see **Pump Totalizers** on page 264.

2.7.3.5. Reset Running Totalizer

Select **YES** to reset pumped volume totalizer value to zero.

Options	*	NO
		YES

2.8. Alarms

The SITRANS LUT400 supports eight alarm types. Any alarm can be assigned to any available relay.

It is possible to assign more than one alarm to the same relay. In this case, the relay will activate if any one of the alarms is activated. If no alarms are activated, the relay will become inactive.

For details on relay behaviour under fail-safe conditions, see **Alarm relays** on page 66.

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.8.1. High Level Alarm

Reported when material level is within a user-defined range (see 2.8.1.2.High Level Value ON and 2.8.1.3.High Level Value OFF).

Can be used in conjunction with 2.8.12.Time To Spill feature.

2.8.1.1. Enable

Enables/disables High Level Alarm.

Options		ENABLED
	*	DISABLED

2.8.1.2. High Level Value ON

Sets the material level (defined in 2.1.1.Units) at which the High Level Alarm will activate.

Values	Range: 0.000 to 99999.000
	Default: 0.000

Value must be lower than Level To Spill (2.8.12.1.) if Time to Spill feature is used.

2.8.1.3. High Level Value OFF

Sets the material level (defined in 2.1.1.Units) at which the High Level Alarm will de-activate.

Values	Range: 0.000 to 99999.000
	Default: 0.000

2.8.1.4. Assigned Relay

Determines which relay (if any) will be activated when the High Level Alarm activates.

Options	*	NO RELAY
		RELAY 1
		RELAY 2
		RELAY 3

2.8.1.5. Alarm State

Read only. Used to view the current state of the High Level Alarm.

Options	ACTIVE
	INACTIVE

Appendix 2F

2.8.2. Low Level Alarm

Reported when material level is within a user-defined range (see 2.8.2.2.Low Level Value ON and 2.8.2.3.Low Level Value OFF).

2.8.2.1. Enable

Enables/disables Low Level Alarm.

Options		ENABLED
	*	DISABLED

2.8.2.2. Low Level Value ON

Sets the material level (defined in 2.1.1.Units) at which the Low Level Alarm will activate.

Values	Range: 0.000 to 99999.000
	Default: 0.000

2.8.2.3. Low Level Value OFF

Sets the material level (defined in 2.1.1.Units) at which the Low Level Alarm will de-activate.

Values	Range: 0.000 to 99999.000
	Default: 0.000

2.8.2.4. Assigned Relay

Determines which relay (if any) will be activated when the Low Level Alarm activates.

Options	*	NO RELAY
		RELAY 1
		RELAY 2
		RELAY 3

2.8.2.5. Alarm State

Read only. Used to view the current state of the Low Level Alarm.

Options	ACTIVE
	INACTIVE

2.8.3. Switch (Discrete Input) Alarm

Reported when Discrete Input (2.8.3.2.Discrete Input Number) is in a pre-defined state (2.8.3.3.Discrete Input State).

2.8.3.1. Enable

Enables/disables Switch Alarm.

Options		ENABLED
	*	DISABLED

2.8.3.2. Discrete Input Number

Determines which discrete input to monitor for Switch Alarm.

Options	*	DISCRETE INPUT 1
		DISCRETE INPUT 2

2.8.3.3. Discrete Input State

Sets the state of the discrete input (2.8.3.2.Discrete Input Number) that will cause the Switch Alarm to activate.

Options	*	ON
		OFF

2.8.3.4. Assigned Relay

Determines which relay (if any) will be activated when the Switch Alarm activates.

Options	*	NO RELAY
		RELAY 1
		RELAY 2
		RELAY 3

2.8.3.5. Alarm State

Read only. Used to view the current state of the Switch Alarm.

Options	ACTIVE
	INACTIVE

2.8.4. In-bounds Level Alarm

Reported when material level is within a user-defined range (see 2.8.4.2.High Level Value and 2.8.4.3.Low Level Value).

2.8.4.1. Enable

Enables/disables In-bounds Level Alarm.

Options		ENABLED
	*	DISABLED

2.8.4.2. High Level Value

Sets the upper level value for range within which the In-bounds Level Alarm will activate.

Values	Range: 0.000 to 99999.000
	Default: 0.000

2.8.4.3. Low Level Value

Sets the lower level value for range within which the In-bounds Level Alarm will activate.

Values	Range: 0.000 to 99999.000
	Default: 0.000

2.8.4.4. Assigned Relay

Determines which relay (if any) will be activated when the In-bounds Level Alarm activates.

Options	*	NO RELAY
		RELAY 1
		RELAY 2
		RELAY 3

2.8.4.5. Alarm State

Read only. Used to view the current state of the In-bounds Level Alarm.

Options	ACTIVE
	INACTIVE

2.8.5. Out-of-bounds Level Alarm

Reported when material level is outside a user-defined range (see 2.8.5.2.High Level Value or 2.8.5.3.Low Level Value).

2.8.5.1. Enable

Enables/disables Out-of-bounds Level Alarm.

Options		ENALBED
	*	DISABLED

2.8.5.2. High Level Value

Sets the upper level value for range outside of which the Out-of-bounds Level Alarm will activate.

Values	Range: 0.000 to 99999.000
	Default: 0.000

2.8.5.3. Low Level Value

Sets the lower level value for range outside of which the Out-of-bounds Level Alarm will activate.

Values	Range: 0.000 to 99999.000
	Default: 0.000

2.8.5.4. Assigned Relay

Determines which relay (if any) will be activated when the Out-of-bounds Level Alarm activates.

Options	*	NO RELAY
		RELAY 1
		RELAY 2
		RELAY 3

2.8.5.5. Alarm State

Read only. Used to view the current state of the Out-of-bounds Level Alarm.

Options	ACTIVE
	INACTIVE

2.8.6. Low Temperature Alarm

Reported when process temperature is within a user-defined range (see 2.8.6.2.Low Temperature Value ON and 2.8.6.3.Low Temperature Value OFF).

2.8.6.1. Enable

Enables/disables Low Temperature Alarm.

Options		ENABLED
	*	DISABLED

2.8.6.2. Low Temperature Value ON

Sets the temperature value (defined in °C) at which the Low Temperature Alarm will activate.

Values	Range: -273.0 to +273.0 °C (-459.0 to +523.0 °F)
	Default: 0.0 °C

2.8.6.3. Low Temperature Value OFF

Sets the material level (defined in °C) at which the Low Temperature Alarm will de-activate.

Values	Range: -273.0 to +273.0 °C (-459.0 to +523.0 °F)
	Default: 0.0 °C

2.8.6.4. Assigned Relay

Determines which relay (if any) will be activated when the Low Temperature Alarm activates.

Options	*	NO RELAY
		RELAY 1
		RELAY 2
		RELAY 3

2.8.6.5. Alarm State

Read only. Used to view the current state of the Low Temperature Alarm.

Options	ACTIVE
	INACTIVE

2.8.7. High Temperature Alarm

Reported when process temperature is within a user-defined range (see 2.8.7.2.High Temperature Value ON and 2.8.7.3.High Temperature Value OFF).

The temperature used for the alarm is the same temperature used for sound velocity compensation (see 2.12.1.3.Temperature Source).

2.8.7.1. Enable*Enables/disables High Temperature Alarm.*

Options		ENABLED
	*	DISABLED

2.8.7.2. High Temperature Value ON*Sets the temperature value (defined in °C) at which the High Temperature Alarm will activate.*

Values	Range: -273.0 to +273.0 °C (-459.0 to +523.0 °F)
	Default: 100.0 °C

2.8.7.3. High Temperature Value OFF*Sets the material level (defined in °C) at which the High Temperature Alarm will de-activate.*

Values	Range: -273.0 to +273.0 °C (-459.0 to +523.0 °F)
	Default: 100.0 °C

2.8.7.4. Assigned Relay*Determines which relay (if any) will be activated when the High Temperature Alarm activates.*

Options	*	NO RELAY
		RELAY 1
		RELAY 2
		RELAY 3

2.8.7.5. Alarm State*Read only. Used to view the current state of the High Temperature Alarm.*

Options	ACTIVE
	INACTIVE

2.8.8. Fail-safe Fault Alarm*Reported when fault that has caused a fail-safe condition is present.***2.8.8.1. Enable***Enables/disables Fail-safe Alarm.*

Options		ENABLED
	*	DISABLED

2.8.8.2. Assigned Relay

Determines which relay (if any) will be activated when the Fail-safe Alarm activates.

Options	*	NO RELAY
		RELAY 1
		RELAY 2
		RELAY 3

2.8.8.3. Alarm State

Read only. Use to view the current state of the Fail-safe Alarm.

Options	ACTIVE
	INACTIVE

2.8.9. High Flowrate Alarm

Available only on LUT440 (OCM model).

Reported when the OCM flowrate is within a user-defined range (see 2.8.9.2.High Flowrate Value ON and 2.8.9.3.High Flowrate Value OFF).

2.8.9.1. Enable

Enables/disables High Flowrate Alarm.

Options		ENABLED
	*	DISABLED

2.8.9.2. High Flowrate Value ON

Sets the flowrate value (defined in 2.15.3.7.Flowrate Units) at which the High Flowrate Alarm will activate.

Values	Range: 0 to 9999999
	Default: 0

2.8.9.3. High Flowrate Value OFF

Sets the material level (defined in 2.15.3.7.Flowrate Units) at which the High Flowrate Alarm will de-activate.

Values	Range: 0 to 9999999
	Default: 0

2.8.9.4. Assigned Relay

Determines which relay (if any) will be activated when the High Flowrate Alarm activates.

Options	*	NO RELAY
		RELAY 1
		RELAY 2
		RELAY 3

2.8.9.5. Alarm State

Read only. Used to view the current state of the High Flowrate Alarm.

Options	ACTIVE
	INACTIVE

2.8.10. Low Flowrate Alarm

Available only on LUT440 (OCM model).

Reported when the OCM flowrate is within a user-defined range (see 2.8.10.2.Low Flowrate Value ON and 2.8.10.3.Low Flowrate Value OFF).

2.8.10.1. Enable

Enables/disables Low Flowrate Alarm.

Options		ENABLED
	*	DISABLED

2.8.10.2. Low Flowrate Value ON

Sets the flowrate value (defined in 2.15.3.7.Flowrate Units) at which the Low Flowrate Alarm will activate.

Values	Range: 0 to 9999999
	Default: 0

2.8.10.3. Low Flowrate Value OFF

Sets the material level (defined in 2.15.3.7.Flowrate Units) at which the Low Flowrate Alarm will de-activate.

Values	Range: 0 to 9999999
	Default: 0

2.8.10.4. Assigned Relay

Determines which relay (if any) will be activated when the Low Flowrate Alarm activates.

Options	*	NO RELAY
		RELAY 1
		RELAY 2
		RELAY 3

2.8.10.5. Alarm State

Read only. Used to view the current state of the Low Flowrate Alarm.

Options	ACTIVE
	INACTIVE

2.8.11. Relay Logic

Relay contact operation is NORMALLY CLOSED for alarms and NORMALLY OPEN for controls.

By default an alarm contact is **Normally Closed**. When an alarm activates, the corresponding relay coil is de-energized. By setting this parameter to **Normally Open**, the relay coil will be energized when an alarm assigned to the relay activates.

2.8.11.1. Relay 1 Logic

Use to change the behaviour of Relay 1 when assigned to an alarm.

Options		NORMALLY OPEN
	*	NORMALLY CLOSED

2.8.11.2. Relay 2 Logic

Use to change the behaviour of Relay 2 when assigned to an alarm.

Options		NORMALLY OPEN
	*	NORMALLY CLOSED

2.8.11.3. Relay 3 Logic

Use to change the behaviour of Relay 3 when assigned to an alarm.

Options		NORMALLY OPEN
	*	NORMALLY CLOSED

2.8.12. Time To Spill

Used to predict when an overflow (spill) condition may occur. This feature works in conjunction with the 2.8.1.High Level Alarm.

2.8.12.1. Level To Spill

Value (defined in 2.1.1.Units) representing material level at which a spill will occur.

Options	-999999.000 to 999999.000
	Default: 0.000

This value must be greater than high level alarm ON setpoint [High Level Value ON (2.8.1.2.)].

2.8.12.2. Minutes Left To Spill

Read only. Calculated value representing minutes remaining before a spill will occur.

Enter the level at which a spill condition will occur in 2.8.12.1.Level To Spill. When the High Level Alarm is tripped, the estimated time to spill is displayed in 2.8.12.2.Minutes Left To Spill. The estimated time is calculated by the LUT400 based on the material level and the rate of change of the material level. If the High Level alarm is not tripped, or the material level is falling, then the estimated time to spill will display as zero.

2.9. Discrete Inputs

Discrete inputs are used to trigger or alter the way SITRANS LUT400 controls devices such as pumps and alarms. Discrete inputs can be used for the following:

- as a backup level override
- allowing the device to be more flexible by interlocking control functions with external conditions.

For more detail see **Discrete Inputs** on page 69.

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.9.1. Backup Level Override

Use this feature to override the material reading by a discrete input such as a contacting point device. The material reading will be fixed at the programmed switch level until the discrete input is released. The LUT400 makes decisions based on the override values.

2.9.1.1. Enable

Enables/disables the Backup Level Override function.

Options		ENABLED
	*	DISABLED

2.9.1.2. Level Override Value

This value is substituted for the current reading when the selected discrete input is enabled and ON.

Values	Range: 0.000 to 60.000
	Default: 0.000

Value is defined in current *2.1.1.Units*, and is valid only for level (and head when *2.1.2.Sensor Mode* set to Flow). (Volume is calculated based on the Backup level.)

2.9.1.3. Discrete Input Number

Sets the discrete input to act as the source for a level reading override when enabled.

Options	*	DISCRETE INPUT 1
		DISCRETE INPUT 2

2.9.2. Discrete Input Logic

Use the following parameters to configure the discrete input itself.

Normal state is standard operation, with the SITRANS LUT400 sensing the material level and controlling the pumps, and no faults or alarms present. The discrete input contacts are either **NORMALLY OPEN** or **NORMALLY CLOSED** when the system state is normal.

Discrete Input Logic	Terminal Block	Discrete Input Scaled State
Normally Open	Voltage applied	ON
	No voltage applied	OFF
Normally Closed	Voltage applied	OFF
	No voltage applied	ON

For example:

When discrete input logic is set to Normally Open and discrete input has no voltage applied on the terminal block, the discrete input will be inactive (OFF).

2.9.2.1. Discrete Input 1 Logic

Use to change the behaviour of the Discrete Input 1.

Options	*	NORMALLY OPEN
		NORMALLY CLOSED

2.9.2.2. Discrete Input 1 Scaled State

Read only. Indicates the current state of Discrete Input 1.

Options		ON
	*	OFF

2.9.2.3. Discrete Input 2 Logic

Use to change the behaviour of Discrete Input 2.

Options	*	NORMALLY OPEN
		NORMALLY CLOSED

2.9.2.4. Discrete Input 2 Scaled State

Read only. Indicates the current state of Discrete Input 2.

Options		ON
	*	OFF

2.9.3. Pump Interlock

Available only on LUT430 (Pump and Flow model), and LUT440 (OCM model). Discrete inputs allow you to supply pump information to the SITRANS LUT400 so that it can modify pump algorithms. The following parameters are used to program actions that should take place when a pump is determined to be in a failed state. For example, a pump interlock can be used to ensure that any pump reporting a failure is removed from the pumping rotation.

2.9.3.1. Enable Pump 1

Enables/disables the pump start interlock. If ON, then Pump 1 will not start if the corresponding discrete input [Pump 1 Discrete Input (2.9.3.2.)] is active.

Options		ENABLED
	*	DISABLED

2.9.3.2. Pump 1 Discrete Input

Sets the discrete input to use for pump start interlock on Pump 1.

Options	*	DISCRETE INPUT 1
		DISCRETE INPUT 2

2.9.3.3. Enable Pump 2

Enables/disables the pump start interlock. If ON, then Pump 2 will not start if the corresponding discrete input [Pump 2 Discrete Input (2.9.3.4.)] is active.

Options		ENABLED
	*	DISABLED

2.9.3.4. Pump 2 Discrete Input

Sets the discrete input to use for pump start interlock on Pump 2.

Options	*	DISCRETE INPUT 1
		DISCRETE INPUT 2

2.10. Data Logging

Use data logging to keep track of a parameter value on regular intervals or when an event is triggered. Up to 3 data logs can be configured, and collectively the logs can hold approximately 30,000 entries. [To view these data logs, see View Logs (3.2.6.).]

Notes:

- No data logs are written while device is connected to a PC via USB.
- Always disable Data Logging before removing log files (when log memory becomes full). See **Viewing the Data Log** on page 119.

2.10.1. Process Value Log

2.10.1.1. Enable

Enables/disables Process Value (PV) Logging.

Options		ENABLED
	*	DISABLED

2.10.1.2. Process Values Log Rate

Sets Process Value (PV) Logging rate in minutes.

Values	Range: 1 to 1440
	Default: 1

2.10.2. Alarm Log

2.10.2.1. Enable

Enables/disables Alarm Logging.

Options		ENABLED
	*	DISABLED

2.10.3. Flow Log

Available only on LUT430 (Pump and Flow model), and LUT440 (OCM model).

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.10.3.1. Flow Log Mode

Menu number *2.10.3.1* visible on LUT430 (Pump and Flow model).

OR

2.10.3.2. Flow Log Mode

Menu number *2.10.3.2* visible on LUT440 (OCM model).

Sets flow log mode.

Options	*	OFF
		FIXED RATE
		VARIABLE PERCENTAGE MAX FLOW / MIN ^a
		VARIABLE PERCENTAGE MAX FLOW ^a
		VARIABLE PERCENTAGE MAX HEAD ^a

^aOption available only for LUT440.

2.10.3.3. Standard Flow Log Interval

Sets standard flow log interval in minutes, when 2.10.3.1.Flow Log Mode set to a fixed or variable rate.

Values	Range: 1 to 1440
	Default: 1

2.10.3.4. Standard Flow Log Setpoint

Sets standard flow setpoint as a percent based on flow log mode, when 2.10.3.1.Flow Log Mode set to a variable rate.

Values	Range: 0.000 to 110.000
	Default: 0.000

2.10.3.5. Rapid Flow Log Interval

Sets rapid flow log interval in minutes, when 2.10.3.1.Flow Log Mode set to a variable rate.

Values	Range: 1 to 1440
	Default: 1

2.10.3.6. Rapid Flow Log Setpoint

Sets rapid flow setpoint as a percent based on flow logger mode, when 2.10.3.1.Flow Log Mode set to a variable rate.

Values	Range: 0.000 to 110.000
	Default: 0.000

2.11. Other Control

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.11.1. Elapsed Time Relay

This function drives a relay based on an interval and duration of time. The relay toggles on and off at a rate set by the parameters below. (This relay is not affected by LOE, faults, alarms, or any other condition within the device.)

2.11.1.1. Enable

Enables/disables elapsed time relay control.

Options		ENABLED
	*	DISABLED

2.11.1.2. Interval

The interval in minutes from the activation of the relay until the next activation.

Values	Range: 0.1 to 99999 ^a
	Default: 60.0

^a. Fractional values are allowed, such as 0.5 for 30 seconds

This value must be greater than the 2.11.1.3.Relay Duration or the relay will never reset. The first activation occurs when the device is powered on.

2.11.1.3. Relay Duration

The time in seconds from one change of state in the relay to the next.

Values	Range: 1 to 9999
	Default: 10

This value must be less than the 2.11.1.2.Interval or the relay will never reset.

2.11.1.4. Assigned Relay*Determines the relay assigned to elapsed time control.*

Options	*	RELAY 1
		RELAY 2
		RELAY 3

2.11.1.5. Relay Logic*Use to change the behaviour of the relay assigned to elapsed time control.*

Options	*	NORMALLY OPEN
		NORMALLY CLOSED

Relay contact operation is **NORMALLY CLOSED** for alarms and **NORMALLY OPEN** for controls.

By default a control contact is **Normally Open**. For *2.11.1.3.Relay Duration* the corresponding relay coil is energized. By setting this parameter to **Normally Closed**, the relay coil will be de-energized for the duration phase.

2.11.2. Time of Day Relay*This function drives a relay based on time of day. The relay toggles on and off at a rate set by the parameters below. This relay is not affected by LOE, faults, alarms, or any other condition within the device.***2.11.2.1. Enable***Enables/disables time of day relay control.*

Options		ENABLED
	*	DISABLED

2.11.2.2. Activation Time*Sets time of day, using a 24-hour clock, at which the relay should activate.*

Values	Range: 00:00 to 23:59
	Format: HH:MM (24 hour format, e.g. for 5:30 pm, set parameter to 17:30)
	Default: 00:00

For instructions on how to edit parameters with a string editor, see *Using the string editor:* on page 187.

2.11.2.3. Relay Duration*The time in seconds from one change of state in the relay to the next.*

Values	Range: 1 to 9999
	Default: 10

2.11.2.4. Assigned Relay*Determines the relay assigned to time of day control.*

Options	*	RELAY 1
		RELAY 2
		RELAY 3

2.11.2.5. Relay Logic

Use to change the behaviour of the relay assigned to time of day control.

Options	*	NORMALLY OPEN
		NORMALLY CLOSED

Relay contact operation is NORMALLY CLOSED for alarms and NORMALLY OPEN for controls.

By default a control contact is **Normally Open**. For *2.11.2.3.Relay Duration* the corresponding relay coil is energized. By setting this parameter to **Normally Closed**, the relay coil will be de-energized for the duration phase.

2.11.3. External Totalizer

Available only on LUT430 (Pump and Flow model), and LUT440 (OCM model).

*This function tracks the volume of material that passes through a system. The external totalizer controls a relay to signal an external totalizing device. The relay toggles on and off at a rate set by the parameters below. (For details on relay behaviour under fail-safe conditions, see **Miscellaneous relays** on page 66.)*

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.11.3.1. Enable

Enables/disables external totalizer relay control.

Options		ENABLED
	*	DISABLED

2.11.3.2. Multiplier

Use to scale the external totalizer up or down as required.

Values	Range: 0.0000001 to 99999.000
	Default: 1.000

This allows the totalizer relay to click for different values of volume.

Example:

To click once every 4310 units, set *2.11.3.2. Multiplier* to 4310.

2.11.3.3. Relay Duration

The time in seconds from one change of state in the relay to the next.

Values	Range: 0.1 to 1024.0
	Default: 0.2

2.11.3.4. Assigned Relay

Determines the relay assigned to external totalizer control.

Options	*	RELAY 1
		RELAY 2
		RELAY 3

2.11.3.5. Relay Logic

Use to change the behaviour of the relay assigned to external totalizer control.

Options	*	NORMALLY OPEN
		NORMALLY CLOSED

Relay contact operation is **NORMALLY CLOSED** for alarms and **NORMALLY OPEN** for controls.

By default a control contact is **Normally Open**. For *2.11.3.3. Relay Duration* the corresponding relay coil is energized. By setting this parameter to **Normally Closed**, the relay coil will be de-energized for the activation phase.

2.11.4. External Sampler

Available only on LUT430 (Pump and Flow model), and LUT440 (OCM model).

*This function uses a relay to signal a flow sampling device when a certain volume of material has passed through a system (set by the Multiplier), or after a defined period of time (set by the Interval). The relay toggles on and off at a rate set by the parameters below. (For details on relay behaviour under fail-safe conditions, see **Miscellaneous relays** on page 66.)*

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.11.4.1. Enable

Enables/disables flow sampler relay control.

Options		ENABLED
	*	DISABLED

2.11.4.2. Multiplier

Use to scale the external sampler up or down as required.

Values	Range: 0.0000001 to 99999.000
	Default: 1.000

This allows the sampler relay to click for different values of volume.

Example:

To click once every 4310 flow units, set *2.11.4.2. Multiplier* to 4310.

2.11.4.3. Interval

The time in hours from the activation of the relay until the next activation.

Values	Range: 0.10 to 99999.00
	Default: 1.00

Set the time to activate the relay during low-flow conditions.

2.11.4.4. Relay Duration

The time in seconds from one change of state in the relay to the next.

Values	Range: 0.1 to 1024.0
	Default: 0.2

This value must be less than the *2.11.4.3.Interval* or the relay will never reset.

2.11.4.5. Assigned Relay

Determines the relay assigned to flow sampler control.

Options	*	RELAY 1
		RELAY 2
		RELAY 3

2.11.4.6. Relay Logic

Use to change the behaviour of the relay assigned to flow sampler control.

Options	*	NORMALLY OPEN
		NORMALLY CLOSED

Relay contact operation is NORMALLY CLOSED for alarms and NORMALLY OPEN for controls.

By default a control contact is **Normally Open**. For *2.11.4.3.Interval* the corresponding relay coil is energized. By setting this parameter to **Normally Closed**, the relay coil will be de-energized for the activation phase.

2.12. Signal Processing

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.12.1. Temperature and Velocity

2.12.1.1. Sound Velocity

*The value adjusted based on the **Sound Velocity at 20 degrees C (2.12.1.5.)** vs. **Process Temperature (2.12.1.2.)** characteristics of air.*

Values	Range: 125.000 to 20000.000 m/s
	Default: 344.130 m/s

Alternatively, enter the current sound velocity (if known), or perform an *2.12.1.6.Auto Sound Velocity* calibration. Value is always reported in m/s.

2.12.1.2. Process Temperature

View the transducer temperature in °C.

If **Temperature Source (2.12.1.3)** is set to any value other than **Fixed Temperature (2.12.1.4.)**, the value displayed is the temperature measured. If Temperature Source is set to **Temp Fixed**, the **Fixed Temperature (2.12.1.4.)** value is displayed.

2.12.1.3. Temperature Source

Source of the temperature reading used to adjust the speed of sound.

Options	*	TRANSDUCER
		FIXED TEMPERATURE
		EXTERNAL TS-3
		AVERAGE OF SENSORS (Transducer and TS-3)

With this default, the SITRANS LUT400 uses the transducer's internal temperature sensor (standard in all Siemens EchoMax Transducers).

If the transducer does not have an internal temperature sensor, Fixed Temperature value, or an External TS-3 temperature sensor can be used.

If the acoustic beam atmosphere temperature varies with distance from the transducer, connect a TS-3 Temperature Sensor and Ultrasonic/Temperature Transducer, and select Average of Sensors (Transducer and TS-3).

In gasses other than air, the temperature variation may not correspond with the speed of sound variation. In these cases, turn off the temperature sensor, select value Fixed Temperature, and set a fixed temperature [see **Fixed Temperature (2.12.1.4.)**].

If Ultrasonic/Temperature Transducer, TS-3 Temperature Sensor, or Average of Sensors value is selected, faults on the temperature sensors will be displayed if the sensor appears open or short.

When a transducer temperature sensor fault occurs, Temperature Source can be set to FIXED. This allows the device to continue measuring (and no cable fault will display), until the transducer is replaced. Once replaced, set Temperature Source back to its original setting.

2.12.1.4. Fixed Temperature

Use this feature if a temperature sensing device is not used.

Values	Range: -100.0 to +150.0 °C
	Default: +20.0 °C

Enter the temperature (in °C) of the atmosphere within the transducer acoustic beam. If the temperature varies with distance from the transducer, enter the average temperature.

2.12.1.5. Sound Velocity at 20 degrees C

This value is used to automatically calculate sound velocity.

Values	Range: 125.000 to 20000.000 m/s
	Default: 344.13 m/s

If the acoustic beam atmosphere sound velocity at 20°C (68 °F) is known, and the sound velocity vs. temperature characteristics are similar to that of air (344.1 m/s), enter the sound velocity. Units displayed in meters per second (m/s).

2.12.1.6. Auto Sound Velocity

Note: Auto Sound Velocity supports adjustments to distance value only.

Adjusts the speed of sound and changes the distance measurement calculations. Defined in 2.1.1.Units.

Values	Range: 0.000 to 60.000
---------------	-------------------------------

Condition for use of this feature:

- The acoustic beam atmosphere is other than air
- The acoustic beam atmosphere temperature is unknown
- The Reading accuracy is acceptable at higher material levels only

For best results, calibrate with the level at a known value near Low Calibration Point.

Using Auto Sound Velocity:

Start with a steady distance at a known high distance value (high distance value equates to a low level value).

1. Review the distance measurement via LUI for approximately 30 seconds to verify repeatability.
2. Measure the actual distance (for example, with a tape measure).
3. Enter the actual distance, defined in 2.1.1.Units.

Repeat this procedure if the atmosphere type, concentration, or temperature conditions are different from when the last sound velocity calibration was performed.

Note: In gasses other than air, the temperature variation may not correspond with the speed of sound variation. Turn off temperature sensor and use a fixed temperature.

2.12.2. Echo Select

2.12.2.1. Algorithm

Selects the algorithm to be applied to the echo profile to extract the true echo.

Options	TF	TRUE FIRST	True First echo
	TR	TRACKER	TRacker
	L	LARGEST ECHO	Largest echo
	*	BLF BEST F-L	Best of First and Largest echo
	ALF	AREA LARGEST FIRST	Area, Largest and First

For more details, see *Algorithm* on page 257.

2.12.2.2. Echo Threshold

*Sets the minimum echo confidence that the echo must meet in order to prevent a Loss of Echo condition and the expiration of the Fail-safe (LOE) timer. When **Confidence (3.2.9.2.)** exceeds **Echo Threshold (2.12.2.2.)**, the echo is accepted as a valid echo and is evaluated.*

Values	Range: -20 to 128
	Default: 5

Use this feature when an incorrect material level is reported.

2.12.2.3. Reform Echo

Smooth jagged peaks in the echo profile.

Values	Range: 0 to 50 intervals ^a (greater = wider)
	Default: 0

^{a.} one interval = span of 24.5 micro seconds

Use this feature when monitoring solids if the reported level fluctuates slightly though the monitored surface is still. Enter the amount (in ms) of Echo Profile smoothing required. When a value is keyed in, the nearest acceptable value is entered.

2.12.2.4. Narrow Echo Filter

Filters out echoes of a specific width.

Values	Range: 0 to 14 intervals ^a (greater = wider)
	Default: 2

^{a.} one interval = span of 24.5 micro seconds

Use this for transducer acoustic beam interference (e.g. ladder rungs). Enter the width of false echoes (in groups of 25 ms), to be removed from the Echo Profile. [For example, select value of 3 to remove 75 ms (3 x 25 ms) of false echos from the profile.]

When a value is keyed in, the nearest acceptable value is entered.

2.12.2.5. Submergence Detection

Enables/disables submergence detection.

Values		Enabled
	*	Disabled

(Submergence Detection Shield must first be installed on transducer.)

When this parameter is enabled and the transducer becomes submerged:

- fault code 26 is displayed (see **General Fault Codes** on page 231),
- mA output immediately advances to **Minimum mA Limit (2.5.5.)** or **Maximum mA Limit (2.5.6.)**, as defined by the application,
- DISTANCE is set to zero (corresponding to a high level),
- pumps and alarms operate normally (according to level), therefore they remain ON (or activate if not already ON).

The submergence condition remains in effect until the transducer is no longer submerged. A valid echo must then be detected before the LOE Timer expires or the device will enter fail-safe condition (see 2.4. *Fail-Safe*).

2.12.3. TVT Setup

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.12.3.1. Auto False Echo Suppression

Used together with **Auto False Echo Suppression Range (2.12.3.2.)** to screen out false echoes in a vessel with known obstructions. A 'learned TVT' (time varying threshold) replaces the default TVT over a specified range. See **Shaper Mode and Auto False Echo Suppression** on page 258 for a more detailed explanation.

Notes:

- Make sure material level is below all known obstructions when Auto False Echo Suppression is used to learn the echo profile. (An empty or almost empty vessel is recommended.)
 - Note the distance to material level when Auto False Echo learns the environment. Set Auto False Echo Suppression Range to a shorter distance to avoid the material echo being screened out.
 - Set Auto False Echo Suppression and Auto False Echo Suppression Range during startup, if possible.
 - All other tuning and filter adjustments (such as 2.12.2.4. *Narrow Echo Filter*, 2.12.2.3. *Reform Echo*, 2.12.3.3. *Hover Level*, etc.) should be completed prior to using Auto False Echo Suppression to ensure that the learned profile is representative.
- a) Determine Auto False Echo Suppression Range. Measure the actual distance from the sensor reference point to the material surface using a rope or tape measure.
 - b) Subtract 0.5 m (20") from this distance, and use the resulting value.

To set Auto False Echo Suppression via SIMATIC PDM:

Open the menu **Device – Echo Profile Utilities** and click on the tab **Auto False Echo Suppression**.

(For more detailed instructions see *Auto False Echo Suppression* in LUT400 Communications manual¹.)

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

To set Auto False Echo Suppression via the local push buttons:

Options		OFF	Default TVT will be used.
	*	ON	'Learned' TVT will be used.
		LEARN	'Learn' the TVT.

- Navigate to **Setup (2.) > Signal Processing (2.12.) > TVT Setup (2.12.3.) > Auto False Echo Suppression Range (2.12.3.2.)**, and enter the value calculated in step b).
- Navigate to **Setup (2.) > Signal Processing (2.12.) > TVT Setup (2.12.3.) > Auto False Echo Suppression (2.12.3.1.)**, and press **RIGHT arrow** to open Edit Mode
- Select **Learn**. The device will automatically revert to **On** (Use Learned TVT) after a few seconds.

2.12.3.2. Auto False Echo Suppression Range

*Specifies the range within which Learned TVT is used (see **Auto False Echo Suppression** on page 183 for more detail).*

Values	Range: 0.000 to 60.000 m
	Default: 1.000

- Calculate range according to **Auto False Echo Suppression (2.12.3.1.)** steps a) and b).
- Press **RIGHT arrow** to open Edit mode.
- Enter the new value and press **RIGHT arrow** to accept it.
- Navigate to **Setup (2.) > Signal Processing (2.12.) > TVT Setup (2.12.3.) > Auto False Echo Suppression (2.12.3.1.)**, and set value.

2.12.3.3. Hover Level

*Defines how high the TVT (Time Varying Threshold) is placed above the noise floor of the echo profile, as a percentage of the difference between the peak of the largest echo in the profile and the noise floor. See **Example before Auto False Echo Suppression** on page 259 for an illustration.*

Values	Range: 0 to 100
	Default: 40

When the device is located in the center of the vessel, the TVT hover level may be lowered to increase the confidence level of the largest echo.

2.12.3.4. Shaper Mode

Enables/disables the TVT shaper.

Options		ON
	*	OFF

Turn TVT Shaper Mode ON before using *2.12.4. TVT Shaper*. Turn the TVT Shaper **ON** and **OFF** while monitoring the effect to pick up the true echo.

2.12.4. TVT Shaper

Adjusts the TVT (Time Varying Threshold) at a specified range (breakpoint on the TVT). This allows you to reshape the TVT to avoid unwanted echoes. There are 40 breakpoints arranged in 5 groups. (We recommend using SIMATIC PDM to access this feature.)

To use TVT shaper via SIMATIC PDM:

- a) Open the menu **Device – Echo Profile Utilities** and click on **TVT Shaper**. (For more details see *TVT Shaper* in LUT400 Communications manual¹.)

To use TVT shaper via local push buttons:

- a) Navigate to **Setup (2.) > Signal Processing (2.12.) > TVT Setup (2.12.3.) > Shaper Mode (2.12.3.4.)**, and select **ON**.
- b) From the TVT Setup menu, **LEFT ARROW** to the Signal Processing menu, and **DOWN ARROW** to TVT Shaper. **RIGHT ARROW** to enter the TVT Shaper menu and **RIGHT ARROW** to edit **Breakpoint 1-8 (2.12.4.1.)**.
- c) Open TVT Breakpoint 1 enter the TVT Offset value (between –50 and 50).
- d) Go to the next TVT Breakpoint and repeat steps c) and d) till all desired breakpoint values have been entered.

2.12.4.1. Breakpoint 1-8

Values	Range: –50 to 50 dB
	Default: 0 dB

2.12.4.2. Breakpoint 9-16

Values	Range: –50 to 50 dB
	Default: 0 dB

2.12.4.3. Breakpoint 17-24

Values	Range: –50 to 50 dB
	Default: 0 dB

2.12.4.4. Breakpoint 25-32

Values	Range: –50 to 50 dB
	Default: 0 dB

2.12.4.5. Breakpoint 33-40

Values	Range: –50 to 50 dB
	Default: 0 dB

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

2.12.5. Measured Values

Read only. Allows you to view measured values for diagnostic purposes.

To access measured values via SIMATIC PDM:

Open the menu **View – Process Variables**.

Note: These parameters will display the simulated value when in simulation mode (see *Simulation process* on page 122).

2.12.5.1. Level Measurement

*The distance to monitored surface referenced from **Low Calibration Point (2.2.1.)**, defined in **Units (2.1.1.)**.*

2.12.5.2. Space Measurement

*The distance to monitored surface referenced from **High Calibration Point (2.2.2.)**, defined in **Units (2.1.1.)**.*

2.12.5.3. Distance Measurement

*The distance to monitored surface referenced from the transducer face (sensor reference point), defined in **Units (2.1.1.)**.*

2.12.5.4. Volume Measurement

*The calculated vessel volume (calculated from level and scaled according to vessel shape) in **Volume Units (2.6.2.)**.*

2.12.5.5. Head Measurement

Available only on LUT430 (Pump and Flow model), and LUT440 (OCM model).

*Corresponds to Head [the distance from **Zero Head Offset (2.15.3.5.)** to the monitored surface in **Units (2.1.1.)**].*

2.12.5.6. Flow Measurement

Available only on LUT430 (Pump and Flow model) and LUT440 (OCM model).

*The calculated flowrate, defined in **Flowrate Units (2.15.3.7.)**.*

2.13. Display

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.13.1. Local Display Backlight

Time the backlight remains on.

Options		OFF
	*	ON
		TIMED (on for five minutes after key press - takes effect in Measurement View only)

Available only via LUI.

2.13.2. LCD Contrast

The factory setting is for optimum visibility at room temperature and in average light conditions. Extremes of temperature will lessen the contrast.

Values	Range: 0 (Low contrast) to 20 (High contrast)
	Default: 10

Adjust the value to improve visibility in different temperatures and luminosity.
Available only via LUI and web browser.

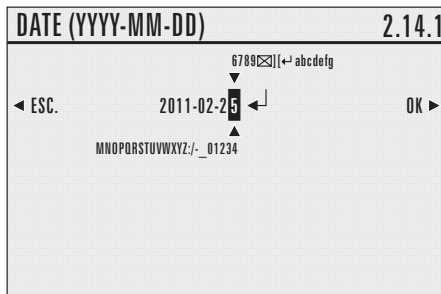
2.14. Date and Time

Enter the current date and time using the local push buttons.

Parameter **Edit** mode displays a string editor.

Using the string editor:

- Use **RIGHT/LEFT arrow** to select the character position in the parameter field to be edited.



- As each character is highlighted (selected), use the **UP/DOWN arrow** to change the character.
 - Use the **DOWN arrow** to select a character from the string *above* the parameter value.
 - Use the **UP arrow** to select a character from the string *below* the parameter value.
- To escape without saving your changes, press **LEFT arrow** continually until **ESC** is highlighted. Press **LEFT arrow** again to escape without saving changes. Otherwise, when new parameter value is correct, press **RIGHT arrow** continually until **OK** is highlighted.
- Press **RIGHT arrow** to accept the new value. The LCD returns to parameter view and displays the new selection. Review for accuracy.

Special Characters:

Character	Description	Function
:	colon	enters colon in text string
	space	enters space in text string
/	slash	enters slash in text string
-	hyphen	enters hyphen in text string
_	underscore	enters underscore in text string

Character	Description	Function
☒	'x' in box	deletes highlighted character in text string
]]	square brackets	inserts space between two characters in text string (limited to one space between characters)
↵	return arrow key	deletes characters (including currently highlighted character) to end of text string

2.14.1. Date

Date is the current date in the format: YYYY-MM-DD.

Values	Range: 1900-01-01 to 2155-12-31
---------------	---------------------------------

2.14.2. Time

Time is the current time in 24-hour format: HH:MM[:SS].

Values	Range: 00:00:00 to 23:59:59
---------------	-----------------------------

A value for seconds [:SS] is optional. If a value is not entered, the clock will default to 0 seconds.

2.14.3. Daylight Saving

Use the following parameters to enable and define start/end dates for daylight saving. (Start/end time of day is always 2:00am.)

Example:

Set the start of daylight saving to the second Sunday in February, and the end of daylight saving to the first Sunday in November:

- Starting Ordinal = Second
- Starting Day = Sunday
- Starting Month = February
- Ending Ordinal = First
- Ending Day = Sunday
- Ending Month = November

2.14.3.1. Enable

Enables/disables daylight saving.

Options		ENABLED
	*	DISABLED

2.14.3.2. Starting Ordinal

The order of the day within the month when daylight saving will begin.

Options		FIRST, SECOND, THIRD, FOURTH
	*	FIRST

2.14.3.3. Starting Day

The day of the week on which daylight saving will begin.

Options		SUNDAY, MONDAY, TUESDAY, WEDNESDAY, THURSDAY, FRIDAY, SATURDAY
	*	SUNDAY

2.14.3.4. Starting Month

The month in which daylight saving will begin.

Options		JANUARY, FEBRUARY, MARCH, APRIL, MAY, JUNE, JULY, AUGUST, SEPTEMBER, OCTOBER, NOVEMBER, DECEMBER
	*	JANUARY

2.14.3.5. Ending Ordinal

The order of the day within the month when daylight saving will end.

Options		FIRST, SECOND, THIRD, FOURTH
	*	FIRST

2.14.3.6. Ending Day

The day of the week on which daylight saving will end.

Options		SUNDAY, MONDAY, TUESDAY, WEDNESDAY, THURSDAY, FRIDAY, SATURDAY
	*	SUNDAY

2.14.3.7. Ending Month

The month in which daylight saving will end.

Options		JANUARY, FEBRUARY, MARCH, APRIL, MAY, JUNE, JULY, AUGUST, SEPTEMBER, OCTOBER, NOVEMBER, DECEMBER
	*	JANUARY

2.15. Flow

Available only on LUT430 (Pump and Flow model) and LUT440 (OCM model).

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

2.15.1. Primary Measuring Device (PMD)

The type of primary measuring device (PMD) used.

Values	*	OFF (no calculation)
		EXPONENTIAL DEVICES
		RECTANGULAR FLUME BS-3680
		ROUND NOSE HORIZONTAL CR. BS-3680
		TRAPEZOIDAL FLUME BS-3680
		U-FLUME BS-3680
		FINITE CREST WEIR BS-3680
		THIN PLATE RECT. WEIR BS-3680
		THIN PLATE V-NOTCH WEIR BS-3680
		RECT. WEIR CONTRACTED
		ROUND PIPE
		PALMER BOWLUS FLUME
		H-FLUME
		UNIVERSAL HEAD FLOW

The LUT400 is pre-programmed for common PMD flow calculations. If your PMD is not listed, use a Universal Flow calculation. See ***Universal calculation support*** on page 116.

2.15.2. Auto Zero Head

Calibrates 2.15.3.5.Zero Head Offset (defined in 2.1.1.Units) based on actual head measurements.

Values	Range: -60.000 to 60.000
	Default: 0.000

Use this parameter when the reported head is consistently high or low by a fixed amount.

Before using this feature, verify the following parameters are correct:

- *2.2.1.Low Calibration Point*
- *2.12.1.2.Process Temperature*

With HEAD steady...

- a) Measure the actual head (e.g. with a tape measure or solid rule)
- b) Enter the actual head value

The deviation between the entered head value and the calibrated value, is stored in *2.15.3.5.Zero Head Offset*.

2.15.3. Basic Setup

2.15.3.1. Method of Flow Calculation

Sets the method of flow calculation.

Options	*	ABSOLUTE
		RATIOMETRIC

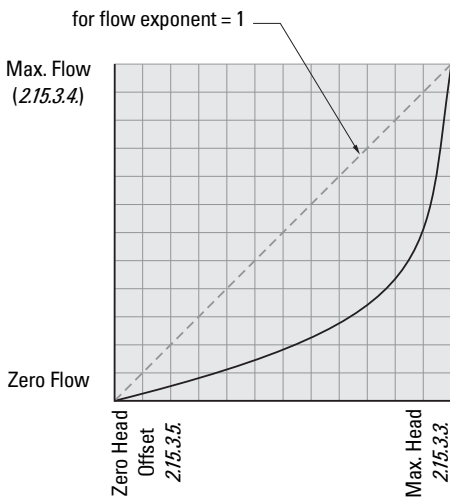
Set this parameter to **Ratiometric** only if the primary measuring device (PMD) supports ratiometric calculations. (Note that Palmer Bowlus Flume and H-Flume support ratiometric calculations only.) For more details on Absolute and Ratiometric calculations, see **Method of Flow Calculation** on page 266.

2.15.3.2. Flow Exponent

The exponent for the flow calculation formula.

Values	Range: -999.000 to 9999.000
	Default: 1.550

Use this parameter if the PMD is set to **Exponential devices**. It creates an exponential curve with end points set by *2.15.3.3.Maximum Head* and *2.15.3.5.Zero Head Offset* and with the curve based on the specified exponent.



Exponents
The exponential equation is: $Q = KH^{\text{Flow Exponent (2.15.3.2.)}}$
Where: Q = flow K = constant factor H = head

Use the exponent specified by the PMD manufacturer, if available, or relevant Open Channel Monitoring reference material.

2.15.3.3. Maximum Head

The maximum level value associated with the PMD and works in conjunction with 2.15.3.4. Maximum Flow at 20 mA for Ratiometric calculations. (Defined in 2.1.1.Units.)

Values	Range: 0.000 to 60.000
	Default: 60.000

This represents the highest head level supported by the Primary Measuring Device (PMD) and works in conjunction with 2.15.3.4. Maximum Flow at 20 mA to define the highest point in the exponential curve. Use it when the PMD requires a maximum head and flow reference point. Maximum Head must be set for all Absolute and Ratiometric PMDs.

2.15.3.4. Maximum Flow at 20 mA

<p>Note:</p> <ul style="list-style-type: none"> • The display of the measured value is limited to 7 Characters. Setting a Maximum Flow value larger than 7 characters will not display correctly. • If measured value is larger than 7 characters, #### will be displayed. A larger unit (2.15.3.7.Flowrate Units) should be used, or number of decimal points (2.15.3.6.Flowrate Decima) should be reduced.

The maximum flowrate associated with 2.15.3.3.Maximum Head shown in 2.15.3.7.Flowrate Units.

Values	Range: 0 to 9999999
	Default: 100

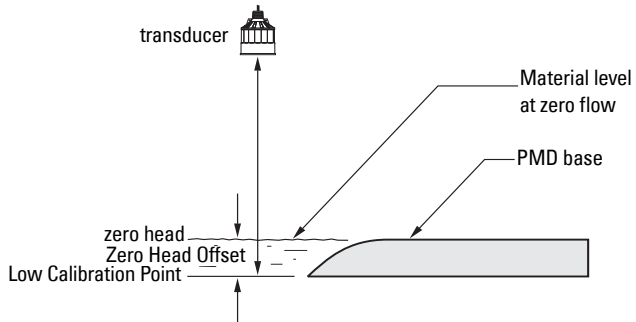
This represents the flow at the highest head level supported by the Primary Measuring Device (PMD) and works in conjunction with 2.15.3.3.Maximum Head to define the highest point in the exponential curve. Use it when the PMD requires a maximum head and flow reference point. Maximum Flow must be set for all Absolute and Ratiometric PMDs.

2.15.3.5. Zero Head Offset

The difference (positive or negative) between Low Calibration Point and zero head (level at zero flow), defined in 2.1.1.Units.

Values	Range: -60.000 to 60.000
	Default: 0.000

This feature can be used for most weirs and some flumes (e.g. Palmer Bowlus) where the zero reference is at a higher elevation than the channel bottom.



2.15.3.6. Flowrate Decimal

The maximum number of decimal places to be displayed.

Options	*	NO DIGITS	no digits after the decimal point
		1 DIGIT	1 digit after the decimal point
		2 DIGITS	2 digits after the decimal point
		3 DIGITS	3 digits after the decimal point

2.15.3.7. Flowrate Units

The volume units used to display total flow.

