Sentinel™ LCT8
User's manual

Panametrics

a Baker Hughes business

Sentinel™ LCT8

High accuracy ultrasonic liquid flow meter for custody transfer

User's manual

910-314 Rev. A
October 2017

[no content intended for this page - proceed to next page]

Contents

Product registration

Thank you for purchasing your **Sentinel™ LCT8** from Panametrics. Please register your product at https://info.bakerhughes.com/New-Product-Registration-LP.html for product support such as the latest software/firmware upgrades, product information and special promotions.

Services

Panametrics provides customers with an experienced staff of customer support personnel ready to respond to technical inquiries, as well as other remote and on-site support needs. To complement our broad portfolio of industry-leading solutions, we offer several types of flexible and scalable support services including: training, product repairs, extended warranties, service agreements and more. Please visit https://www.bakerhughesds.com/panametrics/services for more details.

Terms and conditions

Sales terms and conditions for your recent purchase of a Panametrics product, including the applicable product Warranty, can be found on our website at the following link: https://www.bakerhughesds.com/sales-terms-conditions.

Typographical conventions

NOTE: These paragraphs provide information that provides a deeper understanding of the situation, but is not essential to the proper completion of the instructions.

IMPORTANT
These paragraphs provide information that emphasizes instructions that are essential to proper setup of the equipment. Failure to follow these instructions carefully may cause unreliable performance.

	CAUTION!
	This symbol indicates a risk of potential minor personal injury and/or severe damage to the equipment, unless these instructions are followed carefully.

	WARNING!
	This symbol indicates a risk of potential serious personal injury, unless these instructions are followed carefully.

Safety Issues

	WARNING!
	It is the responsibility of the user to make sure all local, county, state and national codes, regulations, rules and laws related to safety and safe operating conditions are met for each installation.

	Attention European customers!
	To meet CE Mark requirements for all units intended for use in the EU, all electrical cables must be installed as described in this manual.

Auxiliary equipment

Local safety standards

The user must make sure that he operates all auxiliary equipment in accordance with local codes, standards, regulations, or laws applicable to safety.

Working area

⚠️	**WARNING!**
	Auxiliary equipment may have both manual and automatic modes of operation. As equipment can move suddenly and without warning, do not enter the work cell of this equipment during automatic operation, and do not enter the work envelope of this equipment during manual operation. If you do, serious injury can result.

⚠️	**WARNING!**
	Make sure that power to the auxiliary equipment is turned OFF and locked out before you perform maintenance procedures on this equipment.

Qualification of personnel

Make sure that all personnel have manufacturer-approved training applicable to the auxiliary equipment.

Personal safety equipment

Make sure that operators and maintenance personnel have all safety equipment applicable to the auxiliary equipment. Examples include safety glasses, protective headgear, safety shoes, etc.

Unauthorized operation

Make sure that unauthorized personnel cannot gain access to the operation of the equipment.

Environmental compliance

RoHS

The *Sentinel™ LCT8* fully complies with RoHS regulations (Directive 2011/65/EU).

Waste Electrical and Electronic Equipment (WEEE) Directive

Panametrics is an active participant in Europe's Waste Electrical and Electronic Equipment (WEEE) take-back initiative (Directive 2012/19/EU).
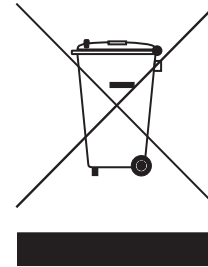
Panametrics is an active participant in Europe's Waste Electrical and Electronic Equipment (WEEE) take-back initiative (Directive 2012/19/EU).

The equipment that you bought has required the extraction and use of natural resources for its production. It may contain hazardous substances that could impact health and the environment.

In order to avoid the dissemination of those substances in our environment and to diminish the pressure on the natural resources, we encourage you to use the appropriate take-back systems. Those systems will reuse or recycle most of the materials of your end life equipment in a sound way.

The crossed-out wheeled bin symbol invites you to use those systems.

If you need more information on the collection, reuse and recycling systems, please contact your local or regional waste administration.

Please visit https://www.bakerhughesds.com/health-safetyand-environment-hse for take-back instructions and more information about this initiative.

Chapter 1. General information

1.1   Theory of operation

The **Sentinel LCT8** measurement system uses ultrasonic transit-time technology. A brief description of transit-time theory follows. For more information about the theory, and the use of Panametrics ultrasonic flow meters for measuring flow, please refer to *Ultrasonic measurements for process control* by L.C. Lynnworth (Academic Press, 1989).

1.1.1   Transit-time method

The transit time technique uses a pair of transducers, with each transducer alternately sending and receiving coded ultrasonic signals through the fluid. When the fluid is flowing, signal transit time in the downstream direction is shorter than in the upstream direction. The difference between these transit times is proportional to the flow velocity. The **Sentinel LCT8** measures this very small time difference and, using various digital signal processing techniques combined with programmed pipe parameters, determines the flow rate and direction.

1.1.2   Transducers

When in a transmit cycle, transducers convert electrical energy into ultrasonic pulses and then convert the ultrasonic pulses back to electrical energy when in a receive cycle. In other words, they act like loudspeakers when transmitting the signal and like microphones when receiving it. They perform the actual data transmission and collection, thus interrogating the flow.

The transducers in the **Sentinel LCT8** measurement system were specifically designed to be replaced under normal operating conditions. A damaged or non-functional transducer, can be replaced without shutting down the pipeline. Recalibration of the replacement is not necessary.

1.2   Multi-path design

Multi-path ultrasonic flow meters are designed with more than one pair of transducers to interrogate the flow field in different locations and more accurately determine the actual flow rate. The *Sentinel LCT8* measurement system uses eight measurement locations. These measurement paths are located across the meter body and tilted at an angle. The eight measurement paths are orthogonal to each other. The sensor path placements provide the best swirl and disturbance immunity.

1.3   Flow profile

One of the main factors that can adversely affect the performance of an ultrasonic flow measurement is a disturbed and unsymmetrical flow profile. Maintaining a desired flow-profile shape across all flow velocities, pipe sizes and upstream flow disturbances is difficult. For this reason, Panametrics has tested the *Sentinel LCT8* under various pipe configurations in an effort to determine its operational specifications and immunity against cross flow and swirl. Panametrics also completes calibrations based on the specific customer application needs to ensure the best meter performance. Owning to the design of our Eight-path flowmeter, we are able to meet performance specifications across a range of disturbances. Use of flow conditions is normally unnecessary due to calibration methods and meter design. If the need of a flow conditioner is concluded, the meter calibration will be performed with the flow conditioner in place.

1.4   Unpacking

The *Sentinel LCT8* is typically packaged in a wooden crate, the size of which will depend on the size of product ordered. It will be secured by several 2x4 wood blocks to prevent shifting during transit. Simply remove these 2x4 braces to unpack the system. For local-mount systems the transmitter will be installed directly on top of the pressure vessel. For remote-mount systems the transmitter and remote cable may ship in a separate package.

1.5   Inspection

Prior to installation, inspect all materials to be used in the installation:

- **Gaskets** - check for cracks, tears and over compression (not included in *Sentinel LCT8* package)
- **Nuts and bolts** - check for damaged threads and for debris (not included in *Sentinel LCT8* package)
- **RF flange faces** - check for damage to serrations that may cause gaskets to not seal properly.
- **Flow conditioners** - check for blockages or damage to the flow conditioner

In general, check for anything that may prevent safe operation of the equipment.

IMPORTANT

If pipes are shipped pre-assembled as a single section, care should be taken to inspect and check the bolts and gaskets.

1.6   Meter components

Figure 1 on page 3 shows a **Sentinel LCT8** system, with items 1–8 as described in *Table 1* below.

No	Component	Material (ASTM)	Qty
	Table 1: Sentinel LCT8 system components		
1	Meter body with flanges	SA216 Gr. WCB (carbon steel) SA352 Gr. LCB (low temp carbon steel) SA351 Gr. CF8 (304 SS) SA351 Gr. CF8M (316 SS)	1
2	Model tag plate		1
3	Transmitter tag plate		1
4	Part string and serial number tag plate		1
5	Transducer insert/buffer	316 SS	16
6	Transducer	316 SS	16
7	SEN898 electronics		1
8	External conduit connections, 3/4" cable glands		3
9	Upstream meter run (not supplied by Panametrics)		N/A
10	Flow conditioner (optional)		A/R
11	Downstream meter run (not supplied by Panametrics)	See *Figure 11 on page 7*	N/A
12	Temperature probe (optional, not supplied by Panametrics)		N/A
13	Pressure probe (optional, not supplied by Panametrics)		N/A
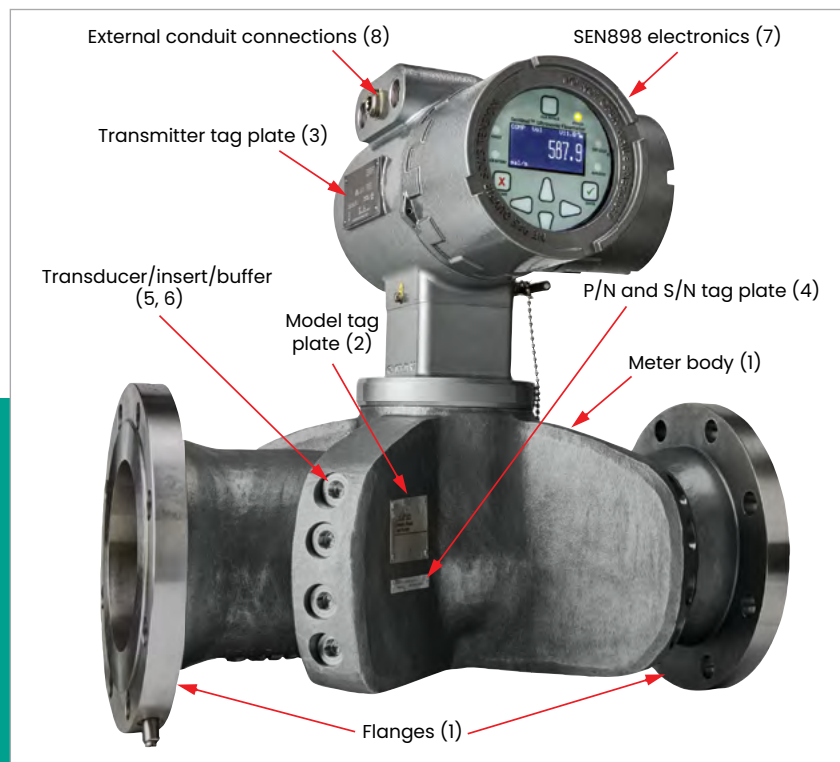
Figure 1: Typical **Sentinel LCT8** assembly

NOTE: Design details changes slightly with pipe size.

1.7   Marking and Labeling

1.7.1   Tag plates

There are four tag plates affixed to the **Sentinel LCT8** which provide details about the system. Three are located on the vessel and one is located on the transmitter. Their locations are shown in *Figure 2* below.
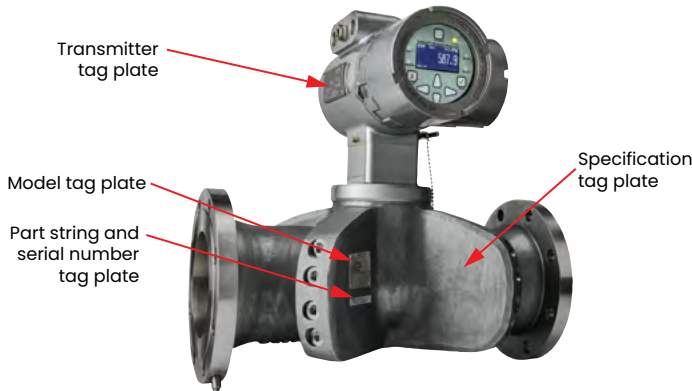
Figure 2: **Sentinel LCT8** tag plate locations

1.7.2   Model tag plate

The *model tag plate* (see *Figure 3* below) contains the model name and certification markings for the pressure vessel and its hazardous area usage.
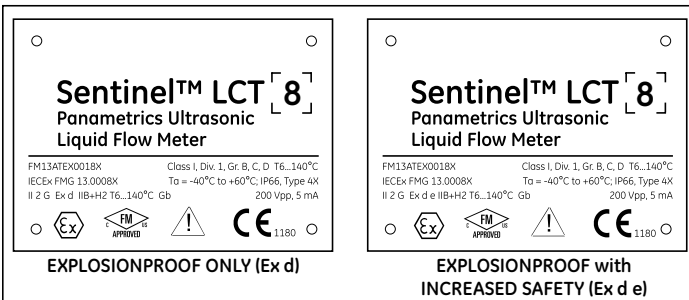
Figure 3: **Sentinel LCT8** model tag plate (ref. 442–1402)

1.7.3   Specification tag plate

The *specification tag plate* (see *Figure 4* below) contains information pertaining to the build and test of the pressure vessel. It contains the following information:

- Vessel nominal size, flange rating, wall thickness, material
- Dry weight (including transmitter)
- Vessel manufacturer serial number
- Ambient and fluid temperature ranges
- Operating pressures
- Hydro test pressure and date
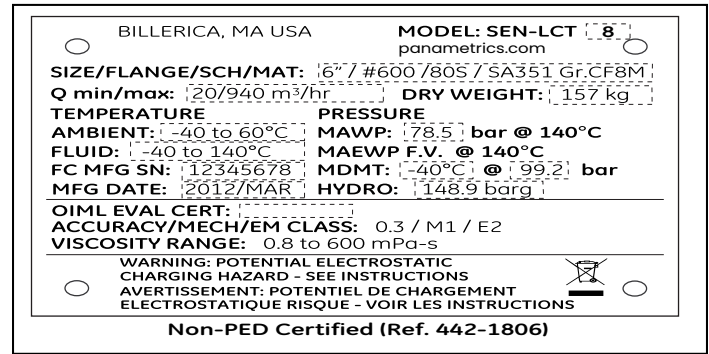
Figure 4: Specification tag plate

NOTE: Information in dashed boxes above is shown only as an example.

1.7.4   Part string and serial number tag plate

The *part string and serial number tag* (see *Figure 5* below) contains the specific configuration of the pressure vessel as well as the final assembly date, Panametrics serial number and customer tag information.
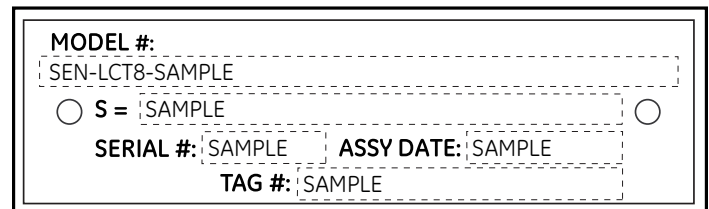
Figure 5: Part string and S/N tag plate (ref. 442–1445)

NOTE: Information in dashed boxes is shown only as an example.

1.7.5   Transmitter tag plate

The *SEN898 transmitter tag plate* (see *Figure 6* below) is affixed to the transmitter and includes the configuration per the model information detailed on the model tag plate. This tag plate also contains the hazardous area certification information for the transmitter.
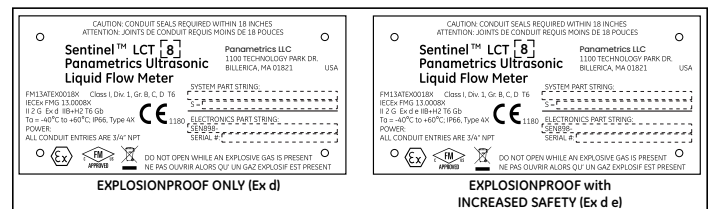
Figure 6: SEN898 transmitter tag plate (ref. 442–1521)

Chapter 2. Installation

2.1   Installation guidelines

This section provides general information with respect to the mechanical and electrical installation, and should be thoroughly reviewed before the system is installed. To ensure safe and reliable operation of the *Sentinel LCT8*, the system must be installed in accordance with the guidelines established by Panametrics, as explained in this chapter.

	WARNING!
⚠️	The *Sentinel LCT8* flow measurement system can measure the flow rate of many fluids, some of which are potentially hazardous. Strict observance of proper safety practices is essential.

	WARNING!
⚠️	Be sure to follow all applicable local safety codes and regulations for installing electrical equipment and working with hazardous gases or flow conditions. Consult company safety personnel or local safety authorities to verify the safety of any procedure or practice.

	Attention European customers!
⚠️	To meet CE Mark requirements, all cables must be installed as described in *Appendix A. CE Mark compliance and high noise environments on page 111*.

	Attention European customers!
⚠️	This manual fulfills the requirements of the Pressure Equipment Directive 97/23/EC. Please read it carefully in order to guarantee safe operation of this pressure equipment. Follow all warnings and instructions marked on the product.

2.2   Bill of materials

The following items should have been included in the shipment:

- *Sentinel LCT8* flow meter
- Magnetic wand
- User's manual
- CD with PanaView SEN898 software (optional)

2.3 Preparing for Installation

2.3.1 Installation precautions

Any questions with respect to the installation should be addressed prior to beginning the installation. Failure to install the **Sentinel LCT8** correctly can increase measurement uncertainty.

All the mechanical and electronic components are shipped fully assembled, however the following precautions should be observed:

• Only authorized personnel should perform the installation. The proper personal protection equipment (PPE) should always be used when working with this equipment.

• The vessel shall be installed in such a way that it can be safely operated, maintained and inspected. Please refer to specific outline and installation drawings for proper clearances and specific distances for each system size. In general, allow for a minimum of 12" of space on all sides of pressure vessel and transmitter, with an ideal clearance of 24" on all sides.

• You must provide suitable over-pressure protection at or in the main piping to the flowcell in order to prevent damage to the flowcell and injury to personnel. The utilized over-pressure protection device shall be supplied with all declarations of conformity and EC-type design certificates.

• Make sure the difference between the inside diameter of the pipe and that of the **Sentinel LCT8** meter does not exceed 0.5%, as changes in internal diameters will cause flow profile disturbances.

• Make sure any non-symmetrical offset does not exceed 1%, as misalignment between the piping and the meter may cause flow profile disturbances.

• Make sure the gasket is centered on the flange faces and does not protrude into the pipe, as protrusion of the gasket into the pipe may cause flow profile disturbances.

• Make sure the **Sentinel LCT8** is oriented with the flow transmitter in a vertical position at the top, as shown in *Figure 7* below.
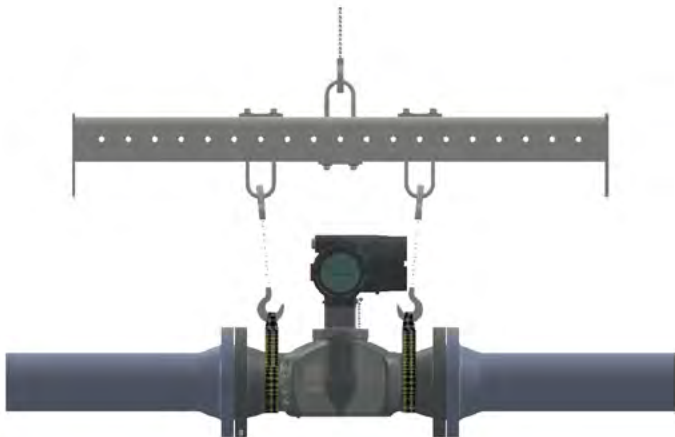
Figure 7: Lifting strap locations

2.3.2 Lifting Instructions

⚠	**WARNING!** To avoid possible strain, refer to the **Sentinel LCT8** label for the assembly weight, use a properly-rated lifting assembly, and place the lifting straps in the indicated locations (see *Figure 7 on page 6*). **Never stand below any object being lifted!**

Use proper lifting techniques when moving the **Sentinel LCT8** (see *Figure 8* below). No lifting hooks or eyelets are provided. The recommended method for lifting the **Sentinel LCT8** is by using lifting straps on each side of the pressure vessel with a stabilizer bar between them, located above the transmitter enclosure. Additional care may need to be taken to prevent the transmitter from rotating, especially on smaller systems where the transmitter weight is a larger percentage of the total system weight.

Figure 8: Proper lifting method

⚠	**WARNING!** Do not use the transmitter to support the weight of the flowcell, as shown in *Figure 9* below. The transmitter cannot support the weight of the pressure vessel.

Figure 9: Improper lifting method

2.4 Mechanical installation

Being mindful of the *Installation precautions on page 6*, complete the following steps:

1. Make sure the gaskets are in place on the flanges.
2. Support the **Sentinel LCT8** between the flanges on the pipe.
3. Align the flange mounting holes as shown in *Figure 10* below.
4. Secure the meter to the pipe by using the appropriate hardware.

Figure 10: **Sentinel LCT8** mounting flange

2.4.1 Standard installation recommendations

2.4.1.1 Installation location

Proper installation of the **Sentinel LCT8** is important to achieve maximum performance from the system. The following installation recommendations provide general guidelines of how this system should be installed. If the following recommendations cannot be met, please consult the factory for a more detailed review of the application to see what performance may be achievable. Following these recommendations may not be the solution for all situations, since every installation is different.

2.4.1.2 Straight pipe run requirements

The **Sentinel LCT8** should be installed to meet one of the following condition:

- A minimum of 5 nominal pipe diameters upstream of the metering section (pressure vessel) and a minimum of 3 nominal pipe diameters downstream.

For any other straight run configurations, consult Panametrics for an application assessment.

2.4.1.3 Flow direction - straight pipe run differences

For both uni-directional and bi-directional flow, the user must provide the minimum straight pipe runs upstream and downstream from the flowcell, as shown in *Figure 11* below. Any additional length of straight pipe run will help produce a more symmetrical flow profile, thus further reducing measurement uncertainty.
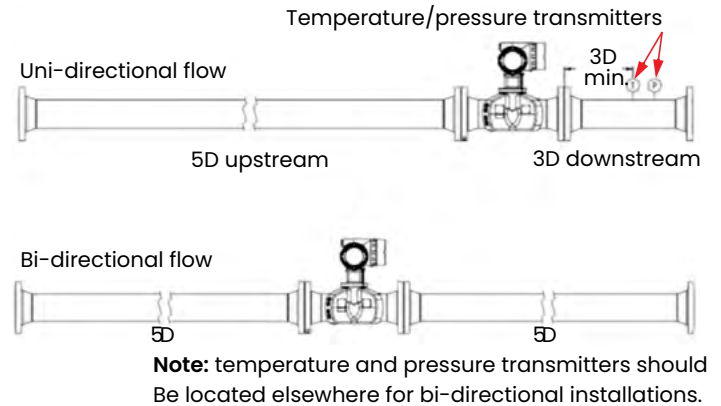
Figure 11: Minimum straight pipe runs for **Sentinel LCT8** installations

2.4.1.4 Inner diameter matching

To maintain optimal product performance, the inner diameter of the upstream sections should be within 0.5% of the metering section inner diameter at the flange. The downstream matching is not as critical but should be of the same schedule and matched as closely as possible.

In addition, gaskets should not protrude past the inner diameter to disrupt the flow profile.

2.4.1.5 Location of temperature and pressure measurements

Temperature and pressure measurements should always made downstream of the **Sentinel LCT8** and be located a minimum of 3D downstream of the pressure vessel, with a preferred distance of 5D downstream. For any other locations for temperature and pressure measurement consult Panametrics for an application assessment.

2.4.1.6 Calibration recommendations

In general, the best practice is to calibrate as much of the measuring section as possible. This would include upstream and downstream straight pipe runs and the **Sentinel LCT8**. While this is not always possible or cost effective, it will provide the best transferability from calibration to field usage. This methodology is highly recommended for *custody transfer master meter and duty* systems to maintain the lowest possible system uncertainty. Each application is different and requires a customized calibration plan. For calibration recommendations, consult the factory for an application assessment.

2.4.2 Fluid requirements

Gas - To avoid measurement errors, suitable measures should be taken to make sure the line is full and the gas in the line is kept below 1%. While the system may still be able to measure with larger amounts, it has the potential to affect accuracy. When gas is present, keep flow rates as high as possible to help push the gas through the metering section.

Particulate - To avoid measurement errors, suitable measures should be taken to minimize solid particulate in the line. Particulate should ideally be less than 1% for accurate measurement.

Water in oil - Water and oil mixtures under 5% should not affect accuracy as long as they are well mixed. Keep flow rates high enough to ensure a well-mixed solution. Higher percentages of water may be present, but this could affect the accuracy of measurements.

Please consult Panametrics for any applications where conditions are outside the above recommendations for a more comprehensive application review.

2.4.3 Guidelines for installing pipe insulation

If pipe insulation is required:

- Install all insulation materials and accessories in accordance with the manufacturer's instructions and the recognized industry practices. Adhere to the local code where applicable to ensure that the safe and proper installation will serve its intended purpose.

- Install the insulation material in layers, with smooth and even surfaces. Allow adequate space (air pockets) around all extended transducer buffer rods, conduit fittings, junction boxes, and cables, for proper ventilation. Avoid using cut pieces or scrap insulation when abutting the sections being installed. Butt insulation joints firmly to ensure a complete, tight fit over and around all piping surfaces.

- Maintain the integrity of any factory-applied vapor barrier jacketing on all pipe insulation, if applicable. Seal all joints and seams, protecting the insulation against puncture, tears or other damage.

2.5 Making the electrical connections

This section contains instructions for making the necessary electrical connections to the flow transmitter (see *Figure 12* below). The wiring between the transmitter and the transducers has been installed at the factory, and no further connections are required on this portion of the wiring.

IMPORTANT

When wires are connected to terminal blocks, use wire ties routed through the blocks, to secure them.

Attention European customers!

To meet CE Mark requirements, all cables must be installed as described in *Appendix A. CE Mark compliance and high noise environments on page 111*.

IMPORTANT

The meter is grounded to the electronics. This configuration must be considered when applying cathodic protection to the pipe line. The power ground applied to the instrument should be at the cathodic protection voltage level.

2.5.1 Removing the enclosure covers

WARNING!

Always disconnect the line power from the meter before removing either the front display cover or the wiring access cover. This is especially important in a hazardous environment.

1. Disconnect any previously wired power line from the flow transmitter.

2. Loosen the set screw on the side cover using a 2.5 mm hex wrench.

3. Place a rod or long screwdriver across the cover in the slots provided, and rotate the cover counterclockwise until it comes free from the enclosure.

4. Note the text printed on the terminal board (see *Figure 13 on page 31*) to assist in wiring the power and option card connections.

Proceed to the appropriate section of this chapter to make the desired wiring connections.

2 frequency
2 alarms
1 analog output (4-20 ma)
3 analog inputs (4-20 ma) or
2 analog inputs (4-20 ma) + 1 RTD input

RS232/RS485 modbus

Flow Computer

Corrected Volumetric Flow

RS232 or RS485

Pressure   Temperature

Sentinel LCT8

Meter calibration, data collection, configuration, and security

Panaview™ instrument interface software

Figure 12: *Sentinel LCT8* flow measurement system connections

Figure 13: Typical terminal board (three 4-20mA inputs option)

2.5.2 Cable tie-down posts

There are two cable tie-down posts provided in the **Sentinel LCT8** transmitter (see *Figure 14* below). These posts enable the user to insert a cable tie through them, and secure the wiring coming into or out of the instrument. The posts rotate on the printed circuit board to provide ease-of-use.

• **Power cable tie-down post** - use this tie-down post to secure the power cable.

• **Optional I/O cable tie-down post** - use this tie-down post to secure all I/O cables.
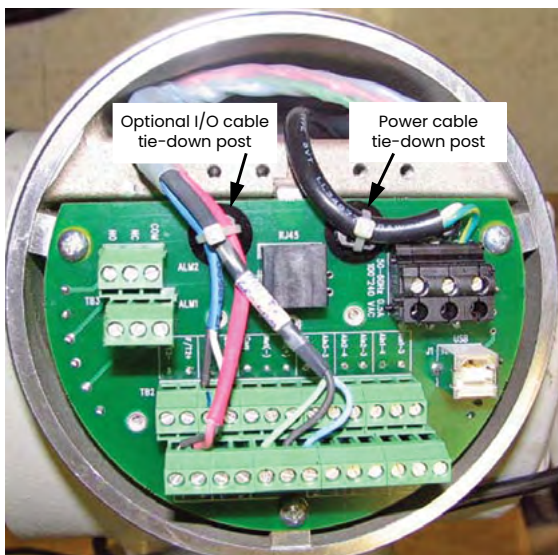
Figure 14: Cable tie-down posts locations

2.5.3 Wiring the line power

The **Sentinel LCT8** may be ordered for operation with a power input of either 100-240 VAC or 12–32 VDC. The label on the side of the electronics enclosure lists the required line voltage and power rating for your unit. Be sure to connect the **Sentinel LCT8** to the specified line voltage only.

NOTE: For compliance with the North American and European low voltage directive, this unit requires an external power disconnect device such as a switch or circuit breaker. The disconnect device must be marked as such, clearly visible, directly accessible, and located within 1.8 m (6 ft) of the unit.

NOTE: Use one conduit inlet for the power cable, and use the two remaining conduit inlets for any I/O cables as needed. All unused conduit inlets should be sealed with suitable blank plugs (see *Figure 15* below).

Figure 15: Conduit inlet ports

See *Figure 16 on page 11* or *Figure 17 on page 11* to locate terminal block TB1 and to connect the line power as follows:

⚠	**WARNING!** Improper connection of the line power leads, or connecting a **Sentinel LCT8** to the incorrect line voltage, may damage the unit. It may also result in hazardous voltages at the meter body and associated piping as well as within the electronics enclosure.

1. Prepare the line power leads by trimming the line and neutral AC power leads (or the positive and negative DC power leads) to a length 0.5 in. (1 cm) shorter than the ground lead. This ensures that the ground lead is the last to detach if the power cable is forcibly disconnected from the meter.

2. Route the cable through one of three conduit inlet ports (see Figure 15 above) and connect the line power leads to terminal block **TB1**, using the pin number assignments shown in *Figure 30 on page 17* and *Figure 16 on page 11* or *Figure 17 on page 11*.

⚠	**Attention European customers!** To meet CE Mark requirements, all cables must be installed as described in *Appendix A. CE Mark compliance and high noise environments on page 111*.
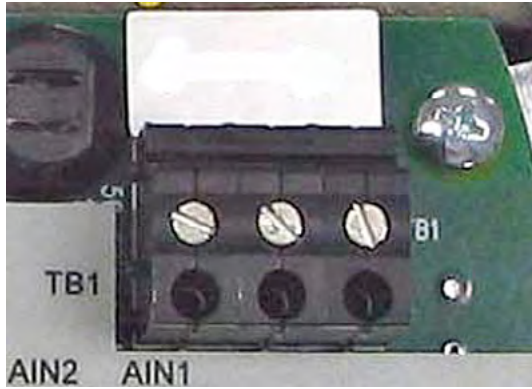
Figure 16: Wiring the AC line power
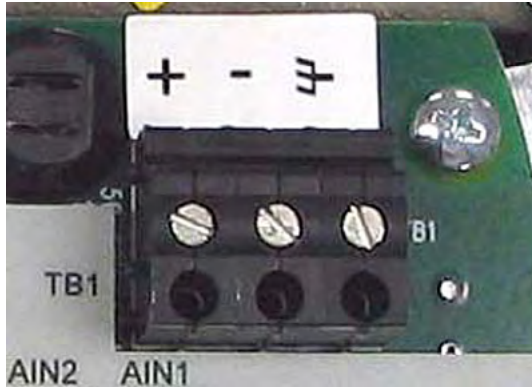
Figure 17: Wiring the DC line power

NOTE: All wires shall have a temperature/type rating 10K above the maximum service temperature of 85ºC, be stripped back 5/16 in. (8 mm) and torqued to a minimum of 4.4 in.-lb (0.5 N-m).

3. Run the power connections to the *power terminal block* shown in Figure 16 (AC power) or Figure 17 (DC power) above. The use of 12-18 AWG (3.3 - 0.82 mm2) wire is recommended for the power connections.

4. Strip 1/4-in. of insulation from the end of each of the three line power leads.

5. Route the cable through the chosen conduit hole and connect the line power leads to terminal block **TB1**, using the pin number assignments shown in *Figure 31 on page 18* and *Figure 16 on page 11* or *Figure 17 on page 11*.

6. Leaving a bit of slack, secure the power line with the cable clamp.

⚠️ **WARNING!**

Make sure both covers, with their o-ring seals, are installed, and the set screws tightened, before applying power in a hazardous environment.

7. After the line power has been connected to the flow transmitter, replace the side cover, tighten the set screw using a 2.5 mm hex wrench and proceed to the next section.

2.5.4 Wiring the serial port

The flow transmitter is equipped with a built-in serial communications port. This port is user-selectable to be either an RS232 or RS485 port. For more information on serial communications refer to Panametrics document *EIA serial communications* (916-054), which is included on the *flow manuals CD* included with your order. The use of 12-24 AWG (3.3 - 0.2 mm^2) twisted pair wiring is recommended for single conductors, and a minimum 18 AWG (1.5 mm^2) is recommended for two conductors per terminal.

2.5.4.1 Wiring the serial interface

To wire the serial port, refer to *Figure 31 on page 18* and complete the following steps:

1. Disconnect the main power to the meter and remove the wiring access cover.

2. Install the required cable gland in the chosen conduit hole of the electronics enclosure.

3. Feed one end of the cable through the cable gland, wire it to terminal block **TB2**, and secure it.

Figure 18: Serial connections

⚠️ **Attention European customers!**

To meet CE Mark requirements, all cables must be installed as described in *Appendix A. CE Mark compliance and high noise environments on page 111*.

4. If the wiring of the unit has been completed, reinstall the wiring access cover and tighten the set screw.

2.5.5 Wiring the modbus communications line (optional)

The **Sentinel LCT8** uses the RS485 interface with *modbus* communications protocol for a maximum line distance of up to 4000 ft (1200 m). Panametrics recommends using shielded 18-24 AWG (0.82 - 0.2 mm^2) cable having a characteristic impedance of 120 ohms, with 120-ohm termination at each end of the communications line. This interface is also user-configurable as an RS232 interface.

Connect the two leads and the shield of the modbus line to the **NET** section of terminal block **TB2** in the flow meter. See *Figure 13 on page 31*, *Table 2 on page 105* and *Figure 31 on page 18*.

2.5.6 Wiring the alarm relay

NOTE: The alarm relay can be wired as either normally open (NO) or normally closed (NC).

An alarm relay should be wired for *fail-safe* operation. In fail-safe mode, the alarm relay is constantly energized, except when it is triggered, or a power failure or other interruption occurs. See *Figure 19* below for the operation of a normally open alarm relay in *fail-safe* mode.

Connect the alarm relay in accordance with the wiring instructions shown on the terminal board label (see *Figure 13 on page 31* and *Figure 29 on page 16*). For a wiring diagram see *Figure 31 on page 18*.
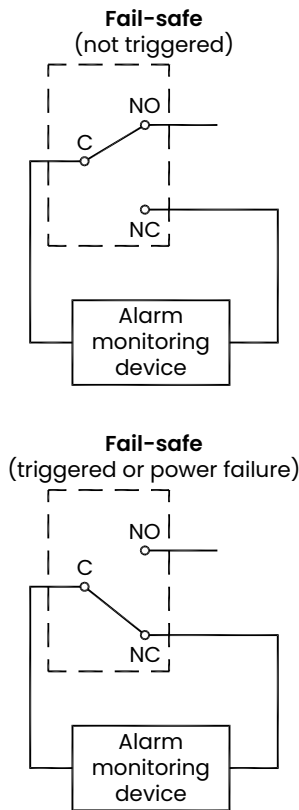
Figure 19: Fail-safe operation

The use of 12-24 AWG (3.3 - 0.2 mm^2) is recommended for single conductor wiring, and 16-24 AWG (1.5 - 0.2 mm^2) is recommended for two conductors per terminal.

2.5.7 Wiring the 4-20mA analog input (optional)

1. Disconnect the main power to the flow meter and remove the wiring access cover.

2. Install a cable gland in the chosen conduit hole of the electronics enclosure and feed a standard twisted-pair cable through this conduit hole.

3. Locate the 26-pin terminal block (**TB2**) in *Figure 29 on page 16* and wire the I/O terminal as indicated on the label inside the wiring access cover (see *Figure 13 on page 31* and *Figure 29 on page 16*). For a wiring diagram, see *Figure 31 on page 18*.

4. Secure the cable clamp.

> ⚠️ **Attention European customers!**
>
> To meet CE Mark requirements, all cables must be installed as described in *Appendix A. CE Mark compliance and high noise environments on page 111*.

5. If wiring of the unit has been completed, reinstall the side cover on the enclosure and tighten the set screw.

The analog input option provides either three isolated 4-20mA analog inputs (designated as Ain1, Ain2 and Ain3) or two isolated 4-20mA analog inputs and one RTD input (designated as Ain1, Ain2 and RTD1). Each of the 4-20mA inputs includes a 24 VDC power supply for loop-powered transmitters. The inputs may be used to process temperature, density and pressure signals.

Note: To enter programming data during operation of the **Sentinel LCT8**, it will be necessary to know which input is assigned to which process parameter. This information should be entered in *Appendix C. Modbus register map on page 117*.

The analog inputs, which have an impedance of 118 ohms, should be connected with standard twisted-pair wiring. Power to the transmitters may be supplied either by the internal 24 VDC power supply on the analog input terminal or by an external power supply. *Figure 20 on page 13* shows typical wiring diagrams, with and without an external power supply, for one of the analog inputs. *Figure 21 on page 13* shows 4-wire RTD 100 Ω input wiring. Wire the analog inputs as shown on the label in the enclosure side cover (see *Figure 13 on page 31* and *Figure 29 on page 16*). Terminal locations are shown in *Figure 22 on page 13* through *Figure 25 on page 13*.

The use of 12-24 AWG (3.3 - 0.2 mm^2) is recommended for single conductor wiring, and 16-24 AWG (1.5 - 0.2 mm^2) is recommended for two conductors per terminal.
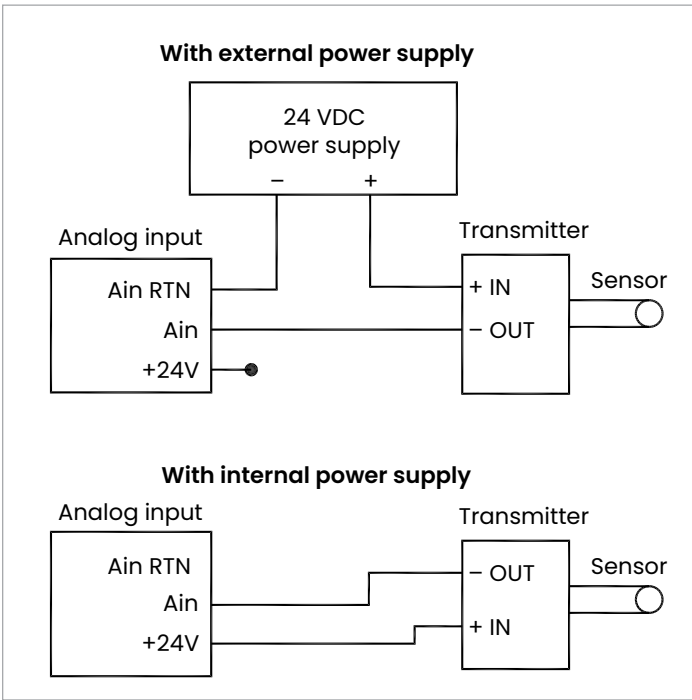
Figure 20: Analog input wiring diagram
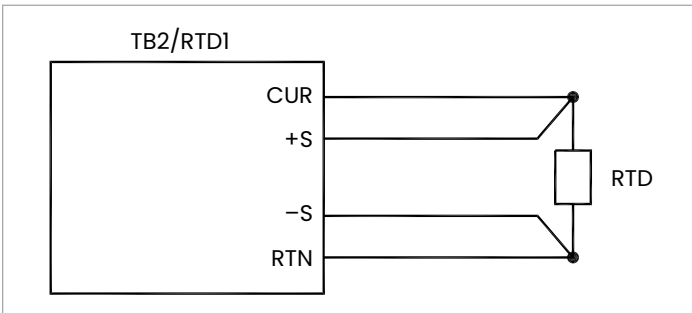
Figure 21: 4-Wire RTD input wiring diagram
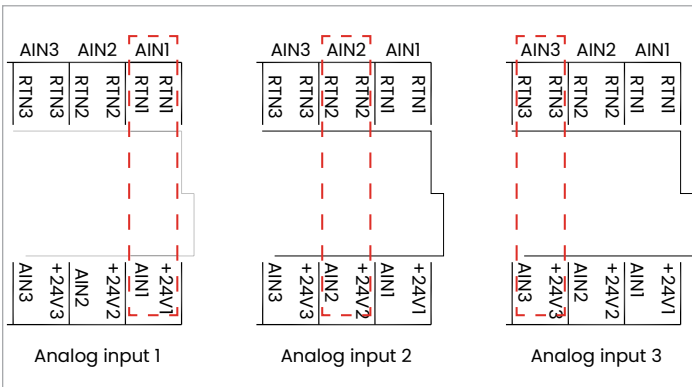
Figure 22: Terminal locations for 3 analog input option
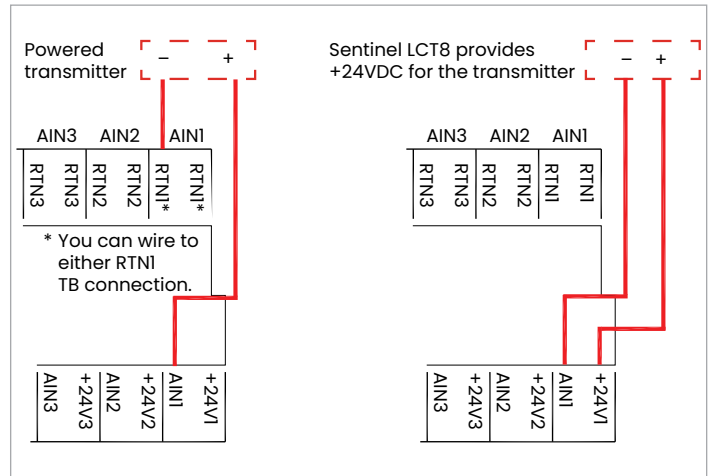
Figure 23: Terminal locations for analog transmitter use
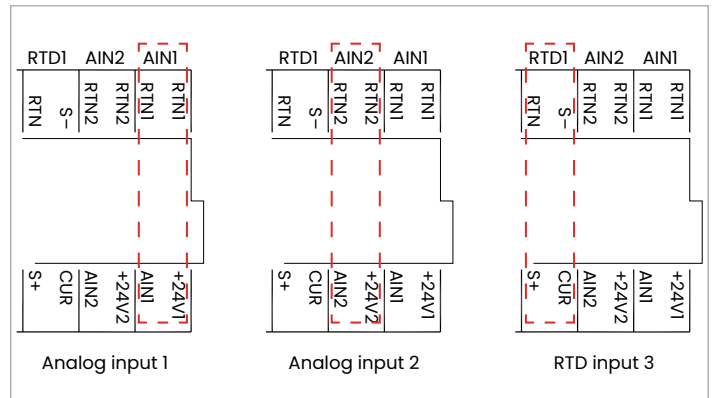
Figure 24: Terminal locations for 2 analog input and 1 RTD input option
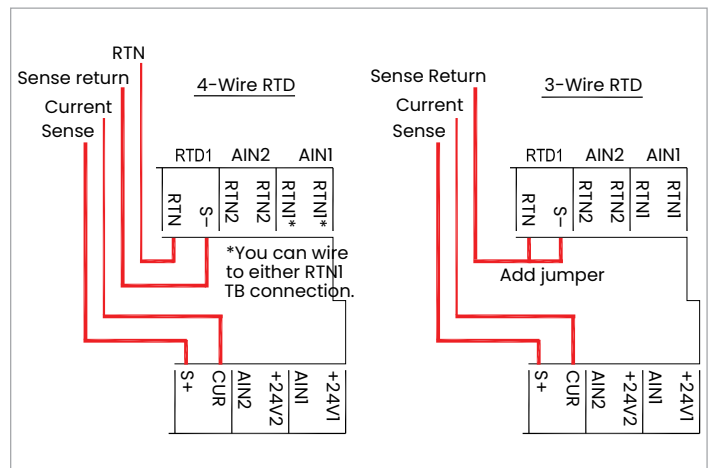
Figure 25: Terminal locations for 4-wire and 3-wire RTD use

2.5.8 Wiring the frequency/totalizer output

Figure 26 below shows sample wiring diagrams of the frequency/totalizer output circuit for open drain and push-pull configurations. The use of 12-24 AWG (3.3 - 0.2 mm^2) is recommended for single conductor wiring, and 16-24 AWG (1.5 - 0.2 mm^2) is recommended for two conductors per terminal.

