[no content intended for this page]
Information and Safety Paragraphs

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.

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 the 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

Waste Electrical and Electronic Equipment (WEEE) Directive
GE Measurement & Control is an active participant in Europe’s *Waste Electrical and Electronic Equipment* (WEEE) take-back initiative, directive 2012/19/EU.

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

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.

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

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Chapter 1. Features and Capabilities

1.1 Overview

The GE Sentinel™ LCT4 is an ultrasonic flow meter for high accuracy liquid metering applications. It is intended for the applications of fiscal metering, custody transfer, duty metering, check metering, leak detection and allocation. The entire system is shipped fully assembled and preconfigured.

1.1.1 Applications

The Sentinel LCT4 is designed specifically for the custody transfer of petroleum liquids, meeting the strict requirements of API MPMS 5.8, OIML R117-1 and MID MI-005.

- Crude Oil
- Petroleum
- Refined products
- Fuel oil
- Pipeline balancing

1.1.2 Advantages

The Sentinel LCT4 Ultrasonic Liquid Flow Transmitter features numerous unique advantages:

- 0.15% Accuracy
- Fast response electronics
- Advanced signal processing
- Negligible pressure drop
- Bi-directional flow capability
- Excellent low-end resolution
- Internal Flow Computer
- Active Tw compensation
- High turndown ratio
- Low sensitivity to many upstream flow disturbances
- Minimal maintenance
- Transducer replacement without the need for pipe shutdown or recalibration
- Electronic replacement without the need for recalibration
1.1.3 Meter Components

Figure 16 on page 34 shows the complete Sentinel LCT4 system and each of the items is described in Table 1 below.

Table 1: Sentinel LCT4 System Components

<table>
<thead>
<tr>
<th>No</th>
<th>Component</th>
<th>Description</th>
<th>Qty</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Meter Body</td>
<td>Measurement section of a Sentinel LCT4 system</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Model Tag Plate</td>
<td>Model tag plate</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Specification Tag Plate</td>
<td>Specification tag plate</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Part String and Serial Number Tag Plate</td>
<td>Part string and serial number tag plate</td>
<td>1</td>
</tr>
<tr>
<td>5</td>
<td>Transducer Insert (Buffer)</td>
<td></td>
<td>8</td>
</tr>
<tr>
<td>6</td>
<td>Transducer</td>
<td>Flow sensor to transmit and receive ultrasonic signals.</td>
<td>8</td>
</tr>
<tr>
<td>7</td>
<td>SEN898 Electronics Unit</td>
<td>Meter electronics including power supply, processing unit, and communications.</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>External Conduit Connections</td>
<td>Location for power and communications connections. Cable glands are 3/4&quot; NPT.</td>
<td>3</td>
</tr>
<tr>
<td>9</td>
<td>Upstream Meter Run</td>
<td>Not supplied by GE.</td>
<td>N/A</td>
</tr>
<tr>
<td>10</td>
<td>Flow Conditioner</td>
<td>Optional.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>Downstream Meter Run</td>
<td>Not supplied by GE.</td>
<td>N/A</td>
</tr>
<tr>
<td>12</td>
<td>Temperature Probe</td>
<td>Optional. Not supplied by GE.</td>
<td>N/A</td>
</tr>
<tr>
<td>13</td>
<td>Pressure Probe</td>
<td>Optional. Not supplied by GE.</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 2: Sentinel LCT4 Component Materials

<table>
<thead>
<tr>
<th>Component</th>
<th>Materials (ASTM)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meter Body/Flanges</td>
<td>SA216 Gr. WCB (Carbon Steel)</td>
</tr>
<tr>
<td></td>
<td>SA352 Gr. LCB (Low Temp Carbon Steel)</td>
</tr>
<tr>
<td></td>
<td>SA351 Gr. CF8 (Stainless Steel 304)</td>
</tr>
<tr>
<td>Buffers</td>
<td>SA351 Gr. CF8M (Stainless Steel 316)</td>
</tr>
<tr>
<td>Transducers</td>
<td>Stainless Steel 316</td>
</tr>
<tr>
<td></td>
<td>Stainless Steel 316</td>
</tr>
</tbody>
</table>
1.1.3 Meter Components (cont.)

Figure 1: Sentinel LCT4 Ultrasonic Flow Transmitter Assembly (3” to 24” Diameter Pipes)

Note: Actual design changes slightly with size.
1.1.4  Marking and Labeling

1.1.4a  Tag Plates

There are four tag plates affixed to the Sentinel LCT4 which provide details about the system. Three are located on the vessel and one is located on the transmitter. Their locations are shown in the Figure 2 below.

![Figure 2: Sentinel LCT4 Tag Plate Locations](image)

1.1.4b  Model Tag Plate

The Model Tag Plate (see Figure 3 below) contains the model name and certification markings for Pressure Vessel and Hazardous Area usage.

![Figure 3: Model Tag](image)
1.1.4c Model Number String

SEN - LCT4 - B - C - D - E - F - G - H - I - J - K - L - Z

B - CONFIG
4-path full bore - F

C - SIZE
3" - 3
4" - 4
6" - 6
8" - 8

D - PRESSURE CLASS
150# B16.5 - A
300# B16.5 - B
600# B16.5 - C
Special - S

E - MATERIAL
Carbon Steel (WCB) - CS
Low Temp Carbon Steel (LCB) - LCS
Stainless Steel 304 (CF8) - 304
Stainless Steel 316 (CF8M) - 316
Special - S

F - SCHEDULE
10S
STD
40
40S
XS
80
80S
Special - S

G - MOUNTING
Local Integrated Transmitter - L
Remote Transmitter (25 ft) - R25
Remote Transmitter (50 ft) - R50
Remote Transmitter (100 ft) - R100
Remote Transmitter (200 ft) - R200
Remote Transmitter (300 ft) - R300

H - POWER
100-240 VAC - 1
12-32 VDC - 2

I - INPUTS
AAR - 2x 4mA, 1x RTD - 1
AAA - 3x 4-20mA - 2

J - COMMUNICATION
Standard PanaLink - 1
Standard PanaLink + Modbus RTU - 2

K - CORRECTIONS
None - 0
API Chapter 11.1 - 1

L - HAZARDOUS LOCATIONS
North America (FM/CSA) - 1
ATEX/IECEx (Ex e) - 2
ATEX/IECEx with increased safety (Ex de) - 3
Stainless Steel - North America (FM/CSA) - 4
Stainless Steel - ATEX/IECEx (Ex e) - 5
Stainless Steel - ATEX/IECEx with increased safety (Ex de) - 6

Z - MISCELLANEOUS
None - 0
Special - S
1.1.4d 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 OIML certificate information, in addition to 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](image)

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

1.1.4e Part String and Serial Number Tag Plate

The Part String and Serial Number Tag Plate contains the specific configuration of the pressure vessel as well as the final assembly date, GE serial number and customer tag information.

![Figure 5: Part String and S/N Tag Plate](image)

**Note:** Information in dashed boxes is shown only as an example.
1.1.4f Transmitter Tag Plate

The SEN898 Transmitter Tag Plate 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 associated with the transmitter.

![SEN898 Transmitter Tag Plate](image)

**Figure 6: SEN898 Transmitter Tag Plate**

1.2 Theory of Operation


1.2.1 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 LCT4 measures this very small time difference and, using various digital signal processing techniques combined with programmed pipe parameters, determines the flow rate and direction.

1.2.2 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 LCT4 Measurement System were specifically designed to be replaced under normal operating conditions. In the event that a transducer becomes damaged or non-functional, it can be replaced without shutting down the pipeline. Recalibration of the replacement is not necessary.
1.2.3 Multipath Design

Multipath ultrasonic flowmeters are designed with more than one pair of transducers to interrogate the flow field in different locations and more accurately determine the actual flowrate. The Sentinel LCT4 Measurement System uses four measurement locations. These measurement paths are located across the meter body and tilted at an angle. The four measurement paths are orthogonal to each other.

1.2.4 Flow Profile

One of the main factors affecting an ultrasonic flow measurement is the flow profile. If the flow profile is known, mathematical modeling of the flow and the relationships between the raw data of the two paths can be made. A simulation example of how the flow conditioner reduces secondary flow is shown in Figure 7 below. Maintaining a constant flow-profile shape across all flow velocities, pipe sizes and upstream flow disturbances is difficult. For this reason, the factory has tested the Sentinel LCT4 under various conditions in an effort to determine its operational limits. Flow conditioning is optional but highly recommended under certain installation conditions.

![Figure 7: Using a Flow Conditioner to Influence Flow Profile](image-url)
1.2.5 Maximum and Minimum Flow

Maximum and minimum flow rates through the Sentinel LCT4 Ultrasonic Liquid Flow Transmitter are based on the pipe diameter and the process fluid pressure. The information in Table 3 below is approximate, and is based on representative liquid components at a process temperature of 70°F (21°C).

<table>
<thead>
<tr>
<th>Nominal Pipe Size</th>
<th>Flow Velocity</th>
<th>Volumetric Flow</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ft/s</td>
<td>m/s</td>
</tr>
<tr>
<td>in.</td>
<td>mm</td>
<td>Vmin</td>
</tr>
<tr>
<td>3</td>
<td>75</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>1</td>
</tr>
<tr>
<td>6</td>
<td>150</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>200</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>250</td>
<td>1</td>
</tr>
<tr>
<td>12</td>
<td>300</td>
<td>1</td>
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<tr>
<td>14</td>
<td>350</td>
<td>1</td>
</tr>
<tr>
<td>16</td>
<td>400</td>
<td>1</td>
</tr>
<tr>
<td>18</td>
<td>450</td>
<td>1</td>
</tr>
<tr>
<td>20</td>
<td>500</td>
<td>1</td>
</tr>
<tr>
<td>24</td>
<td>600</td>
<td>1</td>
</tr>
</tbody>
</table>
1.3 Specifications

The system specifications for the Sentinel LCT4 Ultrasonic Liquid Flow Transmitter are divided into the following categories:

1.3.1 Operation and Performance

**Note:** The Sentinel LCT4 has been designed to meet the OIML R117-1, MID MI-005 and API MPMS 5.8 requirements.

1.3.1a Fluid Types

Liquid hydrocarbons, crude and refined products, other liquids.

1.3.1b Flow Measurement

Correlation Transit Time mode

1.3.1c Linearity

±0.15% of measured volume for flow rates between 1 and 33 ft/s (0.3 and 10 m/s)

**Note:** Higher flow rates are possible. Consult the factory.

1.3.1d Accuracy

< ±0.15% of measured volume for flow rates between 3 and 30 ft/s.

1.3.1e Uncertainty

< ±0.027% according to API MPMS 5.8

1.3.1f Zero Stability

< 0.003 ft/s

1.3.1g Viscosity Range

0 to 660 cSt
Consult factory for higher Reynolds numbers.

1.3.1h Reynolds Range

Re >10,000
Consult factory for lower Reynolds numbers.

1.3.1i Process Temperature

–40° to +140°C (–40° to +284°F) Standard
(Remote mount required above 85°C (185°F)).
1.3.1j **Ambient Temperature**  
–40° to +60°C (–40° to +140°F)

1.3.1k **Storage Temperature**  
–40° to +85°C (-40 to +176°C)

1.3.2 **Meter Body**

1.3.2a **Path Configuration**  
4 path Gaussian Quadrature

1.3.2b **Meter Body Materials**
- Carbon steel SA216 Gr. WCB
- Low temperature carbon steel SA352 Gr. LCB
- Stainless steel SA351 Gr. CF8
- Stainless steel SA351 Gr. CF8M

Others on request.

1.3.2c **Flowcells**

3” (75 mm) to 24” (600 mm)

Others on request.

![Figure 8: Flowcell Assembly for Sentinel LCT4 with 3” and 4” Pipes](image)
1.3.2c Flowcells (cont.)

Figure 9: Flowcell Assembly for Sentinel LCT4 with 6” to 24” Pipes

Note: Use Figure 8 on page 11 and Figure 9 above to identify L, H2 and A measurements in Table 4 on page 13. The A dimension is the MAX depth of the system. Dimensional extremes as depicted depend on the actual meter and flange size.
### 1.3.2c  Flowcells (cont.)

#### Table 4: Flowcell Dimensions

<table>
<thead>
<tr>
<th>Pipe Diameter (inches)</th>
<th>Flange Class (lb)</th>
<th>Dimensions in English Units (rounded)</th>
<th>Dimensions in Metric Units (rounded)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L (in.)</td>
<td>H2 (in.)</td>
</tr>
<tr>
<td>3</td>
<td>150#</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td>300#</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>600#</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>4</td>
<td>150#</td>
<td>20</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>300#</td>
<td>20</td>
<td>21</td>
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<td>150#</td>
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<td></td>
<td>300#</td>
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<td></td>
<td>600#</td>
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<tr>
<td></td>
<td>600#</td>
<td>32</td>
<td>29</td>
</tr>
<tr>
<td>12</td>
<td>150#</td>
<td>30</td>
<td>29</td>
</tr>
<tr>
<td></td>
<td>300#</td>
<td>32</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>600#</td>
<td>36</td>
<td>31</td>
</tr>
<tr>
<td>14</td>
<td>150#</td>
<td>36</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>300#</td>
<td>38</td>
<td>33</td>
</tr>
<tr>
<td></td>
<td>600#</td>
<td>40</td>
<td>33</td>
</tr>
<tr>
<td>16</td>
<td>150#</td>
<td>38</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td>300#</td>
<td>40</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>600#</td>
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</tr>
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<td>18</td>
<td>150#</td>
<td>38</td>
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<td>300#</td>
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<td>39</td>
</tr>
<tr>
<td></td>
<td>600#</td>
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<td>20</td>
<td>150#</td>
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<td></td>
<td>300#</td>
<td>48</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>600#</td>
<td>50</td>
<td>43</td>
</tr>
<tr>
<td>24</td>
<td>150#</td>
<td>48</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>300#</td>
<td>50</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>600#</td>
<td>52</td>
<td>46</td>
</tr>
</tbody>
</table>
1.3.2d  Flange Ratings

- 150 #
- 300 #
- 600#

Others on request.

1.3.2e  Pipe Schedules

- 40S
- STD
- 80S
- 10S
- XS

Others on request.

1.3.2f  PED Compliance

- PED Cat II, Module B + C1

1.3.2g  Installation Requirement

The meter must be installed with 20D straight piping upstream and 5D straight piping downstream. Inlet and outlet piping shall match the meter ID within 0.5%. In case a 20D inlet cannot be mounted, a 10D inlet with flow conditioned could be applied. Pressure, temperature and density connections must be located in the downstream piping. The upstream piping and flow conditioner) must be free of items that could disturb the flow profile.
1.3.3  Electronics

1.3.3a  Electronics Enclosure Material
Epoxy-coated aluminum
Stainless steel A351, Gr 316/316L (optional)

1.3.3b  Weight
29 lb (13.2 kg) aluminum
58 lb (24.3 kg) stainless

1.3.3c  Dimensions
Size (l x h x d): 13” x 11” x 9”

1.3.3d  Ingress Protection
Type 4X / IP66

1.3.3e  Power Supply
• 100 - 240 VAC
• 12 - 32 VDC

1.3.3f  Power Consumption
7 Watts

1.3.3g  Display
High contrast 128 x 64 pixel graphical display with LED illumination.

1.3.3h  Outputs
• Two frequency/pulse outputs
• Two alarm relays
• One 4/20 mA output with HART (version 6)

1.3.3i  Inputs
Two 4/20 mA and one 100 Ohm RTD input for density, pressure and temperature input (optional), or
Three 4/20 mA inputs for density, pressure and temperature input (optional).
1.3.3j Digital Interfaces

- HART over 4/20 mA output (version 6)
- PanaLink over RS232/485/USB
- Modbus over RS232/485 (optional)

1.3.3k Flow Computer Functionality

Integrated flow computer with full P and T volume corrections according to API 11.1

1.3.3l Hazardous Area Classification

- USA/Canada: Class I, Division 1, Groups B, C, D T6
- Europe/International: II 2 G Ex d e IIB+H2 T6 Gb
- \( T_a = -40°C \text{ to } +60°C \)

1.3.3m CE Compliance

- 2004/108/EC
- 2006/95/EC LVD

1.3.4 Custody Transfer Approvals

1.3.4a USA / Canada

Compliant with API MPMS 5.8

1.3.4b Europe

MID MI-005

1.3.4c Rest of World

OIML R117-1 Accuracy Class 0.3

Note: The Custody Transfer approvals are valid for the flowmeter only. These approvals are not applicable for the built-in flow computer.
1.3.5 Standards

The Sentinel LCT4 has been designed in accordance with the following standards:

- ASME B31.3
- ASME Section IX
- ASME B16.5
- ANSI/NACE MR0175/ISO 15156 AND NACE MR0103
- ANSI/NACE B.1.20.1
- ASME B36.10M and B36.19M
- EN 10204, TYPE 3.1

1.4 Maximum Allowable Operating Data

1.4.1 Operating and Storage Temperatures

Process Fluid Operating Temperature: -40 to +140°C (-40 to +284°F)

Ambient Operating Temperature: -40 to +60°C (-40 to +140°F) for electronics and pressure vessel

Storage Temperature: -40 to +85°C (-40 to +185°F) for electronics and pressure vessel

Note: Remote-mount electronics are required when Process Fluid Temperature exceeds +85°C (185°F).

1.4.2 Operating Pressures

Maximum operating pressures specified are listed in Table 5 below by material and pressure class.

<table>
<thead>
<tr>
<th>Flange Class</th>
<th>WCB 100°F</th>
<th>LCB 100°F</th>
<th>CF8 100°F</th>
<th>CF8M 100°F</th>
<th>WCB 284°F</th>
<th>LCB 284°F</th>
<th>CF8 284°F</th>
<th>CF8M 284°F</th>
</tr>
</thead>
<tbody>
<tr>
<td>150#</td>
<td>285</td>
<td>265</td>
<td>275</td>
<td>275</td>
<td>235</td>
<td>234</td>
<td>209</td>
<td>218</td>
</tr>
<tr>
<td>300#</td>
<td>740</td>
<td>695</td>
<td>720</td>
<td>720</td>
<td>659</td>
<td>643</td>
<td>550</td>
<td>570</td>
</tr>
<tr>
<td>600#</td>
<td>1480</td>
<td>1395</td>
<td>1440</td>
<td>1440</td>
<td>1316</td>
<td>1282</td>
<td>1095</td>
<td>1139</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Flange Class</th>
<th>WCB 38°C</th>
<th>LCB 38°C</th>
<th>CF8 38°C</th>
<th>CF8M 38°C</th>
<th>WCB 140°C</th>
<th>LCB 140°C</th>
<th>CF8 140°C</th>
<th>CF8M 140°C</th>
</tr>
</thead>
<tbody>
<tr>
<td>150#</td>
<td>19.6</td>
<td>18.3</td>
<td>19.0</td>
<td>19.0</td>
<td>16.2</td>
<td>16.1</td>
<td>14.4</td>
<td>15.0</td>
</tr>
<tr>
<td>300#</td>
<td>51.0</td>
<td>47.9</td>
<td>49.6</td>
<td>49.6</td>
<td>45.4</td>
<td>44.3</td>
<td>37.9</td>
<td>39.3</td>
</tr>
<tr>
<td>600#</td>
<td>102.0</td>
<td>96.1</td>
<td>99.2</td>
<td>99.2</td>
<td>90.7</td>
<td>88.4</td>
<td>75.5</td>
<td>78.5</td>
</tr>
</tbody>
</table>
1.4.3 Weight

Table 6 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 6: Fully Assembled Dry Weights

<table>
<thead>
<tr>
<th>Vessel Nominal Diameter (in.)</th>
<th>English [lbs.]</th>
<th>Metric [kg]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>150#</td>
<td>300#</td>
</tr>
<tr>
<td>3</td>
<td>156</td>
<td>170</td>
</tr>
<tr>
<td>4</td>
<td>180</td>
<td>200</td>
</tr>
<tr>
<td>6</td>
<td>239</td>
<td>286</td>
</tr>
<tr>
<td>8</td>
<td>334</td>
<td>398</td>
</tr>
<tr>
<td>10</td>
<td>421</td>
<td>512</td>
</tr>
<tr>
<td>12</td>
<td>582</td>
<td>704</td>
</tr>
<tr>
<td>14</td>
<td>746</td>
<td>925</td>
</tr>
<tr>
<td>16</td>
<td>978</td>
<td>1200</td>
</tr>
<tr>
<td>24</td>
<td>2112</td>
<td>2660</td>
</tr>
</tbody>
</table>

Transmitter Weights:

- *Aluminum*: 29 lbs. (13.2 kg)
- *Stainless Steel*: 58 lbs. (26.3 kg)

**WARNING!** When working with weights over 45 lb (20.4 kg), it is recommended that lifting is assisted.
## 1.4.4 Flowrates

*Table 7* below includes OIML approved minimum and maximum flowrates for which the system has been shown to maintain OIML accuracies and repeatabilities.