Options	*	L/S (Litres per second)
		L/MIN (Litres per minute)
		CUFT/S (Cubic feet per second)
		CUFT/D (Cubic feet per day)
		GAL/MIN (US Gallons per minute)
		GAL/D (US Gallons per day)
		IMPGAL/MIN (Imperial Gallons per minute)
		IMPGAL/D (Imperial Gallons per day)
		CUM/H (Cubic meters per hour)
		CUM/D (Cubic meters per day)
		MMGAL/D (Mega-gallons per day)
		USER DEFINED (units defined in 2.15.3.8.User Defined Unit)

2.15.3.8. User Defined Unit

Set the unit text to display for current flow when 2.15.3.7.Flowrate Units set to **user-defined**. Limited to 16 ASCII characters.

Notes: The text entered is simply for display purposes. No unit conversion occurs.

2.15.3.9. Low Flow Cutoff

Eliminates totalizer activity for head levels at or below the cutoff value.

Values	Range: 0.000 to 60.000
	Default: 0.000

Enter the minimum head in 2.11.Units where totalizer activity should cease.

2.15.4. PMD Dimensions

The dimensions of the Primary Measuring Device (PMD). (The dimensions of the vessel, wet well, or reservoir are only important if you require volume.)

The following table is a reference to the parameters that must be set for each PMD. Parameter definitions follow the table.

Supported PMD	Dimensions required
Exponential Devices	
	2.15.3.2. Flow Exponent
	2.15.4.1. K Factor
Rectangular Flume BS-3680	
	2.15.4.5. OCM Dimension 1 - approach width B
	2.15.4.6. OCM Dimension 2 - throat width b
	2.15.4.7. OCM Dimension 3- hump height p
	2.15.4.8. OCM Dimension 4- throat length L
Round Nose Horizontal Crest Weir BS-3680	
	2.15.4.5. OCM Dimension 1 - crest width b
	2.15.4.6. OCM Dimension 2 - crest height p
	2.15.4.7. OCM Dimension 3- crest length L

Supported PMDs (cont'd)	
Trapezoidal Flume BS-3680	
	<i>2.15.4.5. OCM Dimension 1 - approach width B</i>
	<i>2.15.4.6. OCM Dimension 2 - throat width b</i>
	<i>2.15.4.7. OCM Dimension 3 - hump height p</i>
	<i>2.15.4.8. OCM Dimension 4 - throat length L</i>
	<i>2.15.4.3. Slope</i>
U-Flume BS-3680	
	<i>2.15.4.5. OCM Dimension 1 - approach diameter Da</i>
	<i>2.15.4.6. OCM Dimension 2 - throat diameter D</i>
	<i>2.15.4.7. OCM Dimension 3 - hump height p</i>
	<i>2.15.4.8. OCM Dimension 4 - throat length L</i>
Finite Crest Weir BS-3680	
	<i>2.15.4.5. OCM Dimension 1 - crest width b</i>
	<i>2.15.4.6. OCM Dimension 2 - crest height p</i>
	<i>2.15.4.7. OCM Dimension 3 - crest length L</i>
Thin Plate Rectangular Weir BS-3680	
	<i>2.15.4.5. OCM Dimension 1 - approach width B</i>
	<i>2.15.4.6. OCM Dimension 2 - crest width b</i>
	<i>2.15.4.7. OCM Dimension 3 - crest height p</i>
Thin Plate V-Notch Weir BS-3680	
	<i>2.15.4.2. V-Notch Angle</i>
Rectangular Weir Contracted	
	<i>2.15.4.5. OCM Dimension 1 - crest width b</i>
Round Pipe	
	<i>2.15.4.5. OCM Dimension 1 - pipe inside diameter D</i>
	<i>2.15.4.3. Slope</i>
	<i>2.15.4.4. Roughness Coefficient</i>

Parameters

Supported PMDs (cont'd)	
Palmer Bowlus Flume	
	2.15.4.5. OCM Dimension 1 - maximum flume width hmax
H-Flume	
	2.15.4.5. OCM Dimension 1 - maximum listed head hmax
Universal Head Flow	
	2.15.5.1.1. Head 1 (up to 32)
	2.15.5.1.2. Flow 1 (up to 32)

2.15.4.1. K Factor

The constant used in the flow calculation formula for absolute calculation of an exponential device only.

Values	Range: -999.000 to 9999.000
	Default: 1.000

Use this parameter if the PMD is set to **Exponential devices**. The Constant Factor is used to create an exponential curve with end points set by 2.15.3.3. *Maximum Head* and 2.15.3.5. *Zero Head Offset*, and with the curve based on the specified exponent.

2.15.4.2. V-Notch Angle

The V-Notch angle used in the flow calculation formula.

Values	Range: 25.000 to 95.000
	Default: 25.000

Use when PMD is set to Thin Plate V-Notch Weir.

2.15.4.3. Slope

The Flow Slope used in the flow calculation formula.

Values	Range: -999.000 to 9999.000
	Default: 0.000

Use when PMD is set to Trapezoidal Flume or Round Pipe.

2.15.4.4. Roughness Coefficient

The Flow Roughness Coefficient used in the flow calculation formula.

Values	Range: -999.000 to 9999.000
	Default: 0.000

Use when PMD is set to Round Pipe.

2.15.4.5. OCM Dimension 1**2.15.4.6. OCM Dimension 2****2.15.4.7. OCM Dimension 3**

2.15.4.8. OCM Dimension 4

See table under **PMD Dimensions (2.15.4.)** to relate OCM Dimension 1-4 above to a specific dimension for each directly supported Primary Measuring Device. For PMDs that are not directly supported (*Universal Head Flow*), use a Universal Flow calculation. See **Universal calculation support** on page 116.

For more information on PMD, see **Open Channel Monitoring (OCM)** on page 97.

2.15.5. Universal Head vs. Flow

In the following table, enter Head and Flow Breakpoints for universal PMDs.

*Head Breakpoints: The head breakpoints for which flowrate is known, defined in **Units (2.1.1.)**.*

*Flowrate Breakpoints: The flowrate corresponding to each Head Breakpoint entered, defined in **Flowrate Units (2.15.3.7.)**.*

Head Values	Range: 0.000 to 60.000
	Default: 0.000
Flowrate Values	Range: 0 to 9999999
	Default: 0

See **Universal calculation support** on page 116 for details on how to specify universal flows.

Entering breakpoints via SIMATIC PDM:

See *Quick Start (Flow)* in the LUT400 Communications manual¹.

2.15.5.1. Table 1-8

2.15.5.1.1. Head 1

2.15.5.1.2. Flow 1

2.15.5.2. Table 9-16

2.15.5.2.1. Head 9

2.15.5.2.2. Flow 9

2.15.5.3. Table 17-24

2.15.5.3.1. Head 17

2.15.5.3.2. Flow 17

2.15.5.4. Table 25-32

2.15.5.4.1. Head 25

2.15.5.4.2. Flow 25

2.16. Totalizers

Available only on LUT430 (Pump and Flow model) and LUT440 (OCM model).

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

2.16.1. Daily Totalizer

Read only. Current daily totalizer value. (Automatically resets daily and can be reset by user.)

Values	Range: 0.00 to 999999999
	Default: 0.00

2.16.2. Running Totalizer

Read only. Current running totalizer value. (Reset only by user.)

Values	Range: 0.00 to 999999999
	Default: 0.00

2.16.3. Totalizer Decimal Position

Sets the maximum number of decimal places to be displayed.

Options		NO DIGITS	no digits after the decimal point
		1 DIGIT	1 digit after the decimal point
	*	2 DIGITS	2 digits after the decimal point
		3 DIGITS	3 digits after the decimal point

2.16.4. Totalizer Multiplier

Use this feature if the LCD Total increments by an amount that is too large (or too small).

Options		.001
		.01
		.1
	*	1
		10
		100
		1000
		10,000
		100,000
		1,000,000
		10,000,000

Enter the factor (powers of 10 only) by which actual flow is divided, prior to display on LCD. Use a value such that the eight-digit totalizer doesn't roll over between readings.

Example: For an LCD Total display in 1000s of flow units, enter 1000.

2.16.5. Reset Daily Totalizer

*Select **YES** to reset daily totalizer value to zero.*

Options	*	NO
		YES

2.16.6. Reset Running Totalizer

Select **YES** to reset running totalizer value to zero.

Options	*	NO
		YES

3. Maintenance and Diagnostics

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

3.1. Identification

To edit parameters with a string editor (3.1.1 to 3.1.5), see *Using the string editor:* on page 187.

3.1.1. TAG

*Text that can be used in any way. A recommended use is as a unique label for a field device in a plant. Limited to 32 alphanumeric characters (8 characters via HART). Appears in top left corner of display in measurement mode (see **The LCD Display** on page 34).*

3.1.2. Long TAG

Text that can be used in any way. A recommended use is as a unique label for a field device in a plant. Limited to 32 alphanumeric characters.

3.1.3. Descriptor

Text that can be used in any way. Limited to 32 ASCII characters (16 ASCII characters via HART). No specific recommended use.

3.1.4. Message

Text that can be used in any way. Limited to 32 ASCII characters. No specific recommended use.

3.1.5. Installation Date

Date the device was first commissioned (YYYY-MM-DD).

Manufacturer

Read only. The device manufacturer (e.g. Siemens).

Product Name

Read only. Identifies the product by name (e.g. SITRANS LUT400).

3.1.6. Product

Read only. Identifies the product by name and capability:

SITRANS LUT420 (Level)

SITRANS LUT430 (Pump and Flow)

SITRANS LUT440 (OCM)

3.1.7. Order No. (Order Number in PDM)

Read only. Order number for the current device configuration (e.g. 7ML5050-OCA10-1DA0).

3.1.8. Serial Number

Read only. Unique factory set serial number of the device.

3.1.9. Final Assembly Number

Integer used to identify the device on site, e.g. enter '2' to denote second SITRANS LUT400 in application.

3.1.10. Hardware Revision

Read only. Corresponds to the electronics hardware of the Field Device.

3.1.11. Firmware Revision

Read only. Corresponds to the software or firmware that is embedded in the Field Device.

3.1.12. Loader Revision

Read only. Corresponds to the software used to update the Field Device.

EDD Version

Read only. Corresponds to the Electronics Device Description (EDD) installed with the device.

3.1.13. Manufacture Date (Date of Manufacturing in PDM)

The date of manufacture of the SITRANS LUT400 (YYYY-MM-DD).

3.1.14. Order Option

Read only. Displays the device type: Standard or NAMUR 43-compliant.

3.2. Diagnostics

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

3.2.1. Echo Profile

Allows you to request the current echo profile either locally via the local push buttons, or remotely via SIMATIC PDM.

To request a profile via the local push buttons:

- a) In PROGRAM mode, navigate to **MAIN MENU > DIAGNOSTICS (3) > ECHO PROFILE (3.1)**
- b) Press **RIGHT arrow** to request a profile.

Note: An Echo Profile (3.2.1.) cannot be requested from LUI when:

- **Transducer Enable (3.3.1.)** is set to DISABLED, or when
 - **Transducer (2.1.6.)** is set to NO TRANSDUCER.
- In either case, the local push button will not operate.

For more detail see *Requesting an Echo Profile* on page 57.

For more details on how to interpret an Echo Profile, see *Echo Processing* on page 255.

To request a profile via SIMATIC PDM:

- a) Open the menu **Device – Echo Profile Utilities**. (For more details see *Echo Profile Utilities* in LUT400 Communications manual.¹)

3.2.2. Trend

*Read only. Display of level trends. Captures last 3000 PV values (logged at five minute intervals) in percentage of range (defined in 2.1.1.Units). For more information, see **Trends** on page 118.*

3.2.3. Master Reset

Note: Following a reset to **Factory Defaults**, complete reprogramming is required.

Resets all parameter to factory defaults, with the following exceptions:

- Tag, Long Tag, Description, Message, Assembly Number
- **Device Address (4.1.)** and **Language (6.)** remain unchanged
- **Write Protection (5.1.)** value is not reset
- **Auto False Echo Suppression (2.12.3.1.)** learned TVT is not lost
- **Shaper Mode (2.12.3.4.)**, and breakpoints for **TVT Shaper (2.12.4.)** are not lost
- **Totalizers (2.7.3.)** values are not reset
- **Date (2.14.1.)** and **Time (2.14.2.)** values are not reset

Options	*	DO NOTHING (Return to previous menu)
		FACTORY DEFAULTS

To perform a reset to factory defaults via SIMATIC PDM, open the menu **Device – Master Reset**.

3.2.4. Power-on Resets

The number of power cycles that have occurred since manufacture.

In SIMATIC PDM, open the menu **Device – Wear**.

3.2.5. Power-on Time

Displays the number of days the device has been powered on since manufacture.

In SIMATIC PDM, open the menu **Device – Wear**.

3.2.6. View Logs

*View various log types with entries (to a collective maximum of approximately 30,000) listed by day. For a list of field names that coincide with the comma delimited log file on the PC, see **Data Logging** on page 267.*

Notes:

- No data logs are written while device is connected to a PC via USB.
- To clear entries when log memory becomes full, see **Viewing the Data Log** on page 119.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

3.2.6.1. Alarms

History of alarms. Displays type of alarm, value at which alarm triggered, state of alarm.

3.2.6.2. OCM

Flow logs. Displays head and flow values.

3.2.6.3. Daily Totals

Daily totals for both totalizers. Displays maximum and minimum values for flow and temperature, average flow, and daily totalizer (DT) and running totalizer (RT) values.

3.2.6.4. PV

Primary Variable. Displays PV type (e.g. Level), PV value and temperature.

Note: PV is controlled by the mA function (see 2.5.1. *Current Output Function*). Therefore, the LUI operation can be changed (via 2.1.2. *Sensor Mode*) without affecting the process being controlled.

3.2.7. Pump Records

Relay usage.

3.2.7.1. Run Time Relay 2

Read or set the total running time of Relay 2 in hours.

Values	Range: 0 to 999999
---------------	---------------------------

3.2.7.2. Run Time Relay 3

Read or set the total running time of Relay 3 in hours.

Values	Range: 0 to 999999
---------------	---------------------------

3.2.7.3. Relay Pump 1

Read only. Relay assigned to Pump 1.

To change the relay assignment, see 2.7.1.2. *Relay Pump 1.*

3.2.7.4. Relay Pump 2

Read only. Relay assigned to Pump 2.

To change the relay assignment, see 2.7.1.3. *Relay Pump 2.*

3.2.8. Temperature Peak Values

This feature displays the high and low process temperatures in °C.

If the device is powered up without a temperature sensor connected, the default fixed temperature value 20 °C is displayed [see **Fixed Temperature (2.12.1.4.)**]. This information can help trace problems with both built in and external temperature sensors.

3.2.8.1. Highest Value

View the highest process temperature encountered, as measured by the transducer in °C.

3.2.8.2. Lowest Value

View the lowest process temperature encountered, as measured by the transducer in °C.

3.2.9. Echo Quality

3.2.9.1. Figure of Merit

*This value measures the quality of the reported echo value: higher values represent better quality. This measure combines the noise level, quality of tracking, and signal strength. (For more details see **Echo Processing** on page 255.)*

Values (view only)	Range: 0 to 100 %
---------------------------	--------------------------

3.2.9.2. Confidence

*Indicates echo reliability: higher values represent better echo quality. The display shows the echo confidence of the last measurement. **Echo Threshold (2.12.2.2)** defines the minimum criterion for echo confidence.*

Values (view only)	Range: -20 to 128
---------------------------	--------------------------

In SIMATIC PDM, open the menu **Device – Echo Profile Utilities** and click on the tab **Echo Profile**.

3.2.9.3. Echo Strength

Displays the absolute strength (in dB above 1 μ V rms) of the echo selected as the measurement echo.

Values (view only)	Range: -20 to 128 dB
---------------------------	-----------------------------

In SIMATIC PDM, open the menu **Device – Echo Profile Utilities** and click on the tab **Echo Profile**.

3.2.9.4. Noise Average

Displays the average ambient noise (in dB above 1 μ V rms) of a noise profile after each measurement.

The noise level is a combination of transient acoustic noise and electrical noise (induced into the transducer cable or receiving circuitry). See **Noise Problems** on page 240.

3.2.9.5. Noise Peak

Displays the peak ambient noise (in dB above 1 μ V rms) of a noise profile after each measurement.

3.3. Maintenance

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

3.3.1. Transducer Enable

Enables/disables transducer from taking measurements.

Options	*	ENABLED
		DISABLED

Set parameter to Disabled to stop transducer from measuring while calibration or maintenance work is performed. Set to Enabled to restart measurements after calibration or maintenance complete.

Notes:

- An **Echo Profile (3.2.1.)** cannot be requested from LUI when **Transducer Enable (3.3.1.)** is set to DISABLED. The local push button will not operate.
- When **Transducer Enable (3.3.1.)** is set to DISABLED, the LOE fault will display immediately.
- If **Transducer Enable (3.3.1.)** is set to DISABLED and power to the device is turned off, **Transducer Enable (3.3.1.)** will be reset to ENABLED when power is restored.

3.3.2. Backup Control

LUI only. Determine source of configuration recovery file when sensor has been replaced.

Options	*	DONE	No change required (no fault displayed), or operation is complete
		FROM SENSOR	Sensor parameters will be used as is, and LUI will receive these parameters as backup.
		FROM LUI	Recovery of sensor parameters will come from LUI backup.

When sensor unit has been replaced, fault code 132 is displayed to note that LUI backup file does not match configuration file in sensor. To clear fault, set Backup Control option to location from where parameter configuration should be read; from the LUI backup file or from the new sensor.

3.3.3. Remaining Device Life

Notes:

- Four sets of parameters allow you to monitor the Device/Sensor Lifetimes and set up Maintenance/Service schedules, based on operating hours instead of a calendar-based schedule. See also **Remaining Sensor Life (3.3.4.)**, **Service Schedule (3.3.5.)**, and **Calibration Schedule (3.3.6.)**.
- Performing a reset to **Factory Defaults** will reset all the Maintenance Schedule parameters to their factory defaults.
- The device operates in years. To view Remaining Device Lifetime parameters in hours or days (only via SIMATIC PDM, PACTware FDT, and AMS) see **Lifetime Expected (3.3.3.1.)**.

The device tracks itself based on operating hours and monitors its predicted lifetime. You can modify the expected device lifetime, set up schedules for maintenance reminders, and acknowledge them.

The maintenance warnings and reminders are available through HART communications. This information can be integrated into an Asset Management system. For optimal use, we recommend that you use SIMATIC PCS7 Asset Management Software in conjunction with SIMATIC PDM.

To access these parameters via SIMATIC PDM:

- Open the menu **Device – Maintenance** and select the **Remaining Device Lifetime** tab. (For more details see *Maintenance* in LUT400 Communications manual.¹)

Time Units

Allows you to set the desired units.

Options^a	HOURS
	DAYS
	* YEARS

^a Units are selectable only via SIMATIC PDM, PACTware FDT, and AMS.

3.3.3.1. Lifetime Expected

Note: The device always operates in years. Changing the Time Units affects only the parameter view of the Remaining Device Lifetime parameters in SIMATIC PDM, PACTware FDT, and AMS.

Allows you to override the factory default.

Values	Units ^a : hours, days, years
	Range: 0.000 to 20.000 years
	Default: 10.000 years

^a Units are selectable only via SIMATIC PDM, PACTware FDT, and AMS.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

3.3.3.2. Time in Operation

Read only. The amount of time the device has been operating.

3.3.3.3. Remaining Lifetime

*Read only. **Lifetime Expected (3.3.3.1.)** less **Time in Operation (3.3.3.2.)**.*

3.3.3.4. Reminder Activation

Note: To modify this parameter via SIMATIC PDM it must be accessed via the pull-down menu **Device – Maintenance**.

Allows you to enable a maintenance reminder.

Options	REMINDER 1 (MAINTENANCE REQUIRED)
	REMINDER 2 (MAINTENANCE DEMANDED)
	REMINDERS 1 AND 2
	* OFF

- First set the values in **Reminder 1 before Lifetime (Required) (3.3.3.5.)/Reminder 2 before Lifetime (Demanded) (3.3.3.6.)**.
- Select the desired **Reminder Activation** option.

3.3.3.5. Reminder 1 before Lifetime (Required)

*If **Remaining Lifetime (3.3.3.3.)** is equal to or less than this value, the device generates a **Maintenance Required** reminder.*

Values	Range: 0.000 to 20.000 years
	Default: 0.164 years (8 weeks)

- Modify values as required.
- Set **Reminder Activation (3.3.3.4.)** to the desired option.

3.3.3.6. Reminder 2 before Lifetime (Demanded)

*If **Remaining Lifetime (3.3.3.3.)** is equal to or less than this value, the device generates a **Maintenance Demanded** reminder.*

Values	Range: 0.000 to 20.000 years
	Default: 0.019 years (1 week)

- Modify values as required.
- Set **Reminder Activation (3.3.3.4.)** to the desired option.

3.3.3.7. Maintenance Status

Indicates which level of maintenance reminder is active.

In SIMATIC PDM, open the menu **View – Device Status**, click on the **Maintenance** tab, and check the **Device Lifetime Status** window.

3.3.3.8. Acknowledged Status

Indicates which level of maintenance reminder has been acknowledged.

In SIMATIC PDM, open the menu **View – Device Status**, click on the **Maintenance** tab, and check the **Device Lifetime Status** window.

3.3.3.9. Acknowledged

Acknowledges the current maintenance reminder.

To acknowledge a reminder via SIMATIC PDM:

- a) Open the menu **View – Device Status** and click on the tab **Maintenance**.
- b) In the **Device Lifetime** section, click on **Acknowledge Warnings**.

To acknowledge a reminder via the local push buttons:

- a) Navigate to **Maintenance and Diagnostics (3.) > Maintenance (3.3.) > Remaining Device Life (3.3.3.) > Acknowledged (3.3.3.9.)**, and **RIGHT arrow ►** to acknowledge the reminder.

3.3.4. Remaining Sensor Life**Notes:**

- Four sets of parameters allow you to monitor the Device/Sensor Lifetimes and set up Maintenance/Service schedules, based on operating hours instead of a calendar-based schedule. See also **Remaining Device Life (3.3.3.)**, **Service Schedule (3.3.5.)**, and **Calibration Schedule (3.3.6.)**.
- Performing a reset to **Factory Defaults** will reset all the Maintenance Schedule parameters to their factory defaults.
- The device operates in years. To view Remaining Sensor Lifetime parameters in hours or days (only via SIMATIC PDM, PACTware FDT, and AMS) see **Lifetime Expected (3.3.4.1.)**.

The device monitors the predicted lifetime of the sensor (the components exposed to the vessel environment). You can modify the expected sensor lifetime, set up schedules for maintenance reminders, and acknowledge them.

To access these parameters via SIMATIC PDM:

- Open the menu **Device – Maintenance** and select the **Remaining Sensor Lifetime** tab. (For more details see *Maintenance* in LUT400 Communications manual.¹)

Time Units

Allows you to set the desired units.

Options^a	HOURS
	DAYS
	* YEARS

^a Units are selectable only via SIMATIC PDM, PACTware FDT, and AMS.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

3.3.4.1. Lifetime Expected

Note: The device always operates in years. Changing the Time Units affects only the parameter view of Remaining Sensor Life parameters in SIMATIC PDM, PACTware FDT, and AMS.

Allows you to override the factory default.

Values	Units ^a : hours, days, years
	Range: 0.000 to 20.000 years
	Default: 10.000 years

a. Units are selectable only via SIMATIC PDM, PACTware FDT, and AMS.

3.3.4.2. Time in Operation

The amount of time the sensor has been operating. Can be reset to zero after performing a service or replacing the sensor.

To reset to zero:

- In SIMATIC PDM, open the menu **Device – Maintenance**, click on the **Remaining Sensor Lifetime** tab, and click on **Sensor Replaced** to re-start the timer and clear any fault messages.
- Via the local push buttons, navigate to **Maintenance and Diagnostics (3.) > Maintenance (3.3.) > Remaining Sensor Life (3.3.4.) > Time in Operation (3.3.4.2.)**, and set to zero.

3.3.4.3. Remaining Lifetime

*Read only. **Lifetime Expected (3.3.4.1.)** less **Time in Operation (3.3.4.2.)***

3.3.4.4. Reminder Activation

Note: To modify this parameter via SIMATIC PDM it must be accessed via the pull-down menu **Device – Maintenance**.

Allows you to enable a maintenance reminder.

Options	REMINDER 1 (MAINTENANCE REQUIRED)
	REMINDER 2 (MAINTENANCE DEMANDED)
	REMINDERS 1 AND 2
	* OFF

- First set the values in **Reminder 1 before Lifetime (Required) (3.3.4.5.)/Reminder 2 before Lifetime (Demanded) (3.3.4.6.)**.
- Select the desired Reminder Activation option.

3.3.4.5. Reminder 1 before Lifetime (Required)

*If **Remaining Lifetime (3.3.4.3.)** is equal to or less than this value, the device generates a **Maintenance Required** reminder.*

Values	Range: 0.000 to 20.000 years
	Default: 0.164 years (8 weeks)

- Modify values as required.
- Set **Reminder Activation (3.3.4.4.)** to the desired option.

3.3.4.6. Reminder 2 before Lifetime (Demanded)

If **Remaining Lifetime (3.3.4.3.)** is equal to or less than this value, the device generates a **Maintenance Demanded** reminder.

Values	Range: 0.000 to 20.000 years
	Default: 0.019 years (1 week)

- Modify values as required.
- Set **Reminder Activation (3.3.4.4.)** to the desired option.

3.3.4.7. Maintenance Status

Indicates which level of maintenance reminder is active.

In SIMATIC PDM, open the menu **View – Device Status**, click on the **Maintenance** tab, and check the **Sensor Lifetime Status** window.

3.3.4.8. Acknowledged Status

Indicates which level of maintenance reminder has been acknowledged.

In SIMATIC PDM, open the menu **View – Device Status**, click on the **Maintenance** tab and check the **Sensor Lifetime Status** window.

3.3.4.9. Acknowledged

Acknowledges the current maintenance reminder.

To acknowledge a reminder via SIMATIC PDM:

- Open the menu **View – Device Status** and click on the **Maintenance** tab.
- In the **Sensor Lifetime** section click on **Acknowledge Warnings**.

To acknowledge a reminder via the local push buttons:

- Navigate to **Maintenance and Diagnostics (3.) > Maintenance (3.3.) > Remaining Sensor Life (3.3.4.) > Acknowledged (3.3.3.9.)**, and **RIGHT arrow ►** to acknowledge the reminder.

3.3.5. Service Schedule**Notes:**

- Four sets of parameters allow you to monitor the Device/Sensor Lifetimes and set up Maintenance/Service schedules, based on operating hours instead of a calendar-based schedule. See also **Remaining Device Life (3.3.3.)**, **Remaining Sensor Life (3.3.4.)**, and **Calibration Schedule (3.3.6.)**.
- Performing a reset to **Factory Defaults** will reset all the Maintenance Schedule parameters to their factory defaults.
- The device operates in years. To view Service Interval parameters in hours or days (only via SIMATIC PDM, PACTware FDT, and AMS) see **Service Interval (3.3.5.1.)**.

The device tracks service intervals based on operating hours and monitors the predicted lifetime to the next service. You can modify the Total Service Interval, set schedules for maintenance reminders, and acknowledge them.

The maintenance warnings and reminders are communicated to the end user through status information. This information can be integrated into any Asset Management system. For optimal use, we recommend that you use SIMATIC PCS7 Asset Management Software in conjunction with SIMATIC PDM.

To access these parameters via SIMATIC PDM:

- Open the menu **Device – Maintenance** and select the **Service Schedule** tab. (For more details see *Maintenance* in LUT400 Communications manual.¹)

Time Units

Allows you to set the desired units.

Options^a	HOURS
	DAYS
	* YEARS

- ^a Units are selectable only via SIMATIC PDM, PACTware FDT, and AMS.

3.3.5.1. Service Interval

Note: The device always operates in years. Changing the Time Units affects only the parameter view of the Service Interval parameters in SIMATIC PDM, PACTware FDT, and AMS.

User-configurable recommended time between product inspections.

Values	Units ^a : hours, days, years
	Range: 0.000 to 20.000 years
	Default: 1.000 year

- ^a Units are selectable only via SIMATIC PDM, PACTware FDT, and AMS.

3.3.5.2. Time Last Service

Time elapsed since last service. Can be reset to zero after performing a service.

To reset to zero:

- In SIMATIC PDM, open the menu **Device – Maintenance**, click on the **Service Schedule** tab, and click on **Service Performed** to restart the timer and clear any fault messages.
- Navigate to **Maintenance and Diagnostics (3.) > Maintenance (3.3.) > Service Schedule (3.3.5.) > Time Last Service (3.3.5.2.)**, and set to zero.

3.3.5.3. Time Next Service

*Read only. **Time Next Service (3.3.5.3.)** less **Time Last Service (3.3.5.2.)**.*

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

3.3.5.4. Reminder Activation

Note: To modify this parameter via SIMATIC PDM it must be accessed via the pull-down menu **Device – Maintenance**.

Allows you to enable a maintenance reminder.

Values	*	TIMER OFF
		ON NO LIMITS - no reminders checked
		ON REMINDER 1 (MAINTENANCE REQUIRED) checked
		ON REMINDER 1 AND 2 checked
		ON REMINDER 2 (MAINTENANCE DEMANDED) checked

- First set the values in **Reminder 1 before Service (Required) (3.3.5.5./Reminder 2 before Service (Demanded) (3.3.5.6.)**.
- Select the desired **Reminder Activation** option.

3.3.5.5. Reminder 1 before Service (Required)

*If **Time Next Service (3.3.5.3.)** is equal to or less than this value, the device generates a **Maintenance Required** reminder.*

Values	Range: 0.000 to 20.000 years
	Default: 0.164 years (8 weeks)

- Modify values as required.
- Set **Reminder Activation (3.3.5.4.)** to the desired option.

3.3.5.6. Reminder 2 before Service (Demanded)

*If **Time Next Service (3.3.5.3.)** is equal to or less than this value, the device generates a **Maintenance Demanded** reminder.*

Values	Range: 0.000 to 20.000 years
	Default: 0.019 years (1 week)

- Modify values as required.
- Set **Reminder Activation (3.3.5.4.)** to the desired option.

3.3.5.7. Maintenance Status

Indicates which level of maintenance reminder is active.

In PDM, open the menu **View – Device Status**, click on the **Maintenance** tab and check the **Service Schedule Status** window.

3.3.5.8. Acknowledged Status

Indicates which level of maintenance reminder has been acknowledged.

In PDM, open the menu **View – Device Status**, click on the **Maintenance** tab and check the **Service Schedule Status** window.

3.3.5.9. Acknowledged

Acknowledges the current maintenance reminder.

To acknowledge a reminder via SIMATIC PDM:

- Open the menu **View – Device Status** and click on the **Maintenance** tab.

- b) In the **Service Schedule Status** section click on **Acknowledge Warnings**.

To acknowledge a reminder via the local push buttons:

Navigate to **Maintenance and Diagnostics (3.) > Maintenance (3.3.) >**

Service Schedule (3.3.5.) > Acknowledged (3.3.5.9.), and **RIGHT arrow** ► to acknowledge the reminder.

3.3.6. Calibration Schedule

Notes:

- Four sets of parameters allow you to monitor the Device/Sensor Lifetimes and set up Maintenance/Service schedules, based on operating hours instead of a calendar-based schedule. See also **Remaining Device Life (3.3.3.)**, **Remaining Sensor Life (3.3.4.)**, and **Service Schedule (3.3.5.)**.
- Performing a reset to **Factory Defaults** will reset all the Maintenance Schedule parameters to their factory defaults.
- The device operates in years. To view Calibration Interval parameters in hours or days (only via SIMATIC PDM, PACTware FDT, and AMS) see **Calibration Interval (3.3.6.1.)**.

The device tracks calibration intervals based on operating hours and monitors the predicted lifetime to the next calibration. You can modify the Total Calibration Interval, set schedules for maintenance reminders, and acknowledge them.

To access these parameters via SIMATIC PDM:

- Open the menu **Device – Maintenance** and select the **Calibration Schedule** tab. (For more details see *Maintenance* in LUT400 Communications manual.¹)

Time Units

Allows you to set the desired units.

Options^a	HOURS
	DAYS
	* YEARS

- ^a Units are selectable only via SIMATIC PDM, PACTware FDT, and AMS.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

3.3.6.1. Calibration Interval

Note: The device always operates in years. Changing the units affects only the parameter view of the Calibration Interval parameters in SIMATIC PDM, PACTware FDT, and AMS.

User-configurable recommended time between product calibrations.

Values	Units ^a : hours, days, years
	Range: 0.000 to 20.000 years
	Default: 1.000 year

a. Units are selectable only via SIMATIC PDM, PACTware FDT, and AMS.

3.3.6.2. Time Last Calibration

Time elapsed since last calibration. Can be reset to zero after performing a calibration.

To reset to zero:

- In SIMATIC PDM, open the menu **Device – Maintenance**, click on the **Calibration Schedule** tab, and click on **Calibration Performed** to re-start the timer and clear any fault messages.
- Via the local push buttons, navigate to **Maintenance and Diagnostics (3.) > Maintenance (3.3.) > Calibration Schedule (3.3.6.) > Time Last Calibration (3.3.6.2.)**, and **set** to zero.

3.3.6.3. Time Next Calibration

*Read only. **Calibration Interval (3.3.6.1.)** less **Time Last Calibration (3.3.6.2.)***

3.3.6.4. Reminder Activation

Note: To modify this parameter via SIMATIC PDM it must be accessed via the pull-down menu **Device – Maintenance**.

Allows you to enable a maintenance reminder.

Values	* TIMER OFF
	ON NO LIMITS - no reminders checked
	ON REMINDER 1 (MAINTENANCE REQUIRED) checked
	ON REMINDER 1 AND 2 checked
	ON REMINDER 2 (MAINTENANCE DEMANDED) checked

- First set the values in **Reminder 1 before Calibration (Required) (3.3.6.5.)/Reminder 2 before Calibration (Demanded) (3.3.6.6.)**.
- Select the desired **Reminder Activation** option.

3.3.6.5. Reminder 1 before Calibration (Required)

*If **Time Next Calibration (3.3.6.3.)** is equal to or less than this value, the device generates a **Maintenance Required** reminder.*

Values	Range: 0.000 to 20.000 years
	Default: 0.164 years (8 weeks)

- Modify values as required.
- Set **Reminder Activation (3.3.6.4.)** to the desired option.

3.3.6.6. Reminder 2 before Calibration (Demanded)

If **Time Next Calibration (3.3.6.3.)** is equal to or less than this value, the device generates a **Maintenance Demanded** reminder.

Values	Range: 0.000 to 20.000 years
	Default: 0.019 years (1 week)

- Modify values as required.
- Set **Reminder Activation (3.3.6.4.)** to the desired option.

3.3.6.7. Maintenance Status

Indicates which level of maintenance reminder is active.

In SIMATIC PDM, open the menu **View – Device Status**, click on the **Maintenance** tab and check the **Calibration Schedule Status** window.

3.3.6.8. Acknowledged Status

Indicates which level of maintenance reminder has been acknowledged.

In SIMATIC PDM, open the menu **View – Device Status**, click on the **Maintenance** tab and check the **Calibration Schedule Status** window.

3.3.6.9. Acknowledged

Acknowledges the current maintenance reminder.

To acknowledge a reminder via SIMATIC PDM:

- Open the menu **View – Device Status** and click on the **Maintenance** tab.
- In the **Calibration Schedule Status** section click on **Acknowledge Warnings**.

To acknowledge a reminder via the local push buttons:

Navigate to **Maintenance and Diagnostics (3.) > Maintenance (3.3.) > Calibration Schedule (3.3.6.) > Acknowledged (3.3.6.9.)**, and **RIGHT arrow**

▶ to acknowledge the reminder.

3.4. Simulation

*Use simulation to test your application. For further details, see **Application examples** on page 58.*

3.4.1. Level

Simulates level changes, and activates relays based on the setpoints programmed.

3.4.1.1. Level Simulation Enable

Enables/disables level simulation.

Options	*	DISABLED
		ENABLED

3.4.1.2. Level Value

Sets the level for a fixed level simulation, or the starting level for a ramped simulation.

Values	Range: Low Calibration Point to High Calibration Point	
	Default: 0.000	

3.4.1.3. Ramp

Enables/disables ramped simulation.

Options	*	DISABLED
		ENABLED

3.4.1.4. Ramp Rate

Sets the rate at which the simulated level will change in a ramp simulation.

Options		SLOW	1% of span ^a per second
	*	MEDIUM	2% of span ^a per second
		FAST	4% of span ^a per second

^a. Low Calibration Point to High Calibration Point

3.4.2. Discrete Inputs

Simulates behaviour of external contacts connected to a discrete input.

3.4.2.1. Discrete Input 1

Disables simulation of Discrete Input 1, or sets behaviour of DI during simulation.

Options	*	DISABLED	DI is not simulated
		ON	DI is simulated to be ON
		OFF	DI is simulated to be OFF

3.4.2.2. Discrete Input 2

Disables simulation of Discrete Input 2, or sets behaviour of DI during simulation.

Options	*	DISABLED	DI is not simulated
		ON	DI is simulated to be ON
		OFF	DI is simulated to be OFF

3.4.3. Pump Activations

Sets how physical relays (that are assigned to pumps) will behave in simulation mode.

Options	*	DISABLED	Pump relays are not activated in simulation
		ENABLED	Pump relays are activated in simulation

4. Communication

4.1. Device Address

Sets the device address or poll ID on a HART network.

Values	Range: 0 to 63 (Set within range of 0 to 15 if HART 5 master used.)
	Default: 0

To reset Device Address via SIMATIC PDM:

- Open the project in **Process Device Network View** then right-click on the device.
- Go to **Object Properties** and open the **Connection** tab to access the field **Short Address**.

Note: The following list of parameters are available in PDM. Unless otherwise stated, the options are displayed in integer format (as required by HART communications).

Manufacturer's ID

Read only. Numerical code that refers to the manufacturer of the device (e.g. 42, which refers to Siemens).

Device Id

Read only. Unique identification of the device by manufacturer and device type.

Product Id

Read only. Unique identification of the product by model number.

Device Revision

Read only. Device revision associated with a specific EDD.

EDD Revision

Read only. Revision of a specific EDD associated with the device.

Universal Command Revision

Read only. Revision of the Universal Device Description associated with the device.

Protocol

Read only. The communication protocol supported by the device.

Common Practice Command Revision

Read only. Revision of the set of HART common practice commands supported by the device.

Configuration Change Counter

Read only. Indicates the number of times the device's configuration or calibration has been changed by a host application or from a local operator interface.

5. Security

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

5.1. Write Protection

A public password to prevent any changes to parameters via local push buttons, remote communication, or Windows-based web browser.

Values		Range: 0 to 65535	
	*	Unlock value (2457)	Lock Off
		Any other value	Lock On

- To turn Lock On, key in any value other than the Unlock Value.
- To turn Lock Off, key in the Unlock Value (2457).

6. Language

Note: Default settings in the parameter tables are indicated with an asterisk (*) unless explicitly stated.

Selects the language to be used on the LCD.

Options	*	ENGLISH
		DEUTSCH
		FRANCAIS
		ESPANOL
		简体中文
		ITALIANO
		PORTUGUÊS
		русский

Characteristics

Certificates & Approvals

Device Certification

The approvals certificates applicable to the device.

Alphabetical parameter list

Note: Maintenance Parameters are not listed below. See *Remaining Device Life* on page 205, *Remaining Sensor Life* on page 207, *Service Schedule* on page 209, and *Calibration Schedule* on page 212 for these parameters.

Parameter Name (Parameter Number)	Page Number
<i>4 mA Setpoint</i> (2.5.3.)	146
<i>20 mA Setpoint</i> (2.5.4.)	146
<i>Activation Time</i> (2.11.2.2.)	176
<i>Alarm Log</i> (2.10.2.)	174
<i>Alarm State</i> (2.8.1.5.): <i>High Level Alarm</i> (2.8.1.)	162
<i>Alarm State</i> (2.8.10.5.): <i>Low Flowrate Alarm</i> (2.8.10.)	169
<i>Alarm State</i> (2.8.2.5.): <i>Low Level Alarm</i> (2.8.2.)	163
<i>Alarm State</i> (2.8.3.5.): <i>Switch (Discrete Input) Alarm</i> (2.8.3.)	164
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Service and Maintenance

SITRANS LUT400 requires no maintenance or cleaning under normal operating conditions.

Firmware updates

To update the LUT400 firmware, please contact your Siemens representative to obtain the installer (self-executable .exe file). For a complete list of representatives, go to www.siemens.com/processautomation.

Two installers are available: one to update the firmware in the Local User Interface (LUI) node, and one for the sensor node. One or both may be required, depending on the reason for the update.

To complete an update, follow steps in the installer:

1. Connect your computer to the SITRANS LUT400 USB port.
2. Before running the .exe installer received from your Siemens representative, note the computer COM port to which the LUT400 is connected.
3. From your computer, double-click the .exe, and follow the installer steps. The first step will prompt for Communication Options. These options are set to factory defaults. Ensure the COM Port is set to that noted in step 2 above. No other changes are required.
4. Follow remaining installer steps.
5. Once complete, verify the update was successful by checking the current firmware revision:
 - If updating the **LUI node**, recycle the power on the LUT400. On power-up, you will see the current LUI firmware revision on the LUT400 display.
 - If updating the **sensor node**, view parameter Firmware Revision (3.111.) to see the current sensor node firmware revision.

Complete a Master Reset (3.2.3.) to factory defaults after a successful upgrade of the sensor node, before re-entering parameters.

Transferring parameters using LUT400 display lid

If necessary to transfer parameters from one LUT400 to another, the LUI display maintains a backup file of the parameters on the device. With this backup file, it is possible to connect the remote lid to a second LUT400 to transfer parameters.

When the remote lid is connected to a second device, a fault code is displayed to note that the LUI backup file does not match the configuration file in the sensor. You can then use the Backup Control parameter to specify that sensor parameters be copied from the LUI backup to the device [see Backup Control (3.3.2.) on page 204].

Replacing the Battery

The battery (BR2032) has a life expectancy of ten years, and is affected by ambient temperature. If the device loses external power the battery will maintain the SITRANS LUT400's Real Time Clock (date and time) until power is restored.

The flash memory is updated constantly. Therefore, data logs are unaffected by the loss of power.



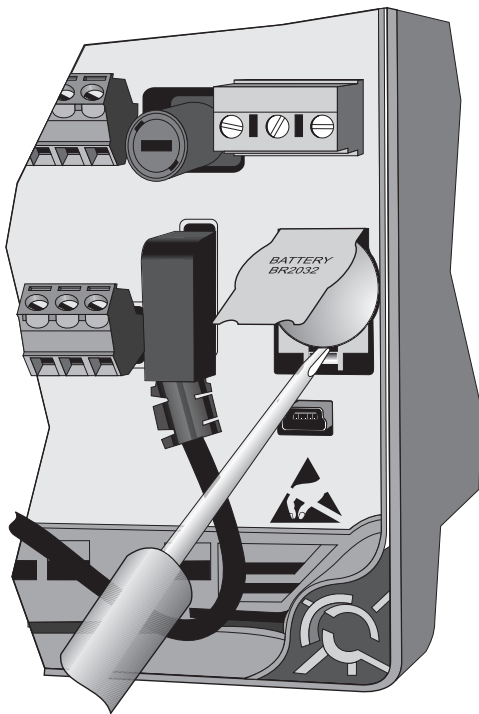
WARNING: Disconnect power before replacing the battery.

Notes:

- To replace, remove the existing battery from the holder as shown below, and reinstall replacement battery (BR2032).
- Battery Type: Lithium metal coin cell
Battery Chemistry: solid-cathode Carbon Monofluoride



Dispose of battery in an environmentally safe manner, and according to local regulations.



1. Open the enclosure lid.
2. Slide the end of a screwdriver under the lip of the plastic battery cover, and lift cover with fingers. (Do not press back on fold.)
3. While holding cover in raised position, place end of screwdriver at an angle into slot below battery, and pry upward.
4. Lift out battery.
5. Insert new battery and press down on face of battery to secure in holder.
6. Press down on plastic battery cover to secure in place.
7. Close enclosure lid and tighten screws.
8. Reset the Real Time Clock (See **Date and Time (2.14.)** on page 187.)

Decontamination Declaration

Any device returned to Siemens for repair must be accompanied by a Declaration of Decontamination. With this declaration you certify *that the returned products/spare parts have been carefully cleaned and are free from any residues.*

If the device has been operated together with toxic, caustic, flammable or water-damaging products, clean the device before return by rinsing or neutralizing. Ensure that all cavities are free from dangerous substances. Then, double-check the device to ensure the cleaning is completed.

Siemens will not service a device or spare part unless the declaration of decontamination confirms proper decontamination of the device or spare part.

Shipments received without a declaration of decontamination will be cleaned professionally at your expense before further processing.

Decontamination Declaration form can be found on the internet at www.siemens.com/processinstrumentation, under Service – Decontamination Declaration.

Notes

Diagnosing and Troubleshooting

Notes:

- Many of the parameters referenced and techniques described here require a good understanding of ultrasonic technologies and Siemens echo processing software. Use this information with caution.
- If the setup becomes too confusing do a *3.2.3. Master Reset* and start again.
- As a further resource, *Understanding Ultrasonic Level Measurement* is available on our website. Go to www.siemens.com/level.

Communication Troubleshooting

Generally

1. Check the following:
 - There is power at the device
 - The optional LCD is showing the relevant data
 - The device can be programmed using the local push buttons.
 - If any fault codes are being displayed, see “General Fault Codes” on page 231 for a detailed list.
2. Verify that the wiring connections are correct.

























Specifically

1. The SITRANS LUT400 is set to communicate via a HART modem but no communication is returning to the master.
 - Check that the device address is set correctly for the HART network.
2. A SITRANS LUT400 parameter is set via remote communications, but the parameter remains unchanged.
 - Try setting the parameter from the local push buttons. If it can not be set using the buttons, ensure *5.1. Write Protection* is set to the unlock value.

If you continue to experience problems, go to our website at:

www.siemens.com/sitransLUT400, and check the FAQs for SITRANS LUT400, or contact your Siemens representative.

Device Status Icons

LUI Icon	PDM Icon	Priority Level ^a	Meaning
		1	<ul style="list-style-type: none"> Maintenance alarm Measurement values are not valid
		2	<ul style="list-style-type: none"> Maintenance warning: maintenance demanded immediately Measured signal still valid
		3	<ul style="list-style-type: none"> Maintenance required Measured signal still valid
		1	<ul style="list-style-type: none"> Process value has reached an alarm limit
		2	<ul style="list-style-type: none"> Process value has reached a warning limit
		3	<ul style="list-style-type: none"> Process value has reached a tolerance limit
	 (red)	1	<ul style="list-style-type: none"> Configuration error Device will not work because one or more parameters/components is incorrectly configured
	 (yellow)	2	<ul style="list-style-type: none"> Configuration warning Device can work but one or more parameters/components is incorrectly configured
	 (green)	3	<ul style="list-style-type: none"> Configuration changed Device parameterization not consistent with parameterization in project. Look for info text.
		1	<ul style="list-style-type: none"> Manual operation (local override) Communication is good; device is in manual mode.
		2	<ul style="list-style-type: none"> Simulation or substitute value Communication is good; device is in simulation mode or works with substitute values.
		3	<ul style="list-style-type: none"> Out of operation Communication is good; device is out of action.

LUI Icon	PDM Icon	Priority Level ^a	Meaning (Continued)
			• Data exchanged
			• No data exchange
			• Write access enabled
			• Write access disabled

a. Lowest priority number equals highest fault severity.




















General Fault Codes

Notes:























- If two faults are present at the same time, the device status indicator and text for the highest priority fault will display.
- Certain faults exist, such as with a loss of echo (LOE) or a broken cable, that when triggered cause the mA output to go to a fail-safe reading (see “Fail-Safe” on page 143) and LUI to display dashes (-----) until fault is cleared. These faults are indicated with an asterisk (*) in the table below.

