Capacitance Transmitters

SITRANS LC500

Operating Instructions • 03/2010

SITRANS

SIEMENS

Safety Guidelines: Warning notices must be observed to ensure personal safety as well as that of others, and to protect the product and the connected equipment. These warning notices are accompanied by a clarification of the level of caution to be observed.

Qualified Personnel: This device/system may only be set up and operated in conjunction with this manual. Qualified personnel are only authorized to install and operate this equipment in accordance with established safety practices and standards.

Unit Repair and Excluded Liability:

- The user is responsible for all changes and repairs made to the device by the user or the user's agent.
- All new components are to be provided by Siemens Milltronics Process Instruments Inc.
- Restrict repair to faulty components only.
- Do not reuse faulty components.

Warning: Cardboard shipping package provides limited humidity and moisture protection. This product can only function properly and safely if it is correctly transported, stored, installed, set up, operated, and maintained.
This product is intended for use in industrial areas. Operation of this equipment in a residential area may cause interference to several frequency based communications.

Note: Always use product in accordance with specifications.

	Disclaimer of Liability
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Safety Notes

Special attention must be paid to warnings and notes highlighted from the rest of the text by grey boxes.

WARNING: relates to a caution symbol on the product, and means that failure to observe the necessary precautions can result in death, serious injury, and/or considerable material damage.

WARNING: means that failure to observe the necessary precautions can result in death, serious injury, and/or considerable material damage.

CAUTION: means that failure to observe the necessary precautions can result in considerable material damage.

Note: means important information about the product or that part of the operating manual.

Safety marking symbols

	Alternating Current
	Direct Current
	Earth (ground) Terminal
	Protective Earth Terminal
	Frame or Chassis Terminal
	Cathodic protection resulting in a potential difference: for example, between the ground on the instrument and the potential of the vessel or tank

The Manual

Notes:

- Please follow the installation and operating procedures for a quick, trouble-free installation and to ensure the maximum accuracy and reliability of your SITRANS LC500.
- This manual applies to the SITRANS LC500 only.
- This product is intended for use in industrial areas. Operation of this equipment in a residential area may cause interference to several frequency based communications.

WARNING: This product can only function properly and safely if it is correctly transported, stored, installed, set up, operated, and maintained

This manual will help you set up your SITRANS LC500 for optimum performance. We always welcome suggestions and comments about manual content, design, and accessibility.

Please direct your comments to techpubs.smpi@siemens.com. For other Siemens Milltronics level measurement manuals, go to: www.siemens.com/level and look under Level Measurement.

Application Examples

- General Purpose, Dust Ignition Proof, and Explosion Proof
- A wide range of applications in high pressure and temperature, chemically aggressive, and other extreme measurement/detection environments
- Liquids, Solids, Quality, and Interface measurement
- Viscous non-conducting and conducting liquids

Technical Support

Support is available 24 hours a day.

To find your local Siemens Automation Office address, phone number and fax number go to:

www.siemens.com/automation/partner

- Click on the tab Contacts by Product then drill down to find your product group (+Process Automation > +Process Instrumentation > Level Measuring Instruments).
- Select the team Technical Support. Click on Next.
- Click on the appropriate continent, then select the country followed by the city. Click on Next.

For on-line technical support go to:

www.siemens.com/automation/support-request

- Enter the device name (SITRANS LC500) or order number, then click on Search, and select the appropriate product type. Click on Next.
- You will be prompted to enter a keyword describing your issue. Then either browse the relevant documentation, or click on Next to email a detailed description of your issue to Siemens Technical Support staff.

Siemens A&D Technical Support Center: phone +49 180 50 50 222
fax +49 180 50 50 223+

Abbreviations and Identifications

Short form	Long Form	Description	Units
A/D	Analog to Digital		
CE / FM / CSA	Conformité Europèene / Factory Mutual / Canadian Standards Association	safety approval	
D/A	Digital to Analog		
DAC	Digital Analog Converter		
DCS	Distributed Control System	control room apparatus	
ESD	Electrostatic Discharge		
Ex	Explosion Proof	safety approval	
Exd	Flame Proof	safety approval	
FV	Full Vacuum		
HART	Highway Addressable Remote Transducer		
LRV	Lower Range Value	value for 0 %	4 mA
LSL	Lower Sensor Limit	below which no PV is anticipated	
µF	micro Farads	10^{-6}	Farad
µs	micro Seconds	10^{-6}	Seconds
PED	Pressure Equipment Directive	safety approval	
pF	pico Farads	10^{-12}	Farad
ppm	parts per million		
PV	Primary Variable	measured value	
Stilling Well	Grounded metal tube with openings		
SV	Secondary Variable	equivalent value	
SVLRV	Secondary Variable Lower Range Value	0% equivalent value	
SVURV	Secondary Variable Upper Range Value	100% equivalent value	
TV	Transmitter Variable		
URV	Upper Range Value	value for 100%	20 mA
USL	Upper Sensor Limit	above which no PV is anticipated	

SITRANS LC500 Overview

Introduction

SITRANS LC500 is a high performance 2-wire capacitance instrument for continuous level and interface measurement in extreme or critical conditions. It uses a unique frequency-based measurement system and patented Active-Shield technology to deliver highly accurate, repeatable results. The measurement is unaffected by moisture, vapors, foam, temperature and pressure variations, or material build-up around the mounting glands.