### IMPORTANT:
Please consult GE for an application assessment if higher or lower flow rates are required for a particular application.

### 1.4.5 Allowable Fluids

Allowable fluids include: liquid petroleum and related products, liquid food and chemical products (including water) in liquid state. With regards to the Pressure Equipment directive, the product is approved for Group 1 liquids.

This product uses Viton® O-rings which provide resistance to degradation by a greater variety of fluids and chemicals than any non-fluorinated elastomer, providing the best proven fluid resistance of any commercial rubber. They provide excellent resistance to oils, fuels, lubricants, and most mineral acids.

### WARNING!
If application fluids have a known incompatibility with Viton®, please consult GE.

---

<table>
<thead>
<tr>
<th>Nominal Vessel Diameter (in.)</th>
<th>English [GPM]</th>
<th>Metric $[\text{m}^3/\text{hr}]$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$Q_{\text{min}}$</td>
<td>$Q_{\text{max}}$</td>
</tr>
<tr>
<td>3</td>
<td>18</td>
<td>1409</td>
</tr>
<tr>
<td>4</td>
<td>44</td>
<td>1828</td>
</tr>
<tr>
<td>6</td>
<td>71</td>
<td>2576</td>
</tr>
<tr>
<td>8</td>
<td>89</td>
<td>6604</td>
</tr>
<tr>
<td>10</td>
<td>106</td>
<td>9026</td>
</tr>
<tr>
<td>12</td>
<td>212</td>
<td>11227</td>
</tr>
<tr>
<td>14</td>
<td>467</td>
<td>15410</td>
</tr>
<tr>
<td>16</td>
<td>608</td>
<td>20033</td>
</tr>
<tr>
<td>18</td>
<td>766</td>
<td>25316</td>
</tr>
<tr>
<td>20</td>
<td>947</td>
<td>31260</td>
</tr>
<tr>
<td>24</td>
<td>1233</td>
<td>43588</td>
</tr>
</tbody>
</table>

In general, ultrasonic flowmeters are capable of measuring fluid flow rates from as low as 0.5 ft/s (0.15 m/s) to over 30 ft/s (9.1 m/s).

### WARNING!
If application fluids have a known incompatibility with Viton®, please consult GE.
1.4.6 Loads and Forces

For all load and force requirements and limitations, please consult GE.

1.4.7 Description of Different Operating Conditions

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

1.4.7a Startup

The Sentinel LCT4 does not have any specific startup requirements once it has been fastened into the piping system. Power should be supplied in accordance with local and national electrical codes. The line does not need to be full of fluid for the system to be powered on.

1.4.7b 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, HART, etc.). If any errors occur they will be reported out as well.

1.4.7c Shutdown

While the Sentinel LCT4 is intended for continuous service there are occasions where shutdown is required. There are no special requirements specific to this product for shutdown. The system should be de-energized prior to troubleshooting and any pressure build-up should be relieved per the procedure in the GE Installation Manual (916-137), Section 5.

1.4.7d Troubleshooting

Refer to Chapter 7, Troubleshooting, for a list of error codes and troubleshooting steps. For any other inquiries or assistance with troubleshooting, please consult GE.
1.5 Certification

1.5.1 Pressure Equipment Directive (PED)

Marking Information - TBD

1.5.2 Canadian Registration Number (CRN)

CRN No: 0F15659 (all provinces)

Sizes: 3", 4", 6, 8"

Pressure Classes: #150, #300, #600

Material: SA216 WCB, SA352 LCB, SA351 CF8, SA351 CF8M

1.5.3 Custody Transfer Performance Approvals

1.5.3a Standard

OIML R 117 - Measuring systems for liquids other than water

1.5.3b Certificate Number

TC7595

1.5.3c Accuracy Class

0.3

1.5.3d Environment Class

M1

1.5.3e Viscosities

Up to 660 cSt; for higher, consult GE
### 1.6 List of Reference Drawings and Documentation

#### 1.6.1 Wiring Diagrams

- 702-884  Wiring Diagram, SEN898 Electronics

#### 1.6.2 Outline and Installation Diagrams

- 712-1420  Outline & Installation, SEN898 Enclosure, Aluminum, Remote Mount
- 712-1761  Outline & Installation, SEN898 Enclosure, SS316, Remote Mount
- 712-1827  Outline & Installation, SEN898 Enclosure, Aluminum, Local Mount
- 712-1828  Outline & Installation, SEN898 Enclosure, SS316, Local Mount
- 712-1832  Outline & Installation, Sentinel LCT4, Local Mount
- 712-1833  Outline & Installation, Sentinel LCT4, Remote Mount

#### 1.6.3 Manuals

- 910-297  Sentinel LCT4 User's Manual (this manual)
- 916-115  Communications Options, User's Guide
- 916-137  Sentinel LCT4 Installation and Maintenance Guide
1.7 Disclaimer

The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties of merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

1.8 Warnings and Cautions

**WARNING!** The Sentinel Flow Measurement System can measure the flow rate of many fluids, some of which are potentially hazardous. The importance of proper safety practices cannot be overemphasized.

**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 B, *CE Mark Compliance*.

**WARNING!** Always disconnect the line power from the meter before removing either the front cover or the side cover. This is especially important in a hazardous environment.

**WARNING!** Improper connection of the line power leads or connecting a Sentinel 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.

**WARNING!** Make sure the front and side covers, along with their O-ring seals, are installed on the transmitters, and the set screws tightened before applying power in a hazardous environment.

**WARNING!** Never remove the flowmeter covers in a hazardous environment while the line power is on.
[no content intended for this page]
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 LCT4, the system must be installed in accordance with the guidelines established by GE Sensing, as explained in this chapter.

**WARNING!** The Sentinel Flow Measurement System can measure the flow rate of many fluids, some of which are potentially hazardous. The importance of proper safety practices cannot be overemphasized.

**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 B, CE Mark Compliance.

**IMPORTANT:** This operating instruction 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 LCT4 flowmeter
- Magnetic Wand
- User’s Manual
- CD with PanaView SEN898 Software (optional)
2.3 Unpacking

The Sentinel LCT4 will typically be packaged in a wooden crate, the size of which will depend on the size of product ordered. There Sentinel LCT4 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 parcel.

2.4 Inspection

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

- **Gaskets** - check for cracks, tears and over compression
- **Nuts and Bolts** - check for damaged threads and for debris
- **RF Flange Faces** - check for damage to serrations that may cause gaskets to not properly seal.
- **Flow Conditioners** - check for blockages or damage to the conditioner

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

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

2.5.1 Location

For both uni-directional and bi-directional flow (see Figure 10 below and Figure 11 on page 28), a minimum of five diameters of straight pipe shall be provided by the customer on either side of the meter run, directly upstream of the flow conditioning plate and downstream of any disturbances or pipe bends. An additional length of straight pipe will help produce a more symmetrical flow profile, thus reducing the measurement uncertainty.

Figure 10: Typical Sentinel LCT4 Installation, Uni-Directional Flow
2.5 Mechanical Installation (cont.)

Figure 11: Typical Sentinel LCT4 Installation, Bi-Directional Flow

Temp. and Pressure transmitters should be located elsewhere for bi-directional installations.
2.5.1 Installation Precautions

Any questions with respect to the installation should be addressed prior to beginning the installation. Failure to install the Sentinel LCT4 correctly can increase measurement uncertainty.

CAUTION! To avoid possible strain, refer to the Sentinel LCT4 label for the assembly weight, use a properly-rated lifting assembly, and place the lifting straps in the indicated locations (see Figure 12 below).

All the mechanical and electronic components are shipped fully assembled (see Figure 8 on page 11 and Figure 9 on page 12), however the following precautions should be observed:

- Only authorized personnel should perform installation. The proper personal protection equipment 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 size system. In general, allow for a minimum of 12” of space on all sides of pressure vessel and transmitter, with a preference for 24” on all sides.

- Users must provide suitable over-pressure protection at or in the main piping to flowcell in order to prevent damage to flowcell and injury to operating personnel and others. 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 LCT4 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 LCT4 is oriented with the flow transmitter in a vertical position at the top, as shown in Figure 12 below.
2.5.2 Lifting Instructions

Use proper lifting techniques when moving the Sentinel LCT4 (see Figure 13 below). No lifting hooks or eyelets are provided. The recommended method for lifting the Sentinel LCT4 is by using lifting straps on each side of the pressure vessel with a stabilizer bar between them, located above the transmitter head. Additional care may need to be taken to prevent the transmitter from rotating, especially on the smaller systems where the transmitter weight is a larger percentage of the total system weight.

**WARNING!** Never stand below any object being lifted.

![Figure 13: Proper Lifting Method](image)

**WARNING!** Do not use the transmitter to support the weight of the flowcell as shown in Figure 14 below. The transmitter cannot support the weight of the pressure vessel.

![Figure 14: Improper Lifting Method](image)
2.6 Installing the System

Being mindful of the “Installation Precautions” on page 29, complete the following steps:

1. Make sure the gaskets are in place on the flanges.
2. Support the Sentinel LCT4 between the flanges on the pipe.
3. Align the flange mounting holes as shown in Figure 15 below.
4. Secure the meter to the pipe by using the appropriate hardware.

Figure 15: Sentinel LCT4 Mounting Flange End View

2.6.1 General Piping Rules

2.6.1a Installation Location

Proper installation of the Sentinel LCT4 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, since every installation is different.

2.6.1b Straight Run Requirements

The Sentinel LCT4 should be installed to meet one of the following conditions:

- A minimum of 20D (i.e., 20 pipe diameters) upstream of the metering section (pressure vessel) and a minimum of 5D downstream.
- A minimum of 10D (i.e., 10 pipe diameters) upstream of the metering section (pressure vessel) using a conditioning plate and a minimum of 5D downstream.

For any other straight run configurations, consult GE for an application assessment.
2.6.1c  **Inner Diameter Matching**

To maintain optimal product performance, the inner diameter of the upstream sections (20D or 10D with conditioning plate) 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.

2.6.1d  **Conditioning Plates & Tube Bundles**

Conditioning plates are recommended over tube bundles for the Sentinel LCT4. The conditioning plate should be installed to the manufacturer's recommendations but in general a minimum of 10D upstream of the metering section (pressure vessel) with a minimum of 5D of upstream of the conditioning plate is preferred. Conditioning plates should be installed the same way from calibration to the end user site. Visual indicators on the plates can assist users in orienting them properly.

**WARNING!** Conditioning plates do have directionality and need to be aligned properly with the direction of flow.

For use of any other type of conditioning plate, consult GE for an application assessment.

2.6.1e  **Location of Temperature and Pressure Measurements**

Temperature and pressure measurements should always be made downstream of the Sentinel LCT4 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 GE for an application assessment.

2.6.1f  **Calibration Recommendations**

In general, the best practice is to calibrate as much of the measuring section as possible. This would include conditioning plates, upstream and downstream straight run and the Sentinel LCT4. While this is not always possible or cost effective this 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.
2.6.1g Fluid Comments

Gas - To avoid measurement errors suitable measures should be taken make sure the line is full and 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 be measurable and 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 could affect accuracy of measurements.

Please consult GE for any applications where conditions are outside the recommended ranges for a more comprehensive application review.

2.6.2 Guidelines for Installing Pipe Insulation

If pipe insulation is required:

1. 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.

2. 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.

3. 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.
2.7 Making Electrical Connections

This section contains instructions for making the necessary electrical connections to the flow transmitter (see Figure 16 below). The wiring between the transmitter and the transducers has been installed at the factory, and no further work is 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 B, CE Mark Compliance.

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.

![Figure 16: Sentinel LCT4 Flow Measurement System Connections](image)
2.7.1 Removing the 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 imprinted on the terminal board (see Figure 17 below) to assist in wiring the power and option card connections.

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

![Figure 17: Terminal Board with Imprinted Text (Three 4-20mA Input Option shown)
2.7.2 Cable Tie-Down Posts

There are two cable tie-down posts provided in the Sentinel LCT4 (see Figure 18 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 instrument power cable.
- **Optional I/O Cable Tie-Down Post** - Use this tie-down post to secure any other instrument I/O cables.

![Figure 18: Cable Tie-Down Posts Locations](image-url)
2.7.3 Wiring the Line Power

The Sentinel LCT4 may be ordered for operation with a power input of 100-240 VAC or 12–32 VDC. The label on the side of the electronics enclosure lists the required line voltage and power rating. The fuse size is listed in “Specifications” on page 10. Be sure to connect the Sentinel LCT4 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. Use the two remaining conduit inlets for other input/output cables as needed. All unused conduit inlets should be sealed with suitable blanking elements (see Figure 19 below).

![Figure 19: Conduit Inlet Ports](image)

See Figure 20 or Figure 21 on page 38 to locate terminal block TB1 and to connect the line power as follows:

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 19 above) and connect the line power leads to terminal block TB1, using the pin number assignments shown in Figure 34 on page 50 and Figure 20 or Figure 21 on page 38.

Attention European Customers! To meet CE Mark requirements, all cables must be installed as described in Appendix B, CE Mark Compliance.
2.7.3 Wiring the Line Power (cont.)

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

3. Run the AC power connections to the Power Terminal Block shown in Figure 20 below. The use of 12-18 AWG (3.3 - 0.82 mm$^2$) 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 35 on page 51 and Figure 20 or Figure 21 below.

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.
2.7.4 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 the EIA-RS Serial Communications Manual (916-054). The use of 12-24 AWG (3.3 - 0.2 mm²) twisted pair wiring is recommended for single conductors, and a minimum 18 AWG (1.5 mm²) is recommended for two conductors per terminal.

2.7.4a Wiring the Serial Interface

To wire the serial port, refer to Figure 35 on page 51 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.

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

2.7.5 Wiring the Modbus Communications Line (Optional)

The Sentinel LCT4 uses the RS485 interface with Modbus communications protocol for a maximum line distance up to 4000 ft (1200 m). GE recommends using shielded 18-24 AWG (0.82 - 0.2 mm²) 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 flowmeter. See Figure 17 on page 35, Table 11 on page 45 and Figure 35 on page 51.

Attention European Customers! To meet CE Mark requirements, all cables must be installed as described in Appendix B, CE Mark Compliance.
2.7.6 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 23 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 17 on page 35 and Figure 33 on page 49). For a wiring diagram see Figure 35 on page 51.

![Figure 23: Fail-Safe Operation](image)

The use of 12-24 AWG (3.3 - 0.2 mm²) is recommended for single conductor wiring, and 16-24 AWG (1.5 - 0.2 mm²) is recommended for two conductors per terminal.
2.7.7 **Wiring the 4-20mA Analog Input (Optional)**

1. Disconnect the main power to the flowmeter 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 33 on page 49* and wire the I/O terminal as indicated on the label inside the wiring access cover (see *Figure 17 on page 35* and *Figure 33 on page 49*). For a wiring diagram, see *Figure 35 on page 51*.

4. Secure the cable clamp.

**Attention European Customers!** To meet CE Mark requirements, all cables must be installed as described in Appendix B, *CE Mark Compliance*.

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, or two isolated 4-20mA analog inputs and one RTD input (designated Ain1, Ain2, Ain3 and RTD1). Each of the 4-20 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 LCT4, it will be necessary to know which input is assigned to which process parameter. This information should be entered in Appendix C, Data Records.*

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 24 on page 42* shows typical wiring diagrams, with and without an external power supply, for one of the analog inputs. *Figure 25 on page 42* shows 4-wire RTD 100 Ω input wiring. Wire the analog inputs as shown on the label in the enclosure side cover (see *Figure 17 on page 35* and *Figure 33 on page 49*). Terminal locations are shown in *Figure 26 on page 43* through *Figure 29 on page 44*.

The use of 12-24 AWG (3.3 - 0.2 mm²) is recommended for single conductor wiring, and 16-24 AWG (1.5 - 0.2 mm²) is recommended for two conductors per terminal.
2.7.7 Wiring the 4-20mA Analog Input (cont.)

**Figure 24: Analog Input Wiring Diagram**

**Figure 25: 4-Wire RTD Input Wiring Diagram**
2.7.7 Wiring the 4-20mA Analog Input (cont.)

Figure 26: Terminal Locations for 3 Analog Input Option

Figure 27: Terminal Locations for Analog Transmitter Use Cases
2.7.7 Wiring the 4-20mA Analog Input (cont.)

Figure 28: Terminal Locations for 2 Analog Input and 1 RTD Input Option

Figure 29: Terminal Locations for 4-Wire and 3-Wire RTD Use Cases

*You can wire to either RTN1 TB connection.
2.7.8 Wiring the Frequency/Totalizer Output

Figure 30 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.

![Wiring Diagrams](image)

**Figure 30: Totalizer and Frequency Output Wiring**

<table>
<thead>
<tr>
<th>I/O Pin #</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>F/T1+</td>
<td>Freq 1/Totalizer 1 OUT</td>
</tr>
<tr>
<td>F/T1−</td>
<td>Freq 1/Totalizer 1 RTN</td>
</tr>
<tr>
<td>F/T2+</td>
<td>Freq 2/Totalizer 2 OUT</td>
</tr>
<tr>
<td>F/T2−</td>
<td>Freq 2/Totalizer 2 RTN</td>
</tr>
<tr>
<td>NET R (+)</td>
<td>MODBUS-RTU RS232 (RI)/RS485 (+)</td>
</tr>
<tr>
<td>NET T (−)</td>
<td>MODBUS-RTU RS232 (T)/RS485 (−)</td>
</tr>
<tr>
<td>NET COM</td>
<td>MODBUS-RTU Common</td>
</tr>
</tbody>
</table>

Table 11: Wiring the TB2 I/O Terminal Block
2.7.9 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 mm²) twisted-pair wire for a single conductor, and 16-24 AWG (1.5 - 0.2 mm²) 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 flowmeter 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 34 on page 50, and wire the I/O terminal as indicated on the label inside the wiring access cover (see Figure 17 on page 35 and Figure 33 on page 49). For a wiring diagram see Figure 31 or Figure 32 below.

![Figure 31: Analog Output Passive Wiring](image)

![Figure 32: Analog Output Active Wiring](image)
2.7.9 Wiring the 4-20 mA Analog Output (cont.)

4. Secure the cable clamp.

**Attention European Customers!** To meet CE Mark requirements, all cables must be installed as described in Appendix B, CE Mark Compliance.

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

After the Sentinel LCT4 has been completely installed and wired, proceed to Chapter 3, *Operation*, to program the flowmeter.

**WARNING!** Make sure both covers, with their o-ring seals, are installed, and the set screws tightened, before applying power in a hazardous environment.
[no content intended for this page]
Figure 33: SEN898 Electronics Enclosure - Front Display and Wiring Access Cover
Figure 34: SEN898 Electronics Enclosure - Terminal Block Layout
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Sentinel™ LCT4 User's Manual

PANALINK RS232/485

- T  RECEIVE / DATA-
- R  TRANSMIT / DATA+

ANALOG OUTPUT

- AOUT+ 4-20mA POS TERMINAL
- AOUT- 4-20mA NEG TERMINAL

POWERED OR UNPOWERED SOFTWARE SELECTABLE

FREQUENCY/TOTALIZER OUTPUT

- F/T1+ OUTPUT1 SIGNAL
- F/T1- OUTPUT1 RETURN
- F/T2+ OUTPUT2 SIGNAL
- F/T2- OUTPUT2 RETURN

MODBUS / TCP CONNECTOR (NON-IS ONLY)

POWER CORD TERMINAL

AC OPTION:

- L1 LINE 1
- L2/N LINE 2/NEUTRAL
- G GROUND

USB CONNECTOR (NON-IS ONLY)

GROUNDING SCREWS FOR 2-WIRE SHIELDABLE CABLES (RECOMMENDED)

8-32 SCREW

DIGITAL INPUT

- Din+ TOTALIZER GATE SIGNAL
- Din RTN TOTALIZER GATE RETURN

ALARM CONNECTORS

ALM1:

- NO NORMALLY OPENED
- NC NORMALLY CLOSED
- COM COMMON

ALM2:

- NO NORMALLY OPENED
- NC NORMALLY CLOSED
- COM COMMON

MODBUS NETWORK RS232/485

- T  MODBUS (TRANSMIT / DATA -)
- R  MODBUS (RECEIVE / DATA +)
- COM MODBUS COMMON

(3) 3/4" NPT CABLE GLANDS PORTS

(CABLE ENTRY ON OPPOSITE SIDE OF ENCLOSURE)

(2) CABLE TIE DOWN POINTS

(3) ANALOG INPUTS OPTION (AAA)

- 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

(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

DC OPTION:

- + (+)
- - (-)
- GROUND

NOTES:

1. I/O CONNECTIONS WIRE GAUGE RANGE 12-24 AWG (3.3 - 0.2 mm ).
2. AC AND DC CONNECTIONS WIRE GAUGE RANGE 12-18 AWG (3.5 - .82 mm).
3. MAXIMUM TERMINAL RATINGS [VOLTAGE, CURRENT].