General Fault Codes			
Code / LUI Icon	Code / PDM Icon	Meaning	Corrective Action
0 	0 	* Loss of echo (LOE). The device was unable to get a measurement within the Fail-safe LOE Timer period. Possible causes: faulty installation, foaming/other adverse process conditions, invalid calibration range.	<ul style="list-style-type: none"> • Ensure installation details are correct. • Adjust process conditions to minimize adverse conditions. • Correct range calibration. • If fault persists, contact your local Siemens representative.
1 	1 	* Cable fault. Broken cable.	Inspect attached cabling and any termination points to ensure no disconnection or damage; repair/replace if necessary. If no issue with cabling, contact your local Siemens representative.
3 	3 	Device is nearing its lifetime limit according to the value set in Maintenance Required Limit.	Replacement is recommended.

**General Fault Codes
(Continued)**

Code / LUI Icon	Code / PDM Icon	Meaning	Corrective Action
4 	4 	Device is nearing its lifetime limit according to the value set in Maintenance Demanded Limit.	Replacement is recommended.
5 		Saving Parameters. (LUI fault only.) Saving is in progress. Do not turn off the device.	Wait for completion.
6 	6 	Sensor is nearing its lifetime limit according to the value set in Maintenance Required Limit.	Replacement is recommended.
7 	7 	Sensor is nearing its lifetime limit according to the value set in Maintenance Demanded Limit.	Replacement is recommended.
8 	8 	Service interval as defined in Maintenance Required Limit has expired.	Perform service.
9 	9 	Service interval as defined in Maintenance Demanded Limit has expired.	Perform service.
10 	10  (red)	Configuration parameters are incorrect. The following conditions will cause this fault: <ul style="list-style-type: none"> • Far Range < Low Cal. Pt. • Near Range > Far Range • Low Cal. Pt - High Cal. Pt. < 10 cm • Far Range - Near Range < 10 cm • Max. mA Limit ≤ Min. mA Limit • Current Output Function set to <i>Volume</i>, but Vessel Shape set to <i>None</i> • Current Output Function set to <i>Volume</i>, but Max. Volume has not been set. 	Check device configuration.
17 	17 	Calibration interval as defined in Maintenance Required Limit has expired.	Perform calibration.
18 	18 	Calibration interval as defined in Maintenance Demanded Limit has expired.	Perform calibration.
25 	25 	Internal device error.	Reset power. If fault persists, contact your local Siemens representative.

**General Fault Codes
(Continued)**

Code / LUI Icon	Code / PDM Icon	Meaning	Corrective Action
26 	26 	* Submergence detected. The transducer appears submerged.	Correct the installation.
27 	27  (red)	Incorrect product model. Basic model does not support flow and advanced pump control features	Only configure the supported features.
39 	39 	* Transducer temperature sensor has failed.	Inspect attached cabling and any termination points to ensure no disconnection or damage; repair/ replace if necessary. If no issue with cabling, contact your local Siemens representative.
46 	46 	* The TS-3 temperature sensor failed.	Inspect attached cabling and any termination points to ensure no disconnection or damage; repair/ replace if necessary. If no issue with cabling, contact your local Siemens representative.
47 	47 	Poor signal from the application. Poor installation or high noise level.	Verify installation.
121 	121  (red)	Flow calculations are not config- ured properly. Incorrect parameter settings.	Reconfigure the unit. Check the configu- ration. If fault persists, do a master reset.
122 	122 	Flow calculations encountered an error.	Reconfigure the unit. Check the break- points. If fault persists, do a master reset.
123 	123 	Flow log could not restore the settings.	Reconfigure the unit. Check the flow log settings. If fault persists, do a master reset.
124 	124  (red)	Flow log is not configured properly.	Reconfigure the unit. Check the flow log settings. If fault persists, do a master reset.
125 	125 	Flow log error. Log failed.	Verify that the drive where the log file resides is not full. Copy the log file to a computer and delete it from the device.
126 	126 	Failed to open log file.	Verify that the drive where the log file resides is not full. Copy the log file to a computer and delete it from the device.

**General Fault Codes
(Continued)**

Code / LUI Icon	Code / PDM Icon	Meaning	Corrective Action
127 	127 	Failed to close log file.	Verify that the drive where the log file resides is not full. Copy the log file to a computer and delete it from the device.
128 	128 	Log file read error. Error reading file. Unexpected error.	Verify that the drive where the log file resides is not full. Copy the log file to a computer and delete it from the device.
129 	129 	Log file write error. Error writing file. The file could not be written; the disk is full.	Copy the log file to a computer and delete it from the device.
130 	130 (red)	Configuration error. One or more settings invalid.	Adjust/correct relay assignments or setpoints.
131 	131 	Parameter backup did not succeed. Communication or file system problems.	Repair required. Contact your local Siemens representative.
132 	132 (red)	User input required. Serial numbers mismatch.	Manually force recovery. (Set parameter <i>3.3.2. Backup Control!</i>)
133 	133 	Simulation Enabled.	Simulation is active. Enable or disable simulation via LUI (<i>3.4.1.1. Level Simulation Enable, 3.4.2.1. Discrete Input 1, 3.4.2.2. Discrete Input 2.</i>)

Common Problems Chart

Symptom	Possible Cause	Action
Display blank, transducer not pulsing	No power, incorrect power	Check mains voltage at terminals; Check fuse; Check wiring connections; Check wiring.
Display blank, transducer is pulsing	Loose or disconnected display cable	Reconnect display cable.
Display active, transducer not pulsing	Incorrect transducer connections or wiring; Incorrect transducer selection (or set to NO Transducer); Transducer has been disabled through the software	Verify terminal connections; Check transducer field wiring; Check any junction box connections; Check that transducer is enabled (see Transducer Enable (3.3.1.) on page 204)

Symptom	Cause	Action
Reading fluctuates while material level is still	Material level is changing	Visually verify, if possible.
	Strong false echoes	Determine source of false echoes; Relocate transducer to avoid source.
	Incorrect damping	Adjust damping. See Damping Filter (2.3.3.) on page 143.
	Improper echo Algorithm selection	Set algorithm to default. If no improvement, try a different algorithm. See Algorithm (2.12.2.1.) on page 181.
	High noise levels	Verify source and minimize. See "Noise Problems" on page 240.
	Weak echo	Determine cause; Check noise, confidence, FOM, and echo strength. See Echo Quality (3.2.9.) on page 203.
	Foam on surface of material	Eliminate source of foaming; Use stilling well.
	Rapid temperature changes	Use an external temperature sensor. See Temperature Source (2.12.1.3.) on page 180.
	Faulty temperature sensor	Verify operation; Replace if required, or use fixed temperature. See Temperature Source (2.12.1.3.) on page 180.
Vapours	If fluctuation is unacceptable, consider an alternative technology. Contact your Siemens representative.	

Symptom	Cause	Action
Reading is fixed, but material level changes or reading does not follow material level	Incorrect speed of response	Verify response speed setting is adequate for process. See <i>Response Rate</i> (set in the Quick Start Wizard).
	Loss of Echo condition (LOE)	Check Noise, Echo Strength, Confidence. See Echo Quality (3.2.9.) on page 203. Check LOE Timer is not set too short. See LOE Timer (2.4.2.) on page 144.
	Agitator blade stopped in front of transducer (false echo)	Ensure agitator is running.
	Foam on surface of material	Eliminate source of foaming. Use stilling well
	Incorrect Algorithm used	Set algorithm to default. If no improvement, try a different algorithm. See Algorithm (2.12.2.1.) on page 181.
	Transducer mounting: wrong location or incorrectly mounted	Ensure beam has a clear path to material surface; Verify transducer is not too tight; Use an isolation coupling.
	Incorrect transducer used for the application	Use correct transducer. Contact your Siemens representative.
	Unavoidable false echoes from obstructions	Relocate transducer to ensure beam has a clear path to material surface; Use manual TVT shaping or Auto False Echo Suppression. See TVT Shaper (2.12.4.) on page 184 or Auto False Echo Suppression (2.12.3.1.) on page 183.

Symptom	Cause	Action
Accuracy Varies	Faulty temperature sensor	Verify operation; Replace if required, or use fixed temperature. See Temperature Source (2.12.1.3.) on page 180.
	Vapours present in varying concentrations	Eliminate vapours or consider a different technology. Contact your Siemens representative.
	Thermal gradients	Insulate vessel; Consider external temperature sensor.
	Calibration required	If accuracy is better when level is close to transducer, and worse when level is far from transducer, perform calibration [see Auto Sound Velocity (2.12.1.6.) on page 181]. If accuracy is consistently incorrect, use Sensor Offset (2.2.3.) on page 141 or perform calibration [see Auto Sensor Offset (2.2.6.) on page 142].
Reading erratic	Transducer mounting: wrong location or incorrectly mounted	Ensure beam has a clear path to material surface; Verify transducer is not too tight; Use an isolation coupling.
	Unavoidable false echoes from obstructions	Use Auto False Echo Suppression. See Auto False Echo Suppression (2.12.3.1.) on page 183.
	Confidence too low	Check Noise, Echo Strength, Confidence. See Echo Quality (3.2.9.) on page 203. Check LOE Timer is not set too short. See LOE Timer (2.4.2.) on page 144.
	Multiple echoes	Check mounting location; Verify material is not entering Near Range zone. See Near Range (2.2.4.) on page 141.
	Noise in the application	Verify source and minimize. See "Noise Problems" on page 240.

Symptom	Cause	Action
Incorrect reading (mA output and/or displayed value)	mA function not assigned to correct measurement	Check mA assignment. See Current Output Function (2.5.1.) on page 144.
	When device configured for flow: exponent or breakpoint not correctly selected	Check configuration: if <i>2.1.2. Sensor Mode</i> set to FLOW , verify correct exponent [Flow Exponent (2.15.3.2.) on page 191] and breakpoints [Universal Head vs. Flow (2.15.5.) on page 197].
	Incorrect vessel or PMD dimensions	For volume application: Verify vessel dimensions. See Vessel Shape (2.6.1.) on page 147. For flow application: Verify PMD dimensions. See PMD Dimensions (2.15.4.) on page 194
Relay not activating	Relay not programmed	Program relay.
	Relay incorrectly assigned	Verify with simulation. See Simulation (3.4.) on page 214.
	Incorrect relay function selected	Verify with simulation. See Simulation (3.4.) on page 214.
	Incorrect relay setpoints	Verify setpoints.
Relay not activating correctly	Relay incorrectly assigned	Verify with simulation. See Simulation (3.4.) on page 214.
	Incorrect relay function selected	Verify with simulation. See Simulation (3.4.) on page 214.
	Incorrect relay setpoints	Verify setpoints.

Symptom	Cause	Action
No response when echo profile requested via LUI (3.2.1. Echo Profile)	Transducer is disabled.	Set Transducer Enable (3.3.1.) on page 204 to ENABLED, then request an echo profile.
Configuration error 130 displayed	Relay/pump configuration errors - possible causes include: <ul style="list-style-type: none"> A relay is assigned to more than one function (e.g. relay 2 is assigned to both an external totalizer and a pump). Pump setpoints are out of order. Wall Cling adjustment range is too large. 	<ul style="list-style-type: none"> Verify that each relay is assigned to one function only. Review relay assignments under Pump Control (page 151) and Other Control functions (page 175). Verify that all 'ON' setpoints are greater than their respective 'OFF' setpoints for pump down applications (or vica versa for pump up applications). Ensure range set in Level Setpoint Variation (2.7.2.1.2.) on page 154 has not caused 'ON' or 'OFF' setpoints to overlap.
Echo profile request results in an error icon that displays for 5 seconds before returning to the echo profile request menu.	Another external communication is trying to access an echo profile at the same time.	Wait for several seconds and then retry the echo profile request, or disconnect / disable any external communications that may be requesting an echo profile.
Data log files are empty or logging has stopped.	<ul style="list-style-type: none"> Data Logging is not enabled. USB cable is connected. USB extension cable has been used (although may not currently be connected). 	<ul style="list-style-type: none"> Verify that Data Logging is enabled. See Data Logging (2.10.) on page 173. Disconnect USB cable, as no data logs are written while device is connected to a PC via USB. If a USB extension cable has been used (remove if currently connected), a power reset of the device is required to restart Data Logging.

Noise Problems

Incorrect readings can be the result of noise problems, either acoustic or electrical, in the application.

The noise present at the input to the ultrasonic receiver can be determined by viewing the echo profile locally via the LUI, or alternatively, using remote software such as SIMATIC PDM, AMS Device Manager, FC375/475, or DTM. View also parameters *3.2.9.4. Noise Average* and *3.2.9.5. Noise Peak*. In general, the most useful value is the average noise.

With no transducer attached the noise is under 5 dB. This is often called the noise floor. If the value with a transducer attached is greater than 5 dB, signal processing problems can occur. High noise decreases the maximum distance that can be measured. The exact relationship between noise and maximum distance is dependent on the transducer type and the material being measured. An average noise level greater than 30 dB may be cause for concern if the installed transducers maximum operation range matches the range of the application (e.g. 8 m application using an 8 m XRS-5). Using a larger transducer with greater transmitted energy should help to improve performance in a noise condition.

Determine the Noise Source

Disconnect the transducer from the SITRANS LUT400. If the measured noise is below 5 dB, then continue here. If the measured noise is above 5 dB go to *Non-Transducer Noise Sources* below.

1. Connect only the shield wire of the transducer to the SITRANS LUT400. If the measured noise is below 5 dB, continue with the next step. If the noise is above 5 dB, go to *Common Wiring Problems* below.
2. Connect the white and black transducer wires to the SITRANS LUT400. Record the average noise.
3. Remove the positive wire of the transducer. Record the average noise.
4. Re-connect the positive wire and remove the negative wire. Record the average noise.

Using the table below, determine the appropriate next step. The terms higher, lower and unchanged refer to the noise recorded in the previous steps.

These are guidelines only. If the suggested solution does not solve the problem, try the other options also.

	- removed	+ removed	Go to:
noise	higher	higher	<i>Reducing Electrical Noise</i>
		unchanged	<i>Common Wiring Problems</i>
		lower	<i>Reducing Acoustical Noise</i>
	unchanged	higher	<i>Reducing Electrical Noise</i>
		unchanged	Contact Siemens representative.
		lower	<i>Reducing Acoustical Noise</i>
	lower	higher	<i>Common Wiring Problems</i>
		unchanged	<i>Common Wiring Problems</i>
		lower	<i>Reducing Acoustical Noise</i>

Acoustical Noise

To confirm that the problem is acoustical, place several layers of cardboard over the face of the transducer. If the noise is reduced, the noise is definitely acoustical.

Non-Transducer Noise Sources

Remove all input and output cables from the SITRANS LUT400 individually while monitoring the noise. If removing a cable reduces the noise, that cable may be picking up noise from adjacent electrical equipment. Check that low voltage cables are not being run adjacent to high voltage cables or near to electrical noise generators such as variable speed drives.

Filtering cables is an option but is not recommended unless all other options have been exhausted.

The SITRANS LUT400 is designed to work near heavy industrial equipment such as variable speed drives. Even so, it should not be located near high voltage wires or switch gear.

Try moving the electronics to a different location. Often moving the electronics a few meters farther from the source of noise will fix the problem. Shielding the electronics is also an option, but it should be a last resort. Proper shielding is expensive and is difficult to install properly—the shielding box must enclose the SITRANS LUT400 electronics completely, and all wires must be brought to the box through grounded metal conduit.

Common Wiring Problems

- Make sure that the transducer shield wire is connected at the electronics end only. Do not ground it at any other location.
- Do not connect the transducer shield wire to the white wire.
- The exposed transducer shield wire must be as short as possible.
- Connections between the wire supplied with the transducer, and any customer installed extension wire should only be grounded at the LUT400.

On Siemens transducers the white wire is negative and the black wire is positive. If the extension wire is colored differently, make sure that it is wired consistently.

Extension wire must be shielded twisted pair. See the installation section for specifications.

Reducing Electrical Noise

- Ensure that the transducer cable does not run parallel to other cables carrying high voltage or current.
- Move the transducer cable away from noise generators like variable speed drives.
- Put the transducer cable in grounded metal conduit.
- Filter the noise source.
- Check grounding.

Reducing Acoustical Noise

- Move the transducer away from the noise source.
- Use a stilling well.
- Install a rubber or foam bushing or gasket between the transducer and the mounting surface.
- Relocate or insulate the noise source.
- Change the frequency of the noise. Ultrasonic devices are sensitive to noise in the frequency range of the transducer employed.
- Check that transducer is not mounted too tightly; only hand-tight.

Measurement Difficulties

If the *2.4.2. LOE Timer* expires due to a measurement difficulty, the *2.4.3. Fail-Safe mA Value* displays. In rare cases, the SITRANS LUT400 may lock on to a false echo and report a fixed or wrong reading.

Loss of Echo (LOE)

The *2.4.3. Fail-Safe mA Value* displays (seen in *2.5.8. Current Output Value*) when the echo confidence is below the threshold value set in *2.12.2.2. Echo Threshold*.

LOE occurs when:

- The echo is lost and no echo is shown above the ambient noise (see low *3.2.9.2. Confidence* and low *3.2.9.3. Echo Strength*)
- Two echoes are too similar to differentiate (when BLF algorithm used) (see low *3.2.9.2. Confidence* and low *3.2.9.3. Echo Strength*)
- No echo can be detected within the programmed range (see *2.2.5. Far Range*).

If *2.4.3. Fail-Safe mA Value* is displayed, check the following:

- Surface monitored is within the transducer maximum range
- *2.1.6. Transducer* model matches the transducer used
- Transducer is located and aimed properly
- Transducer (that is installed without a submergence shield) is not submerged

Adjust Transducer Aiming

See the transducer manual for range, mounting, and aiming details. For optimum performance, adjust transducer aiming to provide the best *3.2.9.2. Confidence* and *3.2.9.3. Echo Strength* for all material levels within the measurement range.

Displaying Echoes

The most efficient method of checking echoes is locally via the LUI, or remotely using SIMATIC PDM, AMS, FC375/475, or DTM software.

Use LUI or remote software to graphically display the echo profile at the installation. Interpret the echo profile and change relevant parameters. For LUI, see “Requesting an Echo Profile” on page 57, and for details on how to interpret an Echo Profile, see “Echo Processing” on page 255.

Increase Fail-safe Timer Value

Increase the *2.4.2. LOE Timer* value, if fail-safe operation will not be compromised by the larger value.

Try this only if LOE exists for short periods of time.

Install a Transducer with a Narrower Beam

A consistent, incorrect level reading may result due to interference echoes from the sides of a vessel. If this occurs, try installing a longer range (narrower beam) transducer, enter the new *2.1.6. Transducer* model, and (if necessary) optimize aiming and frequency again.

Always contact Siemens service personnel before selecting a transducer to solve this type of problem.

Fixed Reading

If the Reading is a fixed value, regardless of the transducer to material surface distance, ensure the:

1. Transducer acoustic beam is free from obstruction.
2. Transducer is properly aimed
3. Transducer is not in contact with any metal object.
4. Material mixer (if used) is operating while the SITRANS LUT400 is operating. If it is stopped, ensure that the mixer blade is not stopped under the transducer.

Obstructions in the Sound Beam

Check for (and remove if present) any acoustic beam obstruction, or relocate the transducer.

If an obstruction cannot be removed or avoided, adjust the Time Varying Threshold (TVT) curve to reduce the Echo Confidence derived from the sound reflected by the obstruction. Use SIMATIC PDM to adjust the TVT curve. (See *TVT Shaper* under *Echo Profile Utilities* in LUT400 Communications manual¹.)

Nozzle Mountings

If the transducer is mounted on or in a nozzle, grind smooth any burrs or welds on the inside or open end (the end that opens into the vessel). If the problem persists, install a larger diameter or shorter length nozzle, bevel the inside of the bottom end, or cut the open end of the nozzle at a 45° angle.

See the transducer manual for complete mounting instructions.

If the mounting hardware is over tightened, loosen it. Over tightening changes the resonance characteristics of the transducer and can cause problems.

¹ Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

Set the SITRANS LUT400 to Ignore the Bad Echo

If the preceding remedies have not fixed the problem, the false echo has to be ignored.

If the Echo is Close to the Transducer

If there is a static, incorrect, high level reading from the SITRANS LUT400 there is probably something reflecting a strong echo back to the transducer. If the material level never reaches that point extend the *2.2.4. Near Range* to a distance to just past the obstruction.

Adjust the TVT to Ignore the Echo

Use *2.12.3.1. Auto False Echo Suppression*. If this does not correct the problem, use *2.12.4. TVT Shaper* to manually shape around false echoes.

Wrong Reading

If the Reading is erratic, or jumps to some incorrect value periodically, ensure the:

1. Surface monitored is not beyond the SITRANS LUT400's programmed range or the transducer's maximum range.
2. Material is not falling into the transducer's acoustic beam.
3. Material is not inside the blanking distance (near range) of the transducer.

Types of Wrong Readings

If a periodic wrong Reading is always the same value, see "Fixed Reading" on page 243.

If the wrong Reading is random, ensure the distance from the transducer to the material surface is less than *2.2.5. Far Range* value plus one meter (i.e. ensure you are still within the measurement range programmed in the device). If the material/object monitored is outside this range, increase *2.2.5. Far Range* as required. This error is most common in OCM applications using weirs.

Liquid Splashing

If the material monitored is a liquid, check for splashing in the vessel. Enter a lower *Response Rate* value (see page 42) to stabilize the Reading, or install a stilling well. (Contact Siemens representative.)

Adjust the Echo Algorithm

Use SIMATIC PDM to view echo profiles and make adjustments to the *Algorithm* parameter. See *2.12.2.1. Algorithm* on page 181 for details.

If the "TRACKER" algorithm is used and narrow noise spikes are evident on the Echo Profile, widen the *2.12.2.4. Narrow Echo Filter*. Also, if the true echo has jagged peaks, use *2.12.2.3. Reform Echo*.

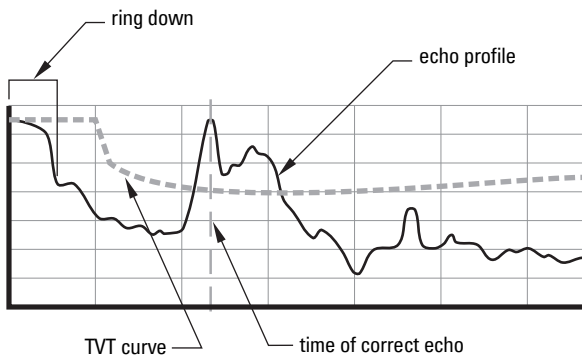
If multiple echoes appear on the Echo Profile, typical of a flat material profile (especially if the vessel top is domed), use the "TF" (True First) algorithm.

Should a stable measurement still not be attainable, contact Siemens representative.

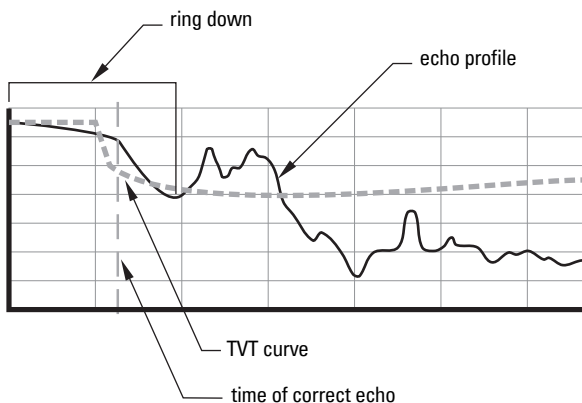
Transducer Ringing

If the transducer is mounted too tightly, or if it is mounted so that its side touches something (such as a vessel wall, or standpipe), its resonance characteristics change and this can cause problems. Hand tighten only. PTFE tape is not recommended as it reduces friction resulting in a tighter connection that can lead to ringing.

Normal Ring Down



Poor Ring Down



Ring down times that extend past the near range area can be interpreted by the SITRANS LUT400 as the material level and are characterized by a steady high level being reported.

Echo Profile Display

To assist in troubleshooting echo profiles, **pan** and **zoom** options are available. See "Requesting an Echo Profile" on page 57.

Trend Display

A trend display is available with pan and zoom options. See "Trends" on page 118.

Notes

Technical Data

Power

AC model

- 100-230 V AC $\pm 15\%$, 50 / 60 Hz, 36 VA (10W)¹
- Fuse: 5 x 20 mm, Slow Blow, 0.25A, 250V

DC model

- 10-32 V DC, 10W¹
- Fuse: 5 x 20 mm, Slow Blow, 1.6A, 125V

Performance

Range

- 0.3 to 60 m (1 to 196 ft), dependent on transducer

Accuracy (measured under Reference Conditions similar to IEC 60770-1)

- Standard operation: ± 1 mm (0.04") plus 0.17 % of distance
- High accuracy OCM²: ± 1 mm (0.04"), within 3 m (9.84 ft) range

Resolution (measured under Reference Conditions similar to IEC 60770-1)

- Standard operation: 0.1 % of range or 2 mm (0.08"), whichever is greater
- High accuracy OCM²: 0.6 mm (0.02"), within 3 m (9.84 ft) range

Reference operating conditions according to IEC 60770-1

- ambient temperature +15 to +25 °C (+59 to +77 °F)
- humidity 45% to 75% relative humidity
- ambient pressure 860 to 1060 mbar g (86 000 to 106 000 N/m² g)

Temperature Compensation

- Range: -40 to +150 °C (-40 to +300 °F)

¹. Power consumption is listed at maximum.

². A high accuracy configuration consists of the LUT440 (OCM) model using XRS-5 transducer, TS-3 temperature sensor, and a Low Calibration Point of 3 m or less.
Under severe EMI/EMC environments per IEC 61326-1 the DC powered device may have an additional error increase of up to 0.5 mm.

Source

- Integral transducer sensor
- TS-3 temperature sensor
- Average (integral transducer and TS-3)
- Programmable fixed temperature

Temperature Error

Fixed

- 0.17 % per °C deviation from programmed value

Memory

- 512 kB flash EPROM
- 1.5 MB flash for data logging

Interface

Outputs

mA Analog

- 4-20 mA
- 600 ohms maximum in ACTIVE mode, 750 ohms maximum in PASSIVE mode
- Resolution of 0.1%
- Isolated

Relays¹ (3)

- 2 control
- 1 alarm control

Control Relays

- 2 Form A (SPST), NO relays
- Rated 5A at 250 V AC, non-inductive
- Rated 3A at 30 V DC

¹ All relays are certified only for use with equipment that fails in a state at or under the rated maximums of the relays.

Alarm Relay

- 1 Form **C (SPDT), NO** or **NC** relay
- Rated 1A at 250 V AC, non-inductive
- Rated 3A at 30 V DC

Inputs

Discrete (2)

- 0-50 V DC maximum switching level
- Logical 0 = < 10 V DC
- Logical 1 = 10 to 50 V DC
- 3 mA maximum draw

Programming

Primary

- Local push buttons

Secondary

- PC running SIMATIC PDM
- PC running Emerson AMS Device Manager
- PC running a web browser
- PC running a Field Device Tool (FDT)
- Field Communicator 375/475 (FC375/FC475)

Compatible Transducers

- EchoMax series and STH series

Transducer Frequency

- 10 to 52 kHz

Communication

- HART 7.0
- USB

Display

- Back-lit LCD
- Dimensions:
 - 60 x 40 mm (2.36 x 1.57")
- Resolution:
 - 240 x 160 pixels
- Removable display, operational up to 5 m from enclosure base

Mechanical

Enclosure

- 144 mm (5.7") x 144 mm (5.7") x 146 mm (5.75")
- IP65 / Type 4X / NEMA 4X
- Polycarbonate

Note: Use only approved, suitable size hubs in the enclosure's conduit holes that maintain the applicable IP / Type / NEMA rating.

Remote Display Lid

- 144 mm (5.7") x 144 mm (5.7") x 22 mm (0.87")
- IP65 / Type 3 / NEMA 3
- Polycarbonate
- Operational up to 5 m from enclosure base

Blank Lid

- 144 mm (5.7") x 144 mm (5.7") x 22 mm (0.87")
- IP65 / Type 4X / NEMA 4X
- Polycarbonate



WARNINGS:

- Ingress protection of the enclosure is reduced to IP20, and Type 4X / NEMA 4X rating is void when cable entry knock-out in the blank lid is removed.
- An enclosure reduced to an IP20 rating and intended for use in non-hazardous locations must be installed in an indoor location free of dust and moisture, or be installed in a suitable rated field enclosure IP54 or better.

Back Mount Bracket

- 190 mm (7.5") x 190 mm (7.5") x 9 mm (0.35")
- Polycarbonate

Weight

- Enclosure with display lid: 1.3 kg (2.87 lbs)
- Enclosure with blank lid: 1.2 kg (2.65 lbs)

Environmental

Location

- Indoor / outdoor
(only suitable for outdoor use with IP65 / Type 4X / NEMA 4X Enclosure)

Altitude

- 2000 m max.

Ambient temperature

- -20 to +50 °C (-4 to +122 °F)

Relative humidity

- Suitable for outdoors
(only with IP65 / Type 4X / NEMA 4X Enclosure)

Installation category

- II

Pollution degree

- 4

Approvals

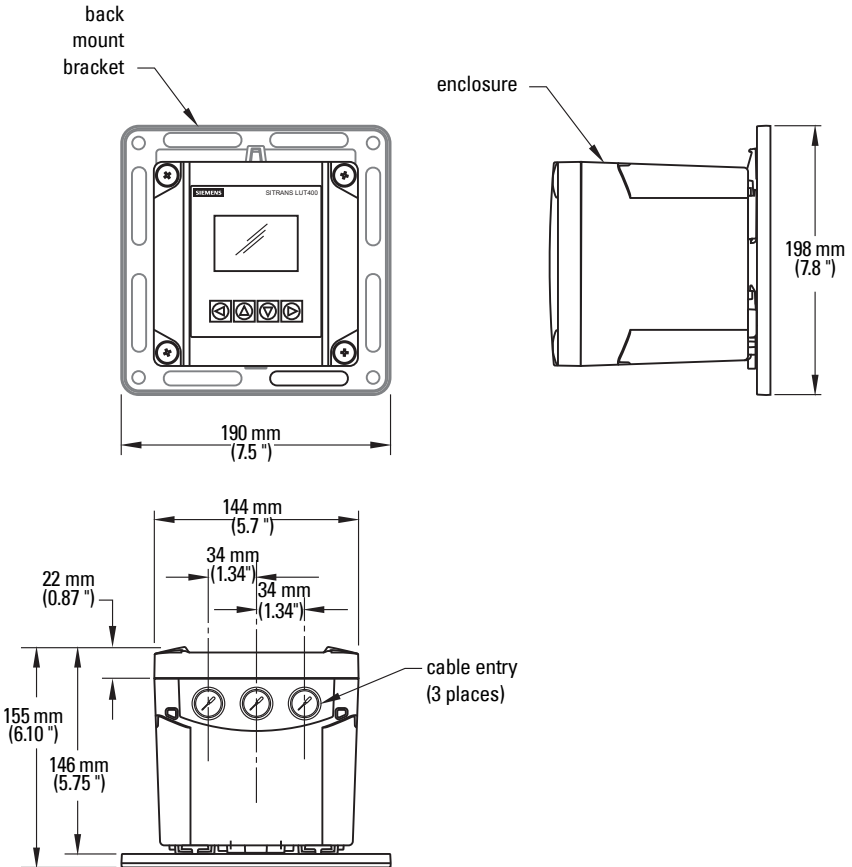
Note: The device nameplate lists the approvals that apply to your device.

- General
CSA_{US/C}, CE, FM, UL listed, C-TICK
- Hazardous
Non-incendive (Canada) CSA Class I, Div. 2, Groups A, B, C, D; Class II,
Div 2, Groups F, G; Class III

Notes

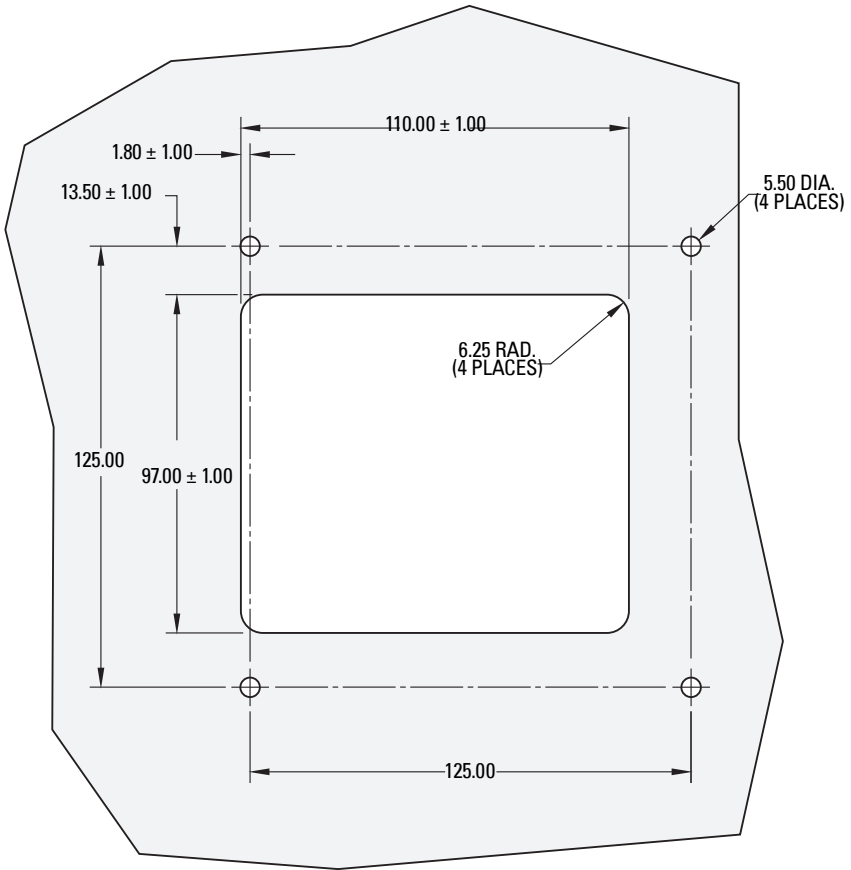
Dimension Drawings

SITRANS LUT400 Dimensions



Dimensions

Cutout Dimensions (for Remote Panel Mount)



DIMENSIONS ARE IN MILLIMETERS.

Note: Cut-out template (printed to scale) shipped with remote panel mount model.

Dimensions

Appendix A - Technical Reference

Note: Where a number precedes a parameter name (for example, *2.12.2.4. Narrow Echo Filter*) this is the parameter access number via the local display. See *Parameter reference (LU)* on page 137 for a complete list of parameters.

Principles of Operation

The SITRANS LUT400 is a high quality ultrasonic controller, configured to meet the needs of different applications, from medium range solids applications to liquids management with open channel measurement capability. The LUT400 features our next generation of Sonic Intelligence[®] advanced echo-processing software for increased reading reliability.

Process Variables

The Primary Variable (PV) is one of six process variables, and is set in *2.5.1.Current Output Function*.

- Level (difference between material level and Low Calibration Point),
- Space (difference between material level and High Calibration Point),
- Distance (difference between material level and sensor reference point),
- Head (difference between liquid level and Zero Head),
- Volume (volume of material based on level),
- Flow (flowrate in an open channel, based on head).

Transmit Pulse

The transmit pulse consists of one or more electrical “shot” pulses, which are supplied to the transducer connected to the SITRANS LUT400 terminals. The transducer fires an acoustic “shot” for each electrical pulse supplied. After each shot is fired, sufficient time is provided for echo (shot reflection) reception before the next (if applicable) shot is fired. After all shots of the transmit pulse are fired, the resultant echoes are processed. The transmit pulse frequency, duration, delay, and associated measurement range are defined by parameters in the Setup menu (see *Setup* on page 138.)

Echo Processing

SITRANS LUT400 uses next generation Sonic Intelligence[®] for echo processing.

Next generation Sonic Intelligence provides adaptive digital filtering of the transducer signal. For example, when noise levels are high, filters are adjusted to maximize the signal to noise ratio. This advanced Sonic Intelligence not only allows for better filtering, but provides improved tracking of echos, and more sophisticated echo positioning algorithms.

Echo processing consists of echo enhancement, true echo selection, and selected echo verification.

Echo enhancement is achieved by filtering (*2.12.2.4. Narrow Echo Filter*) and reforming (*2.12.2.3. Reform Echo*) the echo profile.

True echo selection (selection of echo reflected by the intended target) occurs when that portion of the echo profile meets the evaluation criteria of Sonic Intelligence.

Insignificant portions of the echo profile outside of the measurement range (*2.2.1. Low Calibration Point*), below the TVT curve (*2.12.4. TVT Shaper*) are automatically disregarded. The remaining portions of the Echo Profile are evaluated using the echo select algorithm (*2.12.2.1. Algorithm*), and the Echo Profile portion providing the best echo confidence (*3.2.9.2. Confidence*) is selected.

A confidence value is a static test of a single snapshot profile so to maintain a valid reading, it imposes that each individual profile show its peak above the threshold. The window may be locked on the profile for hours or days so if the profile drops below the TVT curve just once, a loss of echo may occur.

The SITRANS LUT400, with its advanced tracking ability, can find and track the real echo amongst stationary clutter echoes. Therefore, even if the echo drops below the tvt curve, it can be identified with near certainty for approximately 30 seconds. This capability is measured by the FOM (*3.2.9.1. Figure of Merit*).

Selected echo verification is automatic. The position (relation in time after transmit) of the new echo is compared to that of the previously accepted echo. When the new echo is within the Echo Lock Window, it is accepted and displays, outputs, and relays are updated. If the new echo is outside of the Window, it is not accepted until Echo Lock requirements are satisfied.

Echo Selection

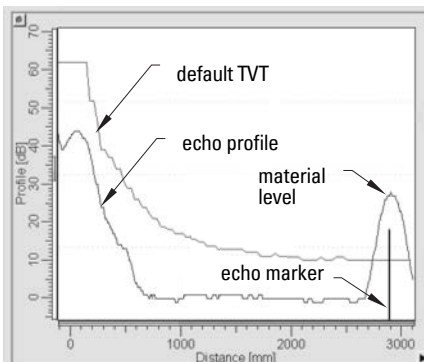
Time Varying Threshold (TVT)

A TVT curve describes a threshold below which any echoes will be ignored. The default TVT curve is used, until *2.12.3.1. Auto False Echo Suppression* and *2.12.3.2. Auto False Echo Suppression Range* are used to create a new 'learned TVT curve'.

A TVT hovers above the echo profile to screen out unwanted reflections (false echoes).

In most cases the material echo is the only one which rises above the default TVT.

In a vessel with obstructions, a false echo may occur. See *Shaper Mode and Auto False Echo Suppression* below for more details.



The device characterizes all echoes that rise above the TVT as potential good echoes. Each peak is assigned a rating based on its strength, area, height above the TVT, and reliability, amongst other characteristics.

Algorithm

The true echo is selected based on the setting for the Echo selection algorithm. For a list of options see **Algorithm (2.12.2.1.)** on page 181. All algorithms ultimately use confidence to select the true echo. However, when applications report a low confidence value, the **TR** algorithm (which tracks the moving echo) can be used to predict the primary variable.

Algorithm		Echo Determination	Suggested Usage
TF	True First echo	Selects the first echo that crosses TVT curve.	Use in liquids applications free of obstructions when confidence of first echo is high.
TR	TR acker	Selects the echo that is closest to the transducer, and is moving. (If echo location is steady, BLF algorithm should be used.)	Only use TR algorithm in process applications with continuous level changes, and a risk of fixed obstructions that could interfere with true level, resulting in low confidence.
L	Largest echo	Selects the largest echo above the TVT curve.	Use in long range liquids applications with large (tall) material return echoes.
BLF	Best of First and Largest echo	Selects the echo (first and highest) with the highest confidence value.	Default and most commonly used. Use in all short to mid range general liquids and solids applications where there is a relatively large (tall), sharp echo.
ALF	Area, Largest, and First	Selects the echo with the highest confidence value based on the three criterion (widest, highest, and first).	Use in mid to long range solids applications where the material return echo is wide and large, and where competing smaller echoes challenge BLF

Confidence

Confidence (3.2.9.2.) describes the quality of an echo. Higher values represent higher quality.

Echo Threshold

Echo Threshold (2.12.2.2.) defines the minimum confidence value required for an echo to be accepted as valid and evaluated.

Figure of Merit

Figure of Merit (3.2.9.1.) measures the quality of the reported process value: higher values represent better quality. Even when a low confidence value exists, a high FOM will ensure the true echo has been selected. Approximately 20 readings are used to support the FOM value.

Example:

FOM greater than 75% = good quality,
FOM less than 50% = poor quality.

Various things contribute to the FOM:

- success of the tracking (how closely can the next level vs. the actual next level be predicted)
- level of noise
- confidence of the last echo
- time interval since last valid echo
- speed at which the process is moving
- quality of the echo shape and how it helps the calculation of the echo position

If FOM is low, reduce the noise in the process, or check the installation to increase signal quality.

Shaper Mode and Auto False Echo Suppression

Notes:

- For detailed instructions on using this feature via PDM, see Auto False Echo Suppression in LUT400 Communications manual^a.
- For detailed instructions on using this feature via the local push buttons, see **Shaper Mode (2.12.3.4.)** on page 184.

- a. Communications for SITRANS LUT400 (HART) Manual (7ML19985NE01)

False echoes can be caused by an obstruction in the transducer shot path (such as pipes, ladders, chains). Such false echoes may rise above the default TVT curve.

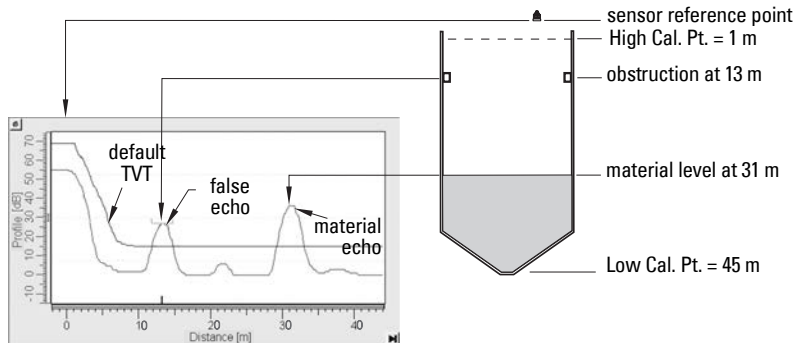
Auto False Echo Suppression Range (2.12.3.2.) specifies the range within which the learned TVT is applied. Default TVT is applied over the remainder of the range.

The material level should be below all known obstructions at the moment when Auto False Echo Suppression learns the echo profile. Ideally the vessel should be empty or almost empty.

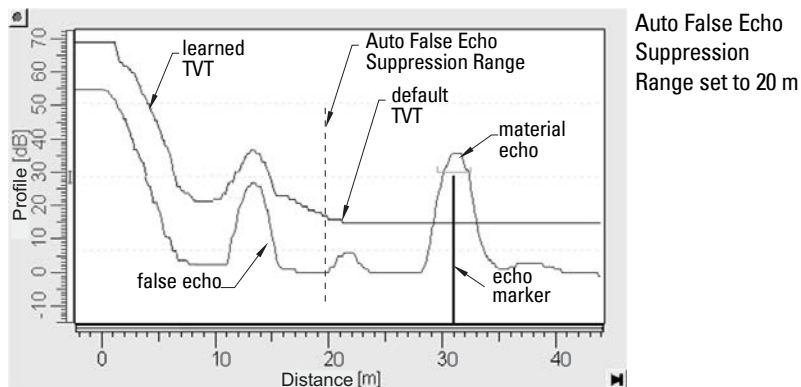
The device learns the echo profile over the whole measurement range and the TVT is shaped around all echoes present at that moment.

Auto False Echo Suppression Range must be set to a distance shorter than the distance to the material level when the environment was learned, to avoid the material echo being screened out.

Example before Auto False Echo Suppression



Example after Auto False Echo Suppression



Auto False Echo Suppression Range set to 20 m

Measurement Range

Near Range

Near Range (2.2.4.) programs SITRANS LUT400 to ignore the area in front of the transducer. The default blanking distance is 27.8 cm (0.91 ft) from the sensor reference point.

Near Range allows you to increase the blanking value from its factory default. But Shaper Mode (2.12.3.4.) is generally recommended in preference to extending the blanking distance from factory values.

Far Range

Far Range (2.2.5.) can be used in applications where the base of the vessel is conical or parabolic. A reliable echo may be available below the vessel empty distance, due to an indirect reflection path.

Increasing Far Range by 30% or 40% can provide stable empty vessel readings.

App. A - Technical Ref.

Measurement Response

Note: Units are defined in **Quick Start (11.)** and are in meters by default.

Response Rate limits the maximum rate at which the display and output respond to changes in the measurement. There are three preset options: slow, medium, and fast.

Once the real process fill/empty rate (m/min by default) is established, a response rate can be selected that is slightly higher than the application rate. Response Rate automatically adjusts the three rate parameters that affect the output response rate.

When Response Rate set to:	Fill Rate per Minute (2.3.1.)/ Empty Rate per Minute (2.3.2.) automatically adjust to:	Damping Filter (2.3.3.) automatically adjusts to:	
*	Slow	0.1 m/min	100.0 s
	Medium	1.0 m/min	10.0 s
	Fast	10.0 m/min	0.0 s

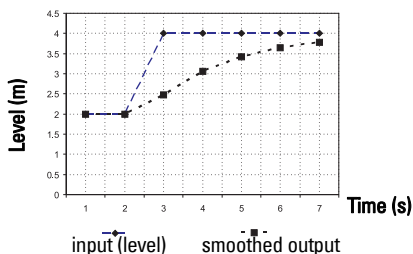
Damping

Damping Filter (2.2.3.) smooths out the response to a sudden change in level. This is an exponential filter and the engineering unit is always in seconds.

In 5 time constants, the output rises exponentially: from 63.2% of the change in the first time constant, to almost 100% of the change by the end of the 5th time constant.

Damping example

time constant = 2 seconds
input (level) change = 2 m



Note: Damping Filter can be set to 0 in order to display measurement readings as fast as fill/empty rates permit. Fill Rate per Minute, and Empty Rate per Minute work in conjunction with Damping Filter, therefore, if readings are slow to respond to changes, check that Fill and Empty Rates are set to values greater than or equal to the desired Response Rate.

Analog Output

The mA output (current output) is proportional to material level in the range 4 to 20 mA. 0% and 100% are percentages of the full-scale reading (m, cm, mm, ft, in). Typically mA output is set so that 4 mA equals 0% and 20 mA equals 100%.

Current Output Function (2.5.1.)

Current Output Function (2.5.1.) controls the mA output and applies any relevant scaling. By default it is set to **LEVEL**. Other options are Space, Distance, Volume, Head, Flow, or Manual. A **MANUAL** setting allows you to test the functioning of the loop.

You can also set the mA output to report when the device is in an error condition and the fail-safe timer has expired. By default, the reported value depends on the device type. A standard device reports the last valid reading, and a NAMUR NE43 compliant device reports the user-defined value for **Material Level** (3.58 mA by default).

Loss of Echo (LOE)

A loss of echo (LOE) occurs when the calculated measurement is judged to be unreliable because the echo confidence value has dropped below the echo confidence threshold.

If the LOE condition persists beyond the time limit set in **LOE Timer (2.4.2.)** the LCD displays the Service Required icon, and the text region displays the fault code 0 and the text LOE.

If two faults are present at the same time, the device status indicator and text for the highest priority fault will display. For example, if both Loss of Echo and Broken cable faults are present, the Broken cable fault will display.



1 Broken cable

Fail-safe Mode

The purpose of the Fail-safe setting is to put the process into a safe mode of operation in the event of a fault or failure. The value to be reported in the event of a fault (as displayed in *2.5.8. Current Output Value*) is selected so that a loss of power or loss of signal triggers the same response as an unsafe level.

LOE Timer (2.4.2.) determines the length of time a Loss of Echo (LOE) condition will persist before a Fail-safe state is activated. The default setting is 100 seconds.

Material Level (2.4.1.) determines the mA value (corresponding to the selected PV) to be reported when **LOE Timer (2.4.2.)** expires. The default setting is device dependent (standard or NAMUR NE 43-compliant).

Upon receiving a reliable echo, the loss of echo condition is aborted, the Maintenance Required icon and error message are cleared, and the mA output return to the current material level. [The PV region on the LUI display will show dashes (-----) when a fault that causes fail-safe is present, and will return to the current reading when the fault is cleared.]