Frequency/totalizer output
(open drain)

Frequency/totalizer output
(push-pull)
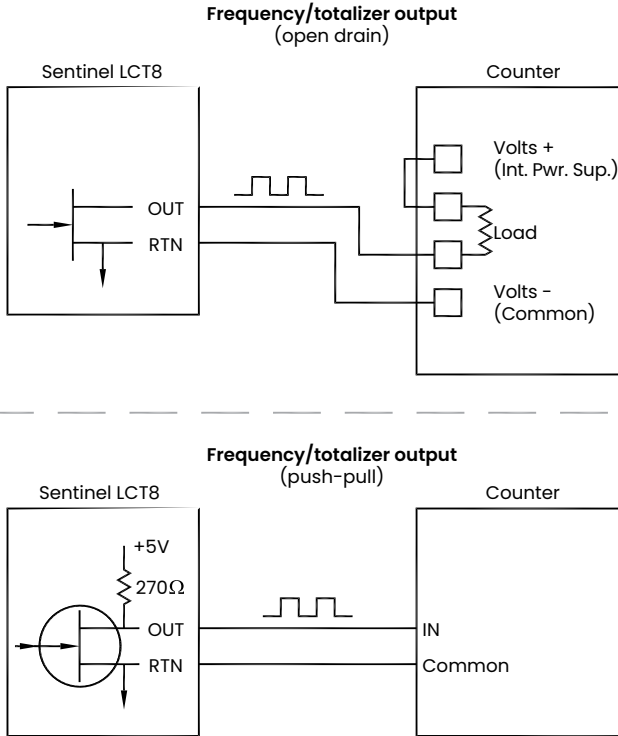
Figure 26: Totalizer and frequency output wiring Table 2: Wiring the TB2 I/O terminal block

Table 2: Wiring the TB2 I/O terminal block	
I/O Pin #	**Function**
F/T1+	Freq 1/totalizer 1 OUT
F/T1–	Freq 1/totalizer 1 RTN
F/T2+	Freq 2/totalizer 2 OUT
F/T2–	Freq 2/totalizer 2 RTN
NET R (+)	MODBUS–RTU RS232 (R)/RS485 (+)
NET T (–)	MODBUS–RTU RS232 (T)/RS485 (–)
NET COM	MODBUS–RTU common

2.5.9 Wiring the 4-20 mA analog output

The standard configuration of the flow transmitter includes an isolated 4-20 mA analog output. Connections to this output may be made with standard 12-24 AWG (3.3 - 0.2 mm^2) twisted-pair wire for a single conductor, and 16-24 AWG (1.5 - 0.2 mm^2) wire for a two-conductor connection, but the current loop impedance for these circuits must not exceed 1000 ohms. To wire the analog outputs, complete the following steps:

1. Disconnect the main power to the flow meter and remove the enclosure side cover.

2. Install the required cable clamp in the chosen conduit hole on the side of the electronics enclosure.

3. Locate the 26-pin terminal block (**TB2**) shown in Figure 30 on page 28, and wire the I/O terminal as indicated on the label inside the wiring access cover (see *Figure 13 on page 31* and *Figure 29 on page 16*). For a wiring diagram see *Figure 27 on page 14* or *Figure 28 below*.
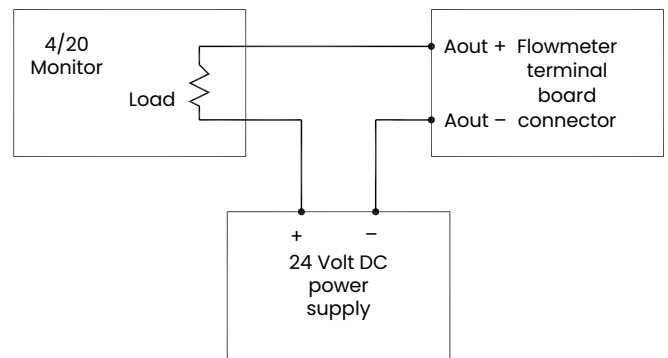
Figure 27: Analog output passive wiring
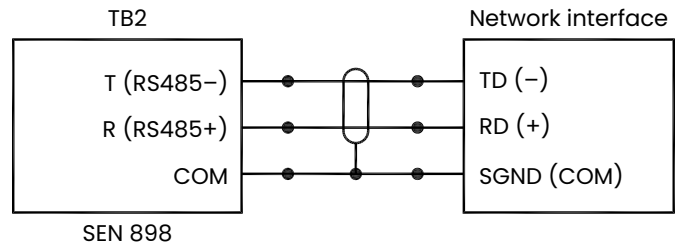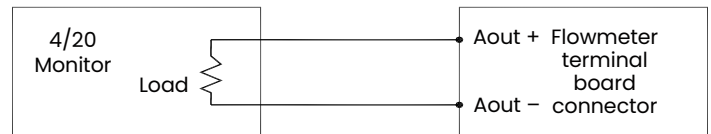

Figure 28: Analog output active wiring

4. Secure the cable clamp.

⚠️ **Attention European customers!**

To meet CE Mark requirements, all cables must be installed as described in *Appendix A. CE Mark compliance and high noise environments on page 111*.

5. If wiring of the unit has been completed, reinstall the wiring access cover on the enclosure and tighten the set screw.

2.6 Operation

After the **Sentinel LCT8** has been completely installed and wired, proceed to *Chapter 3. Programming on page 21*, to configure the flow meter.

⚠	**WARNING!**
	Make sure both covers, with their o-ring seals, are installed, and the set screws tightened, before applying power in a hazardous environment.

Only properly trained personnel are allowed to operate this vessel at the following conditions:

2.6.1 Startup

The **Sentinel LCT8** does not have any specific startup requirements after it has been properly installed into the piping system. Power should be supplied in accordance with local and national electrical codes. The pipeline does not need to be full of fluid for the system to be powered on.

2.6.2 Normal operation

This pressure vessel is intended to measure fluid flow under normal operation. There are no moving parts. The transmitter will make continuous measurements of the flow along with ancillary inputs of temperature and pressure for density compensation. The transmitter will output readings through any of several available output options (4-20mA, pulse out, modbus, etc.). If any errors occur they will be reported out as well.

2.6.3 Shutdown

While the **Sentinel LCT8** is intended for continuous service there are occasions where shutdown is required. There are no special requirements specifically for shutdown. The system should be de-energized prior to troubleshooting and any pressure build-up should be relieved.

2.6.4 Troubleshooting

Refer to *Chapter 5. Troubleshooting on page 89*, for a list of error codes and troubleshooting steps. For any other inquiries or assistance with troubleshooting the **Sentinel LCT8**, please consult Panametrics.
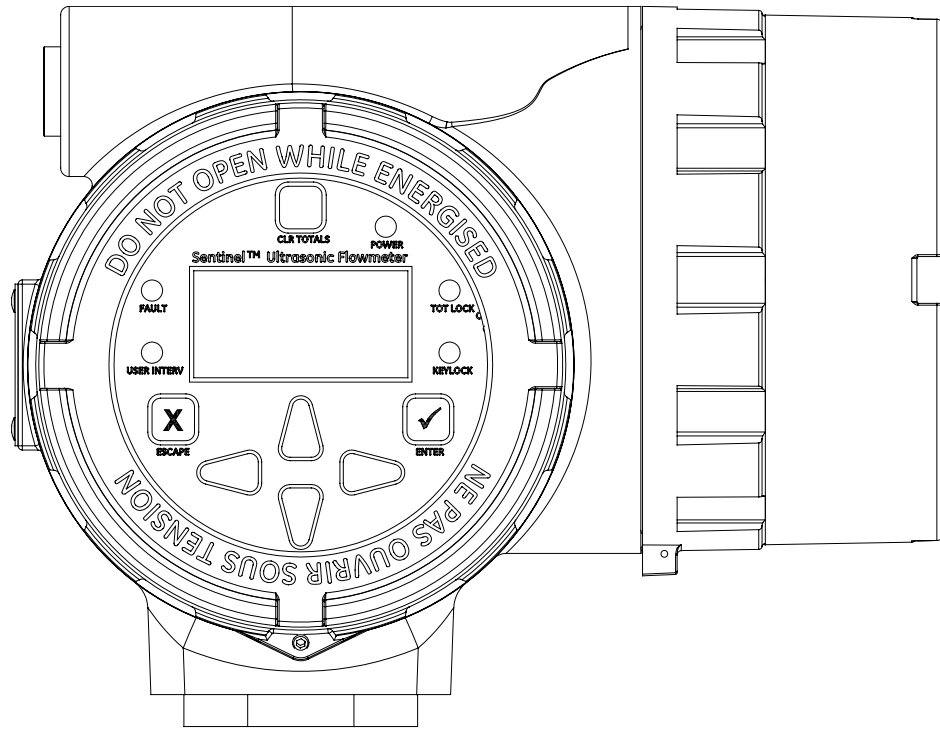
Front Display
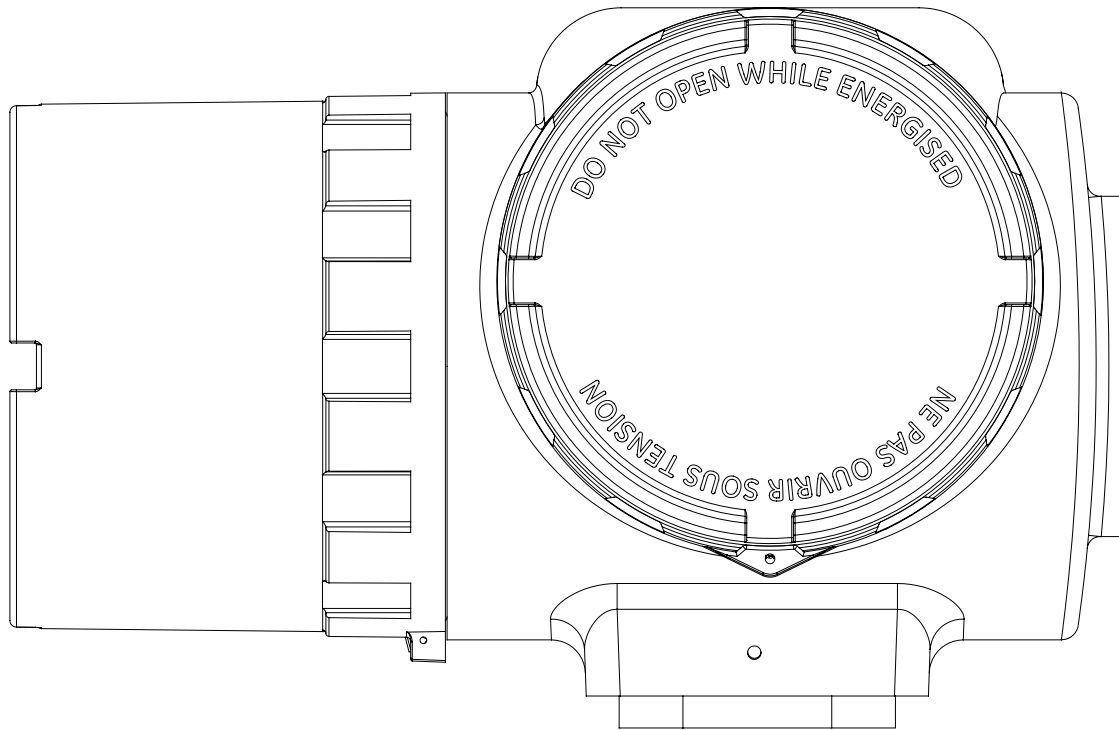
Wiring Access Cover

Figure 29: SEN898 electronics enclosure - front display and wiring access cover
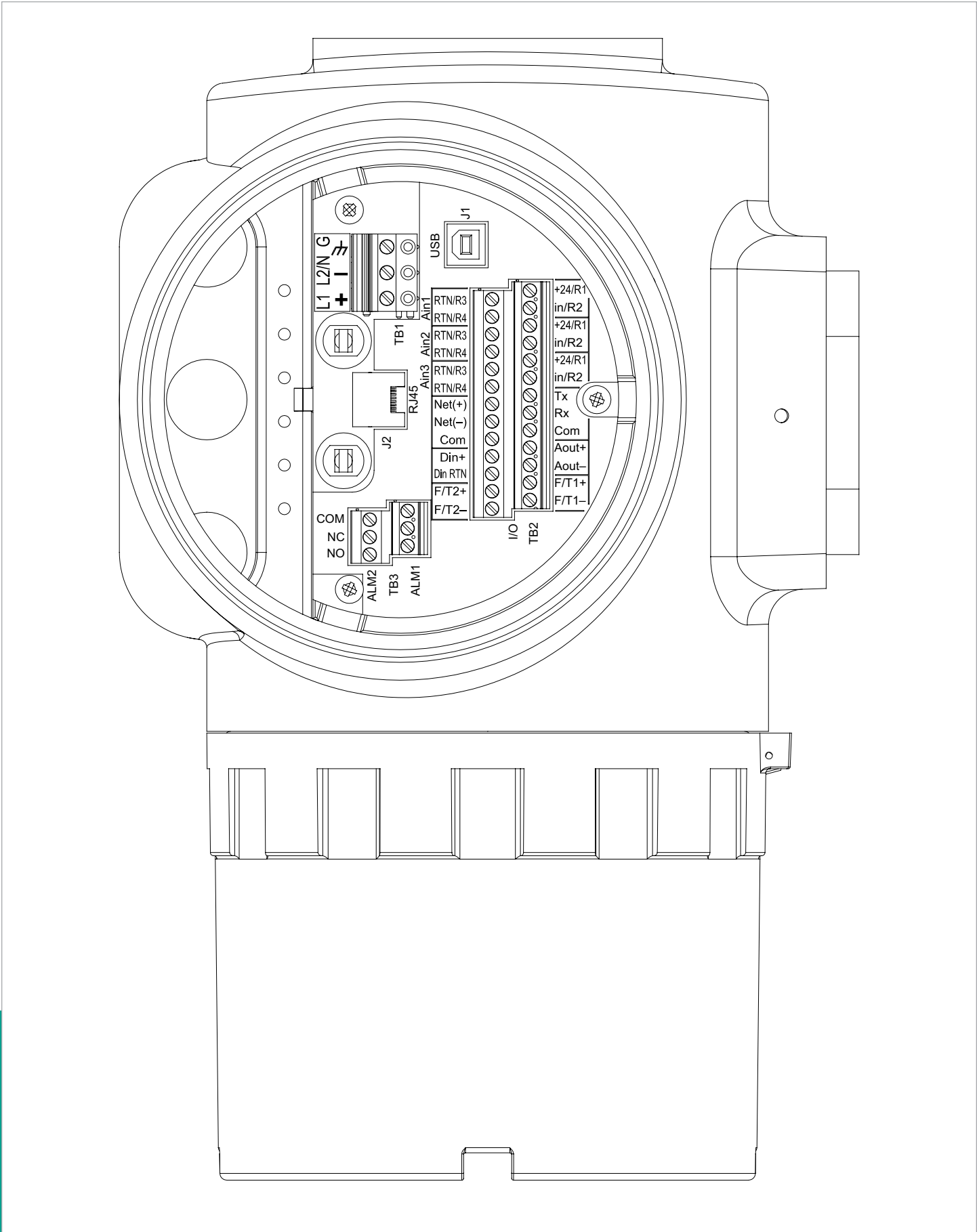
Figure 30: SEN898 electronics enclosure - terminal block layout
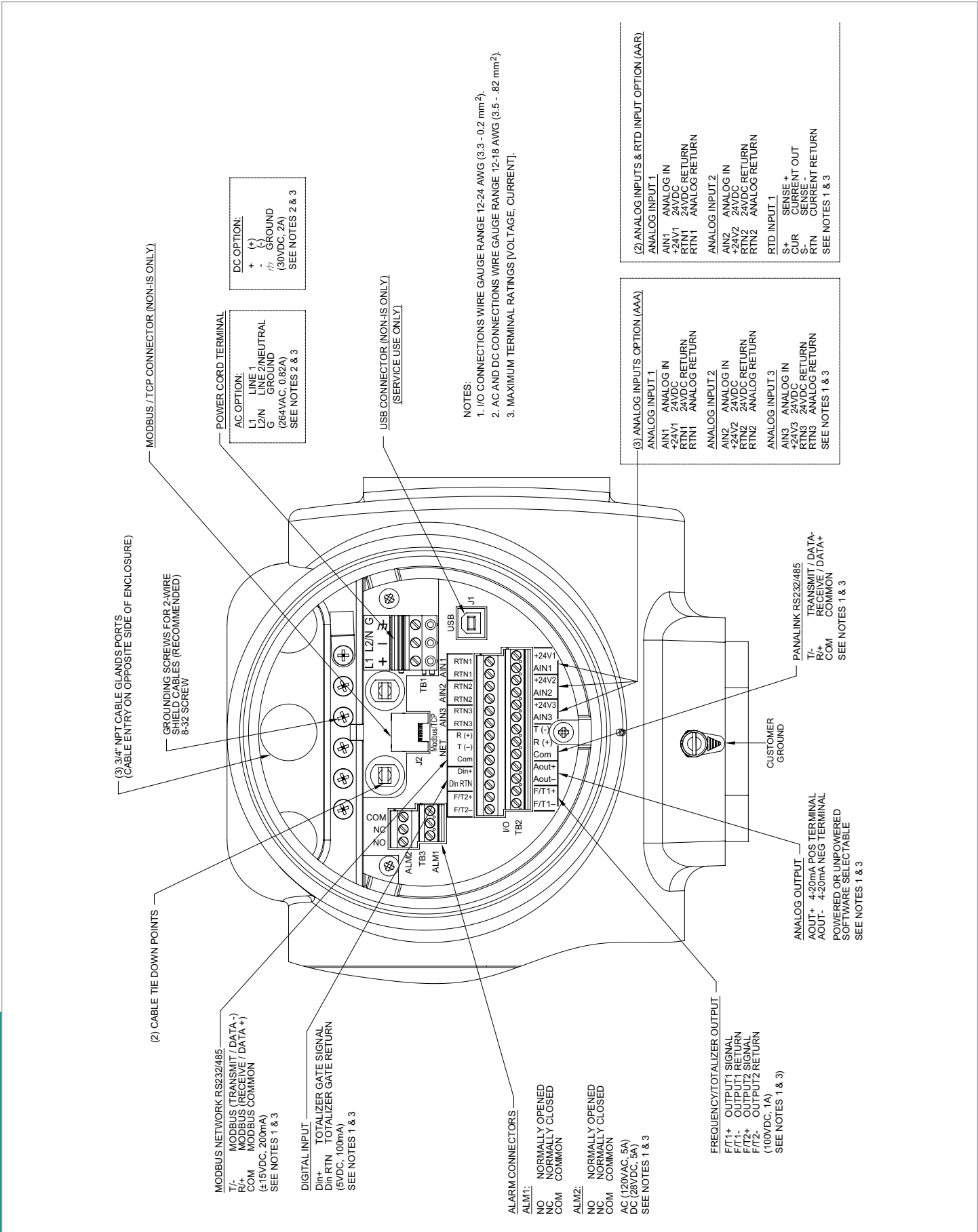
Figure 31: SEN898 electronics - wiring diagram (ref. dwg #702-884)

18

FLOWCELL (REAR VIEW)

FLOW →

8DN / XDCR
7DN / XDCR
6DN / XDCR
5DN / XDCR

4DN / XDCR
3DN / XDCR
2DN / XDCR
1DN / XDCR

INTERNAL CABLE,
SINGLE, 4X

INTERNAL CABLE,
SINGLE, 4X

FEEDTHRU
4X

PORT

PORT

PORT

PORT

FLOWCELL
(TOP VIEW)

INTERNAL CABLE,
SINGLE, 4X

INTERNAL CABLE,
SINGLE, 4X

XDCR / 1UP
XDCR / 2UP
XDCR / 3UP
XDCR / 4UP

XDCR / 5DN
XDCR / 6DN
XDCR / 7DN
XDCR / 8DN

FLOW →

FLOWCELL (FRONT VIEW)

SEN-LCT8
ELECTRONICS

INTERNAL CABLE
4-WIRE UP1-UP4

INTERNAL CABLE
4-WIRE DN1-DN4

PORT
B

PORT
C

PORT
A

PORT
D

INTERNAL CABLE
4-WIRE DN5-DN8

INTERNAL CABLE
4-WIRE UP5-UP8

DN1 DN2 DN3 DN4 DN5 DN6 DN7 DN8

UP1 UP2 UP3 UP4 UP5 UP6 UP7 UP8

FLOW PCB
(VIEWED FROM BOTTOM)

ENCLOSURE
(VIEWED FROM TOP)

Figure 32: Wiring LCT8 to SEN898 electronics - cross plane (6" - 24" flowcell), local mount (ref. dwg #702-2041)

Chapter 3. Programming

3.1   Introduction

The **Sentinel LCT8** flow transmitter includes a user program that provides access to the various programmable features of the instrument. This chapter describes step-by-step configuring instructions using the internal keypad shown in *Figure 33* below.

3.1.1   HMI features
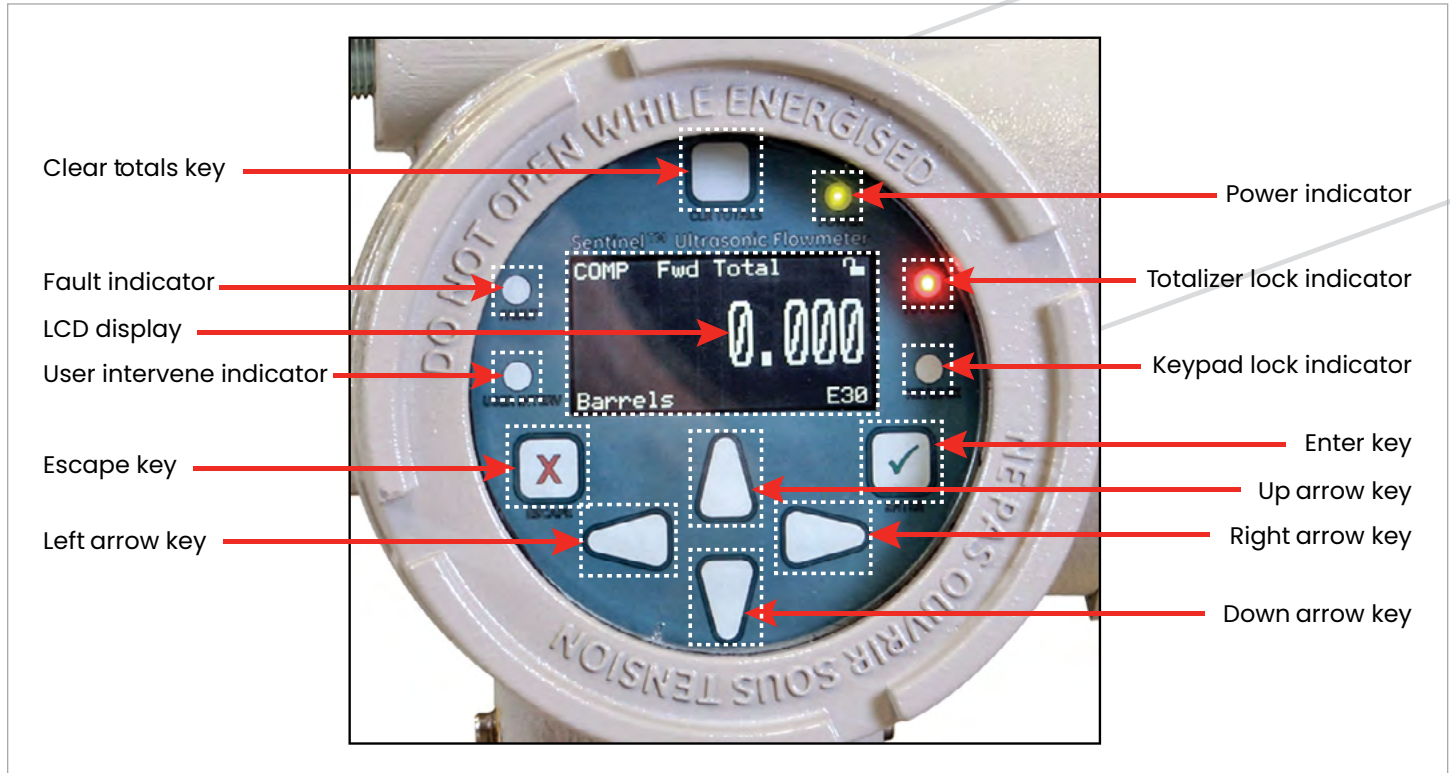
Figure 33: **Sentinel LCT8** HMI

The **Sentinel LCT8** HMI includes the seven keys listed in Table 3 below.

Key symbol	Key name	Functions
Table 3: Keypad symbols and descriptions		
CLR TOTALS	Clear totals key	To clear or reset accumulated totals
✖	Escape key	To cancel a numeric entry change, or exit a menu or as back key
✔	Enter key	To accept a numeric entry or select a menu option
◄	Left arrow key	To navigate among menu choices or pages or set cursor position
►	Right arrow key	To navigate among menu choices or pages or set cursor position
▲	Up arrow key	To navigate among menu choices or pages or increment numeric entries
▼	Down arrow key	To navigate among menu choices or pages or decrement numeric entries

3.1.2   Indicator lights

The **Sentinel LCT8** HMI includes the following indicator lights:

- The power indicator is normally lit when the instrument is powered on.

- The keypad lock indicator is lit if the internal keypad lock-out switch has been engaged.

NOTE: When the keypad lock indicator is lit, the keypad is not functional.

- The totalizer lock indicator is lit if the internal totals lock-out switch has been engaged.

NOTE: When the total lock indicator is lit, it is not possible to reset totals with the Clear totals key or through programming.

- If the fault indicator is lit, an instrument fault has been detected. This will also cause an error indication to be displayed in the lower right-hand corner of the measurement view screen.

- If the user intervene indicator is lit, an alarm has been triggered and will be kept latched until cleared by the user. See *Wiring the alarm relay on page 12* and *Inputs/outputs on page 53* for more information.

3.1.3   Totalizer hard switch

The security switches on the front display can be locked, which will lock out the ability to do any programming changes, even from a PC connected to meter, and the totalizer only lockout, which will not allow anyone to reset the totalizer, even from a PC connected to the meter. The front window cover is screwed into place over the display.

Figure 34: Front cover screwed

The set screw in the cover can be screwed down to tight up against the enclosure. With the set screw in place, the lead and wire seal can be threaded through the channel in such a way that access to loosen the set screw is completely blocked.
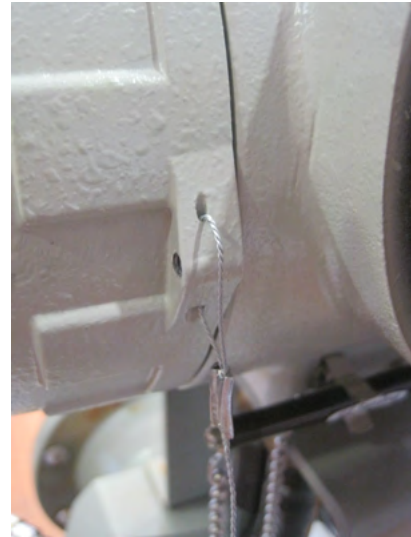
Figure 35: Set screw tied with wire seal

All connections can be made through the back cover while still protecting the key pad and the programming.

Figure 36: Back cover section

3.1.4   The magnetic stylus

Each of the keys can be selected using a hand-held magnet called a *magnetic stylus*, which is included with the meter (see *Figure 37* below). By touching the clear window at a key location, that key will be selected and will flash a red light to verify the contact.

NOTE: The red LED does not flash if contact is not made. Ensure the front cover is fully tightened.

Figure 37: Magnetic stylus

3.2 Navigating through the program options

3.2.1 Conventions and guidelines

In this manual, menu navigation is illustrated with graphics that represent the **Sentinel LCT8** *main display*. The color of the boxes and arrows used in these illustrations follow the conventions listed in *Table 4* below.

	Table 4: Color code descriptions	
Color code	**Monochrome code**	**Description**
	Red box	Option is visible only when logged in with at least user 1 access
	Red arrow	The navigation is only possible when logged in with at least user 1 access
	Red dotted arrow	The navigation is only possible when logged in with at least user 1 access. The dotted arrow indicates that all intermediate display changes are not explicitly shown in the diagram.
	Green box	Option is visible only when logged in with at least user 3 access
	Green arrow	The navigation is only possible when logged in with at least user 3 access
	Green dotted arrow	The navigation is only possible when logged in with at least user 3 access. The dotted arrow indicates, that all intermediate display changes are not explicitly shown in the diagram.
	Yellow box	Option is visible only when logged in with at least user admin access
	Yellow arrow	The navigation is only possible when logged in with at least user admin access
	Yellow dotted arrow	The navigation is only possible when logged in with at least user admin access. The dotted arrow indicates, that all intermediate display changes are not explicitly shown in the diagram.
	Magenta arrow	The navigation is only possible when logged in with at least display locked access
	Magenta dotted arrow	The navigation is only possible when logged in with at least display locked access. The dotted arrow indicates, that all intermediate display changes are not explicitly shown in the diagram.
	Blue arrow	Login not required for this navigation
	Gray arrow	Used as pointers to notes and guidelines

3.2.2 Security access level and privileges

To prevent unauthorized tampering with either the display or the user program, the **Sentinel LCT8** has multiple security access codes which grant different access level privileges (see *Table 5* below).

Level	Security access	Default passcode	Privilege details
Table 5: Security level descriptions
0	Full lock	0000 (fixed)	Meter locked, need passcode to unlock for viewing data or configuration.
1	Display locked	2719 (fixed)	Viewing data, select parameters to show in the measurement view.
2	User 1	0001*	Basic user configuration privileges
3	User 2	0002*	Basic user configuration privileges
4	User 3	0003*	Basic + power user configuration privileges
5	User 4	0004*	Basic + power user configuration privileges
6	User admin	0005*	Basic + power + admin user configuration privileges

*Panametrics recommends user admin to set new passcodes for each user access level.

3.3 Measurement view, security and page overview

The initial screen displayed upon meter startup is known as *measurement view*. The elements of measurement view are shown in *Figure 38* below, with gray arrows pointing to each element.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

Note the following:

- When logged in to *display locked access* level, the user can choose the measurement to be displayed in *measurement view* from a list of options.
- If there are no errors on the channel chosen for *measurement view*, the *error indicator* at the bottom right of the display is blank.
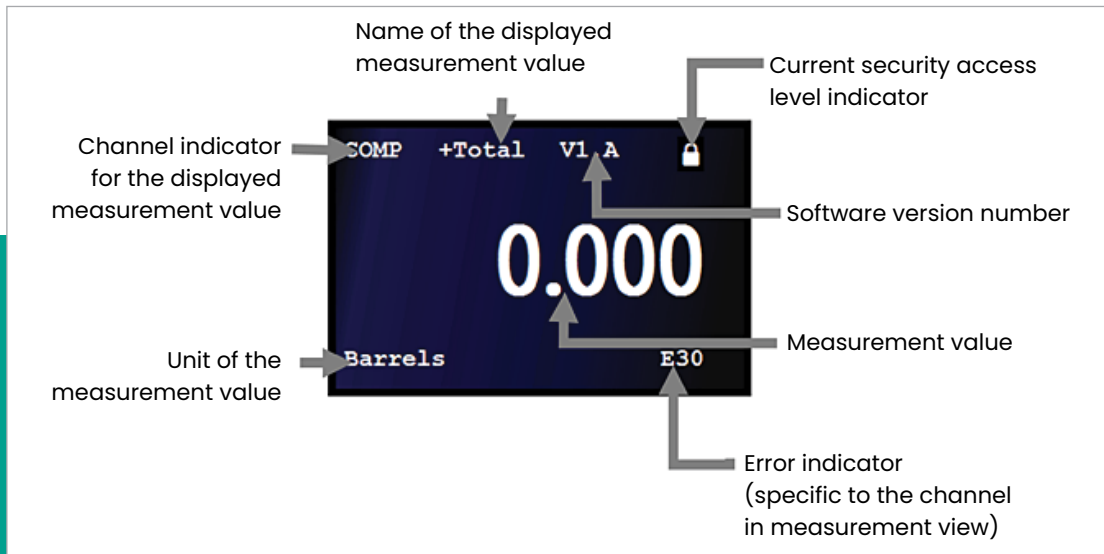
Figure 38: Measurement view

3.3.1 Unlocking the meter

NOTE: The user needs to enter a valid passcode to unlock the meter.

To unlock the display and/or the user program, refer to *Figure 39* below and complete the following steps:

1. From *measurement view*, press the [✖] , ✔, and [✖] keys in sequence (login is not required).

2. Use the [◄] and [►] keys to highlight the desired digit in the passcode display. Then, use the [▲] and [▼] keys to increment or decrement the value for that digit. Repeat this process until all four digits of a valid passcode have been entered.

NOTE: The example passcode shown in *Figure 39* below is the factory default user4 passcode. Your actual passcode may differ.

3. After the passcode has been entered, either press the [✖] key to cancel the unlock sequence and return to the locked *measurement view* or press the [✔] key to login an the unlocked measurement view.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

After unlocking the meter with the required level of security, the meter will remain active at this security level until the security level is changed or the meter keypad inactivity time limit (as set by a user admin) is exceeded.

Press ✖ ✔ ✖ in sequence

Use ◄ or ► arrow keys to position the cursor to the digit.

Use ▲ or ▼ arrow keys to increment or decrement the digits.

Press ✖ key to cancel

Press ✔ key to login

Icon on the upper right corner indicates successful login to user 4 level.

NOTE: The passcode in the picture indicates the default passcode for user 4 level. The actual passcodes may vary.

NOTE: The arrows in this figure are blue and indicate login is not required to follow these steps.

Figure 39: Steps to unlock the meter

3.3.2 Primary pages

The meter menu has nine *primary pages*. It is important to know how to navigate to these pages, as they provide access to the various features, options and configurations of the meter. A typical *measurement view* (unlocked at the *admin level*) and examples of the nine primary pages are shown in *Figure 40* below.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. From measurement view, press the [✖] key to go to *page 2* (at least *user1* access level is required).

2. To navigate between pages, use the [◀] and [▶] keys.

3. From any page, press the [✖] key to return to *measurement view*.

NOTE: The example pages shown above are for *admin* level access. The options may vary for *user* access levels, and some pages will be entirely blank for user1 and user2 access levels.

General instructions

From *measurement view* press ✖ key to go to *page 2*.

- To navigate between *pages*, use ◀ or ▶ keys.
- From any *page*, back to *measurement view* press ✖ key
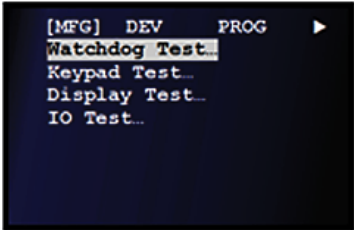
Press ✖ key
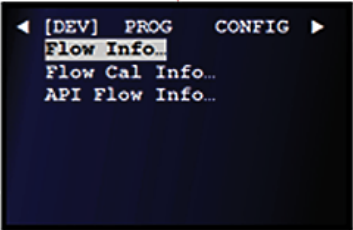
NOTE: The options shown in the *pages* are based on user admin access. User 1 and user 2 or user 3 and user 4 options vary. Some pages will appear blank to user 1 and user 2.
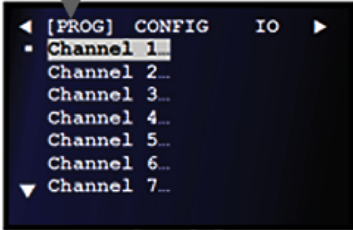
The [ ] highlights the current page,

```
COMP   +Total   V1.A   🔒A

      125.12

Barrels
```

```
[MFG]  DEV     PROG    ▶
Watchdog Test…
Keypad Test…
Display Test…
IO Test…
```
Page 1: Manufacturing tests

```
◀ [DEV]  PROG    CONFIG ▶
Flow Info…
Flow Cal Info…
API Flow Info…
```
Page 2: Device info
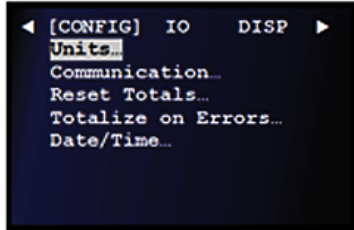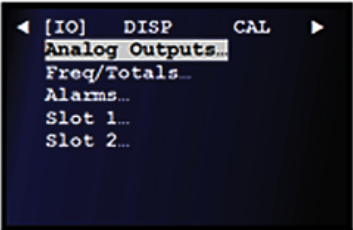
```
◀ [PROG] CONFIG   IO   ▶
▪ Channel 1…
  Channel 2…
  Channel 3…
  Channel 4…
  Channel 5…
  Channel 6…
▼ Channel 7…
```
Page 3: Program

▶ to page 4

◀ to page 3

```
◀ [CONFIG] IO    DISP  ▶
Units…
Communication…
Reset Totals…
Totalize on Errors…
Date/Time…
```
Page 4: Configuration (generic)

```
◀ [IO]   DISP    CAL   ▶
Analog Outputs…
Freq/Totals…
Alarms…
Slot 1…
Slot 2…
```
Page 5: IO
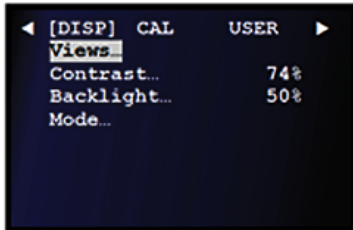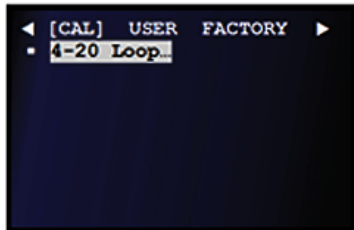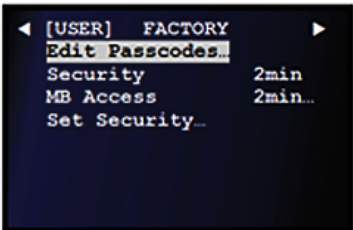
```
◀ [DISP] CAL    USER   ▶
Views…
Contrast…        74%
Backlight…       50%
Mode…
```
Page 6: Display

▶ to page 7

◀ to page 6

```
◀ [CAL]  USER  FACTORY ▶
▪ 4-20 Loop…
```
Page 7: Calibration (loop)

```
◀ [USER]  FACTORY      ▶
Edit Passcodes…
Security         2min
MB Access        2min…
Set Security…
```
Page 8: User configurations.
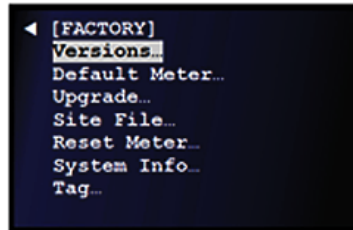
```
◀ [FACTORY]
Versions…
Default Meter…
Upgrade…
Site File…
Reset Meter…
System Info…
Tag…
```
Page 9: Factory

NOTE: The arrows in this figure are red and indicate at least user 1 access level is required to follow these steps.

Figure 40: Primary pages

3.3.3 Changing the access level

The user can change the access level in two ways:

- From *measurement view*
- From *user configurations*

3.3.3.1 Changing the access level from measurement view

To change the access level from *measurement view,* refer to *Figure 41* below and complete the following steps:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. From *measurement view,* use the [◄] and [►] keys to highlight the *security level* icon (at least *display locked* access level is required to make these changes).

2. Press the [✓] key to access the security options list.

3. Use the [▲] and [▼] keys to highlight the desired *security level* option.

4. Press the [✓] key twice confirm your selection.

NOTE: The example screens shown above are for *admin* level access. The options vary for other access levels.

NOTE: The options shown are based on user admin access. Other access level options vary.

Use ▲ or ▼ arrow to highlight the "security level" option you want to select and press ✓ twice to confirm selection.

NOTE: The arrows in this figure are magenta and indicate at least "display locked" access level is required to follow these steps.

Figure 41: Setting the security level from measurement view

3.3.3.2 Changing the access level from user configurations

To change the access level from *user configurations*, refer to *Figure 42* below and complete the following steps:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 8: user configurations*.

2. Use the [▲] and [▼] keys to highlight the set security option. Then, press the [✓] key to access the security options list (at least user1 access level is required).

3. Use the [▲] and [▼] keys to highlight the desired security level option.

4. Press the [✓] key twice confirm your selection.

NOTE: The example screens shown above are for admin level access. The options vary for other access levels.

Use ▲ or ▼ arrow to highlight the "security level" option you want to select and press ✓ twice to confirm selection.

NOTE: The options shown are based on user admin access. Other access level options vary.

NOTE: The arrows in this figure are red and indicate at least user 1 access level is required to follow these steps.
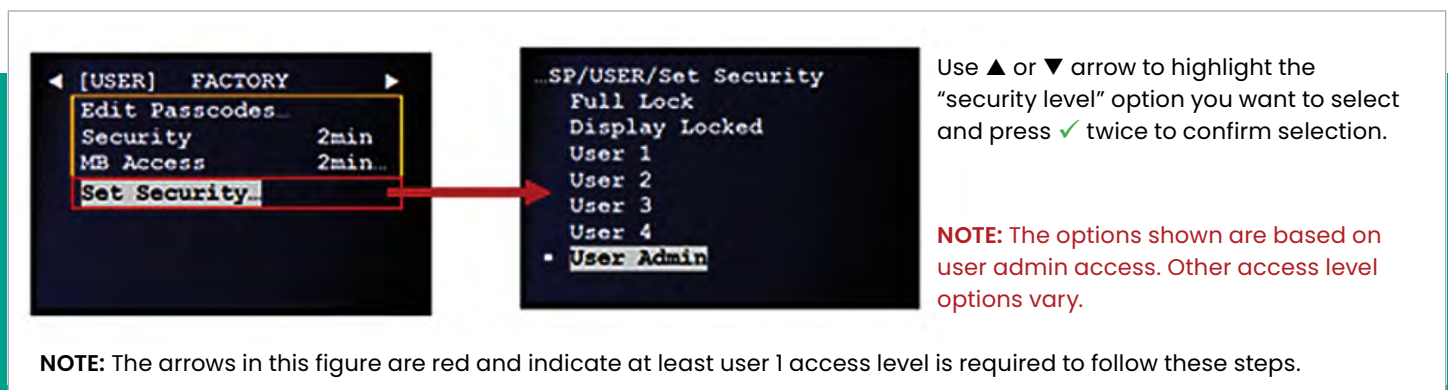
Figure 42: Setting the security level from user configurations

3.4 Programming menu options

3.4.1 Channel programming

The *channel program* allows the entry of *configuration data* and settings adjustments for each physical channel.