(±15VDC, 200mA)

SEE NOTES 1 & 3

(5VDC, 100mA)

SEE NOTES 1 & 3

(100VDC, 1A)

SEE NOTES 1 & 3

(264VAC, 0.82A)

SEE NOTES 2 & 3

(30VDC, 2A)

SEE NOTES 2 & 3

AC (120VAC, 5A)

DC (28VDC, 5A)

SEE NOTES 1 & 3

CUSTOMER GROUND

SEE NOTES 1 & 3

Figure 35: SEN898 Electronics - Wiring Diagram (ref. dwg #702-884)
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Sentinel™ LCT4 User's Manual

FLOW CELL (REAR VIEW)

FLOW CELL (TOP VIEW)

FLOW CELL (FRONT VIEW)

DUAL PLANE (3" & 4" FLOWCELL)

LOCAL MOUNT

FLOW PCB (VIEWED FROM BOTTOM)

INTERNAL CABLE, SINGLE, 4X 2X

INTERNAL CABLE W/FEEDTHRU, 4-WIRE

ENCLOSURE (VIEWED FROM TOP)

SEN898 ELECTRONICS

Figure 36: Interconnection Diagram - Dual Plane (3" & 4" Flowcell), Local Mount (ref. dwg. 702-1373, SH1)
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Sentinel™ LCT4 User's Manual

FLOW CELL (REAR VIEW)

FLOW CELL (TOP VIEW)

FLOW CELL (FRONT VIEW)

FEEDTHRU

INTERNAL CABLE, SINGLE, 4X

INTERNAL CABLE, SINGLE, 2X

SINGLE PLANE (6" - 24" FLOWCELL)

LOCAL MOUNT

FLOW PCB (VIEWED FROM BOTTOM)

INTERNAL CABLE W/FEEDTHRU, 4-WIRE

INTERNAL CABLE W/FEEDTHRU, 2-WIRE

ENCLOSURE (VIEWED FROM TOP)

SEN898 ELECTRONICS

Figure 37: Interconnection Diagram - Single Plane 6” - 24” Flowcell, Local Mount (ref. dwg. 702-1373, SH2)
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FLOW CELL (REAR VIEW)
ENTRY PORT
INTERNAL CABLE, SINGLE, 4X

FLOW CELL (FRONT VIEW)
FLOW PORT
PORT
PORT
PORT

DUAL PLANE (3" & 4" Flowcell)
REMOTE MOUNT

Figure 38: Interconnection Diagram - Dual Plane (3" & 4" Flowcell), Remote Mount (ref. dwg. 702-1373, SH3)
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ENTRY PORT

SINGLE PLANE (6" - 24" FLOWCELL)

REMOTE MOUNT

FLOW PCB

(VIEWED FROM BOTTOM)

INTERNAL CABLE,
8-WIRE

ENCLOSURE

(VIEWED FROM TOP)

SEN898 ELECTRONICS

REMOTE CABLE

FLOW CELL (REAR VIEW)

FLOW

FLOW CELL W/ADAPTER

(TOP VIEW)

INTERNAL CABLE,
SINGLE, 4X

INTERNAL CABLE,
SINGLE, 4X

FLOW CELL (FRONT VIEW)

PORT

PORT

PORT

PORT

Figure 39: Interconnection Diagram - Single Plane, (6" - 24" Flowcell), Remote Mount (ref. dwg. 702-1373, SH4)
Chapter 3. General Programming

3.1 Introduction

The Sentinel LCT4 flow transmitter includes a User Program that provides access to the various programmable features of the instrument. This chapter describes step-by-step programming instructions using the internal keypad, shown in Figure 40 below.

3.2 Keypad Features

The Sentinel LCT4 has seven keys: a Clear Totals key, four arrow keys, an Escape key, and an Enter key:

- Use the Escape key to open the main menu on the display. (If the main menu is locked, see “Unlocking and Locking” on page 59.)
- Use the arrow keys to navigate among menu choices and to increment/decrement numeric entries.
- Use the Escape key to cancel a numeric entry change, or exit a menu.
- Use the Enter key to accept a numeric entry or select a menu option.

Figure 40: Sentinel LCT4 Keypad
3.2.1 Indicator Lights

- If the **Fault Indicator** is lit, an instrument fault is detected. An error indication will be displayed in the lower right-hand corner of the Measurement View.

- 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 40 and *Inputs/Outputs* on page 72 for more information.

- The **Keypad Lock Indicator** will be lit if the Keypad Lock-Out Switch, internal to the instrument, has been engaged.

**Note:** *If the Keypad Lock Indicator is lit, the keypad will not be functional.*

- The **Total Lock Indicator** will be lit if the Totals Lock-Out Switch, internal to the instrument, has been engaged.

**Note:** *If the Total Lock Indicator is lit, totals are not able to be reset by the Clear Totals Key or through programming.*

- The **Power Indicator** is normally lit when the instrument is powered.

3.2.2 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 41* 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.

![Figure 41: Magnetic Stylus](image-url)
3.3 Program Menu Options

3.3.1 Channel Program

The Channel Program allows entry of configuration data for each physical channel, as well as settings adjustment. For the Channel Program setup, refer to “Channel Programming” on page 62.

3.3.2 Composite Program

The Composite Program allows entry of configuration data for the composite channel, as well as adjustment of settings, setup input and configuring API corrections. For the composite program setup, refer to “Composite Programming” on page 67.

3.3.3 Advanced Program

Note: The Advanced Program is accessible only to persons with Field Service, Factory or Engineering status.

3.4 Unlocking and Locking

To prevent unauthorized tampering with either the display or the user program, the Sentinel LCT4 has multiple security codes. After the security level has been set, one of these codes is required to change just the display (Display Lock), or the display and the user program (Full Lock).

3.4.1 Unlocking the Sentinel LCT4

To unlock the display and/or the user program:

1. Press [ESC], [ENT], [ESC]. A Security Check window, similar to Figure 42 below, appears.

![Figure 42: Security Check Window](image-url)
3.4.1 Unlocking the Sentinel LCT4 (cont.)

2. Using the arrow keys, change the code number to the value desired for your security level. The security passcodes can be configured under USER → EDIT PASSCODES when the user is logged in as User Admin.

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>SECURITY LEVEL</th>
<th>PASSCODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Full Lock</td>
<td>0000 (Fixed)</td>
</tr>
<tr>
<td>1</td>
<td>Display Locked</td>
<td>2719 (Fixed)</td>
</tr>
<tr>
<td>2</td>
<td>User 1</td>
<td>0001*</td>
</tr>
<tr>
<td>3</td>
<td>User 2</td>
<td>0002*</td>
</tr>
<tr>
<td>4</td>
<td>User 3</td>
<td>0003*</td>
</tr>
<tr>
<td>5</td>
<td>User 4</td>
<td>0004*</td>
</tr>
<tr>
<td>6</td>
<td>User Admin</td>
<td>0005*</td>
</tr>
<tr>
<td>7</td>
<td>Field Service</td>
<td>----</td>
</tr>
<tr>
<td>8</td>
<td>Factory</td>
<td>----</td>
</tr>
<tr>
<td>9</td>
<td>Engineering/Unlock</td>
<td>----</td>
</tr>
</tbody>
</table>

3. Press [ENT]. The display screen reappears, with the lock removed, partially unlocked, or lettered to represent the level. Security will remain at this level until you change the level in the user program, as described on the next page, or if it times out and returns to full lock.

3.4.2 Locking the Sentinel LCT4

The security level can be accessed in two ways.

From the display screen:

1. Press the [▶] or [◀] key, until the lock in the upper right corner is highlighted.
2. Press [ENT], and proceed to step 4 below.

From the User Program:

1. Press [ESC]. The Sentinel LCT4 enters the User Program.
2. Press the [▶] key until USER is bracketed.
3. Press the [▼] key until Set Security is highlighted. Press [ENT].
3.4.2 Locking the Sentinel LCT4 (cont.)

4. The screen shows the available options (depending on the current security level):
   - **Full Lock** – This will be the default level during meter power-up. Any User who wishes to access the menu will have to press the keys in the following combination (Escape-Enter-Escape) to unlock the meter with a “Valid Passcode”. The entered “Passcode” is validated and the user is allowed to access the menu based on privileges. The meter will go back to Full-Lock mode if no keypad activity is noted for a “Determined Time”. (Default is 2 min.)
   - **Display Locked** – This level can be achieved by entering a “Valid Passcode” assigned for this role. In this Mode/Level, the User has privilege only to view data. The User will be allowed to select the display parameters. Any other changeable parameter is denied access.
   - **User-1 / User-2** is basic user access.
   - **User-3 / User-4** is Power User access with additional privileges.
     - The User has to enter a “Valid Passcode” to have access to the menu attached to these roles. Users with these roles will have rights of Display Locked mode and some predetermined “write privilege” with which they may modify parameters (attached to these roles).
   - **User Admin** – This User will have “Administrator privilege” in addition to privileges of Lower level. This user is given the rights to change the “Passcode” for all user-levels. (This does not include Full Lock and Display Locked). The Administrator has the privilege to modify the timeout value, which is used to determine the time taken to switch back to Full Lock mode (if no keypad activity is noted). The “Administrator privilege” does not include access to Service or Factory Menu. The Administrator has no rights or control on Service/Factory/Engineering Levels or their “Passcodes”.
   - **Field Service** – This User has access to the “Service Menu” in addition to “Administrator privilege”. It is not accessible by User Admin.
   - **Factory** – This User has access to “Factory privilege” in addition to “Service privileges”. It is not accessible by User Admin.
   - **Engineering** – This User is the only user with Full access to the meter. It is not accessible by User Admin.

Scroll to the desired option and press [ENT] twice.

5. Press [ESC] to return to the User Program, or continue pressing [ESC] to return to the display screen. If you have chosen to fully lock the Sentinel LCT4, the screen appears similar to Figure 43 below, with a solid lock in the upper right corner. (For a meter with only the user program locked, the lock shows a keyhole in the center.)

![Figure 43: Screen with Locked Program](image-url)
3.5 Setting Security

3.5.1 Edit Passcodes

This User option is made available only to Security Levels of User-Admin, Field Service, Factory and Engineering (see Table 12 on page 60). On selection, the Passcodes for User-1 to User-4 and User-Admin can be modified. The Passcodes for Field Service, Factory, Engineering, Full-Lock and Program-Lock cannot be customized.

3.5.2 Security Timeout

This User option is made available only to Security Levels of User-Admin, Field Service, Factory and Engineering (see Table 12 on page 60). This option enables the Admin, Field Service, Factory and Engineering users to set a timeout period, after which the meter will switch back to Full-Lock mode, if no keypad activity is noted. The Timeout ranges from 1 minute to 60 minutes. The Security Timeout period set is applicable only for User-1 to User-Admin. For other Security Levels, the Timeout period is invalid. The default is 2 min.

3.5.3 Set Security

The User is allowed to set a security level below the current level.

3.6 Channel Programming

3.6.1 Activating a Channel/Path/CHX (Status)

Use the Status submenu of the PROG menu, to activate or deactivate a channel/path. The channel/path should be activated when the unit is received, however, it should be verified that the channel/path is active before data is acquired. While following the programming instructions, refer to Figure 66 on page 136. Remember to record all programmed data in Appendix C, Data Records.

To access the Status submenu:

1. Press [ESC]. The Sentinel LCT4 enters the User Program.
2. Press the [▲] key until PROG is bracketed in the top left corner and press [ENT].
3. Use the [▲] and [▼] keys to scroll to the desired channel and press [ENT]. The screen appears similar to Figure 44 below.
3.6.1 Activating a Channel/Path/CHX (Status) (cont.)

4. Press [ENT] to open the Status submenu as shown in Figure 45 below.

![Figure 45: The Status Menu](image)

5. The screen offers two options, ON and OFF. Use the [▲] and [▼] keys to scroll to the desired selection and press [ENT].

Note: On any menu, if you scroll to a different option, press [ENT] twice to select it (once to enter and again to confirm).

6. Press [ESC] (or [ENT] twice if you have selected the other option) to return to the channel menu.

After the above steps are completed, the user program returns to the PROG menu. Do one of the following:

- To program in other menus, refer to Appendix A, Menu Maps, to navigate to the desired menu.
- To leave the User Program, press [ESC] three times.

3.6.2 Entering Fluid Data (Not supported at this time)

The Fluid submenu enables selection of the Reynolds Correction factor. While following the programming instructions, see Figure 66 on page 136. Remember to record all programmed data in Appendix C, Data Records.

Note: From the PROG menu, proceed directly to Step 4. To select a different option, scroll to that option and press [ENT] twice to select it (once to enter and again to confirm the selection).

To access the Fluid submenu:

1. Press [ESC]. The Sentinel LCT4 enters the User Program.
2. Press the [▲] key until PROG is bracketed in the top left corner and press [ENT].
3. Use the [▲] and [▼] keys to scroll to the desired Channel and press [ENT].
4. Scroll to the Fluid submenu and press [ENT]. The word Reynolds appears.
3.6.2a Reynolds Correction Data

Reynolds Correction is a correction factor based on the Kinematic Viscosity and flow rate of the fluid. It is necessary, as the velocity of the fluid measured along a diametrical path must be related to the total area average velocity over the entire pipe cross-section. This factor should be ON in most applications, including all those that use clamp-on transducers. To access Reynolds Correction data:

1. From the Fluid window, select Reynolds and press [ENT]. The screen shows three options: Off, Single and Table.

2. Scroll to the desired option, and press [ENT]. The menu varies, depending on the selection in Step 1.
   - If Off is chosen, no further choices are available.
   - If Single is chosen, the Sentinel LCT4 will select and automatically display the Kinematic Viscosity. To change the value, press [ENT]. Use the arrow keys to change the value (available in document #914-004, Soundspeeds and Pipe Size Data), and press [ENT].
   - If Table is selected, the screen displays four options: Units, Rows Used, Edit Table and Reset Table.
     a. Select Units and press [ENT] and the screen displays two more options: Soundspeed and Diagnostic. Select Soundspeed and press [ENT] and the screen displays Meters/sec. Press [ESC] or [ENT] to return to the previous screen. Select Diagnostic and press [ENT] and the meter requests the type of signal to be used, Signal Up or Signal Dn. Scroll to the appropriate signal, and press [ENT].
     b. From the Unit Menu, select Rows Used and press [ENT]. Use the arrow keys to enter the desired number (from 2 to 20) and press [ENT].
     c. Select Edit Table and press [ENT], and the table opens with a series of rows. Scroll to the desired row, and press [ENT].
     d. For each row, the screen displays the Reynolds Correction number (X) and the Kinematic Viscosity (KV). If you wish to change either value, scroll to the value and press [ENT]. Use the arrow keys to change the value (available in Soundspeeds and Pipe Size Data, document #914-004), and press [ENT].
     e. Repeat steps c and d until all available data (from 2 to 20 rows) has been programmed.
     f. Press [ESC] to return to the PROG menu, or continue pressing [ESC] until the display screen reappears.
     g. To confirm changes to the table, from the Unit Menu, select Reset Table... and press Enter. To reset the table select Yes and press Enter. To not reset the table, select No and press Enter.
### 3.6.3 Entering Signal Parameters

In the Signal submenu, set parameters that affect the transducer signal:

> **CAUTION!** The SIGNAL default settings are suitable for most applications. Consult the factory before changing any of these settings.

**Note:** *Under Channel Programming, the only signal parameter that can be changed is Zero Cutoff.*

While following the programming instructions, refer to Figure 66 on page 136.

**Note:** *From the PROG menu, proceed directly to Step 4. To select a different option, scroll to that option and press [ENT] twice to select it (once to enter and again to confirm the selection).*

To enter the Signal submenu:

1. Press [ESC]. The **Sentinel LCT4** enters the User Program.
2. Press the [▶] key until PROG is bracketed and press [ENT].
3. Use the [▲] and [▼] keys to scroll to the desired Channel and press [ENT].
4. Scroll to the Signal option and press [ENT].
5. The prompt requests the Zero Cutoff. Near “zero” flow, the **Sentinel LCT4** may have fluctuating readings due to small offsets (caused by factors such as thermal drift in the fluid). The zero cutoff causes velocity measurements less than the cutoff to be reported as zero. To set the cutoff, press [ENT], and use the arrow keys to enter the new value. Press [ENT] to confirm the entry.

Entering parameters in the Signal option has been completed. Press [ESC] to return to the PROG menu, or continue pressing [ESC] until the display screen reappears.

### 3.6.4 Entering Error Limits

The Error Limits option enables setting limits for an incoming signal. When the signal falls outside the programmed limits, an error indication appears on the display screen. To set error limits, follow the steps below.

**Note:** *From the PROG menu, proceed directly to Step 4. To select a different option, scroll to that option and press [ENT] twice to select it (once to enter and again to confirm the selection).*

1. Press [ESC]. The **Sentinel LCT4** enters the User Program.
2. Press the [▶] key until PROG is bracketed in the upper left corner and press [ENT].
3. Use the [▲] and [▼] keys to scroll to the desired Channel and press [ENT].
3.6.4 Entering Error Limits (cont.)

4. Scroll to the Error Limits option and press [ENT].

5. The first prompt requests the Min Signal limit for the transducer signal received by the Sentinel LCT4. The E1:LOW SIGNAL error message appears if the signal strength falls below the limit programmed here. Press [ENT]. Use the arrow keys to change the value and press [ENT].

6. Repeat the steps above for the Max Signal limit.

7. The next prompt calls for the Min Velocity limit. Press [ENT]. Use the arrow keys to change the value and press [ENT].

8. Repeat the steps above to change the Max Velocity limit. (The E3:VELOCITY RANGE error message appears if the velocity falls outside the minimum and maximum limits.)

9. The meter now requests the Min Amplitude, the lower limit for the amplitude discriminator. The discriminator measures the size of the transducer signal sent from the Sentinel LCT4. If the signal falls outside these limits, the E5:AMPLITUDE error message appears. Press [ENT]. Use the arrow keys to change the value and press [ENT].

10. Repeat these steps for the Max Amplitude, the upper limit for the discriminator.

11. The next prompt calls for the acceptable Soundspeed limits, based on conditions in the particular system. The E2:SOUNDSPEED error message appears if the fluid soundspeed exceeds that entered in the Fluid submenu by more than this percentage. Press [ENT]. Use the arrow keys to change the percentage and press [ENT].

12. The next prompt requests the Acceleration limit for detecting cycle skipping. The E6:ACCELERATION error message appears if the velocity changes by more than this limit from one reading to the next. Press [ENT]. Use the arrow keys to change the value and press [ENT].

13. The final prompt requests the SNR signal for warning about poor signal-to-noise ratio. The E24:SNR error message appears if the SNR is below the programmed limit. Press [ENT]. Use the arrow keys to change the value and press [ENT].

You have finished entering data in the PROG menu. Do one of the following:

- To program in other menus, refer to Appendix A, Menu Maps, to navigate to the desired menu.
- To return to the display screen, press [ESC] until the display screen reappears.
- To configure the display, proceed to the next chapter.
3.7 Composite Programming

Under the PROG menu, select Composite... and press [ENT].

3.7.1 Entering Fluid Type

1. Scroll to Fluid Type and press [ENT]. Two other options appear, Normal and Tracking. Tracking refers to Tracking Windows, which are used to detect the receive signal when you are unsure of the fluid soundspeed, or when the fluid soundspeed changes drastically under process conditions.

2. Scroll to the desired option and press [ENT].

3. Make a selection between Preprogrammed and Other fluids. Scroll to the desired option, and press [ENT].
   - For Normal fluids, the expected fluid Temperature can be programmed. Scroll to the Temperature option and press [ENT]. Then use the arrow keys to enter the process temperature, and press [ENT].
   - For fluids monitored with a Tracking Window, the meter enables the selection of Water (up to 100° or 260°C) or Oil. Scroll to the desired listing and press [ENT].

4. The menu now varies, depending on the selections in steps 6 and 7.
   - If Preprogrammed Fluids has been selected, the Sentinel LCT4 supplies a list of preprogrammed fluids. As shown in Table 13 below, the list varies, depending on whether you have selected normal or tracking window fluid types. In either case, scroll to the desired fluid and press [ENT].
   - If Other was selected, the Sentinel LCT4 requests the fluid soundspeed (for Normal fluids) or minimum and maximum soundspeed (for Tracking Window fluids). In either case, scroll to the Soundspeed option and press [ENT]. Use the arrow keys to enter the appropriate soundspeed, and press [ENT].