Distance Calculation

To calculate the transducer to material level (object) distance, the transmission medium (atmosphere) *2.12.1.1. Sound Velocity* is multiplied by the acoustic transmission to reception time period. This result is divided by 2 to calculate the one way distance.

$$\text{Distance} = \text{Sound Velocity} \times \text{Time} / 2$$

The Reading displayed is the result of performing any additional modification to the calculated distance as determined by:

- *2.1.2. Sensor Mode,*
- *2.1.1. Units,*
- Volume conversion parameters - *2.6. Volume, 2.2.3. Sensor Offset,*
- Flow parameters - *2.15. Flow,*
- and/or Totalizer parameters - *2.16. Totalizers.*

Sound Velocity

The sound velocity of the transmission medium is affected by the type, temperature, and vapor pressure of the gas or vapor present. As preset, the SITRANS LUT400 assumes the vessel atmosphere is air at +20 °C (+68 °F). Unless altered, the sound velocity used for the distance calculation is 344.1 m / s (1129 ft / s).

Variable air temperature is automatically compensated when a Siemens ultrasonic / temperature transducer is used. If the transducer is exposed to direct sunlight, use a sunshield or a separate TS-3 temperature sensor.

Also, if the temperature varies between the transducer face and the liquid monitored, use a TS-3 temperature sensor in combination with an ultrasonic / temperature transducer. The TS-3 must be installed as close to the material as possible to ensure best performance. It is acceptable to submerge the TS-3 if necessary. Set *2.12.1.3. Temperature Source* for **Average of Sensors**, to average the transducer and TS-3 measurements.

Atmosphere composition other than air can pose a challenge for ultrasonic level measurement. However, excellent results may be obtained if the atmosphere is homogeneous (well mixed), at a fixed temperature, and consistent vapour pressure, by performing a *2.12.1.6. Auto Sound Velocity*.

The SITRANS LUT400 automatic temperature compensation is based on the sound velocity / temperature characteristics of "air" and may not be suitable for the atmosphere present. If the atmosphere temperature is variable, perform frequent sound velocity calibrations to optimize measurement accuracy.

Sound velocity calibration frequency may be determined with experience. If the sound velocity in two or more vessels is always similar, future calibrations may be performed on one vessel and the resultant *2.12.1.1. Sound Velocity* entered directly for the other vessel(s).

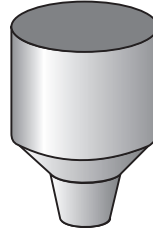
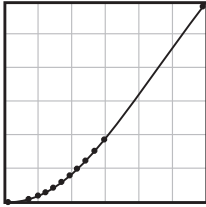
If the sound velocity of a vessel atmosphere is found to be repeatable at specific temperatures, a chart or curve may be developed. Then rather than performing a sound velocity calibration each time the vessel temperature changes significantly, the anticipated *2.12.1.1. Sound Velocity* may be entered directly.

Volume Calculation

The SITRANS LUT400 provides a variety of volume calculation features (see *2.6. Volume*).

If the vessel does not match any of the eight preset vessel shape calculations, a Universal Volume calculation may be used. Use the level/volume graph or chart provided by the vessel fabricator (or create one based on the vessel dimensions). Based on the graph, choose the Universal Volume calculation, and select the level vs. volume breakpoints to be entered (32 max). Generally, the more breakpoints entered, the greater the accuracy.

2.6.1. Vessel Shape set to Universal, Linear



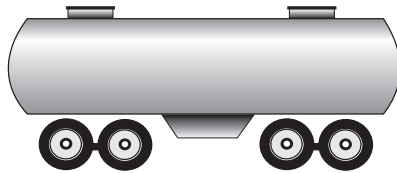
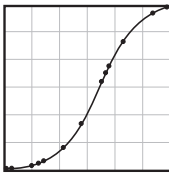
This volume calculation creates a piece-wise linear approximation of the level/volume curve. This option provides best results if the curve has sharp angles joining relatively linear sections.

Enter a Level Breakpoint at each point where the level/volume curve bends sharply (2 minimum).

For combination curves (mostly linear but include one or more arcs), enter numerous breakpoints along the arc, for best volume calculation accuracy.

2.6.1. Vessel Shape set to Universal, Curved

This calculation creates a cubic spline approximation of the level/volume curve, providing best results if the curve is non-linear, and there are no sharp angles.



Select at least enough breakpoints from the curve to satisfy the following:

- two breakpoints very near the minimum level
- one breakpoint at the tangent points of each arc
- one breakpoint at each arc apex
- two breakpoints very near the maximum level

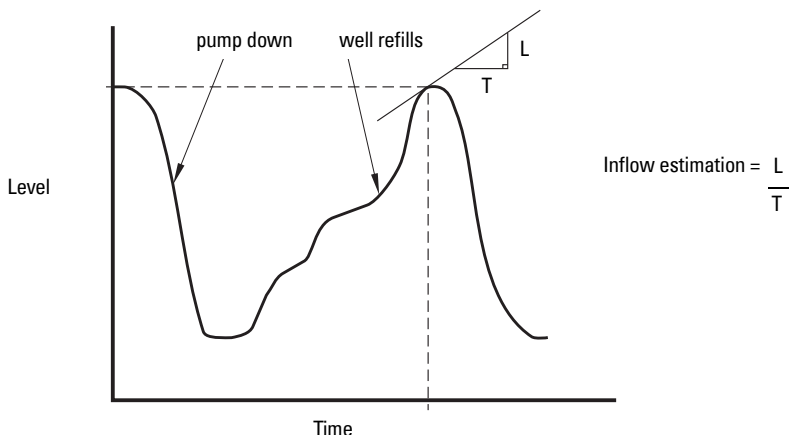
For combination curves, enter at least two breakpoints immediately before and after any sharp angle (as well as one breakpoint exactly at the angle) on the curve.

Pump Totalizers

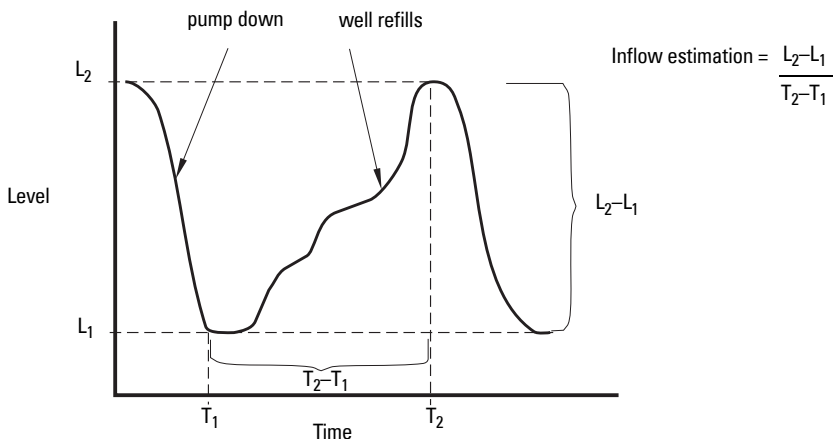
Inflow/Discharge Adjust

Pumped volume totals are affected by the inflow (or discharge) rate. This rate can be calculated based on rate of change estimation, or pump cycle timing.

Using **Inflow/Discharge Adjust (2.73.4.)**, set option **Based on rate estimation** to have the inflow rate measured just prior to the start of the pump cycle.



Set option **Based on pump cycle** to calculate the inflow based on the change of volume between the end of the last pump cycle and the start of the next one, and the time period between the last cycle and the current one.



App. A - Technical Ref.

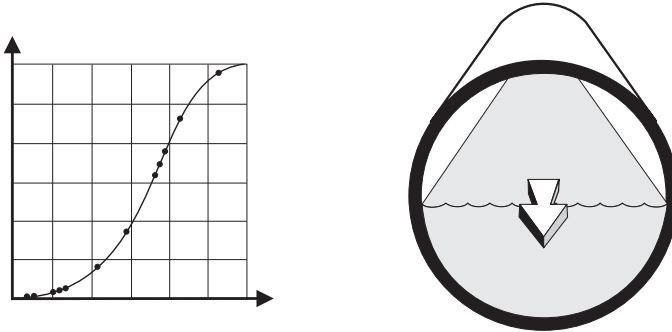
Flow Calculation

Special emphasis has been placed on providing the most accurate flow calculations possible. To this end, specific routines have been written to comply with the British Standards Institute's Specifications BS-3680. These routines calculate correction factors taking into account second order effects such as approach velocity and boundary layer.

If the PMD does not match any of the eleven preset PMD calculations, or if a PMD is not used, select a Universal flow calculation (PMD = Universal Head Flow). Use the head/flow graph or chart provided by the PMD fabricator (or create one based on the PMD or channel dimensions).

The SITRANS LUT400 supports Universal curved flow calculation. This calculation creates a cubic spline approximation of the head/flow curve, providing best results if the curve is non-linear, and there are no sharp angles.

Select the head versus flow breakpoints to be entered (32 max). Generally, the more breakpoints entered, the greater the flow calculation accuracy.



Select at least enough breakpoints from the curve to satisfy the following:

- two breakpoints very near the minimum head
- one breakpoint at the tangent points of each arc
- one breakpoint at each arc apex
- two breakpoints very near the maximum head

For combination curves, enter at least 2 breakpoints immediately before and after any sharp angle (as well as 1 breakpoint exactly at the angle) on the curve.

Method of Flow Calculation

The SITRANS LUT400 can be programmed to use either of two methods for calculating flow from the head measurement: absolute or ratiometric. The result is the same regardless of the method used. The main difference is the information that must be entered in order for the device to carry out the calculation. Refer to 2.15.1. *Primary Measuring Device (PMD)*, and 2.15.4. *PMD Dimensions* for list of information required.

For the ratiometric method, it is usually sufficient that the user know the flow rate (Q_{cal}) which occurs at maximum head (h_{cal}).

On the other hand, absolute calculations require that the user enter information such as: the physical dimensions of the PMD and the constant relating to units of measure for both linear dimensions and flow rates.

Example:

the general formula for flow through a single exponent PMD is:

$$Q = KH^x$$

the specific formula for flow through a 45 ° V-notch weir is:

$$cfs = 1.03H^{2.5}$$

thus: Q = flow in cubic feet per second

K = constant of 1.03

H = head in feet

The absolute method is not applicable to the following:

- Palmer Bowls Flume
- H-Flume

Data Logging

Data logs are available for Alarms, OCM flow, Daily Totals, and Primary Variable. The logs can be examined locally via LUI (see **View Logs (3.2.6.)**), or via USB on a computer.

After connecting the USB cable, browse to the USB drive on the computer. Logs can be viewed on the USB drive, or can be copied from the USB drive to another local computer drive.

Note: No data logs are written while device is connected to a PC via USB.

Log files written to a local computer drive via USB, are comma-delimited files, and a list of file headings for each type of log is shown below.

Log type	Headings
Alarms	Current Date (YYYY/MM/DD)
	Current Time (HH:MM:SS)
	Alarm Name
	Alarm Value
	Alarm State
OCM	Current Date (YYYY/MM/DD)
	Current Time (HH:MM:SS)
	Current Head Value (in level units)
	Current Flow Value (in flowrate units)
Daily Totals	Current Date (YYYY/MM/DD)
	Maximum Daily Flow (in flowrate units)
	Minimum Daily Flow (in flowrate units)
	Daily Average Flow (in flowrate units)
	Daily Totalized Volume (in volume units)
	Daily Running Totalized Volume (in volume units)
	Daily Maximum Temperature (in temperature units)
	Daily Minimum Temperature (in temperature units)
PV	Current Date (YYYY/MM/DD)
	Current Time (HH:MM:SS)
	PV (in Device Variable Code) 0 = Level 1 = Space 2 = Distance 3 = Volume 4 = Flow 5 = Head
	PV Value (in PV units)
	Temperature Value (in temperature units)

To clear entries when log memory becomes full, see *Viewing the Data Log* on page 119.

Notes

Appendix B - Certificates and Support

Certificates

Certificates can be downloaded from the product page of our website at:
www.siemens.com/sitransLUT400.

Technical Support

If you have any technical questions about the device described in these Operating Instructions and do not find the answers, you can contact Customer Support:

- Via the Internet using the **Support Request**:
Support request (<http://www.siemens.com/automation/support-request>)
- Via Phone:
 - Europe: +49 (0) 911 895 7222
 - America: +1 423 262 5710
 - Asia-Pacific: +86 10 6475 7575

Further information about our technical support is available on the Internet at
Technical support (<http://support.automation.siemens.com/WWW/view/en/16604318>)

Service & Support on the Internet

In addition to our documentation, we offer a comprehensive knowledge base online on the Internet at:

Service & Support (<http://www.siemens.com/automation/service&support>)

There you will find:

- The latest product information, FAQs, downloads, tips and tricks.
- Our newsletter, providing you with the latest information about our products.
- Our bulletin board, where users and specialists share their knowledge worldwide.
- Your local contact partner for Industry Automation and Drives Technologies in our partner database.
- Information about field service, repairs, spare parts and lots more under "Services".

Additional Support

Please contact your local Siemens representative and offices if you have additional questions about the device.

Find your contact partner at:

Local contact person (<http://www.siemens.com/automation/partner>)

Notes

List of Abbreviations

Short form	Long Form	Description	Units
AC	Alternating Current	power source	
AFES	Auto False Echo Suppression		
CE / FM / CSA	Conformité Européene / Factory Mutual / Canadian Standards Association	safety approval	
BS-3680	Flow standard from the British Standards Institute		
DC	Direct Current	power source	
DTM	Device Type Manager		
EDD	Electronic Device Description		
EMC	Electromagnetic Compatibility		
ESD	Electrostatic Discharge		
FCC	Federal Communications Commission		
FDT	Field Device Tool		
FOM	Figure of Merit	measurement of echo quality	
HART	Highway Addressable Remote Transducer		
HCF	Hart Communication Foundation		
IEC	International Electrotechnical Commission		
IP	Ingress Protection		
IS	Intrinsically Safe	safety approval	
LCD	Liquid Crystal Display		
LOE	Loss of Echo		
LUI	Local User Interface	view outputs via LCD display; make modifications via local push buttons	
μs	microsecond	10 ⁻⁶	Second
μV	microvolt	10 ⁻⁶	Volt
mA	Milliamp	unit of electric current	
N m	Newton meter	unit of torque	

Short form	Long Form	Description	Units
NEMA	National Electrical Manufacturer's Association		
PDM	Process Device Manager		
PLC	Programmable Logic Controller		
PV	Primary Variable	measured value	
RC	Resistance Capacitance	resistance x capacitance	μs
SCADA	Supervisory Control and Data Acquisition		
SCR	Silicon-controlled rectifier	switching device	
SPDT	Single Pole Double Throw	relay configuration	
SPST	Single Pole Single Throw	relay configuration	
SV	Secondary Variable	equivalent value	
TVT	Time Varying Threshold	sensitivity threshold	
USB	Universal Serial Bus		
VSDs	Variable Speed Drives		

LCD Menu Structure

LCD Menu Structure



Notes:
 •In Navigation mode **ARROW keys** navigate the menu in the direction of the arrow.
 •See *Parameter reference (LUI)* on page 137 for detailed information and instructions.

MAIN MENU

1. WIZARDS

- 1.1 QUICK START
 - 1.1.1 QS LEVEL
 - INTRODUCTION
 - TRANSDUCER
 - OPERATION
 - TEMPERATURE SOURCE
 - FIXED TEMPERATURE
 - UNITS
 - HIGH CALIB. PT.
 - LOW CALIB. PT.
 - RESPONSE RATE
 - APPLY?
 - 1.1.2 QS VOLUME
 - INTRODUCTION
 - TRANSDUCER
 - TEMPERATURE SOURCE
 - FIXED TEMPERATURE
 - VESSEL SHAPE
 - UNITS
 - HIGH CALIB. PT.
 - LOW CALIB. PT.
 - RESPONSE RATE
 - DIMENS. A
 - DIMENS. L
 - VOLUME UNITS
 - MAX. VOLUME
 - APPLY?
 - 1.1.3 QS FLOW (LUT430, 440 only)
 - INTRODUCTION
 - TRANSDUCER
 - TEMPERATURE SOURCE
 - FIXED TEMPERATURE
 - PRIMARY MEASURING DEVICE
 - METHOD OF FLOW CALCULATION
 - UNITS
 - HIGH CALIB. PT.
 - LOW CALIB. PT.
 - RESPONSE RATE
 - Calculation factors (vary per PMD)
 - PMD dimensions (vary per PMD)
 - MAXIMUM HEAD
 - ZERO HEAD OFFSET
 - FLOWRATE UNITS
 - MAXIMUM FLOW AT 20MA
 - FLOWRATE DECIMAL
 - LOW FLOW CUTOFF
 - APPLY?

1. WIZARDS (cont'd)

- 1.2 PUMP CONTROL
 - INTRODUCTION
 - NUMBER OF PUMPS
 - RELAY PUMP 1
 - RELAY PUMP 2
 - PUMP CONTROL MODE
 - SERVICE RATIO PUMP 1
 - SERVICE RATIO PUMP 2
 - RUN TIME PUMP 1
 - RUN TIME PUMP 2
 - ON SETPOINT PUMP 1
 - ON SETPOINT PUMP 2
 - OFF SETPOINT PUMP 1
 - OFF SETPOINT PUMP 2

2. SETUP

- 2.1 SENSOR
 - 2.1.1 UNITS
 - 2.1.2 SENSOR MODE (LUT420)
 - 2.1.3 SENSOR MODE (LUT430, 440)
 - 2.1.4 SENSOR MODE SECONDARY (LUT420)
 - 2.1.5 SENSOR MODE SECONDARY (LUT430, 440)
 - 2.1.6 TRANSDUCER
 - 2.1.7 FREQUENCY
 - 2.1.8 LONG SHOT DURATION
 - 2.1.9 SHORT SHOT DURATION
- 2.2 CALIBRATION
 - 2.2.1 LOW CALIB. PT.
 - 2.2.2 HIGH CALIB. PT.
 - 2.2.3 SENSOR OFFSET
 - 2.2.4 NEAR RANGE
 - 2.2.5 FAR RANGE
 - 2.2.6 AUTO SENSOR OFFSET
- 2.3 RATE
 - 2.3.1 FILL RATE/MIN
 - 2.3.2 EMPTY RATE/MIN
 - 2.3.3 DAMPING FILTER
- 2.4 FAIL-SAFE
 - 2.4.1 MATERIAL LEVEL
 - 2.4.2 LOE TIMER
 - 2.4.3 FAIL-SAFE MA VALUE
- 2.5 CURRENT OUTPUT
 - 2.5.1 CURR. OUT. FUNC. (LUT420)
 - 2.5.2 CURR. OUT. FUNC. (LUT430, 440)
 - 2.5.3 4 MA SETPOINT
 - 2.5.4 20 MA SETPOINT
 - 2.5.5 MIN. MA LIMIT
 - 2.5.6 MAX. MA LIMIT
 - 2.5.7 MANUAL VALUE
 - 2.5.8 CURRENT OUTPUT VALUE
- 2.6 VOLUME
 - 2.6.1 VESSEL SHAPE
 - 2.6.2 VOLUME UNITS
 - 2.6.3 MAX. VOLUME
 - 2.6.4 DIMENS. A
 - 2.6.5 DIMENS. L
 - 2.6.6 USER DEFINED UNIT

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- 2.6.8 TABLE 9-16
- 2.6.9 TABLE 17-24
- 2.6.10 TABLE 25-32
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 - 2.7.1.9 OFF SETPOINT PUMP 2
 - 2.7.1.10 SERVICE RATIO PUMP 1
 - 2.7.1.11 SERVICE RATIO PUMP 2
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 - 2.7.2.1.2 LEVEL SETPOINT VARIATION
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 - 2.7.2.2.1 ENABLE
 - 2.7.2.2.2 PEAK LEAD TIME
 - 2.7.2.2.3 PEAK 1 START TIME
 - 2.7.2.2.4 PEAK 1 END TIME
 - 2.7.2.2.5 PEAK 2 START TIME
 - 2.7.2.2.6 PEAK 2 END TIME
 - 2.7.2.2.7 PEAK 3 START TIME
 - 2.7.2.2.8 PEAK 3 END TIME
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6. LANGUAGE

Glossary

- accuracy:** degree of conformity of a measure to a standard or a true value.
- algorithm:** a prescribed set of well-defined rules or processes for the solution of a problem in a finite number of steps.
- ambient temperature:** the temperature of the surrounding air that comes in contact with the enclosure of the device.
- Auto False-Echo Suppression:** a technique used to adjust the level of a TVT curve to avoid the reading of false echoes. (See TVT.)
- Auto False-Echo Suppression Range:** defines the endpoint of the TVT distance. (See TVT.) This is used in conjunction with auto false echo suppression.
- blanking:** a blind zone extending away from the reference point plus any additional shield length. The device is programmed to ignore this zone.
- confidence:** describes the quality of an echo. Higher values represent higher quality. Confidence threshold defines the minimum value.
- damping:** term applied to the performance of a device to denote the manner in which the measurement settles to its steady indication after a change in the value of the level.
- dB (decibel):** a unit used to measure the amplitude of signals.
- derating:** to decrease a rating suitable for normal conditions according to guidelines specified for different conditions.
- echo:** a signal that has been reflected with sufficient magnitude and delay to be perceived in some manner as a signal distinct from that directly transmitted. Echoes are frequently measured in decibels relative to the directly transmitted signal.
- echo confidence:** the recognition of the validity of the echo. A measure of echo reliability.
- echo lock window:** a window centered on an echo in order to locate and display the echo's position and true reading. Echoes outside the window are not immediately processed.
- Echo marker:** a marker that points to the processed echo.
- Echo Processing:** the process by which the device determines echoes.
- Echo Strength:** describes the strength of the selected echo in dB referred to 1 μ V rms.
- Echo Profile:** a graphical display of a processed echo.
- false echo:** any echo which is not the echo from the desired target. Generally, false echoes are created by vessel obstructions.
- far range:** the distance below the zero percent or empty point in a vessel.
- figure of merit:** combines noise level, tracking quality, and signal strength to measure the quality of the reported echo value.

frequency: the number of periods occurring per unit time. Frequency may be stated in cycles per second.

Hertz (Hz): unit of frequency, one cycle per second. 1 Gigahertz (GHz) is equal to 10^9 Hz.

HART: Highway Addressable Remote Transducer. An open communication protocol used to address field devices.

multiple echoes: secondary echoes that appear as double, triple, or quadruple echoes in the distance from the target echo.

parameters: in programming, variables that are given constant values for specific purposes or processes.

range: distance between a transducer and a target.

shot: one transmit pulse or measurement.

speed of sound: the speed at which sound is propagated through some medium under specified conditions.

stillpipe: a pipe that is mounted inside a vessel parallel to the vessel wall, and is open to the vessel at the bottom.

stilling well: see **stillpipe**.

TVT (time varying threshold): a time-varying curve that determines the threshold level above which echoes are determined to be valid.

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For more information

www.siemens.com/level

www.siemens.com/continuous-weighing

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6

Sensors and Electrodes

Model S80 Intelligent Sensors



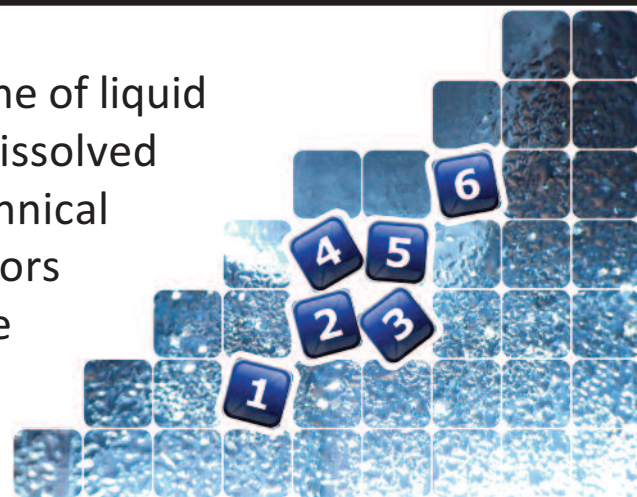
Measure pH, ORP, Specific Ion, Dissolved Oxygen,
Turbidity, Conductivity or Resistivity with
Model T80 Universal Transmitter



ELECTRO-CHEMICAL DEVICES



Electro-Chemical Devices offers a complete line of liquid analytical sensors: pH, ORP, Specific Ion, Dissolved Oxygen, Conductivity & Resistivity. The technical advantage of the Model S80 Intelligent Sensors are the 6 points of design flexibility to configure a sensor that best fits your application.



6 Point Advantage

- 1** **Intelligent sensor design with digital communication**
Calibration data is stored in the sensor allowing field installation of a pre-calibrated sensor. Detachable cable option simplifies the installation of pre-calibrated sensors.
- 2** **Multiple individual measurement parameters** in the same mechanical configuration- pH, ORP, Specific Ion, Dissolved Oxygen, Conductivity & Resistivity
- 3** Readily available **application specific electrode cartridges**. Many unique pH electrode design formulations and materials of construction which are field proven and selected for long life and accuracy.
- 4** Long life **replaceable electrode cartridges** lower the over all operating cost.
- 5** **Submersible and Retractable Sensors** Various process fittings with adjustable insertion lengths - threaded fittings, sanitary fittings, flanges and valve retractable fittings.
- 6** **Industrial housing materials for compatibility with process fluid**. Stainless Steel, Titanium, Hastelloy C-22, Polypropylene or PVDF (Kynar™). Standard 10" or 17" lengths additional lengths available.



Model S80 Intelligent Sensors

ECD Model S80 Sensor Overview - The intelligent sensor choice to fit your application. The S80 sensors have two Universal Sensor Designs; Insertion/Submersion or Valve Retractable with flaired end to prevent blow out. The standard Model S80 sensors have a rugged $\frac{3}{4}$ " O.D. 316 stainless steel body with a 10 ft. cable or an optional waterproof detachable cable assembly.

S80 Sensor

Insertion/Submersion

The **S80 Sensor** uses a $\frac{3}{4}$ " MNPT compression fitting as the process connection. This allows a variable insertion length to accommodate installation in pipe tees, flow cells, or through tank walls. If the fitting is reversed the sensor can be installed in a stand pipe for submersion into a tank.

Pre-Calibrated Detachable Sensor Option

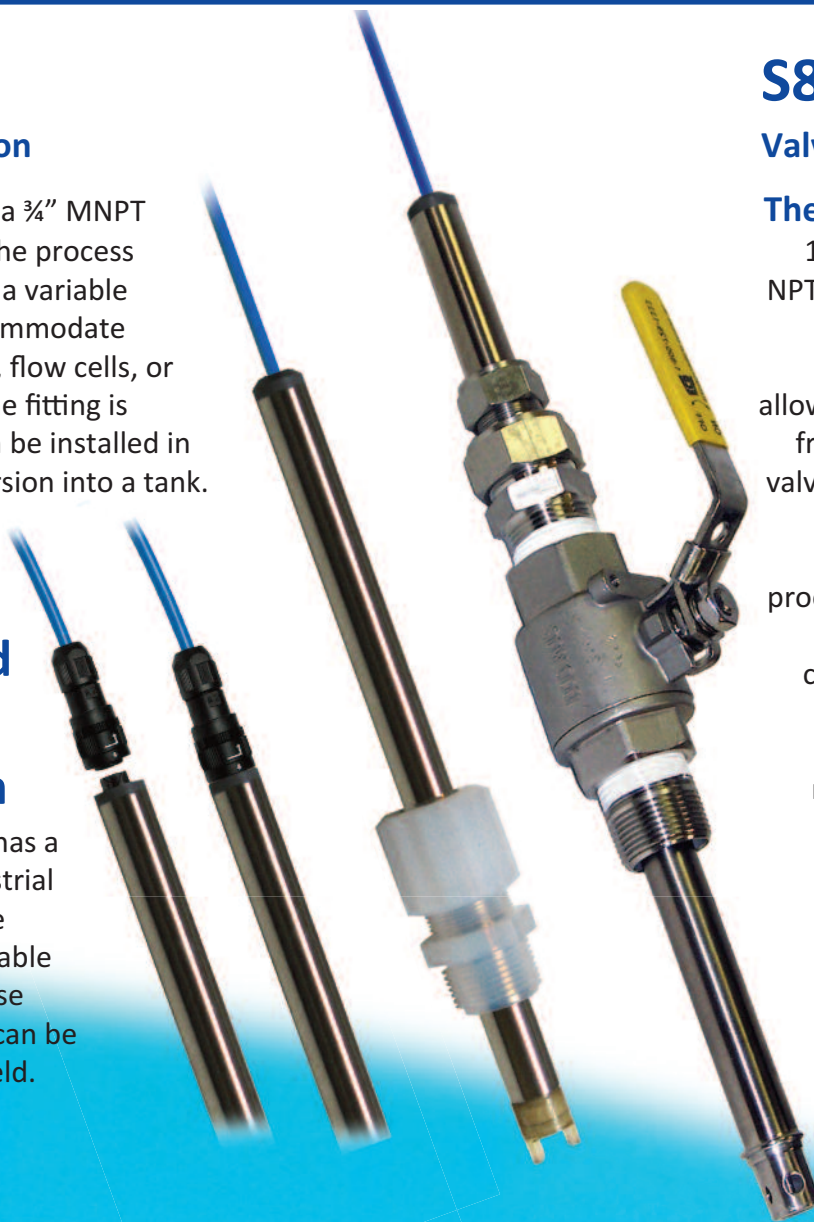
this detachable sensor has a rugged IP68 rated industrial connector. Just a simple quarter turn locks the cable connector in place. These Pre-Calibrated sensors can be easily installed in the field.

S80 Sensor

Valve Retractable

The **S80 Sensor** uses a 1" ball valve with a 1" NPT process connection.

Loosening the rear compression fitting allows the sensor to slide freely through the ball valve for either insertion into the process or retraction from the process. Once retracted, the ball valve can be closed and the sensor removed for maintenance or replacement without shutting down the process line.



pH and ORP Electrodes

The **Model S80 Intelligent Sensors** use **replaceable electrode cartridges** to provide application specific solutions for the most demanding pH measurements.

- Radel (PES) or PEEK construction
- Single tine, double tine or full crown style pH bulb protection.
- Spherical bulbs (best response), hemispherical bulbs (more durable) or a slightly radiused flat surface (easily cleaned)
- Platinum tip ORP electrodes.
- Double or Triple junction reference cells
- Porous Teflon® and ceramic junctions with various reference electrolytes.

One of these three widely used pH electrode cartridges will satisfy most installations, Consult our technical support staff for additional configurations.

6 Point Advantage



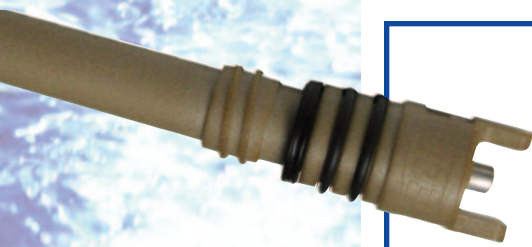
2005145 – This **General Purpose Electrode** has a two tine Radel body, double junction reference and slightly radiused pH bulb. While suitable for higher temperatures it is optimized for fast and stable readings in ambient temperature applications. Neutralizations, waste effluent monitoring, rinse applications and potable water are just a few of the suggested applications.



2005157 – This **High Temperature Electrode** has a two tine PEEK body, triple junction reference and hemispherical pH bulb. This electrode is designed for the process control or neutralization of most mineral acids and bases in applications up to 130°C. The triple junction design is resistant to sulfide ion poisoning making it ideal for use in petroleum refineries and metal processing plants.



2005066 – This **Chemically Resistant Electrode** has a two tine PEEK body, double junction reference and slightly radiused pH bulb. The PEEK body is suitable for use in most aggressive solvents, oxidizing solutions and acids or bases. This electrode is optimized for a harsh chemical environment and is suitable for service up to 130°C. Chemical separations and solvent recovery in the CPI and pharmaceutical industries along with chlorine production and flotation in mining are suggested applications.



2005167 – This **ORP (Oxidation Reduction Potential) Electrode** has a two tine PEEK body, double junction reference and a platinum tip. This general purpose sensor can be used for monitoring the oxidant level of cooling towers, swimming pools, aquariums or the de-chlorination of waste water. Metal finishing and mining also provide applications such as cyanide destruction and monitoring chrome plating baths.

Specific Ion & Dissolved Oxygen Electrodes

Ion selective electrodes are not limited to laboratory use; some are suitable for continuous online measurement. ECD offers Specific Ion Electrode cartridges to measure the various ions listed below. Specific Ion electrodes measure the activity (concentration) of the ion in solution, the “free” ion, not a complexed version. Cyanide, Fluoride and Sulfide ions only exist in a specific pH range as free ions and outside this pH range some percentage of the total concentration is complexed as H(X) which is not seen by the sensor. These measurements can be pH compensated using the dual channel transmitter or controller with a pH sensor to determine the total ion concentration. Most plon sensors are subject to interfering ion errors. A positive interference caused by similar ions in the solution. Consult with the factory on all new installations to determine the suitability of the measurement.

Specific Ion (plon) Electrodes

Part#	Type	Measurement Range	pH Range	Temperature Range
2005083	Ammonium	0.05 - 18,000 ppm	2-10 pH	0°-40°C
2005062	Bromide	1 - 80,000 ppm	2 - 12pH	0°-50°C
2005140	Cadmium	0.1 - 11,200 ppm	3 - 9 pH	0°-80°C
2005143	Calcium	0.1 - 40,000 ppm	2.5 - 10 pH	0°-40°C
2005008	Chloride	2 - 35,000 ppm	2 - 12 pH	0°-50°C
2005142	Cyanide	0.1 - 260 ppm	11 - 13 pH	0°-80°C
2005058	Cupric	1.0 ppb -6,300 ppm	2 - 6 pH	0°-80°C
2005163	Fluoride	0.02 - 2,000 ppm	5 - 8 pH	0°-80°C
2005141	Lead	2.0 - 20,700 ppm	4 - 8 pH	0°-80°C
2005086	Nitrate	0.1 - 1000 ppm	2 - 12 pH	0°-40°C
2005161	Nitrite	0.5 - 500 ppm	4.5 - 8 pH	0°-40°C
2005034	Potassium	0.1 - 40,000 ppm	2 - 12 pH	0°-40°C
2005031	Sodium	0.2 - 23,000 ppm	2 - 14 pH	0°-80°C
2005122	Sulfide	0.01 - 32,000 ppm	11 - 14 pH	0°-80°C
2005016	Silver	0.1 - 107,000 ppm	2 - 14 pH	0°-80°C



Dissolved Oxygen Electrodes

The ECD Dissolved Oxygen electrodes are galvanic cells with a lead anode, silver cathode and either the quick response 2 mil or rugged 5 mil Teflon membrane. The electrode is ready to use as received, there are no solutions or membranes to install before the electrode can be used. The membrane is protected by a double tine PEEK body allowing for easy cleaning. Designed for ppm level measurements it is ideal for environmental water measurements and aerobic waste treatment.

Part#	Type	Range	Pressure Range	Temperature Range
2005622 (2 mil)	Dissolved or Gaseous Oxygen	0 - 20 ppm (mg/L) 250% Saturation	0 - 50 psig	-5° - 80°C
2005623 (5 mil)	Dissolved or Gaseous Oxygen	0 - 20 ppm (mg/L) 250% Saturation	0 - 50 psig	-5° - 80°C



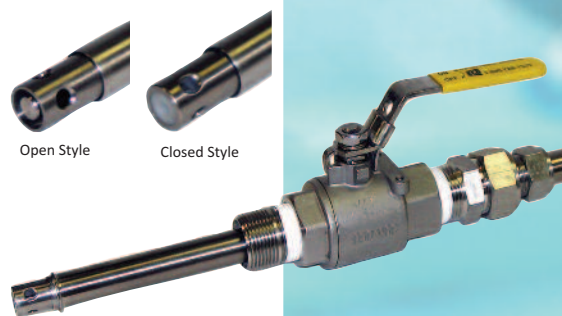
Conductivity Measurements

Two technologies are used to measure Conductivity. **Contacting Conductivity** is an impedance measurement made between two metal contacts in the solution. **Inductive Conductivity** is a non-contacting measurement made between two toroidal coils inside the sensor that are inductively coupled through the solution's conductivity. Inductive sensors excel in the higher conductivity ranges and where coating is a problem. The chemically resistant PVDF (KYNAR) body is excellent for corrosive environments. Contacting sensors can measure from very low conductivities, (resistivity measurements) to very high conductivities but they are subject to coating and corrosion issues, conditions where the inductive sensors excel. The Contacting Conductivity S80 sensors come in two ranges, Conductivity Range, 0.5 μ S – 50mS and Resistivity Range, 0 – 20M Ω . Inductive Sensors measure from 50 μ S to 1000 mS.

6 Point Advantage

Conductivity and Resistivity Sensors

The **Model S80 Conductivity** sensor is available for measurements from 0.05 μ S to 50mS. The **Model S80 Resistivity** sensor measures from 0 - 20 M Ω . The design of the inner electrode defines the measurement range of the sensor. The Open Style with its large surface area inner electrode and short path length is best for resistivity and low conductivity measurements while the Closed Style is best suited to high conductivity measurements. The standard wetted materials are 316 Stainless Steel, PEEK insulators and VITON o-rings.



Inductive Conductivity Sensors - (non-contacting)

The **Model S80 Inductive** sensors have a 3/4" diameter PVDF body. These sensors are ideal for measuring high conductivity solutions and % concentration measurements. Since the toroidal electrodes are inside the PVDF body, the inductive sensors are ideal for any application that coats or corrodes the electrode of the standard contacting conductivity sensors. The measurement range of the inductive sensor is from 50 μ S to 1000 mS.



High Temperature/Pressure Sensors

The **CSX2** High Temperature- High Pressure sensor is designed for service to 200°C and 250 psig, 400 psig at 100°C. This insertion style 3/4" MNPT, 316 stainless steel sensor has PEEK insulators and is available with or without an integral signal conditioner. An aluminum junction box is mounted on the rear of the sensor that contains a terminal block and optional signal conditioner. The junction box is rated Class I, Div I, Groups C & D, Class II, Groups E, F and G hazardous locations. It is an ideal choice for boiler control applications, blowdown control, condensate monitoring, leak detection on heat exchangers, and steam purity measurements.



Fittings and Accessories

The proper installation and calibration of an analytical loop is critical for a successful measurement. Using the flow of the sample in an insertion application to maximize the cleaning potential can be as simple as changing the size of the Pipe Tee, changing the insertion depth or using an ECD Flow Cell with a spray cleaning port in the most difficult applications. Spray Cleaning heads are also available for immersion applications where the sample velocity is much lower and fouling is more common. Valve retractable units allow the sensor to be removed, serviced and installed without shutting down the sample flow in a pipe or emptying a tank. A compression gland fitting seals the sensor into a ball valve, loosening the gland fitting allows the sensor to be retracted through the ball valve which is then closed, isolating the process solution, before removing the sensor for service. Materials of construction for the Valves, Glands, Flanges and Immersion Assemblies vary from PVC, PVDF and polypropylene plastics to 316 SS, Titanium and Hastelloy C-22. Contact our application specialists for the most cost effective solution to your application.

Calibration Solutions



All of the S80 sensors require periodic calibration and ECD offers a full range of calibration solutions. For pH applications we offer pH 4.00, 7.00 and 10.00 buffers. ORP calibrations can be accomplished with a +465 mV ferric-ferrous solution or by adding quinhydrone to pH 4 and pH 7 buffer solutions creating +267 mV ORP and +90 mV ORP respectively. Specific ion calibration solutions are standardly 10 ppm and 100 ppm although any value can be formulated at no extra cost. Conductivity solutions are made with KCl and Deionized water, values from 10 μ S to 500 mS are available. Solutions to simulate % acid or % caustic are labelled as the actual solution, i.e. 4% NaOH, even though the solution is made from KCl with an equivalent conductivity providing a safe and accurate calibration system.

Fittings and Flow cells



The Model S80 sensors are offered with a wide array of fittings, flow cells, immersion assemblies and valve retraction assemblies. $\frac{3}{4}$ " MNPT compression fittings are available for S80 insertion into pipe Tees or flow cells and when reversed, for coupling with Stand Pipes for immersion applications. Flow cells of PVC, PVDF or 316 SS have $\frac{3}{8}$ " or $\frac{1}{2}$ " FNPT ports on a 2" O.D. by 5" body. 316 SS Sanitary 3A Flanges and 150# Flanges can be adapted for insertion or valve retractable service. Contact our Technical support staff for other configurations.

Model T80 Universal Transmitters



The ECD Model T80 transmitter is a single or dual channel transmitter for the measurement of pH, ORP, pION, Conductivity, Resistivity, Dissolved Oxygen and Turbidity. The Model T80 transmitter digitally communicates with any ECD intelligent S80 digital sensor, automatically configuring the transmitter's menus and display screens to the measured parameter. The ECD S80 digital sensors facilitate two way communication with the Model T80 transmitters. The type of sensor, identity and serial number are stored in the sensor's memory along with calibration registers. Ordering pH, ORP or pION sensors with the SENTINEL option automatically activates the "Remaining Life" diagnostic shown in the picture.

S80

All Sensors

Dimensions:

S80 Insertion - 3/4" OD x 10" Length

S80 Valve Retractable - 3/4" OD x 17"

Cable Length:

10 ft. standard, optional lengths in 10 ft increments, optional Detachable cable connection

Housing Materials:

Standard: 316 Stainless Steel

Optional: Titanium (T), grade 2

Hastelloy C-22 (H),

PVDF (K)

Polypropylene (P)

O-Ring Materials:

Standard: Viton® (VIT)

Optional: Ethylene Propylene (EPR),

VITON® 75 (VIT75)

Kalrez® (KLZ)

CV75 (CV)

Process Connections:

S80 Insertion/Immersion

-75 3/4" 316 SS gland fitting with nylon ferrule

-75HT 3/4" 316 SS gland fitting with Teflon® ferrule

-75SF 3/4" 316 SS gland fitting with stainless steel ferrule

-75TFE 3/4" Teflon® gland fitting with Teflon™ ferrule

-100P 1" Polypropylene gland fitting for Polypropylene housing only

S80 Valve Retractable

-VSS 1" 316 SS valve retraction assembly

-VSSE 1" 316 SS valve retraction assembly for Inductive sensors

-VKY 1" PVDF valve retraction assembly

-VPP 1" Polypropylene Valve Retraction assembly

PHS80

pH measurement

Measurement Range:

0-14 pH

Temperature Range:

0° - 100° C

Optional HT version:

0° - 150° C

Pressure Range:

0 - 100 psig @ 90° C

Temperature Compensation:

Automatic 0° - 100° C

Accuracy ± 0.2° C

MVS80

ORP & Specific Ion

Measurement Range:

ORP: -2000 mV to 2000 mV

plon: Sensor Specific, ppb, ppm&ppt

Temperature Range:

ORP -0° - 90° C, plon Sensor Specific

Pressure Range:

0 - 100 psig @ 90° C

Temperature Compensation:

Automatic 0° - 100° C

Accuracy ± 0.2° C

DOS80

Dissolved Oxygen

Measurement Range:

0-20 ppm, 0-250% SAT

Temperature Range:

0° - 90° C

Pressure Range:

0 - 50 psig @ 80° C

Temperature Compensation:

Automatic 0° - 100° C

Accuracy ± 0.2° C

CS80/RS80

Conductivity/Resistivity

Measurement Ranges:

Conductivity: 0.5µS to 50 mS

Resistivity: 0 - 20 MΩ

Temperature Range:

-5° to 100° C

Optional HT version:

-5° to 150° C

Pressure Range:

CS/RS80 0 - 100 psig

Temperature Compensation:

Automatic 0° - 100° C

Accuracy ± 0.2° C, 100K thermistor

CS80

Inductive Conductivity

Measurement Ranges:

50 µS to 1000 mS

Temperature Range:

-5° to 100° C

Pressure Range:

0 - 100 psig

Temperature Compensation:

Automatic 0° - 100° C

Accuracy ± 0.2° C, 100K thermistor

Body material:

KYNAR (PVDF)

CSX2 Series

High Temperature Conductivity

Measurement Ranges:

1.0µS to 50mS

Temperature Range:

0° to 200° C

Pressure Range:

0 -250 psig (400psig @100° C)

Temperature Compensation:

Automatic 0° - 200° C

Accuracy ± 0.2° C, 10K ohm platinum RTD

Wetted Materials:

316 SS and PEEK

Shipping Weight:

S80 (10") 2.5 lbs (1.2 kg)

S80 (17") 2.75 lbs (1.25 kg)

S80-VSS 5.8 lbs (2.65 kg)

Specifications subject to change without notice.

Represented by:

Electro-Chemical Devices

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INSTRUCTION MANUAL

MODEL T80 UNIVERSAL TRANSMITTER



SCREEN MAP

CAL (Calibration)	Auto	Cal 1 (Offset) using Calibration Solution			
		Cal 2 (Slope) using Calibration Solution			
	Standardize	Enter Grab Sample Determined Value			
	Manual	Enter Offset, the PV value and associated mV			
		Enter Slope, mV/pH, mV/decade, mV/ppm...			
Temp	Enter measured Temperature				
CONFIG (Configuration)	LCD	Set Up	Temp. Format	°C or °F	
			Contrast	Adj. 0-100%	
			Back Light	Enter ON time	
			Range Lock	Choose: Auto, ppb, ppm, ppT	
		Legend	Icon buttons		
			Text buttons		
		Graph	Line	Screen Duration	
			Gauge		
			Bar		
		Label	TAG ID	Enter Name	
			TAG	ON/OFF	
			POP UP	ON/OFF	
			SENSOR	Enter Name	
		XMTR	4-20 mA (1 or 2)	Range (PV or Temp.)	4 mA = 20 mA =
				Cal (more)	Trim 4.00 mA Trim 20.00 mA
	Fault (more)			3.5 mA	
				22 mA NONE	
	RELAY		Relay 1	Alarm	Set Point
				Timed	Period, Duration
				Fault	
			Relay 2	Alarm	Set Point
				Timed	Period, Duration
				Fault	
	Relay 3	Alarm	Set Point		
		Timed	Period, Duration		
		Fault			
	HOLD	Time out: None, 15 min, 30 min...			
	Serial	Address			
		Baud rate			
		Format			
	Password	Menu	Off/On " _ _ _ _ "		
		CAL	Off/On " _ _ _ _ "		
		CNFG	Off/On " _ _ _ _ "		
		SIM	Off/On " _ _ _ _ "		
	Sensor	Sensor 1 or 2	Type	Choose Type: pH, Cond, ORP.....	
T COMP			Enter % Comp		
ISO PT			Enter mV value		
Qty of Sensors		Choose 1 sensor or 2 sensors			
COMP		Dissociation, Interference, Percentage, OFF			
Load Default	Sensor/Transmitter	Yes/No			
DAMP	Enter Signal Dampening (# of readings to average, 0-100)				
INFO (Information)	XMTR	Configuration, Serial #, Name, Outputs			
	Sensor	Calibration logs, Serial #, Name			
SIM (Simulate)	System	Sensor 1 or 2	Fixed value Ramp		
		Relays	#1 ON/OFF #2 ON/OFF #3 ON/OFF		
	4-20 mA	4-20 mA Ch 1	Enter Value		
		4-20 mA Ch 2	Enter Value		

PREFACE

Purchasing products from Electro-Chemical Devices, Inc. provides you with the finest liquid analytical instrumentation available. If this is your first purchase from ECD, please read the entire manual before installing and commissioning your new equipment.

Manuals are accessible on the ECD website at <http://www.ecdi.com/literature/manuals.html>.

If there are any questions concerning this equipment, please contact your local ECD representative, or the factory directly at:

Electro-Chemical Devices, Inc.

1681 Kettering






Irvine, CA 92614 USA


Telephone: +1-949-336-6060

FAX: +1-949-336-6064

Website: www.ecdi.comEmail: sales@ecdi.com

SYMBOLS USED IN MANUAL

	This symbol is used to designate important information, warnings and cautions. Failure to follow this information could lead to harm to the instrument or user.
	No operator serviceable parts, service by authorized service personnel only.
	This symbol is used to designate a WARNING "Risk of Electrical Shock"
	Disconnect supply before servicing
	Equipment protected throughout by double insulation.