3.4.1.1 Activating a channel/path/CHX (status)

A channel/path should be activated when the unit is received, however, verify that the channel/path is active before trying to acquire data. To activate a channel/path, refer to *Figure 43* below and complete the following steps:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 3: program.*

2. Use the [▲] and [▼] keys to highlight the desired channel. Press the [✓] key twice to confirm your choice.

3. Use the [▲] and [▼] keys to highlight the *channel status* option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

4. Use the [▲] and [▼] keys to highlight either the *on* or *off* option. Then, press the [✓] key twice to confirm your selection or press the [✗] key to keep the original setting. You will then return to the previous screen.

NOTE: To select channel 2 to channel 8, highlight the option and press ✓ key twice to confirm the selection. Once you confirm your selection you will see the next screen.

Legend		
➜ Red	At least user 1 level access required to follow the step.
➜ Green	At least user 3 level access required to follow the step.
▭ Green	Option only visible to user 3 or above.

The ▼ arrow on the screen usually indicates there are more options below and the ▼ arrow can be used to scroll to those options

Use ▲ or ▼ arrow to highlight the "channel status" option you want to select and press ✓ twice to confirm selection.

Figure 43: Activating a channel/path

29

3.4.1.2 Entering the signal parameters

Use the signal submenu, to set the **Sentinel LCT8** transducer signal parameters.

<table>
<tr><td align="center">**IMPORTANT**</td></tr>
</table>

The factory default *signal parameters* are suitable for most applications. Consult the factory before changing any of these settings.

To configure the *signal parameters*, refer to *Figure 44* below and complete the following steps:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *Page 3: program.*

2. Use the [▲] and [▼] keys to highlight the desired channel.

Press the [✓] key twice to confirm your choice.

3. Use the [▲] and [▼] keys to highlight the signal option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

4. Use the [▲] and [▼] keys to highlight the zero cutoff or the active tw peak pcnt option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

NOTE: The zero cutoff parameter causes fluid velocities less than the setpoint to be reported as zero.

5. Enter the desired value for the signal parameter chosen in the previous step. Press the [✓] key to confirm the new value or press the [✗] key to keep the original value. You will then return to the previous screen.

Figure 44: Entering the signal parameters

3.4.1.3 Entering the error limits

The *error limits* option enables setting limits for the acoustic signals. If a signal falls outside these programmed limits, an error code is displayed. To set the error limits, refer to *Figure 45* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

Figure 45: Entering the error limits

1. Refer to *Primary pages on page 26* and navigate to *Page 3: program*.

2. Use the [▲] and [▼] keys to highlight the desired channel. Press the [✓] key twice to confirm your choice.

3. Use the [▲] and [▼] keys to highlight the *error limits* option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

4. Use the [▲] and [▼] keys to highlight the desired *signal parameter*. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

5. Enter the desired *error limit* for the chosen signal parameter. Press the [✓] key to confirm the new value or press the [✗] key to keep the original value. In either case, you will then return to the previous screen.

6. Repeat *steps 4 and 5* as necessary, to program additional signal parameter error limits.

3.4.1.4 Understanding the error limits

Note the following information about the **Sentinel LCT8** error limits:

- The *signal min* limit is the minimum acceptable value for the transducer signal received by the **Sentinel LCT8**. If the signal falls below the programmed limit, the **E1: LOW SIGNAL** error is displayed.

- The measured velocity value is expected to be within the *min velocity* and *max velocity* limits. If the measured velocity is outside the programmed range, a **W3: VELOCITY RANGE** warning is displayed.

- The amplitude of the received signal is expected to be within the *amplitude min* and *amplitude max.* programmed limits. If the signal falls outside these limits, the **E5: AMPLITUDE** error is displayed.

- If the fluid soundspeed exceeds that entered in the *normal mode of fluid* submenu by more than the percentage programmed in the *NormalMde SoS* error limit, the **E2: SOUNDSPEED** error is displayed.

- If the velocity changes by more than the programmed *acceleration* error limit from one measurement to the next, the **E6: ACCELERATION** error is displayed.

- If the SNR is below the programmed *SNR* error limit, the **W24:SNR** warning is displayed.

NOTE: Refer to *"Table 14"* for more details about errors and warnings.

3.4.2 Composite programming

The *composite program* allows entry of configuration data that applies to the composite calculations. The composite configurations are appropriately set for the intended application during commissioning. However, these settings should be verified before data is acquired or whenever the meter reports an error.

NOTE: Composite programming is accomplished via the *program* primary page (see *Figure 40 on page 26*).

Figure 46: Fluid type/tracking configuration

3.4.2.1 Fluid type/tracking configuration

It is critical to select the appropriate fluid type/tracking option for the application. Tracking refers to *tracking windows*, which is used to detect the receive signal when you are unsure of the fluid sound speed, or when the fluid sound speed changes drastically under process conditions. To program the fluid type/tracking options, refer to *Figure 46 on page 33* and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 3: program*.

2. Use the [▲] and [▼] keys to highlight composite in the list of channels, and press the [✓] key twice to confirm your choice.

3. Use the [▲] and [▼] keys to highlight the fluid option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

4. At the next screen, fluid type is the only option and is already highlighted. Press the [✓] key to confirm this selection or press the [✗] key to return to the previous screen.

IMPORTANT

Consult the factory before choosing either the normal fluid type or preprogrammed tracking options.

5. Use the [▲] and [▼] keys to highlight tracking. Then, press the [✓] key twice to confirm your selection or press the [✗] key to return to the previous screen.

6. Use the [▲] and [▼] keys to highlight either *preprogrammed* or *other*, then, press the [✓] key twice to confirm your selection or press the [✗] key to return to the previous screen.

    a. If *preprogrammed* was selected, use the [▲] and [▼] keys to highlight the desired option. Press the [✓] key twice to confirm your selection or press the [✗] key to cancel. You will return to the previous screen.

    b. If *other* was selected, use the [▲] and [▼] keys to highlight the Soundspeed min option. Press the [✓] key to confirm your selection. Enter the desired value and press the [✓] key to confirm your entry or press the [✗] key to cancel the change. When, you return to the previous screen, repeat the process to enter the *Soundspeed max* value.

3.4.2.2 Signal parameter configuration

⚠️	**CAUTION!**
	The SIGNAL default settings are suitable for most applications. Consult the Panametrics factory before changing these settings.

Use the signal submenu to set the parameters that apply compensations and handle noisy signals. To adjust the error Allowed options, refer to *Figure 47* below and complete the following steps:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 3: program*.

2. Use the [▲] and [▼] keys to highlight *composite* in the list of channels, and press the [✓] key twice to confirm your choice.

3. At the next screen, use the [▲] and [▼] keys to highlight the *signal* option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

4. At the next screen, use the [▲] and [▼] keys to highlight the *error allowed* option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

5. At the next screen, enter the desired value and press the [✓] key to confirm your entry or press the [✗] key to cancel the change.

NOTE: To select composite, highlight the option and press ✓ key twice to confirm the selection. Once you confirm your selection you will see the next screen.

NOTE: Consult Panametrics factory before changing defaults

Legend		
→	Red	At least user 1 level access required to follow the step.
→	Green	At least user 3 level access required to follow the step.
···▸	Dotted green	Not all transitional screens are shown (at least user 3 level access required).
▭	Green	Option only visible to user 3 or above.
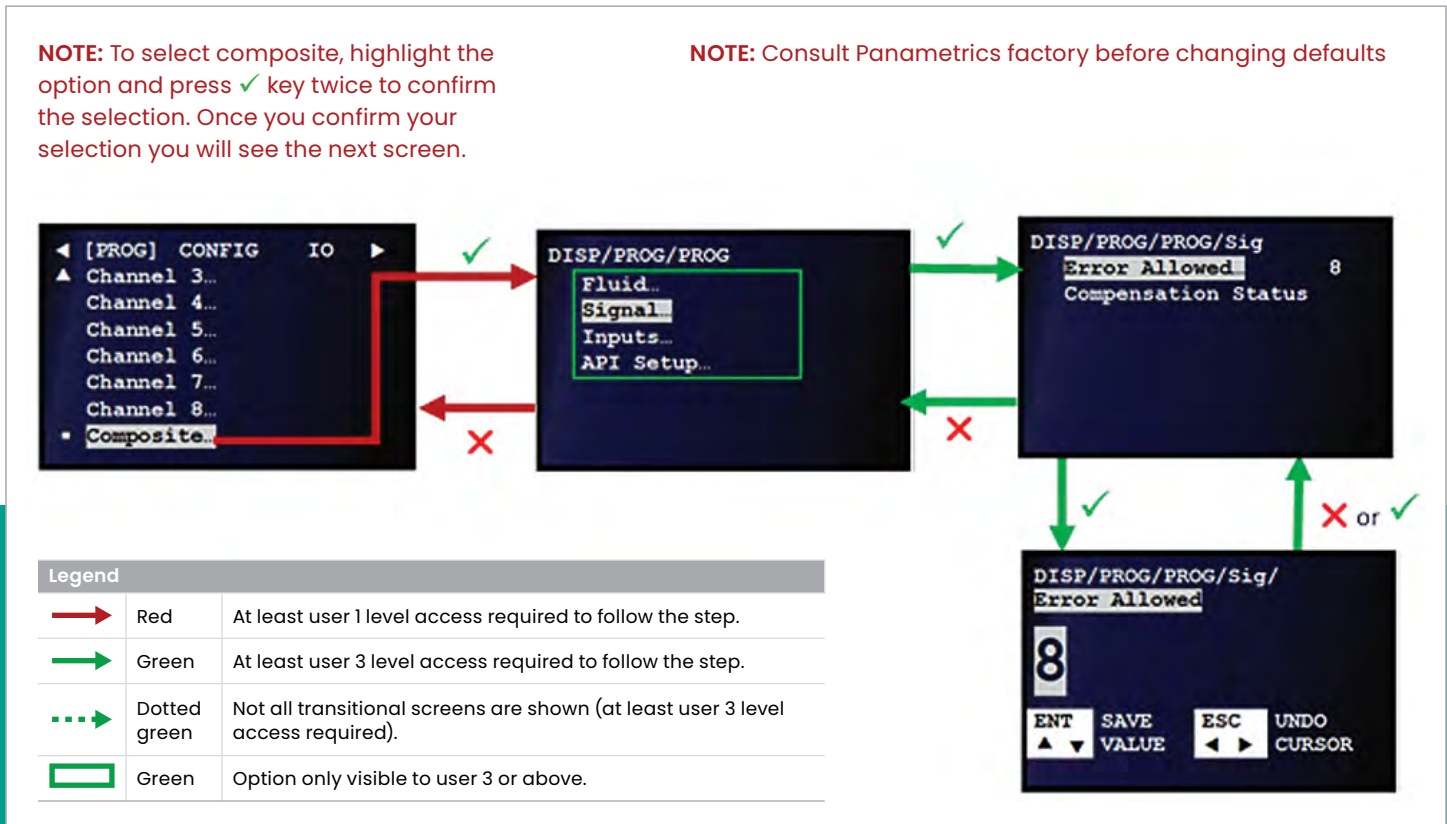
Figure 47: Setting the error allowed

Turning *dimensional compensation* on enables the meter to perform calculations that correct for geometric changes in the flowcell caused be temperature variations. This may be helpful in applications where the temperature in or around the flowcell is known to vary significantly. To select the *dimensional compensation status*, refer to *Figure 48* below and complete the following steps:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 3: program.*

2. Use the [▲] and [▼] keys to highlight *composite* in the list of channels, and press the [✓] key twice to confirm your choice.

3. At the next screen, use the [▲] and [▼] keys to highlight the *signal* option. Then, press the [✓] key to confirm your selection or press the [✖] key to return to the previous screen.

4. At the next screen, use the [▲] and [▼] keys to highlight the *compensation status* option. Then, press the [✓] key to confirm your selection or press the [✖] key to return to the previous screen.

5. At the next screen, use the [▲] and [▼] keys to highlight *on* or *off* and press the [✓] key twice to confirm your status selection or press the [✖] key to cancel the change.

NOTE: To select composite, highlight the option and press ✓ key twice to confirm the selection. Once you confirm your selection you will see the next screen.

NOTE: Consult Panametrics factory before changing defaults

Legend		
→ (Red)	Red	At least user 1 level access required to follow the step.
→ (Green)	Green	At least user 3 level access required to follow the step.
┅► (Dotted green)	Dotted green	Not all transitional screens are shown (at least user 3 level access required).
▭ (Green)	Green	Option only visible to user 3 or above.

Figure 48: Setting the dimensional compensation status

3.4.3 setting up the input data feeds

Use the *inputs* submenu to select where the *temperature, pressure* and *density* inputs are used. To set up the desired inputs, refer to *Figure 49* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.
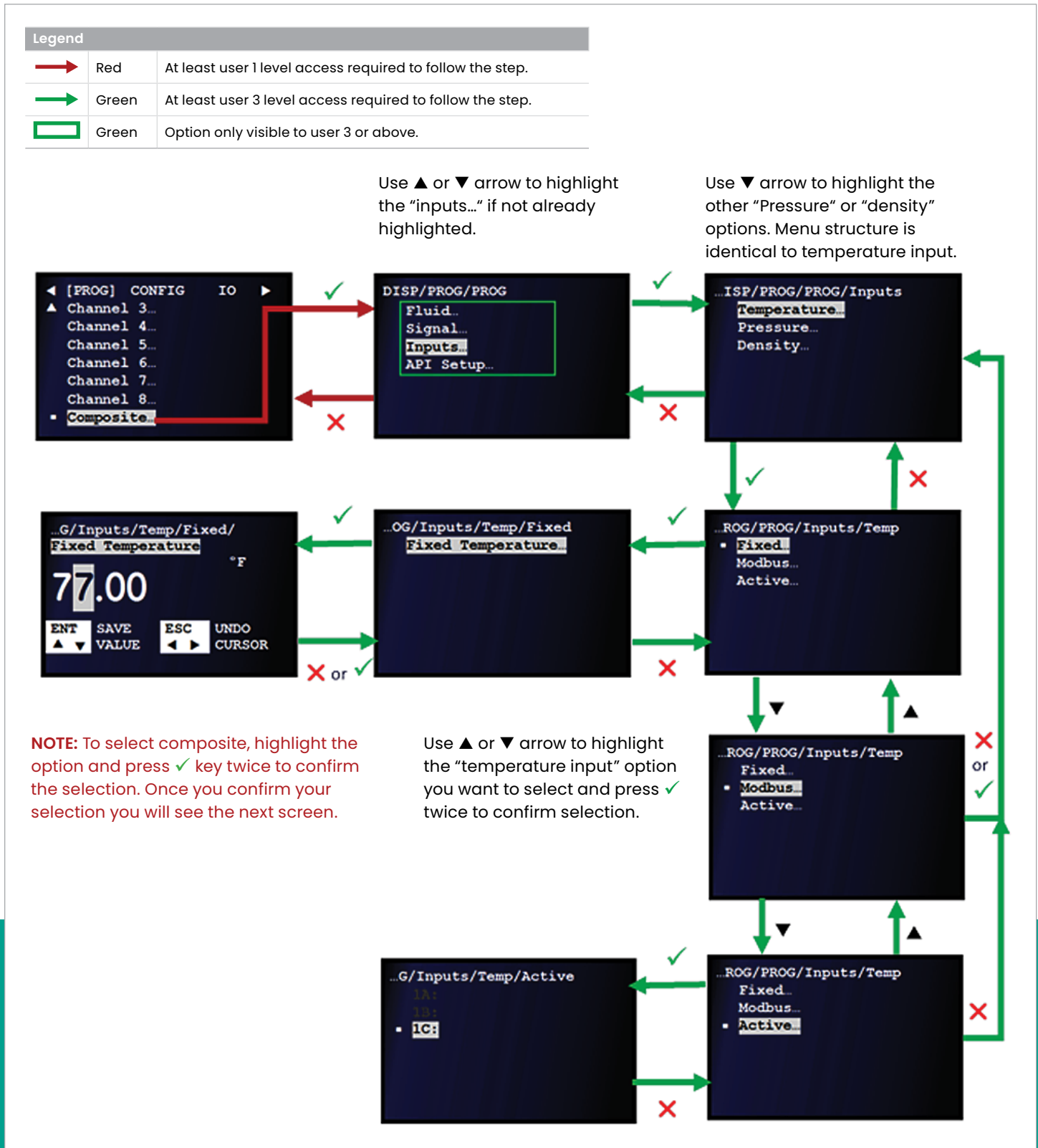
Figure 49: Temperature, pressure and density data feeds

1. Refer to *Primary pages on page 26* and navigate to *page 3: program*.

2. Use the [▲] and [▼] keys to highlight *composite* in the list of channels, and press the [✓] key twice to confirm your choice.

3. At the next screen, use the [▲] and [▼] keys to highlight the *inputs* option. Then, press the [✓] key to confirm your selection or press the [✖] key to return to the previous screen.

4. At the next screen, use the [▲] and [▼] keys to highlight the desired data feed parameter. Then, press the [✓] key to confirm your selection or press the [✖] key to return to the previous screen.

NOTE: The following steps are the same for all three data feed parameters.

5. At the next screen, use the [▲] and [▼] keys to highlight the desired option and press the [✓] key twice to confirm your selection or press the [✖] key to return to the previous screen.

   a. If you selected **fixed**, enter the appropriate value and press the [✓] key to confirm the new value or press the [✖] key to cancel the change.

   b. If you selected **modbus**, select the desired input option and press the [✓] key twice to confirm your selection or press the [✖] key to cancel the change.

   c. If you selected **active**, select the desired input option and press the [✓] key twice to confirm your selection or press the [✖]key to cancel the change.

3.4.4 Setting up the API

NOTE: API is optional and this section is applicable only if the API option was ordered.

Use the *API setup* submenu by completing the following steps:

1. Refer to *Primary pages on page 26* and navigate to *page 3: program*.

2. Use the [▲] and [▼] keys to highlight *composite* in the list of channels, and press the [✓] key twice to confirm your choice.

3. Proceed to the following subsections to complete the setup.

3.4.4.1 Choosing the API table type

To select the appropriate API table type, refer to *Figure 50 on page 39* and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. At the next screen, use the [▲] and [▼] keys to highlight the *API setup* option. Then, press the [✓] key to confirm your selection or press the [✖] key to return to the previous screen.

2. At the next screen, use the [▲] and [▼] keys to highlight the *API table type* option. Then, press the [✓] key to confirm your selection or press the [✖] key to return to the previous screen.

3. At the next screen, use the [▲] and [▼] keys to highlight the *table type* appropriate for your application. Then, press the [✓] key twice to confirm your selection or press the [✖] key to return to the previous screen.

4. At the next screen, with *thermal expansion coefficient (TEC)* highlighted, press the [✓] key to confirm the selection or press the [✖] key to return to the previous screen.

5. Enter the appropriate value and press the [✓] key to confirm the new value or press the [✖] key to cancel the change.

NOTE: To select composite, highlight the option and press ✓ key twice to confirm selection. Once you confirm your selection you will see the next screen.

Use ▲ or ▼ arrow to highlight "API setup…" if not already highlighted.

Use ▲ or ▼ arrow to highlight the "API table type" option you want to select and press ✓ twice to confirm selection.

Legend		
→ Red	At least user 1 level access required to follow the step.
→ Green	At least user 3 level access required to follow the step.
▭ Green	Option only visible to user 3 or above.

Figure 50: API table type selection

3.4.4.2 Setting the API condition - base condition

To set the API Base condition, refer to *Figure 51* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. At the next screen, use the [▲] and [▼] keys to highlight the *API setup* option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

2. At the next screen, use the [▲] and [▼] keys to highlight the *API conditions* option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

3. At the next screen, use the [▲] and [▼] keys to highlight the *base condition* option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

4. At the next screen, use the [▲] and [▼] keys to highlight the desired *base condition* option. Then, press the [✓] key twice to confirm your selection or press the [✗] key to return to the previous screen.

If user defined was selected as the base condition, complete the following additional steps:

5. At the next screen, with *user def base temp* highlighted, press the [✓] key to confirm the selection or press the [✗] key to return to the previous screen.

6. Enter the appropriate value and press the [✓] key to confirm the new value or press the [✗] key to cancel the change.
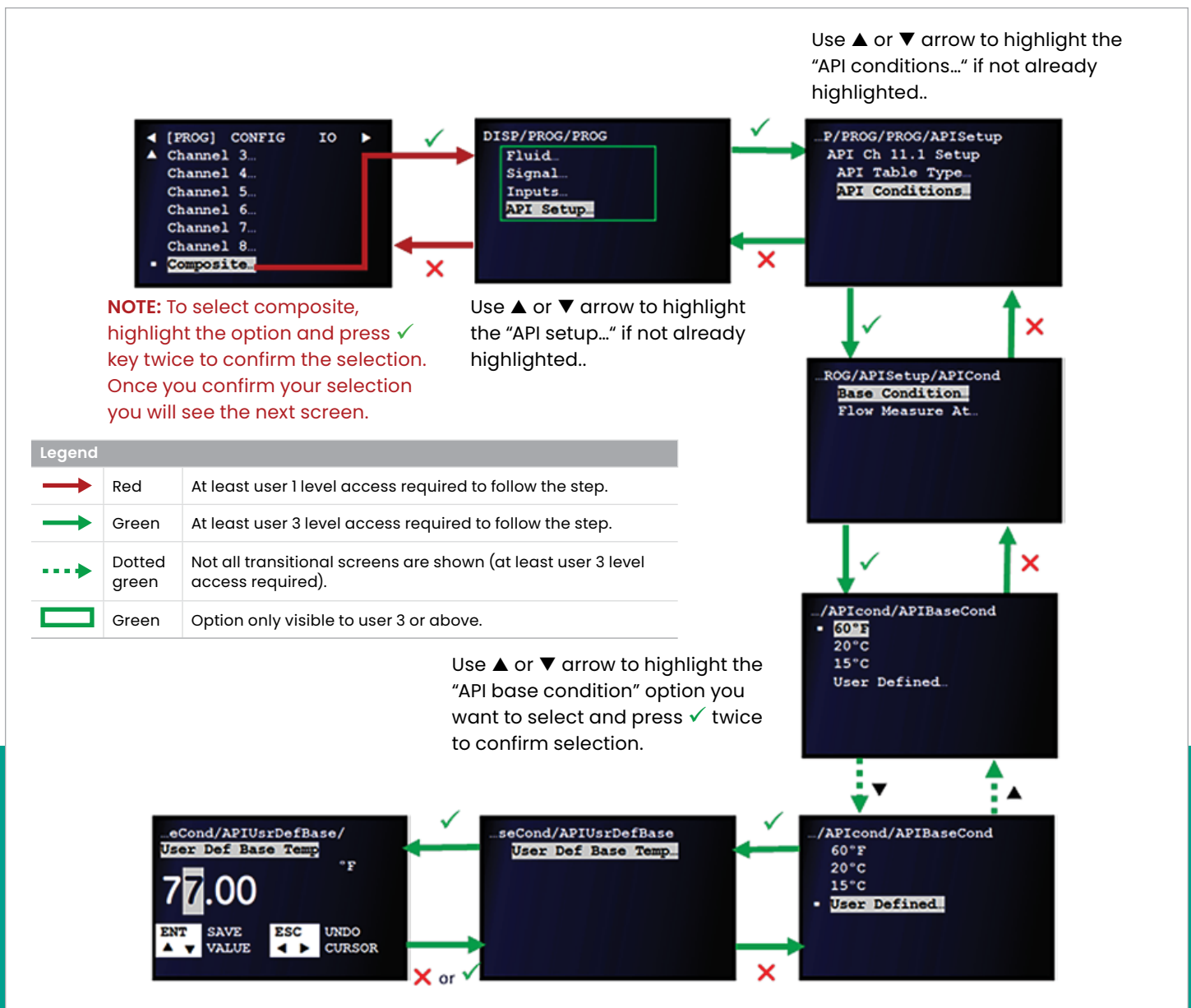
Figure 51: API conditions - base condition

Setting the API condition - flow measurement at

To set the *API base condition*, refer to *Figure 52* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.
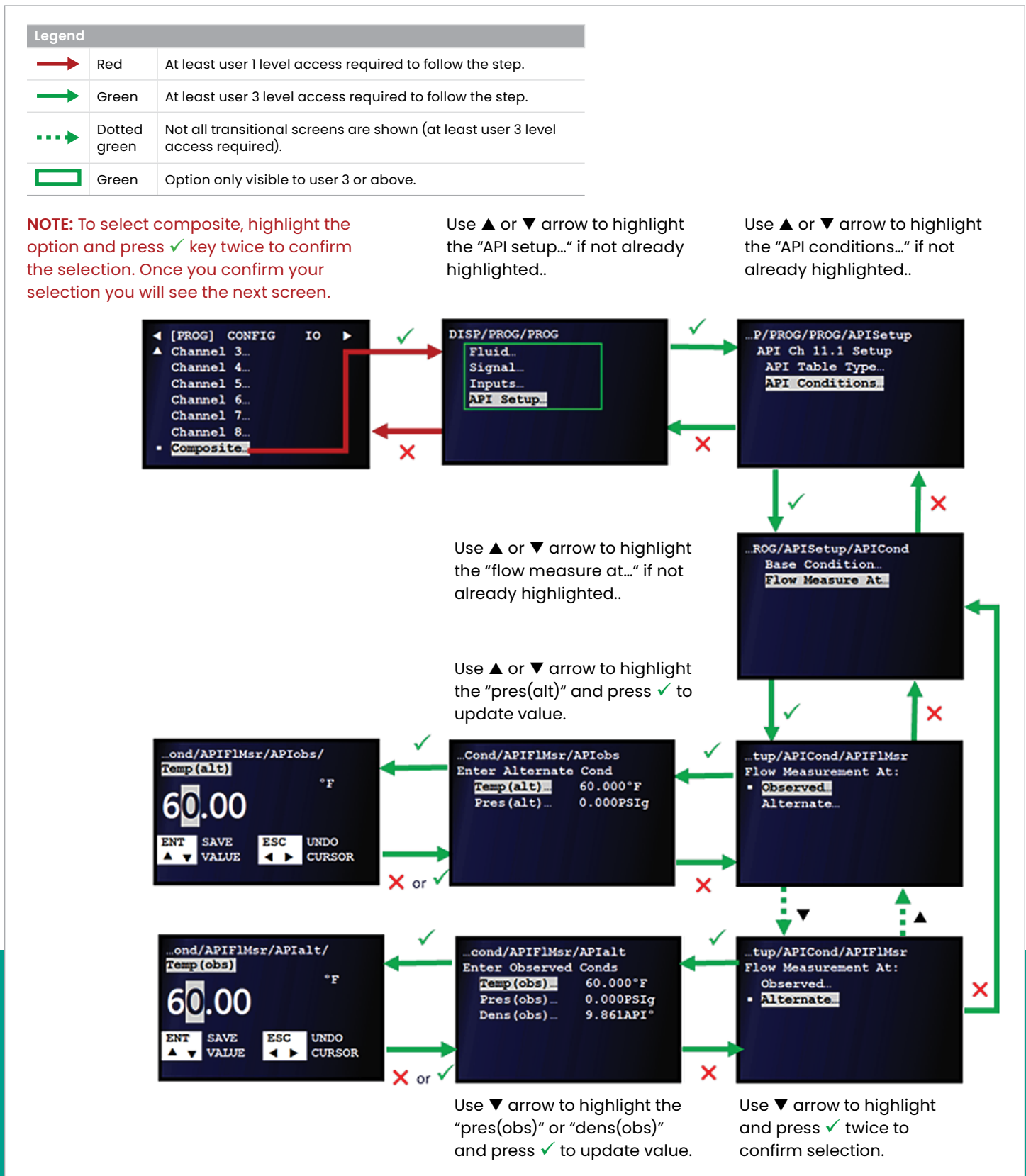
Figure 52: API conditions - flow measurement at

1. At the next screen, use the [▲] and [▼] keys to highlight the *API setup* option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

2. At the next screen, use the [▲] and [▼] keys to highlight the *API conditions* option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

3. At the next screen, use the [▲] and [▼] keys to highlight the *flow measure at* option. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

4. To set the observed conditions:

   a. Use the [▲] and [▼] keys to highlight the *observed* option. Then, press the [✓] key twice to confirm your selection or press the [✗] key to return to the previous screen.

   b. Use the [▲] and [▼] keys to highlight one of the available variables. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

   c. Enter the appropriate value for your application and press the [✓] key to confirm the new value or press the [✗] key to cancel the change.

   d. Repeat the previous two steps until all of the desired variables have been set for your application

5. To set the alternate conditions:

   a. Use the [▲] and [▼] keys to highlight the *alternate* option. Then, press the [✓] key twice to confirm your selection or press the [✗] key to return to the previous screen.

   b. Use the [▲] and [▼] keys to highlight one of the available variables. Then, press the [✓] key to confirm your selection or press the [✗] key to return to the previous screen.

   c. Enter the appropriate value for your application and press the [✓] key to confirm the new value or press the [✗] key to cancel the change.

   d. Repeat the previous two steps until all of the desired variables have been set for your application

3.5 Generic meter configuration

This section describes the procedures for configuring the following:

- **Units** (see *below*)
- **Communication** (see *Setting up communication on page 44*)
- **Reset totals** (see *Setting reset totals on page 50*)
- **Totalize on error** (see *Setting up totalizer error handling on page 51*)
- **Date/time** (see *Setting the date and time on page 52*)

3.5.1 Selecting the preferred unit type

To select the desired units, refer to *Figure 53* below and complete the following steps:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 4: configuration (generic).*
2. Use the [▲] and [▼] keys to highlight *units* and press the [✓] key to confirm your choice.
3. At the next screen, use the [▲] and [▼] keys to highlight either the *metric or English* option. Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.
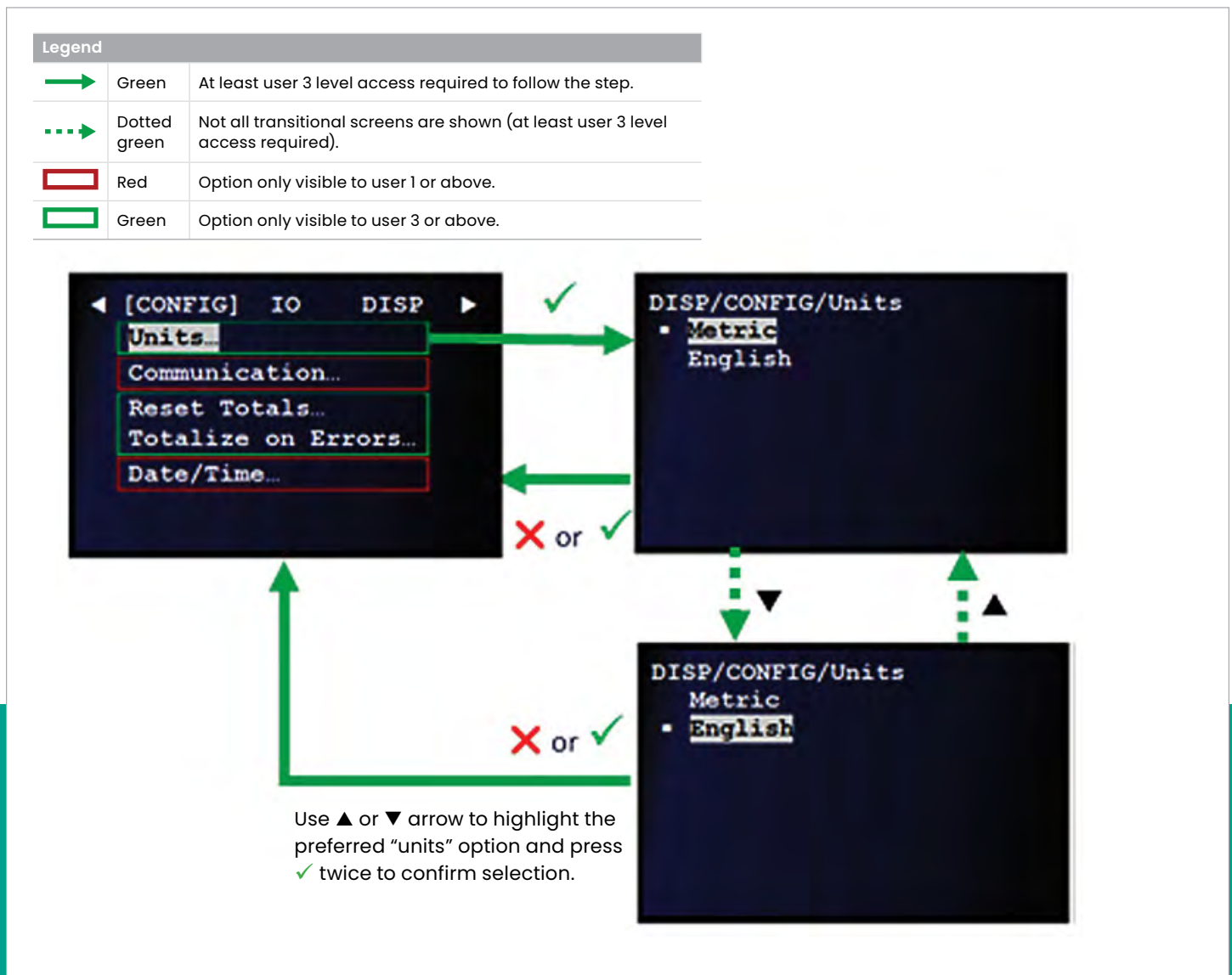
Figure 53: Unit type selection

3.5.2 Setting up communication

This section described how to configure *Panalink* and *modbus* communication.

3.5.2.1 Setting up Panalink communications

To set up Panalink communication, refer to *Figure 54* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

Legend		
→	Green	At least user 3 level access required to follow the step.
→	Dotted green	Not all transitional screens are shown (at least user 3 level access required).
▭	Red	Option only visible to user 1 or above.
▭	Green	Option only visible to user 3 or above.

Use ▲ or ▼ arrow to highlight the preferred option and press ✓ twice to confirm selection.

Use ▼ arrow to highlight "stop bits" or "data bits" options and press ✓ to make further selection. (Navigation pattern similar to parity options.)

Figure 54: Communication – Panalink setup

1. Refer to *Primary pages on page 26* and navigate to *page 4: configuration (generic)*.

2. Use the [▲] and [▼] keys to highlight *communication* and press the [✓] key to confirm your choice.

3. At the next screen, use the [▲] and [▼] keys to highlight the *Panalink* option. Then, press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

4. Set the various parameters as follows:

   a. Use the [▲] and [▼] keys to highlight the *node ID* option and press the [✓] key to confirm your selection. Then, enter the desired value and press the [✓] key to confirm the new value or press the [✗] key to cancel the change and return to the previous screen.

   b. Use the [▲] and [▼] keys to highlight the *interface* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   c. Use the [▲] and [▼] keys to highlight the *baud rate* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   d. Use the [▲] and [▼] keys to highlight the *parity* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   e. Use the [▲] and [▼] keys to highlight the *stop bits* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   f. Use the [▲] and [▼] keys to highlight the *data bits* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the ✗] key to cancel the change and return to the previous screen.

3.5.2.2 Setting up modbus communications - additional option

NOTE: Modbus is optional and this section is applicable only if the modbus option was ordered.

The **Sentinel LCT8** supports digital communications using the **MODBUS/RTU** protocol, with 2-wire RS-485 or 3-wire RS-232C as the physical layer interfaces. Baud rate can be specified from 4800 to 19200 bits per second (bps), with selectable parity and number of stop bits (default = **9600** bps, **even** parity and **1** stop bit).

To set up modbus communication settings, refer to *Figure 55* below and complete the steps on the next page.

**NOTE:** If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.
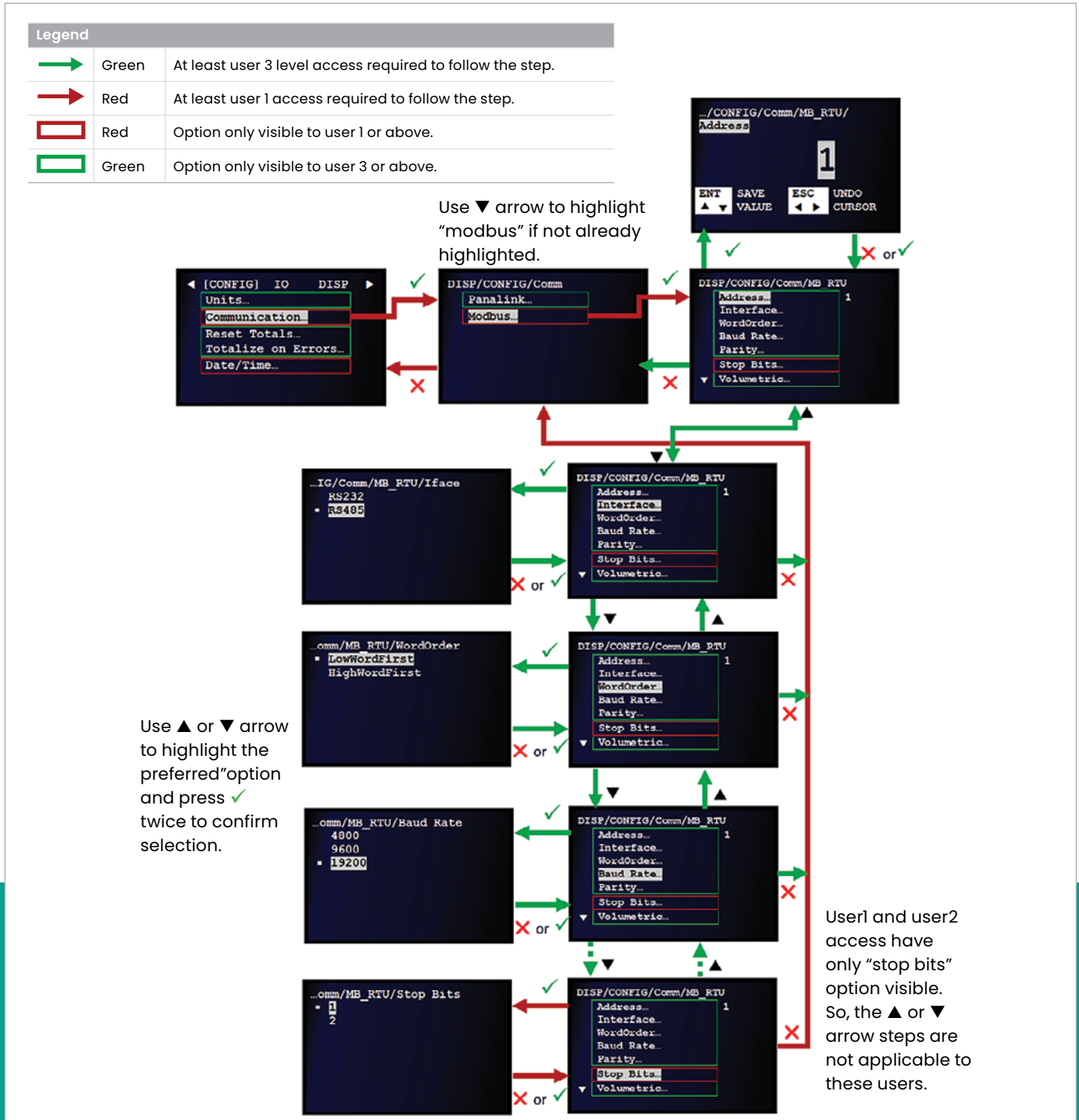
Figure 55: Communication - modbus setup

1. Refer to *Primary pages on page 26* and navigate to *page 4: configuration (generic)*.

2. Use the [▲] and [▼] keys to highlight *communication* and press the [✓] key to confirm your choice.

3. At the next screen, use the [▲] and [▼] keys to highlight the *modbus* option. Then, press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

4. Set the various parameters as follows:

   a. Use the [▲] and [▼] keys to highlight the *address* option and press the [✓] key to confirm your selection. Then, enter the desired value and press the [✓] key to confirm the new value or press the [✗] key to cancel the change and return to the previous screen.

   b. Use the [▲] and [▼] keys to highlight the *interface* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   c. Use the [▲] and [▼] keys to highlight the *word order* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   d. Use the [▲] and [▼] keys to highlight the *baud rate* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   e. Use the [▲] and [▼] keys to highlight the *parity* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   f. Use the [▲] and [▼] keys to highlight the *stop bits* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

NOTE: Additional options after *stop bits* are not visible at the user–1 and user–2 access levels.

To select the units for the volumetric and totalizer output registers, refer to *Figure 56* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.
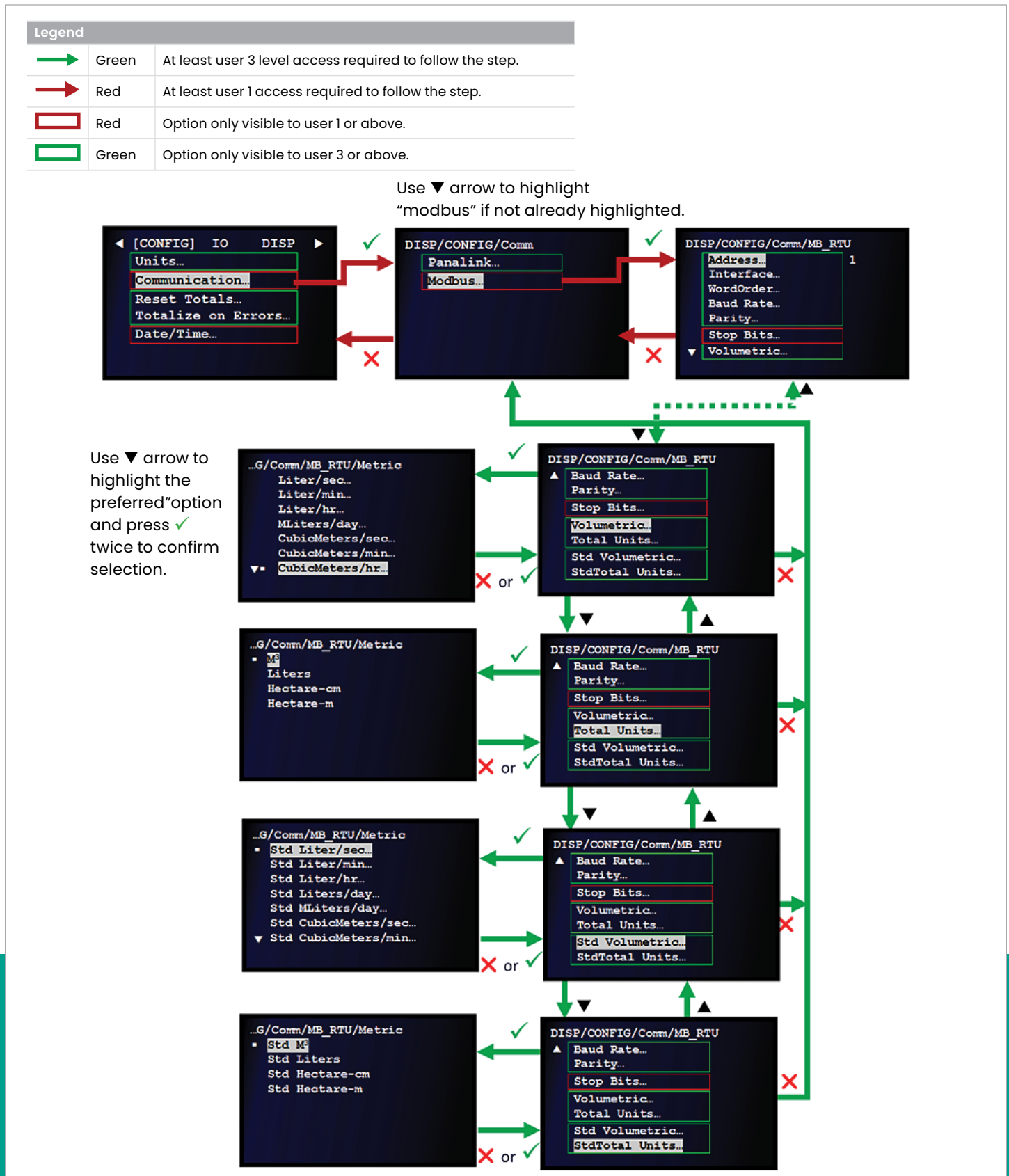
Figure 56: Units selection for volumetric and totalizer output registers

1. Refer to *Primary pages on page 26* and navigate to *page 4: configuration (generic).*

2. Use the [▲] and [▼] keys to highlight *communication* and press the [✓] key to confirm your choice.

3. At the next screen, use the [▲] and [▼] keys to highlight the *modbus* option. Then, press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

4. Set the various parameters as follows:

   a. Use the [▲] and [▼] keys to highlight the *volumetric* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   b. Use the [▲] and [▼] keys to highlight the *total units* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   c. Use the [▲] and [▼] keys to highlight the *std volumetric* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

   d. Use the [▲] and [▼] keys to highlight the *StdTotal units* option and press the [✓] key to confirm your selection. Then, select the desired option from the list and press the [✓] key twice to confirm the selection or press the [✗] key to cancel the change and return to the previous screen.