SITRANS LC500 combines a sophisticated, easy-to-adjust transmitter with a measurement electrode and process seal selected from a range of options[1], to suit a wide variety of applications. The advanced electronics and integrated local display provide for one-step calibration without interrupting the process, and the probe shield design eliminates the need for frequent recalibration.

SITRANS LC500 can be used as a level controller, by connecting the mA output and/or the solid-state switch to a relay, and activating a pump via an auxiliary power circuit.

The SITRANS LC500 is equipped with:

- Smart 2-wire transmitter
- Remote adjustable commissioning / control capabilities via HART[2]
- Analog (2-wire) 4 to 20mA / 20 to 4 mA output
- Solid-state and Current detection (4 or 20 mA / 20 or 4 mA, two-state functionality)
- Adjustable hystereses on/off for solid-state output and for current signal
- Damping functionality
- Signal current (measurement/detection) according to NAMUR NE 43
- Integrated local display for commissioning and services activities
- Full range of local/remote diagnostic facilities
- Polarity-insensitive current loop
- Integrated zener safety barrier

1. Customized probe configurations can also be provided.
2. HART® is a registered trademark of the HART Communications Foundation, Austin, Texas, USA.

Technical Specifications

Power

Supply voltage	
• maximum:	33 V DC
• minimum	12 V DC at 3.6 mA (9.5 V DC at 22 mA)
Loop current	3.6 to 22 mA / 22 to 3.6 mA (2-wire current loop)

Environmental

Location	indoor/outdoor
Altitude	2000 m max.
Ambient temperature	
• standard:	-40 to +85 ^{o}C (-40 to +185 ^{o}F)
• ATEX-Explosion Proof	-40 to +70 ^{o}C (-40 to +158 ^{o}F) for T6
	-40 to +85 ^{o}C (-40 to +185 ^{o}F) for T5 to T1
Relative humidity	suitable for outdoor (Type 4X / NEMA 4X / IP65, IP68 enclosure)
Installation category	I
Pollution degree	4

Performance

Measurement range	
Transmitter type	
• MSP-2002-2	1 to 3300 pF
Minimum span	3.3 pF
Measurement frequency	420 kHz @ Cx = 0 pF
Accuracy	deviation <0.1% of actual measurement value
Non-linearity	0.1% full scale
Repeatability	0.1% actual measurement
Temperature stability	0.15 pF (0pF) or <0.25% (typically <0.1%) of actual measurement value, whichever is greater over the full temperature range of the transmitter

Safety	• current signalling according to NAMUR NE 43; 3.6 to 22 mA / 22 to 3.6 mA • probe input ESD protected to 55 kV • inputs/outputs fully galvanically isolated • polarity-insensitive current loop • fully potted • integrated safety barrier
Diagnostics (Includes fault alarm)	• primary variable (PV) out of limits • system failure measurement circuit • deviation between A/D and D/A converter values • check sum • watch dog • self-checking facility

Outputs

• galvanically isolated	
• damping	range 1 to 10,000
Current loop	
• continuous signal	4 to 20 mA / 20 to 4 mA
• 2-state functionality	4 or 20 mA / 20 or 4 mA, on or off
• time delay	1 to 100 sec. activating / de-activating
• adjustable hysteresis (on / off)	0 to 100%, min. 1% of range
Solid-state switch	
• time delay	1 to 100 sec. activating / de-activating
• adjustable hysteresis (on / off)	0 to 100%, min. 1% of range
• max switching voltage	30 V DC/30 V peak AC
• max. load current	82 mA

User Interface

Local digital display	4 1/2 digit LCD
Rotary function switch	for selecting programmable menu items
• 16 Positions	0 to 9, A to F
Push-buttons: RED (+), BLUE (–)	used in conjunction with rotary switch, for programming menu items

Communications

HART [1] Communication protocol

1. HART® is a registered trademark of the HART Communications Foundation.

Electrodes

Process connections

- threaded connection — AISI 316 L stainless steel, 3/4", 1", 1-1/4", 1-1/2", 2" NPT, BSPT, JIS
- flat-faced flanges — AISI 316 L stainless steel ANSI, DIN[1]

Probe diameter

- Cable: — 9 mm (0.35")
- Rod: — 16 mm (0.63") or 24 mm (0.95")

Probe length

- Rod version: — up to 3500 mm (138") with 16 mm (0.63") diameter probe
  up to 5500 mm (216") with 24 mm (0.95") diameter probe
- Cable version: — 35 m (15 ft.)