5. Press the [ESC] key to return to the Fluid Type window.

<table>
<thead>
<tr>
<th>Table 13: Preprogrammed Fluid Types</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tracking Windows Off</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Water (0-260°C)</td>
</tr>
<tr>
<td>Sea Water</td>
</tr>
<tr>
<td>Oil (22°C)</td>
</tr>
<tr>
<td>Crude Oil</td>
</tr>
</tbody>
</table>
Chapter 3. General Programming

3.7.2 Entering Signal Parameters

CAUTION! The SIGNAL default settings are suitable for most applications. Consult the factory before changing either of these settings.

In the Signal submenu, set parameters that affect the transducer signal:

- Error Allowed
- Compensation Status (additional option)

While following the programming instructions, refer to Figure 66 on page 136.

Note: From the COMPOSITE menu, proceed directly to Step 4. To select a different option, scroll to that option and press [ENT] twice to select it (once to enter and again to confirm the selection).

To enter the Signal submenu:

1. Press [ESC]. The Sentinel LCT4 enters the User Program.
2. Press the [▼] key until PROG is bracketed and press [ENT].
3. Use the [▲] and [▼] keys to scroll to Composite and press [ENT].
4. Scroll to the Signal option and press [ENT].
5. Select Error Allowed, press [ENT], use the arrow keys to enter the new value, and press [ENT] to confirm the entry.
6. If Dimensional Compensation is an included option, at the next parameter, Compensation Status, the screen shows the two options, On or Off. Scroll to the desired option, and press [ENT].

Entering parameters in the Signal option has been completed. Press [ESC] to return to the PROG menu, or continue pressing [ESC] until the display screen reappears.
3.7.3 Setting Up Input Data Feeds

In the Inputs submenu, set the status for three types of inputs:

- Temperature
- Pressure
- Density

To set up the desired inputs, complete the following steps:

1. From the COMPOSITE menu, select Inputs, and press [ENT]. The next screen lists three types of inputs: Temperature, Pressure, and Density.

2. Select the input to be changed and press [ENT]. The input status is described by two options: Fixed or Active.


4. To set a different value, use the arrow keys to change the digits, and press [ENT].

5. To experience an active input, select Active, and press [ENT]. Press [ESC] to return to the previous menu.

3.7.4 Setting Up API (Additional Option)

In the API Setup submenu, set the table types and conditions for several API options:

1. If the API option is included, from the COMPOSITE menu, select API Setup, and press [ENT]. The next screen displays API Table Type and API Conditions.

3.7.4a API Table Type

1. Select API Table Type and press [ENT]. The next screen displays four table types: Table A-Crude or JP, Table B-Gen Product, Table C-User Def TE, and Table D-Lubricants.

2. For Tables A, B and D, select a specific table, press [ENT], and the screen returns to the API Setup menu.

3. Select Table C, press [ENT], and the Thermal Exp Coeff screen appears. To change the coefficient, press [ENT]. On the next screen, use the arrow keys to change the digits, and press [ENT] to save the change, or [ESC] to reject the change. The screen returns to the previous display. Press [ESC] twice to return to the API Setup display.
3.7.4b API Conditions

1. Select API Conditions. Press [ENT]. The next screen displays two options: Base Condition and Flow Measure At...

2. Select Base Condition and press [ENT]. The next screen displays four options: 60°, 20°, 15° and User Defined... Select a given temperature or define a new one.

3. To establish a new base temperature, select User Defined, press [ENT], and the User Def Base Temp screen appears. Press [ENT], and the User Defined temperature is able to be changed.

4. Using the arrow keys, change the appropriate digits, and press [ENT]. Press [ESC] twice and return to the APIcond screen.

5. Select Flow Measure At... and press [ENT]. A screen appears listing two options: Observed and Alternate...

6. To measure at Observed, select Observed and press [ENT]. Two settings appear: Temp(alt) and Pres(alt).

7. To change either alternate condition, select the option, and press [ENT].

8. Using the arrow keys, change the appropriate digits, and press [ENT].

9. Change the other alternate condition if needed, and press [ESC] to return to the Flow Measurement At... screen.

10. To measure at Alternate, select Alternate and press [ENT]. Three settings appear: Temp(obs), Pres(obs), and Dens(obs).

11. To change an observed condition, select the option, and press [ENT].

12. Using the arrow keys, change the appropriate digits, and press [ENT].

13. Change the other observed conditions if needed, and press [ESC] four times to return to the PROG menu.
3.8 **Configuration**

To configure your Sentinel meter, proceed as follows:

1. From the main menu, use the right arrow key to scroll to **CONFIG**. There are five options: Units, Communication, Reset Totals, Totalizer Errors and Date/Time. Use the arrow keys to select an option to be configured.

2. To choose a measurement type, select **Units**, and press [ENT]. The screen displays Metric and English. Select one, press [ENT] and the screen returns to the **CONFIG** menu.

3. To choose a communication type, select **Communication** and press [ENT]. The screen displays three options: Panalink, Modbus (if option is included) and HART.

4. Select the desired communication software, press [ENT], and set up the components by making the appropriate selections from each list of options.

5. To reset the totals, from the **CONFIG** menu, select **Reset Totals** and press [ENT].

   **Note:** *If the totalizer lock is enabled, the previous totals will not be cleared.*

   a. Select a **Channel**, the **Composite** setup, or **All**, and press [ENT].
   
   b. From the next menu, select whether to reset the forward total, the reverse total, or both, and press [ENT].
   
   c. Press [ESC] to return to the **CONFIG** menu.

6. To set up error handling, from the **CONFIG** menu, select **Totalizer Errors**, and press [ENT].

   a. Select a **Channel** or the **Composite** setup and press [ENT].
   
   b. Answer the question, **Totalize on Error?**, by selecting **Yes** or **No**. Then press [ENT].
   
   c. Repeat the process for other channels, if necessary, and press [ESC] to return to the **CONFIG** menu.

7. To reset the date and/or time, from the **CONFIG** menu, select **Date/Time**, and press [ENT].

   a. Press [ENT] again to edit the text.
   
   b. Use the arrow keys to select and change numbers in the date/time format.
   
   c. Press [ENT] to accept the change.
3.9 Inputs/Outputs

From the main menu, use the arrow keys to scroll to IO to display the five available options:

- Analog Outputs
- Freq/Totals
- Alarms
- Slot 1
- Slot 2

**Note:** From the IO menu, proceed directly to Step 3. To select a different option, scroll to that option and press [ENT] twice to select it (once to enter and again to confirm the selection).

Refer to Figure 69 on page 139 or Figure 70 on page 140. To enter the IO Menu, proceed as follows:

1. Press [ESC]. The Sentinel LCT4 enters the User Program.
2. Press the [>] key until IO is bracketed and press [ENT].
3. Use the [\^] and [V] keys to scroll to wanted IO option.
3.9.1 Analog Output

To program an analog output, proceed as follows:

1. Select Analog Output to bring you to the menu.
2. Select Status. Select Off to disable output or On to enable output.
3. Select the Channel of the data source you want to output.
4. Select the Publisher you want to output.
5. Select the Units for the Publisher output.
6. Enter a value for the Base (low end) of the chosen output range that corresponds to a 4mA output.
7. Enter a value for the Span (high end) of the chosen output range that corresponds to a 20mA output.
8. Choose the Error Level, the way the output will respond during an error condition:

<table>
<thead>
<tr>
<th>Option</th>
<th>Output Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hold Value</td>
<td>Holds the last “good” reading.</td>
</tr>
<tr>
<td>Force Hi (20mA)</td>
<td>Forces Output to 20mA.</td>
</tr>
<tr>
<td>Force Lo (4mA)</td>
<td>Forces Output to 4mA.</td>
</tr>
<tr>
<td>Force HH</td>
<td>Forces Output to 21mA</td>
</tr>
<tr>
<td>Force LL</td>
<td>Forces Output to 3.8mA</td>
</tr>
<tr>
<td>Force Value</td>
<td>Enables the user to enter a value between 4mA and 20mA, to be output during an error.</td>
</tr>
</tbody>
</table>

9. Select Mode, either Passive or Active. Passive requires an external power supply, while Active is internally powered by the electronics.

3.9.2 Frequency/Totalizers

To program a Frequency/Totalizer output, proceed as follows:

1. Select Freq/Totals to bring you to the menu.
2. Select Linked or Independent

Note: *If you select Linked, both outputs will be setup the same, just 90° out of phase. If you select Independent, you will set up each output separately.*

3. Select Freq/Total #1.
   a. Status-Select On or Off
   b. Mode-Select Frequency or Totalizer
   c. Drive Ctl-Select Open Drain or Push-Pull
3.9.2a Frequency Output

To program a Frequency output, proceed as follows:

1. Units - Choose the channel, parameter and units to output.
2. Fbase - Enter the lowest value of the Frequency range you want to output.
3. Fspan - Enter the highest value of the Frequency range you want to output.
4. Value\(\text{min}\) - Enter the value of the parameter you want to correspond to the min. value of the frequency range.
5. Value\(\text{max}\) - Enter the value of the parameter you want to correspond to the max. value of the frequency range.
6. Choose the Error Level, the way the output will respond during an error condition. Choose Force LO, Force HI, Hold Last, or Force Value. When the meter goes into Error, the chosen Error level will be output through the Frequency Output:

<table>
<thead>
<tr>
<th>Option</th>
<th>Output Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Force Lo</td>
<td>Forces Output to Fbase.</td>
</tr>
<tr>
<td>Force Hi</td>
<td>Forces Output to Fspan.</td>
</tr>
<tr>
<td>Hold Last</td>
<td>Holds the last “good” reading.</td>
</tr>
<tr>
<td>Force Value</td>
<td>Enables the user to enter a value between the Frequency Range, to be output during an error.</td>
</tr>
</tbody>
</table>

3.9.2b Totalizer

To program a Totalizer output, proceed as follows:

1. Units - Choose the channel, parameter and units to output
2. Unit/Pulse - Choose how many units of the chosen parameter are accumulated until a pulse is sent out.
3. Pulse Width - Choose the length of each pulse output.

Note: Make sure the meter is not going to be outputting more than one pulse during this time, as this could lead to missed pulses.

4. Polarity - Choose the Negative or Positive edge of the pulse.
3.9.3 Alarms

To program an alarm output, proceed as follows:

1. Select Status, and choose either OFF, Normal, or Failsafe.
   a. OFF - Disables alarm functionality.
   b. Normal - Selection for conventional operation.
   c. Failsafe - Selection for fail-safe operation.

2. If Normal or Failsafe has been chosen, select Type and program the following parameters:
   a. Level
      Units - Defines the Unit of Measure for the alarm.
      Trip Point - Defines the level where the alarm trips.
      Dead Band - Defines the amount past the trip point where the alarm resets.
      Trip Direction - Defines the alarm trip direction, above the set Trip Point or below the set Trip Point.
      Error Level -
         Reset - Reset would force the alarm state to reset on error or fault condition. Reset would be such that NO would be NO, unless configured for failsafe.
         Trip - Trip would force the alarm to Trip direction on error or fault condition.
         Hold Last - Hold Last would hold the current state of the alarm on an error or fault condition.
   b. Direction
      The alarm can be tripped on forward or reverse flow. It uses volumetric in m³/s. The alarm will look for a positive or negative change in this flow reading.
   c. Fault Alarm
      Trips the alarm on a particular fault, such as E1 or E2. The alarm can be configured for individual faults, all faults or flow faults.

3. Choose Latch State
   a. Latch - Enables the alarm to hold its state. This selection causes the User Intervene Indicator to be lit when an alarm occurs.
   b. No Latch - The alarm is reset when the error condition clears.
   c. Clear Latch - Changes the latched state. This will turn off the User Intervene Indicator if the meter is no longer in error.
3.9.4 Analog Inputs (Additional Option)

If an option card is installed, Analog Inputs are available to the user and may be configured as follows:

1. Select the appropriate Slot for the Option Card.
2. Select the Ain item that you want to set up.
3. Enter a Value for the Label if you want it changed.
4. Select Mode and choose Off to turn off the input, or choose Temperature, Pressure or Density to set it up as one of those inputs.
   a. Choose the Units for the input.
   b. Enter the Base (low end) of the input.
   c. Enter the Span (high end) of the input.
5. Select Cal to Trim the inputs.

If a Calibration is not going to be performed, load nominal calibration values by selecting Reset Trim. This will enable 4-20 mA to be read with undetermined accuracy. However, to meet the Sentinel LCT4 accuracy specifications, a proper calibration must be performed as follows:

- Make sure the inputs are wired correctly, according to Figure 35 on page 51.
- Set the input to 4mA, for the Low end.
- Select Trim Base.
- Select Yes.
- Set the input to 20mA, for the High end.
- Select Trim Span.
- Select Yes.
- Calibration is complete.
3.9.5 RTD (Additional Option)

If an option card is installed, an RTD input may be available to the user, depending on the option card ordered. If the output is available, configure it as follows:

1. Select the appropriate Slot for the Option Card.
2. Select the Temp(RTD) option.
3. Enter in a Value for the Label if you want it changed.
4. Select Mode and choose Off to turn off the input, or choose Temperature and select the input Temperature units.
5. Select CAL.
   a. Make sure the RTD is connected to the terminal board correctly, according to Figure 35 on page 51.
   b. The GE Sensing calibration process involves using a temperature bath and an iRTD (reference).
   c. The iRTD is connected to iRTD Win Software to read the values.
   d. The Meter is set up to display 1C:RTD.
   e. Under IO/Slot 1/1C:Temp(RTD)/Mode choose temperature and enter in the right units.
   f. A 2 to 5 point calibration is allowed with Sentinel LCT4.
      • Cal points must be entered with the lowest temperature starting at setpoint #1, and in increasing order to the highest setpoint.
      • Cal points must be performed over the full range to be measured. Temperatures that are out of the calibrated range (not on or between the highest and lowest setpoints) will not have calibration information applied to them and will not be corrected. “Falling off of the cal range,” or increasing the temperature beyond the last setpoint could cause data to be discontinuous.
      • Empty locations in the calibration table should be filled with the value “0”.
   g. The Setpoint is the actual temperature that you are trying to read.
   h. The Offset is the temperature the meter is reading from the probe minus the reference reading.
   i. Run all points with the values set to 0, and then fill them in when all cal points are complete.
6. Select Reset Table if you want to reset all Calibration Entries back to 0.
Chapter 3. General Programming

3.10 Display

To configure the display, proceed as follows:

1. From the main menu, use the arrow keys to scroll to DISP. The screen displays four options: Views, Contrast, Backlight, and Mode. Use the arrow keys to select an option to be configured.

2. To set up display Views, select it, and press [ENT]. 1 View and 2 Views appear as options.

3. Move through the categories and set up each view as desired. Press [ESC] to return to the DISP menu.

4. To change the display Contrast, select it, and press [ENT]. Using the arrow keys, change the percentage digits as desired, and press [ENT]. The screen returns to the DISP menu.

5. To change the display Backlight, select it, and press [ENT]. Using the arrow keys, change the percentage digits as desired, and press [ENT]. The screen returns to the DISP menu.

6. To change the display Mode, select it, and press [ENT]. Select Normal or Reverse and press [ENT]. The screen returns to the DISP menu.

3.11 Calibration of Analog Output

To calibrate the analog output, proceed as follows:

1. Connect the Analog Output to an ammeter.

2. From the main menu, use the arrow keys to scroll to CAL. The screen displays one option: 4-20 Loop. Press [ENT] and four categories appear: Base Trim, Span Trim, Percent and Mode.

3. Select Mode, press [ENT], and select Test (Trim).

4. Set the percentage to 0% and press [ENT].

5. Select Base Trim, press [ENT], and using the arrow keys, enter what the ammeter is reading.

6. Set the percentage to 100% and press [ENT].

7. Select Span Trim, press [ENT], and using the arrow keys, enter what the ammeter is reading.

8. Go to Mode and select Normal.

9. Calibration of the 4-20mA Output Loop is complete.
3.12 User Security

From the main menu:

1. Use the arrow keys to scroll to USER.

3.12.1 Edit Passcodes

This User option is made available only to Security Levels of User-Admin, Field Service, Factory and Engineering (see Table 12 on page 60). On selection, the Passcodes for User-1 to User-4 and User-Admin can be modified. The Passcodes for Field Service, Factory, Engineering, Full-Lock and Program-Lock cannot be customized.

To enter or edit user passcodes:

1. Select Edit Passcodes, and press [ENT].
2. Select the USER/ADMIN number to be added or changed, and press [ENT].
3. Use the arrow keys to add or change the appropriate digits, and press [ENT].

3.12.2 Security Timeout

This User option is made available only to Security Levels of User-Admin, Field Service, Factory and Engineering (see Table 12 on page 60). 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 noted. The programmed Security Timeout period is applicable only for User-1 to User-Admin. For other Security Levels, the Timeout period is invalid. To change the Security Timeout, proceed as follows:

2. Use the arrow keys to change the appropriate digits, and press [ENT].

3.12.3 Set Security

The User is allowed to set a security level below the current level. To set or change the security level:

2. The screen lists ten options: Full Lock, Display Locked, User1, User2, User3, User4, User Admin, Field Service, Factory, and Engineering. Select the desired level of security and press [ENT].
3.13 Factory Status

To access the Factory Status menu, proceed as follows:

1. From the main menu, use the arrow keys to scroll to FACTORY. The screen displays five options: Versions, Default Meter, Upgrade, System Info, and Tag.

2. To set the version type, select Versions, and press [ENT]. The screen displays two options: Main and Option Cards.

3. Select Main, and press [ENT], and the screen displays Version Info. Press [ESC] and the screen returns to the Versions menu.

4. Select Option Cards, and press [ENT], and the screen displays Option Card Version Info. Press [ESC] and the screen returns to the Versions menu. Press [ESC] to return to the FACTORY menu.

**IMPORTANT:** Do not return the meter to the factory default settings without first consulting GE.

5. To return the meter to the default settings, from the FACTORY menu, select Default Meter and press [ENT]. Select Yes to confirm or No to cancel, and press [ENT]. The screen returns to the FACTORY menu.

**IMPORTANT:** Do not upgrade the meter code without first consulting GE.

6. To upgrade the meter code, from the FACTORY menu, select Upgrade, and press [ENT]. Select Yes to confirm or No to cancel, and press [ENT]. The screen returns to the FACTORY menu.

7. To access system information, select System Info, and press [ENT]. The screen displays DATE/TIME and UpTime. Press [ESC] to return to the FACTORY menu.

8. To change the Tag, select the given name, and press [ENT]. Use the arrow keys to change the letters to the new name Tag. When complete, press [ENT], and the screen returns to the FACTORY menu.
Chapter 4. MODBUS Communications

4.1 Introduction

The Sentinel LCT4 supports digital communications using the MODBUS/RTU protocol, with 2-wire RS-485 or 3-wire RS-232C as the physical layer. Data rate can be specified from 4800 to 19,200 bits per second (bps), with selectable parity, and number of stop bits (Default = 9600, Even, 1 Stop Bit)

4.2 Setting Up MODBUS Communications

1. To set up MODBUS Communications, from the main screen, use the arrow keys to scroll to [CONFIG]. Select Communication and press ENTER, select Modbus and press ENTER.

2. Address: To change the MODBUS address, use the arrow keys to select Address and press [ENT]. Use the arrow keys to change the address number, and press [ENT] to save the change, or [ESC] to reject it. The screen returns to the CONFIG menu. The allowable address range is 1 to 255.

3. Interface: To set the interface to be used, from the CONFIG menu select Interface and press [ENT]. Two options appear: RS232 and RS485. Use the arrow keys to select the appropriate interface, and press [ENT]. The screen returns to the CONFIG menu.

4. WordOrder: To set the word order, from the CONFIG menu select WordOrder and press [ENT]. Two options appear: LowWordFirst and HighWord First. Use the arrow keys to select the appropriate order, and press [ENT]. The screen returns to the CONFIG menu.

5. Baud Rate: To set the baud rate, from the CONFIG menu select Baud Rate and press [ENT]. Three options appear: 4800, 9600 and 19200. Use the arrow keys to select the appropriate option, and press [ENT]. The screen returns to the CONFIG menu.

6. Parity: To set the parity, from the CONFIG menu select Parity and press [ENT]. Three options appear: None, Even and Odd. Use the arrow keys to select the appropriate option, and press [ENT]. The screen returns to the CONFIG menu.

Note: Considering several possible units are available for volumetric and totalizer output registers, a selection must be made to assign the conversion.