	Read the complete manual before installing or using the equipment.
--	--

Contents of this manual are believed to be correct at the time of printing and are subject to change without notice. ECD is not responsible for damage to the instrument, poor performance of the instrument or losses resulting from such, if the problems are caused by:

- Incorrect operation by the user.
- Use of the instrument in incorrect applications.
- Use of the instrument in an inappropriate environment or incorrect utility program (power supply).
- Repair or modification of the related instrument by anyone not authorized by ECD.
- There are no operator accessible parts. Service and maintenance to be done by authorized personnel only.
- If the equipment is used in a manner not specified by the manufacturer, the protection provided by the equipment may be impaired.

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TERMS AND CONDITIONS OF SALE

1. **ACCEPTANCE.** If this writing differs in any way from the terms and conditions of Buyer's order or if this writing is construed as an acceptance or as a confirmation acting as an acceptance, then Seller's acceptance is **EXPRESSLY MADE CONDITIONAL ON BUYER'S ASSENT TO ANY TERMS AND CONDITIONS CONTAINED HEREIN THAT ARE DIFFERENT FROM OR ADDITIONAL TO THOSE CONTAINED IN BUYER'S WRITING.** Further, this writing shall be deemed notice of objection to such terms and conditions of Buyer. If this writing is construed as the offer, acceptance hereof is **EXPRESSLY LIMITED TO THE TERMS AND CONDITIONS CONTAINED HEREIN.** In any event, Buyer's acceptance of the goods shall manifest Buyer's assent to Seller's terms and conditions. No addition to or modification of these terms will be effective, unless set forth in writing and agreed to by Seller.
2. **WARRANTIES AND REMEDIES**
 - a. **Warranty.** Seller warrants to Buyer that it holds and will pass marketable title to the goods sold hereunder. Seller warrants to Buyer that the items and components manufactured by Seller will be free from defects in material and workmanship (subject, however, to tolerances and variances permitted by the trade hereunder) for a period one (1) year for non-consumable products. Consumable electrodes and sensors have a conditional warranty based shelf life and process conditions and is determined by Seller.
 - b. **Exclusion and Conditions.** Seller's obligations with respect to the express warranties and remedies contained herein are conditioned on the following: (i) Buyer's return of the non-conforming goods, if authorized by Seller; (ii) Buyer shall not assign its rights under these express warranties and any attempted assignment shall render such warranties, but not any disclaimers or limitations, void and the goods sold shall be sold **AS IS**; and (iii) all products shall be carefully inspected for damage by Buyer upon receipt, be properly calibrated for Buyer's particular use, and be used, repaired, and maintained by Buyer in accordance with the instructions set forth in Seller's product literature. Repair and maintenance by non-qualified personnel, product subjected to misuse or negligence, and/or damaged during shipment will invalidate the warranty, as will the use of non-approved consumables or spare parts. As with any other sophisticated product, it is essential, and a condition of Seller's warranty, that all personnel using the product be fully acquainted with its use, capabilities and limitations as set forth in the applicable product literature.
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 - a. **Disclaimer of Damage.** In no event shall Seller be liable for special, indirect, consequential or incidental damages whether arising under contract, warranty, tort, strict liability or any other theory of liability. Such damages include but are not limited to loss of profits, loss of use of goods, damage to property, and claims of third parties.
 - b. **Suitability.** Buyer acknowledges that it alone has determined the intended purpose and suitability of the goods sold hereunder. It is expressly agreed by the parties that any technical or other advice given by the Seller with respect to the use of the goods or services is given without charge and at Buyer's risk; therefore Seller assumes no obligation or liability for the advice given or results obtained.
 - c. **Notice and Time of Claims.**
 - i. Buyer agrees to check and inspect all products against shipping papers and for damage or shortage upon receipt of goods at destination.
 - ii. Every claim for shortage, damage in transit, or other cause visible upon inspection shall be deemed waived by the Buyer, or the Buyer's customer in the case of resale, unless delivered in writing to Seller by Buyer thirty (30) days from the tender of delivery of the goods to Buyer, provided, however, that claims for shortage must be made within seven (7) days of receipt.
 - iii. The parties expressly waive the statute of limitations and agree that any legal proceeding for any breach of this contract shall be waived unless filed within one (1) year after the accrual of the cause of action thereof.
5. **FORCE MAJEURE.** Seller shall not be liable for any delay in delivery, or failure to deliver, due to any cause beyond the Seller's control including but not limited to fires, floods, or other forces of the elements; strikes, or other labor disputes; accidents to machinery; acts of sabotage; riots; precedence or priorities granted at the request or for the benefit, directly or indirectly of the federal or any state government or any subdivision or agency thereof; delay in transportation or lack of transportation facilities; restrictions imposed by federal, state or other governmental legislation or rules or regulations thereof. If Seller, in its sole discretion, determines that Seller's performance hereunder would result in a loss to Seller's on this sale as computed under Seller's normal accounting procedures because of causes beyond Seller's control, then the Seller may terminate this agreement in whole or in part without liability for any delay in the delivery of, or failure to deliver, the goods sold hereunder
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7. **FREIGHT CHARGES.** If the sale hereunder is other than F.O.B. Seller's facility, this acknowledgement is based upon the freight charges now in effect. In the event of an increase or decrease in applicable freight charges before the goods are shipped, such charge in freight will be for the Buyer's account.
8. **PRICES AND DELIVERY.** Prices quoted herein are F.O.B. shipping point. Deliveries specified are only our best estimate and are subject to change. This quotation is based upon freight charges now in effect. Buyer will be invoiced at the freight charge prevailing at the date of shipment. Prices are firm for orders meeting Seller's normal shipping schedules. If shipments are held or postponed for any reason other than Seller's fault, and a price increase becomes effective during the period of such hold or postponement, the increase will apply to all shipments that are held or postponed thirty (30) days or more from the effective date of the increase.
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10. **CANCELLATION OR ALTERATION.** Buyer may not alter or cancel any order without Seller's written consent. For any order altered or cancelled with Seller's consent, Buyer must pay for all expenses and labor incurred up to the time of Seller's consent, plus a reasonable percentage for profit. Any order delayed or deferred by Buyer will be subject to price escalation for increased costs of production, and any other expenses caused by the delay. Material on such orders will be stored at Buyer's risk. Seller reserves the right to invoice Buyer and require payment before shipment of any delayed or deferred order.
11. **TITLE AND RISK OF LOSS.** Title and risk of loss shall pass to buyer at Irvine, California, unless otherwise specified in the contract. If delivery is made by common carrier, risk of loss shall pass upon delivery to the carrier. Claims for loss or damage in transit must be made by Buyer to the carrier. Seller accepts no responsibility for loss or damage to product in transit.
12. **PATENT OR TRADEMARK INFRINGEMENT.** If the goods sold hereunder are to be prepared for manufacture according to Buyers specification, Buyer shall indemnify Seller against any claim or liability for patent, trademark, service mark or trade name infringement on account of preparation, manufacture and/or sale.
13. **NON-WAIVER.** If Government Contract Regulations require the addition, deletion, or modification of these terms and conditions upon prior notification to Seller and Seller's written acceptance thereof, such changes shall become a part of these terms and conditions. Seller shall not be bound by any Government Contract Regulations applicable to Buyer's contracts with the U.S. Government unless Buyer has expressly acknowledged, on the face of this document, the applicability of such Regulations to the transaction between Buyer and Seller contemplated herein. Absent such acknowledgement, Seller is making the assumption in issuing this document that no such Regulations apply.

14. **JURISDICTION.** All such disputes shall be resolved in a court of competent jurisdiction in Orange County, California. Buyer hereby consents to the jurisdiction of the State and Federal Courts sitting in Orange County. Notwithstanding the above, should either party contest the jurisdiction of such courts, the other party may institute its suit in any court of competent jurisdiction.
15. **APPLICABLE LAW.** All questions arising hereunder or in connection with the quotations or any order submitted in connection therewith and/or the performance of the parties hereunder shall be interpreted and resolved in accordance with the laws of the state of California without regard to its conflict of law provisions and excluding the United Nations Convention on the International Sale of Goods.

RETURN GOODS POLICY

All requests for returned goods must be initiated through our Customer Service Department. Please call our phone number (949) 336-6060 with the specifics of your request. The following conditions must be satisfied for consideration of applicable credit for the return of products purchased from Electro-Chemical Devices:

- 1) The item is unused and in the original package.
- 2) The item was shipped directly from Electro-Chemical Devices.
- 3) The item has not been damaged in shipment to Electro-Chemical Devices.
- 4) Items containing date-sensitive parts such as electrodes, must be returned within 1 month of the invoiced date.
- 5) Items without date-sensitive parts must be returned within 3 months of the invoiced date.

A Return Merchandize Authorization Number must be obtained from Customer Service and be provided on all paperwork and packaging. To obtain a Return Merchandize Authorization Number, please provide the reason for return, the date of purchase, your original purchase order number, and either our order number or our invoice number. The issuance of a Return Merchandize Authorization Number is a verbal approval for return only and does not guarantee credit or allowance. Returned goods must be received within 30 days of the issuance date of the Return Merchandize Authorization Number or it will become null and void.

Necessary physical and mechanical inspection is completed upon receipt of the item. Applicable credit or equivalent allowance is determined after inspection of the returned item. If all of the above conditions are met, and the item has been approved to return to our stock, a restocking charge of 25% of the purchase price is deducted from the applicable credit.

UNPACKING THE INSTRUMENT

Your Electro-Chemical Devices instrument has been carefully packaged to protect it from damage during shipment and dry storage. Upon receipt please follow the procedure outlined below.

1. Before unpacking, inspect the condition of the shipping container to verify proper handling by the carrier. If damage is noted, save the shipping container as proof of mishandling for the carrier.
2. Check the contents of the shipping container with the items and quantities shown on the packing list. Immediately report any discrepancies to ECD.
3. Save the original packing material until you are satisfied with the contents. In the event the product(s) must be returned to ECD, the packing material will allow you to properly ship it to ECD.
4. Familiarize yourself with the instrument before installation, and follow proper installation and wiring procedures.



WARNING Electrical installation must be in accordance with the National Electrical Code (ANSI/NFPA-70), Canadian Electrical Code and/or any other applicable national or local codes.

Installation and wiring

Failure to follow the proper instructions may cause damage to this instrument and warranty invalidation.

Use only qualified personnel to install, operate and maintain the product.

The Model T80 transmitter should only be used with equipment that meets the relevant IEC, American or Canadian standards. ECD accepts no responsibility for the misuse of this unit.

Basic Parts List

1. Model T80 Transmitter
2. Mounting Hardware
3. Instruction Manual

INSTRUCTION MANUAL REVISION

<u>Revision</u>	<u>Date</u>	<u>Remarks</u>
A	07/12	Initial release
B	03/13	Added Sensors and Conductivity Data
C	03/13	Updated Symbols
D	07/13	MODBUS Update
E	07/13	Turbidity, Conductivity, Cal Menu
F	05/14	Two Channels, MODBUS Update,

1.0 GENERAL DESCRIPTION

The ECD Model T80 transmitter is a single or dual channel, intelligent, multi-parameter transmitter designed for the online continuous measurement of pH, ORP, pION, dissolved oxygen, conductivity, resistivity and turbidity in a general purpose industrial environment. The Model T80 transmitter digitally communicates with any ECD S80 digital sensor, automatically configuring the transmitter's menus and display screens to the measured parameter.



The Model T80 transmitter can be loop powered, 24 VDC powered or 100-240 VAC line powered. The standard configuration has a 4-20 mA output and a RS485 serial communication port with MODBUS® RTU output. A HART® communication version (single channel version only) is also available. Alarm relays are optionally available on either line powered transmitter.

1.1 FEATURES

- Multi-Parameter, pH, ORP, Specific Ion, Dissolved Oxygen, Conductivity, Resistivity
- Simple, user friendly menu structure
- Noise free digital communication with sensors
- Reads and writes calibration data to sensor
- Dual Channel option has interactive channels, pH compensated readings, interfering ion corrections...
- Isolated 4-20 mA output and MODBUS® RTU standard, optional HART®

1.2 SPECIFICATIONS

1.2.1 INPUT SPECIFICATION

Digital protocol, all ECD S80 sensors

Optional analog to digital converter, 5 inputs [mV+, mV-, solution ground, temp + temp - (100 K-ohm)]

1.2.2 INPUT RANGES

pH	-1.00 - 15.00 pH
ORP	-1500 - +1500 mV
pION	000.1 - 999.9, Auto Ranging: ppb ↔ ppm ↔ ppT (thousand)
Dissolved Oxygen	000.1 - 999.9, Auto Ranging: ppb ↔ 20.00 ppm, % SAT, mg/L
Conductivity	0.000 - 2.000, Auto Ranging: μS ↔ mS ↔ S
	TDS 0.00 - 9999 ppm
Resistivity	0.000 - 20.00 MΩ
Turbidity	0 - 4000 NTU/FNU, 0 - 9999 ppm, mg/l, 0 - 100% % solids
Temperature	100 K-ohm TC, -30°C - 140°C

1.2.3 ACCURACY

pH	0.02 pH
ORP	± 1 mV
pION	Specific to electrode type
Dissolved Oxygen	2% of range
Conductivity	2% of range

Resistivity	2% of range
Turbidity	2% of reading
Temperature	± 0.3°C

1.2.4 OUTPUT SIGNALS

4-20 mA output (standard, one per Channel), Fault Condition: 3.5 mA, 22 mA or none
 Modbus RTU (standard)
 HART® (optional)

1.2.5 CONTACT RELAYS

(Optional) Three (3) SPDT, 1 form C, 250 VAC, 10 Amp resistive maximum, relays, user configurable as Hi/Lo alarms with expiration timer, Periodic Timers or Fault alarms

1.2.6 DISPLAY

128 x 64 pixels (2.75" x 1.5") LCD, Black on Grey background on loop powered instruments, Blue on White background with LED backlight on 100-250 VAC and 24 VDC powered instruments, English or icon based menus, numeric and graphical displays

1.2.7 ENCLOSURE

Beige Polycarbonate, IP65, weatherproof, ½ DIN, (L x W x D) 5.7" X 5.7" X 3.5" (14.4cm X 14.4cm X 9.0cm)

1.2.8 POWER

Code -0 Loop powered, 24 VDC 600 Ω maximum load (18-36VDC @ 35 mW minimum)
 Code -1 24 VDC (18-36 VDC @ 250 mW minimum)
 Code -2 100-240 VAC, 50/60 Hz, 4W, protected with 250V, 1A, Slow Blow fuse

1.2.9 ENVIRONMENTAL CONDITIONS

Outdoor use (IP65)
 Ambient Temperature -20°C - 70°C (24 VDC Models)
 -20°C - 60°C (100-240 VAC Models)
 Storage Temperature -30°C - 85°C
 Relative Humidity 0 – 80%, up to 31°C
 Decreasing linearly to 50% RH a 40°C
 Altitude Up to 2000 m (6500 ft)
 Mains Supply Voltage Fluctuations up to ±10% of the nominal voltage
 Transient over voltages: CAT II
 Pollution Degree: 2

1.2.10 SHIPPING

Size 8" x 8" x 5" (20.5 cm x 20.5 cm x 12.7 cm)
 Weight 1.6 lbs. (0.75 kg)

1.3 MODEL CODES

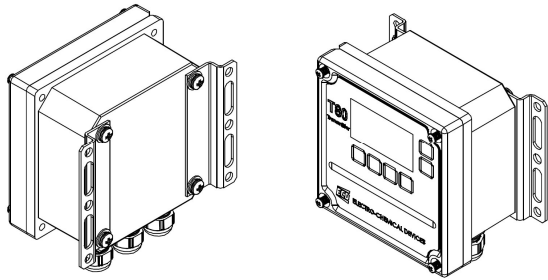
Model T80-							
1 st Channel	1 (S80) S80 Digital Sensor, pH, ORP, pION, DO, DO90 ppb DO, Conductivity, Resistivity						
	2 Triton® DO80 Optical DO						
	3 Internal Preamp, Digital to S10/S17 pH, ORP, pION (+mV, -mV, 100K TC, SG)						
	4 Internal Preamp, Digital to SGTC Conductivity/Resistivity (CSX2 or 2 electrode contacting)						
	5 Internal Preamp, Digital to SGTC Dissolved Oxygen, (Steam Sterilizable Products)						
	6 Triton® TR6 Turbidity						
	2 nd Channel	0 No Second Channel					
		1 (S80) S80 Digital Sensor, pH, ORP, pION, DO, Conductivity, Resistivity					
		2 (ODO) Triton® DO80 Optical DO					
		Power Supply	-0 Loop Powered Transmitter				
			-1 24 VDC Powered Transmitter				
-2 100-240 VAC powered Transmitter							
Relay Option		0 No Relays					
		1 (3) form 1C 250 V 3A relays					
		Outputs	0 4-20 mA output and MODBUS				
1 HART®							
2 2 x 4-20 mA & MODBUS							
Mounting Hardware	00 No Mounting						
	01 Universal						
	02 Panel Mount						
	03 Handrail Mount						
	04 Sunshield						
05 Sunshield							
Model T80-	1	1	-2	1	2	01	

Example above shows part# T80-11-212-01, a two channel T80 transmitter for use with two S80 sensors, 110/220 VAC powered with two 4-20 mA outputs and MODBUS RTU and a universal mounting bracket.

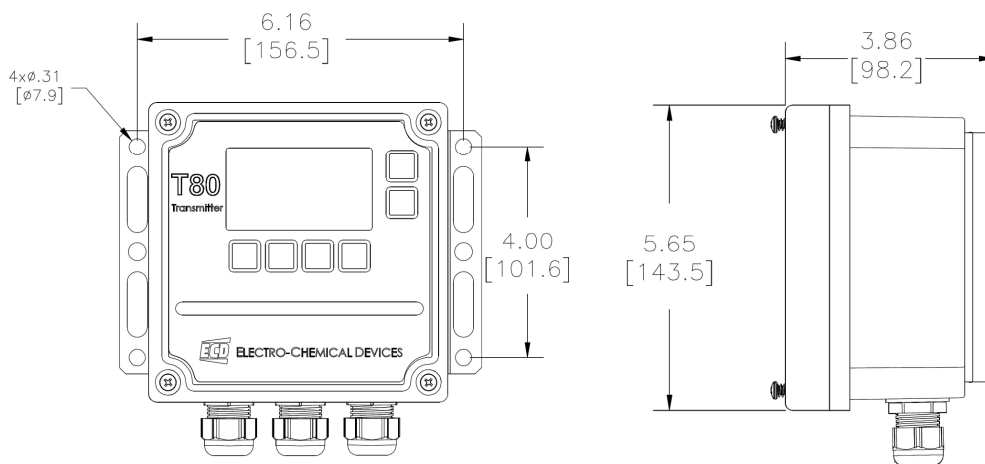
2.0 INSTALLATION

2.1 MOUNTING

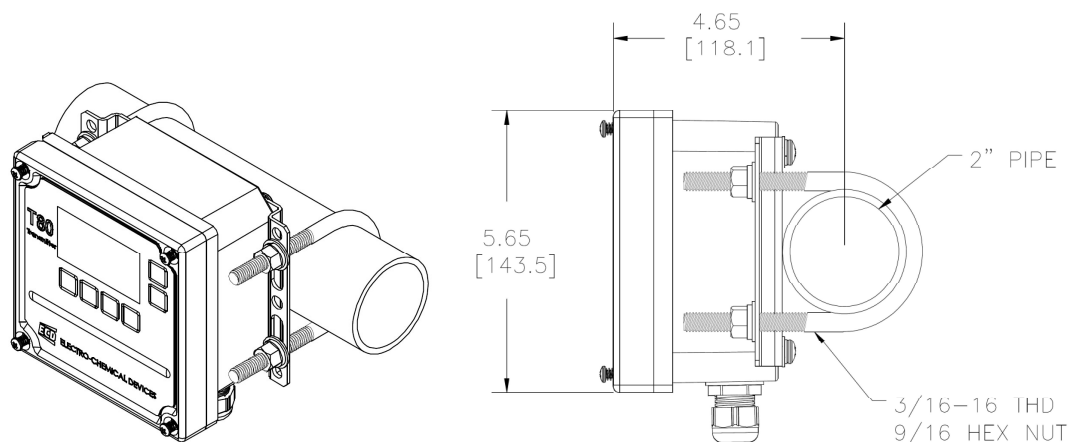
Mount the T80 in a location where there is easy access to the analyzer and sensors. Install the system in an area where vibrations, electromagnetic and radio frequency interference are minimized or absent. Do not mount in direct sunlight or areas of extreme heat (temperature > 120°F). The IP65 T80 is suitable for outdoor use but it is best to mount it with a protective cover or sunshield to prevent discoloring over the years.



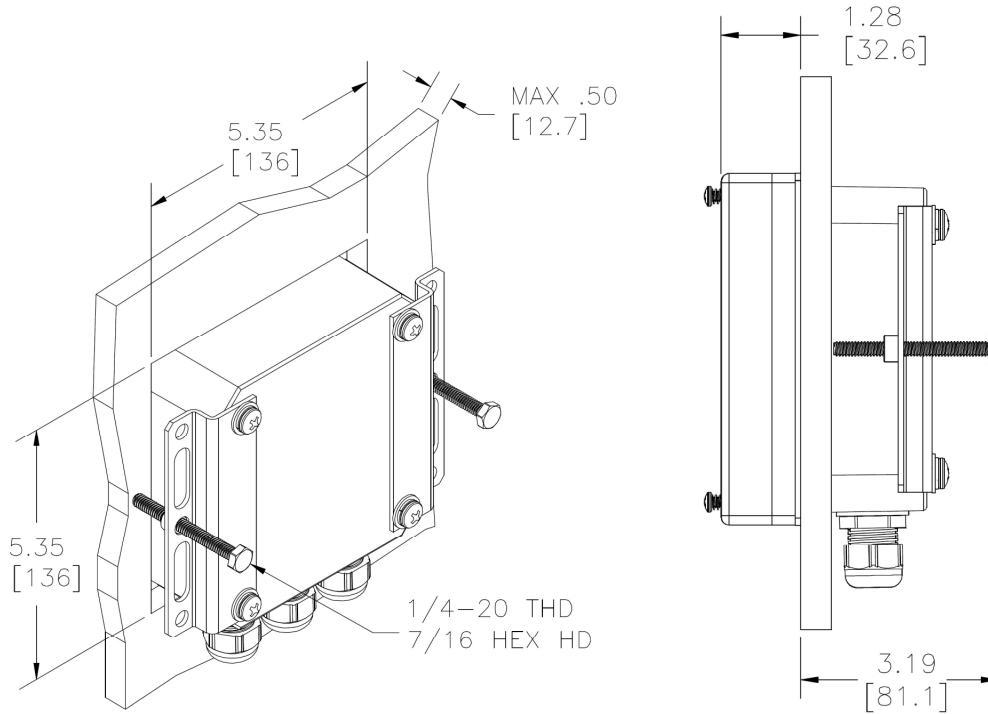
Universal Mounting Brackets



Rail Mounting



Panel Mounting



Cut Out: 5.35" x 5.35" (13.6 cm x 13.6cm)

2.2 WIRING

Electrical wiring should only be conducted by qualified personnel. See the T80 wiring diagram in Figure 2.2.X

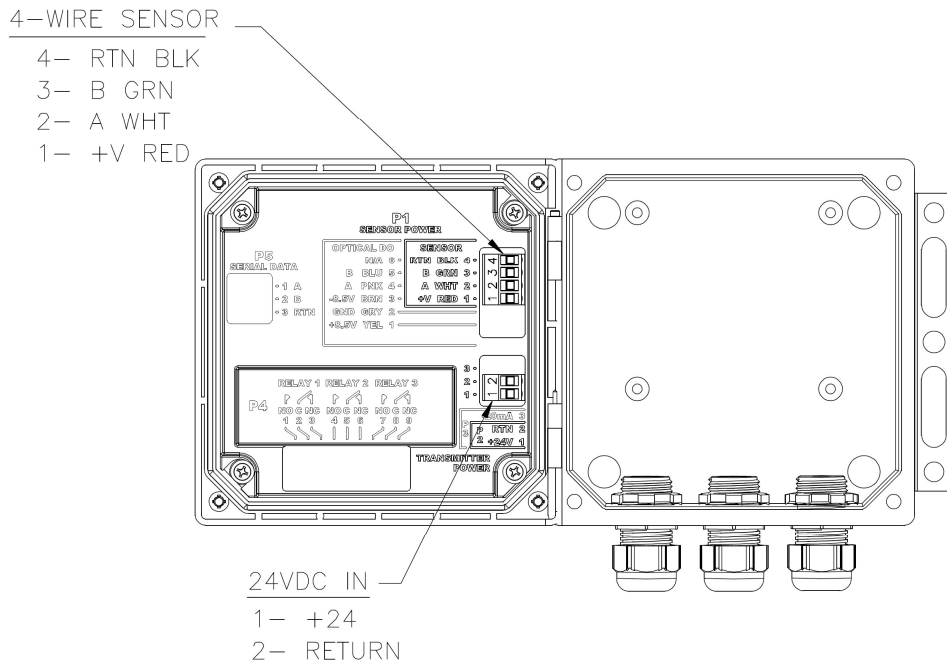


Figure 2.2.1 Loop Powered Transmitter

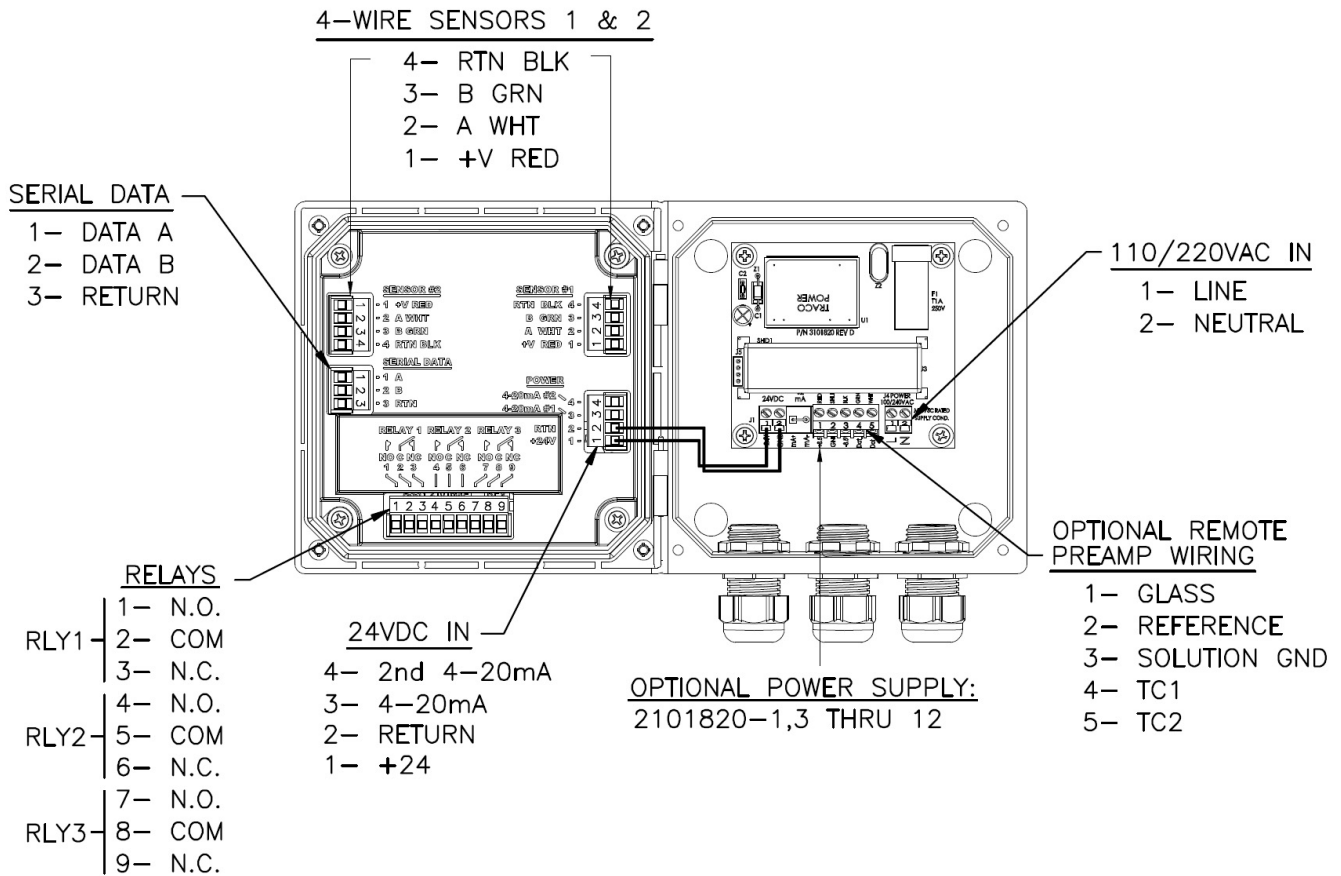


Figure 2.2.2 4-Wire Transmitter, 24VDC or /110/22 VAC, MODBUS, Relays/Optional Digital Preamp

	Warning: RISK OF ELECTRICAL SHOCK
	Disconnect Power before opening instrument.
	WARNING Electrical installation must be in accordance with the National Electrical Code (ANSI/NFPA-70), Canadian Electrical Code and/or any other applicable national or local codes.

2.2.1 WIRING, POWER

ECD recommends using a thermoplastic, outdoor sunlight resistant jacketed cable, wet location rated and 1/2" flexible conduit. The power should be hard wired with a switch or breaker to disconnect the analyzer from the main power supply. Install the switch or breaker near the analyzer and label it as the Power Switch for the analyzer.

Loop Powered (2 wire configuration)

Attach the 24VDC signal cable to terminals #1 and #2 as shown in Figure 2.2.1 and on the diagram inside of the T80 cover. Feed the cable through the gland fitting on the right hand side of the T80. Tighten the cable gland to

provide a good seal to the cable. The instrument can be powered up at this point with no harm to the analyzer but it is best to wait until the sensor is installed.

24VDC (4 wire configuration)

Attach the 24VDC power cable to terminals #1 and #2 as shown in Figure 2.2.2 and on the diagram inside of the T80 cover. Attach the 4-20 mA1 cable to terminals #3 (out) and #2 (return) single channel unit and attach the 4-20 mA2 cable to terminals #4 (out) and #2 (return) for a two channel instrument. Feed the cables through the gland fitting on the right hand side of the T80. Tighten the cable gland to provide a good seal to the cable. The instrument can be powered up at this point with no harm to the analyzer but it is best to wait until the sensor is installed.

110/220 VAC (4 wire configuration)

Attach power cable as shown in Figure 2.2.2 or as on the diagram inside of the T80 cover. Feed the cable through the gland fitting on the right hand side of the T80. Tighten the cable gland to provide a good seal to the cable. The instrument can be powered up at this point with no harm to the analyzer but it is best to wait until the sensor is installed.

2.2.2 WIRING, SENSOR

Attach the sensor wires as described on the diagram inside the T80 cover. Feed the sensor cable through the gland fitting on the left hand side of the T80. Do not use the same gland fitting for the AC power or Alarm/Relays. The green terminal strip connectors are detachable from the circuit boards. Remove the connector by pulling straight back from the circuit board.

2.2.3 WIRING, 4-20 MA OUTPUTS

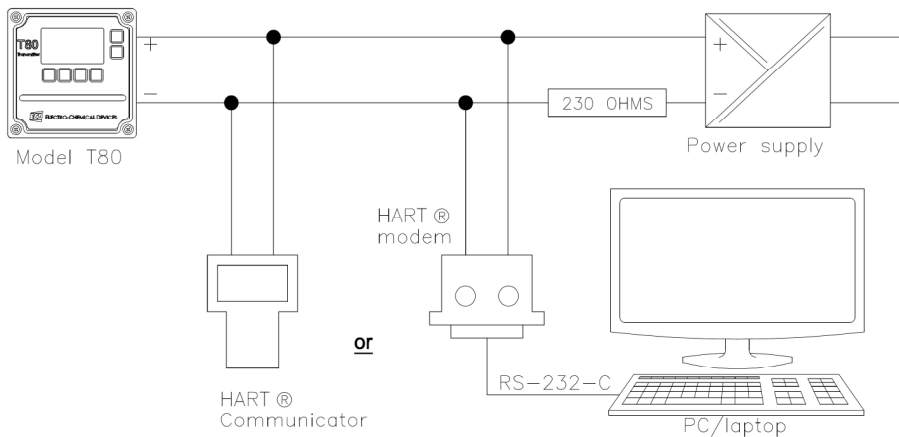
Loop Powered Instruments:

Connect the 4-20 mA cable to terminals #1 (+24V) and #2 (-24V), Model T80-XX-0 X-XX.

24 VDC or 110/220 VAC powered instruments:

For instruments powered with 24VDC or the internal power supply, Model T80-XX-1X-XX (24VDC) and T80-XX-2X-XX (110/220 VAC), connect the 4-20 mA cable(s) to terminals #3 (out) for channel 1 and #2 (return) and to terminals #4 (out) for channel 2 and #2 (return).

Transmitters with HART® Communication can be wired as shown below. See HART® Communication menu in Appendix 9.2:



2.2.4 WIRING, CONTACT RELAY OUTPUTS

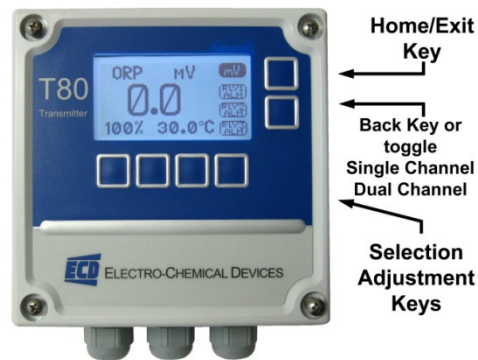
The standard configuration has three SPDT 230V 5 A relays that can be wired either **normally open (NO)** or **normally closed (NC)**. The default configuration is set to use the relays as normally open.

2.2.5 WIRING, SERIAL OUTPUT MODBUS RTU

Attach the sensor wires as shown in Figure 2.2.2 or as described on the diagram inside the T80 cover. Feed the sensor cable through the gland fitting on the left hand side of the T80. Do not use the same gland fitting for the AC power or Alarm/Relays. See MODBUS command register in [Appendix D](#).

3.0 OPERATION

The ECD Model T80 transmitter is an intelligent, single or dual channel multi-parameter transmitter designed for the online continuous measurement of pH, ORP, pION, conductivity, resistivity or Dissolved Oxygen in a general purpose industrial environment. The Model T80 transmitter digitally communicates with any ECD S80 digital sensor. The measurement identity is contained in the sensor’s memory. When an S80 sensor is connected to the transmitter it automatically configures the transmitter’s menus and display screens to the measured parameter.



3.1 KEYS

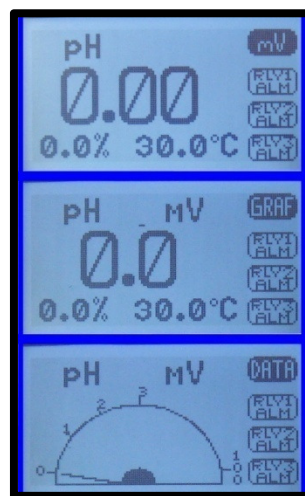
The functions associated with each key are displayed on the screen, above the key for the Selection Adjustment Keys and to the left of the key for the HOME and BACK keys. **Press any Selection Adjustment key twice within one second to enter the HOME Menu Screen.**

3.1.1 HOME/EXIT KEY

The **HOME key** performs two functions, it selects which Home Screen is displayed and it returns the active screen to the HOME Menu Screen from anywhere inside the menu structure.

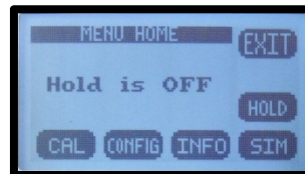
Three Display screens are available:

1. **DATA SCREEN:** Displays the measurement type, numerical value, engineering Units, % Output of the 4-20 mA channel and temperature.
2. **mV SCREEN:** Displays the measurement type, the sensor’s raw millivolt Value, % Output of the 4-20 mA channel and temperature.
3. **GRAF SCREEN:** Displays a Graphical representation of the 4-20 mA channel % Output, the measurement type, the engineering units, and temperature. Only one of the three graphical display styles is available through the HOME key, either the Bar, Gauge or Line display. Choose which style will be displayed in the Graph Menu. (pathway to Graph Menu: CONFIG → XMTR → LCD → Graph menu)



Each of the above screens also displays the condition of the optional Alarm Relays, black if energized and white if de-energized.

The HOME key changes to the **EXIT key** in the HOME Menu Screen, pressing EXIT prompts the user to “Save Changes” YES/NO when exiting the HOME Menu. YES applies any changes made in the menus, NO exits the HOME Menu without applying any changes made in the menus.



3.1.2 BACK/HOLD KEY

The **BACK key** changes the screen to the previously displayed screen when inside a menu, it moves BACK one screen. On a dual channel transmitter it toggles between the PV1, PV2 and Dual Channel Screens. The **HOLD key** toggles the output HOLD function ON/OFF in the MENU HOME screen.

3.1.3 SELECTION ADJUSTMENT KEYS

The (4) Selection/Adjustment keys allow navigation and numerical adjustments to be made in the MENUS. **To enter the HOME Menu screen press any of the Selection/Adjustment keys twice within one second.** The various Menu choices and adjustment tools are displayed above the buttons once inside the MENU.

3.1.4 ALPHA NUMERIC ENTRY

The **LABEL** and **PASSWORD** (Caps and Numbers only) Menus allow alphanumeric entry. Entry is accomplished by scrolling through the alphanumeric list with the ▲ (forward) and ▼ (backwards) arrows to the character of choice and then moving to the NEXT digit. Pressing and holding the ▲ or ▼ keys will initiate two speed auto scrolling. The character set is sequentially listed below. The first character in the set is an empty space.

! " # \$ % & ' () * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [\] ^ _ ' a b c d e f g h i j k l m n o p q r s t u v w x y z { | } → ←

3.2 MENU STRUCTURE

Double tap any Selection/Adjustment key to enter the HOME Menu Screen. Five menu choices will appear, **CAL, CONFIG, INFO, SIM and HOLD**. Each of the Menus is detailed below.

3.2.1 HOLD (OUTPUT HOLD)

Pressing the **HOLD Key** activates the HOLD function, HOLD is ON, displayed.

- ❖ Freezes the 4-20 mA output at the last value prior to activation
- ❖ Freezes optional Alarm Relays in the current state
- ❖ While in the HOLD mode the % Output display toggles between the last value and HOLD



Pressing HOLD again turns the hold function off, Hold is OFF, displayed. The HOLD function remains ON until it is turned OFF. (See Time Out in CONFIG>XMTR>OUTPUT>HOLD)

3.2.2 CAL (CALIBRATION MENU)

Four options are available, **AUTO, STAND, MANUAL and TEMP**. On dual channel instruments choose Sensor 1 or Sensor 2 when prompted.

The first screen asks, "Is this a New Sensor, YES / NO". If YES the calibration history from the previous sensor is cleared from memory and a new register is started, if NO then the calibration is written to the memory stack, (3) sets of data are stored.



- ❖ **AUTO** is a two point calibration. The calibration proceeds in two steps, AutoCal 1 is an offset calibration and AutoCal 2 is a slope calibration. Auto Cal provides automatic solution recognition of the calibration solutions used for each measurement in accordance with the following list:

1. pH Calibration Buffers (US Standard), pH 4.01, pH 7.00 and pH 10.00 (see [Appendix A](#))
2. ORP Calibration Solutions: Quinhydrone saturated: pH 4.01= +89 mV, pH 7.00= +266 mV
3. plon Calibration Solutions: 1.00, 10.00, 100.0 ppb, ppm, ppt (thousand)
4. Dissolved Oxygen: Zero ppm (Sodium sulfite, Na₂SO₃ in water), Air saturated water, 8.25 ppm



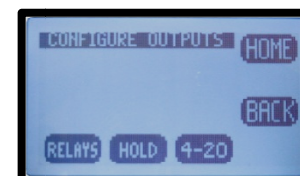
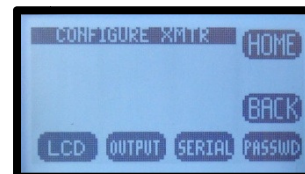
Any two solutions can be used for AUTO calibration however if solutions other than those listed above are used for calibration then the calibration values must be entered manually.

- ❖ **STAND** is standardization, a single point calibration. Standardizations are typically used to adjust the process reading to agree with a laboratory determined “grab sample” reading.
- ❖ **MANUAL** is a data entry screen. Manual calibration allows the user to enter a concentration with the corresponding mV value and a slope for an electrode. Laboratory generated calibration data for an electrode can be input to a remote analyzer where calibration is difficult or impractical.
- ❖ **TEMP** allows the displayed temperature to be trimmed to agree with actual process temperature.

3.2.3 CONFIG (CONFIGURATION MENU)

Four options are available in the Configure Menu, **XMTR**, **SENSOR**, **LOAD DEFAULT** and **Dampen**.

- ❖ **XMTR** enters the Transmitter Configuration menu.
 - **LCD** access the Display Configuration Menu
 - **SETUP** adjust screen lighting characteristics
 - **Temp.** Choose °C or °F
 - **CONT** adjust Contrast
 - **BACK LIGHT** adjust Backlight Timeout, from always ON to OFF after 10 minutes
 - **LEGEND** provides the choice of **Text** Menus or [Icon based Menus](#)
 - **GRAPH** provides the choice of which Graph style is displayed on the Home screen.
 - **LINE**, Moving average, vertical scale set to 0-100% of the 4-20 mA output and user defined time scale
 - **GAUGE**, Current reading 0-100% of 4-20 mA range
 - **BAR**, Current reading 0-100% of 4-20 mA range
 - **LABELS**
 - **TAG**, Enter up to 2 lines x 16 characters, example, Name, tag #... Displayed in INFO screen
 - **TAG ON**, Turn TAG ON/OFF, adds TAG to Main Display Sequence, DATA → mV → GRAF → TAG → DATA
 - **POP UP**, Turns ON/OFF, the double tap HOME Screen pop up memo
 - **SENSOR**, Enter up to 2 lines x 16 characters
 - **OUTPUT** access the Output Configuration Menu
 - **4-20 mA** configure 4-20 mA output (PV or Temp or More)
 - **RANGE** Enter 4 mA value and 20 mA value
 - **CAL** Trim 4.00 mA output and 20.00 mA output
 - **FAULT** Choose fault condition 3.5 mA, 22 mA, None
 - **Optional 2nd 4-20 mA** for Temperature Output only
 - **RELAY**
 - **RLY1** Choose relay type:
 - **Alarm**, enter the Set point ON, Set Point OFF,



Expiration time, Delay ON and Delay OFF times and the State, **energize:** changes state from de-energized to energized on alarm.

- **Timed**, Enter Period, Duration times and Hold On/Off
- **Fault**, No input required, relay condition changes from energize to de-energize.
- **Disable**, Inactivates relay and removes the relay 1 button from the HOME Screen display.
 - **RLY2** Same features as Relay 1
 - **RLY3** Same features as Relay 1
- **HOLD**, Freezes outputs at current value and locks relays in their current state.
 - **Hold Timeout**, Removes HOLD after a certain period of time, default setting: No Timeout, selections include 15 minutes, ½ hour, 1 hour



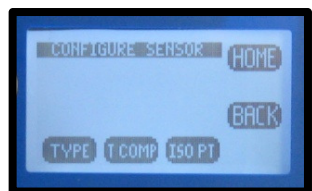
- **SERIAL MODBUS** configure serial output,
 - **ADDRESS**, enter address: 001 to 247
 - **BAUD**, Choose baud rate, default 9600
 - **FORMAT**, set serial data format, default value: 8N1, 8 bit, no parity bit, 1 stop bit
- **SERIAL HART** configure output,
 - **ADDRESS**, enter address: 01-63
 - **BAUD**, default 1200, no adjustment available
 - **FORMAT**, default value: 8O1, 8 bit, Odd parity bit, 1 stop bit, no adjustment available
- **PASSWD** Enter 4 character password to protect access to MENU Level, CAL Menu, CONFIG Menu and SIM Menu (simulate). Each level can be turned ON or OFF and can have a unique password.

▪ MENU	ON/OFF	----	Locks Main Menu
▪ CAL	ON/OFF	----	Locks CAL and CONFIG
▪ CONFIG	ON/OFF	----	Locks CONFIG
▪ SIM	ON/OFF	----	Locks SIM and CONFIG



❖ **SENSOR** enters the sensor configuration menu.

- **Choose SENSOR 1 or 2**
 - **TYPE**, Allows T80 transmitter to configure the S80 sensor. For use only when switching the measurement electrode type in an S80 sensor, i.e. for a pH electrode to a pION electrode. Select Sensor Type: pH, ORP, DO₂, NH₃, NH₄⁺, Br⁻, Ca⁺⁺, Cl⁻, Conductivity, Resistivity, Cu⁺⁺, CN⁻, F⁻, NO₃⁻, K⁺, Ag⁺, Na⁺, S⁻
 - **T COMP**, Enter % temperature compensation per degree: pH, pION 0.33%, ORP 0.00%, DO₂ 4%
 - **ISO PT**, Enter Iso Potential value in mV. The Iso Potential is the point where changes in the temperature do not cause changes to the signal.
- **COMP** Dual Channel Only, Sets interaction Type: **Dissociation** (pKa), **Interference**, X ppm Sensor 1 = 1 ppm Sensor 2, **Percentage** per pH.

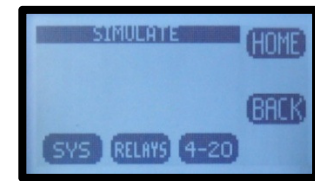
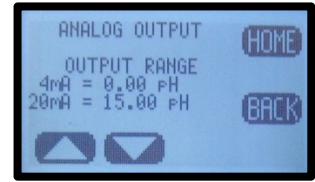


- Qty of **SENSORS**, Choose 1 or 2
- ❖ **Load Default** resets all Menus to factory default configuration.

3.2.4 INFO (INFORMATION MENU)

The Information Menu provides two choices,

- ❖ **Transmitter Screen**, details the Name, Power type, Serial #, Firmware version and the output configuration(s).
- ❖ **Sensor Screen**, details the Name, Part #, Serial # and three sets of Calibration data.



3.2.5 SIM (SIMULATION MENU)

The Simulation menu allows the Input or Output signals to be simulated.

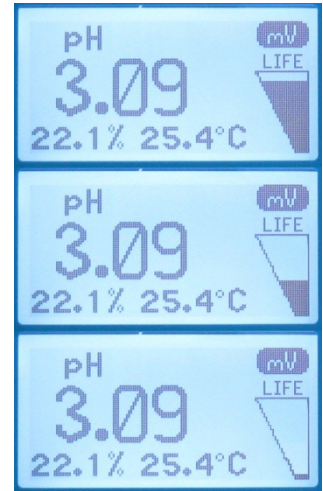
- ❖ **SYSTEM** allows the Input to be simulated. Two choices are available, FIXED is a fixed value, RAMP varies the signal across the 4-20 mA range, from the lowest value to the highest value and back, activating and deactivating relays if present. The RAMP has two adjustments the Ramp period, 30 seconds to 2 minutes and Duration; 1 cycle, 5, 10, 20, 30 minutes.
- ❖ **RELAYS** allows individual relays, #1, #2, and #3 to be activated and deactivated
- ❖ **4-20 mA** allows the output to be simulated from 4.00 mA to 20.00 mA.