IMPORTANT

Modbus communications are now set up and ready to use. See *Appendix C. Modbus register map on page 117.*

3.5.3 Setting reset totals

<table>
<tr><td colspan="1">IMPORTANT</td></tr>
</table>

If the totalizer lock is enabled, the previous totals will not be cleared by this process.

To reset the totals, refer to *Figure 57* below and proceed as follows:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to Page 4: configuration (generic).

2. Use the [▲] and [▼] keys to highlight *reset totals* and press the [✓] key twice to confirm your choice.

3. At the next screen, use the [▲] and [▼] keys to highlight either the *reset both* or *reset fwd totals* or *reset rev totals* option. Then, press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.
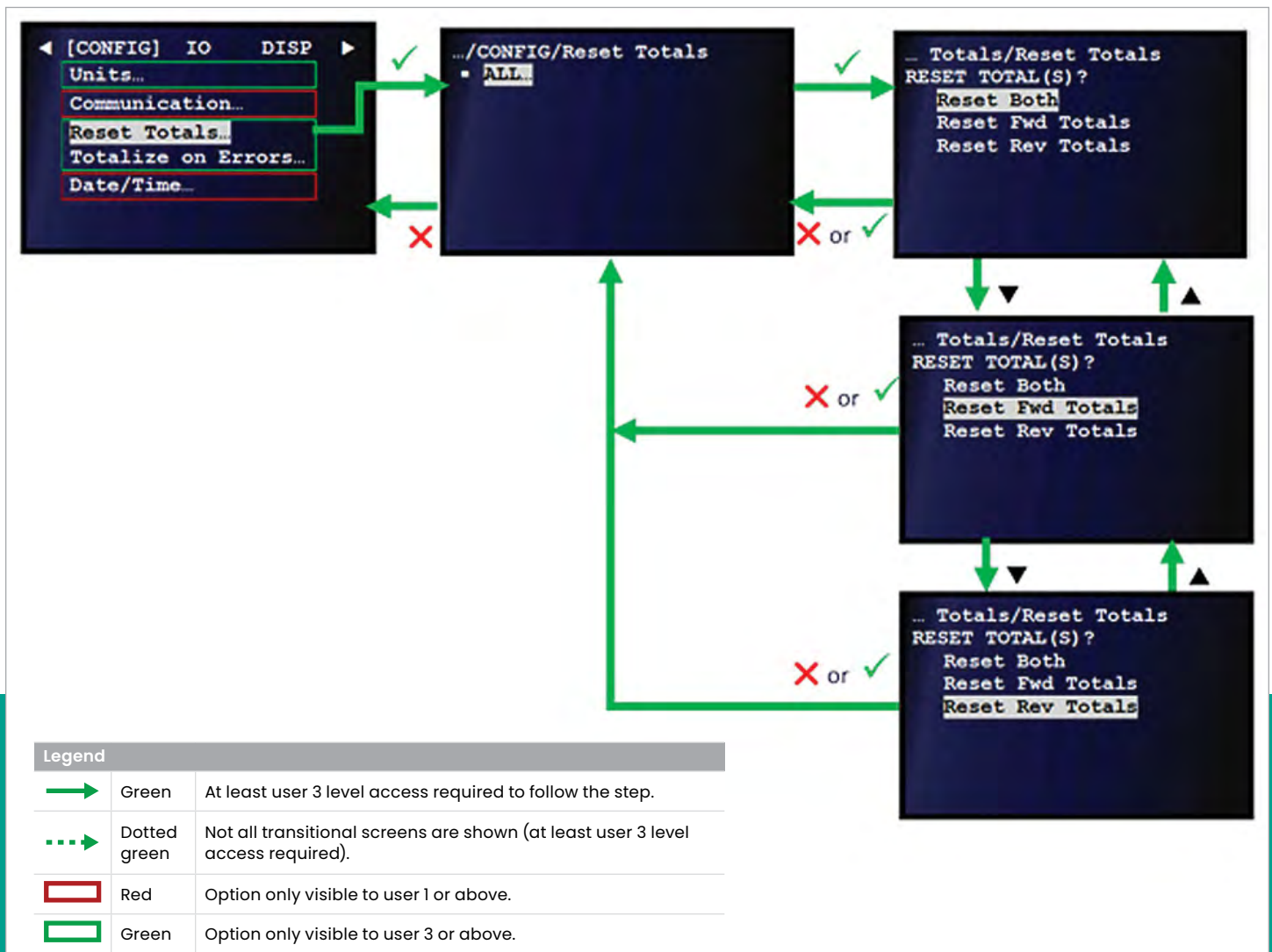
Figure 57: Resetting the fwd and/or rev totals

3.5.4 Setting up totalizer error handling

To select the totalize on errors options, refer to *Figure 58* below and proceed as follows:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to Page 4: configuration (generic).

2. Use the [▲] and [▼] keys to highlight *totalize on errors* and press the [✓] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight the desired *channel* (channels 1 to 8, or composite). Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

4. Use the [▲] and [▼] keys to select either the *yes* or *no* option and press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

5. Repeat the previous step as many times as necessary to configure additional channels.

Legend		
→	Green	At least user 3 level access required to follow the step.
···▶	Dotted green	Not all transitional screens are shown (at least user 3 level access required).
▭	Red	Option only visible to user 1 or above.
▭	Green	Option only visible to user 3 or above.

Use ▲ or ▼ arrow to highlight the preferred option and press ✓ twice to confirm selection.
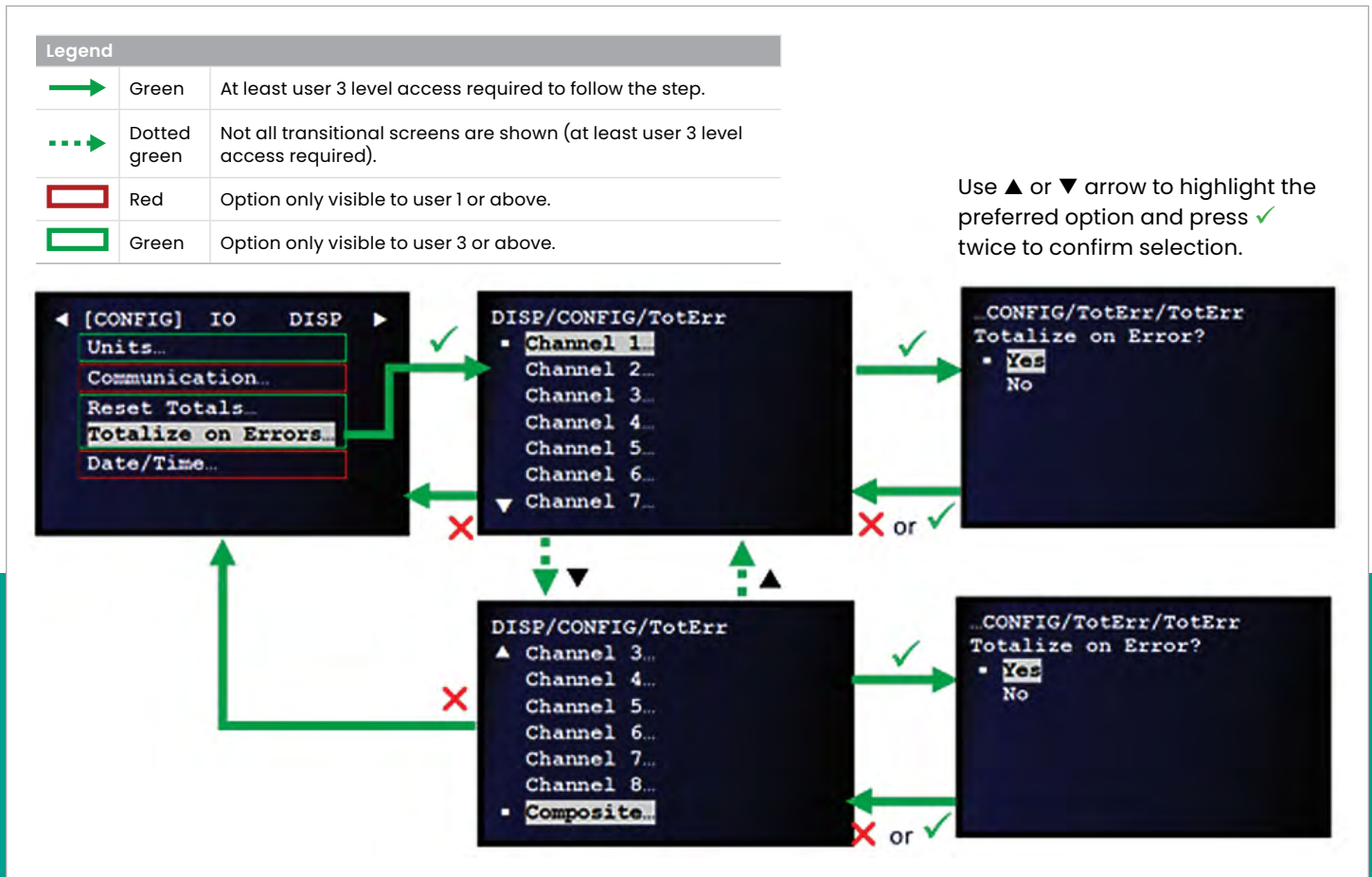
Figure 58: Selecting the totalize on errors options

3.5.5 Setting the date and time

To set the *date/time*, refer to *Figure 59* below and proceed as follows:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 4: configuration (generic)*.

2. Use the [▲] and [▼] keys to highlight *date/time* and press the [✓] key to confirm your choice.

3. When the screen with the current *date/time* opens, press the [✓] key to edit the setting or press the [✗] key to cancel and return to the previous screen.

4. If you chose to edit the setting, use the [◀] and [▶] keys to highlight the desired character. Then, use the [▲] and [▼] keys to increment or decrement the value for that character. Repeat this process until all characters of the *date/time* have been set as desired. Then, press the [✓] key to confirm the new setting or press the [✗] key to cancel and return to the previous screen.

Legend		
→	Red	At least user 1 level access required to follow the step.
▭	Red	Option only visible to user 1 or above.
▭	Green	Option only visible to user 3 or above.

Use ◀ or ▶ arrow keys to position the cursor.

Use ▲ or ▼ arrow keys to increment or decrement the digits to set the desired "date and time."
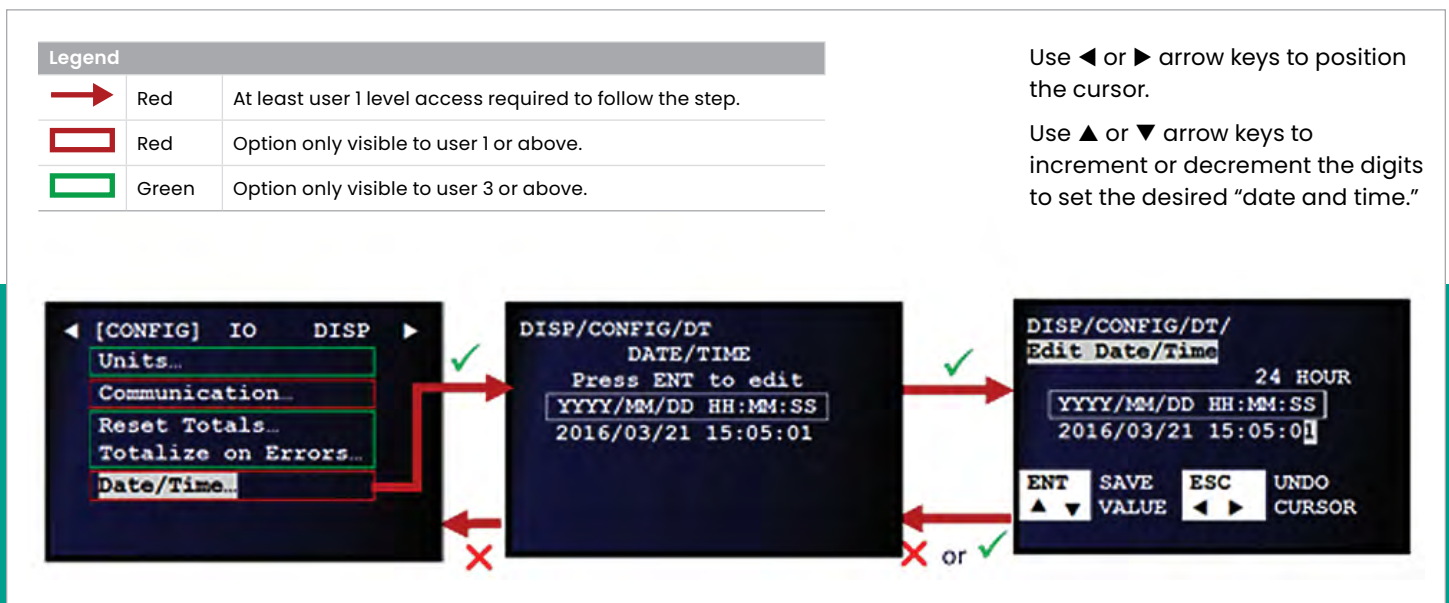
Figure 59: Setting the date and time

3.6 Inputs/outputs

Configure the analog and digital inputs/outputs via *primary page 5*: *IO*. See the following sections for details:

- *Setting up an analog output 1 on page 53*
- *Setting up a frequency/totalizer output on page 55*
- *Setting up an alarm output on page 60*
- *Setting up an analog input (optional) on page 63*
- *Setting up an RTD input (optional) on page 65*

3.6.1 Setting up an analog output

To configure an *analog output*, refer to *Figure 60 on page 54* and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 5*: *IO*.

2. Use the [▲] and [▼] keys to highlight analog outputs and press the [✓] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight *analog output*. Then, press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.
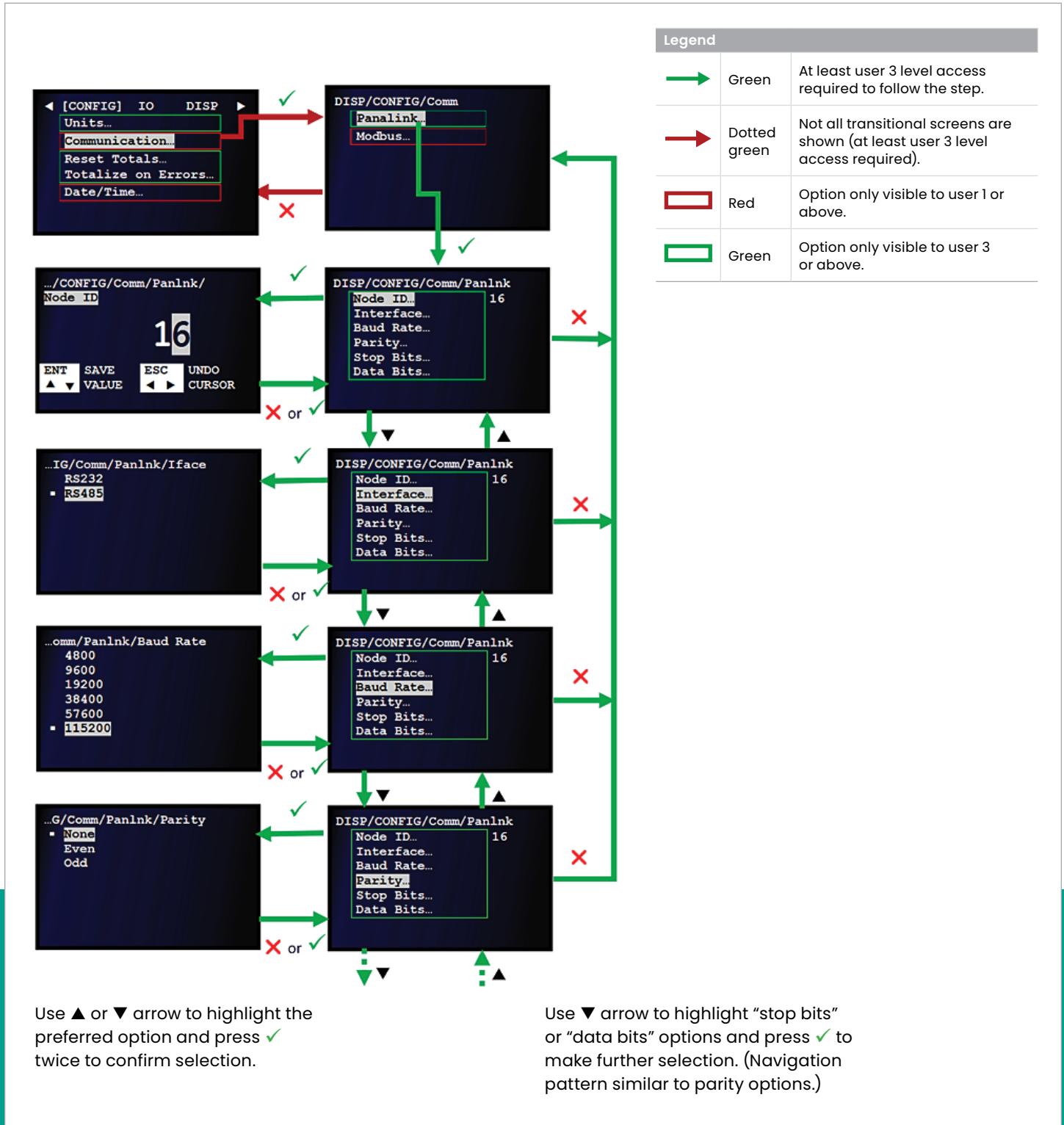
4. Use the [▲] and [▼] keys to highlight one of the options, then, press the [✓] key to confirm your selection. Configure each of the following options:

   a. **Loop status** - select from list and press the [✓] twice key to confirm

   b. **Channel** - select from list and press the [✓] key twice to confirm

   c. **Publisher** - select from list and press the [✓] key twice to confirm

   d. **Unit** - select from list and press the [✓] key twice to confirm (available choices depend on *unit type* and *publisher* settings)

   e. **Base** - enter value and press the [✓] key to confirm

   f. **Span** - enter value and press the [✓] key to confirm

   g. **Error level** - select from list and press the [✓] key twice to confirm (see Table 6 below)

   h. **Mode** - select from list and press the [✓] key twice to confirm (*passive* = external power, *active* = internal LCT8 power)

Table 6: Analog output error level options	
Option	**Output response**
Hold value	Holds the last "good" reading
Force HI (20 mA)	Forces the output to 20 mA on error
Force LO (4 mA)	Forces the output to 4 mA on error
Force HH	Forces the output to 21 mA on error
Force LL	Forces the output to 3.8 mA on error
Force value	Forces the output to a user-defined value (between 4 and 20 mA) on error

Legend

→	Green	At least user 3 level access required to follow the step.
···►	Dotted green	Not all transitional screens are shown (at least user 3 level access required).
▭	Green	Option only visible to user 3 or above.
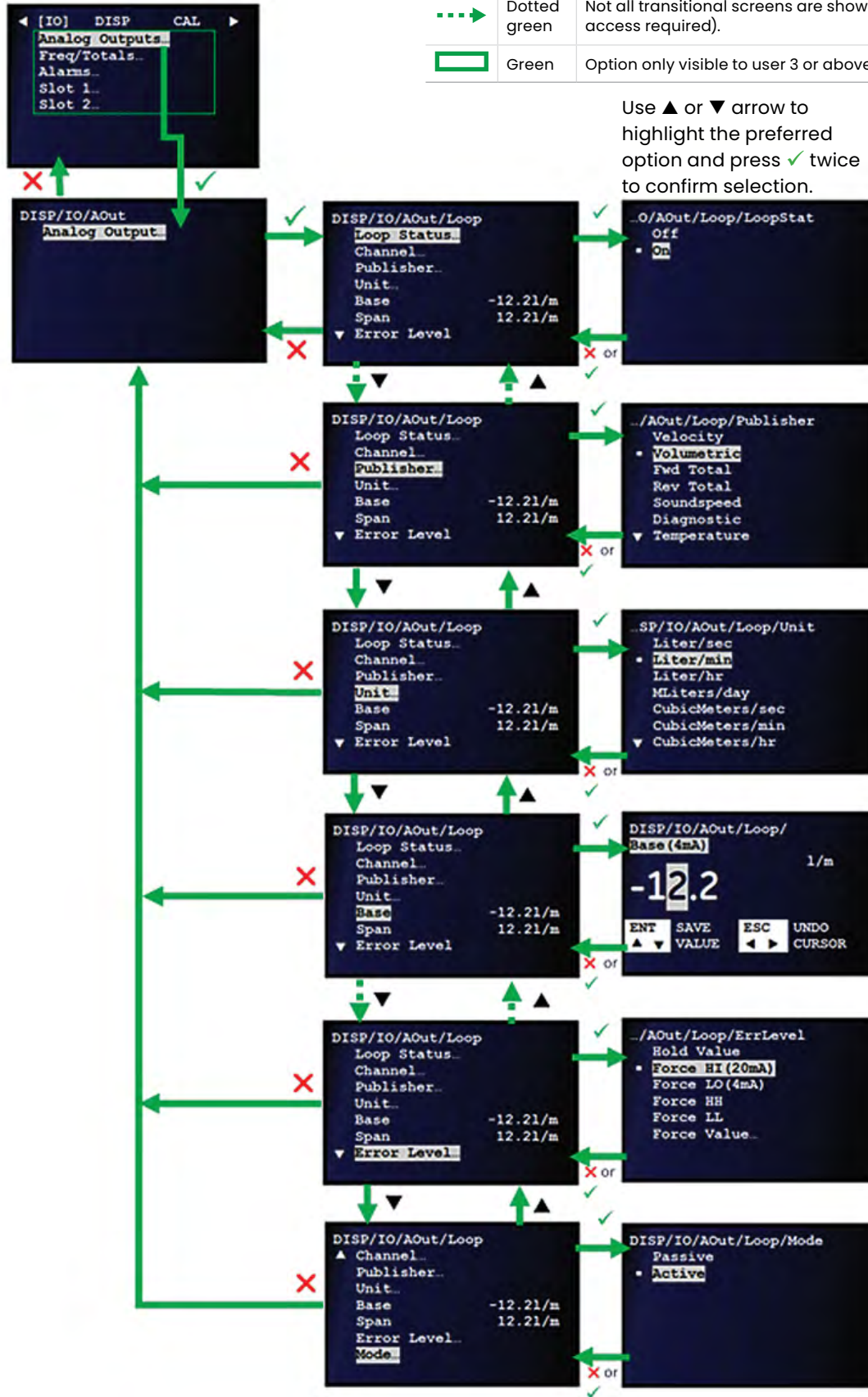
Use ▲ or ▼ arrow to highlight the preferred option and press ✓ twice to confirm selection.

Displayed units depend on the "unit type" and "publisher" selections

Follow similar steps to also set the "span"

"Force value option has additional screens that allows setting the preferred mA value

"Passive" requires an external power supply, while "active" is internally powered by the electronics.

Figure 60: Setting Up an analog output

3.6.2   Setting up a frequency/totalizer output

To configure a frequency/totalizer output, refer to *Figure 61* below and complete the steps on the next page.

**NOTE:** If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

Legend		
→	Green	At least user 3 level access required to follow the step.
⋯▶	Dotted green	Not all transitional screens are shown (at least user 3 level access required).
▭	Green	Option only visible to user 3 or above.

If you select linked, both outputs will be set up the same, just 90° out of phase. If you select independent, you will set up each output separately.

Figure 61: Setting Up a frequency/totalizer output

1. Refer to *Primary pages on page 26* and navigate to *page 5*: *IO*.

2. Use the [▲] and [▼] keys to highlight *frequency/totals* and press the [✓] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight either *linked (90°)* or *independent*. Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

NOTE: If you select linked, both outputs will be set up the same, except they will be 90° out of phase. If you select independent, each output is set up separately.

4. Based on your selection in the previous step, complete one of the following steps:

   a. If you selected *linked (90°)*, *freq/total #*1 is highlighted on the next screen. Press the [✓] key to confirm the selection or press the [✗] key to cancel and return to the previous screen.

   b. If you selected *independent*, use the [▲] and [▼] keys to highlight the desired output on the next screen. Then, press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

The meter can support both a frequency output or a totalizer output, even at the same time on independent outputs. While both function in similar manners, one may be more appropriate over the other depending on the application. The frequency output can be programmed for virtually any meter parameter, with the most common selected as volumetric flow rate. The totalizer output can only be set to discrete units of volume or time.

The maximum frequency the meter can deliver is 10kHz through a continuous pulse train that is linearly proportional to the minimum and maximum frequency output settings (base and span) scaled to the minimum and maximum output parameter values. See section 3.6.2.2 for programming steps.

The totalizer output can deliver a pulse per unit volume (or time) at a minimum pulse width of 1ms. This minimum works out to a maximum pulse train frequency of 500Hz. Care must be exercised when setting the units/pulse and the pulse width values so the pulse outputs is not overwhelmed. The totalizer output will only generate pulses when the totalize gate digital input sees an open circuit. The totalizer will not generate pulses when this input is shorted.

5. Use the [▲] and [▼] keys to highlight and configure each of the following options:

   a. If you selected *freq/tot status*, use the [▲] and [▼] keys to highlight the desired option (off or on). Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

   b. If you selected *mode*, use the [▲] and [▼] keys to highlight the desired option (*frequency* or *totalizer*). Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

   c. If you selected *drive ctl*, use the [▲] and [▼] keys to highlight the desired option (*Open drain* or *push-pull*). Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

6. When you have finished, press the [✗] key until you return to measurement view.

3.6.2.1 Frequency output termination

When driving the **Sentinel LCT8** frequency/totalizer output over distances greater than 100 feet, a 24 AWG twisted-pair I/O cable is typically used. With a data acquisition system that requires a high enough voltage to read the signal (typically a 3 - 4V threshold), the connection shown in *Figure 62* below should be used. This open-drain configuration provides a clean, ideal signal with a high enough voltage to trigger the DAC to properly count the pulses.
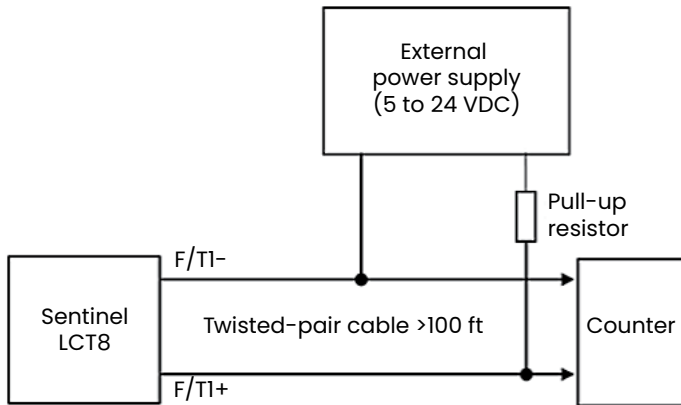
Figure 62: Open-drain frequency output wiring

Carefully select the pull-up resistor to be sure it has a high enough resistance and wattage rating for the size of the power supply. Use *Table 7* below as a guide to select the appropriate value.

Table 7: Selecting the Pull-Up resistor		
Power supply voltage (VDC)	Resistor value (ohms)	Minimum power rating (W)
5	1200	1/40
5	2400	1/90
9	1200	1/10
9	2400	1/25
12	5100	1/30
12	10,000	1/70
24	5100	1/8
24	10,000	1/15
24	20,000	1/30

Figure 63 below shows a typical output waveform at the end of a terminated I/O cable when driven by the **Sentinel LCT8** in push-pull configuration. This waveform is an example of what a "good" pulse output should look like.
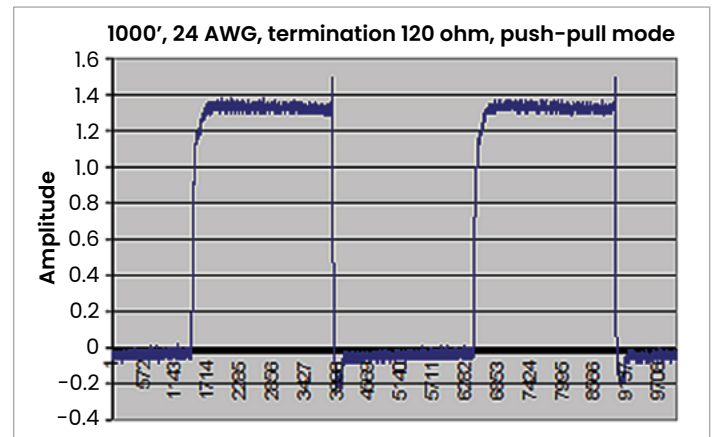
Figure 63: Ideal frequency output signal shape

3.6.2.2 Programming a frequency output

To program a frequency output, refer to *Figure 64* below and complete the following steps:

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

Legend		
→	Green	At least user 3 level access required to follow the step.
···▶	Dotted green	Not all transitional screens are shown (at least user 3 level access required).
▭	Green	Option only visible to user 3 or above.

If you select linked, both outputs will be set up the same, just 90° out of phase. If you select independent, you will set up each output separately.
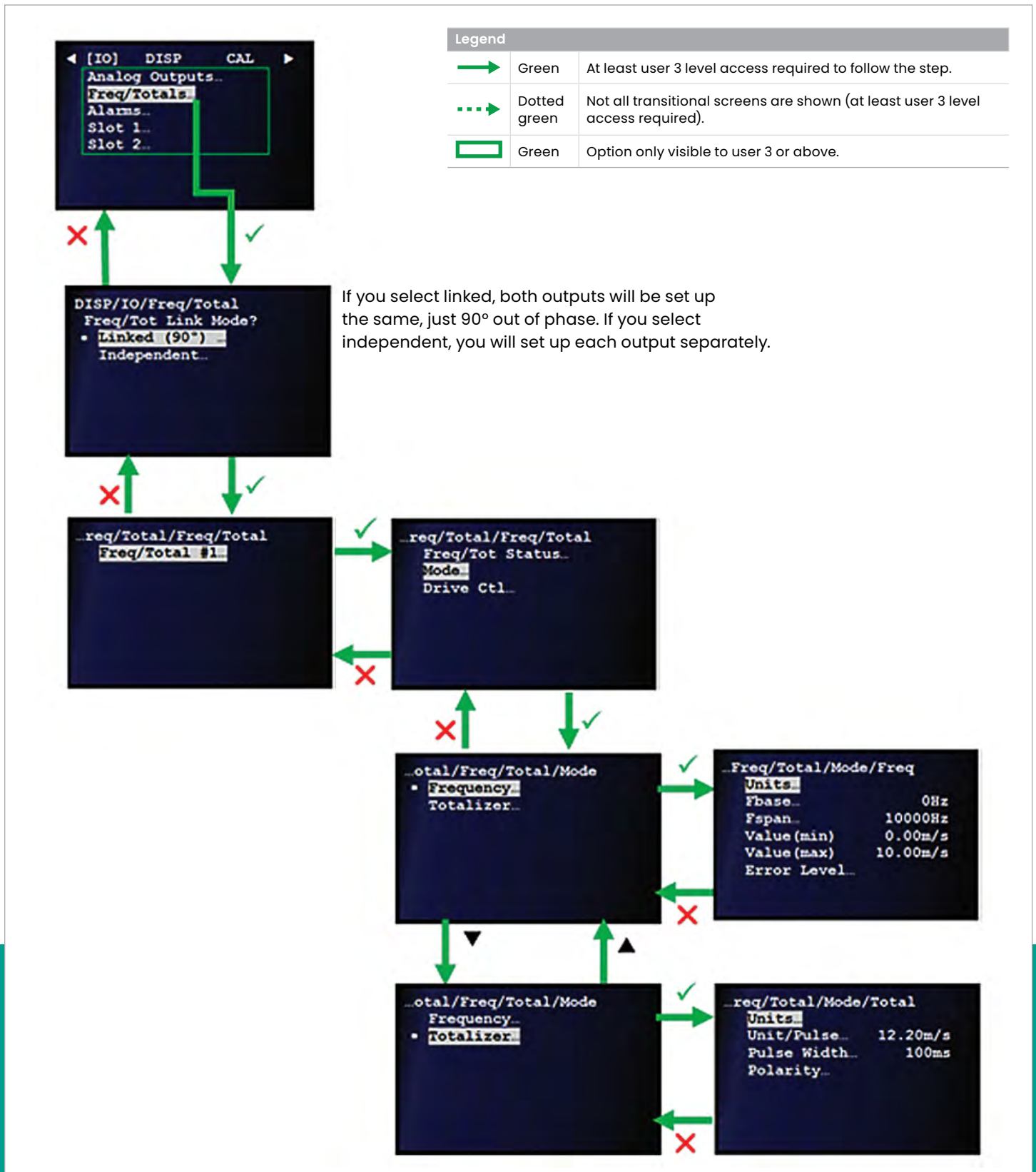
Figure 64: Programming a frequency or totalizer output

1. Navigate to the mode option on the freq/tot status screen (see *Setting up a frequency/totalizer output on page 55*). Then, press the [✓] key to confirm this choice.

2. Use the [▲] and [▼] keys to highlight the frequency option. Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

3. Use the [▲] and [▼] keys to select and program each of the six frequency output options. Refer to *Table 8* below for guidance in choosing the appropriate setting for your application. Also, see *Table 9* below for descriptions of the available options for the error level setting.

4. After programming all of the frequency output options, press the [✓] key to accept your new settings or press the [✗] key to keep the previous settings and return to the previous screen.

Table 8: Frequency output options	
Option	**Description**
Units	Choose the channel, parameter and units to output.
Fbase	Enter the lowest value of the frequency range you want to output. Typically 0Hz.
Fspan	Enter the highest value of the frequency range you want to output. max possible 10000Hz.
Value (min)	Enter the value of the parameter you want to correspond to the min. value of the frequency range.
Value (max)	Enter the value of the parameter you want to correspond to the max. value of the frequency range.
Error level	Choose the output response during an error condition: *force lo, force hi, hold last*, or *force value*. During a meter error, the chosen *error level* will be sent to the *frequency output*.

Table 9: Frequency output error level options	
Option	**Description**
Force low (4 mA)	Forces output to Fbase
Force low (20 mA)	Forces output to Fspan
Hold value	Holds the last "good" reading
Force value	Outputs a user-defined value (from 4 to 20 mA) during an error condition

3.6.2.3 Programming a totalizer output

To program a totalizer output, refer to *Figure 64 on page 58* and proceed as follows:

1. Navigate to the mode option on the freq/tot status screen (see *Setting up a frequency/totalizer output on page 55*). Then, press the [✓] key to confirm this choice.

2. Use the [▲] and [▼] keys to highlight the totalizer option. Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

3. Use the [▲] and [▼] keys to select and program each of the four totalizer output options. Refer to *Table 10* below for guidance in choosing the appropriate setting for your application.

4. After programming all of the totalizer output options, press the [✓] key to accept your new settings or press the [✗] key to keep the previous settings and return to the previous screen.

Table 10: Totalizer output options	
Option	**Description**
Units	Choose the channel, parameter and units to output.
Units/ pulse	Choose how many units of the chosen parameter are accumulated before a pulse is output.
Pulse width	Choose the duration of each pulse that is output. **NOTE:** Make sure the meter is not configured to output more than one pulse during this time, as this could lead to missed pulses.
Polarity	Choose the negative or positive edge of the pulse.

3.6.3 Setting up an alarm output

To set up an alarm output, refer to *Figure 65* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

Alarm #1 and alarm #2 have similar options and hence alarm #2 is not explicitly shown in this figure.

Legend

	Color	Description
→	Green	At least user 3 level access required to follow the step.
···►	Dotted green	Not all transitional screens are shown (at least user 3 level access required).
▭	Green	Option only visible to user 3 or above.

Off	Disables alarm functionality
Normal	Selection for conventional operation
Failsafe	Selection for fail-safe operation

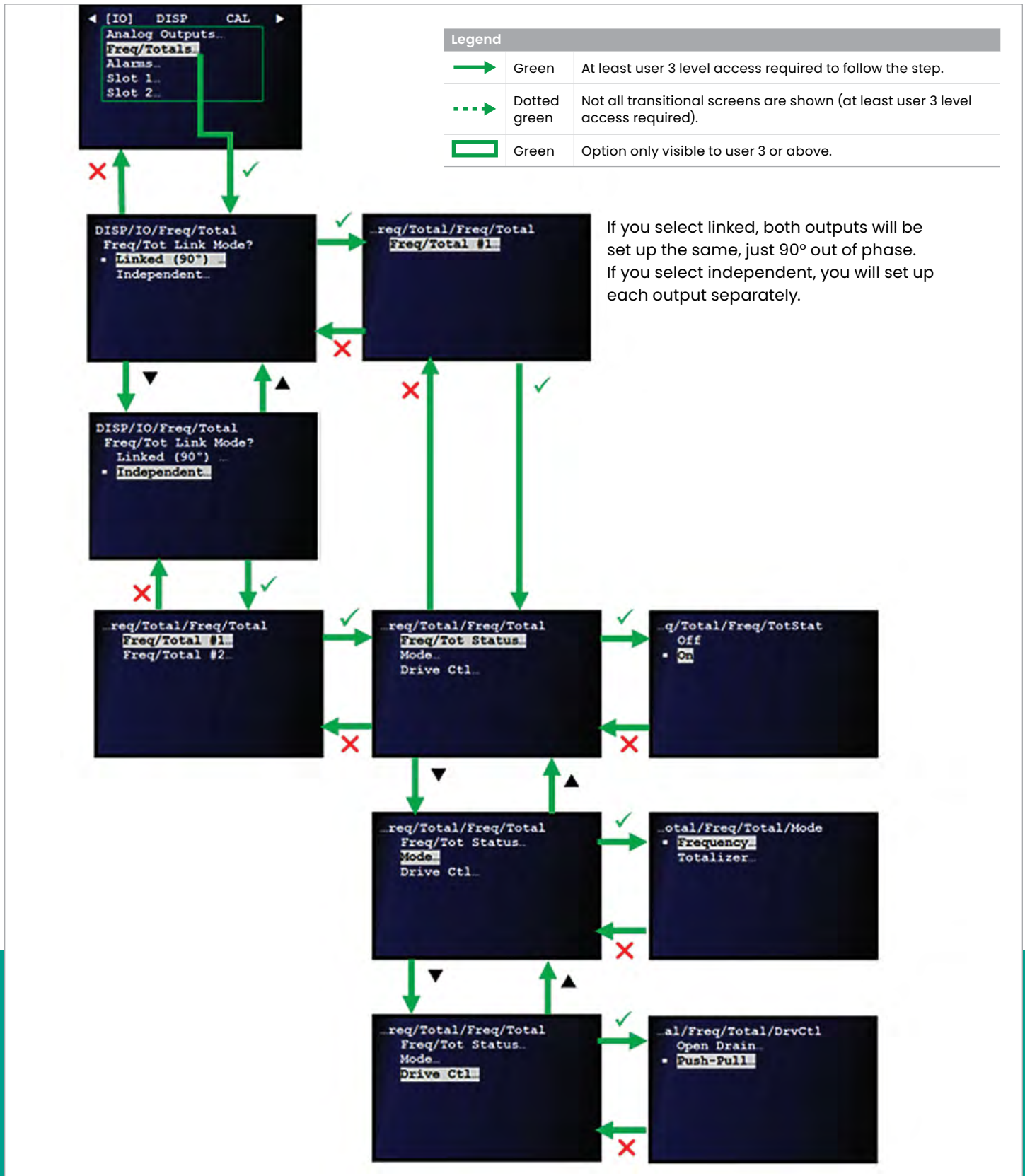Figure 65: Setting up an alarm output

1. Refer to *Primary pages on page 26* and navigate to *page 5*: *IO*.

2. Use the [▲] and [▼] keys to highlight alarms and press the [✓] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight either alarm #1 or alarm #2. Then, press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

NOTE: As the two alarms have similar options, only the set up of alarm #1 is described here, as an example.

4. Use the [▲] and [▼] keys to highlight alarm status and press the [✓] key to confirm your selection. Then, use the [▲] and [▼] keys to highlight the desired option (off, normal or failsafe) and press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

NOTE: Off = alarm is disabled, normal = alarm is normally de-energized and is energized when tripped, failsafe = alarm is normally energized and is de-energized when tripped. See "Understanding the alarm type Selection" on page 77 for more information.

5. Use the [▲] and [▼] keys to highlight type and press the [✓] key to confirm your selection. Then, highlight and configure each of the following options (see Table 11 on page 77):

   a. **Level** - program the units, trip point, dead band, trip direction, and error level. Then, press the [✓] key to confirm your settings or press the [✗] key to cancel and return to the previous screen.

   b. **Direction** - program the units. Then, press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

   c. **Fault** - Select from alarm units, flow, Non-flow, All, and custom. Then, press the [✓] key to confirm your settings or press the [✗] key to cancel and return to the previous screen.

6. Use the [▲] and [▼] keys to highlight Latch state and press the [✓] key to confirm your selection. Then, use the [▲] and [▼] keys to highlight the desired option (Latch, No Latch or Clear Latch) and press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

NOTE: See "configuring the alarm Latch state" on page 77 for a description of the latch state options.

7. When you have finished, press the [✓] key to confirm your selections or press the [✗] key to cancel and return to the previous screen.

3.6.3.1 Understanding the alarm type selection

If *normal* or *failsafe* was selected as the *alarm type*, you must then program the parameters listed in *Table 11* below.