7. Volumetric: To set the volumetric measurement, from the CONFIG menu select Volumetric and press [ENT]. Twelve options appear. Use the arrow keys to select the appropriate measurement type, and press [ENT]. The screen returns to the CONFIG menu.
4.2 Setting Up MODBUS Communications (cont.)

8. **Total Units:** To set the total units measurement, from the CONFIG menu select **Total Units**, and press [ENT]. Four options appear: M³, Liters, Hectare-cm and Hectare-m. Use the arrow keys to select the appropriate measurement type, and press [ENT]. The screen returns to the CONFIG menu.

9. **StdVolumetric:** To set the standard volumetric measurement, from the CONFIG menu select **StdVolumetric** and press [ENT]. Twelve options appear. Use the arrow keys to select the appropriate measurement type, and press [ENT]. The screen returns to the CONFIG menu.

10. **StdTotal Units:** To set the standard total units measurement, from the CONFIG menu select **StdTotal Units**, and press [ENT]. Four options appear: M³, Liters, Hectare-cm and Hectare-m. Use the arrow keys to select the appropriate measurement type, and press [ENT]. The screen returns to the CONFIG menu.

Modbus communications are now set up and ready to use (refer to Table 14 below).

<table>
<thead>
<tr>
<th>Category</th>
<th>Measurement</th>
<th>Type</th>
<th>Size Format</th>
<th>Composite Register Address</th>
<th>Channel 1 Register Address</th>
<th>Channel 2 Register Address</th>
<th>Channel 3 Register Address</th>
<th>Channel 4 Register Address</th>
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1Correction factor for the effect of Temperature on the Liquid.
2Correction factor for the effect of Pressure on the Liquid.
3Correction factor for the effects of Temperature and Pressure on the Liquid, a.k.a. “full VCF,” is product of CTL and CPL.
### Table 14: Modbus Register Map (cont.)

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<thead>
<tr>
<th>Category</th>
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<th>Size Format</th>
<th>Composite Register Address</th>
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<td>4371 0X1112</td>
</tr>
<tr>
<td></td>
<td>REV Mass Register 1</td>
<td>L</td>
<td>2 LSW float</td>
<td>277 0x0114</td>
<td>1301 0X0514</td>
<td>2325 0X0914</td>
<td>3349 0X0D14</td>
<td>4373 0X1114</td>
</tr>
<tr>
<td></td>
<td>REV Mass Register 2</td>
<td>L</td>
<td>2 LSW float</td>
<td>279 0x0116</td>
<td>1303 0X0516</td>
<td>2327 0X0916</td>
<td>3351 0X0D16</td>
<td>4375 0X1116</td>
</tr>
<tr>
<td></td>
<td>FWD Energy Register 0</td>
<td>L</td>
<td>2 LSW float</td>
<td>281 0x0118</td>
<td>1305 0X0518</td>
<td>2329 0X0918</td>
<td>3353 0X0D18</td>
<td>4377 0X1118</td>
</tr>
<tr>
<td></td>
<td>FWD Energy Register 1</td>
<td>L</td>
<td>2 LSW float</td>
<td>283 0x011A</td>
<td>1307 0X051A</td>
<td>2331 0X091A</td>
<td>3355 0X0D1A</td>
<td>4379 0X111A</td>
</tr>
<tr>
<td></td>
<td>FWD Energy Register 2</td>
<td>L</td>
<td>2 LSW float</td>
<td>285 0x011C</td>
<td>1309 0X051C</td>
<td>2333 0X091C</td>
<td>3357 0X0D1C</td>
<td>4381 0X111C</td>
</tr>
<tr>
<td></td>
<td>REV Energy Register 0</td>
<td>L</td>
<td>2 LSW float</td>
<td>287 0x011E</td>
<td>1311 0X051E</td>
<td>2335 0X091E</td>
<td>3359 0X0D1E</td>
<td>4383 0X111E</td>
</tr>
<tr>
<td></td>
<td>REV Energy Register 1</td>
<td>L</td>
<td>2 LSW float</td>
<td>289 0x0120</td>
<td>1313 0X0520</td>
<td>2337 0X0920</td>
<td>3361 0X0D20</td>
<td>4385 0X1120</td>
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</table>
### Table 14: Modbus Register Map (cont.)

<table>
<thead>
<tr>
<th>Category</th>
<th>Measurement</th>
<th>Type</th>
<th>Size</th>
<th>Format</th>
<th>Channel 1</th>
<th>Channel 2</th>
<th>Channel 3</th>
<th>Channel 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Totals (scientific notation)</td>
<td>REV Energy Register 2</td>
<td>L</td>
<td>2 LSW float</td>
<td>291 0x0122</td>
<td>1315 0x0522</td>
<td>2339 0x0922</td>
<td>3363 0x0D22</td>
<td>4387 0X1122</td>
</tr>
<tr>
<td></td>
<td>Totl. Time days&lt;sup&gt;a&lt;/sup&gt;</td>
<td>L</td>
<td>2 LSW float</td>
<td>293 0x0124</td>
<td>1317 0x0524</td>
<td>2341 0x0924</td>
<td>3365 0x0D24</td>
<td>4389 0X1124</td>
</tr>
<tr>
<td></td>
<td>Totl. Time seconds</td>
<td>L</td>
<td>2 LSW float</td>
<td>295 0x0126</td>
<td>1319 0x0526</td>
<td>2343 0x0926</td>
<td>3367 0x0D26</td>
<td>4391 0X1126</td>
</tr>
<tr>
<td></td>
<td>STD FWD Total Register 0</td>
<td>L</td>
<td>2 LSW float</td>
<td>297 0x0128</td>
<td>1321 0x0528</td>
<td>2345 0x0928</td>
<td>3369 0x0D28</td>
<td>4393 0X1128</td>
</tr>
<tr>
<td></td>
<td>STD FWD Total Register 1</td>
<td>L</td>
<td>2 LSW float</td>
<td>299 0x012A</td>
<td>1323 0x052A</td>
<td>2347 0x092A</td>
<td>3371 0x0D2A</td>
<td>4395 0X112A</td>
</tr>
<tr>
<td></td>
<td>STD FWD Total Register 2</td>
<td>L</td>
<td>2 LSW float</td>
<td>301 0x012C</td>
<td>1325 0x052C</td>
<td>2349 0x092C</td>
<td>3373 0x0D2C</td>
<td>4397 0X112C</td>
</tr>
<tr>
<td></td>
<td>STD REV Total Register 0</td>
<td>L</td>
<td>2 LSW float</td>
<td>303 0x012E</td>
<td>1327 0x052E</td>
<td>2351 0x092E</td>
<td>3375 0x0D2E</td>
<td>4399 0X112E</td>
</tr>
<tr>
<td></td>
<td>STD REV Total Register 1</td>
<td>L</td>
<td>2 LSW float</td>
<td>305 0x0130</td>
<td>1329 0x0530</td>
<td>2353 0x0930</td>
<td>3377 0x0D30</td>
<td>4401 0X1130</td>
</tr>
<tr>
<td></td>
<td>STD REV Total Register 2</td>
<td>L</td>
<td>2 LSW float</td>
<td>307 0x0132</td>
<td>1331 0x0532</td>
<td>2355 0x0932</td>
<td>3379 0x0D32</td>
<td>4403 0X1132</td>
</tr>
<tr>
<td></td>
<td>Std Totl. Time days&lt;sup&gt;a&lt;/sup&gt;</td>
<td>L</td>
<td>2 LSW float</td>
<td>309 0x0134</td>
<td>1333 0x0534</td>
<td>2357 0x0934</td>
<td>3381 0x0D34</td>
<td>4405 0X1134</td>
</tr>
<tr>
<td></td>
<td>Std Totl. Time seconds</td>
<td>L</td>
<td>2 LSW float</td>
<td>311 0x0136</td>
<td>1335 0x0536</td>
<td>2359 0x0936</td>
<td>3383 0x0D36</td>
<td>4407 0X1136</td>
</tr>
<tr>
<td>Meter Status</td>
<td>Error Code&lt;sup&gt;5&lt;/sup&gt;</td>
<td>B</td>
<td>2 LSW unsigned long integer</td>
<td>385 0x0180</td>
<td>1409 0x0580</td>
<td>2433 0x0980</td>
<td>3457 0x0D80</td>
<td>4481 0x1180</td>
</tr>
<tr>
<td></td>
<td>Reset Totals&lt;sup&gt;6&lt;/sup&gt;</td>
<td>I</td>
<td>1 Unsigned integer</td>
<td>513 0x0200</td>
<td>1537 0x0600</td>
<td>2561 0x0A00</td>
<td>3585 0x0E00</td>
<td>4609 0x1200</td>
</tr>
<tr>
<td>Meter Control</td>
<td>Reset Batch Total</td>
<td>I</td>
<td>1 Unsigned integer</td>
<td>514 0x0201</td>
<td>1538 0x0601</td>
<td>2562 0x0A01</td>
<td>3586 0x0E01</td>
<td>4610 0x1201</td>
</tr>
<tr>
<td></td>
<td>Error Code&lt;sup&gt;7&lt;/sup&gt;</td>
<td>I</td>
<td>1 Unsigned integer</td>
<td>515 0x0202</td>
<td>1539 0x0602</td>
<td>2563 0x0A02</td>
<td>3587 0x0E02</td>
<td>4611 0x1202</td>
</tr>
<tr>
<td></td>
<td>Word Order</td>
<td>I</td>
<td>1 Unsigned integer</td>
<td>5121 0x1400</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Baud Rate</td>
<td>I</td>
<td>1 Unsigned integer</td>
<td>5122 0x1401</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>1 day = 86,400 seconds

<sup>5</sup>Each of the 32 bits represents an error type.

<sup>6</sup>Writing any non-zero value will clear totals (unless locked per MID requirements).

<sup>7</sup>Represented as integer value (i.e. E1, E2, E3, etc.)
Table 14: Modbus Register Map (cont.)

<table>
<thead>
<tr>
<th>Category</th>
<th>Measurement</th>
<th>Type</th>
<th>Size Format</th>
<th>Composite Register Address</th>
<th>Channel 1 Register Address</th>
<th>Channel 2 Register Address</th>
<th>Channel 3 Register Address</th>
<th>Channel 4 Register Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comm Settings</td>
<td>Parity</td>
<td>I</td>
<td>1 Unsigned integer</td>
<td>5123 0x1402</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stop Bits</td>
<td>I</td>
<td>1 Unsigned integer</td>
<td>5124 0x1403</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Meter Address</td>
<td>I</td>
<td>1 Unsigned integer</td>
<td>5125 0x1404</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>All Ones</td>
<td>I</td>
<td>1 Unsigned integer</td>
<td>5126 0x1405</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note 5:** Regarding meter status, each bit field indicates the error number from LSB corresponding to E1, and from MSB corresponding to E32.

**Note 6:** Writing any non-zero value will clear the totals (unless they are locked using TOT LOCK/KEY LOCK switches on the front panel - per MID requirements).

**Note 6:** Writing to COMP will clear all channels.

**Note:** The Modbus Register Map, Table 14 on page 82, has some fields in grey boxes. These are currently not supported and will return a value of –1.0.
Chapter 5. HART Communications

5.1 Introduction

The Sentinel LCT4 generates a 4-20 mA analog output signal that enables two-way communication with a HART communication device.

5.2 Wiring the HART Interface

Interconnect the HART interface and the HART device as shown in either Figure 46 or Figure 47 below.

Figure 46: HART Wiring (External Power Supply/Passive Mode)

Figure 47: HART Wiring (Internal Power Supply/Active Mode)
5.3 Flowmeter Software Setup

**Sentinel LCT4**’s require no special setup procedures by the user. The meter automatically configures itself for HART communication on startup. The analog output must be on, and the mode must be set to the desired state. See [I/O], analog output menu.

In addition to setting up the HART variables and configuration, the analog output may be configured using either of the following methods (if available):

- the flowmeter keypad
- PanaView™ SEN898 graphical user interface software

The choice of parameters must be limited to those listed in Table 16 on page 89. To use the HART device for configuration of the analog output, refer to the instructions that came with that device.

Some flowmeter parameters can be read only by the HART device during startup. It is recommended that both the flowmeter and the HART device be rebooted after any reprogramming of the HART parameters. Failure to do so may result in erroneous information or a communication failure between the flowmeter and the HART device.

5.4 Product Interfaces

5.4.1 Process Interface

5.4.1a Sensor Input Channels

One to four pairs of acoustic transducers are connected to the device. Additionally, as many as three inputs (temperature, pressure or density) may be wired to the flowmeter. The temperature probes can be either four-wire PT100 RTDs or, like the pressure sensors, 4-20 mA transmitters. Refer to the manufacturers’ manuals for connection instructions.

5.4.1b Actuator Output Channels

No **Sentinel LCT4** outputs are designated exclusively as external process-control actuators.
5.4.2 Host Interface

5.4.2a Analog Output

The Sentinel LCT4 is equipped with a single 4-20 mA output (see Table 15 below for specifications), which can be configured using software to supply 24-volt power internally (active), or to regulate current from an external source (passive). When set to either mode it will support the HART communication channel.

### Table 15: Analog Output Linear Over Range

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Direction</th>
<th>Values (percent of range)</th>
<th>Values (ma or V)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Linear Over-Range</td>
<td>Down</td>
<td>-0.6% ± 1.0%</td>
<td>3.89 to 3.92 mA</td>
</tr>
<tr>
<td></td>
<td>Up</td>
<td>+105.0% ± 1.0%</td>
<td>20.64 to 20.96 mA</td>
</tr>
<tr>
<td>Device Malfunction Indication</td>
<td>Down: less than</td>
<td>-1.0%</td>
<td>3.84 mA</td>
</tr>
<tr>
<td></td>
<td>Up: greater than</td>
<td>+110.0%</td>
<td>21.6 mA</td>
</tr>
<tr>
<td>Maximum Current</td>
<td></td>
<td>+112.5%</td>
<td>22.0 mA</td>
</tr>
<tr>
<td>Multi-Drop Current Draw</td>
<td></td>
<td></td>
<td>4.0 mA</td>
</tr>
<tr>
<td>Lift-Off Voltage</td>
<td></td>
<td></td>
<td>4.5 V</td>
</tr>
</tbody>
</table>

5.5 Device Variables

The quantity and complexity of flow rates, secondary measurements and diagnostics in the list precludes elaboration within the FDS. Refer to Chapter 3, Operation, for more information about each parameter. All Sentinel LCT4 Device Variable Codes are tabulated in Table 16 below.

### Table 16: Device Variable Codes

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Device Variable Code</th>
<th>Device Variable Classification Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Comp</td>
<td>Ch. 1</td>
</tr>
<tr>
<td>Velocity</td>
<td>0 (00)</td>
<td>48 (30)</td>
</tr>
<tr>
<td>Volumetric</td>
<td>1 (01)</td>
<td>49 (31)</td>
</tr>
<tr>
<td>FWD Total</td>
<td>2 (02)</td>
<td>50 (32)</td>
</tr>
<tr>
<td>REV Total</td>
<td>3 (03)</td>
<td>51 (33)</td>
</tr>
<tr>
<td>Totl. Time</td>
<td>4 (04)</td>
<td>52 (34)</td>
</tr>
<tr>
<td>Mass Flow</td>
<td>5 (05)</td>
<td>53 (35)</td>
</tr>
<tr>
<td>FWD Mass</td>
<td>6 (06)</td>
<td>54 (36)</td>
</tr>
<tr>
<td>REV Mass</td>
<td>7 (07)</td>
<td>55 (37)</td>
</tr>
<tr>
<td>EnergyRate</td>
<td>8 (08)</td>
<td>56 (38)</td>
</tr>
<tr>
<td>FWD Energy</td>
<td>9 (09)</td>
<td>57 (39)</td>
</tr>
<tr>
<td>REV Energy</td>
<td>10 (0A)</td>
<td>58 (3A)</td>
</tr>
<tr>
<td>Reynolds #</td>
<td>11 (0B)</td>
<td>59 (3B)</td>
</tr>
<tr>
<td>KIRE</td>
<td>12 (0C)</td>
<td>60 (3C)</td>
</tr>
<tr>
<td>CTL</td>
<td>13 (0D)</td>
<td>61 (3D)</td>
</tr>
</tbody>
</table>
### Table 16: Device Variable Codes (cont.)

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Comp</th>
<th>Ch. 1</th>
<th>Ch. 2</th>
<th>Ch. 3</th>
<th>Ch. 4</th>
<th>Code</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPL</td>
<td>14 (0E)</td>
<td>62 (3E)</td>
<td>110 (6E)</td>
<td>158 (9E)</td>
<td>206 (CE)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>CTPL</td>
<td>15 (0F)</td>
<td>63 (3F)</td>
<td>111 (6F)</td>
<td>159 (9F)</td>
<td>207 (CF)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Soundspeed</td>
<td>16 (10)</td>
<td>64 (40)</td>
<td>112 (70)</td>
<td>160 (A0)</td>
<td>208 (D0)</td>
<td>67</td>
<td>Velocity</td>
</tr>
<tr>
<td>Up Transit</td>
<td>17 (11)</td>
<td>65 (41)</td>
<td>113 (71)</td>
<td>161 (A1)</td>
<td>209 (D1)</td>
<td>70</td>
<td>Time</td>
</tr>
<tr>
<td>Dn Transit</td>
<td>18 (12)</td>
<td>66 (42)</td>
<td>114 (72)</td>
<td>162 (A2)</td>
<td>210 (D2)</td>
<td>70</td>
<td>Time</td>
</tr>
<tr>
<td>DeltaT</td>
<td>19 (13)</td>
<td>67 (43)</td>
<td>115 (73)</td>
<td>163 (A3)</td>
<td>211 (D3)</td>
<td>70</td>
<td>Time</td>
</tr>
<tr>
<td>Gain Up [dB]</td>
<td>20 (14)</td>
<td>68 (44)</td>
<td>116 (74)</td>
<td>164 (A4)</td>
<td>212 (D4)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Gain Dn [dB]</td>
<td>21 (15)</td>
<td>69 (45)</td>
<td>117 (75)</td>
<td>165 (A5)</td>
<td>213 (D5)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Up Sig Strength</td>
<td>22 (16)</td>
<td>70 (46)</td>
<td>118 (76)</td>
<td>166 (A6)</td>
<td>214 (D6)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>DN Sig Strength</td>
<td>23 (17)</td>
<td>71 (47)</td>
<td>119 (77)</td>
<td>167 (A7)</td>
<td>215 (D7)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>UP DAC</td>
<td>24 (18)</td>
<td>72 (48)</td>
<td>120 (78)</td>
<td>168 (A8)</td>
<td>216 (D8)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>DN DAC</td>
<td>25 (19)</td>
<td>73 (49)</td>
<td>121 (79)</td>
<td>169 (A9)</td>
<td>217 (D9)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>UP Amp Discrim</td>
<td>26 (1A)</td>
<td>74 (4A)</td>
<td>122 (7A)</td>
<td>170 (AA)</td>
<td>218 (DA)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>DN Amp Discrim</td>
<td>27 (1B)</td>
<td>75 (4B)</td>
<td>123 (7B)</td>
<td>171 (AB)</td>
<td>219 (DB)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Peak%</td>
<td>28 (1C)</td>
<td>76 (4C)</td>
<td>124 (7C)</td>
<td>172 (AC)</td>
<td>220 (DC)</td>
<td>81</td>
<td>Analytical</td>
</tr>
<tr>
<td>UP Signal Q</td>
<td>29 (1D)</td>
<td>77 (4D)</td>
<td>125 (7D)</td>
<td>173 (AD)</td>
<td>221 (DD)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>DN Signal Q</td>
<td>30 (1E)</td>
<td>78 (4E)</td>
<td>126 (7E)</td>
<td>174 (AE)</td>
<td>222 (DE)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>UP ++ Peak</td>
<td>31 (1F)</td>
<td>79 (4F)</td>
<td>127 (7F)</td>
<td>175 (AF)</td>
<td>223 (DF)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>DN ++ Peak</td>
<td>32 (20)</td>
<td>80 (50)</td>
<td>128 (80)</td>
<td>176 (B0)</td>
<td>224 (E0)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>UP Norm Factor</td>
<td>33 (21)</td>
<td>81 (51)</td>
<td>129 (81)</td>
<td>177 (B1)</td>
<td>225 (E1)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>DN Norm Factor</td>
<td>34 (22)</td>
<td>82 (52)</td>
<td>130 (82)</td>
<td>178 (B2)</td>
<td>226 (E2)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Theta 3</td>
<td>35 (23)</td>
<td>83 (53)</td>
<td>131 (83)</td>
<td>179 (B3)</td>
<td>227 (E3)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>CEE1</td>
<td>36 (24)</td>
<td>84 (54)</td>
<td>132 (84)</td>
<td>180 (B4)</td>
<td>228 (E4)</td>
<td>67</td>
<td>Velocity</td>
</tr>
<tr>
<td>Supply Temp</td>
<td>37 (25)</td>
<td>85 (55)</td>
<td>133 (85)</td>
<td>181 (B5)</td>
<td>229 (E5)</td>
<td>64</td>
<td>Temperature</td>
</tr>
<tr>
<td>Return Temp</td>
<td>38 (26)</td>
<td>86 (56)</td>
<td>134 (86)</td>
<td>182 (B6)</td>
<td>230 (E6)</td>
<td>64</td>
<td>Temperature</td>
</tr>
<tr>
<td>Supply-Rtn</td>
<td>39 (27)</td>
<td>87 (57)</td>
<td>135 (87)</td>
<td>183 (B7)</td>
<td>231 (E7)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Supply Dens</td>
<td>40 (28)</td>
<td>88 (58)</td>
<td>136 (88)</td>
<td>184 (B8)</td>
<td>232 (E8)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Return Dens</td>
<td>41 (29)</td>
<td>89 (59)</td>
<td>137 (89)</td>
<td>185 (B9)</td>
<td>233 (E9)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Delta h</td>
<td>42 (2A)</td>
<td>90 (5A)</td>
<td>138 (8A)</td>
<td>186 (BA)</td>
<td>234 (EA)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Pressure Input</td>
<td>43 (2B)</td>
<td>91 (5B)</td>
<td>139 (8B)</td>
<td>187 (BB)</td>
<td>235 (EB)</td>
<td>65</td>
<td>Pressure</td>
</tr>
<tr>
<td>Special Input 1</td>
<td>44 (2C)</td>
<td>92 (5C)</td>
<td>140 (8C)</td>
<td>188 (BC)</td>
<td>236 (EC)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Special Input 2</td>
<td>45 (2D)</td>
<td>93 (5D)</td>
<td>141 (8D)</td>
<td>189 (BD)</td>
<td>237 (ED)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Special Input 3</td>
<td>46 (2E)</td>
<td>94 (5E)</td>
<td>142 (8E)</td>
<td>190 (BE)</td>
<td>238 (EE)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
<tr>
<td>Special Input 4</td>
<td>47 (2F)</td>
<td>95 (5F)</td>
<td>143 (8F)</td>
<td>191 (BF)</td>
<td>239 (EF)</td>
<td>0</td>
<td>Not Classified</td>
</tr>
</tbody>
</table>
5.5 Device Variables (cont.)