3.2.6 FAULT SCREENS

Fault	Definition	Recommendation
Memory Error	AN ERROR WAS FOUND WITH THE MEMORY OF THE MICROCONTROLLER	RETURN TO FACTORY FOR SERVICE
Input Voltage OOT	POWER IS OUT OF TOLERANCE	CHECK WIRING TO THE TRANSMITTER
+12V OOT	ONBOARD 12V IS OUT OF TOLERANCE	RETURN TO FACTORY FOR SERVICE
+3.3V OOT	ONBOARD 3.3V IS OUT OF TOLERANCE	RETURN TO FACTORY FOR SERVICE
Loss of Comm	COMMUNICATION WITH THE SENSOR WAS LOST	CHECK WIRING TO THE SENSOR
No Sensor	NO SENSOR WAS FOUND AT START-UP	CHECK WIRING TO THE SENSOR
Cal Failed	SENSOR CALIBRATION FAILED	1) CLEAN SENSING TIP 2) VERIFY SOLUTIONS 3) DO NOT LEAVE UNATTENDED 4) RE-CALIBRATE
Relay 1 Expired	RELAY 1 TIME ON EXPIRED	1) CHECK SENSOR OP 2) CHECK AUX EQUIP A) PUMPS B) TANKS
Relay 2 Expired	RELAY 2 TIME ON EXPIRED	1) CHECK SENSOR OP 2) CHECK AUX EQUIP A) PUMPS B) TANKS
Relay 3 Expired	RELAY 3 TIME ON EXPIRED	1) CHECK SENSOR OP 2) CHECK AUX EQUIP A) PUMPS B) TANKS

3.2.7 SENTINEL® SCREENS

The SENTINEL feature allows the Model T80 transmitter to provide Pre-pHault diagnostic information about the accuracy of a pH, ORP or plon measurement. The SENTINEL displays a filled triangular gauge that decreases proportionally to the degradation of the reference electrode. A filled gauge indicates a properly functioning measurement while the emptying gauge indicates the remaining life of the electrode. This Pre-pHault diagnostic alerts the user to potential problems and provides a visual indicator of the sensor’s remaining life before the measurement actually fails.



The Model T80 transmitter only displays the SENTINEL functions when a Model S80 SENTINEL sensor is connected. The Model S80 SENTINEL sensor uses Diagnostic electrodes designated by Part#’s 20053XX, these electrodes use a triaxial connector with a, PV connection (pH, ORP, Ion), Reference connection and Diagnostic connection.

On a dual channel instrument an asterisk *, will be displayed in the sensor name block, SENSOR 2 *. The SENTINEL function will only be visible in the Single Screen mode, not in the Dual Screen mode. Toggle the BACK Key from Dual → Sensor 1 → Sensor 2 to see the SENTINEL function.

Configure SENTINEL Function

The SENTINEL function is located in the Configure Sensor menu:

CONFIG → SENSOR → SENSOR 1 or 2 →MORE → SNTL

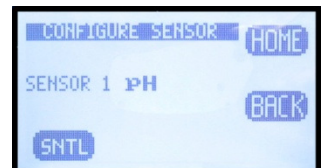
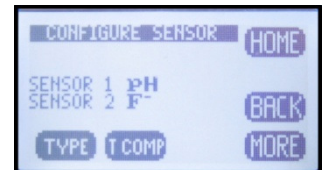
There are three values displayed:

V_o = SENTINEL Voltage offset, The diagnostic voltage of a new electrode

V_e = SENTINEL expiration Voltage, $V_o + \text{Range}$

RANGE = The shift in the diagnostic voltage required to trigger diagnostic fault.

The default values of $V_o = 0.0 \text{ mV}$ and the Range = 60 mV are good for most situations. The starting diagnostic voltage is typically near 0 mV on a new electrode and if the readings have drifted 60 mV apart (a full pH unit) then electrode service is required.



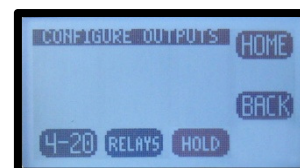
3.3 START UP GUIDE

Install and wire the T80 Transmitter as described in Sections 2.1 and 2.2 above.

Connect the sensor to the transmitter as described in Section 2.2 above.

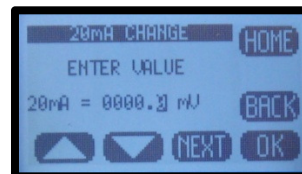
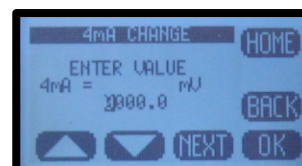
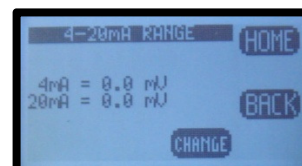
Supply power to the Model T80 transmitter.

Verify the proper measurement type is displayed, pH, ORP or Ion. The sensor automatically uploads the measured parameter, the calibration data and the range of measurement to the transmitter. The default configuration of the 4-20 mA output is the range of the sensor, 0-14 pH for pH sensors, -1500 - +1500 for ORP or 0-XXXX ppm for a plon Sensor. To change the 4-20 mA range, follow the instructions in Section 3.3.1 below.



3.3.1 CONFIGURE 4-20 MA OUTPUT RANGE

- ❖ Double press any key except the HOME key to enter the HOME Menu. Follow the path below to set the 4-20 mA range.
- ❖ HOME Menu → Press CONFIG → XMTR → OUTPUT → 4-20 (1)(2) → PV or TEMP
- ❖ Press CHANGE to enter New Values.
- ❖ Choose 4 mA value, press OK
- ❖ Enter value using ▲ or ▼ and NEXT to move to the next digit, press OK→Back
- ❖ Choose 20 mA value, press OK,
- ❖ Enter value using ▲ or ▼ and NEXT to move to the next digit, press OK→Back
- ❖ Press BACK to return to the CONFIGURE 4-20 mA screen or HOME to return to the HOME Menu screen.



3.3.2 CONFIGURE 4-20 MA FAULT CONDITION

- ❖ In the CONFIGURE 4-20 mA screen, Press **MORE** → **FAULT** or
- ❖ Choose **Low Fault 3.5 mA** or **Hi Fault 22 mA** or **NONE**, (default setting **NONE**), Press OK
- ❖ Press BACK → **CAL**, connect DVM to 4-20 mA line, Press 4.00 mA then adjust value to the DVM reading, Press 20.00 mA and adjust value to the DVM reading. The 4-20 mA output is calibrated.

3.3.3 CONFIGURE ALARM RELAYS (RELAYS OPTIONAL)

- ❖ HOME Menu → Press CONFIG → XMTR → OUTPUT → RELAYS→RLY1
- ❖ Choose the **ALARM**, **TIMER**, **FAULT** or **DISABLE** mode for Relay 1
- ❖ **ALARM** Displays:
 - **SET POINT ON:** The Process Variable Value that activates the relay.
 - **EXPIRATION:** Enter a time that should not be exceeded before the PV should have changed enough to activate the OFF set point. At the Expiration time the relay is deactivated and a Fault condition is initiated. Fault: Relay 1 Time expired: Cause: Loss of reagent, failed sensor
 - **Delay ON:** The amount of time the PV must remain above/below the set point before the relay activates.
 - **SET POINT OFF:** The Value of the process variable that deactivates the relay.
 - SET POINT OFF > Set Point → Low Set Point
 - SET POINT OFF < Set Point → Hi Set Point



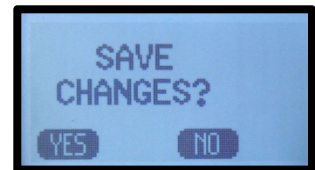
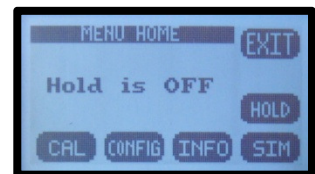
- **Delay OFF:** The amount of time the PV must remain above/below the hysteresis point before the relay deactivates.
- **STATE: Energize** (relay is energized on activation)/**De-energize** (relay is de-energized on activation)
- ❖ **TIMER** activates the relay periodically for a specific duration, user configured period and duration
- ❖ **FAULT** sets the relay condition to a de-energize state and NC relay closes in response to a Fault condition.
- ❖ **DISABLE** turns off the relay and removes it's icon from the HOME screen

Setting up an Alarm Relay

- ❖ Choose **ALARM**
- ❖ Press **CHANGE** to enter new values
- ❖ Choose ON Set Point, Press OK
- ❖ Enter value using ▲ or ▼ and NEXT to move to the next digit, press OK, press BACK (Min –Max values indicate the range of acceptable values)
- ❖ Choose Expiration, Press OK,
- ❖ Choose time from drop down menu using ▲ or ▼, press OK, press BACK
- ❖ Choose OFF Set Point, Press OK
- ❖ Enter value using ▲ or ▼ and NEXT to move to the next digit, press OK, press BACK
- ❖ Choose Delay ON, Press OK
- ❖ Enter value using ▲ or ▼ and NEXT to move to the next digit, press OK, press BACK
- ❖ Choose Delay OFF, Press OK
- ❖ Enter value using ▲ or ▼ and NEXT to move to the next digit, press OK, and press BACK when done to exit Relay 1.
- ❖ Repeat for Relay 2 and Relay 3.

3.3.4 EXIT MENUS AND RETURN TO MAIN DISPLAY

- ❖ Press HOME Key to return to the Home Menu Screen
- ❖ Press Hold to turn OFF Hold
- ❖ Press EXIT Key to exit the menu
- ❖ "Save Changes?" press YES
- ❖ Choose Display Mode, **DATA**, **mV** or **GRAF** by pressing selection Key. The selection key displays which screen will be displayed next.
 - The type of graphical display used, Line, Bar or Gauge is selected in CONFIG → XMTR → LCD → GRAPH → LINE, GAUGE, BAR



3.3.5 SENSOR START UP

All sensors are supplied with protective caps over the sensing end. Remove the cap(s) from the sensor before installing in the process. All sensors were calibrated at the factory before shipment, no calibration should be necessary before use. Allow the sensor to equilibrate to the process solution conditions for ½ hour before verifying the reading against a grab sample. If calibration is required follow the instruction in Section 4.0 below.

3.4 USER SELECTABLE OPTIONS

3.4.1 SCREEN LIGHTING

LED back lighting is available on AC and DC powered instruments only, this feature is inactive on loop powered instruments.

Contrast can be adjusted for optimal viewing. The Backlight can be adjusted to timeout after a set period of time or remain on.

Location: CONFIG → XMTR → LCD → Set Up → CONT, BACK LIGHT



3.4.2 SCREEN LEGEND

The keys can be displayed as English Text or Icons. See [Appendix C](#) for Button/Icon legend.

Location: CONFIG → XMTR → LCD → LEGEND → ICON, TEXT

3.4.3 GRAPHICAL DISPLAY

There are three graphical display choices:

- ❖ **LINE**, The Line graph is a moving average of the process variable with the 4-20 mA range as the maximum/minimum values and a choice of time scales.

The Time scale is the amount of time displayed across the full screen. Choices include:

Full Screen Period	15 minutes	1 hour	12 hours	1 day	2 days
Sample Rate (1 point every)	10 seconds	40 seconds	8 minutes	15 minutes	30 minutes

- ❖ **GAUGE**, Live reading displaying 0-100% of 4-20 mA range. The Alarm Relay number(s), #1, #2 and#3 mark the respective set points on graph.
- ❖ **BAR**, Live reading displaying 0-100% of 4-20 mA range. The Alarm Relay number(s), #1, #2 and#3 mark the respective set points on graph.

Pressing **OK** after selecting a Graphical Display will exit the menu structure and return to the Main Display.

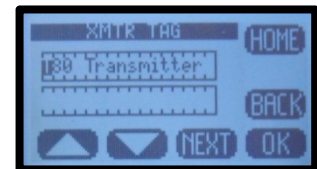
Location: CONFIG → XMTR → LCD → GRAPH



3.4.4 TAG TRANSMITTER NAME

Two 16 character lines are available for naming the transmitter, Upper and Lower case characters, Numbers and Punctuation are available. The information entered will be displayed in the INFO screen and optionally in the Main display sequence if activated in the TAG ON menu. The character set is listed below sequentially; the first character in the set is an empty space.

! " # \$ % & ' () * + , - . / 0 1 2 3 4 5 6 7 8 9 : ; < = > ? @ A B C D E F G H I J K L M N O P Q R S T U V W X Y Z [\] ^ _ ` a b c d e f g h i j k l m n o p q r s t u v w x y z { | } → ←



Entry is accomplished by scrolling through the alphanumeric list with the ▲ (forward →) and ▼ (backwards ←) arrows to the character of choice and then pressing **NEXT** to advance the cursor to the next digit. Pressing and holding the ▲ or ▼ keys will initiate two speed auto scrolling. Press **BACK** to exit the screen.

Location: CONFIG → XMTR → LCD → LABELS → TAG

3.4.5 SENSOR NAME

Two 16 character lines are available for naming the Sensor, Upper and Lower case characters, Numbers and Punctuation are available. The information entered will be displayed in the INFO screen. Entry is accomplished by scrolling through the alphanumeric list with the ▲ (forward →) and ▼ (backwards ←) arrows to the character of choice and then pressing **NEXT** to advance the cursor to the next digit. Pressing and holding the ▲ or ▼ keys will initiate two speed auto scrolling. Press **BACK** to exit the screen.

Location: CONFIG → XMTR → LCD → LABELS → SENSOR

3.4.6 PASSWORD PROTECTION

PASSWD Enter 4 character password to protect access to MENU Level, CAL Menu, CONFIG Menu and SIM Menu (simulate). Each level can be turned ON or OFF and can have a unique password. Upper Case Characters and Numbers are available for use.

Place the cursor in front of the level to be changed and Press **OK**. Move the cursor to **ON** and press **OK** to change the password status from OFF to ON.

Entry is accomplished by scrolling through the alphanumeric list with the ▲ (forward →) and ▼ (backwards ←) arrows to the character of choice and then pressing **NEXT** to advance the cursor to the next digit. Pressing and holding the ▲ or ▼ keys will initiate two speed auto scrolling.



- **MENU** ON/OFF - - - - Locks Main Menu
- **CAL** ON/OFF - - - - Locks CAL and CONFIG
- **CONFIG** ON/OFF - - - - Locks CONFIG
- **SIM** ON/OFF - - - - Locks SIM and CONFIG

In the case of a **Lost or Forgotten password** enter **MSTR** to access the screen.

Location: CONFIG → XMTR → PSSWD

4.0 CALIBRATION

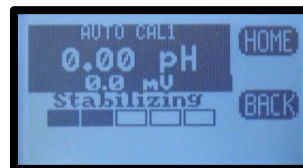
The Model T80 transmitter provides three methods of calibration:



4.0.1 AUTO CALIBRATION DESCRIPTION

Auto calibration is the primary calibration method for all measurements. AUTO calibration automatically recognizes the calibration solution the sensor is in and proposes the actual temperature compensated value for acceptance. AUTO calibration can be a single point or two point calibration. A single point calibration sets the zero point or offset value of the sensor. The second calibration sets the slope or span of the sensor.

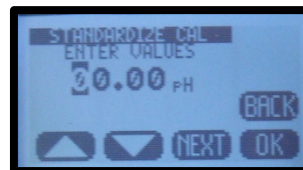
When the AUTO key is pressed the transmitter displays the PV (Process Variable) and the associated mV signal from the sensor. When the reading has stabilized a calibration value is AUTOMATICALLY proposed, i.e. 7.00 pH, 10 ppm Fluoride ion, 0.00 mg/L Dissolved Oxygen. **The user is prompted to accept the proposed calibration value or enter and accept another value.** Once Cal 1 is accepted the user is asked to continue to Cal 2, yes/no. If yes, then a second calibration value is proposed when the sensor has stabilized in the second calibration solution. Accept the value and the calibration is complete.



At the end of each calibration the Offset and Slope are displayed in the respective units, pH, mV, ppm, mg/l.

4.0.2 STANDARDIZE CALIBRATION DESCRIPTION

A Standardize Calibration is a single point calibration where the transmitter's reading is adjusted to agree with a solution of known value, either a calibration standard, a grab sample or laboratory determined value. In many cases the constituents and the pressure and temperature of the process solution are very different from the calibration solution. In these cases, once the sensor has equilibrated, the Zero Point or Offset value may have shifted from the original calibration point. Standardization allows for correction of this type of offset.

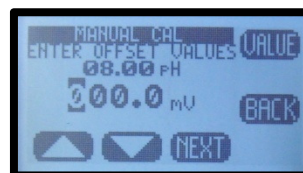


When the STAND key is pressed, the user is prompted to ENTER VALUE. The user enters the value they want the transmitter to read and press OK. The user is then prompted to accept the value, yes/no, and the calibration is complete. Standardizations are single point calibrations.

At the end of each calibration the Offset and Slope are displayed in the respective units, pH, mV, ppm, mg/l.

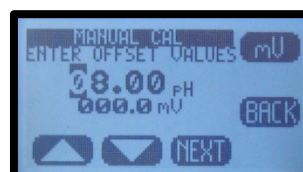
4.0.3 MANUAL CALIBRATION DESCRIPTION

Manual calibration allows the user to enter calibration data for an electrode into the transmitter without performing a calibration. A MANUAL Calibration requires the entry of three pieces of data, (1) A **concentration** with the (2) **corresponding mV** value and (3) a **slope** for an electrode. This allows laboratory generated calibration data for an electrode to be entered in a remote analyzer where calibration is difficult or impractical.

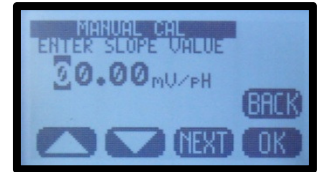
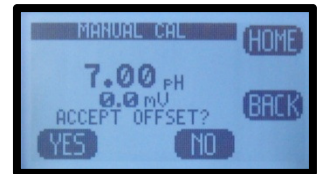


Example: MANUAL Calibration for a pH electrode

1. Calibrate the pH electrode in the laboratory
2. Record the mV value of some pH Standard, pH 7.00 buffer = 6.8 mV (any pH – mV pair will work)



3. Calculate and Record the slope of the electrode, 58.2 mV/pH
4. Install the electrode into the field mounted sensor
5. **Press MANUAL** and enter the pH value, 7.00 pH, **press mV** and enter the corresponding mV value, 6.8 mV, **press OK**, Accept Offset?, **press YES**, enter slope 58.2 mV/pH, **press OK**, Accept Slope?, **Press YES**
6. The Calibration is complete, the Offset and Slope values are displayed, **press OK** to exit.



4.1 PH CALIBRATION PROCEDURES

AUTO Calibration recognizes pH 4.01, pH 7.00 and pH 10.00 buffer solutions for automatic, temperature compensated calibrations. Any calibration solutions can be used but the pH value will have to be entered manually. Follow the steps below to accomplish a pH calibration. Example uses pH 7.00 and pH 4.01 buffers.

4.1.1 AUTO CAL USING PH 4.01, 7.00, 10.00 BUFFERS

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes erases CAL Log in INFO, NO adds CAL to existing Log)
Press Yes/NO	Place Sensor in CAL Solution (use pH 7.00 buffer)
Press AUTO then CAL 1	STABILIZING, 7.00 pH x.x mV, 7.00 pH corrected Accept Cal 1?
Press YES	CAL1 Value 7.00 pH, Continue to CAL2? Move sensor to 4.01 pH buffer solution
Press YES	STABILIZING, 4.00 pH xxx.x mV, 4.00 pH corrected Accept Cal?
Press YES	OFFSET: 7.00 pH x.x mV, SLOPE: 59.16 mV/pH (data written to Log)
Press OK	Calibration complete
Press HOME	Hold is ON
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.1.2 AUTO CAL USING OTHER PH BUFFERS

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes erases CAL Log in INFO, NO adds CAL to existing Log)
Press YES/NO	Place Sensor in CAL Solution
Press AUTO then CAL 1	STABILIZING, xx.xx pH x.x mV, 7.00 pH corrected Accept Cal?
Press NO	Enter CAL 1 Value
Press ▲ ▼ NEXT	xx.xx pH (use arrows and NEXT to enter pH Buffer value)
Press OK	xx.xx pH, xxx.x mV, Accept this Value
Press YES	CAL 1 Value xx.xx pH, Continue to CAL 2? (Place Sensor in 2 nd calibration buffer)
Press YES	STABILIZING, xx.xx pH xxx.x mV, 4.00 pH corrected Accept Cal?
Press NO	Enter CAL 2 Value
Press ▲ ▼ NEXT	xx.xx pH (use arrows and NEXT to enter pH Buffer value)
Press OK	xx.xx pH, xxx.x mV, Accept this Value
Press YES	OFFSET: xx.xx pH x.x mV, SLOPE: 59.16 mV/pH (data written to Log)
Press OK	Calibration complete
Press HOME	Hold is ON
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.1.3 STANDARDIZE

Leave the sensor in the process solution, take a grab sample from the process and determine the pH.

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes, erases CAL Log in INFO, NO adds CAL to existing Log)

Press NO	Place Sensor in CAL Solution (or leave in the process solution)
Press STAND	Enter Value
Press ▲ ▼ NEXT	xx.xx pH (use arrows and NEXT to enter process pH value)
Press OK	xx.xx pH, xxx.x mV, Accept Value?
Press YES	OFFSET: xx.xx pH x.x mV, SLOPE: xx.xx mV/pH (this data written to Log)
Press OK	Back to Cal Menu
Press HOME	Hold is ON (Press HOLD to turn off Hold)
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.2 ORP CALIBRATION PROCEDURES

AUTO Calibration recognizes Quinhydrone solutions (mVa), pH 7.00 quinhydrone solution (90 mV) and pH 4.01 quinhydrone solution (267 mV) for automatic ORP calibrations. Any calibration solutions can be used but the ORP value will have to be entered manually. Follow the steps below to accomplish an ORP calibration.

4.2.1 AUTO CAL WITH QUINHYDRONE

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes erases CAL Log in INFO, NO adds CAL to existing Log)
Press Yes/NO	Place Sensor in CAL Solution (use pH 7.00 Q solution)
Press AUTO then CAL 1	STABILIZING, xxx.x mV, xxx.x mV _a , 90.0 mV corrected Accept Cal?
Press YES	CAL1 Value 90.0 mV, Continue to CAL2? Move sensor to pH 4.01 Q solution
Press YES	STABILIZING, 269.2 mV 267.0 mV _a , 267 mV corrected Accept Cal?
Press YES	OFFSET: 90.0 mV _a , 87 mV, SLOPE: 1.02 mV/ mV _a (data written to Log)
Press OK	Calibration complete
Press HOME	Hold is ON
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.1.2 STANDARDIZE

Leave the sensor in the process solution, take a grab sample from the process and determine the ORP.

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes, erases CAL Log in INFO, NO adds CAL to existing Log)
Press NO	Place Sensor in CAL Solution (or leave in the process solution)
Press STAND	Enter Value
Press ▲ ▼ NEXT	xx.xx mV (use arrows and NEXT to enter process ORP value)
Press OK	xxx.x mV, xxx.x mV, Accept Value?
Press YES	OFFSET: xxx.x mV xxx.x mV, SLOPE: xx.xx mV/mV (this data written to Log)
Press OK	Back to Cal Menu
Press HOME	Hold is ON (Press HOLD to turn off Hold)
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.3 PION CALIBRATION PROCEDURES

AUTO Calibration recognizes 1, 10 or 100 ppm/ppb calibration solutions. Any calibration solutions can be used but the ppm value will have to be entered manually. Follow the steps below to accomplish a pION calibration.

4.3.1 AUTO CAL USING 1, 10, 100 PPM SOLUTIONS

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes erases CAL Log in INFO, NO adds CAL to existing Log)
Press Yes/NO	Place Sensor in CAL Solution (use 10 ppm solution)
Press AUTO then CAL 1	STABILIZING, 10.00 ppm, xxx.x mV, 10.00 ppm corrected, Accept Cal?
Press YES/NO	CAL1 Value 10.00 ppm, Continue to CAL2? Move sensor to 100 ppm solution
Press YES	STABILIZING, 100.0 ppm, xx.xx mV, 100 ppm corrected, Accept Cal?
Press YES	OFFSET: 10.00 ppm, 310 mV, SLOPE: 55.1 mV/ decade (data written to Log)
Press OK	Calibration complete
Press HOME	Hold is ON
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.3.2 AUTO CAL USING NON-DECIMAL PPM SOLUTIONS

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes erases CAL Log in INFO, NO adds CAL to existing Log)
Press YES/NO	Place Sensor in CAL Solution
Press AUTO then CAL 1	STABILIZING, xx.xx pH x.x mV, 10.00 ppm corrected Accept Cal?
Press NO	Enter CAL 1 Value
Press ▲ ▼ NEXT	xxxx.x ppm (use arrows and NEXT keys to enter Cal value)
Press OK	xxxx.x ppm, xxx.x mV, Accept this Value
Press YES	CAL 1 Value xxxx.x ppm, Continue to CAL 2? (Place Sensor in 2 nd calibration solution)
Press YES	STABILIZING, xxxx.x ppm xxx.x mV, xxx.x ppm corrected Accept Cal 2?
Press NO	Enter CAL 2 Value
Press ▲ ▼ NEXT	xxxx.x ppm (use arrows and NEXT keys to enter Cal value)
Press OK	xxxx.x ppm, xxx.x mV, xxx.x ppm corrected Accept Cal 2?
Press YES	OFFSET: xxxx.x ppm xxx.x mV, SLOPE: 55.40mV/decade (data written to Log)
Press OK	Calibration complete
Press HOME	Hold is ON
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.3.3 STANDARDIZE

Leave the sensor in the process solution, take a grab sample from the process and determine the Ion concentration.

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration

Press CAL	Is this a new Sensor? (Yes, erases CAL Log in INFO, NO adds CAL to existing Log)
Press NO	Place Sensor in CAL Solution (or leave in the process solution)
Press STAND	Enter Value
Press ▲ ▼ NEXT	xxxx.x ppm (use arrows and NEXT to enter process Ion ppm value)
Press OK	xxxx.x ppm, xxx.x mV, Accept Value?
Press YES	OFFSET: xxxx.x ppm xxx.x mV, SLOPE: xx.xx mV/DEC (this data written to Log)
Press OK	Back to Cal Menu
Press HOME	Hold is ON (Press HOLD to turn off Hold)
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.4 S80/DO90 DISSOLVED OXYGEN CALIBRATION PROCEDURES

There are two separate calibration procedures for Dissolved Oxygen sensors, Section 4.4 for S80 DO and DO90 ppb DO and Section 4.5 for TRITON® DO80 Optical.

The dissolved oxygen AUTO Cal acknowledges zero ppm, mg/l, % SAT for CAL 1 and the temperature compensated value for atmospheric oxygen, 8.25 ppm, mg/l at 25°C or 100 % SAT for CAL 2.

The zero point is set by placing the sensor into an oxygen free solution and verifying the displayed value drops to a value below 1 mV. The sensor will take a few minutes to equilibrate to the zero oxygen solution but for the highest accuracy it is best to wait 15-20 minutes before initiating a calibration. The typical sensor will burn down to 0.5 – 0.7 mV in an hour or so in a zero ppm solution. A zero ppm O2 solution can be made by adding approximately 5 grams of sodium sulfite to a liter of distilled water or purging the sample with nitrogen gas.

The slope (CAL 2) is set by placing the sensor in air saturated distilled water or water saturated (100% humidity) air. The easiest method is to suspend the sensor vertically in beaker with a ½” of water in the bottom slightly above the water.

A STANdardize calibration adjusts the CAL 2 value, resetting the slope of the sensor, mV/ppm.

The actual concentration in mg/L (C) is equal to the Saturation value at the given temperature multiplied by the altitude and air pressure corrections. Determine the calibration temperature and look up the saturation value (S) in Table 1 below. Then determine the altitude correction (K) from Table 2 and the current air pressure in bar (P), 1 bar equals 14.7 psi. Use 1 bar if the actual air pressure is unknown.

$$C = S \times K \times P$$

Example:

Temperature = 20°C → Saturation = 9.08 mg/L, Altitude = 1200 ft → K = 0.960, Air Pressure 1.014 bar

$$C = 9.08 \times 0.960 \times 1.014 = 8.84 \text{ mg/L}$$

The T80 transmitter uses the temperature compensated Saturation Index for AUTO Cal, however the user can enter the altitude and pressure compensated value of 8.84 ppm as the calibration value when prompted to “Accept Value?” in CAL 2.

Table 1 Saturation Index

Temperature °C (°F)	Saturation mg/L	Temperature °C (°F)	Saturation mg/L	Temperature °C (°F)	Saturation mg/L
0 (32)	14.64	14 (57)	10.28	28 (82)	7.82

1 (34)	14.23	15 (59)	10.06	29 (84)	7.69
2 (36)	13.83	16 (61)	9.85	30 (86)	7.55
3 (38)	13.45	17 (63)	9.64	31 (88)	7.42
4 (39)	13.09	18 (64)	9.45	32 (90)	7.30
5 (41)	12.75	19 (66)	9.26	33 (91)	7.18
6 (43)	12.42	20 (68)	9.08	34 (93)	7.06
7 (45)	12.11	21 (70)	8.90	35 (95)	6.94
8 (46)	11.81	22 (72)	8.73	36 (97)	6.83
9 (48)	11.53	23 (73)	8.57	37 (99)	6.72
10 (50)	11.25	24 (75)	8.41	38 (100)	6.61
11 (52)	10.99	25 (77)	8.25	39 (102)	6.51
12 (54)	10.75	26 (79)	8.11	40 (104)	6.41
13 (55)	10.51	27 (81)	7.96		

Table 2 Altitude Correction

Altitude m (ft)	K	Altitude m (ft)	K	Altitude m (ft)	K
Sea Level 0	1.000	700 (2300)	0.922	1400 (4600)	0.849
50 (160)	0.994	750 (2450)	0.916	1450 (4750)	0.844
100 (330)	0.988	800 (2600)	0.911	1500 (4900)	0.839
150 (500)	0.982	850 (2800)	0.905	1550 (5100)	0.834
200 (660)	0.977	900 (2950)	0.900	1600 (5250)	0.830
250 (820)	0.971	950 (3100)	0.895	1650 (5400)	0.825
300 (980)	0.966	1000 (3300)	0.890	1700 (5600)	0.820
350 (1200)	0.960	1050 (3450)	0.885	1750 (5750)	0.815
400 (1300)	0.954	1100 (3600)	0.879	1800 (5900)	0.810
450 (1500)	0.949	1150 (3775)	0.874	1850 (6050)	0.805
500 (1650)	0.943	1200 (3950)	0.869	1900 (6200)	0.801
550 (1800)	0.938	1250 (4100)	0.864	1950 (6375)	0.796
600 (2000)	0.932	1300 (4250)	0.859	2000 (6550)	0.792
650 (2150)	0.927	1350 (4400)	0.854		

4.4.1 AUTO CAL USING ZERO PPM SOLUTION AND AIR

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes erases CAL Log in INFO, NO adds CAL to existing Log)
Press Yes/NO	Place Sensor in CAL 1 Solution (use 0.00 ppm solution) or CAL 2 Solution (Air)
	To perform zero CAL press CAL 1, to skip zero cal press CAL 2
Press AUTO then CAL ?	STABILIZING, 0.00 ppm, xxx.x mV, 0.00 ppm corrected, Accept Cal?
Press YES	CAL 1 Value 0.00 ppm, Continue to CAL2? Move sensor to Air or saturated water
Press YES	STABILIZING, 8.25 ppm, xxx.x mV, 8.25 ppm corrected, Accept Cal?
Press YES	OFFSET: 0.00 ppm, 2.3 mV, SLOPE: 40.1 mV/ ppm (data written to Log)
Press OK	Calibration complete
Press HOME	Hold is ON
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.4.2 STANDARDIZE

Leave the sensor in the process solution or in the air, take a grab sample from the process and determine the dissolved oxygen concentration or enter the temperature and pressure corrected value for air.

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes, erases CAL Log in INFO, NO adds CAL to existing Log)
Press NO	Place Sensor in Air or the process solution
Press STAND	Enter Value
Press ▲ ▼ NEXT	xxx.xx ppm or % SAT (use arrows and NEXT to enter process value)
Press OK	xxx.xx ppm, xxx.x mV, Accept Value?
Press YES	OFFSET: 0.00 ppm xx.x mV, SLOPE: xx.xx mV/ppm (this data written to Log)
Press OK	Back to Cal Menu
Press HOME	Hold is ON (Press HOLD to turn off Hold)
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.4.3 MANUAL CAL

Leave the sensor in the process solution or in the air, take a grab sample from the process and determine the dissolved oxygen concentration or enter the temperature and pressure corrected value for air.

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes, erases CAL Log in INFO, NO adds CAL to existing Log)
Press NO	Place Sensor in Air or the process solution, it doesn't matter which
Press MANUAL	Enter Zero Value
Press ▲ ▼ NEXT	000.00 ppm or % SAT (use arrows and NEXT to enter ppm value)
Press mV Button	Enter mV value for zero ppm solution (default use 0.5 mV)
Press ▲ ▼ NEXT	000.00 mV (use arrows and NEXT to enter mV value)
Press OK	OFFSET: 0.00 ppm 00.5 mV, Accept Value?
Press YES	Slope 000.0 mV/ppm or 000.0 mV/% SAT
Press ▲ ▼ NEXT	048.00 mV/ppm (use calculated value or 45 mV/ppm or 4.0 mV/% SAT)
Press OK	Slope 48.00 mV/ppm, Accept this Value?
Press YES	Back to Cal Menu
Press HOME	Hold is ON (Press HOLD to turn off Hold)
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.5 TRITON® DISSOLVED OXYGEN CALIBRATION PROCEDURES

Before starting a calibration Enter the Salinity and Barometric pressure in the CONFIG→SENSOR menu. The default values are Salinity 0% and 1013 mbar. Use Table 2 above to calculate the pressure using elevation if the actual pressure is not known.

The TRITON® DO80 sensor was calibrated at the factory prior to shipment and should not require a re-calibration at start up. Calibration is required whenever the fluorescence cap/membrane cap is replaced.

Calibrations can be performed as a one point (Air cal), a two point (zero point & Air cal) or a standardization, there is no Manual Cal option available for the TRITON® dissolve oxygen sensors.

The Auto Cal allows both 0% and 100% calibrations. The sensor senses the oxygen partial pressure and if it is less than 20% of saturation it assumes a Zero Point calibration and calibrates to 0.00% saturation, 0.00 mg/l or 0.00 mbar depending on the measurement mode. If the sensed value is above 75% of saturation it assumes an Air Calibration and calibrates to the value equivalent to 100% saturation.

The zero point of the sensor is relatively stable through the life of the fluorescence/membrane cap. The zero point is checked by placing the sensor into an oxygen free solution and verifying the displayed value drops to a value near zero ppm. The sensor will take a few minutes to equilibrate to the zero oxygen solution but it is best to wait 15-20 minutes before initiating a calibration (up to a 10 minute cycle time) for the highest accuracy. A zero ppm O₂ solution can be made by adding approximately 5 grams of sodium sulfite to a liter of distilled water or purging the sample with nitrogen gas.

Air saturated water and water saturated air (100% humidity) have the same oxygen partial pressure. The preferred calibration method uses water saturated air. The Protective Guard can be removed from the front of the sensor and filled a small amount of distilled water, ~5 ml, for an easy to use Calibration Cap.

The calibration cycle takes up to 10 minutes once initiated. The DO80 sensor should be equilibrated for 10-15 minutes to the air sample (100% humidity, 0% Salinity) and the ambient temperature before starting the calibration. When measuring in the “% Saturation mode”, 100% will be reported as the calibration value.

4.5.1 AUTO CAL USING ZERO PPM SOLUTION AND AIR

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Place Sensor in Zero Solution (0.00 ppm solution) (Optional Zero Cal)
Press AUTO (Optional)	CALIBRATING, SAVING CAL, AUTO CAL COMPLETE, OK? (up to 10 minutes)
Press OK (Optional)	
AIR CALIBRATION	Move sensor to Air (100% humidity) or Air saturated water
Press AUTO	CALIBRATING, SAVING CAL, AUTO CAL COMPLETE, OK?
Press OK	Returned to Cal Menu
Press HOME	Hold is ON
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.5.2 STANDARDIZE

Leave the sensor in the process solution or in the air, take a grab sample from the process and determine the dissolved oxygen concentration or enter the temperature and pressure corrected value for air.

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Place Sensor in Air or with the sensor in the process solution
Press STAND	Enter Value
Press ▲ ▼ NEXT	xx.xx ppm or % SAT (use arrows and NEXT to enter process value)
Press OK	xx.xx ppm, Accept Value?
Press YES	CALIBRATING, SAVING CAL, CURRENT VALUE: x.xx ppm, DESIRED VALUE: x.xx ppm, OFFSET xxx ppb or ppm
Press OK	Back to Cal Menu
Press HOME	Hold is ON (Press HOLD to turn off Hold)
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.6 TRITON® TR6 TURBIDITY/SUSPENDED SOLIDS SENSOR

The TRITON® TR6 turbidity sensors are dual range sensors available in four different ranges. The TR6 turbidity sensors have a non-linear output. The calculation of the turbidity is accomplished using a 2nd order polynomial of the millivolt output, $NTU = ax^2 + bx + c$, where x = millivolt output of the sensor. A three point calibration is required to define the shape of the curve. The Model T80 turbidity analyzer was calibrated at the factory before shipment in three Formazine solutions using the values listed below. The calibration was performed with the three solutions specific for the NTU range of the sensor ordered.

Changing the range of the sensor (Hi to Low or Low to Hi) or changing the measurement unit will require a new three point calibration. The calibration points for the three point calibration are 0%, 50% and 100% of the measurement range, NTU, FNU, ppm, mg/L or % Solids. Calibrations of NTU or FNU can be made with formazine solutions diluted from the 4000 NTU stock solution to the values listed in the table below. Calibrations of ppm, mg/L, and % Solids require the actual process solutions to be used for the calibration. The 100% solution for the ppm, mg/L and % solids should be near the high point of the measurement, it does not need to be the maximum value but it should be in the upper range of the measurement. The value of the solution must be known or determined by another method such as a grab sample and laboratory measurement. Then make the 50% solution from 1 part of the high sample to one part deionized water, its value is half of the high value and finally use deionized water for the 0% solution.

Calibrations should be performed in a vessel with similar characteristics to the actual process installation. Black plastic containers work best, minimizing reflectance problems in lower NTU solutions. ECD offers a TRITON® TR6 Turbidity Calibration Kit that includes a TR6 Calibration Cup, 250 ml, 100 ml and 50 ml graduated cylinders and a 1 liter volumetric flask. The kit provides the necessary laboratory equipment to make calibration standards from a 4000 NTU formazine stock solution and an easy to use calibration cup. This kit is ideal for calibration of inline pipe mounted TR6 turbidity sensors.

Example of a mg/L Calibration: The process solution ranges around 3000 mg/L. A 2 liter sample was taken from the process and tested, it was determined to be 2850 mg/L. Keep one liter of the 2850 mg/L solution for the (100%) solution calibration and mix 500 mls of the 100% solution with 500 mls of deionized water, making the

(50%) solution, 1425 mg/L and one liter of deionized water (0%). Start the calibration in the deionized water in the calibration cup and accept 0.00 mg/L when prompted, then put the sensor into the 1425 mg/L solution and enter 1425 mg/L when prompted and finally into the 2850 mg/L solution and enter 2850 mg/L. Accept the calibration and put the sensor back into the process.

Sensor Measurement Ranges	Low Calibration Values	High Calibration Values
0-250 NTU and 0-1000 NTU	0 NTU, 125 NTU, 250 NTU	0 NTU, 500 NTU, 1000 NTU
0-500 NTU and 0-2000 NTU	0 NTU, 250 NTU, 500 NTU	0 NTU, 1000 NTU, 2000 NTU
0-1000 NTU and 0-4000 NTU	0 NTU, 500 NTU, 1000 NTU	0 NTU, 2000 NTU, 4000 NTU
0-2000 NTU and 0-4000 NTU	0 NTU, 1000 NTU, 2000 NTU	0 NTU, 2000 NTU, 4000 NTU

4.6.1 AUTO CAL

The TRITON® TR6 turbidity sensors use a three point AUTO Cal sequence. Cal 1 is a zero point calibration, Cal 2 is a 50% of the measured range calibration and Cal 3 is a 100% of range calibration.

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes erases CAL Log in INFO, NO adds CAL to existing Log)
Press YES/NO	Place Sensor in 0.00 NTU (or FNU, mg/L, ppm, % Solids)CAL Solution
Press AUTO (CAL 1)	STABILIZING, xx.xx NTU x.xx V, 0.00 NTU corrected Accept Cal 1?
Press YES	Place sensor in 50 % solution
	STABILIZING, 492.0 NTU 1.18V, 500.0 ppm corrected, Accept Cal 2?
Press YES/NO	If suggested corrected value is not correct press NO, Enter CAL 2 Value
Press ▲ ▼ NEXT	xxxx.x NTU (use arrows and NEXT keys to enter Cal value)
Press OK	xxxx.x NTU, xxx.x V, 500.0 NTU corrected Accept Cal 2?
Press YES	Place sensor in 100% solution
	STABILIZING, 1000 NTU 2.46V, 1000.0 ppm corrected, Accept Cal 3?
Press YES/NO	If suggested corrected value is not correct press NO, Enter CAL 3 Value
Press ▲ ▼ NEXT	xxxx.x NTU (use arrows and NEXT keys to enter Cal value)
Press OK	1000 NTU, 2.46 V, 1000.0 NTU corrected Accept Cal 3?
Press OK	Calibration complete, returns to Cal Menu
Press HOME	Hold is ON
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.6.2 STANDARDIZE

Standardize is an online/in process **Zero Point Calibration Only**. To change a non-zero value to a new value use the Slope feature in the Manual Cal section. (see below) Standardize is used to zero out the reflectance effects generated by the installation. The sensor will generate a mV signal in a zero NTU environment and this will be different than the zero point value recorded in the AUTO Cal. Standardize shifts the calibration curve to the new zero value. Perform a Standardize calibration with the sensor installed in the process line or tank and immersed in clear water only.

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Place Sensor in Air or with the sensor in the process solution

Press STAND	Enter Zero Value
Press ▲ ▼ NEXT	0.00 NTU or ppm, mg/L, % Solids (use arrows and NEXT to enter process value)
Press OK	0.00 NTU, Accept Value?
Press YES	Stand Cal Complete: 8.61 NTU, DESIRED VALUE: 0.00 NTU, OFFSET 8.61 NTU
Press OK	Back to Cal Menu
Press HOME	Hold is ON (Press HOLD to turn off Hold)
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.6.3 MANUAL CAL

Manual Cal provides two options, OFFSET and SLOPE. **OFFSET** is an online/in process **Zero Point Calibration Only**. It is the same value that is adjusted in **Standardize** and it is the set same way. **SLOPE** is an adjustment of the NTU/volt aspect of the turbidity curve pivoting from the Offset point. The SLOPE window displays a unit less number that is changed to adjust the calibration.

Example: TRITON® TR6 in 400 NTU solution but reads 380 NTU. The SLOPE reads 108. The slope of the calibration curve needs to increase so that the voltage that is generating 380 NTU will generate 400NTU. To determine the new slope, first divide the desired value (400 NTU) by the actual value (380 NTU) and multiply the current slope by that number. $400 \text{ NTU} / 380 \text{ NTU} * 108 = 113.7$ the new slope. Enter 113.7 in the SLOPE window, Save the calibration and the analyzer will read 400 NTU.

SLOPE ADJUSTMENT

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Place Sensor in Air or with the sensor in the process solution
Press MANUAL	OFFSET or SLOPE
Press SLOPE	Enter SLOPE Value108.00
Press ▲ ▼ NEXT	113.7 (use arrows and NEXT to enter process value)
Press OK	113.7 Accept Value?
Press YES	Manual Cal Complete: OFFSET 8.61 NTU, SLOPE 113.7
Press OK	Back to Cal Menu
Press HOME	Hold is ON (Press HOLD to turn off Hold)
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.7 CONDUCTIVITY SENSORS

AUTO Calibration recognizes Air for zero point (Cal 1) and 50µS, 100µS, 500µS, 1mS, 5mS, 10mS, 50mS and 100mS solutions for the span (Cal 2). Any calibration solutions can be used but the conductivity value will have to be entered manually. Use a calibration standard near the conductivity of the process solution. Example uses air and 1mS.

4.7.1 AUTO CAL USING AIR AND CONDUCTIVITY STANDARD

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes erases CAL Log in INFO, NO adds CAL to existing Log)

Press Yes/NO	Remove the Sensor from Solution and dry the front end, Air = 0.00 μ S
To perform zero CAL press CAL 1, to skip zero cal press CAL 2, only if a zero cal was previously done on the sensor	
Press AUTO then CAL 1	STABILIZING, 0.00 μ S, 1.17 V, 0.00 μ S corrected, Accept Cal?
Press YES	CAL 1 Value 0.00 μ S, Continue to CAL2? Move sensor to 1.00 mS solution
Press YES	STABILIZING, 1.00 mS, 98X.X mV, 1.000 μ S corrected, Accept Cal?
Press YES	OFFSET: 0.00 ppm, 174.4 mV, SLOPE: 984 (data written to Log)
Press OK	Calibration complete
Press HOME	Hold is ON
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.7.2 STANDARDIZE

With the sensor in the process solution, take a grab sample from the process and determine the conductivity using a qualified laboratory conductivity meter.

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes, erases CAL Log in INFO, NO adds CAL to existing Log)
Press NO	With the sensor in the process solution
Press STAND	Enter the laboratory determined conductivity value
Press ▲ ▼ NEXT	xxx.xx μ S/mS (use arrows and NEXT to enter process value)
Press OK	xxx.xx μ S/mS, xxx.x mV, Accept Value?
Press YES	OFFSET: 0.00 μ S 1.0 mV, SLOPE: xx.xx mV/ppm (this data written to Log)
Press OK	Back to Cal Menu
Press HOME	Hold is ON (Press HOLD to turn off Hold)
Press HOLD	Turn off Hold
Press EXIT	Main Display

4.8 TDS CONDUCTIVITY SENSORS

The Total Dissolved Solids measurement (TDS) on the Model T80 transmitter is made with an S80 conductivity sensor and a correlation factor. *(Conductivity in μ S x correlation factor = ppm)*

Conductivity is a measurement of a solution’s electrolytic conductivity, 1/ohms. The type of dissolved ions in the solution is irrelevant to the measurement. TDS is a measurement of concentration, ppm (mg/L). Since different salts contribute different amounts of conductivity to a solution, TDS measurements are only valid between solutions of the same chemical makeup. As an example, 1000 ppm of TDS in natural waters has a conductivity around 1400 μ S (correlation factor 0.6712), 1000 ppm of KCl has a conductivity around 2000 μ S (correlation factor 0.5000) and 1000 ppm of NaOH has a conductivity around 6000 μ S (correlation factor 0.1667). All three solutions have a TDS of 1000 ppm but the conductivities are 1400 μ S, 2000 μ S and 6000 μ S. A TDS measurement is only valid for a solution with the same chemical make up as the solution used for calibration.

Calibration is accomplished in two steps; Step 1 Conductivity AUTO Calibration of the sensor (see section 4.7.1 above) and then Step 2 correlation of conductivity to the TDS. The second step can be done by entering the correlation factor into the CONFIG →SENSOR→ TDS menu or by standardizing the sensor in a solution of known TDS in the CAL→STAND menu by entering the TDS value. Since the correlation of conductivity to concentration is not linear it is best to calibrate the sensor near the measured value.

4.8.1 STANDARDIZE

With the sensor in the process solution, take a grab sample from the process and determine the TDS using a qualified laboratory method.

Action	Prompt
Double Press any Button	MENU HOME, Hold is OFF
Press HOLD	Hold freezes 4-20 mA Output and locks Alarm Relays during Calibration
Press CAL	Is this a new Sensor? (Yes, erases CAL Log in INFO, NO adds CAL to existing Log)
Press NO	With the sensor in the process solution or calibration standard
Press STAND	Enter the laboratory determined TDS value
Press ▲ ▼ NEXT	xxx.xx ppm (use arrows and NEXT to enter process value)
Press OK	xxx.xx ppm, xxx.x mV, Accept Value?
Press YES	Current value: xx.xx ppm, Desired value: xx.xx ppm, Offset: xx.xx ppm
Press OK	Back to Cal Menu
Press HOME	Hold is ON (Press HOLD to turn off Hold)
Press HOLD	Turn off Hold
Press EXIT	Main Display

5.0 MAINTENANCE

No periodic maintenance is required for the ECD Model T80 Transmitter.

When you open the front cover and/or cable glands, make sure that the seals are clean and correctly fitted when the unit is re-assembled in order to maintain the housing's NEMA 4X weatherproof integrity against water and water vapor.

Fuse: There is a circuit board mounted fuse protecting the instrument. If you suspect that this needs to be replaced, contact the ECD service center for parts and instructions.