Table 11: Alarm type options		
Options	**Parameters**	**Description**
Level	Units	This defines the measured units monitored by the alarm
	Trip point	This defines the measured value required to trip the alarm
	Dead band	This defines a range of values around the trip point which neither trip nor reset the alarm.
	Trip direction	The alarm may be set to trip either when the value drops below the trip point (low alarm) or when the value moves above the trip point (high alarm).
	Error level	Choose from the following options: **Reset** - Forces the alarm to reset on an error or fault condition. **Trip** - Forces the alarm to trip on an error or fault condition. **Hold last** - Holds the current alarm status on an error or fault condition.
Direction	Units	The alarm can be tripped on either forward or reverse flow, using volumetric flow in m³/s of the selected channel. The alarm determines direction by looking for a positive or negative change in the flow reading.
Fault	Alarm units	The alarm is set to trip based on the *channel* selected here.
	Flow	This trips the alarm when a flow error occurs on the selected channel.
	Non-flow	This trips the alarm when a non-flow error occurs on the selected channel.
	All	This trips the alarm on any error on the selected channel.
	Custom	The user can select the errors that should trip the alarm.

3.6.3.2 Configuring the alarm latch state

To configure the alarm latch state options, see *Table 12* below.

Table 12: Latch state options	
Option	**Description**
Latch	This enables the alarm to hold its current state, by causing the *user intervene indicator* to be lit when the alarm is tripped.
No Latch	The alarm is reset when the fault or error condition clears.
Clear latch	This changes the latched state, by turning off the *user intervene indicator* when the fault or error condition clears.

3.6.4 Setting up an analog input (optional)

If an option card with an analog input is installed, to set up the analog input, refer to *Figure 66 on page 63 below* and complete the steps on the following page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.
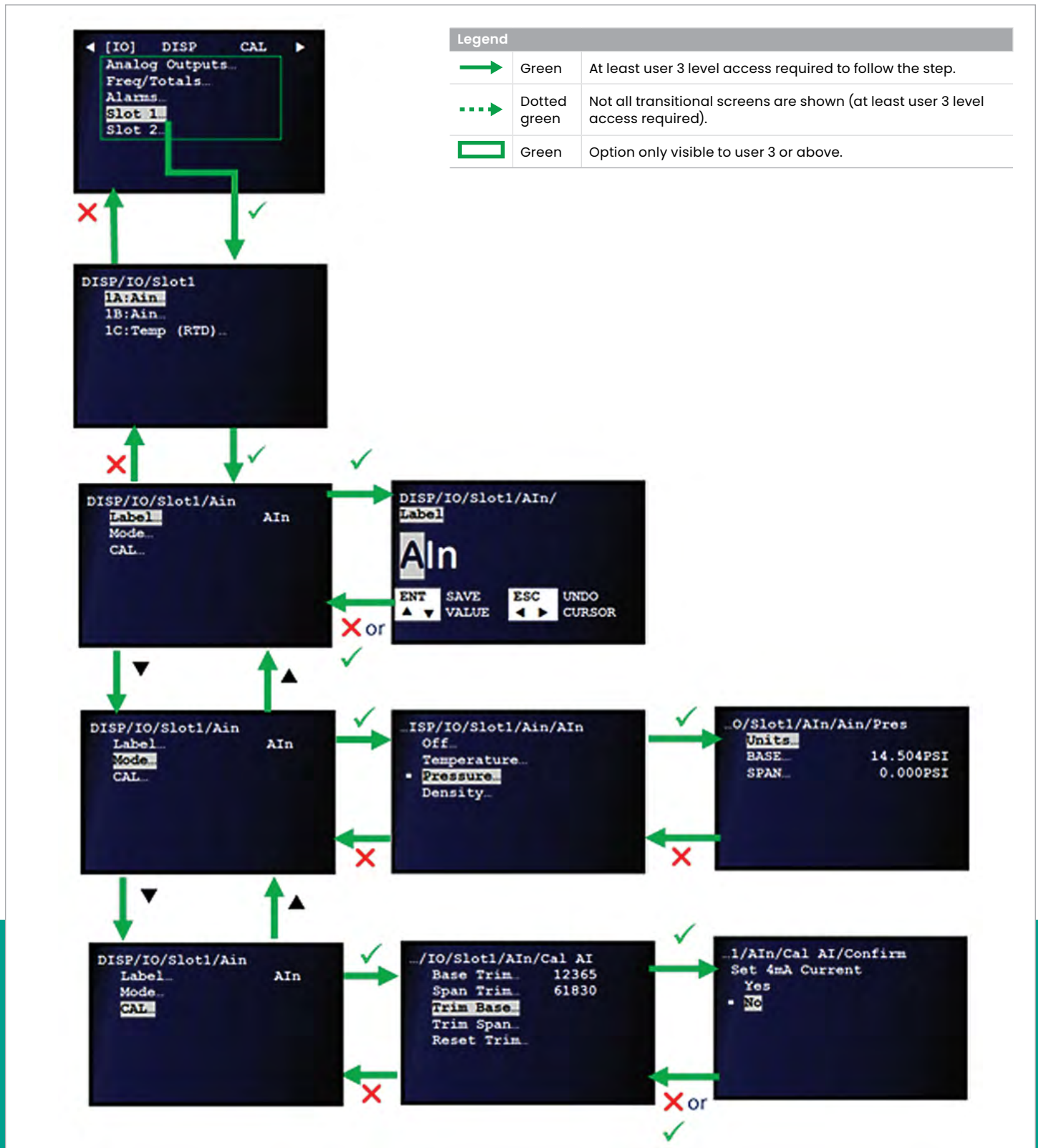
Figure 66: Setting up an analog input

1. Refer to *Primary pages on page 26* and navigate to *page 5: IO*.

2. Use the [▲] and [▼] keys to highlight *slot 1* and press the [✓] key to confirm your choice.

NOTE: An analog input located in slot 1 as input A is used here as an example.

3. Use the [▲] and [▼] keys to highlight *1A:Ain* and press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

4. Use the [▲] and [▼] keys to highlight *label* and press the [✓] key to confirm your selection. Then, enter the desired label (i.e., *name*) for the analog input and press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

5. Use the [▲] and [▼] keys to highlight *mode* and press the [✓] key to confirm your selection. Then, select either the *off, temperature, pressure*, or *density* option and press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

NOTE: For any option except *off*, you will need to enter the *units, base*, and *span* values for the selected parameter.

6. Use the [▲] and [▼] keys to highlight *cal* and press the [✓] key to confirm your selection. Then, select either the *base trim, span trim, trim base, trim span*, or *reset trim* option and press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

NOTE: After making your selection in the above step, you will need to complete the programming on the next screen.

If a calibration is not going to be performed at this time, enter the nominal calibration values by selecting reset trim. This will enable 4-20 mA to be read with undetermined accuracy. However, to meet the **Sentinel LCT8** accuracy specifications, **a proper calibration must be performed**. To calibrate the analog input, make sure it is wired correctly (see *Wiring the 4-20mA analog input (optional) on page 12*) and then proceed as follows:

• Set the input to *4 mA* to calibrate the *low* end of the range.

• Select *trim base* and confirm by selecting yes.

• Set the input to *20 mA*, to calibrate the high end of the range.

• Select *trim span* and confirm by selecting yes.

3.6.5 Setting up an RTD input (optional)

If an option card with an RTD input is installed, to set up the *RTD input*, refer to *Figure 67* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.
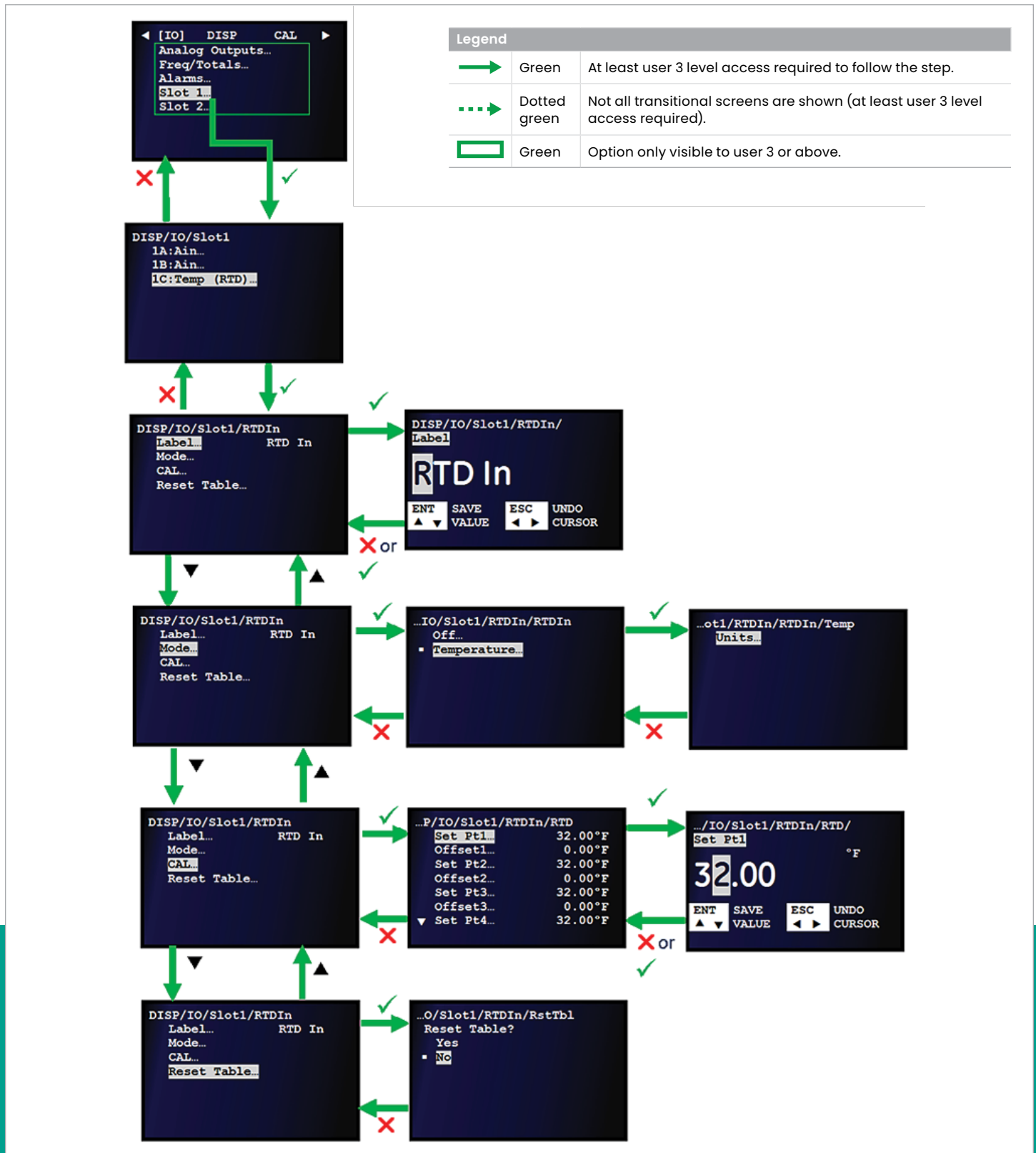
Figure 67: Setting Up an RTD input

65

1. Refer to *Primary pages on page 26* and navigate to *page 5*: *IO.*

2. Use the [▲] and [▼] keys to highlight *slot 1* and press the [✓] key to confirm your choice.

NOTE: An RTD input located in *slot 1* as *input C* is used here as an example.

3. Use the [▲] and [▼] keys to highlight *1C:temp (RTD)* and press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

4. Use the [▲] and [▼] keys to highlight *label* and press the [✓] key to confirm your selection. Then, enter the desired *label (i.e., name)* for the RTD input and press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

5. Use the [▲] and [▼] keys to highlight *mode* and press the [✓] key to confirm your selection. Then, select either the *off* or *temperature* option and press the [✓]key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

NOTE: If *temperature* was selected above, enter the desired *units* when prompted.

6. Use the [▲] and [▼] keys to highlight *cal* and press the [✓] key to confirm your selection. This option allows a *2-5 point calibration* of the RTD input (see the instructions below).

7. Use the [▲] and [▼] keys to highlight *reset table* and press the [✓] key to confirm your selection. Then, select either Yes or No and press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen. **Important** - selecting *yes* will reset all calibration entries back to zero.

Calibration instructions:

To calibrate an RTD input, make sure the input is wired per *Figure 25 on page 13*, and use a temperature bath and an iRTD (reference) connected to *iRTD Win software* to read temperature values. Then, proceed as follows:

1. Enter the calibration points starting with the lowest temperature as **set Pt1** and in increasing order up to the highest **set Pt**.

2. Be sure the calibration points are performed over the full temperature range to be measured. temperatures that are out of the calibrated range (i.e., not between the highest and lowest Cal set points) will not have calibration information applied to them and will not be corrected. Note that increasing the temperature beyond the last Cal set point could cause data to be discontinuous.

3. Be sure to initially fill any empty cells in the calibration table with a value of zero (0).

4. Note that the *set Pt* is the actual temperature you are trying to read, and the *offset* is the probe temperature reading minus the *reference temperature* reading.

5. Start the calibration with the value of all points set to zero (0), and then enter the actual values as each Cal point is completed.

3.7 Configuring the display

To configure the **Sentinel LCT8** display, refer to *Figure 68* below and complete the steps on the next page.

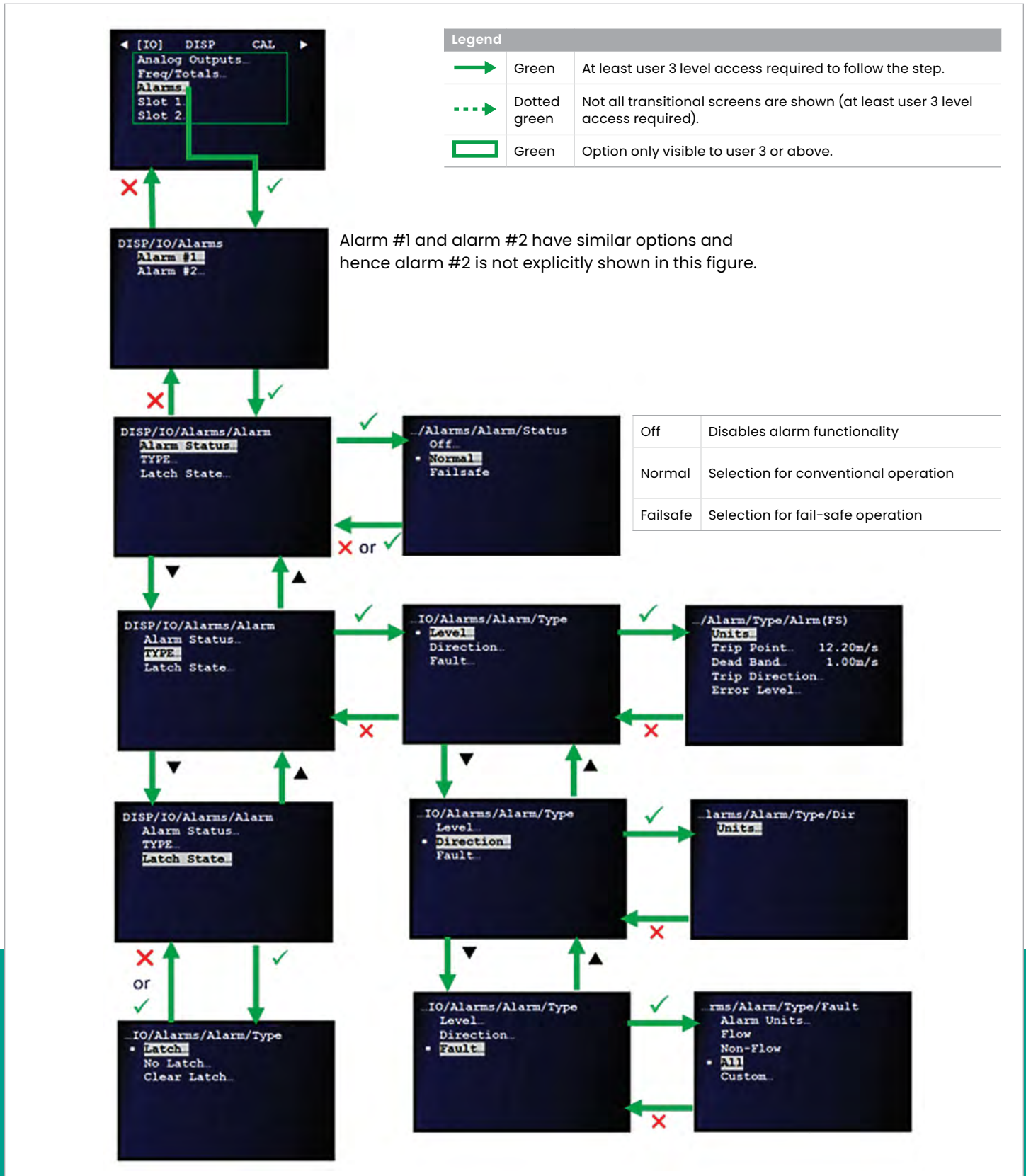**NOTE:** If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

Legend		
→	Red	At least user 1 level access required to follow the step.
▭	Red	Option only visible to user 1 or above.
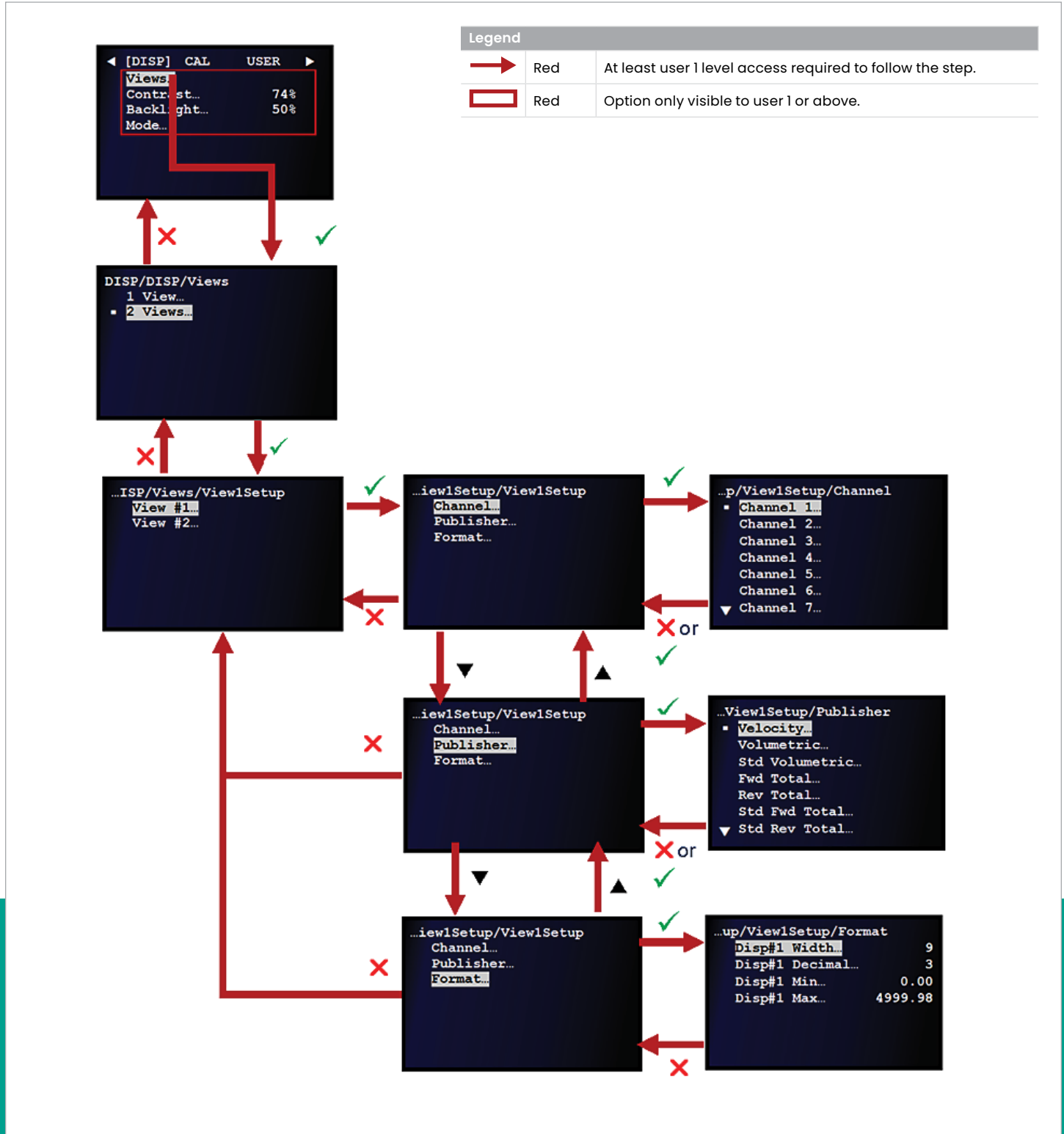
Figure 68: Configuring the display

1. Refer to *Primary pages on page 26* and navigate to *page 6*: *display*.

2. Use the [▲] and [▼] keys to highlight *views* and press the [✓] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight either *1 view* or *2 views* and press the [✓] key twice to confirm your selection.

4. Use the [▲] and [▼] keys to highlight the *view #* you wish to configure and press the [✓] key to confirm your selection.

5. Highlight and configure each of the following options:

   a. **Channel** – Select the desired channel to be displayed in this view. Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

   b. **Publisher** – Select the measurement parameter to be displayed in this view. Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

   c. **Format** – program the *width, decimal, min*, and *max* settings for the display in this view. Then, press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

6. Use the [▲] and [▼] keys to highlight *contrast* and press the [✓] key to confirm your selection. Then, adjust the display contrast as desired and press the [✓] key to confirm your setting or press the [✗] key to cancel and return to the previous screen.

7. Use the [▲] and [▼] keys to highlight *backlight* and press the [✓] key to confirm your selection. Then, adjust the display backlight as desired and press the [✓] key to confirm your setting or press the [✗] key to cancel and return to the previous screen.

8. Use the [▲] and [▼] keys to highlight *mode* and press the [✓] key to confirm your selection. Then, configure the display mode and press the [✓] key to confirm your setting or press the [✗] key to cancel and return to the previous screen.

3.8 Calibrating the analog output

To calibrate the 4–20 loop, refer to *Figure 69* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

Legend		
→	Green	At least user 3 level access required to follow the step.
····▶	Dotted green	Not all transitional screens are shown (at least user 3 level access required).
▭	Green	Option only visible to user 3 or above.

Use ▲ or ▼ arrow to highlight the preferred option and press ✓ twice to confirm selection.

NOTE 1: Make sure the equipment used is properly calibrated.

NOTE 2: After completing calibration set the mode selection to normal

To calibrate 4mA (0%), set percent value to 0
1. If the base trim value is not 4mA set to 4mA
2. Enter the value read in ammeter into the base trim
3. Verify the ammeter reads 4mA +/- 0.02mA. If not, repeat steps 2 and 3

To calibrate 20mA (100%), set percent value to 100
1. If the span trim value is not 20mA set to 20mA
2. Enter the value read in ammeter into the base trim
3. Verify the ammeter reads 20mA +/- 0.02mA. If not, repeat steps 2 and 3

Figure 69: Calibrating the analog output

1. Refer to *Primary pages on page 26* and navigate to *page 7: CAL*.

2. Connect an *ammeter* to the **Sentinel LCT8** *analog output* terminals.

3. With *4-20 loop* highlighted, press the [✓] key twice to confirm your choice.

4. With *mode* highlighted, press the [✓] key to confirm your choice.

5. Choose one of the following options:

   - Use the [▲] and [▼] keys to highlight *normal* and press the [✓] key twice to confirm your selection and return to the previous screen. After completing an analog input calibration, the *mode* should always be reset to *normal* using this step.

   - Use the [▲] and [▼] keys to highlight *test (trim)* and press the [✓] key twice to confirm your selection and proceed the next screen. Continue to the next step.

6. Use the [▲] and [▼] keys to highlight *base trim* and press the [✓] key to confirm your selection and proceed to the next screen.

   a. If the *base trim* value is not 4 mA, set it to 4 mA.

   b. Enter the value read on the ammeter into the *base trim* screen.

   c. Verify that the ammeter now reads 4 mA ±0.02 mA. If necessary, repeat these steps until the reading is correct. Then, press the [✓] key to save the value and return to the previous screen, or press the [✗] key to cancel the trim and return to the previous screen.

7. Use the [▲] and [▼] keys to highlight *span trim* and press the [✓] key to confirm your selection and proceed to the next screen.

   a. If the *span trim* value is not 20 mA, set it to 20 mA.

   b. Enter the value read on the ammeter into the span trim screen.

   c. Verify that the ammeter now reads 20 mA ±0.02 mA. If necessary, repeat these steps until the reading is correct. Then, press the [✓] key to save the value and return to the previous screen, or press the [✗] key to cancel the trim and return to the previous screen.

8. Use the [▲] and [▼] keys to highlight *percent* and press the [✓] key to confirm your selection. If the value is not already at 100%, set it to 100%. Then, press the [✓] key to save the value and return to the previous screen, or press the [✗] key to cancel and return to the previous screen.

3.9 User configuration setting

To configure the **Sentinel LCT8** User settings, refer to *Figure 70* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.
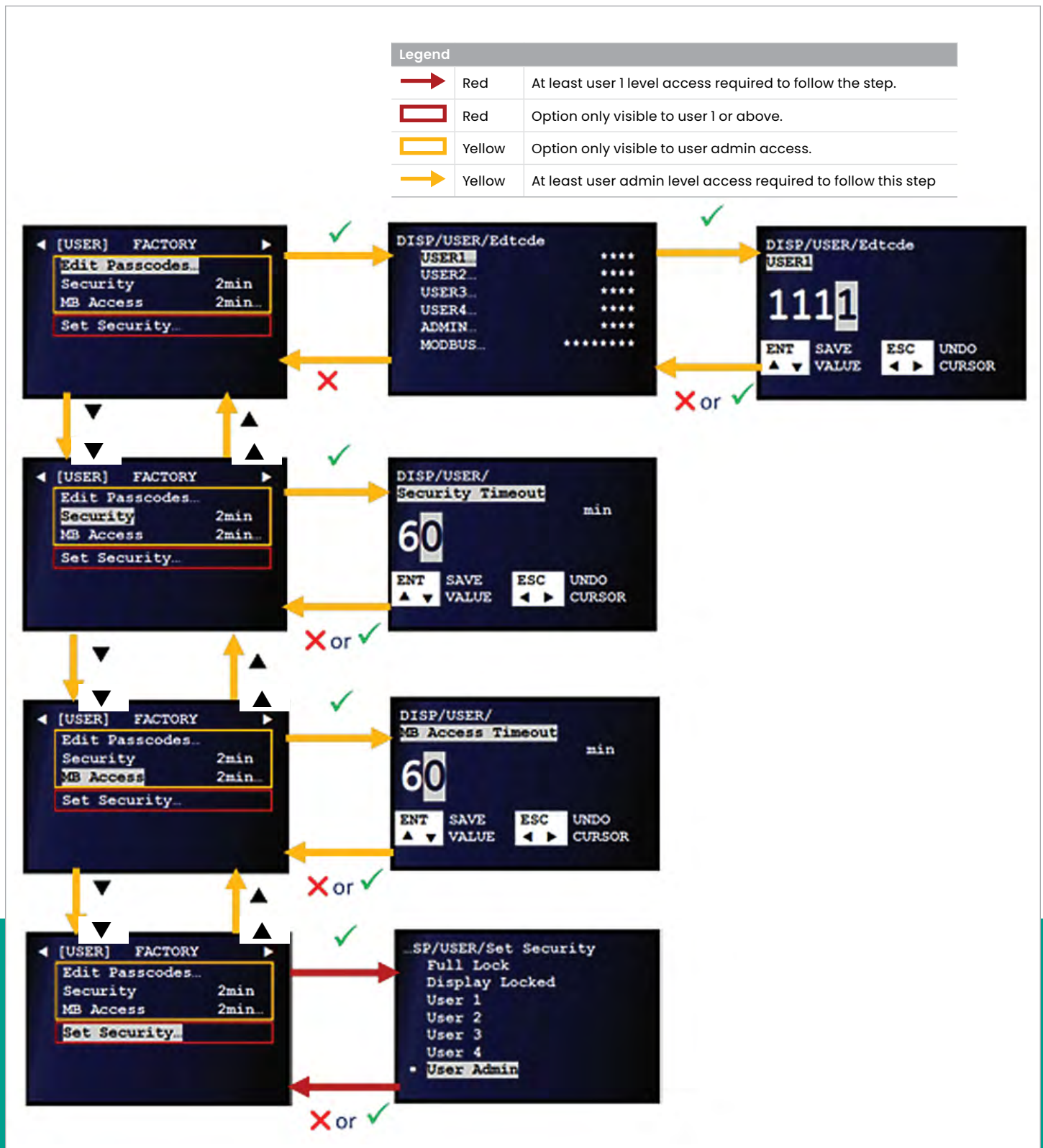

Figure 70: Setting the User configuration options

1. Refer to *Primary pages on page 26* and navigate to *page 8*: *user configuration*.

2. Use the [▲] and [▼] keys to highlight the *edit passcodes, security, MB access*, or *set security* option and press the [✓] key (press twice for the set security option) to confirm your choice.

3. After you have finished configuring these options, press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

IMPORTANT

See the following sections for information in the available *user configuration* options.

3.9.1 The edit passcodes option

This *user* option is available only at the *user-admin* access level. By means of this option, the *passcodes* for *user-1* to *user-admin* access levels can be modified. In addition, the *user-admin* can also modify the passcode for modbus access. The *user-1 to user-admin* passcode must be four (4) characters long, and the *modbus access* passcode must be from six (6) to nine (9) characters long.

3.9.2 The security timeout option

Use this option to set a timeout period from 1 minute to 60 minutes, after which the meter will switch back to Full-lock mode if no keypad activity is detected. The programmed *security timeout* period is applicable for *user-1 to user-admin* access levels.

3.9.3 The modbus access timeout option

Use this option to set a timeout period from 1 minute to 60 minutes for modbus access, after which the meter will block modbus writes. This programmed modbus access timeout period is applicable only to *modbus access*.

3.9.4 The set security option

The *user* can set a security level, only if it is below the current level.

3.10 Factory status

Attention! Always consult the Panametrics factory before using the default meter and Upgrade options!

To configure the **Sentinel LCT8** factory settings, see *Figure 71* below and complete the steps on the next page.

**NOTE:** If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

Legend		
→	Red	At least user 1 level access required to follow the step.
▭	Red	Option only visible to user 1 or above.
▭	Yellow	Option only visible to user admin access.
→	Yellow	At least user admin level access required to follow this step
▭	Green	Option only available to user 3 or above
→	Green	At least user 3 level access required to follow the step.

NOTE: Do not use default meter and upgrade options before consulting Panametrics factory.

Use ▶ arrow on the screen indicates there are more info pages ▶ arrow can be used to scroll to those options. Options available:

- NVM status
- SD card status
- Modbus status
- Panalink status
- Optioncard status

Figure 71: Setting the factory options

1. Refer to *Primary pages on page 26* and navigate to *page 9*: *factory*.

2. Use the [▲] and [▼] keys to highlight *versions* and press the [✓] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight *main* or *option cards* and press the [✓] key twice to confirm your choice and view the currently installed hardware and software versions. Then, press the [✗] key to return to the previous screen.

4. Use the [▲] and [▼] keys to highlight *site file* and press the [✓] key to confirm your choice.

5. Use the [▲] and [▼] keys to highlight *save, restore* or *delete* and press the [✓] key to confirm your choice or press the [ ] key to return to the previous screen.

6. Use the [▲] and [▼] keys to highlight *yes* or *no* about your intention to save, restore, or delete the current site file. Then, press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

7. To turn the meter off and reboot it, use the [▲] and [▼] keys to highlight *power cycle meter* and press the [✓] key to confirm your choice.

8. Use the [▲] and [▼] keys to highlight *system info* and press the [✓] key to confirm your choice.

9. Use the [◄] and [►] keys to view the following pages: *system info, NVM status, SD card status, modbus status, Panalink status*, and *option card status*. After you have finished viewing these pages, press the [✓] key to return to the previous screen.

10. Use the [▲] and [▼] keys to highlight *tag* and press the [✓] key to confirm your choice.

11. If desired, change the current meter tag (i.e., name), and press the [✓] key to confirm your selection or press the [✗] key to cancel and return to the previous screen.

Chapter 4. Maintenance

4.1 Software

If the software code needs to be updated, we do suggest using a trained Panametrics service engineer to make sure that best practices are followed prior to, during and after the new code loading.

4.1.1 Checking the software version numbers

An important step when troubleshooting your meter is to make sure the expected software code is installed. This information is very helpful whenever you contact the factory for assistance with a problem. To check the meter software version, refer to *Figure 72* below and complete the step-by-step instructions after the figure.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 9*: *factory*.

2. Use the [▲] and [▼] keys to highlight *versions* and press the [✔] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight *main* and press the [ ] key twice to confirm your selection. After recording the version info - main, press the [✖] key to return to the previous screen.

NOTE: For help in understanding the version info, see *Figure 73 on page 77*.

4. Use the [▲] and [▼] keys to highlight *option cards* and press the [✔] key twice to confirm your selection. After recording the *option card version info*, press the [✖] key to return to the previous screen.

5. After you have finished, press the [✖] key until you return to the *measurement view*.
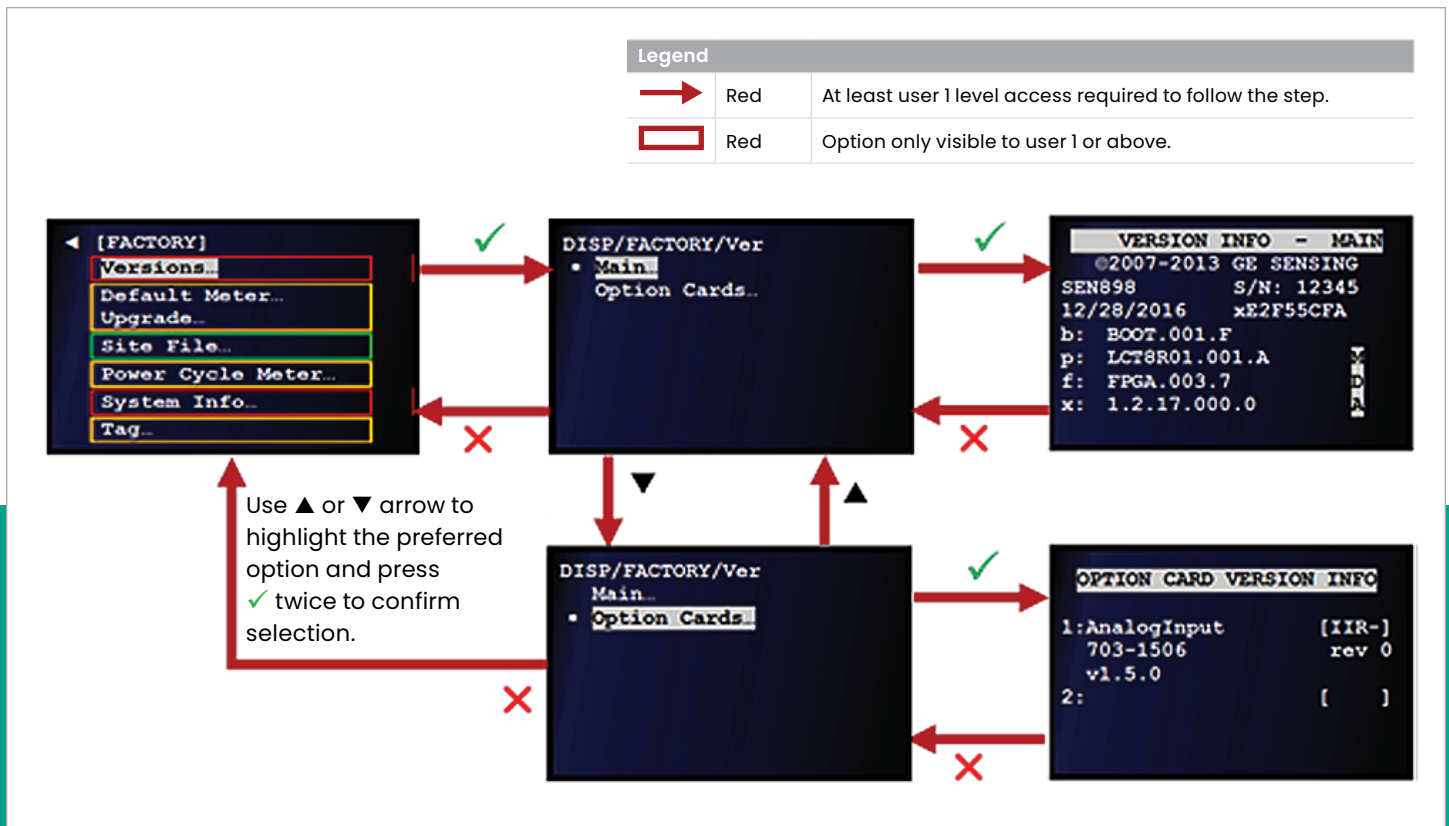
Figure 72: Checking the meter software versions

4.1.2 Save, restore or delete a site file

Anytime the meter programming is changed, the current site file should be saved. If a software corruption occurs, this allows the possibility of loading the saved site file to quickly resolve the problem and resume normal operation. Using Panametrics' Panaview SEN898 PC software provides the additional option of saving a site file to a location external to the meter. During commissioning, the trained Panametrics service engineer will save the initial site file for you.

CAUTION!

Accidentally saving or deleting a site file can have unintended consequences when you attempt to restore the site file. For example, restoring an accidentally saved version of the site file will overwrite the current site file and may change your meter configuration.
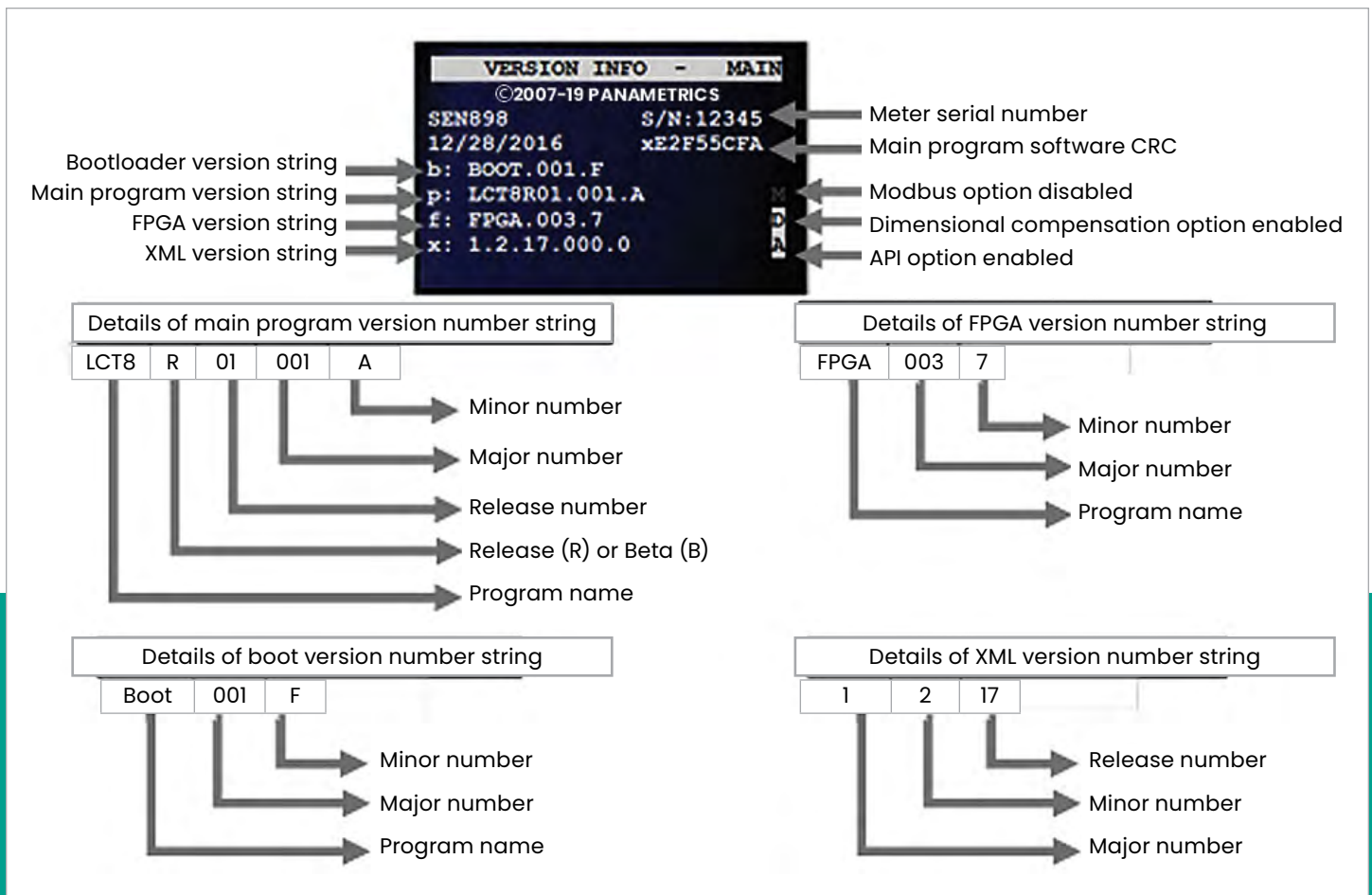
Figure 73: Version info-main Layout and details

To save, restore or delete a site file, refer to *Figure 74* below and complete the steps on the next page.