The available device variable codes that can currently be published are tabulated in Table 17 below. The Device Variable Family Code for all measurements is 250, “Not Used.” Device variable numbers and unit types are listed in this section. Selectable Unit Types are restricted in such a way that each Variable Class can use only a single unit at a time. For instance, if a Volumetric Flow variable unit is changed, all subsequent Volumetric Flow variables will switch to that unit. This keeps forward and reverse internal Sentinel LCT4 units in sync with the HART variable type.

Table 17: Publishable Device Variables

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Device Variable Code</th>
<th>Device Variable Classification Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Comp</td>
<td>Ch. 1</td>
</tr>
<tr>
<td>Velocity</td>
<td>0 {00}</td>
<td>48 (30)</td>
</tr>
<tr>
<td>Volumetric</td>
<td>1 {01}</td>
<td>49 (31)</td>
</tr>
<tr>
<td>FWD Total</td>
<td>2 {02}</td>
<td>50 (32)</td>
</tr>
<tr>
<td>REV Total</td>
<td>3 {03}</td>
<td>51 (33)</td>
</tr>
<tr>
<td>Totl. Time</td>
<td>4 {04}</td>
<td>52 (34)</td>
</tr>
<tr>
<td>Mass Flow</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FWD Mass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REV Mass</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EnergyRate</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FWD Energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REV Energy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reynolds #</td>
<td>59 (3B)</td>
<td>107 (6B)</td>
</tr>
<tr>
<td>K(RE)</td>
<td>60 (3C)</td>
<td>108 (6C)</td>
</tr>
<tr>
<td>CTL</td>
<td>13 (0D)</td>
<td></td>
</tr>
<tr>
<td>CPL</td>
<td>14 (0E)</td>
<td></td>
</tr>
<tr>
<td>CTPL</td>
<td>15 (0F)</td>
<td></td>
</tr>
<tr>
<td>Soundspeed</td>
<td>16 (10)</td>
<td>64 (40)</td>
</tr>
<tr>
<td>Up Transit</td>
<td>65 (41)</td>
<td>113 (71)</td>
</tr>
<tr>
<td>Dn Transit</td>
<td>66 (42)</td>
<td>114 (72)</td>
</tr>
<tr>
<td>DeltaT</td>
<td>67 (43)</td>
<td>115 (73)</td>
</tr>
<tr>
<td>Gain Up[dB]</td>
<td>68 (44)</td>
<td>116 (74)</td>
</tr>
<tr>
<td>Gain Dn[db]</td>
<td>69 (45)</td>
<td>117 (75)</td>
</tr>
<tr>
<td>Up Sig Strength</td>
<td>70 (46)</td>
<td>118 (76)</td>
</tr>
<tr>
<td>DN Sig Strength</td>
<td>71 (47)</td>
<td>119 (77)</td>
</tr>
<tr>
<td>UP DAC</td>
<td>72 (48)</td>
<td>120 (78)</td>
</tr>
<tr>
<td>DN DAC</td>
<td>73 (49)</td>
<td>121 (79)</td>
</tr>
<tr>
<td>UP Amp Discrim</td>
<td>74 (4A)</td>
<td>122 (7A)</td>
</tr>
<tr>
<td>DN Amp Discrim</td>
<td>75 (4B)</td>
<td>123 (7B)</td>
</tr>
</tbody>
</table>
When optional *API Correction* is installed, the Composite Volumetric and Volume variables are mapped to standard units. The supported units are referenced in section 11. Individual channel volumetric flowrate and volume units remain actual units.

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Device Variable Code</th>
<th>Device Variable Classification Code</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Comp</td>
<td>Ch. 1</td>
</tr>
<tr>
<td>Peak%</td>
<td></td>
<td>76 (4C)</td>
</tr>
<tr>
<td>UP Signal Q</td>
<td></td>
<td>77 (4D)</td>
</tr>
<tr>
<td>DN Signal Q</td>
<td></td>
<td>78 (4E)</td>
</tr>
<tr>
<td>UP +– Peak</td>
<td></td>
<td>79 (4F)</td>
</tr>
<tr>
<td>DN +– Peak</td>
<td></td>
<td>80 (50)</td>
</tr>
<tr>
<td>UP Norm Factor</td>
<td></td>
<td>81 (51)</td>
</tr>
<tr>
<td>DN Norm Factor</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Theta 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CEE1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Temp</td>
<td></td>
<td>37 (25)</td>
</tr>
<tr>
<td>Return Temp</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply-Rtn</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Dens</td>
<td></td>
<td>40 (28)</td>
</tr>
<tr>
<td>Return Dens</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Delta h</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pressure Input</td>
<td></td>
<td>43 (2B)</td>
</tr>
<tr>
<td>Special Input 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Input 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Input 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Special Input 4</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 17: Publishable Device Variables (cont.)
5.6 Dynamic Variables

Only certain device variables can be published and are listed in Table 17 on page 91. More publishable variables may be added as the capabilities are added to the meter. Only the device variables listed in C may be assigned as primary, secondary, tertiary or quaternary variables (PV, SV, TV and QV). Certain diagnostic variables have units specific to that diagnostic. Refer to the Sentinel LCT4 for details on the use of diagnostic variables indicated by the variable class specified as “Not Classified.”

5.7 Status Information

5.7.1 Device Status

Bit 4 (“More Status Available”) is set whenever any failure is detected. Command #48 furnishes specific information about the failure. Refer to Section Error! Reference source not found., to this Sentinel LCT4 User’s Manual and to Common Tables Specification (Table 17 on page 91). Due to the large number of device variables, the Non-Primary Variable Out of Limits flag bit, Table 12, section 7.4.3 HCF_SPEC-99, is never set. Instead, monitor the Extended Device Status to determine overall device variable status.

Bit 1 (“Non-Primary variable out of limits”) is set only when any of the SV, TV or QV variables are out of their respective limits. This bit is not set for variables not mapped to the SV, TV or QV.

5.7.2 Extended Device Status

Extended Device Code 0x01, Maintenance Required, is never set by the Sentinel LCT4.

Code 0x02, Device Variable Alert, is set if the meter is in an alarm or warning state. Because of the complexity of meter configuration and flow computation, the SEN898 may not set Device Variable Status indicators to identify specific Device Variables as the cause of the alert. Refer to the manual for information about “flow” and “non-flow” errors.
5.7.3 Additional Device Status

Command 48 returns four data bytes. Error bits are cleared only when the cause is rectified. Refer to the service manual for troubleshooting information. Table 18 below shows the error bits and associated SEN898 error condition.

<table>
<thead>
<tr>
<th>HART Additional Device Status</th>
<th>Sentinel LCT4 Meaning</th>
<th>Sentinel LCT4 Error Condition</th>
<th>Class</th>
<th>Device Status Bits Set</th>
</tr>
</thead>
<tbody>
<tr>
<td>Byte</td>
<td>Bit</td>
<td>E0</td>
<td>No Error</td>
<td>-</td>
</tr>
<tr>
<td>0 0</td>
<td>E1</td>
<td>Low Signal</td>
<td>Flow</td>
<td>error</td>
</tr>
<tr>
<td>0 1</td>
<td>E2</td>
<td>Soundspeed</td>
<td>Flow</td>
<td>error</td>
</tr>
<tr>
<td>0 2</td>
<td>E3</td>
<td>Velocity/Range</td>
<td>Flow</td>
<td>error</td>
</tr>
<tr>
<td>0 3</td>
<td>E4</td>
<td>Signal Quality</td>
<td>Flow</td>
<td>error</td>
</tr>
<tr>
<td>0 4</td>
<td>E5</td>
<td>Amplitude</td>
<td>Flow</td>
<td>error</td>
</tr>
<tr>
<td>0 5</td>
<td>E6</td>
<td>Cycle Skip</td>
<td>Flow</td>
<td>error</td>
</tr>
<tr>
<td>0 6</td>
<td>E7</td>
<td>Analog Output</td>
<td>IO</td>
<td>warning</td>
</tr>
<tr>
<td>0 7</td>
<td>E8</td>
<td>Supply Temperature</td>
<td>IO</td>
<td>warning</td>
</tr>
<tr>
<td>1 0</td>
<td>E9</td>
<td>Return Temperature</td>
<td>IO</td>
<td>warning</td>
</tr>
<tr>
<td>1 1</td>
<td>E10</td>
<td>not used</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1 2</td>
<td>E11</td>
<td>not used</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1 3</td>
<td>E12</td>
<td>not used</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1 4</td>
<td>E13</td>
<td>Tracking AGC Settled</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>1 5</td>
<td>E14</td>
<td>Tracking Seek Mode</td>
<td>Flow HP</td>
<td>error</td>
</tr>
<tr>
<td>1 6</td>
<td>E15</td>
<td>Active TW</td>
<td>Flow Lp</td>
<td>warning</td>
</tr>
<tr>
<td>1 7</td>
<td>E16</td>
<td>Totalizer</td>
<td>IO</td>
<td>warning</td>
</tr>
<tr>
<td>2 0</td>
<td>E17</td>
<td>Temperature Input</td>
<td>IO</td>
<td>warning</td>
</tr>
<tr>
<td>2 1</td>
<td>E18</td>
<td>Pressure Input</td>
<td>IO</td>
<td>warning</td>
</tr>
<tr>
<td>2 2</td>
<td>E19</td>
<td>Density Input</td>
<td>IO</td>
<td>warning</td>
</tr>
<tr>
<td>2 3</td>
<td>E20</td>
<td>Special Input</td>
<td>IO</td>
<td>warning</td>
</tr>
<tr>
<td>2 4</td>
<td>E21</td>
<td>API Correction</td>
<td>Flow LP</td>
<td>warning</td>
</tr>
<tr>
<td>2 5</td>
<td>E22</td>
<td>Degraded Performance</td>
<td>Flow LP</td>
<td>warning</td>
</tr>
<tr>
<td>- -</td>
<td>E29</td>
<td>Stale Data</td>
<td>Flow</td>
<td>error</td>
</tr>
<tr>
<td>3 4</td>
<td>E30</td>
<td>Channel Off</td>
<td>Flow</td>
<td>error</td>
</tr>
</tbody>
</table>
5.8 Universal Commands

All universal commands are implemented per the HART Universal Command Specification (HCF_SPEC-127, rev. 6.0). The transducer serial number is not relevant to flowmeters, so a zero is returned in the first two data bytes of Command 14, Read Primary Variable Transducer Information.

5.9 Common-Practice Commands

5.9.1 Supported Common Practice Commands

<table>
<thead>
<tr>
<th>Number</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>33</td>
<td>Read Device Variables</td>
</tr>
<tr>
<td>34</td>
<td>Write Primary Variable Damping Value</td>
</tr>
<tr>
<td>35</td>
<td>Write Primary Variable Range Values</td>
</tr>
<tr>
<td>36</td>
<td>Set Primary Variable Upper Range Value</td>
</tr>
<tr>
<td>37</td>
<td>Set Primary Variable Lower Range Value</td>
</tr>
<tr>
<td>38</td>
<td>Reset Configuration Changed Flag</td>
</tr>
<tr>
<td>40</td>
<td>Enter/Exit Fixed Current Mode</td>
</tr>
<tr>
<td>41</td>
<td>Perform Self Test - restricted</td>
</tr>
<tr>
<td>42</td>
<td>Perform Device Reset</td>
</tr>
<tr>
<td>43</td>
<td>Set Primary Variable Zero</td>
</tr>
<tr>
<td>44</td>
<td>Write Primary Variable Units</td>
</tr>
<tr>
<td>45</td>
<td>Trim Loop Current Zero</td>
</tr>
<tr>
<td>46</td>
<td>Trim Loop Current Gain</td>
</tr>
<tr>
<td>48</td>
<td>Read Additional Device Status</td>
</tr>
<tr>
<td>49</td>
<td>Write Primary Variable Transducer Serial Number</td>
</tr>
<tr>
<td>50</td>
<td>Read Dynamic Variable Assignments</td>
</tr>
<tr>
<td>51</td>
<td>Write Dynamic Variable Assignments</td>
</tr>
<tr>
<td>52</td>
<td>Set Device Variable Zero</td>
</tr>
<tr>
<td>53</td>
<td>Write Device Variable Units</td>
</tr>
<tr>
<td>54</td>
<td>Read Device Variable Information</td>
</tr>
<tr>
<td>55</td>
<td>Write Device Damping Value</td>
</tr>
<tr>
<td>59</td>
<td>Write Number of Response Preambles</td>
</tr>
<tr>
<td>72</td>
<td>Squawk</td>
</tr>
</tbody>
</table>
5.9.1a Command 34 and 55 Damping Value
The variable damping value is fixed and not programmable.

5.9.1b Command 35 Units Restriction
Command 35 does not allow range to be set with units other than the current publishing units. If the units do not match the selected Primary Variable units, the response “Invalid Selection” is returned. The meter does not provide the capability to convert values between units in Command 35.

5.9.1c Command 41 Perform Self Test
Due to the complex nature of the SEN898 sensor, the self-test mode is Restricted. However, the device status is constantly monitored and Command 48, Read Additional Device Status, should be used to determine the current state of the meter.

5.9.1d Command 43 Set Primary Variable Zero
Only the Totals variable can be set to Zero with this command. Any other variable that is not a Forward or Reverse Total will return Invalid Selection.

5.9.1e Command 72 Squawk Command
The Squawk function, command 72, causes the LCD backlight to flash.

5.9.1f Command 52 Set Device Variable Zero
This is the same as the Device Specific command 181: Clear Totals, if the variable specified is a Totals variable. Any totals variable specified with this command will affect all totals variables. This command does not affect variables that are not a Totals variable. Invalid selection is returned for non-totals variables.

5.9.2 Burst Mode Commands
The Sentinel LCT4 does not support burst mode.

5.9.3 Catch Device Variable Command
The Sentinel LCT4 does not support the catch device variable mechanism.
5.10 Device-Specific Commands

A single device specific command is implemented, Clear Totals.

5.10.1 Command 181 (0xB5): Clear Totals

The Clear Totals command resets the accrued values for volume, mass and energy that have flowed through the meter. The timer associated with the trio of totals is also set back to zero. All totalizers resume aggregating flow immediately after the command is executed.

The effect of this command is equivalent to Command 52, Set Variable Zero, if the command 52 device variable specified is a Totals variable, it will clear all totals.

**Note:** The function is global. Sentinel LCT4 can be configured to use individual transducer pairs, or channels, to measure flow in separate pipes. The clear totals command will reset the volume, mass, energy and time for every channel.

<table>
<thead>
<tr>
<th>Table 20: Device Specific Command 181 - Clear Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Byte</strong></td>
</tr>
<tr>
<td>Request Data Bytes</td>
</tr>
<tr>
<td>Response Data Bytes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Code</th>
<th>Class</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Success</td>
<td>No Command-Specific Errors</td>
</tr>
<tr>
<td>1-6</td>
<td></td>
<td>Undefined</td>
</tr>
<tr>
<td>7</td>
<td>Error</td>
<td>In Write Protect Mode</td>
</tr>
<tr>
<td>8-127</td>
<td></td>
<td>Undefined</td>
</tr>
</tbody>
</table>
5.11 Tables

5.11.1 HART Engineering Units

The unit types allowed for Sentinel LCT4 device variables in Section 5.11 are listed below. Unit types for device variables in Section 5.11 are shown, but only units from Publishable variables are listed. As publishable device variables are added, so with the corresponding units.

5.11.1a Velocity

Table 21: Velocity

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>67</td>
<td>Velocity</td>
<td>20</td>
<td>feet per second</td>
</tr>
<tr>
<td></td>
<td></td>
<td>21</td>
<td>meters per second</td>
</tr>
</tbody>
</table>

5.11.1b Volumetric Flow

Table 22: Volumetric Flow

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>66</td>
<td>Volumetric Flow</td>
<td>130</td>
<td>cubic feet per hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15</td>
<td>cubic feet per minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>26</td>
<td>cubic feet per second</td>
</tr>
<tr>
<td></td>
<td></td>
<td>19</td>
<td>cubic meters per hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>131</td>
<td>cubic meters per minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>28</td>
<td>cubic meters per second</td>
</tr>
<tr>
<td></td>
<td></td>
<td>136</td>
<td>gallons per hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16</td>
<td>gallons per minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22</td>
<td>gallons per second</td>
</tr>
<tr>
<td></td>
<td></td>
<td>23</td>
<td>million gallons per day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>135</td>
<td>barrels per day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>134</td>
<td>barrels per hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>132</td>
<td>barrels per second</td>
</tr>
<tr>
<td></td>
<td></td>
<td>138</td>
<td>liters per hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td>liters per minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>24</td>
<td>liters per second</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25</td>
<td>million liters per day</td>
</tr>
</tbody>
</table>
5.11.1c Standard Volumetric Flow

Table 23: Standard Volumetric Flow

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>66</td>
<td>Volumetric Flow</td>
<td>185</td>
<td>Standard cubic feet per hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>123</td>
<td>Standard cubic feet per minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>186</td>
<td>Standard cubic feet per second</td>
</tr>
<tr>
<td></td>
<td></td>
<td>184</td>
<td>Standard cubic feet per day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>187</td>
<td>Standard cubic meters per day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>188</td>
<td>Standard cubic meters per hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>189</td>
<td>Standard cubic meters per minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>190</td>
<td>Standard cubic meters per second</td>
</tr>
<tr>
<td></td>
<td></td>
<td>178</td>
<td>Standard liters per hour</td>
</tr>
<tr>
<td></td>
<td></td>
<td>179</td>
<td>Standard liters per minute</td>
</tr>
<tr>
<td></td>
<td></td>
<td>180</td>
<td>Standard liters per second</td>
</tr>
<tr>
<td></td>
<td></td>
<td>177</td>
<td>Standard liters per day</td>
</tr>
</tbody>
</table>

5.11.1d Volume

Table 24: Volume

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>Volume (FWD)</td>
<td>112</td>
<td>cubic feet</td>
</tr>
<tr>
<td>68</td>
<td>Volume (REV)</td>
<td>43</td>
<td>cubic meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40</td>
<td>gallons</td>
</tr>
<tr>
<td></td>
<td></td>
<td>41</td>
<td>liters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>46</td>
<td>barrels</td>
</tr>
</tbody>
</table>

5.11.1e Standard Volume

Table 25: Standard Volume

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>68</td>
<td>Volume (FWD)</td>
<td>168</td>
<td>Standard cubic feet</td>
</tr>
<tr>
<td>68</td>
<td>Volume (REV)</td>
<td>172</td>
<td>Standard cubic meters</td>
</tr>
<tr>
<td></td>
<td></td>
<td>171</td>
<td>Standard liters</td>
</tr>
</tbody>
</table>
5.11.1f Mass Flow

Table 26: Mass Flow

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>72</td>
<td>Mass Flow</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.11.1g Mass

Table 27: Standard Volume

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>71</td>
<td>Mass (FWD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>71</td>
<td>Mass (REV)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.11.1h Power

Table 28: Power

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>79</td>
<td>Power</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.11.1i Energy

Table 29: Energy

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>77</td>
<td>Energy (FWD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>77</td>
<td>Energy (REV)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5.11.1j Time

Table 30: Time

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>79</td>
<td>Power</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5.11.1k Temperature

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>64</td>
<td>Temperature</td>
<td>32</td>
<td>Degrees Celsius</td>
</tr>
<tr>
<td></td>
<td></td>
<td>33</td>
<td>Degrees Fahrenheit</td>
</tr>
<tr>
<td></td>
<td></td>
<td>34</td>
<td>Degrees Rankine</td>
</tr>
<tr>
<td></td>
<td></td>
<td>35</td>
<td>Kelvin</td>
</tr>
</tbody>
</table>

5.11.1l Analytical

<table>
<thead>
<tr>
<th>Class Code</th>
<th>Variable Classification</th>
<th>Unit Code</th>
<th>Unit Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>81</td>
<td>Analytical</td>
<td>57</td>
<td>Percent</td>
</tr>
</tbody>
</table>

5.12 Performance

5.12.1 Sampling Rate

All flow rates are updated at least 10 times per second. Auxiliary inputs, like pressure and temperature probes used to refine flow calculations, are also updated at least 10 times per second.