5.1 CLEANING

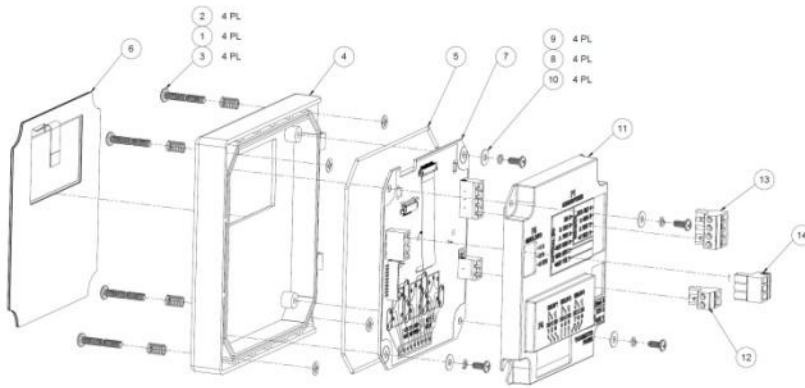
The Model T80 transmitter requires no periodic maintenance, except to make sure the front window is kept clean in order to permit a clear view of the display and allow proper operation of the navigation buttons. If the window becomes soiled, clean it using a soft damp cloth or soft tissue. To deal with more stubborn stains, a neutral detergent or spray cleaner like Windex may be used. Never use harsh chemicals or solvents.

6.0 TROUBLESHOOTING

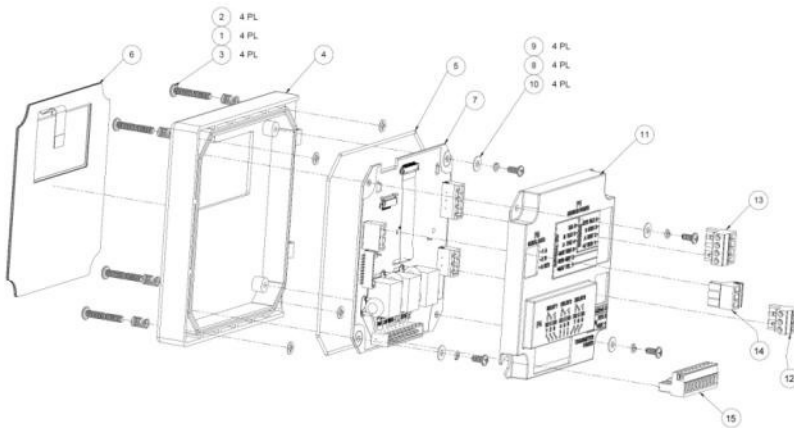
Symptom	Probable cause	Remedy
Blank Display	No Power	Check power source, 24VDC loop, 24VDC, 110/220VAC
	Sensor Failure, causing power draw down below transmitter threshold	Unplug sensor from transmitter, replace sensor if instrument powers up.
Incorrect Readings	Sensor needs calibration	Perform a standardization calibration. See INFO for calibration log
	Incorrect Temperature measurement	Calibrate/Trim Temperature to correct value
	Temperature Compensation set up incorrectly	Verify: 0.33% for pH, plon 0.00% for ORP 4.0% for DO
“Looking For Sensor” prompt	Lost connection between sensor and transmitter	Check sensor connection to transmitter, loose connector? Visually inspect cable for cuts or crushed areas, replace sensor if cable is compromised

7.0 PARTS AND ACCESSORIES

7.1 FRONT PANEL CONTROL BOARD EXPLODED

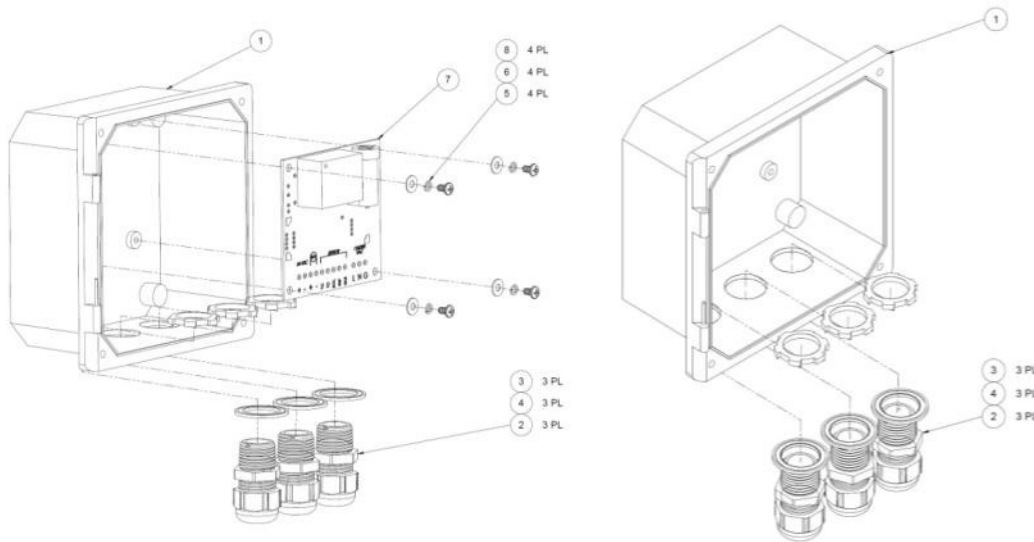


7.2 FRONT PANEL CONTROL BOARD EXPLODED, WITH RELAYS



Item #	Part #	Description
1	9630005	Spring, Mounting Screw Set
2	9870621	Retaining Washer, Mounting Screw Set
3	3600390	8-32 x 1" SS Screw, Mounting Screw Set
4	3400152	Front Housing
5	9560005	Sealing O-ring, grey silicone
6	9240503-1	Touch pad membrane
7	2101800-1	PCB, Control Board, Loop Powered
7	2101800-2	PCB, Control Board, Loop Powered, Relays
7	2101800-3	PCB, Control Board, Loop Powered, HART
8	9870650	Locking Washer, PCB Screw Set
9	9730905	6-32 x 5/16" SS Screw, PCB Screw Set
10	9870620	Flat Washer, PCB Screw Set
11	3400006-1	Control Board Cover
12	9090112	24 VDC, 4-20 mA Terminal Block/2 pins
13	9090114	Sensor Terminal Block/4 pins
14	9090113	Serial connection Terminal Block/3 pins
15	9090119	Relay Connection Terminal Block/9 pins

7.3 TRANSMITTER CASE, BACK WITH CABLE GLANDS



Item #	Part #	Description
1	3600449	Transmitter Case
2	9360005	PVC Cable Gland, ½" NPT, Grey
3	9300034	Locking Nut, ½" NPT, Steel
4	9300017	Sealing ring, ½" elastomer
5	9870650	Split Washer, PS mounting
6	9870620	Flat Washer, PS mounting
7	2101820-1	Power Supply Board
8	9730604	6-32 x ¼" screw, SS, PS mounting

7.4 REPLACEMENT PARTS

Part #	Description
2000002-1	Front Panel, Loop-Powered
2000002-2	Front Panel, AC/DC Powered
2000002-3	Front Panel, Loop-Powered, Hart Output
2101820-1	Power Supply Board, 110/220 VAC Input
2101820-3	Power Supply Board, 110/220 VAC Input, w/preamp
2101820-4	Preamp Board
3400006	Control Board Cover
9090112	Connector Plug, 2 Position (Loop, AC/DC, or Hart Versions)
9090113	Connector Plug, 3 Position (Loop or AC/DC Versions)
9090114	Connector Plug, 4 Position (Loop, AC/DC or Hart Versions)
9090119	Connector Plug, 9 Position (AC/DC Version)
9240503-1	Front Panel Membrane Switch
9300017	Sealing ring, Cable Gland
9300034	Locking Nut, Cable Gland
9360005	Fitting, Cable Gland
9830214	Screw, Front Panel

7.5 ACCESSORIES

Part #	Description
2000006	Kit, Universal Mount
2000007	Kit, Handrail Mount
2000008	Kit, Panel Mount
1000300-1	4-20 mA USB Data Logger
9130007	Replacement Battery for Data Logger
1000260-1	Sunshield for Pole Mount
1000260-2	Sunshield for Rail Mount

8.0 S80 SENSORS

S80 sensors are a family of digital sensors designed for use with ECD digital analyzers, the Model T80 transmitter or the Model C80 controller. S80 sensors accept the standard ECD electrode cartridges. The S80 sensors convert the analog signals into a temperature compensated digital protocol that allows two way communications with the transmitter. The type of sensor, identity and serial number are stored in the sensor's memory along with three calibration registers. When connected to an ECD digital analyzer the sensor's information is uploaded to the analyzer configuring the displays and outputs to the values appropriate to the sensor's measured parameter. Connect an S80 pH sensor to a Model T80 Transmitter and the Transmitter configures itself into a calibrated pH transmitter.

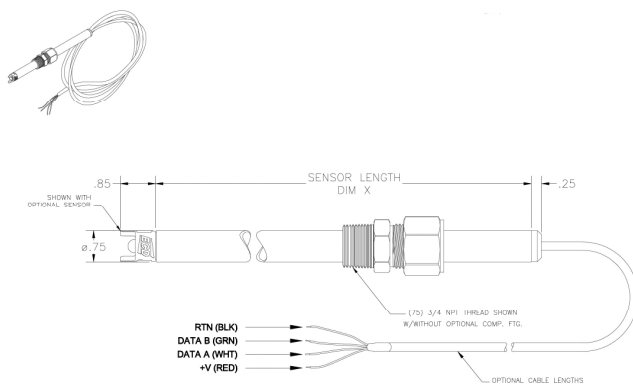
The internal components of the S80 sensors, the signal conditioner, temperature sensor and cable assembly are epoxy encapsulated inside the $\frac{3}{4}$ " O.D. housing. Epoxy encapsulation of the components increases the reliability of the sensor by eliminating failures caused by wiring and connector breakage. The S80 sensors use the same easily replaceable electrode cartridges as the S10 and S17 sensor assemblies.

8.1 S80 INSTALLATION

Four typical installation configurations are available for ECD sensors: insertion, immersion, flow-through and valve-retraction. Although there are many ways to accomplish these mounting configurations, ECD recommends the following installation configurations.

8.1.1 INSERTION

The S80 sensor is installed using a $\frac{3}{4}$ " MNPT compression fitting with choice of nylon, Teflon or 316 SS ferrule. The $\frac{3}{4}$ " MNPT can be inserted into a pipe Tee or through a tank wall, the S80 is then inserted through the fitting and compression gland is tightened to secure the sensor in place. The torque specification for the gland fitting is 20-ft/lbs. Over-tightening of the nut may swage the nylon or Teflon ferrules to the housing crushing the internal sensor components.



8.1.2 IMMERSION

The $\frac{3}{4}$ " MNPT compression fitting is reversed and threaded into an extension/immersion pipe so the compression gland is facing the measurement end of the sensor. Feed the cable through the immersion tube, insert the S80 sensor at least 5" into the tube and tighten the sensor in place.

8.1.3 FLOW THROUGH

Although the insertion configuration can be used as a flow-through mounting by inserting the S80 sensor into a pipe tee, ECD has various flow cells available for convenience. The flow cells are 2.0" diameter by 5" long, ported ½" FNPT through and ¾" FNPT for the sensor. The flow cells are available in 316 Stainless Steel, PVC and Kynar. Use of the flow cell can facilitate an optional spray cleaning nozzle for the electrode. Connecting 40+ psi of water or air to the nozzle will remove particulate materials or biofilms from the sensor tip. Detergents or solvents can be used to remove greases or oils from the sensor while acids can be used for hard water scale.

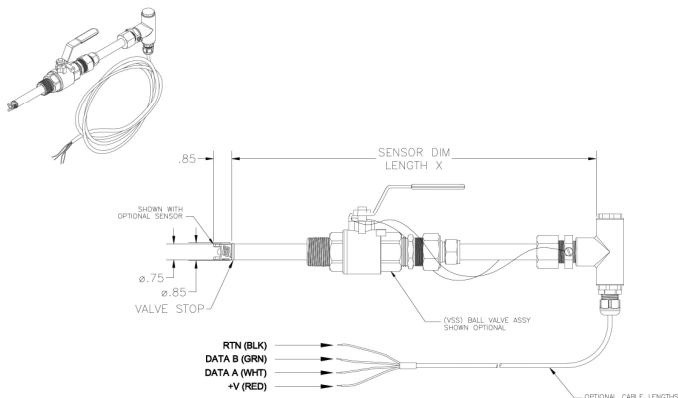
8.1.4 VALVE RETRACTABLE

The S80 sensor is optionally designed for valve retraction service, (-1) Sensor Style. Mounting is directly into a process line or through a tank wall. The ball valve system allows the sensor to be removed from service without shutting down the line or emptying the tank. ECD recommends the valve-retraction mounting for ease of maintenance or in applications where the process line cannot be shut down and the pressure does not exceed 100 psig.

To remove the sensor from the valve assembly refer to the following directions:

CAUTION: Do not put hands or fingers between the safety lanyard cables and any part of the sensor. Use the external cable seal/handle to pull or guide the sensor through the valve.

1. Loosen the small swage nut at the rear of the fitting assembly slowly as this compression fitting is holding the sensor in place. **CAUTION** the sensor may snap back quickly if it is under pressure. (do not remove the nut from the body of the fitting).
2. Slide the sensor to its stop by pulling it through the ball valve. The safety lanyards will be extended, confirming that the sensor is fully retracted. Note: the safety lanyards are redundant protection; the sensor will come to a stop when the high pressure stop reaches the front of the retainer fitting.
3. Close the ball valve.
4. Remove the **handle retaining nut** and the valve handle.
5. Remove the **safety lanyards** from the valve stem.
6. For the stainless steel ball valves, loosen and remove the large **retainer nut** from the **retainer fitting**. For Kynar ball valves, loosen and remove the union nut on the sensor side of the ball valve.
7. Firmly pull the **retainer fitting** from the valve. The sensor will be removed with the fitting.



8.1.5 FLANGE FITTINGS

Flange mountings can be accomplished with the insertion and valve-retraction configurations using the desired flange and by mounting the gland fitting or valve-retraction assembly to the flange.

8.2 S80 PART NUMBER CONFIGURATOR

S80 sensors are available in five measurement types, (-0) a millivolt style for pH, ORP and ion selective measurements, (-1) dissolved oxygen style, (-2) contacting conductivity style, (-3) inductive conductivity style and (-4) resistivity style. Each style is available in a variety of materials and insertion lengths.

S80 Digital Sensor	
Measurement Type	
-0 S80 Digital Sensor, pH, ORP, pION measurement	
-1 S80 Digital Sensor, Dissolved Oxygen measurement	
-2 S80 Digital Sensor, Contacting Conductivity, 1µS to 50 mS	
-3 S80 Digital Sensor, Inductive Conductivity, 50 mS to 1000 mS	
-4 S80 Digital Sensor, Resistivity	
-5 S80 Diagnostic Sensor, pH, ORP, pION measurement SENTINEL S80 Sensor	
Sensor Style	
0 Insertion Style (Standard)	
1 Valve Retractable Style with flanged blow out protector	
Housing Material	
-0 Stainless Steel, ¾" O.D., (Standard)	
-1 Titanium, ¾" O.D.	
-2 Hastelloy, ¾" O.D.	
-4 Kynar, ¾" O.D., Inductive Conductivity Only	
-9 Other Material, Consult with Factory	
Housing Length	
0 10" length, ¾" O.D.	
1 17" length, ¾" O.D.	
2 24" length, ¾" O.D.	
3 30" length, ¾" O.D.	
4 36" length, ¾" O.D.	
Process Connection	
00 No Fitting or Valve Assembly	
01 (75) ¾" MNPT SS Fitting with Nylon Ferrule	
02 (75HT) ¾" MNPT, 316 SS gland, Teflon ferrule	
03 (75SF) ¾" MNPT, 316 SS gland, SST ferrule	
04 (75HC) ¾" MNPT, Hastelloy gland, Teflon ferrule	
05 (75TT) ¾" MNPT, Titanium gland, Teflon ferrule	
06 (75PP) ¾" MNPT, All Polypropylene gland fitting	
07 (75K) ¾" MNPT, All Kynar gland Fitting	
08 (75TFE) ¾" MNPT, All Teflon gland fitting	
29 Other Fittings, Consult Factory	
30 (VSS) 1" NPT 316 Stainless Steel Valve Retraction Assembly, nylon	
31 (VSSHT) 1" NPT 316 Stainless Steel Valve Retraction Assembly, Teflon	
32 (VSSSE) 1" NPT 316 Stainless Steel Valve Retraction Assembly Toroidal	
33 (VHC) 1" NPT Hastelloy Valve Retraction Assembly	
34 (VTT) 1" NPT Titanium Valve Retraction Assembly	
36 (VPP) 1" NPT All Poly Propylene Valve Retraction Assembly	
37 (VKY) 1" NPT All Kynar Valve Retraction Assembly	
59 Other Assemblies, Consult Factory	
80 1/1.5" Sanitary Flange, 316ss, Viton o-rings, nylon ferrule	
81 2" Sanitary Flange, 316ss, Viton o-rings, nylon ferrule	
82 2 ½" Sanitary Flange, 316ss, Viton o-rings, nylon ferrule	
99 Other Fittings, Consult Factory	
Cable Length	
-0 10 ft. (Standard)	
-2 20 ft.	
-3 30 ft.	
-4 40 ft.	
-5 50 ft.	
-A 100 ft.	

								"T" Handle 0 No "T" Handle 1 "T" Style handle, 3/4" polypro fitting 2 "T" Style handle, 3/4" stainless steel fitting 3 "T" Style handle with Lanyards Detachable Cable Connector 0 None 1 Straight (axial) Connector 2 Right Angle Connector O-rings Guard & Fittings 0 Viton Any/All 1 HF Viton Cond Guard 2 EPR Cond Guard 3 Kalrez Cond Guard 4 CV75 Cond Guard 5 HF Viton Valve & Fitting 6 EPR Valve & Fitting 7 Kalrez Valve & Fitting 9 CV-75 Valve & Fitting A HF Viton Grd & Val & Fit B EPR Grd & Val & Fit C Kalrez Grd & Val & Fit D CV-75 Grd & Val & Fit	
S80	-0	0	-0	0	01	-0	1	1	0

8.3 TRITON® DO80 SENSORS

DO80 Dissolved Oxygen Sensor			
	Sensor Style		
	-0	(I) Immersion Style Sensor - 3/4" MNPT Mounting Thread	
	-1	(IM) Immersion Style Sensor - G1 thread Mounting Thread	
	-2	(F) Flow Cell and Sensor - 3/4" FNPT entries	
	-3	(FM) Flow Cell and Sensor - 1" Slip entries	
	Spray Cleaner		
	00	No Spray Cleaner	
	01	(SC) Spray Cleaner	
	02	PVC Compression Fitting, DO80 to 1 1/4" MNPT	
	Cable Style		
	-0	Fixed Cable	
	-1	(DA) Axially Detachable Cable	
	Cable Length		
	00	No Cable	
	10	10 ft (3 meters)	
20	20 ft (6.1 meters)		
30	30 ft (9.1 meters)		
40	40 ft (12.2 meters)		
50	50 ft (15.2 meters)		
X0	Specify Length		
DO80	-1	00	-1 10

8.4 TRITON® TR6 SENSORS

TR6 Turbidity Suspended Solids Sensor		
	Optical Style	
	1	Front Mounted Optics, for use with Immersion assembly
	2	Side Mounted Optics, for use with Immersion assembly
	3	Side Mounted Optics, for use with Flow Through Cell
	Process Connection	
	0	None
	1	1" MNPT Nylon Gland Fitting
	2	Flow Through Cell, 2 x 2" FNPT entries, 1 x 1" FNPT sensor port
	Cable Type and Length	
	01	10 ft (3.0 meters) (Waterproof/Submersible Cable Style)

			02	20 ft (6.1 meters) (Waterproof/Submersible Cable Style)		
			03	30 ft (9.1 meters) (Waterproof/Submersible Cable Style)		
			04	10 ft (3.0 meters) (Water Resistant Cable Style)		
			05	20 ft (6.1 meters) (Water Resistant Cable Style)		
			06	30 ft (9.1 meters) (Water Resistant Cable Style)		
			Measurement Range			
			0	0-250 NTU and 0-1000 NTU		
1	0-500 NTU and 0-2000 NTU					
2	0-1000 NTU and 0-4000 NTU					
3	0-2000 NTU and 0-4000 NTU					
TR6	3	2	01	1		

8.3 S80 SENSOR MAINTENANCE

All electrochemical sensors require periodic cleaning and/or replacement. The life of an electrode is dependent on the process conditions it is exposed to, a pH electrode may last a year or longer in potable water and only a few weeks in a hot caustic bath. The chemical constituents in the process may coat the electrode surfaces requiring the electrode to be removed and cleaned or replaced.

Cleaning agents should be specific to the type of coating, detergents and alcohols for removing greases and oils, acids for removing hard water scales and metallic deposits or spray washing for flocculants and biofilms.

8.3.1 ELECTRODE CARTRIDGE INSTALLATION

Unless ordered separately, electrode cartridges are generally shipped installed in a sensor. Sensors ordered without an electrode are shipped with a shipping plug to keep contamination from getting inside the sensor during shipment or storage. The following procedure explains how to install the electrode cartridge in the sensor assembly:

1. Remove the shipping plug by turning it counterclockwise.
2. Remove the electrode cartridge from the protective soaker boot. *Be careful not to flex the electrode body while removing the tape and the protective boot.*
3. Rinse the electrode tip in tap water and wipe the electrode body dry then lubricate the o-ring seals with the included lubricant. *Save the protective soaker boot in the event the electrode must be stored at a future time.*
4. Carefully insert the electrode cartridge into the sensor assembly by turning until **hand tight**. The first o-ring, closest to the front of the electrode, will be slightly visible if held horizontally.

NOTE: IF EXCESS FORCE IS REQUIRED DURING ELECTRODE INSTALLATION, CHECK FOR PROPER THREAD ENGAGEMENT OR FOR AN OBSTRUCTION.

8.3.2 ELECTRODE CARTRIDGE REPLACEMENT

Periodic replacement of the electrode cartridge is required for pH, ORP and Specific Ion sensors. The following procedure explains how to replace the electrode cartridge in the sensor assembly:

1. Remove the electrode cartridge from the front of the sensor assembly by turning it counterclockwise.
2. For installation procedure follow steps 2, 3, and 4 in section 8.3.1 electrode cartridge installation.

8.3.3 ELECTRODE CLEANING

An important aspect of sensor maintenance is the service of the electrode cartridge. After being in operation, an electrode may begin to exhibit slow response or non-reproducible measurements. This may be due to coating of the measurement electrode or clogging of the reference junction. Regular electrode cleaning reduces problems associated with the coating and clogging. Frequency of cleaning will depend on the process and application. The following procedures are used to clean pH and ORP electrodes.

If possible, the electrode should be cleaned without removing it from the sensor body. However, if the electrode must be removed, the o-rings must be inspected and re-lubricated. See section 3.10.

8.3.4 PH ELECTRODE CARTRIDGE CLEANING

Remove the sensor from the process and carefully wash the wetted end of the electrode cartridge in a mild solution of detergent and water or with methyl alcohol. If the electrode response is not improved, soak the electrode in 0.1 Molar HCl for 5 minutes. Remove and rinse the electrode with tap water and soak in 0.1 Molar NaOH for 5 minutes.

Remove the electrode from the NaOH solution, rinse the electrode and soak in a 4 pH buffer solution for 10 minutes. This should improve the response of the electrode. If not, replace the electrode.

If the electrode must be left out of the process for an extended period of time, store it in a solution of water saturated with KCl or a 4.0 pH buffer solution. *ECD does not recommend the storage of electrodes in distilled or deionized water.*

8.3.5 ORP ELECTRODE CARTRIDGE CLEANING

Cleaning the platinum surface to remove coating can be done using an abrasive cleaner like 600-800 grit wet/dry sand paper or chemical reagents specific for the type of coating. Abrasive cleaning is the most common method of cleaning and is usually sufficient to restore the platinum surface; however, some processes can form a hard coating requiring chemical cleaning with a strong acid solution. Acid solutions greater than 10% are not recommended.

8.3.6 ION ELECTRODE CARTRIDGE CLEANING

Ion selective electrodes require periodic service. Weekly checks should be performed to assure the accuracy of the measurement.

The ion selective crystal that senses the ion concentration can become sluggish in response due to coating or reactions with the process solution. Periodic cleaning or polishing will minimize drift and maintain the sensors response.

CLEANING

The solid state crystal based electrodes, bromide, chloride, copper, cyanide, fluoride, silver, sulfide are fairly robust and can be cleaned with alcohols, detergents or dilute acids to remove coatings caused by greases, oils or films. A soft tooth brush or paper towel should be used to remove stubborn coatings. Do not clean with a wire brush. Metal carryover from the brush will compromise the measurement. Cleaning should be followed by polishing before calibrating the sensor.

The PVC membrane sensors, Ca⁺⁺, K⁺, NH₄⁺, NO₃⁻ are fragile membranes and should be cleaned using a soft artist style paint brush while rinsing with a stream of water. Dilute dish washing detergents can be used to remove oily films. Solvents or strong acid/alkaline solution will irreparably harm the electrode.

Calibration may be necessary after cleaning.

POLISHING

Abrasive polishing is only recommended for the solid state crystal style Combination Electrodes. ECD supplies two styles of abrasive cleaning kits, a package of light blue colored polishing strips or a small vial of 0.3 micron alumina powder with Q-tips with the fluoride electrodes.

The sensing surface of solid state electrodes can wear over time, which causes drift, poor reproducibility and loss of response in low level samples. The electrode can be restored by polishing the sensing surface with a polishing kit. The polishing kit can also be used if the sensing surface has been etched or chemically poisoned.

Fluoride Electrodes

- a. Moisten the end of the Q-tip with water and dip it in the alumina polishing powder to pick up a small amount of the powder.
- b. Rub the polishing powder onto the fluoride crystal in a circular motion and moisten the tip if necessary to produce a liquid consistency more than a paste.
- c. Polish the electrode for about 30 seconds and examine the tip for a shiny surface, repeat if necessary.
- d. Rinse the electrode with distilled water and soak the electrode in a low ppm Calibration solution for a few minutes.
- e. Perform a Two Point Calibration.

Other Solid State electrodes, Bromide, Cadmium, Chloride, Copper, Lead, Sulfide, Silver...

- a. Place a few drops of distilled water on the blue polishing strip to wet the polishing surface.
- b. Hold the electrode with the sensing surface facing up.
- c. Slide the polishing strip back and forth across the electrode tip, the sensing tip will be abraded and a new electrode surface will be generated.
- d. Polish the electrode for about 30 seconds and examine the tip for a shiny surface, repeat if necessary.
- e. Rinse the electrode with distilled water and soak the electrode in a low ppm Calibration solution for a few minutes.
- f. Perform a Two Point Calibration.

8.3.7 DISSOLVED OXYGEN CARTRIDGES

The Teflon membrane of the Dissolved Oxygen sensors is fragile and should be cleaned using a soft cloth or an artist style paint brush while rinsing with a stream of water. Dilute dish washing detergents can be used to remove oily films. Solvents are not recommended as they could diffuse through the membrane and harm the electrode. Strong acid/alkaline solutions should not harm the electrode but should only be used as a last resort before replacing the electrode.

8.3.8 TRITON DO80 DISSOLVED OXYGEN

The Triton DO80 sensor should receive maintenance on a regular basis. The maintenance interval should be determined empirically as it will depend on the installation conditions and the nature of the media being measured. The interval should be no greater than every two months.

Maintenance Procedure

The typical procedure would include;

- Cleaning the sensor (See section 5.2)
- Check the measuring function:
 - Remove the sensor from the medium.
 - Clean and dry the sensor/membrane.
 - After about 10 minutes in air, measure the oxygen saturation index (without recalibration).
 - The measured value should be at 100 ± 4 % SAT
- If necessary, replace a defective membrane or one which cannot be cleaned any more.
- Recalibration, if necessary.

Cleaning the Sensor

The fluorescence cap of the Triton DO80 sensor must be clean to ensure an accurate measurement. The measurement will degrade as the fluorescence cap gets coated. Build-up of material on the cap will increase the response time and decrease the slope. The sensor should be cleaned on a regular basis and before every calibration.

***** Do Not Scrub the Sensing Portion of the Cap with any abrasive material, use only a soft sponge or cloth and water to clean the tip*****

The cleaning method depends on the nature of the coating. For insoluble mineral or salt deposits, the sensor should be soaked in a 1-5 % solution of HCl, hydrochloric acid, for no more than 10 minutes. After this acid treatment rinse the sensor with copious amounts of tap water and then allow it to soak in the tap water for at least 5 minutes before evaluating the performance. Repeat if necessary.

For biological films or dirt, rinse the tip with tap water and gently wipe the sensing surface with a soft sponge or cloth.

Cleaning Internal Optics

The internal optical surface should only need cleaning if the Fluorescence Cap is broken or defective. The following steps should be followed in the case of a leaking cap.

1. Unscrew the protective guard and the fluorescence cap from the sensor head.
2. Carefully clean the optical surface with a soft cloth and water until the buildup is fully removed.
3. Use only drinking or distilled water to clean the optics, do not scratch the optical surface.
4. Dry the optics with a soft lint free cloth and screw on a new fluorescence cap.

8.3.8.1 Replacing the Fluorescent Cap

The Fluorescence Cap (P/N 2500207) can provide up to two years service, if damaged or when it expires, it is easily replaced.

Removing the Old Fluorescence Cap

- Remove the sensor from the medium.
- Unscrew the protection guard.
- Clean the outside of the sensor.
- Unscrew the fluorescence cap.
- Clean and dry the optical surface if necessary.

Installing the New Fluorescence Cap

- Make sure that there are no dirt particles on the sealing surface.
- Visually inspect the sealing o-ring, replace if necessary. (P/N 1000225)
- Carefully screw the fluorescence cap onto the sensor head until the stop.
- Screw the protection guard back on.

***** After replacing the Fluorescence Cap the sensor must be calibrated. *****

8.3.9 TRITON TR6 TURBIDITY

The TR6 turbidity sensors don't require periodic service except in coating applications. Quarterly checks should be performed to assure the accuracy of the measurement.

The TR6 response can become sluggish due to coating from materials in the process solution. Periodic cleaning will minimize drift and maintain the sensors response.

CLEANING

The most important maintenance item is keeping the optically clear epoxy window clean. The TR6 turbidity sensors are fairly robust and can be cleaned with alcohols, detergents or dilute acids to remove coatings caused by greases, oils or films. **Do not use solvents such as MEK, Toluene, Acetone, or trichloroethylene on TR6 sensors.** A soft tooth brush or paper towel should be used to remove soft coatings. A Scotch Brite scouring pad works well for most types of stubborn window fouling. First wet the pad and then place it on a counter with a plastic-laminate top so that the side of the pad is aligned with the edge of the counter. Work the window of the TR6 sensor back and forth on the pad until it is clean while removing as little epoxy as possible. If encrusting organisms such as barnacles or tube worms have attached to the sensor, it will have to be gently scraped with a flexible knife blade prior to using the pad.

POLISHING

Some applications will result in pitting of the sensor face. Pits can be removed with abrasive cloth. Polish the sensor window as follows:

- 1) Tape a strip of 400 grit wet-or-dry abrasive cloth to the edge of a counter.
- 2) Add a few drops of water to the abrasive and work the sensor window in smooth one-way strokes on the cloth using the counter edge as a guide.
- 3) Continue until the sensor is shiny and pit free.

It is **important to remove as little epoxy as possible.**

8.4 S80 SENSOR SPECIFICATIONS

Dimensions:

S80 - ¾"OD x 10" Length, optional lengths, 17", 24", 30", 36" in 6" increments to 8 ft.

Cable Length:

10 ' standard, Optional lengths in 10 ' increments

4 conductors shielded

Housing Materials:

Standard, 316 Stainless Steel, Optional, Titanium (T), grade 2, Hastelloy (H), C-22, PVDF (K),

O-Ring Materials:

Viton™ (VIT), Standard, Ethylene Propylene (EPR), Optional, Fluoro-silicone (FSIL), Optional, Silicone (SIL),

Optional, KALREZ™ (KLZ), Optional, CV75 (CV), Optional

Process Connections:

- 75 ¾" 316 SS gland fitting with nylon ferrule
- 75PP ¾" poly propylene gland fitting with ferrule
- 75SF ¾" 316 SS gland fitting with stainless steel ferrule
- 75TFE ¾" Teflon™ gland fitting with Teflon™ ferrule
- 100 1" Teflon™ glands fitting for PVDF housing only
- VSS 1" 316 SS valve retraction assembly
- VKY 1" PVDF valve retraction assembly

Shipping Weight:

S80 2.5 lbs (1.2 kg)

S80 with VSS 5.8 lbs (2.65 kg)

8.4.1 PH ELECTRODES

Part#	Description	pH Range	Temperature	Max. Pressure
2005005-HPW	High Purity Water, RADEL Body, dbl jct TFE Ref, Full bulb pH glass,	2-12 pH	-10°-90°C	150 psig
2005145	General Purpose, RADEL body, dbl jct TFE Ref, Flat pH glass,	0-14 pH	-10°-90°C	150 psig
2005146	General Purpose, PEEK body, dbl jct ceramic Ref, Flat pH glass,	0-14 pH	-10°-90°C	150 psig
2005148	Non aqueous service, RADEL body, dbl jct TFE Ref, Flat pH glass,	0-14 pH	-10°-90°C	150 psig
2005157	Hi Temp/ Hi pH, PEEK body, dbl jct TFE Ref, Hemi pH glass,	0-14 pH	0°-130°C	150 psig
2005059	Recessed Bulb, RADEL Body, dbl jct TFE Ref, Hemi pH glass,	0-14 pH	-10°-90°C	150 psig
2005066	Chemical Resistant, PEEK body, triple jct TFE Ref, Flat pH glass,	0-14 pH	0°-130°C	150 psig
2005169	Chemical Resistant, PEEK body, dbl jct TFE Ref, Hemi pH glass,	0-14 pH	0°-130°C	150 psig
2005130	Sulfide Resistant, PEEK body, triple jct TFE Ref, Hemi pH glass,	0-14 pH	0°-130°C	150 psig
2005150	Solvent Resistant, PEEK body, dbl jct TFE Ref, Flat pH glass,	0-14 pH	-10°-90°C	150 psig

2005103	Fluoride resistant, Peek body, Rugged pH glass, dbl jct TFE Ref,	0-14 pH	-10°-90°C	150 psig
2005013	pH, antimony, RADEL body, TFE junction	3-10 pH	10°-50°C	150 psig

8.4.2 ORP ELECTRODES

Part#: 2005167 (2005367 SENTINEL)

ORP sensor: Platinum

Construction: PEEK body,

Reference Electrode: double porous Teflon junction

Measurement Range: -1500 mV - +1500 mV

Temperature Range: -10° - 80°C

Pressure Range: 150 psig

8.4.3 DISSOLVED OXYGEN

Part#: 2005622

2 mil Teflon membrane

Galvanic cell: Silver/Lead

Construction: PEEK body,

Measurement Range: 0-20 ppm

Temperature Range: -10° - 130°C

Pressure Range: 30 psig

8.4.4 AMMONIUM ELECTRODE

Part #: 2005083 (2005383 SENTINEL)

ISE sensor: PVC membrane

Construction: Radel (PES) body,

Reference Electrode: double porous Teflon junction

Measurement range: 0.05 - 18,000 ppm

pH Range: 2-10 pH

Temperature Range: 0°- 40°C

Pressure Range: 50 psig

8.4.5 BROMIDE ELECTRODE

Part #: 2005062 (2005362 SENTINEL)

ISE sensor: solid state AgS/AgBr membrane

Construction: Radel (PES) body,

Reference Electrode: double porous Teflon junction

Measurement range: 0.1 - 80,000 ppm

pH Range: 2-12 pH

Temperature Range: 0°-50°C

Pressure Range: 150 psig

8.4.6 CALCIUM ELECTRODE

Part #: 2005043 (2005343 SENTINEL)

ISE sensor: PVC membrane

Construction: Radel (PES) body,

Reference Electrode: double porous Teflon junction

Measurement range: 0.1 - 40,000 ppm

pH Range: 2.5 - 10 pH

Temperature Range: 0°-40°C

Pressure Range: 50 psig

8.4.7 CHLORIDE ELECTRODE

Part #: 2005008 (2005308 SENTINEL)

ISE sensor: solid state AgS/AgCl membrane

Construction: Radel (PES) body,

Reference Electrode: double porous Teflon junction

Measurement range: 2 - 35,000 ppm

pH Range: 2-12 pH

Temperature Range: 0°-80°C

Pressure Range: 150 psig

8.4.8 CUPRIC ELECTRODE

Part #: 2005058 (2005358 SENTINEL)

ISE sensor: solid state CuS membrane

Construction: Radel (PES) body,

Reference Electrode: double porous Teflon junction

Measurement range: 1 ppb – 6,300 ppm

pH Range: 2 - 8 pH

Temperature Range: 0°-80°C

Pressure Range: 150 psig

8.4.9 CYANIDE ELECTRODE

Part #: 2005042 (2005342 SENTINEL)

ISE sensor: solid state AgS/AgCN membrane

Construction: Radel (PES) body,

Reference Electrode: double porous Teflon junction

Measurement range: 0.1- 260 ppm

pH Range: 11-13 pH

Temperature Range: 0°-80°C

Pressure Range: 150 psig

8.4.10 FLUORIDE ELECTRODE

Part #: 2005163 (2005363 SENTINEL)

ISE sensor: solid state LaF crystal

Construction: PEEK body,

Reference Electrode: double porous Teflon junction

Measurement range: 0.02 - 2,000 ppm

pH Range: 5-8 pH

Temperature Range: 0°- 80°C

Pressure Range: 50 psig

8.4.11 POTASSIUM ELECTRODE

Part #: 2005034 (2005334 SENTINEL)

ISE sensor: PVC membrane

Construction: Radel (PES) body,

Reference Electrode: double porous Teflon junction

Measurement range: 0.1- 40,000 ppm

pH Range: 2-12 pH

Temperature Range: 0°-40°C

Pressure Range: 50 psig

8.4.12 SILVER ELECTRODE

Part #: 2005016 (2005316 SENTINEL)

ISE sensor: solid state AgS membrane

Construction: PEEK body,

Reference Electrode: double porous Teflon junction

Measurement range: 0.1-107,000 ppm

pH Range: 2-14 pH

Temperature Range: 0°-80°C

Pressure Range: 150 psig

8.4.13 SODIUM ELECTRODE

Part #: 2005031 (2005331 SENTINEL)

ISE sensor: Sodium selective Glass membrane

Construction: PEEK body,

Reference Electrode: double porous Teflon junction

Measurement range: 0.2 - 23,000 ppm

pH Range: 2-14 pH (pH must be 3 units higher than pNa)

Temperature Range: 0°-80°C

Pressure Range: 150 psig

8.4.14 SULFIDE ELECTRODE

Part #: 2005122 (2005322 SENTINEL)

ISE sensor: solid state AgS membrane

Construction: PEEK body,

Reference Electrode: double porous Teflon junction

Measurement range: 0.01 - 32,000 ppm

pH Range: 11-14 pH

Temperature Range: 0°-80°C

Pressure Range: 150 psig

8.4.15 TRITON® DO80

Measurement Range: 0 - 20 mg/l (0 - 20 ppm)

0 - 200 % Saturation

0 - 400 mbar (0 - 6 psi)

Pressure Range: Maximum Pressure 10 bar (159 psi)

Temperature Range: -5° - 50°C (20° - 120°F) Measuring

-20° - 60°C (0° - 140°F) Ambient

Response Time: T90 = 60 sec

Accuracy: Max. Error < 2 % of measured range

Repeatability: ±0.5 % of measured range

Resolution: 0.01 ppm or 0.01 % Saturation

Operating Lifetime of Sensor Cap: Up to 2 years in recommended service, typically > 1 year

Wetted Materials: 316 SS, POM, PVC, Silicone

Sensor Cable: Shielded 7 core cable, 7 meter (23 ft) or 15 meter (49 ft) lengths

Process Connection: G1 Thread (¾" FNPT adapter available)

Maximum Cable Length: 100 m maximum from C-22 controller

Dimensions: Length 8.7" (220 mm), Diameter 1.6" (40 mm)

Weights: Cable length 7 m (23 ft): 0.7 kg (1.5 lbs)
Cable length 15 m (49 ft): 1.1 kg (2.4 lbs)

8.4.16 TRITON® TR6

Measuring principle:

Particle caused back scattering of 850 nm near infrared light with sunlight rejection filter

Measuring Range:

-1 Sensor

0.0 ... 250.0 NTU, FNU & 0 ... 1000 NTU, FNU

-2 Sensor

0.0 ... 500.0 NTU, FNU & 0 ... 2000 NTU, FNU

-3 Sensor

0 ... 1000 NTU, FNU & 0 ... 4000 NTU, FNU

-4 Sensor

0 ... 2000 NTU, FNU & 0 ... 4000

NTU, FNU ppm, mg/L and %solids to equivalent NTU value

Accuracy:

2% of reading or 0.5 NTU, whichever is larger

Process Temperature Range:

-5 ... 50°C

Temperature Compensation:

Internal Temperature compensation

Process pressure range:

50 psi maximum in Flow Cell

500meter submersion depth (50 bar, 725 psi)

Vacuum operation is not permitted

Drift:

< 1% / month

Wetted Materials

Sensor body: stainless steel AISI 316 Ti

Sensing end: epoxy

Process Connection:

1" NPT Nylon compression fitting

Electrical connection

Waterproof 5-wire measuring cable or

Water Resistant 5-wire measuring cable (Standard)

Cable Length:


10ft. (3.0 m), 20ft (6.1 m), 30ft (9.1 m) cables

APPENDIX

A. AUTO CAL BUFFER TABLES

°C	pH	pH	pH
0	4.00	7.115	10.32
5	4.00	7.085	10.25
10	4.00	7.06	10.18
15	4.00	7.04	10.12
20	4.00	7.015	10.06
25	4.005	7.00	10.01
30	4.015	6.985	9.97
35	4.025	6.98	9.93
40	4.03	6.975	9.89
45	4.045	6.975	9.86
50	4.06	6.97	9.83
55	4.075	6.97	
60	4.085	6.97	
65	4.10	6.98	
70	4.13	6.99	
75	4.14	7.01	
80	4.16	7.03	
85	4.18	7.05	
90	4.21	7.08	

B. T80 HART MENU

T80 Root Menu						
1 DEVICE SETUP 	DEVICE SETUP	CALIBRATION				
	1 CALIBRATION	1 AUTO				
		2 STANDARDIZE				
		3 MANUAL				
		4 TEMP				
	2 BASIC SETUP	CONFIG				
		1 XMTR	XMTR CONFIG	ANALOG CONFIG		
			1 ANALOG	1 SCALE	ANALOG SCALE	
					1 UPPER	
					2 LOWER	
				2 PID	PID CONFIG	
					1 P Term	
					2 I Term	
			3 CALIBRATE	CALIBRATE		
				1 Zero cal		
	2 Gain cal					
	3 Save					
	2 ALARMS	ALARM CONFIG				
1 Alrm 1 thresh						
2 Alrm 1 hyst						

				3 Alarm 1 dly on					
				4 Alarm 1 dly off					
				5 Alarm 2 thresh					
				6 Alarm 2 hyst					
				7 Alarm 2 dly on					
				8 Alarm 2 dly off					
				9 Alarm 3 thresh					
				10 Alarm 3 hyst					
				11 Alarm 3 dly on					
				12 Alarm 3 dly off					
		3 Address							
	2 Device information	DEVICE INFORMATION			1 Distributor				
					2 Model				
					3 Dev ID				
					4 Cfg chng count				
					5 Tag				
					6 Long tag				
					7 Date				
					9 Descriptor				
					10 Message				
11 Final asbly num									
3 INFORMATION	INFORMATION								
				1 XMTR	XMTR INFO			1 Serial #	
								2 FW Rev	
								3 HW Rev	
								4 Fld dev rev	
				2 SENSOR	SENSOR INFO			1 Serial #	
								2 FW Rev	
								3 HW Rev	
				3 DEVICE	DEVICE INFORMATION			1 Distributor	
								2 Model	
								3 Dev ID	
								4 Cfg chng count	
								5 Tag	
6 Long tag									
7 Date									
9 Descriptor									
10 Message									
11 Final asbly num									
2 PV									
3 Temperature									
4 Output %									
5 Sensor Name									

C. TEXT/ICON LEGEND

The Text button is paired with its corresponding Icon Button

4-20			HOME			RLY2			RAMP TIME	
ADDRESS			INFO			RLY3			RUN TIME	
ALARM			ISO PT			SCALE			CAL1	
AUTO			LABELS			SENSOR			CAL2	
BACK			LCD			SERIAL	0101			
BACK LIGHT			LEGEND			SETUP				
BAR			LINE			SIM				
BAUD			LOAD DEFAULT			STAND				
BRITE			LOOP			SYS				
CAL			MANUAL			T COMP				
CANCEL			mU			TAG				
CHANGE			NEXT			TAG ON				
CONFIG			NO			TEMP				
CONT			OFF			TEMP FORMAT				
DISABLE			OK			TIME				
DUTY			ON			TYPE				
ENTER			OUTPUT			VALUE	#			
EXIT			PASSWD			XMTR				
FAULT			POPUP			YES				
FIXED			RAMP							
FORMAT			RANGE							
GAUGE			RELAYS							
GRAPH			RESET							
HOLD			RLY1							

MODBUS RTU REGISTER LISTING

03 (0x03) READ HOLDING REGISTERS

This function code is used to read the contents of a contiguous block of holding registers in a remote device. The Request Protocol Data Unit specifies the starting register address and the number of registers. In the Protocol Data Unit Registers are addressed starting at zero. Therefore registers numbered 1-16 are address as 0-15.

The register data in the response message are packed as to bytes per register, with the binary contents right justified within each byte. For each register, the first byte contains the high order bits and the second contains the low order bits.

Request

Modbus ID (Slave Address)	1 Byte	1 to 247 (0x01 to 0xF7)
Function code	1 Byte	0x03
Starting Address	2 Bytes	0x0000 to 0xFFFF
Quantity of Registers	2 Bytes	1 to 125 (0x01 to 0x7D)
CRC	2 Bytes	calculated

Response

Modbus ID (Slave Address)	1 Byte	1 to 247 (0x01 to 0xF7)
Function code	1 Byte	0x03
Byte Count	1 Byte	2 X N*
Register Value(s)	*N X 2 Bytes	
CRC	2 Bytes	calculated
*N = Quantity of Registers		

Error

Modbus ID (Slave Address)	1 Byte	1 to 247 (0x01 to 0xF7)
Error Code	1 Byte	0x86
Exception Code	1 Byte	01, 02, 03 or 04
CRC	2 Bytes	calculated

06 (0x06) WRITE SINGLE REGISTER

This function code is used to write a single holding register in a remote device.

The Request Protocol Data Unit specifies the address of the register to be written. Registers are addressed starting at zero. Therefore register number 1 is addressed as 0.

The normal response is an echo of the request, returned after the register contents have been written.