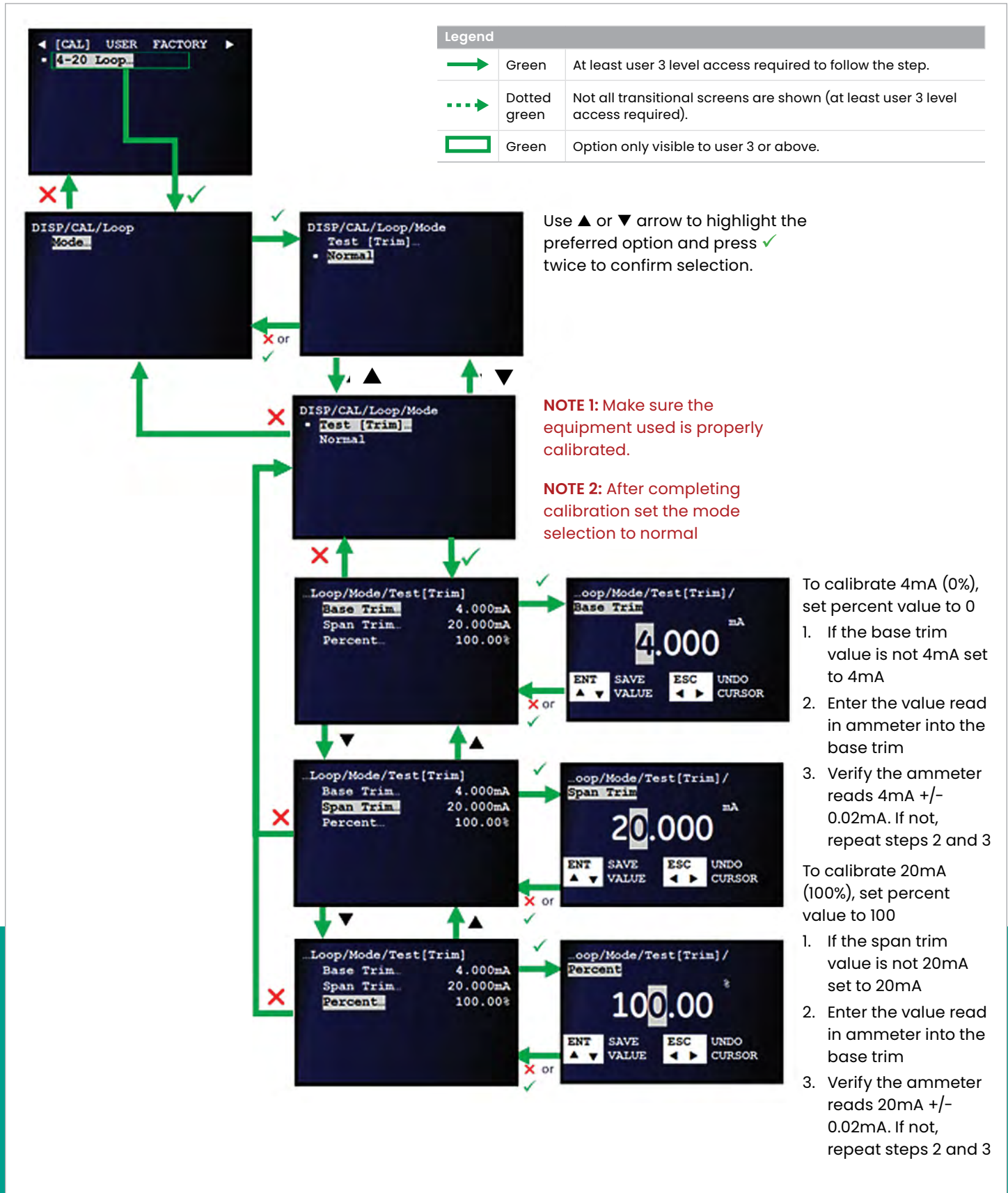**NOTE:** If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

NOTE: Do not use default meter and upgrade or site file options before consulting Panametrics factory.

Legend		
→	Red	At least user 1 level access required to follow the step.
▭	Red	Option only visible to user 1 or above.
▭	Yellow	Option only visible to user admin access.
→	Yellow	At least user admin level access required to follow this step
▭	Green	Option only available to user 3 or above
→	Green	At least user 3 level access required to follow the step.

A copy of the current configuration is saved inside the meter as a "sitefile" after selecting "yes" to confirm. Any previously saved "sitefile" will be overwritten.

The meter configurations are updated/restored with the previously saved "sitefile" after selecting "yes" to confirm.

The "sitefile" saved in the meter is deleted after selecting "yes" to confirm.

Figure 74: Save, restore or delete a site file

Note the following:

- **Save:** copies the current meter configuration to internal memory, overwriting any existing site file.
- **Restore:** replaces the current meter configuration with the previously saved site file.
- **Delete:** deletes the previously saved site file.

Complete the following steps;

1. Refer to *Primary pages on page 26* and navigate to *page 9*: *factory*.

2. Use the [▲] and [▼] keys to highlight *site file* and press the [✔] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight *save, restore* or *delete* and press the [✔] key to confirm your selection.

4. Use the [▲] and [▼] keys to highlight *yes* or *no* and press the [✔] key twice to confirm your selection or press the [✖] key to cancel and return to the previous screen.

5. After you have finished, press the[✔] key until you return to the *measurement view*.

4.1.3 Updating the instrument software

WARNING!

Use RS232 connections in non-hazardous areas only.

To update the instrument software, complete the following steps:

1. Make a note of the *main program version* and the *XML version number* (see *Checking the software version numbers on page 76*).

2. Save the site file (see *Save, restore or delete a site file on page 77*).

3. Set up the RS232 communication by connecting one end of a 9-pin RS232 cable to a serial port on the PC and the other end of the cable to com port I/O on terminal block TB2 on the **Sentinel LCT8** (see *Wiring the serial port on page 11*).

NOTE: If your PC does not have a serial port, use a serial-to-USB converter, as in this example:

4. On your PC, set up a terminal emulator program. The screen shots below show the use of *Tera Term* software.

NOTE: If you use a different communication software, see its manual for detailed instructions.

5. Select the appropriate *COM port*, as shown in *Figure 75* below, then click OK.
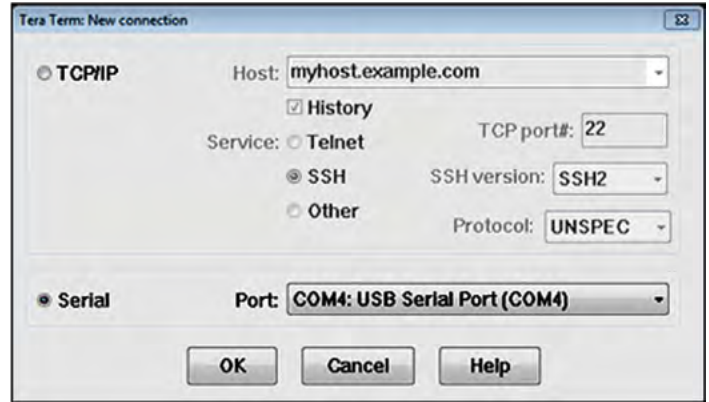
Figure 75: Tera Term com port selection

6. On the *Tera Term* terminal window click on the *setup menu* and select *serial port* to configure the COM port, as shown in *Figure 76* below. Then, click OK
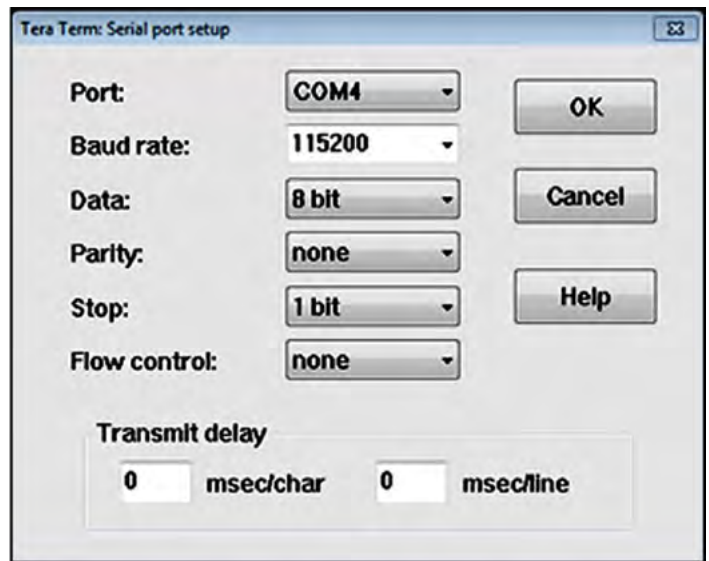
Figure 76: Configure the com port

7. There are two methods that can be used to update the meter software. Choose one of the following methods:

   a. **Method 1:** see Section *4.1.3.1 Meter software update method 1 on page 80* for detailed instructions.

   b. **Method 2:** see Section *4.1.3.2 Meter software update method 2 on page 82* for detailed instructions.

4.1.3.1 Meter software update method 1

To update the meter software from the factory Page, refer to *Figure 77* below and complete the following steps.

**NOTE:** If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 9: factory*.

2. Use the [▲] and [▼] keys to highlight Upgrade and press the [✓] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight Yes or No and press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.

4. At the next screen, the meter is ready to receive the new software over the serial port. Proceed to the next step.

5. In the *Tera Term* terminal window (see *Figure 78 on page 80*), select *file, transfer, XMODEM*, and *send* in the subsequent drop-down menus.

6. When the *Tera Term*: *XMODEM send* file selector window opens (see *Figure 79 on page 81*), locate and select the .cod extension file from your PC. After selecting the **.cod** extension file, click open and the status window shown on the left in *Figure 80 on page 81* opens. At this time, the meter display shows the file receive status (see the right of *Figure 80 on page 81*).
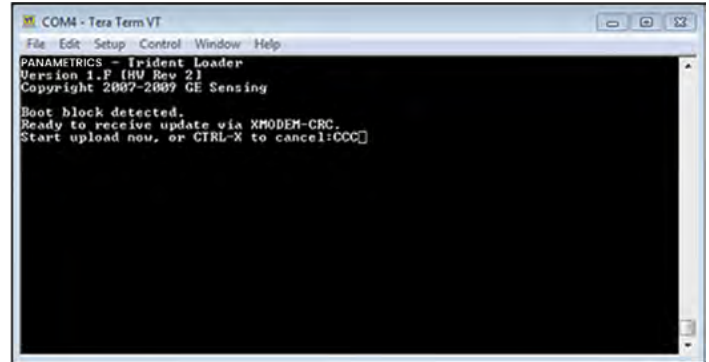
Figure 78: Tera Term indicates meter ready to receive update

NOTE: Do not use default meter and upgrade options before consulting Panametrics factory.

Legend		
→ Red	Red	At least user 1 level access required to follow the step.
▭ Red	Red	Option only visible to user 1 or above.
▭ Yellow	Yellow	Option only visible to user admin access.
→ Yellow	Yellow	At least user admin level access required to follow this step
▭ Green	Green	Option only available to user 3 or above
→ Green	Green	At least user 3 level access required to follow the step.

When in this screen, the meter is ready to receive the new software over the serial port.
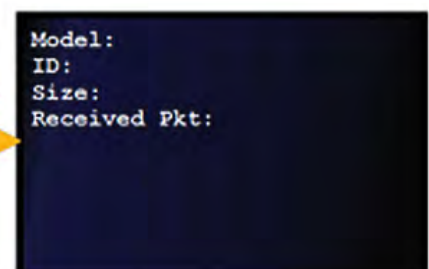
Figure 77: Update the meter software from the factory page

7. After the file transfer is complete, the *Tera Term* terminal window will appear as in *Figure 81 on page 81*, and the meter will start up.

8. The meter software update is now complete. Proceed to *Post Update recommendations on page 83*.

Figure 79: XMODEM send file selector

Figure 80: XMODEM Send status (left) and meter display file receive status (right)
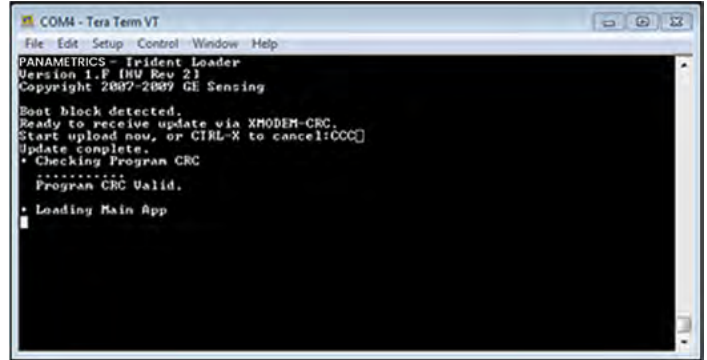
Figure 81: Update complete message in Tera Term

4.1.3.2 Meter software update method 2

To update the meter software using the *Tera Term* software, proceed as follows:

1. Power on the **Sentinel LCT8**, then launch the *Tera Term* software and press **ESC** on your PC keyboard. The Tera Term terminal window indicates that the meter is awaiting your input, as in *Figure 82* below.
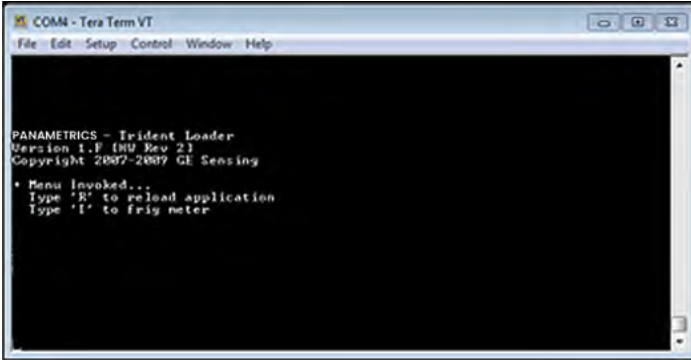
Figure 82: Tera Term Awaiting input

2. Press **R** (not case sensitive) using your PC keyboard and the *Tera Term* terminal window indicates that the meter is ready to receive the update via XMODEM-CRC (see *Figure 83* below). Select *file, transfer, XMODEM*, and *send* in the subsequent drop-down menus.
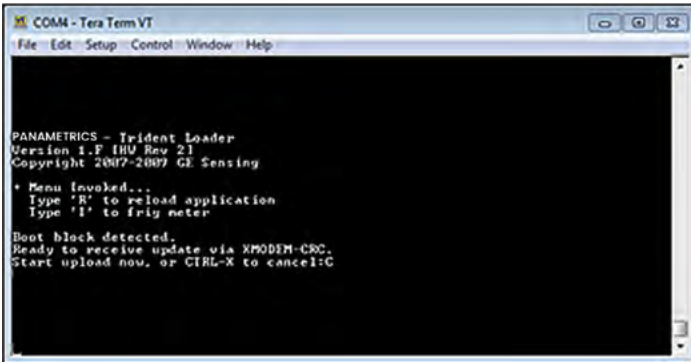
Figure 83: Tera Term indicates meter is ready to receive Update

3. When the *Tera Term: XMODEM send* file selector window opens (see Figure 13 below), locate and select the **.cod** extension file from your PC. After selecting the **.cod** extension file, click **open** and the status window shown on the left in *Figure 84* below opens. At this time, the meter display shows the *file receive status* (see the right of *Figure 85 on page 82* below).
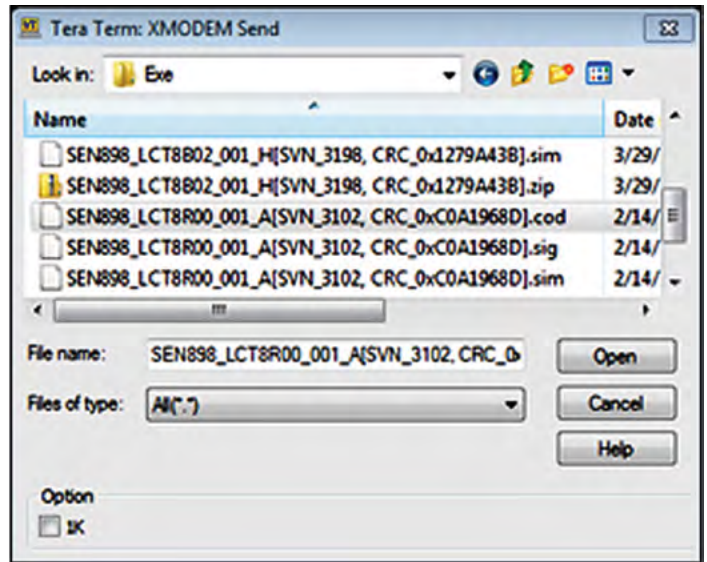
Figure 84: XMODEM Send file selector
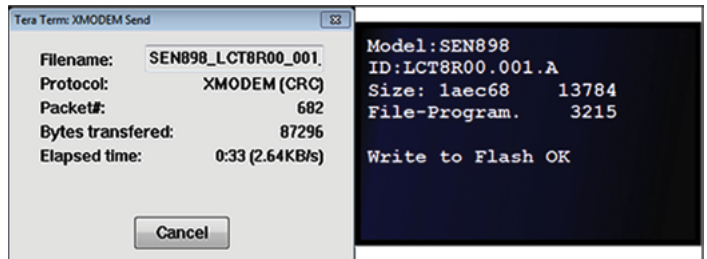
Figure 85: XMODEM Send status (left) and meter display file receive status (right)

4. After the file transfer is complete, the Tera Term terminal window will appear as in *Figure 86* below, and the meter will start up.
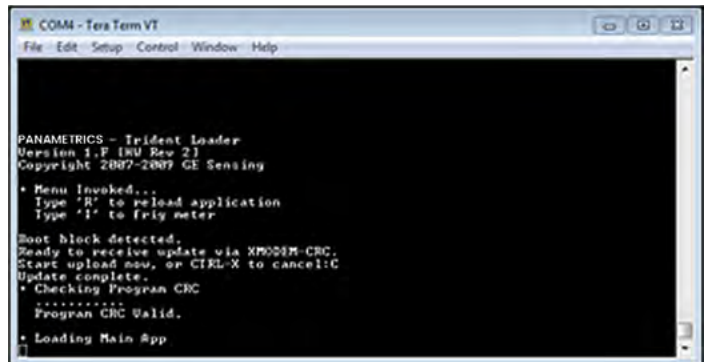
Figure 86: Update complete message in Tera Term

5. The meter software update is now complete. Proceed to *Post Update recommendations on page 83*.

4.1.3.3 Post update recommendations

To ensure that the **Sentinel LCT8** operates correctly, Panametrics recommends defaulting the meter after software updates.

	CAUTION!
⚠️	**All site configuration and calibration data will be lost when the meter is defaulted!** It is highly recommended that a site file archive is captured via PanaView SEN898 or using the *site file menu* under the *factory menu*. This archive can then be used to restore the site and calibration data after the meter default is complete (see *Save, restore or delete a site file on page 77*).

NOTE: After the **Sentinel LCT8** has been defaulted, it restarts in the locked mode. See *Unlocking the meter on page 25* for instructions on unlocking the meter.

To default the meter, use either of the two following methods:

Method 1: Using the factory menu

Refer to *Figure 87* below and complete the step-by-step instructions after the figure.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 9: factory*.
2. Use the [▲] and [▼] keys to highlight default meter and press the [✓] key to confirm your choice.
3. Use the [▲] and [▼] keys to highlight *yes* or *no* and press the [✓] key twice to confirm your selection or press the [✗] key to cancel and return to the previous screen.
4. If you selected and confirmed *yes*, verify that the meter restarts.

NOTE:
Do not use default meter, upgrade or site file options before consulting Panametrics factory

Legend		
➡️ Red	Red	At least user 1 level access required to follow the step.
▭ Red	Red	Option only visible to user 1 or above.
▭ Yellow	Yellow	Option only visible to user admin access.
➡️ Yellow	Yellow	At least user admin level access required to follow this step
▭ Green	Green	Option only available to user 3 or above
➡️ Green	Green	At least user 3 level access required to follow the step.

Use ▲ or ▼ arrow to highlight the preferred option and press ✓ twice to confirm selection.

Figure 87: Defaulting the meter from the factory menu

Method 2: During power on

Refer to *Figure 88* below and complete the step-by-step instructions after the figure.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Press and hold the **CLR TOTALS** key during power on until the *default meter?* screen opens, then release the key.

2. Do one of the following:
   - Press the [▼] key to power on the meter without defaulting it.
   - Press the [▲] key to quickly power on the meter and begin defaulting it.

NOTE: Do not default meter before consulting Panametrics factory.

Press and hold clr totals key during power on until the screen below appears after a few seconds. Once screen appears, release clr totals key.

Press and hold clr totals

Press ▲ key to default meter.

Meter restarts quickly and starts defaulting the meter.

Meter continues start-up process without defaulting the meter.

NOTE: The arrows in this figure are blue and indicate login is not required to follow these steps.

Figure 88: Defaulting the meter during power on

4.2 Mechanical

<table>
<tr><td>

WARNING!

Before opening the pressure vessel, it must be completely de-pressurized! This warning applies to all three interfaces described in this section (flange interface, transmitter connection and sensor ports). The appropriate procedure should be followed to properly relieve any pressure build up in the system prior to servicing the equipment.

</td></tr>
</table>

<table>
<tr><td>

WARNING!

All equipment must be de-energized prior to servicing.

</td></tr>
</table>

Attention! Only trained and qualified personnel should service the pressure vessel.

The **Sentinel LCT8** system has three serviceable interfaces (see Figure 18 below):

- **Flanges** (see *Servicing the pipe flange interface on page 85*)

- **Sensor ports** (see *Servicing the sensor ports and transmitter connection on page 86*)

- **Transmitter connection** (see *Servicing the sensor ports and transmitter connection on page 86*)
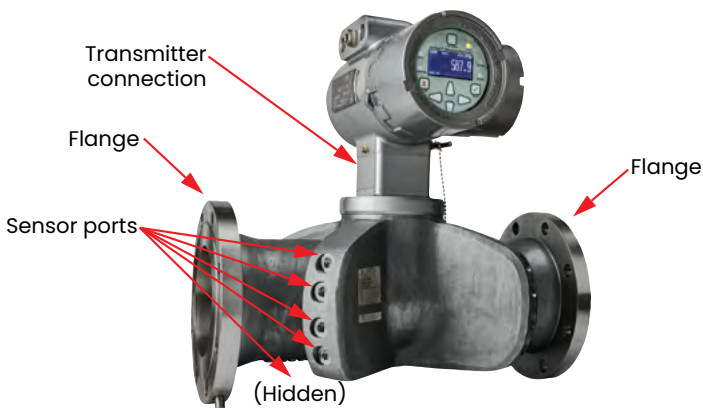
Figure 89: **Sentinel LCT8** serviceable interfaces

4.2.1 Servicing the pipe flange interface

<table>
<tr><td>

WARNING!

Before opening the pressure vessel, it must be completely de-pressurized!

</td></tr>
</table>

Only properly trained personnel, such as pipe fitters, should service the pipe flanges. The proper gasket material, bolts, bolt torque, and tightening sequence must always be used. See the procedure in *Mechanical installation on page 7* for reference.

4.2.2 Servicing the sensor ports and transmitter connection

⚠	**WARNING!**
	Before you open the sensor ports or the transmitter connection, the system must be completely de-pressurized!

The sensor ports contain the sensors and sensor wiring. These ports should only be serviced by properly trained and qualified service technicians. Modification or alteration in any manner may degrade the performance of the system.

4.2.2.1 Required equipment

Before proceeding, ensure that the following tools are available:

- 10 mm hex drive socket or wrench
- 12 mm hex drive socket or wrench

4.2.2.2 Checking for internal leaks

To relieve the system pressure, see *Figure 90* below and *Figure 91* below to complete the following steps:

1. Locate the upstream **"A"** plane sensor quadrant. This quadrant can be found by locating the tag plates on the pressure vessel (see *Figure 2 on page 4*).
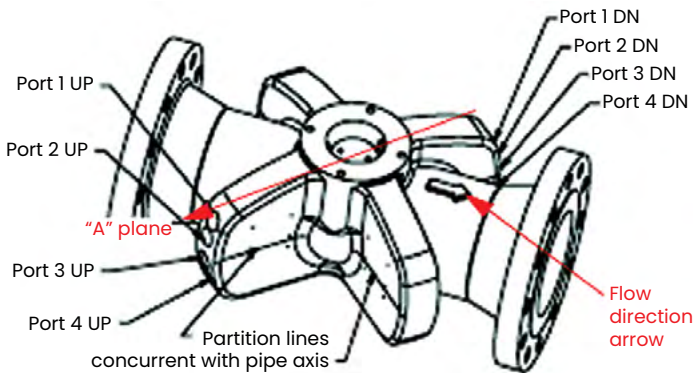
Figure 90: Upstream "A" plane sensor quadrant - top view
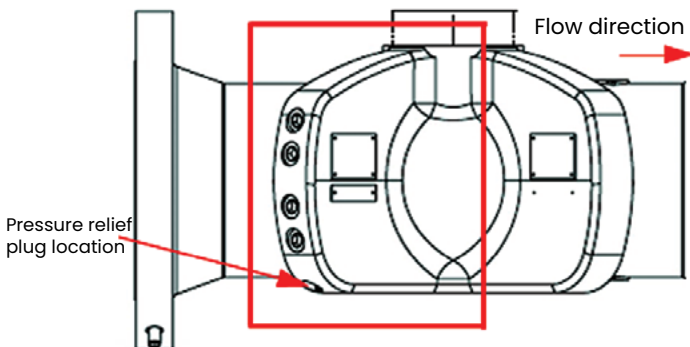
Figure 91: Upstream "A" plane sensor Quadrant - side view

2. Relieve potential pressure build-up by loosening the *pressure relief plug* on the bottom of the upstream "A" plane sensor quadrant (see *Figure 91* above), using a 10 mm hex drive socket or wrench. Slowly loosen the pressure relief plug 2-3 full turns or until the plug bottoms out on the built-in safety stop.

3. Listen to and observe the area near the pressure relief plug:

   a. If any hissing is heard, indicating air or gas release, stop loosening the plug and wait for the hissing to stop. If the hissing continues for more than 10 minutes, re-tighten the plug and consult Panametrics.

   b. If any liquid discharge is observed, stop loosening the plug and re-tighten it completely.

⚠	**WARNING!**
	If any liquid discharge is observed at the pressure relief plug, then the process pressure must be removed from the pipeline prior to servicing the sensor ports or transmitter connection.

   c. If no hissing or discharge is observed and the plug has been backed out to the safety stop, then any pressure buildup has been released and the ports are now serviceable.

4. Avoid servicing the equipment contained within the sensor ports and transmitter connection, as it is serviceable only by factory trained service technicians.

5. After the service work is complete, all *sensor port plugs* and the *pressure relief plug* should be reinstalled and tightened fully.

4.2.3 Spare parts list

The **Sentinel LCT8** is a high-accuracy calibrated flow meter. Local custody transfer requirements may disallow field replacement of any parts in this flow metering system without a proper calibration of the entire system at an approved calibration facility. Check with local authorities to determine if field replacement of parts is allowed.

If fault is found with the flow meter electronics, the entire measurement head can be replaced to ensure hardware and firmware compatibility. The replacement part number will be as shown in *Transmitter tag plate on page 4*. To ensure that the correct part number is ordered, provide your local Panametrics representative with the serial number of the meter, which is located as shown in *Part string and serial number tag plate on page 4*.

If it is determined that a flow transducer has been damaged or is faulty, it may also be replaced in the field with no need for recalibration. Please contact Panametrics for the appropriate part number.

Table 12 below lists the available spare parts for the **Sentinel LCT8**.

Table 12: Available spare parts			
Option code	**Description**	**Option code**	**Description**
703-1653-00	SEN898 main PCB assembly	LCT8-SPARE-XDCR-KIT-2MHZ	LCT8 transducer kit pair (2MHz) for 6"–8" flowcells
705-1912-00	SEN898 flow/receiver PCB assembly	LCT8-SPARE-XDCR-KIT-1MHZ	LCT8 transducer kit pair (1MHz) for 10"–24" flowcells
703-1506-03	SEN898 analog input option card (AAR)	LCT8-SPARE-CBL-KIT-6IN	LCT8 cable kit for 6" flowcells
703-1506-04	SEN898 analog input option card (AAA)	LCT8-SPARE-CBL-KIT-8IN	LCT8 cable kit for 8" flowcells
705-1217-01	SEN898 HMI assembly	LCT8-SPARE-CBL-KIT-10IN	LCT8 cable kit for 10" flowcells
705-1246-00	SEN898 AC power supply PCB assembly	LCT8-SPARE-CBL-KIT-12IN	LCT8 cable kit for 12" flowcells
705-1247-00	SEN898 DC power supply PCB assembly	LCT8-SPARE-CBL-KIT-14IN	LCT8 cable kit for 16" flowcells
193-076-14	Fuse AC power supply	LCT8-SPARE-CBL-KIT-16IN	LCT8 cable kit for 18" flowcells
193-076-20	Fuse DC power supply	LCT8-SPARE-CBL-KIT-18IN	LCT8 cable kit for 20" flowcells
SEN_KIT-WAND	Magnetic wand with lanyard + screw + washer kit	LCT8-SPARE-CBL-KIT-20IN	LCT8 cable kit for 24" flowcells
412-1906	Stopping plug, ½" NPT (ATEX, IECEx, FM, CSA) - SS	LCT8-SPARE-CBL-KIT-24IN	LCT8 spare plug kit for 6"–14" flowcells
419-373	Stopping plug, ¾" NPT (ATEX, IECEx, FM, CSA) - SS	LCT8-SPARE-PLG-KIT-6_14	LCT8 spare plug kit for 16"–24" flowcells
401-083	Pyrogel couplant (4 oz tube)	LCT8-SPARE-PLG-KIT-16_24	LCT8 spare plug kit for 16"–24" flowcells

Chapter 5. Troubleshooting

5.1   Introduction

The **Sentinel LCT8** flow transmitter is a reliable, easy to maintain instrument. When properly installed and operated, as described in Chapter 2, installation, the meter provides accurate flow rate measurements with minimal user intervention. However, if a problem should arise with the electronics enclosure or transducers, this chapter explains how to troubleshoot the **Sentinel LCT8**. Indications of a possible problem include:

• Display of an error message on the LCD screen

• Erratic flow readings

• Readings of doubtful accuracy (e.g., readings that are not consistent with readings from another flow measuring device connected to the same process)

If any of the above conditions occur, proceed with the instructions presented in this chapter.

NOTE: For high electrical noise areas, it is recommended that you follow the wiring instructions in *Appendix A. CE Mark compliance and high noise environments on page 111*.

5.2 Error codes

5.2.1 Overview

If a problem occurs with the electronics or transducers, a built-in error code message system greatly simplifies the troubleshooting process.

All the possible **Sentinel LCT8** error code messages are discussed in this chapter, along with the possible causes and the recommended actions. When an error code is generated, it will appear in the lower right corner of the LCD screen, as discussed in *Chapter 3. Programming on page 21*.

If an error message appears on the display screen during operation of the **Sentinel LCT8**, refer to the appropriate section of this chapter for instructions on how to proceed. You may be asked to contact Panametrics. It would be very helpful to enter all of the diagnostic data and parameter information for each channel in *Appendix B. Service record on page 113* prior to calling your local Panametrics sales or service center.

5.2.2 General guidelines for troubleshooting with error codes

Refer to *Flow info on page 94* to identify the number of channels reporting an error, then proceed to the appropriate section below. Also, refer to *Table 13 on page 91* for causes and recommended actions for each error code.

5.2.2.1 Only one channel in error

If only one channel is in error, the most likely causes are:

• Incorrect programming of the *error limits* or flow condition changes that now make previous programming invalid.

• Defective or damaged cables, transducers, couplant, buffer, or electronics.

If the error still exists after you have tried eliminating or correcting the most likely causes mentioned above, check for these process and/or flow conditions changes:

• Excessive turbulence

• Discontinuities in fluid characteristics such as: multi-phase flow, flashing, pockets of gas, the presence of bubbles or solid particles, cavitation, or rapidly changing fluid type

• Extreme fluid properties, such as pressure or temperature conditions

• Wax build-up on the face of a buffer/transducer, or clogged transducer ports due to sedimentation

• A pipe that is not completely full

5.2.2.2 More than one channel in error

If more than one channel is in error, the most likely cause is changes in process and/or flow conditions such as:

• Excessive turbulence

• Discontinuities in fluid characteristics such as: multi-phase flow, flashing, pockets of gas, the presence of bubbles or solid particles, cavitation, or rapidly changing fluid type

• Extreme fluid properties, such as pressure or temperature conditions

• Wax build-up on the face of a buffer/transducer, or clogged transducer ports due to sedimentation

• A pipe that is not completely full

If the error still exists after you have tried eliminating or correcting the most likely causes mentioned above, check for the following:

• Incorrect programming of the *error limits* or flow condition changes that now make previous programming invalid.

• Defective or damaged cables, transducers, couplant, buffer, or electronics.

If you are unable to clear the errors, collect diagnostic data and parameter information for each channel and enter it in *Appendix B. Service record on page 113* prior to calling your local Panametrics sales or service center. Refer to *Flow info on page 94* to gather the required diagnostics data.

5.2.2.3 Table of error codes

	Error code	Problem	Cause	Recommended action
			Table 13: Error code descriptions	
E0:	No error	No error condition currently exists	This message appears briefly to indicate that the meter is now measuring without errors and any previous errors have now cleared.	No action is required.
E1:	Low signal	The ultrasonic signal strength is poor or the signal exceeds the programmed limits.	Poor signal strength may be caused by a defective cable, a flow cell problem, an empty pipe at the channel, a defective transducer or a problem in the electronics console. A signal that exceeds the programmed limits is probably caused by the entry of an improper value in the error limits option.	Check the value entered into the *signal min error* limits option (see the *entering error limits* and *understanding error limits* sections). Also, refer to the *fluid and pipe problems* and the *transducer problems* sections to correct for any issues.
E2:	Soundspeed	The measured soundspeed exceeds the programmed limits.	The error may be caused by incorrect programming, poor flow conditions, changing fluid properties that are outside expected values. It may also occur if signal quality is poor.	Compare the measured soundspeed to tabulated nominal values for the process fluid and correct any programming errors. Refer to the *fluid and pipe problems* and *transducer problems* sections to correct for any issues. In case you are unable to clear the errors, refer to the *flow Info* section to gather diagnostics data before contacting Panametrics.
W3:	Velocity range	The measured velocity exceeds the programmed limits.	This warning may be caused by incorrect programming, poor flow conditions and/or excessive turbulence.	Make sure the actual flow rate is within the programmed error limits (see the entering error limits and understanding error limits sections). refer to the fluid and pipe problems and the transducer problems sections to correct any issues.
E5:	Amplitude	The signal amplitude exceeds the programmed limits.	This error may occur due to high signal attenuation or amplification due to changes in fluid properties, transducer/buffer/couplant issues.	Make sure the amplitude is within the programmed error limits (see the *entering error limits* and *understanding error limits* sections). Refer to the *fluid and pipe problems* and *transducer problems* sections to correct any issues. Refer to the *flow info* section to gather diagnostics data before contacting Panametrics.
E6:	Cycle skip (or) acceleration	A cycle skip is detected while processing the signal for measurement.	This is usually due to poor signal integrity, possibly because of bubbles in the pipeline, sound absorption by very viscous fluids, or cavitation.	If this error is caused by changes in flow rate, it will be auto corrected when the flow rate stabilizes after initial acceleration. But, if the error remains, refer to the *fluid and pipe problems* section to correct any issues. Check the *threshold peak* percentage, refer to the flow info section to gather diagnostics data before contacting Panametrics.

	Error code	Problem	Cause	Recommended action
	Table 13: Error code descriptions			
E7:	**Analog output**	The current setting is outside the programmed limits.	The calculated output value exceeds the programmed limits.	Verify that the 4–20 mA loop configuration base and span settings are correct for the process. Revise the output range as necessary.
E13:	**Settle tracking AGC**	The meter is unable to find a signal that is of sufficient quality.	Every time the meter is in E1, E2, E5 or E6, the meter also has an E13 error.	Refer to the actions for E1, E2, E5 or E6 errors.
E14:	**Tracking seek mode**	The signal is intermittent.	Discontinuities in the fluid characteristics such as multi-phase flow, flashing, pockets of gas, or rapidly changing fluid type make it difficult for the meter to lock in on the signal.	Check the process conditions. If thermal insulation is present, ensure an even application to mitigate hot or cold spots. In case you are unable to clear the errors, refer to the *flow info* section to gather diagnostics data before contacting Panametrics.
E15:	**Active Tw**	The active Tw measurement is invalid.	A transducer or cable is damaged, or a transducer needs to be re-coupled. This may also be due to incorrect programming, or extreme process temperatures.	Refer to the *transducer problems* section to correct any issues. If you are unable to clear the errors, refer to the *flow info* section to gather diagnostics data before contacting Panametrics.
E16:	**Totalizer overflow**	The totalizers are unable to keep up with the total accumulated flow signals	The programmed units/pulse value is too small.	Select a larger number for the units/pulse value (see the *setting up frequency/totalizer* and *setting up totalizer* sections).
E17:	**Temperature input**	This message indicates a temperature input error	The temperature exceeds the specified limits for the analog/RTD inputs, or no input device is connected.	Check the temperature transmitter and the connecting cable. Recalibrate the analog/RTD inputs
E18:	**Pressure input**	This message indicates a pressure input error.	The pressure exceeds the specified limits for the analog inputs, or no input device is connected.	Check the pressure transmitter and the connecting cable. Recalibrate the analog input.
E19:	**Density input**	This message indicates a density input error.	The density exceeds the specified limits for the analog inputs, or no input device is connected.	Check the density input device and the connecting cable. Recalibrate the analog input.
E21:	**API**	This message indicates an error in the API calculations.	The combination of pressure, temperature, density, and/or flow inputs causes the calculation to not properly resolve.	The specific API error can be found in the *API info* section of the meter program.
E22:	**Degraded performance**	One of the measurement channels is in error.	One measurement channel is in error, and the accuracy of the measurement may be degraded because the meter is using a chord substitution.	Check the individual channel errors, and refer to this table for recommended actions to correct those channel errors.
E23:	**Reduced accuracy**	Three or more related measurement channels are in error.	All 4 outer measurement channels or all 4 inner measurement channels are in error. The accuracy of the measurement is compromised because the meter is unable to use chord substitution.	Check the individual channel errors, and refer to this table for recommended actions to correct those errors. Refer to the *more than one channel in error* section for general troubleshooting guidelines.

Table 13: Error code descriptions			
Error code	**Problem**	**Cause**	**Recommended action**
W24: **Low SNR**	The signal to Noise ratio is low.	The acoustic signal from the process is of very low quality due to excessive noise in the signal. This could be due to bubbles, solids or other non-homogeneous fluid conditions, or issues with transducers, couplant or buffers.	Refer to the *fluid and pipe problems* and *transducer problems* sections to correct any issues. Refer to the *flow info* section to gather diagnostics data before contacting Panametrics.
E25: **Half full pipe**	The pipe might not be filled completely.	If the top-most channel on each plane is in error, the pipe might not be completely filled. The meter is using chord substitution to continue measuring. Please check the individual chord diagnostics to diagnose problem.	Check if the pipe is full. Check for individual channel errors, and refer to this table for recommended actions to correct those errors.
E26: **Possible sediment**	Possible sedimentation covering the sensors	If the bottom-most channel on each plane is in error, there could be sedimentation covering the sensor faces. The meter is using chord substitution to continue measuring. Check the individual chord diagnostics to diagnose the problem.	Check for individual channel errors, and refer to this table for recommended actions to correct those errors. Refer to the *more than one channel in error* section for general troubleshooting guidelines.
E27: **Inner chord(s)**	Two or more inner chords in error.	Two or more inner chords are in error. The meter is using chord substitution to continue measuring. Check the individual chord diagnostics to diagnose the problem.	Check for individual channel errors, and refer to this table for recommended actions to correct those errors. Refer to the *more than one channel in error* section for general troubleshooting guidelines.
E28: **Symmetry**	The velocity symmetry is compromised.	Two or more chords are in error, and the velocity symmetry is compromised. The meter is using chord substitution to continue measuring. Check the individual chord diagnostics to diagnose problem.	Check for individual channel errors, and refer to this table for recommended actions to correct those errors. Refer to the *more than one channel in error* section for general troubleshooting guidelines.
E29: **Stale data**	Internal data may be stale.	There is an internal data processing failure.	This condition is self-recovering and the error will be automatically corrected.
E30: **Channel off**	Channel is currently disabled.	The channel is currently disabled. The meter will continue to measure with the enabled channels. However, the accuracy of the measured flow may be compromised.	Check the *channel status* in the meter program.

5.3 Flow info

The **Sentinel LCT8** offers built-in diagnostic parameters to aid in troubleshooting. To view multiple diagnostics for all channels via the flow info form, refer to *Figure 92* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

NOTE: The flow info pages are updated with live measurement diagnostics and hence constantly varying.

Use ◄ or ► arrow to view these (p1 to p7) diagnostics for other channels (ch1 to ch8).

This page provides "active tw" diagnostics. Use ◄ or ► arrow to view "active tw" diagnostics for other channels (ch1 to ch8).

This page provides "current errors" diagnostics. This page displays all errors on a specific channel at any point in time. Use ◄ or ► arrow to view "current errors" for other channels (ch1 to ch8).

This page provides "error bitmap" diagnostics. This page displays all errors on a specific channel at any point in time and past 15 measurement cycles. Use ▼ arrow to view page2 or the "error bitmap" diagnostics. Use ◄ or ► arrow to view these diagnostics for other channels (ch1 to ch8).

This page provides "tracking" diagnostics. This page displays diagnostics related to tracking the signal. This page is helpful only when the meter is in error. Use ◄ or ► arrow to view "tracking" diagnostics for other channels (ch1 to ch8).

NOTE: The arrows in this figure are red and indicate at least user1 access level is required to follow these steps.

Figure 92: Using flow info in troubleshooting

1. Refer to *Primary pages on page 26* and navigate to *page 2*: *device info*.

2. Use the [▲] and [▼] keys to highlight flow info and press the [✓] key to confirm your choice.

NOTE: Because the flow info pages are updated with flow measurement diagnostics, they vary constantly.

3. Use the [▲] and [▼] keys to view the following flow info pages:

   a. **P1:** Use the [◄] and [►] keys to view this diagnostic data for channels 1-8.

   b. **P2:** Use the [◄] and [►] keys to view this diagnostic data for channels 1-8.

   c. **P3:** Use the [◄] and [►] keys to view the *active tw* diagnostic data for channels 1-8.

   d. **P4:** Use the [◄] and [►] keys to view the *current errors* diagnostic data for channels 1-8.

   e. **P5:** Use the [◄] and [►] keys to view the *error bitmap* diagnostic data for channels 1-8.

   f. **P6:** Use the [◄] and [►] keys to view this diagnostic data for channels 1-8.

   g. **P7:** Use the [◄] and [►] keys to view the *tracking* diagnostic data for channels 1-8.

4. After you have finished viewing the diagnostic data, use the [▲] and [▼] keys to return to the **P1** screen and press the [✗] key to return to the previous screen.

NOTE: For future reference, the flow info may be recorded in the tables in *Appendix B. Service record on page 113*.

5.4   Fluid and pipe problems

If preliminary troubleshooting with the *error code messages* and the *diagnostic parameters* indicates a possible problem, proceed with this section. Measurement problems fall into two categories:

- **Fluid problems**
- **Pipe problems**

Read the following sections carefully to determine if the problem is related to the fluid or the pipe. If the instructions in this section fail to resolve the problem, contact Panametrics for assistance.

5.4.1   Fluid problems

Most fluid-related problems result from a failure to observe the flow meter system installation instructions, as described in *Chapter 2. Installation on page 5*. Refer to that chapter to correct any installation problems.

If the physical installation of the system meets the recommended specifications, it is possible that the fluid itself may be preventing accurate flow rate measurements. The fluid being measured must meet the following requirements:

- **The fluid must be homogeneous, single-phase, relatively clean and flowing steadily.**

  Although a low level of entrained particles may have little effect on the operation of the *Sentinel LCT8*, excessive amounts of solid particles will absorb or disperse the ultrasound signals. This interference with the ultrasound transmissions through the fluid will cause inaccurate flow rate measurements. In addition, temperature gradients in the fluid flow may result in erratic or inaccurate flow rate readings.

- **The fluid must not cavitate near the measurement point.**

  Fluids with a vapor pressure relatively close to the process pressure may cavitate near the measurement point. This causes problems resulting from gas bubbles in the fluid. Cavitation can usually be controlled through proper system design.

- **The fluid must not excessively attenuate ultrasound signals.**

  Some fluids, particularly those that are very viscous, readily absorb ultrasound energy. In such cases, signal warning and error messages will appear on the display screen to indicate that the ultrasonic signal strength is insufficient for reliable measurements.