5.12.2 Power-Up

The **Sentinel LCT4** requires approximately 15 to 60 seconds to boot after it is energized, depending on whether the non-volatile memory is being restored from default. No HART requests are processed during initiation. The analog output will default to 4mA until the primary variable is available.

5.12.3 Device Reset

The **Sentinel LCT4** reset performance is identical to Power-Up, described in the preceding section. The meter will always exit fixed-current mode before resuming operation.

5.12.4 Self-Test

The meter responds to the self-test request, but performs no additional diagnostic functions. (The meter tests for errors and reports them after each measurement cycle.) Support for command 41 is included to facilitate future implementation.
5.12.5 Command Response Delay

Table 33: Slave Response Time

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum</td>
<td>1ms</td>
</tr>
<tr>
<td>Typical</td>
<td>20ms</td>
</tr>
<tr>
<td>Maximum</td>
<td>256ms</td>
</tr>
</tbody>
</table>

5.12.6 Busy and Delayed Response

The Sentinel LCT4 never transmits a busy response code when replying to a command. The delayed response mechanism is not implemented.

5.12.7 Long Messages

The data field in Command 21, Read Unique Identifier Associated with Long Tag, is the largest that the Sentinel LCT4 will receive. The message contains 32 characters (bytes). The reply to Command 21 contains the largest data field sent by the Sentinel LCT4, 18 bytes (including the two status bytes).

5.12.8 Non-Volatile Memory

The meter uses nonvolatile memory to store the configuration parameters. Flow totals are also periodically cached to preserve data in case power is interrupted.

5.12.9 Operating Modes

Fixed current mode is implemented using Command 40. This mode is cleared by power loss or reset.

5.12.10 Write Protection

The meter contains two write protect switches.

5.12.11 Write Protect Switch

The write protect switch activates the write protect mode and will generate “In Write Protect” response when active. An LED will be lit when the write protect switch is active.

5.12.12 Totals Protect Switch

The Totals Protect switch is used to ensure conformity to the Measuring Instruments Directive (MID). The meter totals cannot be reset (CMD 181) when the meter is restricted via the Totals Protect switch. An LED on the front panel is lit when the Totals Protect Switch is active.
## 5.13 Capability Checklist

**Table 34: Capability Checklist**

<table>
<thead>
<tr>
<th>Manufacturer, model and revision</th>
<th>GE Measurement &amp; Control Sentinel LCT4 flowmeter, Rev. 1.0</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device type</td>
<td>Transmitter</td>
</tr>
<tr>
<td>HART revision</td>
<td>6.3</td>
</tr>
<tr>
<td>Device Description available</td>
<td>Yes</td>
</tr>
<tr>
<td>Number and type of sensors</td>
<td>1 to 4 pairs of acoustic transducers, 0 to 3 temperature or pressure sensors for flow correction</td>
</tr>
<tr>
<td>Number and type of actuators</td>
<td>0</td>
</tr>
<tr>
<td>Number and type of host side signals</td>
<td>One 4-20mA analog output, two optional frequency/totalizer outputs</td>
</tr>
<tr>
<td>Number of Device Variables</td>
<td>240</td>
</tr>
<tr>
<td>Number of Dynamic Variables</td>
<td>4</td>
</tr>
<tr>
<td>Mappable Dynamic Variables?</td>
<td>Yes</td>
</tr>
<tr>
<td>Number of common-practice commands</td>
<td>22</td>
</tr>
<tr>
<td>Number of device-specific commands</td>
<td>1</td>
</tr>
<tr>
<td>Bits of additional device status</td>
<td>32</td>
</tr>
<tr>
<td>Alternative operating modes?</td>
<td>No</td>
</tr>
<tr>
<td>Burst mode?</td>
<td>No</td>
</tr>
<tr>
<td>Write-protection?</td>
<td>Yes</td>
</tr>
</tbody>
</table>
5.14 Default Configuration

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Default Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device variable mapped to PV</td>
<td>Average velocity</td>
</tr>
<tr>
<td>Lower Range Value</td>
<td>0</td>
</tr>
<tr>
<td>Upper Range Value</td>
<td>100</td>
</tr>
<tr>
<td>PV Units</td>
<td>Feet per second</td>
</tr>
<tr>
<td>Damping time constant</td>
<td>NaN (not a number)</td>
</tr>
<tr>
<td>Total lock</td>
<td>Off (i.e., reset is enabled)</td>
</tr>
<tr>
<td>Number of response preambles</td>
<td>5</td>
</tr>
</tbody>
</table>

Refer to Chapter 3, *Operation*, for more information about factory default settings for the **Sentinel LCT4**. For DD or FDT/DTM files, consult GE.

5.15 Manufacturer and Device ID

<table>
<thead>
<tr>
<th>Table 36: Manufacturer and Device ID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer Name:</td>
</tr>
<tr>
<td>Model Name(s):</td>
</tr>
<tr>
<td>Manufacturer ID Code:</td>
</tr>
<tr>
<td>Device Type Code:</td>
</tr>
<tr>
<td>HART Protocol Revision</td>
</tr>
<tr>
<td>Device Revision:</td>
</tr>
<tr>
<td>Number of Device Variables</td>
</tr>
<tr>
<td>Physical Layers Supported</td>
</tr>
<tr>
<td>Physical Device Category</td>
</tr>
</tbody>
</table>
Chapter 6.  Maintenance

6.1 Calibration

In the CALIB menu, the user can calibrate and trim the analog output and inputs and check other meter functions. This chapter also covers updating Sentinel LCT4 software over the RS232 interface.

Before performing calibration of the Sentinel LCT4, be sure the following equipment is available:

- Current meter capable of precisely measuring 4 to 20 mA current levels
- PC with RS232 Cable and Hyperterminal software (available on Windows operating systems)

While following the programming instructions in this section, refer to Figure 71 on page 141.

6.1.1 Updating Sentinel LCT4 Instrument Software

1. To set up the RS232, connect one end of a 9-pin RS232 cable to the COM-1 serial port on a PC and the other end to Com Port I/O on terminal block TB2 on the Sentinel LCT4, as described in Chapter 2, Installation.

WARNING!  Use RS232 connections in Non-Hazardous areas only.

Note: The RS232 cable connection is not limited to the COM-1 serial port of the PC. Connect the RS232 cable to any available RS232 serial port on the PC, and follow the same instructions as for the COM-1 port.

2. On your PC, set up the Hyperterminal program.

Note: The use of Hyperterminal is shown here as an example. If you are using a different communications software, see its manual for detailed instructions.

a. From the PC Start Menu, click Programs/Accessories/Communications/Hyperterminal to open the Hyperterminal window.

b. If the call is not connected, click on New Connection and enter a name. Click OK.

c. In the Connect To window, select COM 1 as the desired port.

d. In the Properties window, set the following parameters:

- Bits per second: 115200
- Data bits: 8
- Parity: None.
- Stop Bits: 1
- Flow control: None
6.1.1 Updating Sentinel LCT4 Instrument Software (cont.)

3. From the Sentinel LCT4 FACTORY menu, scroll to the Upgrade option and press [ENT] twice. Confirm = YES. The Sentinel LCT4 screen should appear as in Figure 48 below after approximately one minute,

or

Power on the Sentinel LCT4, and enter ESC-R from the PC keyboard. The Sentinel LCT4 screen should appear as in Figure 48 below.

![Sentinel LCT4 Screen](image)

The Hyperterminal window on your PC should appear as follows:

![PC Load Request Window](image)

Press CTRL-X on the PC keyboard to abort the process, or continue as follows to send the file.
6.1.1 Updating Sentinel LCT4 Instrument Software (cont.)

4. In Hyperterminal, select Transfer, and then Send File. (The protocol should be Xmodem.) Use Browse to locate the file, which will have a .cod extension. Double click on this file and click the Send button. The screens on the Sentinel LCT4 (Figure 50 below) and on Hyperterminal (Figure 51 below) should both display the status of the transfer.

![Figure 50: Sentinel LCT4 Transfer Status Window](image1)

![Figure 51: PC Transfer Status Window](image2)
6.1.1 Updating Sentinel LCT4 Instrument Software (cont.)

5. To ensure the Sentinel LCT4 operates correctly, GE recommends defaulting the meter after software updates. From the Sentinel LCT4 Factory Menu, scroll to Default Meter and press [ENT]. Press the up arrow key [▲] and press [ENT] twice, or at power on, press and hold the [CLR-TOT] key until the following screen appears after several seconds. Release the key. Press the up arrow key [▲] to default the meter, or the down arrow key [▼] to cancel the default.

![Default Meter Screen](image)

**Figure 52: Default Meter? Screen**

**CAUTION!** All site configuration and calibration data will be lost if the meter is defaulted. It is highly recommended that a site archive is captured via PanaView SEN898 or using Site File Menu under the Factory Menu and restored after default is complete!

Note: After the Sentinel LCT4 has been defaulted, it restarts in the locked mode. See “Unlocking the Sentinel LCT4” on page 59 for instructions on unlocking the meter.

6. To check that the software has been loaded correctly, proceed to the next section.
6.1.2  Checking the Meter Software

To check the meter software, complete the following steps:

1. Turn power on. The display should boot up with a typical cycling procedure.
2. To verify which version of software has been loaded:
   a. Press [ESC] to enter the User Program.
   b. Press the [ ► ] key until FACTORY is highlighted. Scroll to the Versions option and press [ENT].
   c. Press [ENT] again to enter Main. The display should appear similar to Figure 53 below.

![Figure 53: Software Verification Screen](image)

6.1.2a  Checking Option Card Version Information

To verify which option card version has been loaded, complete the following steps:

1. Press [ESC] to enter the User Program.
2. Press the [ ► ] key until FACTORY is highlighted. Scroll to the Versions option and press [ENT].
3. Press [ENT] again to enter Option Cards. The display should appear similar to Figure 54 below.

![Figure 54: Option Card Verification Screen](image)
6.1.3 Trimming 4-20 mA Loop Using the Keypad

To trim the 4-20 mA loop using the keypad, complete the following steps:

1. In the User Program, scroll to CAL with 4-20 Loop highlighted. Press [ENT].
2. Scroll to Mode and press [ENT]. In the Mode window, scroll to Test[Trim] and press [ENT].
3. Return to the Loop window, and scroll to Percent.
4. In the Percent window, use the arrow keys to set the percentage to 100%. Press [ENT]. Record the value shown on the current meter.
5. Now use the arrow keys to set the percentage to 0%. Press [ENT]. Record the value shown on the current meter.
6. Return to the Loop window, and scroll to Base Trim. Press [ENT].
7. Use the arrow keys to enter the base trim value, the value recorded in step 5. (The loop current should now be the same as the current meter. It should read 4.0 +/-0.01 mA.) Press [ENT].
8. Repeat steps 3 and 4.
9. Return to the Loop window, and scroll to Span Trim. Press [ENT].
10. Use the arrow keys to enter the span trim value, the value recorded in step 4. (The loop current should now be the same as the current meter. It should read 20.0 +/-0.01 mA.) Press [ENT].

Note: The difference between “Test” and “Test [TRIM]” is that “Test” is the raw output current without the trim applied. “Test [TRIM]” is the output current with trim applied.
6.2 Hardware Maintenance and Inspection

**WARNING!** Before opening the vessel, it must not contain any pressure! This warning pertains to all three interfaces described below (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.

**WARNING!** All equipment must be de-energized prior to servicing.

Only trained and qualified personnel should service the pressure vessel. The system has three serviceable interfaces:

- Flanges
- Sensor ports
- Transmitter connection

![Figure 55: Serviceable Interfaces]
6.2.1 Servicing the Pipe Flange Interface

WARNING! Before you open the pressure vessel, it must not contain any pressure.

Only properly trained personnel, such as pipe fitters, should service the pipe flanges. The proper gasket material, bolts, bolt torque and tightening sequence should always be used. See the procedure in “General Piping Rules” on page 31 for reference.

6.2.2 Servicing the Sensor Ports or Transmitter Interface

WARNING! Before you open the sensor ports or transmitter interface, the system must not contain any pressure.

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.

6.2.2a Required Equipment

- 10 mm hex drive socket or wrench
- 12 mm hex drive socket or wrench
6.2.2b  Instructions to Relieve Pressure in the Sensor Port or Transmitter Interface

To relieve the pressure in the system, refer to Figure 56 and Figure 57 below and 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. It is also easily identifiable, as the Sentinel LCT4 has only the “A” Plane.

![Figure 56: Upstream “A” Plane Sensor Quadrant — View 1 (Top)](image)

![Figure 57: Upstream “A” Plane Sensor Quadrant — View 2](image)
6.2.2b Instructions to Relieve Pressure in the Sensor Port or Transmitter Interface (cont.)

2. Relieve potential pressure build-up by loosening the **Pressure Relief Plug** on the bottom of the **Upstream “A” Plane Sensor Quadrant** as shown in step 1 on the previous page, using a 10 mm hex tool. Slowly loosen the pressure relief plug 2-3 full turns or until the plug bottoms out on the built-in safety stop.

3. Listen and observe:
   a. If any hissing is heard (air or gas release), stop loosening the plug and wait for the hissing to stop. If hissing continues for more than 10 minutes, retighten the plug and consult GE.
   b. If any liquid discharge is observed, stop loosening the plug and retighten completely.

   ![WARNING!](image)
   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 interface.

   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. The equipment contained within the sensor ports and transmitter interface is serviceable by only factory trained service technicians. Please refer to the Sentinel LCT4 *Technical Service Manuals* for further details.

5. After service work is complete, all **Sensor Port Plugs** and **Pressure Relief Plug** should be reinstalled and tightened fully.

### 6.3 Spare Parts

The **Sentinel LCT4** is a high-accuracy calibrated flowmeter. 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 flowmeter 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 7 of this manual. To ensure that the correct part number is ordered, provide your local GE Measurement & Control representative with the serial number of the meter, located as shown on the “Part String and Serial Number Tag Plate” on page 6.

If it is determined that a flow transducer has been damaged or is faulty, it may also be replaced in the field. Please contact GE for the appropriate part number.
6.4 Installing Replacement Parts

The Sentinel LCT4 is a high-accuracy calibrated flowmeter. Local custody transfer requirements may disallow field replacement of any parts of 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 it is appropriate to replace any component of the flow metering system, the GE Measurement & Control field service team is trained and equipped to perform the replacement on-site. Installation of these field replaceable parts by a GE field service team member will maintain the accuracy of the system and any applicable warranty. Transducer and electronics replacement has been proven to maintain calibration as shown in OIM certificate TC 7595. Please contact GE to order the appropriate components and to schedule installation in the field.
[no content intended for this page]
Chapter 7. Troubleshooting

7.1 Introduction

The Sentinel LCT4 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 LCT4. 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 to use the CE Installation methods in Appendix B.

7.2 Error Codes

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

All of the possible Sentinel LCT4 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.

If an error message appears on the display screen during operation of the Sentinel LCT4, refer to the appropriate section of this chapter for instructions on how to proceed. You may be asked to contact GE. It would be very helpful to enter all of the diagnostic data and parameter information for each channel in the Data Records in Appendix C prior to calling your local sales or service center.
Chapter 7. Troubleshooting

7.2.1 E0: No Error

Problem: No error condition currently exists.
Cause: This message appears briefly to confirm that the response to another error message has corrected the problem.
Action: No action is required.

7.2.2 E1: Low Signal

Problem: Poor ultrasonic signal strength or the signal exceeds the limits entered via the User Program.
Cause: Poor signal strength may be caused by a defective cable, a flowcell problem, 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 of the User Program.
Action: Using the procedures in Chapter 1, check the components listed above. Also, check the value entered into the Signal Strength Error Limits option, as described in “Entering Error Limits” on page 65.

7.2.3 E2: Soundspeed Error

Problem: The soundspeed exceeds the limits programmed in the Error Limits option of the User Program.
Cause: The error may be caused by incorrect programming, poor flow conditions or poor transducer orientation.
Action: Compare the measured soundspeed to tabulated nominal values for the process fluid and correct any programming errors. Refer to “Fluid and Pipe Problems” on page 126 and “Transducer Problems” on page 127 to correct any problems.

7.2.4 E3: Velocity Range Error

Problem: The velocity exceeds the limits programmed in the Error Limits option of the User Program.
Cause: This error may be caused by the entry of improper programming data or by poor flow conditions and/or excessive turbulence.
Action: Make sure the actual flow rate is within the programmed limits. Also, check the value entered into the Error Limits option, as described on page 65. Refer to “Fluid and Pipe Problems” on page 126 and “Transducer Problems” on page 127 to correct any problems. If this error persists, and no fluid or pipe problems appear to exist, consider enabling the Tracking Windows option.
7.2.5  **E4: Signal Quality Error**

**Problem:** The signal quality is outside the limits programmed in the Error Limits option of the User Program.

**Cause:** The peak of the upstream or downstream correlation signals has fallen below the correlation peak limit, as set in the Error Limits option in “Entering Error Limits” on page 65. This may be caused by a flowcell or electrical problem.

**Action:** Contact GE.

7.2.6  **E5: Amplitude Error**

**Problem:** The signal amplitude exceeds the limits programmed in the Error Limits option of the User Program.

**Cause:** Solid or liquid particulates may be present in the flowcell. The error could also be caused by poor coupling for clamp-on transducers.

**Action:** Contact GE.

7.2.7  **E6: Cycle Skip, Acceleration Error**

**Problem:** The acceleration exceeds the limits programmed in the Error Limits option of the User Program.

**Cause:** This condition is usually caused by erratic flow conditions.

**Action:** Contact GE.

7.2.8  **E7: Analog Output Error**

**Problem:** The current setting is outside the programmed limits.

**Cause:** The calculated output value exceeds the programmed limits.

**Action:** Verify that the 4-20 mA loop configuration base and span settings are correct for the process. Revise the output range as necessary.

7.2.9  **E13: Settle Tracking AGC**

**Problem:** The meter is not finding the signal where it is expected.

**Cause:** The pipe may be empty or actual sound speed is outside of programmed range.

**Action:** Verify the fluid sound speed settings and fluid type.
7.2.10  **E14: Tracking Seek Mode**

**Problem:** The signal is intermittent.

**Cause:** Discontinuities in 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.

**Action:** Check the process conditions. If thermal insulation is present, ensure an even application to mitigate hot or cold spots.