Request

Modbus ID (Slave Address)	1 Byte	1 to 247 (0x01 to 0xF7)
Function code	1 Byte	0x06
Register Address	2 Bytes	0x0000 to 0xFFFF
Register Value	2 Bytes	0x0000 to 0xFFFF
CRC	2 Bytes	calculated

Response

Modbus ID (Slave Address)	1 Byte	1 to 247 (0x01 to 0xF7)
Function code	1 Byte	0x06
Register Address	2 Bytes	0x0000 to 0xFFFF

Register Value	2 Bytes	0x0000 to 0xFFFF
CRC	2 Bytes	calculated

*N = Quantity of Registers

Error

Modbus ID (Slave Address)	1 Byte	1 to 247 (0x01 to 0xF7)
Error Code	1 Byte	0x86
Exception Code	1 Byte	01, 02, 03 or 04
CRC	2 Bytes	calculated

REGISTERS

Per the Modbus Application Protocol Specification (V1.1b)

Name	Meaning (2 bytes each register)	Number of Registers	Return Data Format	Read Write	Requires Storage Initiate	Register #	
						dec	hex
Modbus ID (slave address)	Defined as 1 to 247 per the Modbus Application Protocol Specification (V1.1b)	1	16 bit Integer	RW		0	00
Data Format	Data Format of the User Bus to the T80 (0-DF8N2, 1-DF8O1, 2-DF8E1, 3-DF8N1)	1	16 bit Integer	RW		1	01
Baud Rate	Baud Rate of the User Bus to the T80 (0-1200, 1-2400, 2-4800, 3-9600)	1	16 bit Integer	RW		2	02
BusMessage	total message count detected by the slave (remote device)	1	16 bit Integer	R		3	03
BusCommunicationsError	total CRC error count	1	16 bit Integer	R		4	04
SlaveExceptionError	total count of exceptions detected	1	16 bit Integer	R		5	05
SlaveMessage	total messages addressed to the slave (remote device)	1	16 bit Integer	R		6	06
SlaveNoResponse	total count of messages not responded to by the slave (remote device)	1	16 bit Integer	R		7	07
SlaveNAK	total Negative Acknowledges returned by slave (remote device)	1	16 bit Integer	R		8	08
SlaveBusy	total count of "slave busy" was returned for an address message	1	16 bit Integer	R		9	09
BusCharacterOverrun	count of messages that couldn't be handled due to character over-run condition	1	16 bit Integer	R		10	0A
Reset all Modbus Error Counters	Resets all of the Modbus Error counters (defined in Modbus spec) to 0, Write any value.	1	16 bit Integer	W		11	0B
Product T80 Model Number (Modbus)	The Model Number of the Unit polled	1	16 bit Integer	R		12	0C
T80 Serial Number (hi word)	Unit Serial Number (32 bit integer hi word, bytes 3 and 2)	2	32 bit Long Integer	R		13	0D
T80 Serial Number (lo word)	Unit Serial Number (32 bit integer lo word, bytes 1 and 0)					14	0E
T80 Mode	Unit operating mode (1-Startup, 2-Sensor Search, 3-Operate)	1	16 bit Integer	R		15	0F
T80 Fault Status	Unit Fault flags, bit defined	1	16 bit Integer	R		16	10
T80 2nd Fault Status	Unit Fault flags (2nd word reserved, currently not used)	1	16 bit Integer	R		17	11
T80 Warning Status	Unit Warning flags, bit defined	1	16 bit Integer	R		18	12
T80 2nd Warning Status	Unit Warning flags (2nd word reserved, currently not used)	1	16 bit Integer	R		19	13
T80 FW Rev	Firmware revision of the Control BD in ASC, ex. " 1".	1	16 bit Integer	R		20	14
Relay Number to read/write	Relay number to access data (0 - Relay 1, 1 - Relay 2, 2 - Relay 3)	1	16 bit Integer	RW		21	15
Relay Type	Read/Write Relay Type (0 - Fault Type, 1 - Alarm Type, 2 - Disabled, 3 - Timed)	1	16 bit Integer	RW	Y	22	16

Relay ON Setpoint (hi word)	Read/Write Relay ON Setpoint (byte 3 and byte 2)	2	32 bit Floating Point	RW	Y	23	17
Relay ON Setpoint (lo word)	Read/Write Relay ON Setpoint (byte 1 and byte 0)					24	18
Relay OFF Setpoint (hi word)	Read/Write Relay OFF Setpoint (byte 3 and byte 2)	2	32 bit Floating Point	RW	Y	25	19
Relay OFF Setpoint (lo word)	Read/Write Relay OFF Setpoint (byte 1 and byte 0)					26	1A
Relay ON Delay (hi word)	Read/Write Relay turn on Delay time (byte 3 and byte 2)	2	32 bit Floating Point	RW	Y	27	1B
Relay ON Delay (lo word)	Read/Write Relay turn on Delay time (byte 1 and byte 0)					28	1C
Relay OFF Delay (hi word)	Read/Write Relay turn off Delay time (byte 3 and byte 2)	2	32 bit Floating Point	RW	Y	29	1D
Relay OFF Delay (lo word)	Read/Write Relay turn off Delay time (byte 1 and byte 0)					30	1E
Relay Energized State	Read/Write Relay 0 - Energized, 1 - De-Energized	1	16 bit Integer	RW	Y	31	1F
Relay Expiration	Read/Write Expiration Time, used with alarm type (0 - None, 2 - 5min., 3 - 10min., 4 - 15min., 6 - 30min.)	1	16 bit Integer	RW	Y	32	20
Relay Period	Read/Write Timed Relay Period (0 - 15min., 1 - 30min., 2 - 1hr., 3 - 2hr., 4 - 4hr., 5 - 8hr., 6 - 24hr.)	1	16 bit Integer	RW	Y	33	21
Relay Duration	Read/Write Timed Relay Duration (0 - 15sec., 1 - 30sec., 2 - 1min., 3 - 2min., 4 - 5min., 5 - 15min., 6 - 10min.)	1	16 bit Integer	RW	Y	34	22
Relay Hold Time	Read/Write Timed Relay Hold Time (0 - Off, 1 - held for the duration time, 2 - duration + 15sec., 3 - duration + 30sec., 4 - duration + 1min., 5 - duration + 2min., 6 - duration + 5 min., 7 - duration + 15min., 8 - duration + 30min.)	1	16 bit Integer	RW	Y	35	23
4-20 mA Channel Number to read/write	4-20 mA channel number to access data (0 - 1st 4-20mA, 1 - 2nd 4-20)	1	16 bit Integer	RW	Y	36	24
4-20 Analog Type	Read/Write 4-20 Type (0 - Range, 1 - Temperature, 2 - Sentinel)	1	16 bit Integer	RW	Y	37	25
4-20 Analog Range, 4mA range (hi word)	Read/Write 4mA range (bytes 3 and 2) applies to both range and temperature types	2	32 bit Floating Point	RW	Y	38	26
4-20 Analog Range, 4mA range (lo word)	Read/Write 4mA range (bytes 1 and 0) applies to both range and temperature types					39	27
4-20 Analog Range, 20mA range (hi word)	Read/Write 4mA range (bytes 3 and 2) applies to both range and temperature types	2	32 bit Floating Point	RW	Y	40	28
4-20 Analog Range, 20mA range (lo word)	Read/Write 4mA range (bytes 1 and 0) applies to both range and temperature types					41	29
Long Tag Line number to read/write	Tag Line number to access data (0 - Line 1, 1 - Line 2)	1	16 bit Integer	RW	Y	42	2A
Long Tag Line 1 (16 characters max)	ASCII character bytes 0 and 1, ex. "AB" A - 65 (41 hexadecimal), B - 66 (42 hex), send 6566 (4142 hex). The characters permitted are space ' ' (32 base 10, 20 hex) through '}' 125 base 10, 7D hex).	1	16 bit Integer	RW	Y	43	2B
Long Tag Line	ASCII bytes 2 and 3	1	16 bit Integer	RW	Y	44	2C
Long Tag Line	ASCII bytes 4 and 5	1	16 bit Integer	RW	Y	45	2D
Long Tag Line	ASCII bytes 6 and 7	1	16 bit Integer	RW	Y	46	2E
Long Tag Line	ASCII bytes 8 and 9	1	16 bit Integer	RW	Y	47	2F
Long Tag Line	ASCII bytes 10 and 11	1	16 bit Integer	RW	Y	48	30
Long Tag Line	ASCII bytes 12 and 13	1	16 bit Integer	RW	Y	49	31
Long Tag Line	ASCII bytes 14 and 15	1	16 bit Integer	RW	Y	50	32
Initiate T80 Parameter Storage	Signals the user has completed entering the data and wants it stored. Write any value.	1	16 bit Integer	RW		51	33
Sensor Channel to read/write	Sensor channel number to access data (0 - Sensor 1, 1 - Sensor 2)	1	16 bit Integer	RW		52	34
S80 Mode	Unit operating mode (0-	1	16 bit Integer	R		53	35

S80 Serial Number (hi word)	Unit Serial Number (32 bit integer hi word)	2	32 bit Long Integer	R		54	36
S80 Serial Number (lo word)	Unit Serial Number (32 bit integer lo word)					55	37
S80 Fault Status		1	16 bit Integer	R		56	38
S80 Sensor Type	Specific S80 sensor type (see S80 Sensor Types tab)	1	16 bit Integer	R		57	39
S80 Sensor Chemical Type	Specific chemicals the S80 is set to detect (see S80 Sensor Types tab)	1	16 bit Integer	RW	Y	58	3A
S80 Max Range (hi word)	Max sensor range (bytes 3 and 2)	2	32 bit Floating Point	R		59	3B
S80 Max Range (lo word)	Max sensor range (bytes 1 and 0)					60	3C
S80 Min Range (hi word)	Min sensor range (bytes 3 and 2)	2	32 bit Floating Point	R		61	3D
S80 Min Range (lo word)	Min sensor range (bytes 1 and 0)					62	3E
S80 Sensor Value (hi word)	Current sensor value (bytes 3 and 2)	2	32 bit Floating Point	R		63	3F
S80 Sensor Value (lo word)	Current sensor value (bytes 1 and 0)					64	40
S80 Sensor Voltage (hi word)	Corresponding sensor voltage to the sensor value (byte 3 and byte 2)	2	32 bit Floating Point	R		65	41
S80 Sensor Voltage (lo word)	Corresponding sensor voltage to the sensor value (byte 1 and byte 0)					66	42
S80 Sensor Temperature (hi word)	Sensor Temperature (bytes 3 and 2)	2	32 bit Floating Point	R		67	43
S80 Sensor Temperature (lo word)	Sensor Temperature (bytes 1 and 0)					68	44
S80 Sensor is a Sentinel	Sensor is a Sentinel Type (0 - No, 1 - Yes)	1	16 bit Integer	R		69	45
S80 Sentinel Life %	% of Sensor life remaining	1	16 bit Integer	R		70	46
S80 Sentinel Vs (hi word)	Scaled Sentinel Voltage (in mV) normalized to Vo (bytes 3 and 2)	2	32 bit Floating Point	R		71	47
S80 Sentinel Vs (lo word)	Scaled Sentinel Voltage (in mV) normalized to Vo (bytes 1 and 0)					72	48
S80 Sentinel Vo (hi word)	Sentinel 100% value (in mV) on the life relative to 0V (bytes 3 and 2)	2	32 bit Floating Point	RW	Y	73	49
S80 Sentinel Vo (lo word)	Sentinel 100% value (in mV) on the life relative to 0V (bytes 1 and 0)					74	4A
S80 Sentinel Range (hi word)	Sentinel Range (bytes 3 and 2)	2	32 bit Floating Point	RW	Y	75	4B
S80 Sentinel Range (lo word)	Sentinel Range (bytes 1 and 0)					76	4C
Sensor Full Name (18 characters max)	ASCII character bytes 0 and 1, ex. "AB" A - 65 (41 hexadecimal), B - 66 (42 hex), send 6566 (4142 hex). The characters permitted are space ' ' (32 base 10, 20 hex) through '}' 125 base 10, 7D hex).	1	16 bit Integer	RW	Y	77	4D
Sensor Full Name	ASCII bytes 2 and 3	1	16 bit Integer	RW	Y	78	4E
Sensor Full Name	ASCII bytes 4 and 5	1	16 bit Integer	RW	Y	79	4F
Sensor Full Name	ASCII bytes 6 and 7	1	16 bit Integer	RW	Y	80	50
Sensor Full Name	ASCII bytes 8 and 9	1	16 bit Integer	RW	Y	81	51
Sensor Full Name	ASCII bytes 10 and 11	1	16 bit Integer	RW	Y	82	52
Sensor Full Name	ASCII bytes 12 and 13	1	16 bit Integer	RW	Y	83	53
Sensor Full Name	ASCII bytes 14 and 15	1	16 bit Integer	RW	Y	84	54
Sensor Full Name	ASCII bytes 16 and 17	1	16 bit Integer	RW	Y	85	
Sensor Abbreviated Name (8 characters max)	ASCII character bytes 0 and 1, ex. "AB" A - 65 (41 hexadecimal), B - 66 (42 hex), send 6566 (4142 hex). The characters permitted are space ' ' (32 base 10, 20 hex) through '}' 125 base 10, 7D hex).	1	16 bit Integer	RW	Y	86	56
Sensor Abbreviated Name	ASCII bytes 2 and 3	1	16 bit Integer	RW	Y	87	57

Sensor Abbreviated Name	ASCII bytes 4 and 5	1	16 bit Integer	RW	Y	88	58
Sensor Abbreviated Name	ASCII bytes 6 and 7	1	16 bit Integer	RW	Y	89	59
Initiate S80 Storage	Signals the user has completed entering the data and wants it stored. Write any value.	1	16 bit Integer	W		90	5A
Cal log number to read	Cal log number to read (0 - Cal Log 1, 1 - Cal Log 2, 2 - Cal Log 3)	1	16 bit Integer	RW		91	5B
S80 Cal Log slope (hi word)	(bytes 3 and 2)	2	32 bit Floating Point	R		92	5C
S80 Cal Log slope (lo word)	(bytes 1 and 0)					93	5D
S80 Cal Log offset (hi word)	(bytes 3 and 2)	2	32 bit Floating Point	R		94	5E
S80 Cal Log offset (lo word)	(bytes 1 and 0)					95	5F
S80 Cal Log offset Voltage (hi word)	(bytes 3 and 2)	2	32 bit Floating Point	R		96	60
S80 Cal Log offset Voltage (lo word)	(bytes 1 and 0)					97	61

FAULT STATUS

Bit #	bit meaning
0	Memory Error, either a Program Flash, RAM or NVM RAM checksum error has occurred
1	Input Voltage Out Of Tolerance
2	The On Board +12V is Out of Tolerance
3	The On Board +3.3V is Out of Tolerance
4	The Transmitter has lost communication link with the Sensor
5	There is no Sensor connected
6	Sensor Calibration Failed
7	Relay 1 on-time expired
8	Relay 2 on-time expired
9	Relay 3 on-time expired
10	Sentinel Error (useable life has expired)
11	Sentinel Poisoned
12	Membrane Error
13	NU
14	NU
15	NU

WARNING STATUS

Bit #	bit meaning
0	The Sensor has changed from previously connect Sensor
1	Not Used (NU)
2	NU
3	NU
4	NU
5	NU
6	NU
7	NU
8	NU
9	NU
10	NU
11	NU
12	NU
13	NU
14	NU
15	NU

SENSOR TYPE

Data		Meaning		
Decimal	Hexadecimal	Chemical	Sensor Type	Measurement Units
0	0000	Unknown Chemical	None	None
1	0001	Ammonia	mV	ppm
2	0002	Ammonium	mV	ppm
3	0003	Bromide	mV	ppm
4	0004	Calcium	mV	ppm
5	0005	Chloride	mV	ppm
6	0006	Conductivity	Conductivity	S
7	0007	Cupric	mV	ppm
8	0008	Cyanide	mV	ppm
9	0009	DO	mV	ppm
10	000A	DO	mV	% saturation
11	000B	DO	mV	mg/L
12	000C	Fluoride	mV	ppm
13	000D	Hardness (CaCO ₃)	mV	ppm
14	000E	Nitrate	mV	ppm
15	000F	ORP	mV	mVa
16	0010	pH	mV	none
17	0011	Potassium	mV	ppm
18	0012	Resistivity	Conductivity	Ohm (W)
19	0013	Silver	mV	ppm
20	0014	Sodium	mV	ppm
21	0015	Sulfide	mV	ppm
22	0016	Turbidity	TR6	FNU
23	0017	Turbidity	TR6	NTU
24	0018	Turbidity	TR6	ppm
25	0019	Turbidity	TR6	mg/L
26	001A	Turbidity	TR6	% solid
27	001B	DO	DO80	ppm
28	001C	DO	DO80	% saturation
29	001D	DO	DO80	mg/L
30	001E	Calcium	mV	mg/L
31	001F	TDS	Conductivity	ppm
32	0020	Nitrite	mV	ppm
33	0021	TCA (max range)	TCA	mg/L
34	0022	TCA (min range)	TCA	mg/L
35	0023	FCA (max range)	FCA	mg/L
36	0024	FCA (min range)	FCA	mg/L

E. SOFTWARE HISTORY

Date	Version	Changes
July 2012	Rev. A	Initial Release
Feb. 2013	Rev. B	Conductivity Resistivity specifications added
June 2013	Rev. C	TRITON® DO80 and TR6 added
July 2013	Rev. D	Conductivity Resistivity Calibrations added
July 2013	Rev. E	MODBUS Register update
May 2014	Rev. F	2 Channel addition, MODBUS Register update

Overview



SITRANS LR100 is a 2 wire loop powered radar transmitter for continuous level measurement of liquids and slurries to a range of 8 m (26 ft).

Benefits

- Bluetooth connectivity for easy setup with SITRANS mobile IQ
- Chemically resistant PVDF enclosure
- W band FMCW radar yields narrow beam with small antenna for superior performance in short range applications
- Approved for open air applications outside of a tank
- Compact design fits in limited space installations

Application

SITRANS LR100 is a W band FMCW radar level transmitter, packaged in a hermetically sealed PVDF enclosure for years of trouble-free reliable measurement service.

4 to 20 mA loop powered, it provides accurate level measurement to ranges of 8 m (26 ft). Measurement is possible non-intrusively through plastic vessel tops for easy installation. Programming is convenient using the Bluetooth connection and SITRANS mobile IQ application on your smart device.

Technical specifications

Mode of operation	
Measuring principle	W band FMCW radar
Measuring range	0 ... 8 m (0 ... 26 ft)
Frequency	80 GHz nominal
Beam angle	8°
Power Supply	
Voltage	12 ... 35 V DC
Current	4 ... 20 mA
Accuracy	
	± 5 mm
Rated operating conditions	
Vessel pressure	-1 ... +3 bar (14.50 ... 43.51 psi g)
Ambient temperature	-40 ... +60 °C (-40 ... +140 °F)
Process temperature	-40 ... +60 °C (-40 ... +140 °F)
Storage temperature	-40 ... +80 °C (-40 ... +176 °F)
Design	
Weight	0.5 kg (1.1 lb), plus 0.1 kg/m (0.2 lb/ft) cable length
Material (enclosure)	PVDF
Process connection	1-1/2" NPT, 1-1/2" BSPT, or 1-1/2" BSPP
Degree of protection	IP66/IP68
Cable connection	<ul style="list-style-type: none"> • 8 m (26 ft) long, 2 conductor, twisted with shield 18 AWG, PVC jacket • 1" NPT or 1" BSPT threaded connection
Certificates and approvals	
	General Purpose CE
Programming	
SITRANS mobile IQ App	SITRANS mobile IQ is a Bluetooth app that provides an intuitive interface to quickly configure, set up and monitor SITRANS LR100 series. For more information: http://www.siemens.com/mobileIQ

Operation & Maintenance Plan
Level Measurement

Continuous level measurement
Radar level transmitters

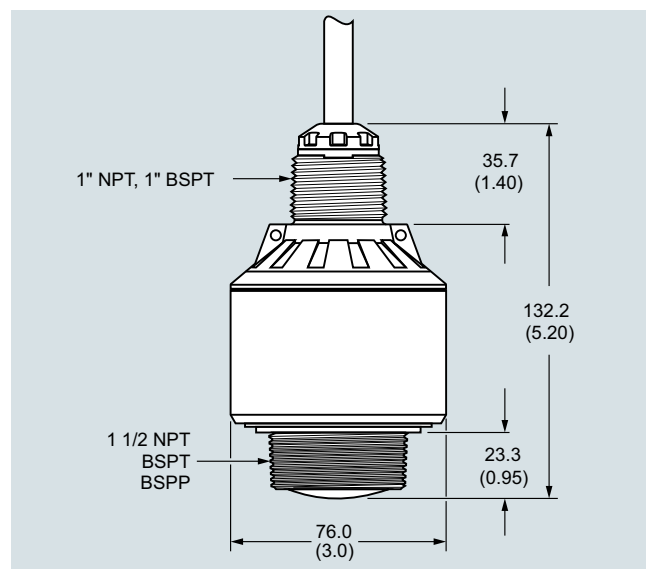
SITRANS LR100

Selection and Ordering data	Article No.
SITRANS LR100 Radar level transmitter Continuous, non-contact, 8 m (26 ft) range, for liquids and slurries, integrated cable connection.	7ML530
➤ Click on the Article No. for the online configuration in the PIA Life Cycle Portal.	7 - 1 A 0 6 - 0 A A 0
Process connection 1-½" NPT [(Taper), ASME B1.20.1]/electrical connection 1" NPT	A
R 1-½" [(BSPT), EN 10226]/electrical connection 1" BSPT	B
G 1-½" [(BSPP), EN ISO 228-1]/electrical connection 1" BSPT	C

Selection and Ordering data	Article No.
SITRANS RD100, loop powered display - see Chapter 7	7ML5741-.....-
SITRANS RD150, remote digital display for 4 to 20 mA and HART devices - see Chapter 7	7ML5742-.....-
SITRANS RD200, universal input display with Modbus conversion - see Chapter 7	7ML5740-.....-
SITRANS RD300, dual line display with totalizer and linearization curve and Modbus conversion - see Chapter 7	7ML5744-.....-
For applicable back up point level switch - see point level measurement section	

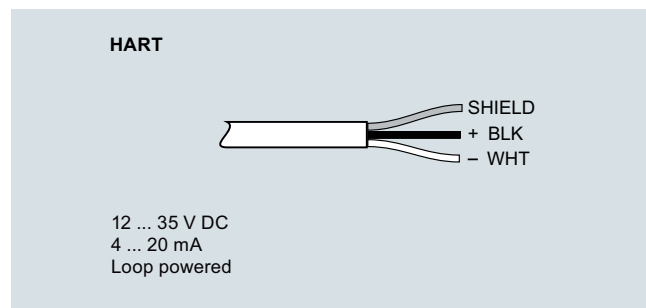
Selection and Ordering data	Order code
Further designs Please add "-Z" to Article No. and specify Order code(s).	
Tag (device parameter, max. 32 characters) plate stainless steel 304/1.4301	Y15
Operating Instructions All literature is available to download for free, in a range of languages, at http://www.siemens.com/processinstrumentation/documentation	
Accessories	Article No.
Easy Aimer 2, aluminum, NPT with ¾" x 1" PVC coupling	7ML1830-1AQ
Easy Aimer 2, aluminum with M20 adapter and 1" and 1½" BSPT aluminum couplings	7ML1830-1AX
Easy Aimer 304, NPT with 1" stainless steel coupling	7ML1830-1AU
Easy Aimer 304, with M20 adapter and 1" and 1½" BSPT 304 stainless steel couplings	7ML1830-1GN
FMS-200 universal box bracket, mounting kit	7ML1830-1BK
FMS-210 channel bracket, wall mount	7ML1830-1BL
FMS-220 extended channel bracket, wall mount	7ML1830-1BM
FMS-310 channel bracket, floor mount	7ML1830-1BN
FMS-320 extended channel bracket, floor mount	7ML1830-1BP
FMS-350 bridge channel bracket, floor mount (see Mounting Brackets on page 4/186 for more information)	7ML1830-1BQ
1" NPT locknut, plastic	7ML1830-1DS
1" BSP locknut, plastic	7ML1830-1DR
Plastic adapter 1" BSP - 20 mm	7ML1830-1EA
Plastic adapter 1" NPT	7ML1830-1FX
Plastic adapter 1" NPT/M20	7ML1830-1EF
SIMATIC RTU3010C compact, remote data manager with alarming	6NH3112-0BA00-0XX0
SIMATIC RTU3030C compact, remote data manager with alarming	6NH3112-3BA00-0XX0

Dimensional drawings



SITRANS LR100, dimensions in mm (inch)

Circuit diagrams



SITRANS LR100 connections

4

Agri Drain

Smart Drainage System[®]

www.agridrain.com

Operator's Manual

Multiple Valve, 2-Level, Day of Week, Locally Programmable
Controller

Version August 25, 2021
RSG1744

Agri Drain Corporation
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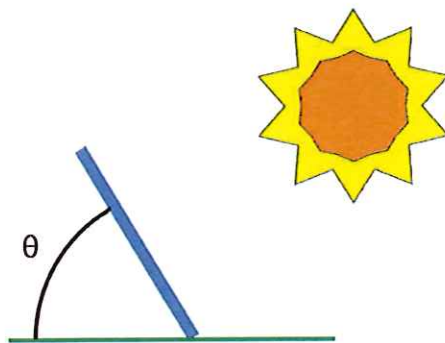
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1. Hardware Installation

*Bagged hardware included: 8 pcs. – 3/8" x 2.5" long bolts with nuts.
8 pcs. – 1/4"-20 x 3/4" long countersunk Phillips machine screws*

Located inside controller: 5 pcs. – 5 Amp 250 Volt, slow blow/time delayed, 5x20mm cartridge fuses.

- 1.1. Secure the two posts in place
 - 1.1.1. Ensure that the tops of the posts are level to each other and at approximately the level you intend to install the top of the controller enclosure.
- 1.2. Bolt the controller mounting plate onto the posts, resting the top bend of the plate on the top of the posts.
- 1.3. Attach the solar panel mounting rod to the back of the controller mounting plate using the included U-clamps.
- 1.4. Attach the solar panel (pre-installed in its bracket) to the top of the solar panel mounting rod using the included U-clamps.
- 1.5. Adjust the solar panel to receive the maximum amount of sunlight by orienting it to the south and adjusting the angle according to the table below, then tighten the 4 – 1/4" bolts at the bracket pivot point to secure panel in position.



Latitude	Solar Panel Angle (θ)
25	48.43
30	53.43
35	58.43
40	63.43
45	68.43
50	73.43
55	78.43

- 1.6. Attach the controller enclosure to the controller mounting plate using the 4 machine screws provided.
- 1.7. Ensure all five (5) of the fuse holders inside the enclosure are open.

- 1.8. Connect the included extension cable between the actuator cable and the enclosure bulkhead connector labeled "VALVE[1..3]".
- 1.9. Install the included 12V battery into the enclosure connecting the positive (+/red) cable first and the negative (-/black) cable second. Always connect the battery before connecting the solar panel to avoid high voltage being present at the battery cables.*

*If the battery must be removed/disconnected for replacement or maintenance, always be sure to open all fuse holders and disconnect the solar panel BEFORE disconnecting the battery.

- 1.10. Attach the solar panel cables from the enclosure to the connectors on the solar panel.
- 1.11. Once all electrical connections are made, install the included fuses into the fuse holders and close the fuse holders to start the controller.
- 1.12. When the controller starts, follow the instructions in the Operator's Manual for programming the desired schedule.

2. Overview

The [Banner DXM Series Industrial Controller](#) makes it possible to control external equipment and create a simple schedule that is configurable from the front panel of this device.



This configuration allows for manual and automatic modes of operation. Manual mode consists of setting the valves open or closed from the controller interface. Automatic mode allows the user to configure a time to open each valve, the duration the valve will remain open and the day(s) of the week this schedule will be run. A manual override switch is also included for each valve to allow the valve commands from the Banner DXM Controller to be overridden (see section 9 for details).

By default, when power is applied or the controller restarted, the system returns to the mode it was previously in. From the factory, the system is in automatic mode and will attempt to run the schedule programmed into the controller. If the battery voltage drops below 11.5 V, the unit will go into low power mode. In low power mode, the unit will close the valve. If the battery voltage

goes back above 12 V in low power mode, it will return to normal power mode and run the configured schedule.

The controller allows for the open day, time and duration for each valve to be set individually. Multiple valves can be open at the same time if the times overlap.

3. Controls

3.1. Buttons

The device has 4 buttons on the front panel.

Up/Down Arrows - Used for choosing menu items or changing values of registers

Enter - Used for Navigator to current chosen menu item / adding or setting value in register

Back - Used for Navigating back to previous screen or menu / Deleting character from register

3.2. Indicators

LED1 (GREEN) - On when main script loop is executing

LED2 (RED) - On when set to manual mode

LED3 (ORANGE) - On when any valve is open

LED4 (RED) - Unused

4. Automatic Mode Operation

Automatic mode allows the user to schedule the valve to be opened for a specified duration at a specified time for each day of the week.

The examples below will cover the following:

- Setting the unit into automatic mode
- Setting the start time for the daily schedule
- Setting the duration for the daily schedule
- Setting which days of the week to run the schedule.

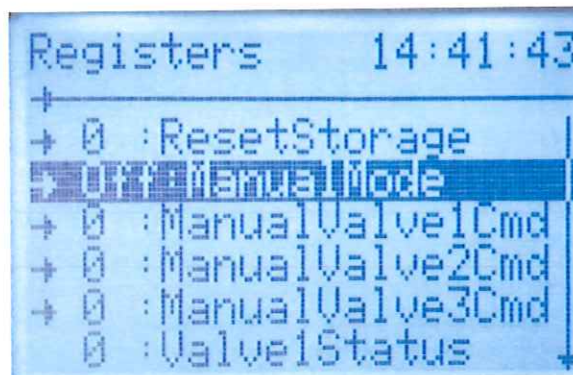
For the purpose of this example, we will schedule Valve1 to open on Monday at 22:30 UTC (4:30 pm CST) for 3 hours (180 minutes). Valve2 will open on Tuesday at 22:30 UTC (4:30 pm CST) for 3 hours (180 minutes). Valve3 will open on Wednesday at 22:30 UTC (4:30 pm CST) for 3 hours (180 minutes). This is the factory default program.

NOTE: Hours and Display time are in UTC. Maximum value for duration should not exceed 1440 minutes (24 hours). See Section 7 for a conversion chart.

4.1. Set Automatic Mode

The factory default mode is automatic so this should not have to be changed unless it was explicitly set to manual mode.

- 4.1.1. Press "ENTER" to access the Registers menu
- 4.1.2. Press "Down arrow" to ManualMode register
- 4.1.3. Press "ENTER" to access the ManualMode setting



- 4.1.4. Set the ManualMode to 0 (OFF):

- 4.1.4.1. Press "Down arrow" to change from 1 (ON) to 0 (OFF)
- 4.1.4.2. Press "ENTER" to "accept" the value
- 4.1.4.3. Press "ENTER" to navigate to "SEND" value
- 4.1.4.4. Press "ENTER" to "send" the value to the register

4.2. Set the Start Time

4.2.1. Set StartHour (Example: 22 UTC)

- 4.2.1.1. Press "ENTER" to access the Registers menu
- 4.2.1.2. Press "Down Arrow" until you are on the StartHour register
- 4.2.1.3. Press "ENTER" to access StartHour register



- 4.2.1.4. Set the desired hour to open the valve (Example: 22 UTC)
 - 4.2.1.4.1. Press "Up arrow" to 2, Press "ENTER" to move to the next digit
 - 4.2.1.4.2. Press "Up arrow" to 2, Press "ENTER" to move to the next digit
- 4.2.1.5. Press "ENTER" to "accept" the value
- 4.2.1.6. Press "ENTER" to navigate to "SEND" value
- 4.2.1.7. Press "ENTER" to "send" the value to the register

4.2.2. Set StartMinutes (Example: 30)

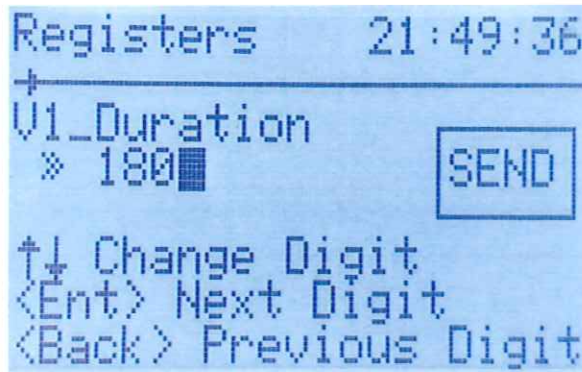
- 4.2.2.1. Press "ENTER" to access the Registers menu
- 4.2.2.2. Press "Down Arrow" until you are on the StartMinutes register
- 4.2.2.3. Press "ENTER" to access StartMinutes register
- 4.2.2.4. Set the desired minutes to open the valve (Example: 30)
 - 4.2.2.4.1. Press "Up arrow" to 3, Press "ENTER" to move to the next digit
 - 4.2.2.4.2. Press "Up arrow" to 0, Press "ENTER" to move to the next digit
- 4.2.2.5. Press "ENTER" to "accept" the value
- 4.2.2.6. Press "ENTER" to navigate to "SEND" value
- 4.2.2.7. Press "ENTER" to "send" the value to the register

4.3. Set the Duration

- 4.3.1. Press "ENTER" to access the Registers menu
- 4.3.2. Press "Down Arrow" until you are on the Duration register
- 4.3.3. Press "ENTER" to access Duration register



- 4.3.4. Press "Up/Down Arrow" to set to the duration in minutes to keep valve open



- 4.3.5. Press "ENTER" to "accept" the value
- 4.3.6. Press "ENTER" to navigate to "SEND" value
- 4.3.7. Press "ENTER" to "send" the value to the register

4.4. Enable schedule per day

For each day of the week, you can enable or disable the schedule set above for the time and duration. So, if you only wanted to run this schedule on Mondays, you would turn this on for Monday and leave it off for the other days of the week. (The same steps below can be followed for any other day by changing the choice of register based on the day's schedule you would like to set.)

- 4.4.1. Press "ENTER" to access the Registers menu
- 4.4.2. Press "Down Arrow" until you are on the Monday register
- 4.4.3. Press "ENTER" to access the Monday Register



- 4.4.4. Change the value from 0 (OFF) to 1 (ON)



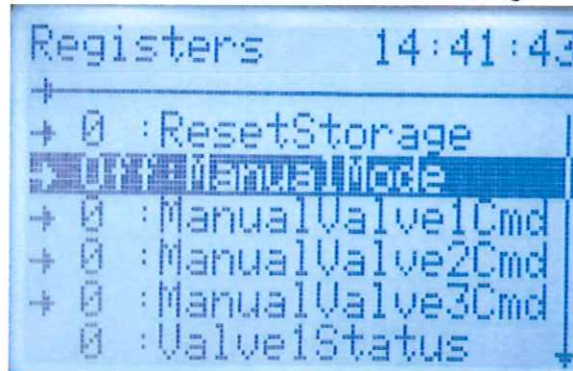
- 4.4.5. Press "ENTER" to "accept" the value
- 4.4.6. Press "ENTER" to navigate to "SEND" value
- 4.4.7. Press "ENTER" to "send" the value to the register

5. Manual Mode Operation

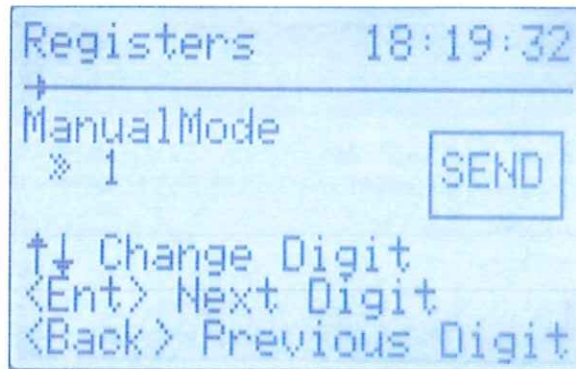
Manual mode operation allows the user to disable the schedule and set the valve to the desired position. The following example below shows setting the device into manual mode and opening the valve.

5.1. Set Manual Mode

- 5.1.1. Press "ENTER" to access the Registers menu
- 5.1.2. Press "Down Arrow" until you are on the ManualMode register
- 5.1.3. Press "ENTER" to access ManualMode Register



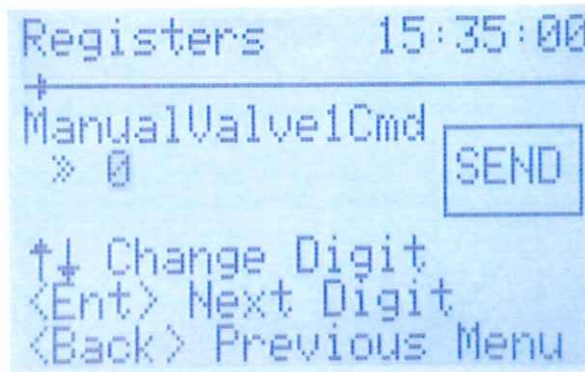
- 5.1.4. Set the ManualMode to 1 (ON):
 - 5.1.4.1. Press "Up arrow" to change from 0 (OFF) to 1 (ON)
 - 5.1.4.2. Press "ENTER" to "accept" the value
 - 5.1.4.3. Press "ENTER" to navigate to "SEND" value
 - 5.1.4.4. Press "ENTER" to "send" the value to the register



5.2. Open or Close the Valve

In ManualMode the ManualValve[1,2,3]Cmd register is used to manually control the state of the valve.

- 5.2.1. Press "ENTER" to access the Registers menu
- 5.2.2. Press "Down Arrow" until you are on the ManualValve[1,2,3]Cmd register
- 5.2.3. Press "ENTER" to access ManualValve[1,2,3]Cmd Register
- 5.2.4. Press "Up arrow" to change from 0 (CLOSED) to 1 (OPEN)
- 5.2.5. Press "ENTER" to "accept" the value
- 5.2.6. Press "ENTER" to navigate to "SEND" value
- 5.2.7. Press "ENTER" to "send" the value to the register



6. Checking Unit Voltages

6.1. Check Battery Voltage

- 6.1.1. Press "ENTER" to access the Registers menu
- 6.1.2. Press "Down Arrow" until you are on the Battery register



6. Register Reference

6.1. ResetStorage (1=RESET/0=NORMAL)

- Set to 1 to reset to "no" schedule

6.2. ManualMode (1=ON/0=OFF)

- While ON, the user can open/close the valve by setting the ManualValveCmd.
- While ON, the controller will ignore any scheduled open/close times.
- While ON, LED2 (RED) will be ON.
- While OFF, LED2 (RED) will be OFF.

6.3. ManualValve[1,2,3]Cmd (1=OPEN, 0=CLOSED)

- Controls Valve state when ManualMode is ON.
- While any valve is OPEN, LED3 (ORANGE) will be ON.
- While any valve is CLOSED, LED3 (ORANGE) will be OFF.

6.4. Valve[1,2,3]Status (1=OPEN, 0=CLOSED)

- Displays the current status of the valve.
- While any valve is OPEN, LED3 (ORANGE) will be ON.
- While any valve is CLOSED, LED3 (ORANGE) will be OFF.

6.5. Days of the Week [V1_Sunday...V3_Saturday] (1=ON/0=OFF)

- Set which days of the week the valve should open.
- When set to ON, the valve will open at the specified StartHour and StartMinute and remain open for the specified Duration.

6.6. [V1..V3]Duration (minutes)

- The amount of time in minutes that the valve will remain open.
- At the end of the Duration, the valve will close.
- Valves will close in 1,2,3 sequence if multiple valves are scheduled to close at the same time.

6.7. [V1..V3]StartHour

- The hour portion of the time you wish the valve to open.
- The same StartHour applies to all valves
- Valves will open in 1,2,3 sequence if multiple valves are scheduled to open at the same time.
- NOTE: This is based on the time displayed in the upper right-hand corner of the LCD display.

6.8. StartMinutes

- The minute portion of the time you wish the valve to open.
- Valves will open in 1,2,3 sequence if multiple valves are scheduled to open at the same time.
- NOTE: This is based on the time displayed in the upper right-hand corner of the LCD display.

6.9. Battery

- The current battery voltage.

8. Local time to UTC Conversion

To use this chart:

1. Find your local time in the row on the left.
2. The time converted to UTC will be in the column of your timezone.

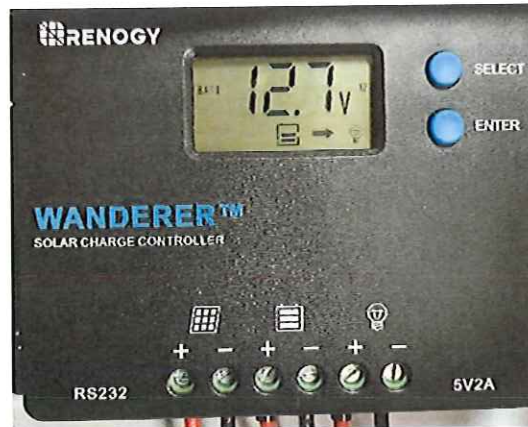
LOCAL	EDST	EST	CDST	CST	MDST	MST	PDST	PST
Midnight	0400	0500	0500	0600	0600	0700	0700	0800
1:00 AM	0500	0600	0600	0700	0700	0800	0800	0900
2:00 AM	0600	0700	0700	0800	0800	0900	0900	1000
3:00 AM	0700	0800	0800	0900	0900	1000	1000	1100
4:00 AM	0800	0900	0900	1000	1000	1100	1100	1200
5:00 AM	0900	1000	1000	1100	1100	1200	1200	1300
6:00 AM	1000	1100	1100	1200	1200	1300	1300	1400
7:00 AM	1100	1200	1200	1300	1300	1400	1400	1500
8:00 AM	1200	1300	1300	1400	1400	1500	1500	1600
9:00 AM	1300	1400	1400	1500	1500	1600	1600	1700
10:00 AM	1400	1500	1500	1600	1600	1700	1700	1800
11:00 AM	1500	1600	1600	1700	1700	1800	1800	1900
NOON	1600	1700	1700	1800	1800	1900	1900	2000
1:00 PM	1700	1800	1800	1900	1900	2000	2000	2100
2:00 PM	1800	1900	1900	2000	2000	2100	2100	2200
3:00 PM	1900	2000	2000	2100	2100	2200	2200	2300
4:00 PM	2000	2100	2100	2200	2200	2300	2300	2400
5:00 PM	2100	2200	2200	2300	2300	2400	2400	0100
6:00 PM	2200	2300	2300	2400	2400	0100	0100	0200
7:00 PM	2300	2400	2400	0100	0100	0200	0200	0300
8:00 PM	2400	0100	0100	0200	0200	0300	0300	0400
9:00 PM	0100	0200	0200	0300	0300	0400	0400	0500
10:00 PM	0200	0300	0300	0400	0400	0500	0500	0600
11:00 PM	0300	0400	0400	0500	0500	0600	0600	0700
LOCAL	EDST	EST	CDST	CST	MDST	MST	PDST	PST

Key Notes:

- EDST= Eastern Daylight Standard Time.
- EST= Eastern Standard Time.
- CDST= Central Daylight Savings Time.
- CST= Central Standard Time.
- MDST= Mountain Daylight Savings Time.
- MST= Mountain Standard Time.
- PDST= Pacific Daylight Savings Time.
- PST= Pacific Standard Time.

9. Renogy Wanderer Solar Charge Controller

The [Renogy Wanderer](#) solar charge controller ensures the health of the solar charging system and displays different information about the health of the battery and solar panel.



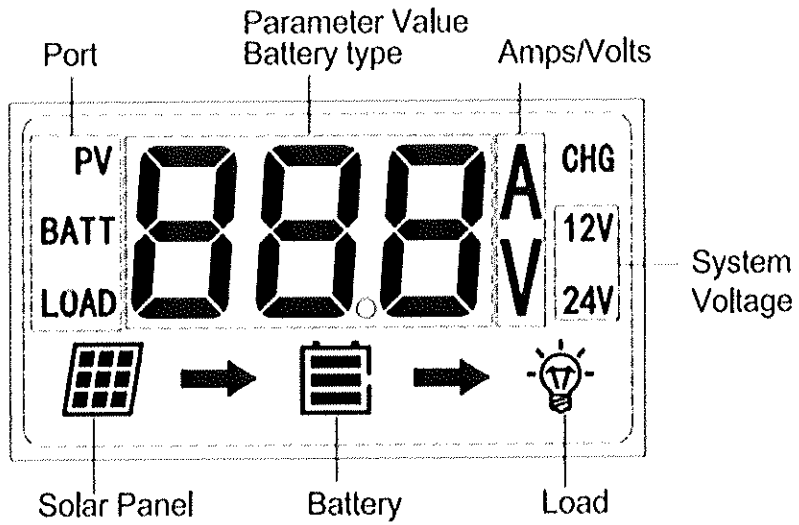
The LCD display of the controller automatically cycles through the various parameters:

- Solar Voltage
- Solar Charging Current
- Battery Voltage
- Load Current
- Load Setting

You can also cycle through the display parameters by pressing the "SELECT" button repeatedly. Do not press the "ENTER" button, as there are no parameters that should be changed for proper operation of the system.

The display also indicates the following parameters:

- Solar Charge Active
- Battery charge meter
- Load Active
- Errors



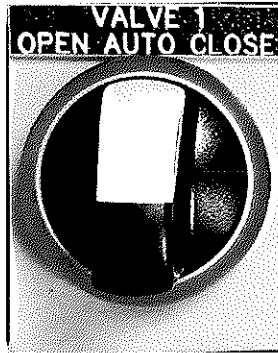
Icon or Value	State	Description
	Steady on	Solar Panels Charging Battery
	3 Bars Flashing	Battery Voltage (16.1V+)
	3 Bars	Battery Voltage (12.9V- 16.0V)
	2 Bars	Battery Voltage (12.5-12.8V)
	1 Bar	Battery Voltage (11.6-12.4V)
	No Bars	Battery Voltage (11.5V and below)
	No Bars Flashing	Battery Voltage (10.9V and below)
	Steady on	Load is On

Error Number	Description
E0	No error detected
E01	Battery over-discharged
E02	Battery over-voltage
E04	Load short circuit
E05	Load overloaded
E06	Controller over-temperature
E08	PV input over-current
E10	PV over-voltage
E13	PV reverse polarity
E14	Battery reverse polarity

10. Manual Valve Override

To completely bypass the output from the Banner DXM Industrial Controller a manual override switch has been provided. By turning and locking the switch to the desired Open or Closed position the valve will be commanded to move regardless of the output of the DXM controller.

Because this bypasses the controller, the controller will continue to run the scheduled program but will be unable to actuate the valve. To disable the override, return the switch to the middle "Auto" position. Upon returning to automatic mode the controller will check the position of the valve and actuate it as necessary according to the schedule.



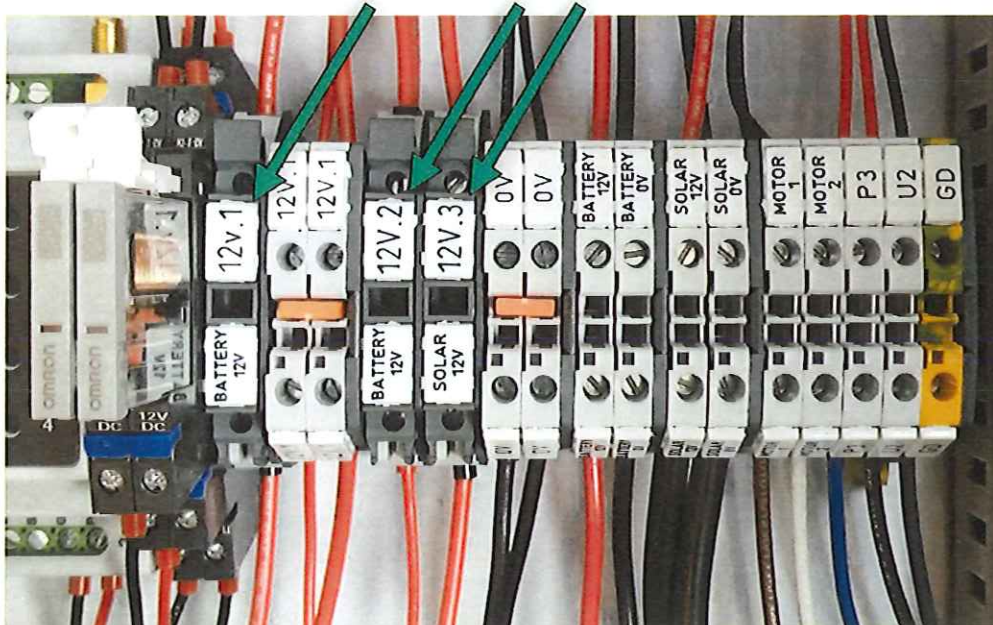
WARNING!

TO AVOID DAMAGE TO HARDWARE

Install fuses AFTER connecting antenna, solar panel, pressure transducer, and battery. If replacing hardware, disconnect fuses prior.

Fuse location shown below.

Fuse Specification: 5Ah 250Volts, slow blow/time delayed, 5x20mm (Qty 5).



Be sure to attach the battery to the system BEFORE connecting the solar panel. If you need to remove the battery from the system for charging or replacement, disconnect the solar panel FIRST.