- **The fluid soundspeed must not vary excessively.**

  The *Sentinel LCT8* will tolerate relatively large changes in the fluid soundspeed, as may be caused by variations in fluid composition and/or temperature. However, such changes must occur slowly. Rapid fluctuations in the fluid soundspeed, to a value that is considerably different from that programmed into the *Sentinel LCT8*, will result in erratic or inaccurate flow rate readings. This may occur when changing batch fluids, though most likely the *Sentinel LCT8* will recover.

NOTE: Refer to *Chapter 3. Programming on page 21* to make sure the appropriate soundspeed is programmed into the meter.

5.4.2   Pipe problems

Pipe-related problems may result from improper choice in meter location or errors in programming. The following may result in problematic installations:

- **The collection of solid material at one or more transducer locations.**

  Accumulated debris at the transducer location(s) will interfere with transmission of the ultrasound signals. Choose an installation point for the meter where solid particles will not settle into the transducer ports. Refer to *Chapter 2. Installation on page 5*, for more details on proper installation practices.

- **The inner surface of the pipe is not sufficiently clean.**

  Excessive buildup of scale, rust or debris will change the inner dimensions of the pipe, which results in inaccuracies in the calculation of the flow rate from the fluid velocity measurement.

5.5 Transducer problems

The **Sentinel LCT8** transducers are rugged, reliable devices that do not come into contact with the process fluid. If erratic or inaccurate readings can be tracked to a problem with one or more transducers, such as physical damage, the Panametrics field service team has the appropriate methods and tools to properly replace the transducer to maintain the accuracy of your flow meter system without the need to recalibrate the system. Contact your local Panametrics representative to schedule this service.

5.6 Uncertainty in flow rate for a non-insulated flowcell

Dimensional compensation considers the effect on the geometrical dimensions of the flowcell due to the material thermal expansion or contraction. The fluid temperature inside the flowcell is measured and used for this purpose. Under severe ambient conditions, such as –40°C in winter, the fluid temperature can be very different, by up to 10°C, from the pipe wall temperature. This will cause about a 0.04% error in the measured flow rate. *Figure 93* below indicates that the errors increase as the difference between the fluid and the ambient temperatures for both insulated and non-insulated flowcells. For non-insulated flowcells, at large temperature differences, the error is about one order of magnitude higher than that for insulated flowcells. Therefore, for applications in severe weather conditions, it is recommended that the flowcell be insulated to ensure the accuracy of the meter.
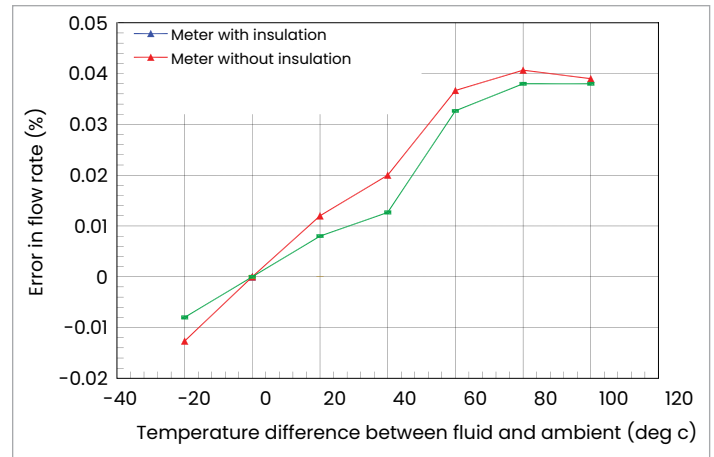
Figure 93: Example of flow error at Various temperature differences

5.7 Manufacturing tests

The procedures for testing certain key functionalities of the **Sentinel LCT8** are described in this section. The **Sentinel LCT8** Watchdog test, keypad test, display test and IO test are available to the user. As an example, the IO test is discussed in detail in this chapter. All other manufacturing tests are performed in a similar manner.

The IO test is used to troubleshoot any problems associated with damaged electronics or changes in the process conditions that may be affecting the **Sentinel LCT8** inputs and/or outputs. Proceed to the following three sections for instructions on how to test specific IO functions.

5.7.1 Frequency output test

To test a frequency output, refer to *Figure 94* below and complete the steps on the following page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.
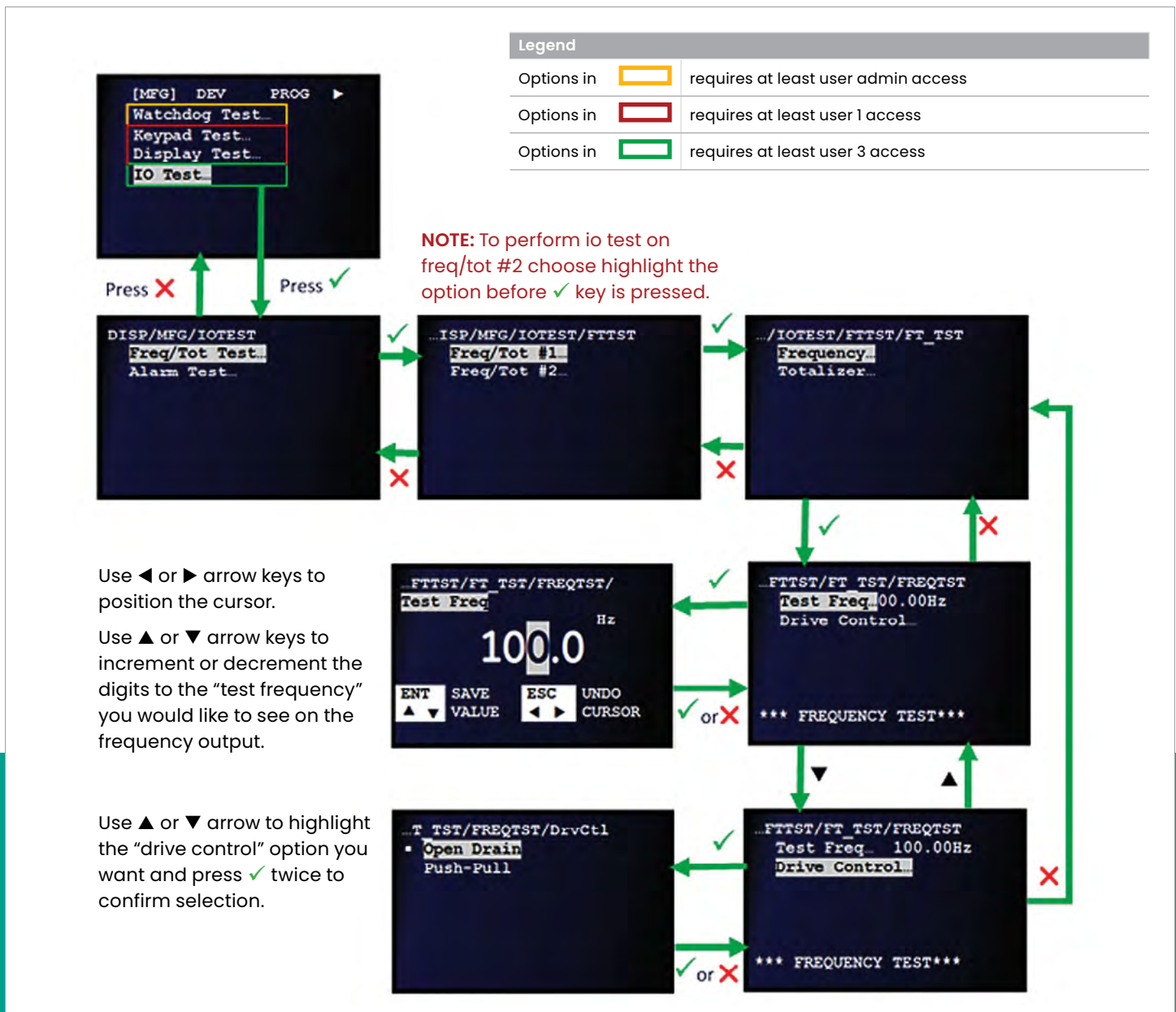
Figure 94: Manufacturing IO test - frequency output

1. Refer to *Primary pages on page 26* and navigate to *page 1: manufacturing tests*.

2. Use the [▲] and [▼] keys to highlight *IO test* and press the [✓] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight *freq/tot test* and press the [✓] key to confirm your choice or press the [✗] key to return to the previous screen.

4. To test the desired *frequency output*, use the [▲] and [▼] keys to highlight either *freq/tot #1* or *freq/tot #2*. Then, press the [✓] key to confirm your choice or press the [✗] key to return to the previous screen.

5. Use the [▲] and [▼] keys to highlight *frequency* and press the [✓] key to confirm your choice or press the [✗] key to return to the previous screen.

   a. Use the [▲] and [▼] keys to highlight *test freq* and press the [✓] key to confirm your choice. At the next screen, enter the test frequency value to be output. Then, press the [✓] key to save the new value or press the [✗] key to keep the old value and return to the previous screen.

   b. Use the [▲] and [▼] keys to highlight *drive control* and press the [✓] key to confirm your choice. At the next screen, use the [▲] and [▼] keys to highlight either *open drain* or *push-pull* and press the [✓] key twice to confirm your choice or press the [✗] key to cancel and return to the previous screen.

5.7.2 Totalizer output test

To test a *totalizer output,* refer to *Figure 95* below and complete the steps on the next page.

NOTE: If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

Use ◄ or ► arrow keys to position the cursor.

Use ▲ or ▼ arrow keys to increment or decrement the digits to the "pulse count" for totalizer test.

Use ◄ or ► arrow keys to position the cursor.

Use ▲ or ▼ arrow keys to increment or decrement the digits to the "pulse width" for totalizer test.

Use ▲ or ▼ arrow to highlight the "polarity" option you want to test and press ✓ twice to confirm selection.

Use ▲ or ▼ arrow to highlight the "drive control" option you want to test and press ✓ twice to confirm.
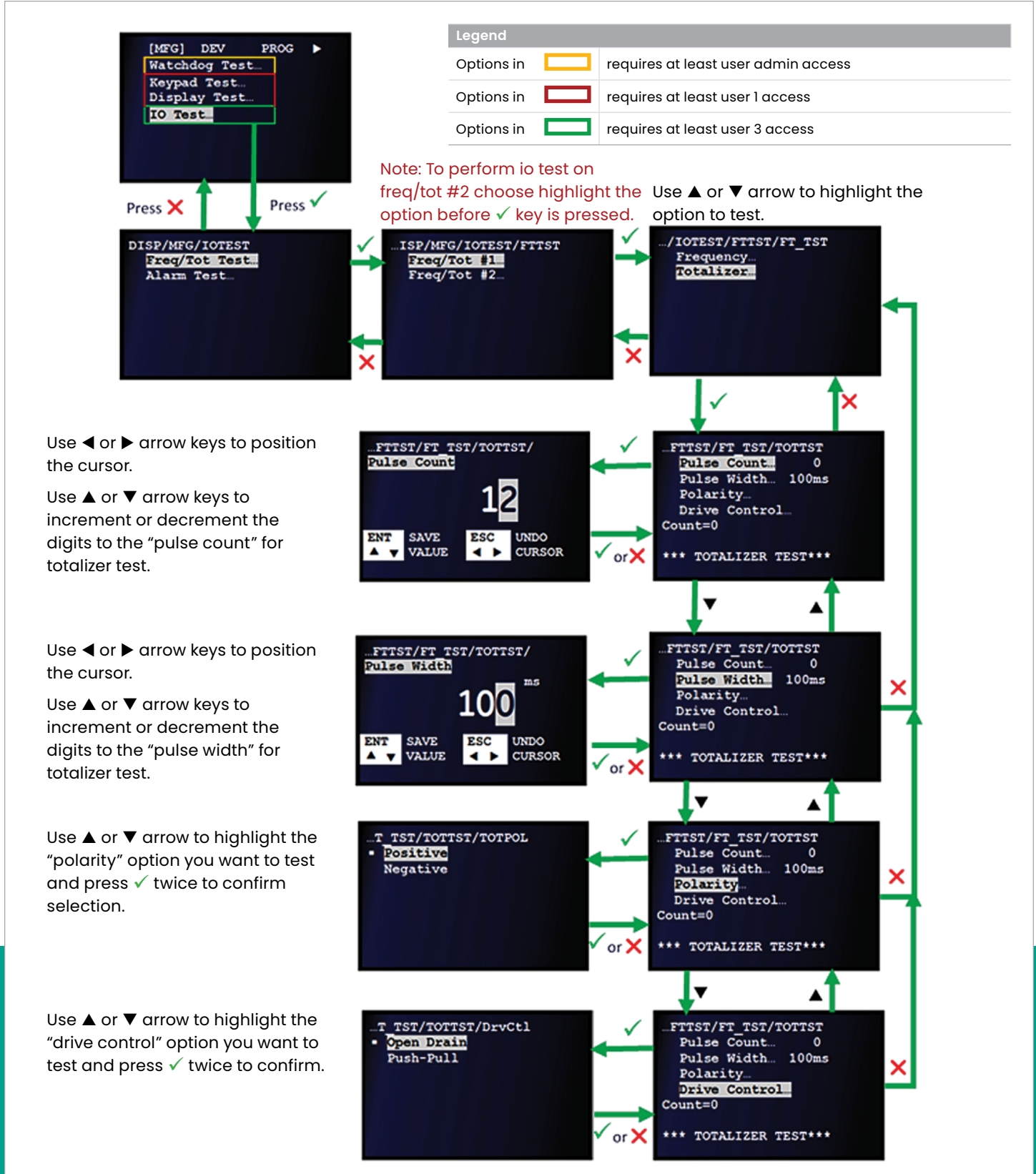
Figure 95: Manufacturing IO test - totalizer output

1. Refer to *Primary pages on page 26* and navigate to *page 1: manufacturing tests*.

2. Use the [▲] and [▼] keys to highlight IO test and press the [✓] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight freq/tot test and press the [✓] key to confirm your choice or press the [✗] key to return to the previous screen.

4. To test the desired totalizer output, use the[▲] and [▼] keys to highlight either freq/tot #1 or freq/tot #2. Then, press the [✓] key to confirm your choice or press the [✗] key to return to the previous screen.

5. Use the [▲] and [▼] keys to highlight totalizer and press the [✓] key to confirm your choice or press the [✗] key to return to the previous screen.

   a. Use the [▲] and [▼] keys to highlight Pulse count and press the [✓] key to confirm your choice. At the next screen, enter the desired pulse count value. Then, press the [✓] key to save the new value or press the [✗] key to keep the old value and return to the previous screen.

   b. Use the [▲] and [▼] keys to highlight Pulse width and press the [✓] key to confirm your choice. At the next screen, enter the desired pulse width value. Then, press the [✓] key to save the new value or press the [✗] key to keep the old value and return to the previous screen.

   c. Use the [▲] and [▼] keys to highlight polarity and press the [✓] key to confirm your choice. At the next screen, use the [▲] and [▼] keys to highlight either positive or negative and press the [✓] key twice to confirm your choice or press the [✗] key to cancel and return to the previous screen.

   d. Use the [▲] and [▼] keys to highlight drive control and press the [✓] key to confirm your choice. At the next screen, use the [▲] and [▼] keys to highlight either open drain or Push-Pull and press the [✓] key twice to confirm your choice or press the [✗] key to cancel and return to the previous screen.

5.7.3 Alarm output test

To test an *alarm output*, refer to *Figure 96* below and complete the following steps.

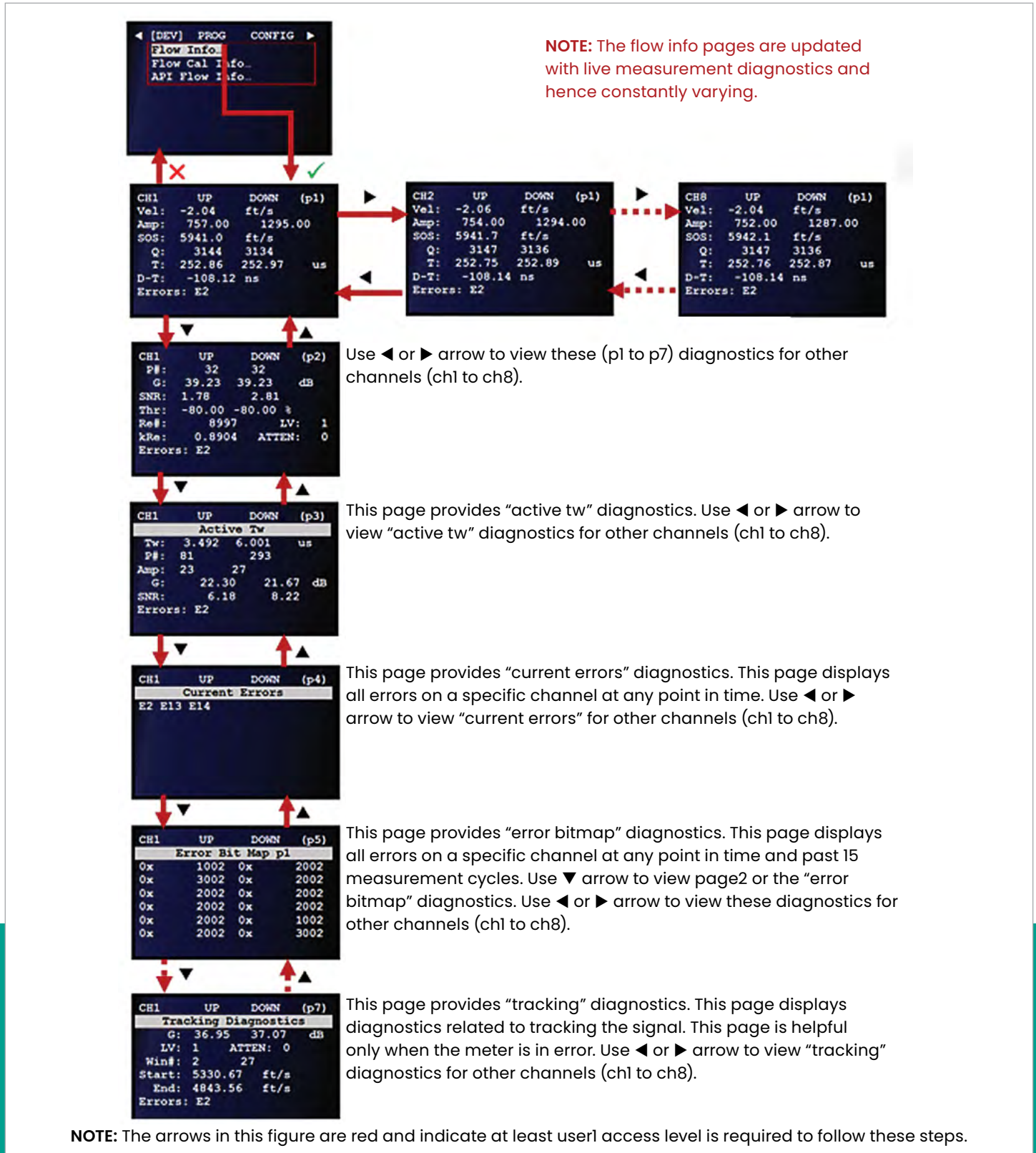**NOTE:** If necessary, refer to *Table 4 on page 23* as a reminder about color code meanings.

1. Refer to *Primary pages on page 26* and navigate to *page 1: manufacturing tests.*

2. Use the [▲] and [▼] keys to highlight *IO test* and press the [✓] key to confirm your choice.

3. Use the [▲] and [▼] keys to highlight *alarm test* and press the [✓] key to confirm your choice or press the [✗] key to return to the previous screen.

4. To test the desired *alarm output,* use the [▲] and [▼] keys to highlight either alarm #1 or alarm #2. Then, press the [✓] key to confirm your choice or press the [✗] key to return to the previous screen.

5. With *alarm state* highlighted, press the [✓] key to confirm the selection or press the [✗] key to return to the previous screen.

6. To select the alarm state you wish to test, use the [▲] and [▼] keys to highlight either *trip or reset* and press the [✓] key twice to confirm your choice or press the [✗] key to cancel and return to the previous screen.
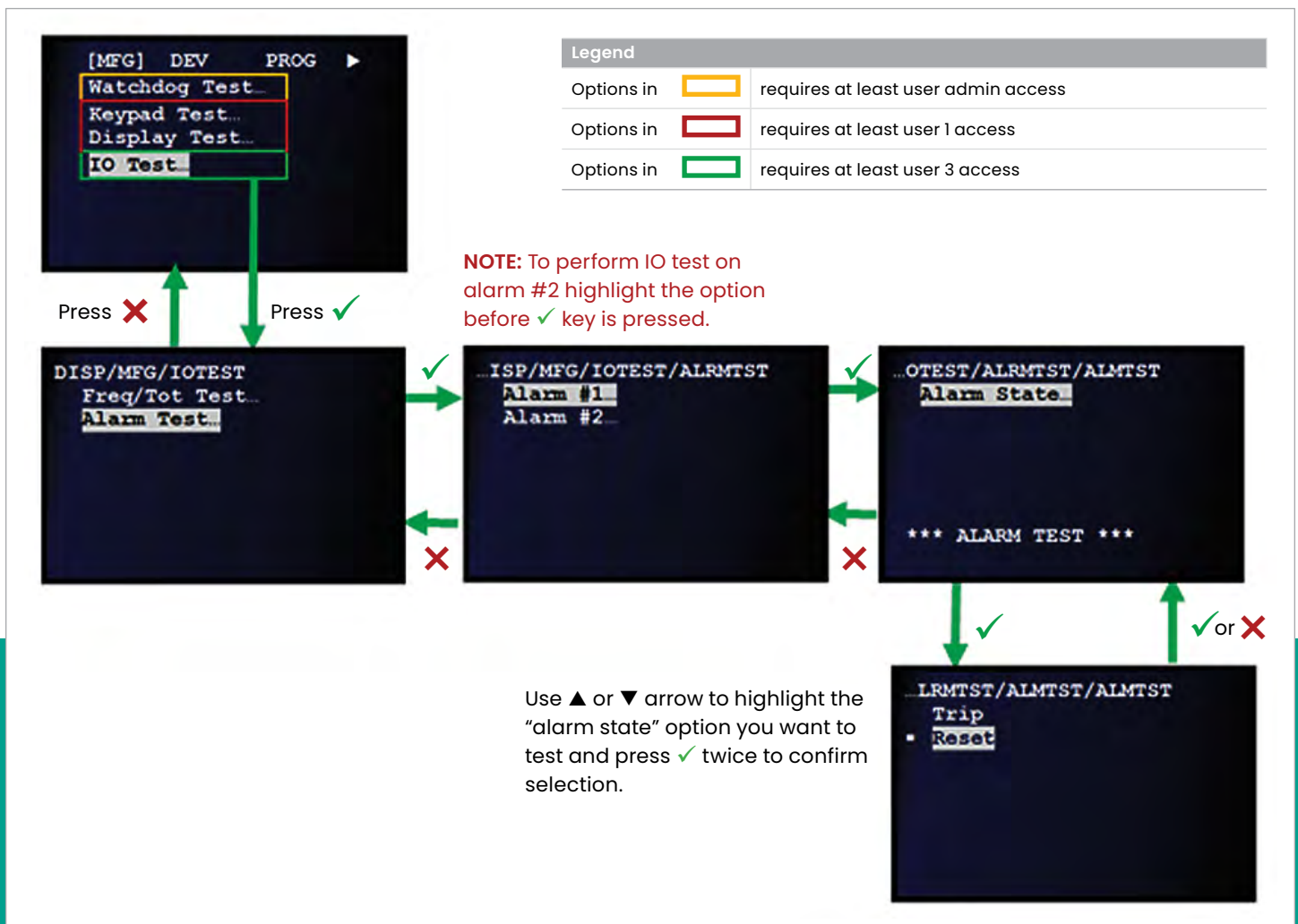
Figure 96: Manufacturing IO test - alarm output

5.8   Internal logs

The **Sentinel LCT8** tracks all changes to the programming, meter status (power on, power off), error status, date/time changes, etc., and stores the information in the internal audit or error logs.

5.8.1   Audit logs

The **Sentinel LCT8** *audit log* records system activity to a user-readable log file and stores it in persistent memory.

5.8.1.1   The audit log file

The meter can store up to 1000 event records in the *audit log* file. When the file size reaches this limit, any new record will overwrite the oldest existing record in the file. This is called

a *circular log*, and it ensures that the user is always viewing the 1000 most recent event records.

The activity types that generate an audit log log file record are listed in *Table 14 on page 103below.*

The audit log file is not viewable on the **Sentinel LCT8** display, and the contents of the file stored in the meter's memory cannot be altered. However, the audit log file can be downloaded to a PC using the Panametrics PanaView SEN898 software. Once saved to a PC, the audit log file may be opened as a text file that includes the details listed in *Table 15* below in each record.

Table 14: Activity types recorded in the audit log file	
Activity type	**Description**
Power on/reset	The *audit log* file can be used to determine the meter start or reset time. The meter *power-on* is usually the first entry in the audit log file, unless the entry was overwritten, which occurs after 1000 events have been recorded.
Parameter change	The meter monitors all parameters that may have an impact on the flow rate measurement and records changes to those parameters in the *audit log* file.
Alarms	When an alarm trips, the event is recorded in the *audit log* file.
Calibration change	As the user needs to be aware of any meter calibration changes, all such events are recorded in the *audit log* file. For example, an option card change might affect the meter calibration, in which case a record is created.
Default meter	When a user intentionally defaults the meter or a software corruption causes the meter parameters to be defaulted, the event is recorded in the *audit log* file.
Save/store/delete site file	When a user saves, restores, or deletes a site file, the event is recorded in the *audit log* file.
Upgrade meter	When the meter firmware is updated to a different version, the event is recorded in the *audit log* file.

Table 15: Information included in each audit log record	
Item	**Description**
Rec#	The event/record *number* (1-1000)
Date	The *date* the event occurred (mm/dd/yyyy)
Time	The *time* the event occurred (hh:mm:ss)
Source	The *channel* on which the event occurred, including the meter or I/O source
ID	The parameter *ID* of the value that changed
Name	The *name* of the event
Auth	The *security level* at the time of the event
Old	The original value of the *parameter* (**NOTE:** Some events may not have an entry in this column, such as alarms being tripped or power events.)
New	The new value of the *parameter* (**NOTE:** This includes meter events, such as alarms being tripped or power events which have no previous values.)

5.8.1.2 Formatting and viewing audit log records

The *audit log* records have neatly formatted columns for easy readability. If the record types listed in *Table 15 on page 103* contain irrelevant/not applicable column values, they are represented as "---" in the corresponding record column. A typical audit log file record appears as follows:

Rec#	Date	Time	Source	ID	Name	Auth	Old	New
1	12/11/2008	2:13:19	Meter	---	Power	---	---	Power-on
2	12/11/2008	2:13:22	---	1	Alarm	---	---	Tripped

Similarly, a parameter change record would appear as follows:

Rec#	Date	Time	Source	ID	Name	Auth	Old	New
1	12/11/2008	5:11:58	1	25798	RxW width	0	1024	2048

The user may view the meter's *audit log file* on the PC screen or may save it as either a text file or a *Microsoft Excel* file. To get the full benefits of the **Sentinel LCT8** *audit trail* feature, we recommend using the Microsoft Excel file option, which is available only if Microsoft® Excel 2000 or later is installed on the PC. Additional formatting may be applied in the Microsoft Excel file for enhanced readability.

5.8.2 Error logs

The **Sentinel LCT8** *error log* records system error events in a user-readable log file and stores that file in persistent memory. The error event is also recorded in the *audit log* file, whenever the meter changes from a No error state to an error state or vice versa.

The meter can store up to 250 error event records in the *error log* file. When the file size reaches this limit, any new record will overwrite the oldest existing record in the file. This is called a *circular log*, and it ensures that the user is always viewing the 1000 most recent event records.

The *error log* file is not viewable on the **Sentinel LCT8** display, and the contents of the file stored in the meter's memory cannot be altered. However, the *error log* file can be downloaded to a PC using the Panametrics PanaView SEN898 software. The log file saved to the PC opens as a text file, and a typical *error log* file record appears as follows:

Rec#	Date	Time	Source	Name	OldBitmap	Old	NewBitmap	New
1	12/12/2016	14:36:35	9	Error	0x0	E0: No error	0xf000001	E25: Half full pipe

Chapter 6.
Specifications

6.1 Physical specifications

6.1.1 Flowcell dimensions

The **Sentinel LCT8** overall dimensions are shown in *Figure 97* below and are listed in *Table 16 on page 106*.
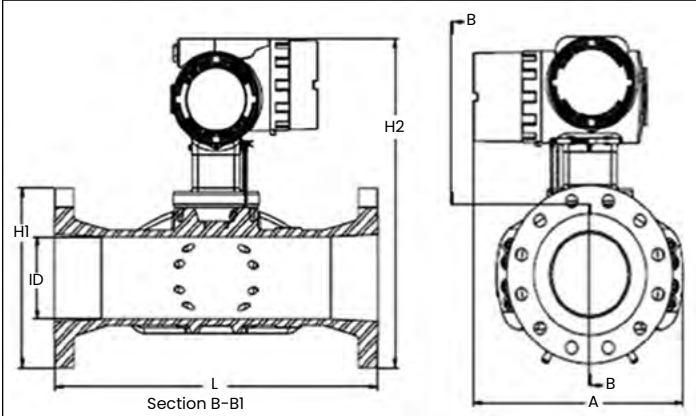
Figure 97: Flowcell assembly for **Sentinel LCT8** (6" to 24" pipes)

Pipe diameter (inches)	Flange class (lb)	Dimensions in English units (rounded)			Dimensions in metric units (rounded)		
		L (in.)	H2 (in.)	A (in.)	L (mm)	H2 (mm)	A (mm)
6	150#	22	23	16	559	585	407
	300#	24	23	16	610	585	407
	600#	26	24	16	661	610	407
8	150#	26	25	17	661	635	432
	300#	28	26	17	712	661	432
	600#	30	26	18	762	661	458
10	150#	28	27	20	712	686	508
	300#	30	28	20	762	712	508
	600#	32	29	20	813	737	508
12	150#	30	30	22	762	762	559
	300#	32	31	22	813	788	559
	600#	36	31	22	915	788	559
14	150#	36	32	23	915	813	585
	300#	38	33	23	966	839	585
	600#	40	33	24	1016	839	610
16	150#	38	35	25	966	889	635
	300#	40	36	26	1016	915	661
	600#	42	37	27	1067	940	686
18	150#	38	38	27	966	966	686
	300#	40	39	28	1016	991	712
	600#	44	40	30	1118	1016	762
20	150#	46	39	30	1169	991	762
	300#	48	41	31	1220	1042	788
	600#	50	41	32	1270	1042	813
24	150#	48	43	33	1220	1093	839
	300#	50	45	36	1270	1143	915
	600#	52	46	37	1321	1169	940

Table 16: Flowcell dimensions

6.1.2 System weight

> **⚠ WARNING!**
>
> When working with weights over 45 lb (20.4 kg), it is recommended that a properly rated lifting device be used.

Table 17 below lists the worst case dry weights for each vessel size by pressure class. The weights are based on the heaviest standard material provided, in this case, stainless steel. These weights include the transmitter supplied with a stainless steel enclosure.

Table 17: Fully assembled dry weights						
Fully assembled dry weight						
Vessel nominal diameter (in.)	**English [lb.]**			**Metric [kg]**		
	150#	**300#**	**600#**	**150#**	**300#**	**600#**
6	239	286	346	108	130	157
8	334	398	497	151	181	225
10	421	512	694	191	232	315
12	582	704	896	264	320	407
14	746	925	1077	339	420	488
16	978	1200	1469	444	545	666
24	2112	2660	3202	958	1207	1453

6.1.3 SEN898 transmitter weight

Aluminum: 29 lb. (13.2 kg)

Stainless steel: 58 lb. (26.3 kg)

6.2 Operation and performance specifications

6.2.1 Flow rate ranges

Maximum and minimum flow rates through the **Sentinel LCT8** ultrasonic liquid flow transmitter are based on the pipe diameter and the process fluid pressure. The information in *Table 18* below is approximate, and it is based on representative liquid components at a process temperature of 70ºF (21ºC).

Table 18: Flow rate ranges											
Nominal pipe size		Flow velocity				Volumetric flow					
		ft/s		m/s		m³/hr		gpm		bbl/hr	
in.	mm	V_{min}	V_{max}	V_{min}	V_{max}	Q_{min}	Q_{max}	Q_{min}	Q_{max}	Q_{min}	Q_{max}
6	150	1	40	0.3	12.2	20	818	90	3602	129	5147
8	200	1	40	0.3	12.2	35	1417	156	6237	223	8913
10	250	1	40	0.3	12.2	56	2233	246	9831	351	14049
12	300	1	40	0.3	12.2	80	3203	353	14100	504	20150
14	350	1	40	0.3	12.2	98	3905	430	17191	614	24566
16	400	1	40	0.3	12.2	129	5172	569	22772	814	32542
18	450	1	40	0.3	12.2	165	6618	728	29137	1041	41637
20	500	1	40	0.3	12.2	206	8241	907	36285	1296	51852
24	600	1	40	0.3	12.2	301	12022	1323	52932	1891	75639

6.2.2 Operating pressures

The maximum operating pressures for **Sentinel LCT8** are listed in *Table 19* below.

Table 19: Maximum operating pressures by material and pressure class								
Maximum operating pressures (psig)								
Flange class	WCB		LCB		CF8		CF8M	
	100ºF	284ºF	100ºF	284ºF	100ºF	284ºF	100ºF	284ºF
150#	285	235	265	234	275	209	275	218
300#	740	659	695	643	720	550	720	570
600#	1480	1316	1395	1282	1440	1095	1440	1139
Maximum operating pressures (barg)								
Flange class	WCB		LCB		CF8		CF8M	
	38ºC	140ºC	38ºC	140ºC	38ºC	140ºC	38ºC	140ºC
150#	19.6	16.2	18.3	16.1	19.0	14.4	19.0	15.0
300#	51.0	45.4	47.9	44.3	49.6	37.9	49.6	39.3
600#	102.0	90.7	96.1	88.4	99.2	75.5	99.2	78.5

NOTE: For all load and force requirements and limitations, please consult Panametrics.

6.2.3 Fluid types

Liquid hydrocarbons, crude and refined products, other liquids

6.2.4 Calibration

Each meter is calibrated to meet the OIML R117-1 international standard. (Other calibrations are available upon request.)

6.2.5 Linearity

± 0.12% of measured volume for flow rates between 1 and 33 ft/s (0.3 and 10 m/s)

6.2.6 Repeatability

0.12% as per OIML R117

6.2.7 Uncertainty

± 0.027% according to API MPMS 5.8

6.2.8 Viscosity range

0 to 660 cSt

6.2.9 Reynolds range

> Re 10,000, consult Panametrics for lower Reynolds numbers

6.2.10 Process temperature

Standard: -40 to +140°C (-40 to +248°F)

6.2.11 Ambient temperature

-40 to +60°C (-40 to 140°F)

6.2.12 Storage temperature

-40 to +85°C (-40 to +176°F)

6.3 Meter body specifications

6.3.1 Meter body materials

- Carbon steel SA216 Gr. WCB (carbon steel)
- Low temperature carbon steel SA352 Gr. LCB (low temp carbon steel)
- Stainless steel SA351 Gr. CF8 (304SS)
- Stainless steel SA351 Gr CF8M (316SS)
- Other materials available upon request

6.3.2 Pipe sizes

6 to 24 in.

6.3.3 Flange ratings

- 150 #
- 300 #
- 600 #

6.3.4 Pipe schedules

6.3.4.1 Carbon steel pipe

STD, XS [contact Panametrics for other options]

6.3.4.2 Stainless steel pipe

10S (for 6" and 8" pipe only), 40S, 80S [contact Panametrics for other options]

6.3.5 Installation requirement (straight pipe run)

Minimum 5 nominal pipe diameters upstream and 3 nominal pipe diameters downstream

6.4 Electronics (SEN898) specifications

6.4.1 Electronics enclosure material

Standard: Epoxy coated aluminum

Optional: Stainless steel A351, Gr 316/316L

6.4.2 Electronics enclosure dimensions

Size (L x H x D): 13 x 11 x 9 in. (33.0 x 27.9 x 22.9 cm)

6.4.3 Electronics enclosure weight

Aluminum: 29 lb (13.2 kg)

Stainless steel: 58 lb (24.3 kg)

6.4.4 Environmental protection

IP66

6.4.5 Power supply

- 100 to 240 VAC
- 12 to 32 VDC

6.4.6 Power consumption

7 W

6.4.7 Display

High-contrast, 128 x 64 pixel, LED graphical display

6.4.8 Outputs

- Two isolated frequency/totalizer outputs
- Two alarm relays
- One 4/20 mA analog output

6.4.9 Inputs

- Two 4/20 mA analog inputs and one 100 ohm RTD input for temperature, pressure and density input (optional)
- Three 4/20 mA analog inputs for temperature, pressure and density input (optional)

6.4.10 Digital interfaces

- PanaLink over RS232/485/USB
- Modbus RTU over RS232/485

6.4.11 Flow computer functionality

Integrated flow computer with full P and T volume corrections according to API 11.1

6.4.12 Hazardous area certifications

- USA/Canada: Class 1, div 1, Groups B, C, and D
- Europe: ATEX II 2 G Ex d IIB+H2 (Ex de as an option)
- IEC Ex: Ex d IIB+H2 (Ex de as an option)

6.4.13 CE Mark compliance

- 2014/30/EU EMC Directive
- 2014/35/EU LVD Directive
- 2014/34/EU ATEX Directive
- 2012/19/EU WEEE Directive
- 2011/65/EU RoHS Directive

6.4.14 Custody transfer performance approvals

Multiple country-specific approvals available upon request

Appendix A. CE Mark compliance and high noise environments

A.1 Introduction

For CE Mark compliance, the **Sentinel LCT8** flow transmitter must meet the EMC and LVD directives.

IMPORTANT
CE Mark compliance is required for all units intended for use in EU countries, and is also recommended for installation in high electrical noise environments.

A.2 EMC compliance

In addition to the standard wiring requirements, the electrical connections must be shielded and grounded as described in *Table 20* below for EMC compliance. After all the necessary electrical connections have been made, seal any unused cable entry holes.

NOTE: If the instructions in this appendix are followed, the unit will comply with the EMC Directive.

Table 20: Wiring modifications		
Connection	**Cable type**	**Termination modification**
Transducer	Shielded cable	Terminate the shield using the cable glands (already done).
Power	Shielded cable	Terminate the shield to the case using the cable glands.
Shielding	Wires enclosed in a properly-grounded metal conduit do not require additional shielding.	
All input/output options	Shielded cable	Terminate the shields to the case using the cable glands or to the closest screw on the bus bar inside the enclosure.

IMPORTANT
Make sure to connect the **Sentinel LCT8** case to the earth ground with a grounding cable, using the external ground screws found on either side of the enclosure. The connection should be less than 9.8 feet (3 meters) long.

[no content intended for this page]

Appendix B.
Service record

B.1 Introduction

Use this appendix to record information that will be beneficial if the meter needs to be updated or for troubleshooting purposes. Whenever an issue occurs or any service procedure is performed on the **Sentinel LCT8**, the details should be recorded in this appendix. An accurate snapshot of the meter, as well as the history of the meter, can prove very helpful in troubleshooting any current or future problems.

NOTE: For instructions on how to find the diagnostic parameters listed in the tables in this appendix, refer to *Flow info on page 94*.

B.2 User defined settings for the input/output connections

Table 21: Analog inputs				
Parameter	Analog input (example)	Analog input #1 AIN1	Analog input #2 AIN2	Analog input #3 AIN3/RTD
Label	Ain1			
Model	Temperature			
Units	°C			
Base (4 mA)	10			
Span (20 mA)	50			

Table 22: Analog output				
Parameter	Analog output (example)		Analog output	
Loop status	Off			
Channel	Composite			
Publisher	Volumetric			
Units	Liter/min			
Base (4 mA)	-12.2	l/m		
Span (20 mA)	12.2	l/m		
Error level	Hold value			
Mode	Passive			

Table 23: Frequency/totalizer output				
Parameter	**Freq/total (example)**		**Freq/total #1**	**Freq/total #2**
FT link mode	Independent			
Freq/tot status	On			
F/T mode	Frequency			
F/T output drive ctl	Open drain			
F/T channel	Composite			
F/T publisher	Volumetric			
F/T units	Cubic meters/hr			
Fbase	0	Hz		
Fspan	10000	Hz		
Freq: value (min)	0	m³/h		
Freq: value (max)	2500	m³/h		
Freq: error level	Hold last			
Tot: unit/pulse	100	m³/h		
Tot: pulse width	100	ms		
Tot: polarity	Positive			

Table 24: Alarm output				
Parameter	**Alarm (example)**		**Alarm #1**	**Alarm #2**
Alarm status	Failsafe			
Alarm type	Level			
Alarm latch	Latch			
Alarm channel	Channel 1			
Level: alarm publisher	Velocity			
Level: alarm unit	Meters/sec			
Level: trip point	100	m/s		
Level: dead band	1	m/s		
Level: trip direction	Trip above			
Level: error level	Reset			
Level: alarm TYPE	All			

B.3 Baseline diagnostics

Table 25: Baseline flow rate								
Diagnostic	Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8
Velocity								
SOS								
Gain								
SNR								
LV								
ATTEN								
ATw TW								
ATw G								
ATw SNR								

B.4 Troubleshooting diagnostics

NOTE: Make additional copies of this table as needed.

Table 26: Baseline flow rate								
Diagnostic	Ch 1	Ch 2	Ch 3	Ch 4	Ch 5	Ch 6	Ch 7	Ch 8
Velocity								
SOS								
Gain								
SNR								
LV								
ATTEN								
ATw TW								
ATw G								
ATw SNR								
Current errors								

B.5   Data entry

Record complete and detailed service data for the **Sentinel LCT8** in *Service record* below. Make additional copies of this table as needed.

Date	Description of service	Performed by

Table 27: Service record

Appendix C. Modbus register map

NOTE: Grayed out register addresses indicate the register is reserved for future use only.