7.2.11  **E15: Active Tw Error**

**Problem:** The active Tw measurement is outside of the expected range.

**Cause:** A transducer or cable is damaged, or a transducer needs to be recoupled.

**Action:** Ensure that the correct transducer is programmed for the meter. If this is not the fault, contact GE.

7.2.12  **E16: Totalizer Overflow Error**

**Problem:** The totalizers are unable to keep up with the total accumulated flow signals.

**Cause:** The programmed units/pulse value is too small.

**Action:** Select a larger number of units/pulse value.

7.2.13  **E17: Temperature Input Error**

**Problem:** This message indicates a temperature input error.

**Cause:** The temperature exceeds the specified limits for the analog/RTD inputs, or no input device is connected.

**Action:** Check the temperature transmitter and the connecting cable. Recalibrate the analog/RTD inputs.

7.2.14  **E18: Pressure Input Error**

**Problem:** This message indicates a pressure input error.

**Cause:** The pressure exceeds the specified limits for the analog inputs, or no input device is connected.

**Action:** Check the pressure transmitter and the connecting cable. Recalibrate the analog input.
7.2.15  **E19: Density Input Error**

**Problem:** This message indicates a density input error.

**Cause:** The density exceeds the specified limits for the analog inputs, or no input device is connected.

**Action:** Check the density input device and the connecting cable. Recalibrate the analog input.

7.2.16  **E20: Special Input Error**

**Problem:** This message indicates a special input error.

**Cause:** The special input exceeds the specified limits for the analog inputs, or no input device is connected.

**Action:** Check the input device and the connecting cable. Recalibrate the analog input.

7.2.17  **E21: API Error**

**Problem:** This message indicates an error in the API calculations.

**Cause:** The combination of pressure, temperature, density, and/or flow inputs causes the calculation to not properly resolve.

**Action:** The specific API error can be found in the API Info section of the meter program.

7.2.18  **E22: Degraded Performance Error**

**Problem:** The accuracy of the measurement is degraded.

**Cause:** A loss of one inner and/or outer chord measurement results in the sister inner/outer chord's measurement to be substituted, to provide a flow measurement with degraded accuracy.

**Action:** Contact GE.

7.2.19  **E23: Reduced Accuracy Error**

**Problem:** The accuracy of the measurement may be reduced.

**Cause:** The loss of two or more chords of measurement results in chord replacement algorithm to be used, which may introduce additional uncertainty.

**Action:** Contact GE.
7.2.20  **E24: Low SNR Error**

**Problem:** Signal to Noise lower than recommended units.

**Cause:** Many possible causes. Check that pipe is full.

**Action:** Contact GE.

7.2.21  **E29: Stale Data Error**

**Problem:** Data internally may be stale.

**Cause:** Data is stuck in internal state machine.

**Action:** The conditioning is self-recovering and will automatically correct itself.

7.2.22  **E30: Channel Disabled**

**Problem:** The channel is not available.

**Cause:** The channel has been turned off.

**Action:** Enter the PROGRAM menu and enable the channel (see “Activating a Channel/Path/CHX (Status)” on page 62).
7.3 Displaying Diagnostic Parameters

The Sentinel LCT4 offers built-in Diagnostic Parameters to aid in the troubleshooting of transducer and electrical problems. These Diagnostics can be set for viewing on the main Display as shown in “Display” on page 78. Some of the available diagnostics are shown in Table 37 below.

<table>
<thead>
<tr>
<th>Table 37: Available Diagnostic Parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Option Bar</strong></td>
</tr>
<tr>
<td>Delta-T[ns]</td>
</tr>
<tr>
<td>Amp Up</td>
</tr>
<tr>
<td>Amp Dn</td>
</tr>
<tr>
<td>T Up [µs]</td>
</tr>
<tr>
<td>T Dn [µs]</td>
</tr>
<tr>
<td>Gain Up [dB]</td>
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<tr>
<td>Gain Dn [dB]</td>
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<tr>
<td>Signal Up</td>
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<tr>
<td>Signal Dn</td>
</tr>
<tr>
<td>Thresh Up [%]</td>
</tr>
<tr>
<td>Thresh Dn [%]</td>
</tr>
<tr>
<td>Norm Factor</td>
</tr>
<tr>
<td>P# Up</td>
</tr>
<tr>
<td>P# Dn</td>
</tr>
<tr>
<td>Quality Up</td>
</tr>
<tr>
<td>Quality Dn</td>
</tr>
<tr>
<td>Reynolds #</td>
</tr>
<tr>
<td>k(Re)</td>
</tr>
<tr>
<td>Cycle Time (ms)</td>
</tr>
<tr>
<td>KFactor</td>
</tr>
<tr>
<td>#Errors</td>
</tr>
</tbody>
</table>
7.3 Displaying Diagnostic Parameters (cont.)

You can view multiple diagnostics for all channels by bringing up the Flow Info Form. To access the Flow Info Form:

1. From the display screen, press [ESC].

**Note:** You may not be able to access this menu with your current security level. Refer to Figure 66 on page 136 to see if your security level has access.


![Figure 58: Flow Info - Diagnostics CH1, p1](image)

3. Press the down arrow ([▼]) to view more diagnostics.

![Figure 59: Flow Info - Diagnostics CH1, p2](image)
7.3 Displaying Diagnostic Parameters (cont.)

4. Press \[\text{▼}\] again to view page 3, which has the Active TW diagnostics.

![Figure 60: Flow Info - Active Tw CH1](image)

5. Now press \[\text{▶}\] to view the other channels or \[\text{◀}\] to view previously viewed channels. The page number will stay the same so use the \[\text{▲}\] and \[\text{▼}\] arrows to navigate.

![Figure 61: Flow Info - Active Tw CH2](image)
7.4 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 GE for assistance.

7.4.1 Fluid Problems

Most fluid-related problems result from a failure to observe the flowmeter system installation instructions, as described in Chapter 2, Installation. Refer to Chapter 2 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 LCT4, 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 high vapor 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 a case, an E1 error code message 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 LCT4 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 LCT4, will result in erratic or inaccurate flow rate readings.

Note: Refer to Chapter 3, Operation, to make sure the appropriate soundspeed is programmed into the meter.
7.4.2 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 material at the transducer location(s).*
  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, for more details on proper installation practices.

- *The inside of the pipe must be relatively clean.*
  Excessive build up of scale, rust or debris will change the inner dimensions of the pipe and will result in inaccuracies in the calculation of the flow from the velocity measurement.

7.5 Transducer Problems

The Sentinel LCT4 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 a transducer or transducers, or if one is physically damaged, the GE Measurement & Control field service team has the appropriate methods and tools to properly replace the transducer to maintain the accuracy of your flow meter system. Contact your local GE representative to schedule this service.

7.6 Audit Trail

The Sentinel LCT4 tracks all changes to the programming, meter status (power on, power off), error status, date/time changes, etc.

7.6.1 Audit Log

The Sentinel LCT4’s Audit Log will record system activity to a human readable log and store it in persistent memory. The activity types that generate a log entry include instances of:

- Power On/Reset
- Parameter Change
- Alarms
- Error
- Calibration Change
- Default Meter
- Save/Restore/Delete Site
- Upgrade Meter
7.6.2 Audit Log (cont.)

The use of additional formatting allows for better readability. The meter can store up to 1000 audit and/or event records. When the log becomes full, the new record will overwrite the oldest record in the Audit trail. This circular log will enable the user to always view the last 1000 records. The audit log file is downloadable using PanaView SEN898 software, and is not viewable from the meter’s display. It is opened as a text file and the following details are part of each record:

- Rec# - The event/record number (1-1000)
- Date - Date that the event occurred (mm/dd/yyyy)
- Time - Time that the event occurred (hh:mm:ss)
- Source - The Channel on which the event occurs. This includes the meter source, or I/O sources as well.
- ID - Corresponding Parameter ID of value that changed
- Name - Event name
- Auth. - Security level
- Old - Original Value of parameter, version, or error
- New - New value of parameter, version, or error. Also includes meter events such as alarms being tripped or power events which have no previous values.

7.6.2a Power-On/Reset

The Audit log can be used to determine the meter start or reset time. The power-on is usually the first entry in the audit log file unless it was overwritten (after 1000 entries).

7.6.2b Parameter Change

The audit log will monitor all parameters which may have an impact on the flow measurement and will record changes to them.

7.6.2c Alarms

The Audit log will record an alarm event.
7.6.2d  **Error**

The error event will be recorded in the audit log file whenever the meter switches from a “No Error” state to “Error” state or vice versa.

7.6.2e  **Calibration**

Any calibration change needs to be notified to the user and is hence logged in the audit log file. For example, an option card changed might affect the calibration, in which case a record will be created.

7.6.2f  **Default Meter**

When a user defaults the meter (option enabled only for authenticated users, For Ex. Service) or a corruption that might lead to meter parameters to be defaulted occurs, an event is logged.

7.6.2g  **Save/Restore/Delete Site File**

When a user saves, restores or deletes a site file, an event is recorded.

7.6.2h  **Upgrade Meter**

When the meter’s firmware is updated to a different version, an event is recorded.
7.6.3 Reading Audit Log Records

The Sentinel LCT4 meter log records are read using the PanaView SEN898 software. To retrieve the meter log, click on Get Audit Log from the New Meter branch (see Figure 62 below). The Audit Log window (see Figure 63 below) opens. Click Get Audit Log to start retrieval of the log. Once the file is completely downloaded, the View File button becomes selectable. Click View File to view the log in a text file.

Figure 62: Options in New Meter Branch

Figure 63: PanaView SEN898 Audit Log Reader
### 7.6.4 Formatting and Viewing Log Records

The log records have neatly formatted columns for easy and better readability. The record types mentioned in *Audit Log*, in “Audit Log” on page 127, may contain irrelevant/not applicable column values that are represented with ‘---’ in the corresponding column. The Audit log file contains the following columns:

<table>
<thead>
<tr>
<th>Rec#</th>
<th>Date</th>
<th>Time</th>
<th>Source</th>
<th>ID</th>
<th>Name</th>
<th>Auth.</th>
<th>Old</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>12/11/2008</td>
<td>2:13:22</td>
<td>---</td>
<td>1</td>
<td>Alarm</td>
<td>---</td>
<td>---</td>
<td>Tripped</td>
</tr>
</tbody>
</table>

For example, a parameter change will be logged in as shown below:

<table>
<thead>
<tr>
<th>Rec#</th>
<th>Date</th>
<th>Time</th>
<th>Source</th>
<th>ID</th>
<th>Parameter Name</th>
<th>Auth.</th>
<th>Old</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>12/11/2008</td>
<td>5:11:58</td>
<td>1</td>
<td>25798</td>
<td>RxWWidth</td>
<td>0</td>
<td>1024</td>
<td>2048</td>
</tr>
</tbody>
</table>

The Audit log file is formatted such that the user has the flexibility of viewing or saving the log file as either a Text file or a Microsoft Excel file. In order to get the full benefits of the Audit trail feature, we recommend using the Microsoft Excel file. This option, however, is available only if Microsoft® Excel® 2000 or later is installed on the PC.
7.7 Uncertainty in Flow Rate for a Non-Insulated Meter

Dimensional compensation considers the effect on the geometrical dimensions of the meter due to the material thermal expansion or contraction. The fluid temperature inside of the meter 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 actual wall temperature. This will cause about a 0.04% error in the flow rate measured. Figure 64 below indicates that the errors increase as the temperature difference between the fluid and the ambient for both insulated and non-insulated meters. For non-insulated meters at large temperature differences, the error is about one order higher than that for insulated meters. Therefore for applications in severe weather conditions, it is recommended that the meter be insulated to ensure the meter accuracy.

Figure 64: Example of Flow Error at Various Temperature Differences
Appendix A. Menu Maps

A.1 List of Menu Maps

This appendix includes the following Sentinel LCT4 menu maps:

- Figure 65, “MFG and DEV Menu Map,” on page 135
- Figure 66, “PROG-CHANNEL Menu Map,” on page 136
- Figure 67, “PROG-COMPOSITE Menu Map,” on page 137
- Figure 68, “CONFIG Menu Map,” on page 138
- Figure 69, “IO-ANALOG OUTPUTS and IO-FREQ/TOTALS Menu Map,” on page 139
- Figure 70, “IO-ALARMS and IO-SLOT Menu Map,” on page 140
- Figure 71, “DISP, CAL, USER, and FACTORY Menu Map,” on page 141
[no content intended for this page]
Appendix A. Menu Maps

**Figure 65: MFG and DEV Menu Map**

- **Watchdog**
  - Pass: Meter restarts within 30 seconds.
  - Fail: Meter does NOT restart.
- **Keypad Test**
- **Display Test**
- **Flow Test**
  - DAC Count
  - Tx Relay
  - Rx Relay
- **Flow Test DAC**
- **Flow Test Tx**
- **Flow Test Rx**

**User 1/2, User 3/4, User Admin Access**

**User 3/4, User Admin Access**

**User Admin Access**
Appendix A. Menu Maps

Figure 68: CONFIG Menu Map
Figure 69: IO-ANALOG OUTPPUTS and IO-FREQ/TOTALS Menu Map
Appendix A. Menu Maps

To IO Menu Map #1 → To DISP, CAL, USER, FACTORY Menu Map

IO

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Figure 70: IO-ALARMS and IO-SLOT Menu Map

Fault State of Alarm

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1</td>
<td>Low Signal</td>
</tr>
<tr>
<td>E2</td>
<td>Soundspeed</td>
</tr>
<tr>
<td>E3</td>
<td>Vel/Range</td>
</tr>
<tr>
<td>E4</td>
<td>Signal Quality</td>
</tr>
<tr>
<td>E5</td>
<td>Amplitude</td>
</tr>
<tr>
<td>E6</td>
<td>Acceleration</td>
</tr>
<tr>
<td>E7</td>
<td>Aout Range</td>
</tr>
<tr>
<td>E13</td>
<td>Tracking AGC</td>
</tr>
<tr>
<td>E14</td>
<td>Tracking Seek</td>
</tr>
<tr>
<td>E15</td>
<td>Active Tw</td>
</tr>
<tr>
<td>E16</td>
<td>Total Overflow</td>
</tr>
<tr>
<td>E17</td>
<td>Temperature Input</td>
</tr>
<tr>
<td>E18</td>
<td>Pressure Input</td>
</tr>
<tr>
<td>E19</td>
<td>Density Input</td>
</tr>
<tr>
<td>E20</td>
<td>Spec Input</td>
</tr>
<tr>
<td>E21</td>
<td>API Error</td>
</tr>
<tr>
<td>E22</td>
<td>Degraded Performance</td>
</tr>
<tr>
<td>E23</td>
<td>Reduced Accuracy</td>
</tr>
<tr>
<td>E24</td>
<td>SNR</td>
</tr>
<tr>
<td>E25</td>
<td>API Error</td>
</tr>
<tr>
<td>E26</td>
<td>Reduced Accuracy</td>
</tr>
<tr>
<td>E27</td>
<td>Stale Data</td>
</tr>
<tr>
<td>E28</td>
<td>Channel Off</td>
</tr>
<tr>
<td>E29</td>
<td>Temperature Input</td>
</tr>
<tr>
<td>E30</td>
<td>Channel Off</td>
</tr>
</tbody>
</table>

Note: #C depends on type of option card selected.

Note: Menu appears only when Slot is occupied.

Sentinel™ LCT4 User’s Manual
Figure 71: DISP, CAL, USER, and FACTORY Menu Map
Appendix B.  CE Mark Compliance and High Noise Areas

B.1 Introduction

For CE Mark compliance, the Sentinel LCT4 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 high electrical noise areas.

B.2 EMC Compliance

In addition to the standard wiring requirements, the electrical connections must be shielded and grounded as described in Table 38 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>
<thead>
<tr>
<th>Connection</th>
<th>Cable Type</th>
<th>Termination Modification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transducer</td>
<td>Shielded cable</td>
<td>Terminate the shield using the cable glands (already done).</td>
</tr>
<tr>
<td>Power</td>
<td>Shielded cable</td>
<td>Terminate the shield to the case using the cable glands.</td>
</tr>
<tr>
<td>Shielding</td>
<td>Wires enclosed in a properly-grounded metal conduit do not require additional shielding.</td>
<td></td>
</tr>
<tr>
<td>All Input/Output Options</td>
<td>Shielded cable</td>
<td>Terminate the cable shields to the closest screw on the bus bar inside the enclosure.</td>
</tr>
</tbody>
</table>

**Note:** Make sure to connect the Sentinel LCT4 case to the earth ground with a grounding cable, using the external ground screws found on either side of the enclosure.
[no content intended for this page]
Appendix C. Service Record

C.1 Introduction

Whenever any service procedure is performed on the Sentinel LCT4 flow transmitter, the details of the service should be recorded in this appendix. An accurate service history of the meter can prove very helpful in troubleshooting any future problems.

C.2 Data Entry

Record complete and detailed service data for the Sentinel LCT4 in Table 39 below. Make additional copies of the table as needed.

<table>
<thead>
<tr>
<th>Date</th>
<th>Description of Service</th>
<th>Performed By</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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</table>
Table 39: Service Record (cont.)

<table>
<thead>
<tr>
<th>Date</th>
<th>Description of Service</th>
<th>Performed By</th>
</tr>
</thead>
<tbody>
<tr>
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Warranty

Each instrument manufactured by GE Sensing is warranted to be free from defects in material and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the instrument, at the sole discretion of GE Sensing. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If GE Sensing determines that the equipment was defective, the warranty period is:

- one year from delivery for electronic or mechanical failures
- one year from delivery for sensor shelf life

If GE Sensing determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified by GE Sensing, the repairs are not covered under this warranty.

The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties of merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

Return Policy

If a GE Sensing instrument malfunctions within the warranty period, the following procedure must be completed:

1. Notify GE Sensing, giving full details of the problem, and provide the model number and serial number of the instrument. If the nature of the problem indicates the need for factory service, GE Sensing will issue a RETURN AUTHORIZATION NUMBER (RAN), and shipping instructions for the return of the instrument to a service center will be provided.

2. If GE Sensing instructs you to send your instrument to a service center, it must be shipped prepaid to the authorized repair station indicated in the shipping instructions.

3. Upon receipt, GE Sensing will evaluate the instrument to determine the cause of the malfunction.

Then, one of the following courses of action will then be taken:

- If the damage is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.

- If GE Sensing determines that the damage is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs at standard rates will be provided. Upon receipt of the owner’s approval to proceed, the instrument will be repaired and returned.
Certification & Safety Statements for the Sentinel™ LCT4

When installing this apparatus, the following requirements must be met:

- Field wiring shall be rated at least 10°C above 85°C.
- 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 GE, the manufacturer's instructions, as supplied to GE, 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 -40°C to 85°C. 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.
- 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. 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.

Markings

- Markings shall appear on the meter and flowcell, as shown below, for the AC and DC powered versions and the flameproof enclosure:

- Markings shall appear on the meter and flowcell, as shown below, for the AC and DC powered versions and for increased safety:
Wiring Connections for Increased Safety

- **Power Connection**
  
  Maximum Size*: Solid - 4.0 mm² (12 AWG)
  Stranded - 2.5 mm² (14 AWG)

  Number of conductors**: 2 Solid - max 1.5 mm² (16 AWG)
  2 Stranded - max 1.0 mm² (18 AWG)

- **All Other Screw Terminal Connections**
  
  Maximum Size*: Solid - 4.0 mm² (12 AWG)
  Stranded - 2.5 mm² (14 AWG)

  Number of conductors**: 2 Solid - max 1.5 mm² (16 AWG)
  2 Stranded - max 1.5 mm² (16 AWG)

* Single conductor; **Multiple conductors of same cross-section
[no content intended for this page]
We,

GE Sensing
1100 Technology Park Drive
Billerica, MA 01821
USA

declare under our sole responsibility that the

Sentinel LCT Liquid Custody Transfer Ultrasonic Flowmeter
Sentinel LNG Cryogenic Liquids Ultrasonic Flowmeter
Sentinel SEN898 Ultrasonic Flow Transmitter

to which this declaration relates, are in conformity with the following standards:

- EN 60079-0: 2006
- EN 60079-1: 2007
- EN 61241-0: 2006, EN 6124101: 2004
- II 2 G Ex de IIIB T6 Ta = -40°C to +60°C IP66; FM09ATEX0072X (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: 2006, Class A, Table 2, Industrial Locations
- EN 61326-2-3: 2006
- EN 61010-1: 2012, Overvoltage Category II

following the provisions of the 2004/108/EC EMC, 2006/95/EC Low Voltage and 94/9/EC 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 97/23/EC for DN<25.

Billerica - October 2013

Issued

Mr. Gary Kozinski
Certification & Standards, Lead Engineer
[no content intended for this page]
Customer Support Centers

U.S.A.
The Boston Center
1100 Technology Park Drive
Billerica, MA 01821
U.S.A.
Tel: 800 833 9438 (toll-free)
    978 437 1000
E-mail: sensing@ge.com

Ireland
Sensing House
Shannon Free Zone East
Shannon, County Clare
Ireland
Tel: +353 61 61470200
E-mail: gesensingsnnservices@ge.com

An ISO 9001:2008 Certified Company

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