						Composite		Channel 1		Channel 2		Channel 3		Channel 4		Channel 5		Channel 6		Channel 7		Channel 8	
						Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.	
Category	Measurements	Read/write	Type	Size	Format	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)
Primary measurements	Velocity	R	F	2	LSW float	1	0x0000	1025	0x0400	2049	0x0800	3073	0x0C00	4097	0x1000	5121	0x1400	6145	0x1800	7169	0x1C00	8193	0x2000
	Volumetric	R	F	2	LSW float	3	0x0002	1027	0x0402	2051	0x0802	3075	0x0C02	4099	0x1002	5123	0x1402	6147	0x1802	7171	0x1C02	8195	0x2002
	Std Volumetric	R	F	2	LSW float	5	0x0004	1029	0x0404	2053	0x0804	3077	0x0C04	4101	0x1004	5125	0x1404	6149	0x1804	7173	0x1C04	8197	0x2004
	Mass flow	R	F	2	LSW float	7	0x0006	1031	0x0406	2055	0x0806	3079	0x0C06	4103	0x1006	5127	0x1406	6151	0x1806	7175	0x1C06	8199	0x2006
	Energy rate	R	F	2	LSW float	9	0x0008	1033	0x0408	2057	0x0808	3081	0x0C08	4105	0x1008	5129	0x1408	6153	0x1808	7177	0x1C08	8201	0x2008
Transit time diagnostics	Sound-speed	R	F	2	LSW float	11	0x000A	1035	0x040A	2059	0x080A	3083	0x0C0A	4107	0x100A	5131	0x140A	6155	0x180A	7179	0x1C0A	8203	0x200A
	UP transit	R	F	2	LSW float	13	0x000C	1037	0x040C	2061	0x080C	3085	0x0C0C	4109	0x100C	5133	0x140C	6157	0x180C	7181	0x1C0C	8205	0x200C
	DN transit	R	F	2	LSW float	15	0x000E	1039	0x040E	2063	0x080E	3087	0x0C0E	4111	0x100E	5135	0x140E	6159	0x180E	7183	0x1C0E	8207	0x200E
	Delta T	R	F	2	LSW float	17	0x0010	1041	0x0410	2065	0x0810	3089	0x0C10	4113	0x1010	5137	0x1410	6161	0x1810	7185	0x1C10	8209	0x2010
Receiver diagnostics	UP sig strength	R	F	2	LSW float	19	0x0012	1043	0x0412	2067	0x0812	3091	0x0C12	4115	0x1012	5139	0x1412	6163	0x1812	7187	0x1C12	8211	0x2012
	DN sig strength	R	F	2	LSW float	21	0x0014	1045	0x0414	2069	0x0814	3093	0x0C14	4117	0x1014	5141	0x1414	6165	0x1814	7189	0x1C14	8213	0x2014
	Gain Up[dB]	R	F	2	LSW float	23	0x0016	1047	0x0416	2071	0x0816	3095	0x0C16	4119	0x1016	5143	0x1416	6167	0x1816	7191	0x1C16	8215	0x2016
	Gain Dn[dB]	R	F	2	LSW float	25	0x0018	1049	0x0418	2073	0x0818	3097	0x0C18	4121	0x1018	5145	0x1418	6169	0x1818	7193	0x1C18	8217	0x2018
	UP DAC	R	U	2	Unsigned integer	27	0x001A	1051	0x041A	2075	0x081A	3099	0x0C1A	4123	0x101A	5147	0x141A	6171	0x181A	7195	0x1C1A	8219	0x201A
	DN DAC	R	U	2	Unsigned integer	29	0x001C	1053	0x041C	2077	0x081C	3101	0x0C1C	4125	0x101C	5149	0x141C	6173	0x181C	7197	0x1C1C	8221	0x201C
	UP amp discrim	R	F	2	LSW float	31	0x001E	1055	0x041E	2079	0x081E	3103	0x0C1E	4127	0x101E	5151	0x141E	6175	0x181E	7199	0x1C1E	8223	0x201E
	DN amp discrim	R	F	2	LSW float	33	0x0020	1057	0x0420	2081	0x0820	3105	0x0C20	4129	0x1020	5153	0x1420	6177	0x1820	7201	0x1C20	8225	0x2020
Signal processing diagnostics	PEAK%	R	F	2	LSW float	35	0x0022	1059	0x0422	2083	0x0822	3107	0x0C22	4131	0x1022	5155	0x1422	6179	0x1822	7203	0x1C22	8227	0x2022
	UP signal Q	R	F	2	LSW float	37	0x0024	1061	0x0424	2085	0x0824	3109	0x0C24	4133	0x1024	5157	0x1424	6181	0x1824	7205	0x1C24	8229	0x2024
	DN signal Q	R	F	2	LSW float	39	0x0026	1063	0x0426	2087	0x0826	3111	0x0C26	4135	0x1026	5159	0x1426	6183	0x1826	7207	0x1C26	8231	0x2026
	UP +- peak	R	F	2	LSW float	41	0x0028	1065	0x0428	2089	0x0828	3113	0x0C28	4137	0x1028	5161	0x1428	6185	0x1828	7209	0x1C28	8233	0x2028
	DN +- peak	R	F	2	LSW float	43	0x002A	1067	0x042A	2091	0x082A	3115	0x0C2A	4139	0x102A	5163	0x142A	6187	0x182A	7211	0x1C2A	8235	0x202A
	UP norm factor	R	F	2	LSW float	45	0x002C	1069	0x042C	2093	0x082C	3117	0x0C2C	4141	0x102C	5165	0x142C	6189	0x182C	7213	0x1C2C	8237	0x202C
	DN norm factor	R	F	2	LSW float	47	0x002E	1071	0x042E	2095	0x082E	3119	0x0C2E	4143	0x102E	5167	0x142E	6191	0x182E	7215	0x1C2E	8239	0x202E
	Theta 3	R	F	2	LSW float	49	0x0030	1073	0x0430	2097	0x0830	3121	0x0C30	4145	0x1030	5169	0x1430	6193	0x1830	7217	0x1C30	8241	0x2030
	CEE1	R	F	2	LSW float	51	0x0032	1075	0x0432	2099	0x0832	3123	0x0C32	4147	0x1032	5171	0x1432	6195	0x1832	7219	0x1C32	8243	0x2032

Table 28: Modbus register map

						Composite		Channel 1		Channel 2		Channel 3		Channel 4		Channel 5		Channel 6		Channel 7		Channel 8	
						Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.	
Category	Measure-ments	Read/write	Type	Size	Format	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)
Correction factors	Reynolds #	R	F	2	LSW float	53	0x0034	1077	0x0434	2101	0x0834	3125	0x0C34	4149	0x1034	5173	0x1434	6197	0x1834	7221	0x1C34	8245	0x2034
	K(RE)	R	F	2	LSW float	55	0x0036	1079	0x0436	2103	0x0836	3127	0x0C36	4151	0x1036	5175	0x1436	6199	0x1836	7223	0x1C36	8247	0x2036
	CTL	R	F	2	LSW float	57	0x0038	1081	0x0438	2105	0x0838	3129	0x0C38	4153	0x1038	5177	0x1438	6201	0x1838	7225	0x1C38	8249	0x2038
	CPL	R	F	2	LSW float	59	0x003A	1083	0x043A	2107	0x083A	3131	0x0C3A	4155	0x103A	5179	0x143A	6203	0x183A	7227	0x1C3A	8251	0x203A
	CTPL	R	F	2	LSW float	61	0x003C	1085	0x043C	2109	0x083C	3133	0x0C3C	4157	0x103C	5181	0x143C	6205	0x183C	7229	0x1C3C	8253	0x203C
Tempera-ture inputs	Supply temp	R	F	2	LSW float	63	0x003E	1087	0x043E	2111	0x083E	3135	0x0C3E	4159	0x103E	5183	0x143E	6207	0x183E	7231	0x1C3E	8255	0x203E
	Return temp	R	F	2	LSW float	65	0x0040	1089	0x0440	2113	0x0840	3137	0x0C40	4161	0x1040	5185	0x1440	6209	0x1840	7233	0x1C40	8257	0x2040
	Supply-Rtn	R	F	2	LSW float	67	0x0042	1091	0x0442	2115	0x0842	3139	0x0C42	4163	0x1042	5187	0x1442	6211	0x1842	7235	0x1C42	8259	0x2042
	Supply dens	R	F	2	LSW float	69	0x0044	1093	0x0444	2117	0x0844	3141	0x0C44	4165	0x1044	5189	0x1444	6213	0x1844	7237	0x1C44	8261	0x2044
	Return dens	R	F	2	LSW float	71	0x0046	1095	0x0446	2119	0x0846	3143	0x0C46	4167	0x1046	5191	0x1446	6215	0x1846	7239	0x1C46	8263	0x2046
	Delta h	R	F	2	LSW float	73	0x0048	1097	0x0448	2121	0x0848	3145	0x0C48	4169	0x1048	5193	0x1448	6217	0x1848	7241	0x1C48	8265	0x2048
Pressure inputs	Pressure input	R	F	2	LSW float	75	0x004A	1099	0x044A	2123	0x084A	3147	0x0C4A	4171	0x104A	5195	0x144A	6219	0x184A	7243	0x1C4A	8267	0x204A
Special inputs	Special input 1	R	F	2	LSW float	77	0x004C	1101	0x044C	2125	0x084C	3149	0x0C4C	4173	0x104C	5197	0x144C	6221	0x184C	7245	0x1C4C	8269	0x204C
	Special input 2	R	F	2	LSW float	79	0x004E	1103	0x044E	2127	0x084E	3151	0x0C4E	4175	0x104E	5199	0x144E	6223	0x184E	7247	0x1C4E	8271	0x204E
	Special input 3	R	F	2	LSW float	81	0x0050	1105	0x0450	2129	0x0850	3153	0x0C50	4177	0x1050	5201	0x1450	6225	0x1850	7249	0x1C50	8273	0x2050
	Special input 4	R	F	2	LSW float	83	0x0052	1107	0x0452	2131	0x0852	3155	0x0C52	4179	0x1052	5203	0x1452	6227	0x1852	7251	0x1C52	8275	0x2052
Flow totals (as doubles)	FWD total	R	D	4	LSW double	129	0x0080	1153	0x0480	2177	0x0880	3201	0x0C80	4225	0x1080	5249	0x1480	6273	0x1880	7297	0x1C80	8321	0x2080
	REV total	R	D	4	LSW double	133	0x0084	1157	0x0484	2181	0x0884	3205	0x0C84	4229	0x1084	5253	0x1484	6277	0x1884	7301	0x1C84	8325	0x2084
	FWD mass	R	D	4	LSW double	137	0x0088	1161	0x0488	2185	0x0888	3209	0x0C88	4233	0x1088	5257	0x1488	6281	0x1888	7305	0x1C88	8329	0x2088
	REV mass	R	D	4	LSW double	141	0x008C	1165	0x048C	2189	0x088C	3213	0x0C8C	4237	0x108C	5261	0x148C	6285	0x188C	7309	0x1C8C	8333	0x208C
	FWD energy	R	D	4	LSW double	145	0x0090	1169	0x0490	2193	0x0890	3217	0x0C90	4241	0x1090	5265	0x1490	6289	0x1890	7313	0x1C90	8337	0x2090
	REV energy	R	D	4	LSW double	149	0x0094	1173	0x0494	2197	0x0894	3221	0x0C94	4245	0x1094	5269	0x1494	6293	0x1894	7317	0x1C94	8341	0x2094
	Total time	R	D	4	LSW double	153	0x0098	1177	0x0498	2201	0x0898	3225	0x0C98	4249	0x1098	5273	0x1498	6297	0x1898	7321	0x1C98	8345	0x2098
	STD FWD total	R	D	4	LSW double	157	0x009C	1181	0x049C	2205	0x089C	3229	0x0C9C	4253	0x109C	5277	0x149C	6301	0x189C	7325	0x1C9C	8349	0x209C
	STD REV total	R	D	4	LSW double	161	0x00A0	1185	0x04A0	2209	0x08A0	3233	0x0CA0	4257	0x10A0	5281	0x14A0	6305	0x18A0	7329	0x1CA0	8353	0x20A0
	STD total time	R	D	4	LSW double	165	0x00A4	1189	0x04A4	2213	0x08A4	3237	0x0CA4	4261	0x10A4	5285	0x14A4	6309	0x18A4	7333	0x1CA4	8357	0x20A4

Table 28: Modbus register map

Table 28: Modbus register map																						
						Composite		Channel 1		Channel 2		Channel 3		Channel 4		Channel 5		Channel 6		Channel 7		Channel 8	
Category	Measure-ments	Read/write	Type	Size	Format	Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.		Reg. add.	
						(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)
Flow totals (scientific notation)	FWD total register 0	R	L	2	LSW float	257	0x0100	1281	0x0500	2305	0x0900	3329	0x0D00	4353	0x1100	5377	0x1500	6401	0x1900	7425	0x1D00	8449	0x2100
	FWD total register 1	R	L	2	LSW float	259	0x0102	1283	0x0502	2307	0x0902	3331	0x0D02	4355	0x1102	5379	0x1502	6403	0x1902	7427	0x1D02	8451	0x2102
	FWD total register 2	R	L	2	LSW float	261	0x0104	1285	0x0504	2309	0x0904	3333	0x0D04	4357	0x1104	5381	0x1504	6405	0x1904	7429	0x1D04	8453	0x2104
	REV total register 0	R	L	2	LSW float	263	0x0106	1287	0x0506	2311	0x0906	3335	0x0D06	4359	0x1106	5383	0x1506	6407	0x1906	7431	0x1D06	8455	0x2106
	REV total register 1	R	L	2	LSW float	265	0x0108	1289	0x0508	2313	0x0908	3337	0x0D08	4361	0x1108	5385	0x1508	6409	0x1908	7433	0x1D08	8457	0x2108
	REV total register 2	R	L	2	LSW float	267	0x010A	1291	0x050A	2315	0x090A	3339	0x0D0A	4363	0x110A	5387	0x150A	6411	0x190A	7435	0x1D0A	8459	0x210A
	FWD mass register 0	R	L	2	LSW float	269	0x010C	1293	0x050C	2317	0x090C	3341	0x0D0C	4365	0x110C	5389	0x150C	6413	0x190C	7437	0x1D0C	8461	0x210C
	FWD mass register 1	R	L	2	LSW float	271	0x010E	1295	0x050E	2319	0x090E	3343	0x0D0E	4367	0x110E	5391	0x150E	6415	0x190E	7439	0x1D0E	8463	0x210E
	FWD mass register 2	R	L	2	LSW float	273	0x0110	1297	0x0510	2321	0x0910	3345	0x0D10	4369	0x1110	5393	0x1510	6417	0x1910	7441	0x1D10	8465	0x2110
	Mass register 2	R	L	2	LSW float	273	0x0110	1297	0x0510	2321	0x0910	3345	0x0D10	4369	0x1110	5393	0x1510	6417	0x1910	7441	0x1D10	8465	0x2110
	REV mass register 0	R	L	2	LSW float	275	0x0112	1299	0x0512	2323	0x0912	3347	0x0D12	4371	0x1112	5395	0x1512	6419	0x1912	7443	0x1D12	8467	0x2112
	REV mass register 1	R	L	2	LSW float	277	0x0114	1301	0x0514	2325	0x0914	3349	0x0D14	4373	0x1114	5397	0x1514	6421	0x1914	7445	0x1D14	8469	0x2114
	REV mass register 2	R	L	2	LSW float	279	0x0116	1303	0x0516	2327	0x0916	3351	0x0D16	4375	0x1116	5399	0x1516	6423	0x1916	7447	0x1D16	8471	0x2116
	FWD energy register 0	R	L	2	LSW float	281	0x0118	1305	0x0518	2329	0x0918	3353	0x0D18	4377	0x1118	5401	0x1518	6425	0x1918	7449	0x1D18	8473	0x2118
	FWD energy register 1	R	L	2	LSW float	283	0x011A	1307	0x051A	2331	0x091A	3355	0x0D1A	4379	0x111A	5403	0x151A	6427	0x191A	7451	0x1D1A	8475	0x211A
	FWD energy register 2	R	L	2	LSW float	285	0x011C	1309	0x051C	2333	0x091C	3357	0x0D1C	4381	0x111C	5405	0x151C	6429	0x191C	7453	0x1D1C	8477	0x211C
	REV energy register 0	R	L	2	LSW float	287	0x011E	1311	0x051E	2335	0x091E	3359	0x0D1E	4383	0x111E	5407	0x151E	6431	0x191E	7455	0x1D1E	8479	0x211E
	REV energy register 1	R	L	2	LSW float	289	0x0120	1313	0x0520	2337	0x0920	3361	0x0D20	4385	0x1120	5409	0x1520	6433	0x1920	7457	0x1D20	8481	0x2120
	REV energy register 2	R	L	2	LSW float	291	0x0122	1315	0x0522	2339	0x0922	3363	0x0D22	4387	0x1122	5411	0x1522	6435	0x1922	7459	0x1D22	8483	0x2122
	Total time days	R	L	2	LSW float	293	0x0124	1317	0x0524	2341	0x0924	3365	0x0D24	4389	0x1124	5413	0x1524	6437	0x1924	7461	0x1D24	8485	0x2124
	Total time seconds	R	L	2	LSW float	295	0x0126	1319	0x0526	2343	0x0926	3367	0x0D26	4391	0x1126	5415	0x1526	6439	0x1926	7463	0x1D26	8487	0x2126
	STD FWD total register 0	R	L	2	LSW float	297	0x0128	1321	0x0528	2345	0x0928	3369	0x0D28	4393	0x1128	5417	0x1528	6441	0x1928	7465	0x1D28	8489	0x2128
	STD FWD total register 1	R	L	2	LSW float	299	0x012A	1323	0x052A	2347	0x092A	3371	0x0D2A	4395	0x112A	5419	0x152A	6443	0x192A	7467	0x1D2A	8491	0x212A

| | | | | | Composite | | Channel 1 | | Channel 2 | | Channel 3 | | Channel 4 | | Channel 5 | | Channel 6 | | Channel 7 | | Channel 8 | |
| | | | | | Reg. add. | | Reg. add. | | Reg. add. | | Reg. add. | | Reg. add. | | Reg. add. | | Reg. add. | | Reg. add. | | Reg. add. | |
Category	Measure-ments	Read/write	Type	Size	Format	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)	(Dec)	(hex)
Flow totals (scientific notation)	STD FWD total register 2	R	L	2	LSW float	301	0x012C	1325	0x052C	2349	0x092C	3373	0x0D2C	4397	0x112C	5421	0x152C	6445	0x192C	7469	0x1D2C	8493	0x212C
	STD REV total register 0	R	L	2	LSW float	303	0x012E	1327	0x052E	2351	0x092E	3375	0x0D2E	4399	0x112E	5423	0x152E	6447	0x192E	7471	0x1D2E	8495	0x212E
	STD REV total register 1	R	L	2	LSW float	305	0x0130	1329	0x0530	2353	0x0930	3377	0x0D30	4401	0x1130	5425	0x1530	6449	0x1930	7473	0x1D30	8497	0x2130
	STD REV total register 2	R	L	2	LSW float	307	0x0132	1331	0x0532	2355	0x0932	3379	0x0D32	4403	0x1132	5427	0x1532	6451	0x1932	7475	0x1D32	8499	0x2132
	Std total time days	R	L	2	LSW float	309	0x0134	1333	0x0534	2357	0x0934	3381	0x0D34	4405	0x1134	5429	0x1534	6453	0x1934	7477	0x1D34	8501	0x2134
	Std total time seconds	R	L	2	LSW float	311	0x0136	1335	0x0536	2359	0x0936	3383	0x0D36	4407	0x1136	5431	0x1536	6455	0x1936	7479	0x1D36	8503	0x2136
Swirl diagnostics	Swirl Angle	R	F	2	LSW float	313	0x0138	1337	0x0538	2361	0x0938	3385	0x0D38	4409	0x1138	5433	0x1538	6457	0x1938	7481	0x1D38	8505	0x2138
	Cross flow	R	F	2	LSW float	315	0x013A	1339	0x053A	2363	0x093A	3387	0x0D3A	4411	0x113A	5435	0x153A	6459	0x193A	7483	0x1D3A	8507	0x213A
Modbus input	Temperature input	R/W	F	2	LSW float	317	0x013C	1341	0x053C	2365	0x093C	3389	0x0D3C	4413	0x113C	5437	0x153C	6461	0x193C	7485	0x1D3C	8509	0x213C
	Pressure input	R/W	F	2	LSW float	319	0x013E	1343	0x053E	2367	0x093E	3391	0x0D3E	4415	0x113E	5439	0x153E	6463	0x193E	7487	0x1D3E	8511	0x213E
	Density input	R/W	F	2	LSW float	321	0x0140	1345	0x0540	2369	0x0940	3393	0x0D40	4417	0x1140	5441	0x1540	6465	0x1940	7489	0x1D40	8513	0x2140
Modbus access control	Modbus access	W	L	2	LSW float	323	0x0142	1347	0x0542	2371	0x0942	3395	0x0D42	4419	0x1142	5443	0x1542	6467	0x1942	7491	0x1D42	8515	0x2142
Meter status	Error code	R	B	2	LSW unsigned long integer	385	0x0180	1409	0x0580	2433	0x0980	3457	0x0D80	4481	0x1180	5505	0x1580	6529	0x1980	7553	0x1D80	8577	0x2180
Meter control	Reset totals	W	I	1	Unsigned integer	513	0x0200	1537	0x0600	2561	0x0A00	3585	0x0E00	4609	0x1200	5633	0x1600	6657	0x1A00	7681	0x1E00	8705	0x2200
	Reset batch total	W	I	1	Unsigned integer	514	0x0201	1538	0x0601	2562	0x0A01	3586	0x0E01	4610	0x1201	5634	0x1601	6658	0x1A01	7682	0x1E01	8706	0x2201
	Error code	R	I	1	Unsigned integer	515	0x0202	1539	0x0602	2563	0x0A02	3587	0x0E02	4611	0x1202	5635	0x1602	6659	0x1A02	7683	0x1E02	8707	0x2202
Comm Settings	Word order	R	I	1	Unsigned integer	16385	0x4000																
	Baud rate	R	I	1	Unsigned integer	16386	0x4001																
	Parity	R	I	1	Unsigned integer	16387	0x4002																
	Stop bits	R	I	1	Unsigned integer	16388	0x4003																
	Meter addr	R	I	1	Unsigned integer	16389	0x4004																
	All ones	R	I	1	Unsigned integer	16390	0x4005																
Modbus access status	Modbus access status	R	I	1	Unsigned integer	16391	0x4006																

Table 28: Modbus register map

Panametrics
a Baker Hughes business

We,

**Panametrics
1100 Technology Park Drive
Billerica, MA 01821
USA**

declare under our sole responsibility that the

**Sentinel LCT/LCTX Liquid Custody Transfer Ultrasonic Flow Meter
Sentinel LNG Cryogenic Liquids Ultrasonic Flow Meter
Sentinel SEN898 Ultrasonic Flow Transmitter**

to which this declaration relates, is in conformity with the following standards:
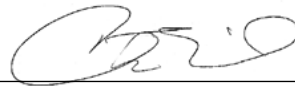
- EN 60079-0: 2012 +A11: 2013
- EN 60079-1: 2014
- EN 60079-7: 2015
- EN 60529: 1991 +A1: 2000
- II 2 G Ex de IIB T6 Ta = -40°C to +60°C IP66; FM09ATEX0072X, FM13ATEX.0018X (FM Global, UK)
- II 2 D Ex tD A21 IP66 T85°C Tz = -40°C to +60°C IP66; FM09ATEX0072 (FM Global, UK)
- EN 61326-1: 2013, Group 1, Class A, Industrial Electromagnetic Environments
- EN 61326-2-3: 2013
- EN 61010-1: 2010, Overvoltage Category II

following the provisions of the 2014/30/EU EMC, 2014/35/EU Low Voltage and 2014/34/EU ATEX Directives.

The units listed above and any ancillary equipment supplied with them do not bear CE marking for the Pressure Equipment Directive, as they are supplied in accordance with Article 3, Section 3 (sound engineering practices and codes of good workmanship) of the Pressure Equipment Directive 2014/68/EU for DN<25.

Billerica - April 2016

Issued

Mr. Chris Frail
Engineering Manager

Certification and safety statements for the Sentinel™ LCT or LCTx ultrasonic flow meter

When installing this apparatus, the following requirements must be met:

- Field wiring shall be rated at least 10ºC above 85ºC.

- Connecting cables shall be mounted securely and protected from mechanical damage, pulling and twisting.

- Cable entries are ¾" NPT.

- Cable glands of an approved flameproof design are required. These must be installed according to the manufacturer's instructions. Where the cable glands are provided by Panametrics, the manufacturer's instructions, as supplied to Panametrics, will be included in the documentation.

- The system is covered by the certificate numbers FM13ATEX0018X and IECEx FMG 13.0008X as shown on the labels on the following page. The system temperature code is dependent upon the process fluid temperature range of -40ºC to 140ºC. The surface temperature of the sensor body and electronics can approach the process fluid temperatures, and all necessary precautions should be taken.

- Unused entries must be sealed using a suitably certified threaded plug.

- Modifications to the flameproof enclosure are not permitted.

- The apparatus should be de-energized before opening.

- Installation shall be in accordance with the installation instructions and the National Electrical Code® ANSI/NFPA 70, the Canadian Electrical Code C22.1, or IEC/EN 60079-14, as applicable.

- Equipment is of type flameproof "d" design or flameproof with increased safety "d e" design and complies with:

- EN 60079-0:2012 +A11:2013, EN 60079-1:2014, EN 60079-7:2015, EN 60529:1991 +A1:2000, IEC 60079-0:2011, IEC 60079-1:2007, IEC 60079-7:2006 and IEC 60529:2001.

- The product contains no exposed parts which produce surface temperature infrared, electromagnetic ionizing, or non-electrical dangers.

- The product must not be subjected to mechanical or thermal stresses in excess of those permitted in the certification documentation and the instruction manual.

- The product cannot be repaired by the user; it must be replaced by an equivalent certified product. Repairs should only be carried out by the manufacturer or by an approved repairer.

- Only trained, competent personnel may install, operate and maintain the equipment.

- The product is an electrical apparatus and must be installed in the hazardous area in accordance with the requirements of the EC Type Examination Certificate. The installation must be carried out in accordance with all the appropriate international, national and local standard codes and practices and site regulations for flameproof apparatus and in accordance with the instructions contained in the manual. Access to the circuitry must not be made during operation.

Special conditions for safe use

- Consult the manufacturer if dimensional information on the flameproof joints is necessary.

- Follow the manufacturer's instructions to reduce the potential of an electrostatic charging hazard.

- Consult the manufacturer for genuine replacement flange fasteners. M10x35 hexagon socket cap screws of

- ISO 12.9 DIN912 grade steel (zinc-plated) or better, with a minimum yield strength of 135,000 psi are acceptable alternatives.

- The sensor body temperature code rating is dependent on the process temperature (see the table below). It is assumed that the external surface of the sensor body will be, at worst case, equal to the process temperature. In all cases, the electronics assembly will be marked T6, as it will be locally mounted for process temperatures up to 85°C and will be remotely mounted for process temperatures exceeding 85°C.

NOTE: The remote mount electronics option is not yet available for the *Sentinel LCT8* model.

Mounting	Process Temperature (TP)	T-code
Local	TP ≤ 85°C	T6
Remote	TP ≤ 85°C	T6
Remote	85°C < TP ≤ 100°C	T5
Remote	100°C < TP ≤ 120°C	T4A (For USA and Canada only)
Remote	100°C < TP ≤ 135°C	T4
Remote	135°C < TP ≤ 140°C	140°C

Markings

- Markings shall appear on the /, as shown below (LCT8 shown as an example):
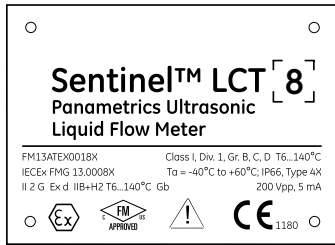
Sentinel™ LCT 8
Panametrics Ultrasonic
Liquid Flow Meter

FM13ATEX0018X	Class I, Div. 1, Gr. B, C, D T6...140°C
IECEx FMG 13.0008X	Ta = -40°C to +60°C; IP66, Type 4X
II 2 G Ex d IIB+H2 T6...140°C Gb	200 Vpp, 5 mA

Ex FM APPROVED ! CE 1180

EXPLOSIONPROOF ONLY (Ex d)

Sentinel™ LCT 8
Panametrics Ultrasonic
Liquid Flow Meter

FM13ATEX0018X	Class I, Div. 1, Gr. B, C, D T6...140°C
IECEx FMG 13.0008X	Ta = -40°C to +60°C; IP66, Type 4X
II 2 G Ex d e IIB+H2 T6...140°C Gb	200 Vpp, 5 mA

Ex FM APPROVED ! CE 1180
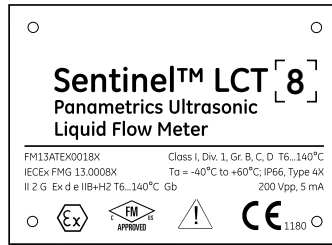
EXPLOSIONPROOF with INCREASED SAFETY (Ex d e)

- Markings shall appear on the specification tag plate, as shown below (LCT8 shown as an example):

BILLERICA, MA USA   MODEL: SEN-LCT 8
                           panametrics.com

SIZE/FLANGE/SCH/MAT: 6" / #600 / 80S / SA351 Gr.CF8M
Q min/max: 20/940 m3/hr   DRY WEIGHT: 157 kg
TEMPERATURE   PRESSURE
AMBIENT: -40 to 60°C   MAWP: 78.5 bar @ 140°C
FLUID: LOCAL   to 85°C   MAEWP F.V. @ 140°C
FLUID: REMOTE   to 140°C   MDMT: -40°C @ 99.2 bar
FC MFG SN: 12345678   HYDRO: 148.9 barg
MFG DATE: 2012/MAR

OIML EVAL CERT: TC7595
ACCURACY/MECH/EM CLASS: 0.3 / M1 / E2   CE 2561
VISCOSITY RANGE: 0.8 to 600 mPa-s

WARNING: POTENTIAL ELECTROSTATIC
CHARGING HAZARD - SEE INSTRUCTIONS
AVERTISSEMENT: POTENTIEL DE CHARGEMENT
ELECTROSTATIQUE RISQUE - VOIR LES INSTRUCTIONS

PED Certified (Ref. 442-1403)

BILLERICA, MA USA   MODEL: SEN-LCT 8
                           panametrics.com

SIZE/FLANGE/SCH/MAT: 6" / #600 /80S / SA351 Gr.CF8M
Q min/max: 20/940 m³/hr   DRY WEIGHT: 157 kg
TEMPERATURE   PRESSURE
AMBIENT: -40 to 60°C   MAWP: 78.5 bar @ 140°C
FLUID: -40 to 140°C   MAEWP F.V. @ 140°C
FC MFG SN: 12345678   MDMT: -40°C @ 99.2 bar
MFG DATE: 2012/MAR   HYDRO: 148.9 barg

OIML EVAL CERT:
ACCURACY/MECH/EM CLASS: 0.3 / M1 / E2
VISCOSITY RANGE: 0.8 to 600 mPa-s

WARNING: POTENTIAL ELECTROSTATIC
CHARGING HAZARD - SEE INSTRUCTIONS
AVERTISSEMENT: POTENTIEL DE CHARGEMENT
ELECTROSTATIQUE RISQUE - VOIR LES INSTRUCTIONS

Non-PED Certified (Ref. 442-1806)

- Markings shall appear on the transmitter tag plate, as shown below (LCT8 shown as an example):

CAUTION: CONDUIT SEALS REQUIRED WITHIN 18 INCHES
ATTENTION: JOINTS DE CONDUIT REQUIS MOINS DE 18 POUCES

Sentinel™ LCT 8
Panametrics Ultrasonic
Liquid Flow Meter   Panametrics LLC
                               1100 TECHNOLOGY PARK DR.
                               BILLERICA, MA 01821   USA

FM13ATEX0018X   Class I, Div. 1, Gr. B, C, D T6
IECEx FMG 13.0008X   SYSTEM PART STRING:
II 2 G Ex d IIB+H2 T6 Gb   S =
Ta = -40°C to +60°C; IP66, Type 4X   CE 1180   ELECTRONICS PART STRING:
POWER: SEN898-
ALL CONDUIT ENTRIES ARE 3/4" NPT   SERIAL #:

Ex FM APPROVED   DO NOT OPEN WHILE AN EXPLOSIVE GAS IS PRESENT
                    NE PAS OUVRIR ALORS QU' UN GAZ EXPLOSIF EST PRESENT

EXPLOSIONPROOF ONLY (Ex d)

CAUTION: CONDUIT SEALS REQUIRED WITHIN 18 INCHES
ATTENTION: JOINTS DE CONDUIT REQUIS MOINS DE 18 POUCES

Sentinel™ LCT 8
Panametrics Ultrasonic
Liquid Flow Meter   Panametrics LLC
                               1100 TECHNOLOGY PARK DR.
                               BILLERICA, MA 01821   USA

FM13ATEX0018X   Class I, Div. 1, Gr. B, C, D T6
IECEx FMG 13.0008X   SYSTEM PART STRING:
II 2 G Ex d e IIB+H2 T6 Gb   S =
Ta = -40°C to +60°C; IP66, Type 4X   CE 1180   ELECTRONICS PART STRING:
POWER: SEN898-
ALL CONDUIT ENTRIES ARE 3/4" NPT   SERIAL #:

Ex FM APPROVED   DO NOT OPEN WHILE AN EXPLOSIVE GAS IS PRESENT
                    NE PAS OUVRIR ALORS QU' UN GAZ EXPLOSIF EST PRESENT

EXPLOSIONPROOF with INCREASED SAFETY (Ex d e)

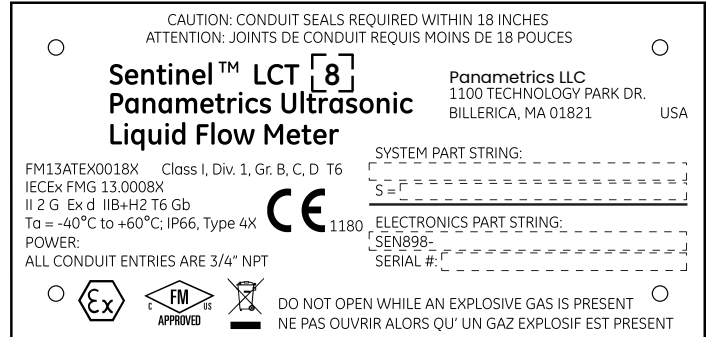- Markings shall appear on the P/N and S/N tag plate, as shown below (LCT8 shown as an example):

MODEL #:
SEN-LCT8-SAMPLE
S = SAMPLE
SERIAL #: SAMPLE   ASSY DATE: SAMPLE
TAG #: SAMPLE

Connection and wiring diagram (ref. dwg. 702–884)

MODBUS / TCP CONNECTOR (NON-IS ONLY)

POWER CORD TERMINAL

AC OPTION:
L1   LINE 1
L2/N LINE 2/NEUTRAL
G   GROUND
(264VAC, 0.82A)
SEE NOTES 2 & 3

DC OPTION:
+   (+)
−   (−)
⏚   GROUND
(30VDC, 2A)
SEE NOTES 2 & 3

USB CONNECTOR (NON-IS ONLY)
(SERVICE USE ONLY)

NOTES:
1. I/O CONNECTIONS WIRE GAUGE RANGE 12-24 AWG (3.3 - 0.2 mm²).
2. AC AND DC CONNECTIONS WIRE GAUGE RANGE 12-18 AWG (3.5 - .82 mm²).
3. MAXIMUM TERMINAL RATINGS [VOLTAGE, CURRENT].

(2) ANALOG INPUTS & RTD INPUT OPTION (AAR)
ANALOG INPUT 1
AIN1   ANALOG IN
+24V1 24VDC
RTN1   24VDC RETURN
RTN1   ANALOG RETURN

ANALOG INPUT 2
AIN2   ANALOG IN
+24V2 24VDC
RTN2   24VDC RETURN
RTN2   ANALOG RETURN

RTD INPUT 1
S+   SENSE +
CUR   CURRENT OUT
S−   SENSE -
RTN   CURRENT RETURN
SEE NOTES 1 & 3

(3) ANALOG INPUTS OPTION (AAA)
ANALOG INPUT 1
AIN1   ANALOG IN
+24V1 24VDC
RTN1   24VDC RETURN
RTN1   ANALOG RETURN

ANALOG INPUT 2
AIN2   ANALOG IN
+24V2 24VDC
RTN2   24VDC RETURN
RTN2   ANALOG RETURN

ANALOG INPUT 3
AIN3   ANALOG IN
+24V3 24VDC
RTN3   24VDC RETURN
RTN3   ANALOG RETURN
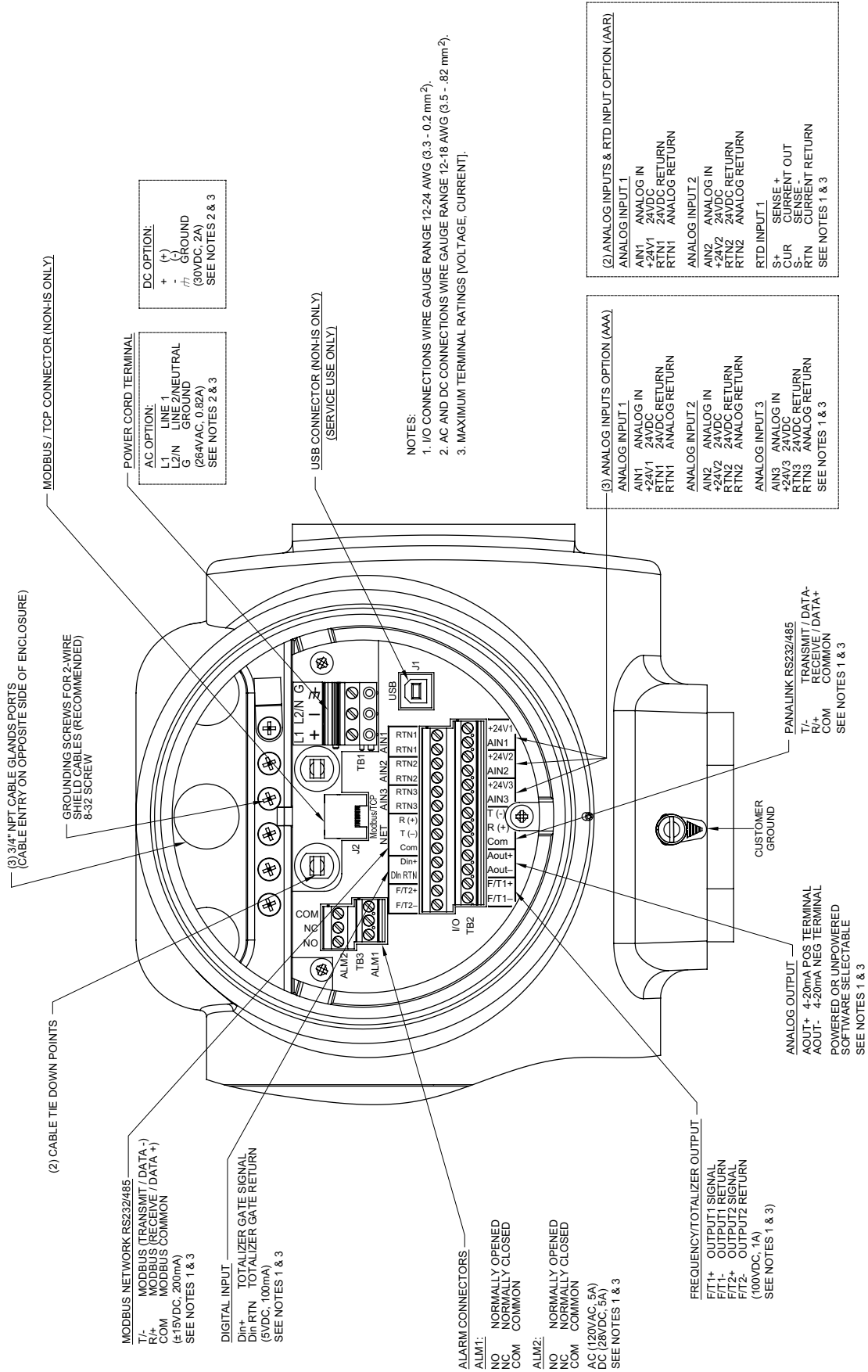SEE NOTES 1 & 3

(3) 3/4"NPT CABLE GLANDS PORTS
(CABLE ENTRY ON OPPOSITE SIDE OF ENCLOSURE)

GROUNDING SCREWS FOR 2-WIRE
SHIELD CABLES (RECOMMENDED)
8-32 SCREW

(2) CABLE TIE DOWN POINTS

PANALINK RS232/485
T/−   TRANSMIT / DATA-
R/+   RECEIVE / DATA+
COM   COMMON
SEE NOTES 1 & 3

CUSTOMER
GROUND

L1 L2/N G
TB1
J2
Modbus/TCP
NET
USB
J1
RTN1
RTN1
RTN2
RTN2
RTN3
RTN3
R (+)
T (−)
Com
Din+
Din RTN
F/T2+
F/T2−
+24V1
AIN1
+24V2
AIN2
+24V3
AIN3
T (−)
R (+)
Com
Aout+
Aout−
F/T1+
F/T1−
I/O
TB2
AIN3 AIN2 AIN1
COM
NC
NO
NC
NO
ALM2
TB3
ALM1

MODBUS NETWORK RS232/485
T/−   MODBUS (TRANSMIT / DATA -)
R/+   MODBUS (RECEIVE / DATA +)
COM   MODBUS COMMON
(±15VDC, 200mA)
SEE NOTES 1 & 3

DIGITAL INPUT
Din+   TOTALIZER GATE SIGNAL
Din RTN TOTALIZER GATE RETURN
(5VDC, 100mA)
SEE NOTES 1 & 3

ALARM CONNECTORS
ALM1:
NO   NORMALLY OPENED
NC   NORMALLY CLOSED
COM COMMON

ALM2:
NO   NORMALLY OPENED
NC   NORMALLY CLOSED
COM COMMON
AC (120VAC, 5A)
DC (28VDC, 5A)
SEE NOTES 1 & 3

FREQUENCY/TOTALIZER OUTPUT
F/T1+   OUTPUT1 SIGNAL
F/T1−   OUTPUT1 RETURN
F/T2+   OUTPUT2 SIGNAL
F/T2−   OUTPUT2 RETURN
(100VDC, 1A)
SEE NOTES 1 & 3

ANALOG OUTPUT
AOUT+ 4-20mA POS TERMINAL
AOUT− 4-20mA NEG TERMINAL
POWERED OR UNPOWERED
SOFTWARE SELECTABLE
SEE NOTES 1 & 3

Wiring connections for increased safety

Power connection	Maximum size*:	Solid - 4.0 mm^2 (12 AWG) stranded - 2.5 mm^2 (14 AWG)
	Number of conductors**:	2 Solid - max 1.5mm^2 (16 AWG)
		2 Stranded - max 1.0 mm^2 (18 AWG)
All other screw terminal connections	Maximum size*:	Solid - 4.0 mm^2 (12 AWG) stranded - 2.5 mm^2 (14 AWG)
	Number of conductors**:	2 Solid - max 1.5 mm^2 (16 AWG)
		2 Stranded - max 1.5 mm^2 (16 AWG)
	* Single conductor; **Multiple conductors of same cross-section	

Customer support centers

Americas

U.S.A.
Panametrics
1100 Technology Park Drive
Billerica, MA 01821
U.S.A.
Tel: +1 800 833 9438 (toll-free)
Tel: +1 978 437 1000
E-mail: panametricstechsupport@bakerhughes.com

Europe

Ireland
Panametrics
Shannon Free Zone East
Shannon, County Clare
Ireland
Tel: +353 61 61470200
E-mail: panametricstechsupport@bakerhughes.com

Panametrics, a Baker Hughes business, provides solutions in the toughest applications and environments for moisture, oxygen, liquid and gas flow measurement.

Experts in flare management, Panametrics technology also reduces flare emissions and optimizes performance.

With a reach that extends across the globe, Panametrics' critical measurement solutions and flare emissions management are enabling customers to drive efficiency and achieve carbon reduction targets across critical industries including: Oil & Gas; Energy; Healthcare; Water and Wastewater; Chemical Processing; Food & Beverage and many others.

Join the conversation and follow us on LinkedIn
linkedin.com/company/panametricscompany

910-314 Rev. A
BHCS39065   (08/2021)

Baker Hughes

panametrics.com