Probe insulation — PFA, Enamel[2]

Wetted Parts

Probe insulation	PFA / Enamel
Threaded connection	AISI 316 L stainless steel
Flange	AISI 316 L stainless steel or Teflon[3] covered

Enclosure (electronic)

- construction — aluminum, epoxy-coated; diameter 160 mm (6.3")
- cable entry — 2 x 1/2" NPT
- ingress protection — Type 4X / NEMA 4X / IP65, IP68

Weight

Depends on configuration.

Example:

rod: PFA insulated, 16 mm (0.63") dia., 1 m (39.4") insertion length
weight: approx. 5 kg

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1. Please see *Flange Standards* on page 92 for a table showing flange sizes.
2. Only available as Rod version, max. length 1500 mm (59"), and only for use in applications where pH $\leq$ 7.
3. Teflon® is a registered trademark of Dupont.

Process Conditions

Pressure range[1]

- standard (PFA) -1 to 150 bar g (2175 psi g)
- High temperature version (Enamel) -1 to 345 bar g (5004 psi g)

Temperature range[1]

- standard (PFA) -50 to +200 °C (-58 to +392 °F)
- High temperature version -60 to +400 °C (-76 to +752 °F)
- Cryogenic version -200 to +200 °C (-328 to +392 °F)

Approvals

CE	Complies with the following European Directives: EMC Directive 2004/108/EC, ATEX Directive 94/9/EC, and PED Directive 97/23/EC	
C-TICK		
Dust Ignition Proof (DIP)	ATEX II 3GD (EEx nA [ib] IIC T4...T6)	
	FM/CSA:	Class I, Div. 2, Gr. A,B,C,D T4 Class II, Div. 1, Gr. E,F,G T4 Class III, Div. 1, Gr. E,F,G T4
Flame-proof/ Explosion-proof enclosure	ATEX II 1/2 GD (EEx d [ia] IIC T6...T1) FM:	 Class I, Div. 1, Gr. A,B,C,D T4
Lloyds Register of Shipping	Categories ENV1, ENV2, ENV3, ENV5	

Notes:

- See *Appendix F: Approvals* on page 104 for details of certification.
- Intrinsically Safe (IS) approval [ATEX II 1 G (EEx ia IIC T4...T6), FM/CSA:Class I, Div. 1, Gr. A,B,C,D T4] no longer available. For LC500 devices purchased prior to June 2008 with IS approval, refer to Instruction Manual 7ML19985GE01, Edition 1.2. Go to www.siemens.com/level. From the LC500 product page, search the **Instructions and Manuals** archive.

1. Please refer to page 19, Temperature/ Pressure Curve chart, for specific combinations of temperature and pressure.

Operating Principles

Capacitance[1] measurement operates by forming a variable capacitor resulting from the installation of a vertical measurement electrode in a vessel or silo. The tank wall usually forms the reference electrode of the capacitor. Whatever material is sandwiched between the two electrodes forms the dielectric. This will be composed of the vessel contents (air, vapor, liquid, solid, or a combination) and, if the measurement electrode is insulated, the insulating layer (PFA, for example). The dielectric gives a capacitance value that is proportional to level.

Capacitance is affected by the surface area of the electrodes, the separation distance between the electrodes, and the dielectric constant of the vessel contents. The dielectric constant is the measure of a material's ability to store energy. The relative dielectric constant of air (vacuum) is 1: all other materials have a higher value.

Note: To preserve linearity of the measurement, both electrodes must be parallel. (When the vessel contents are conductive, the measurement electrode is insulated and the interface between the insulating layer and the contents acts as a parallel reference electrode independent of the tank wall.)

The SITRANS LC500 variable frequency oscillator

The SITRANS LC500 probe is equipped with a variable frequency oscillator which responds to the capacitance: a change in capacitance is registered as a change in frequency. The relationship between capacitance and frequency is inverse, resulting in high resolution and accuracy. The variable frequency maintains a constant relationship to the reading.

Capacitance measurement in a cylindrical metal tank

In a cylindrical tank, it is possible to determine the initial capacitance in air by factoring in the length of the probe, diameter of the probe, diameter of the tank, and the relative dielectric constant of air.

1. For definitions relating to capacitance, see the glossary, page 106.

The formula[1] is: $C = \frac{K \times \varepsilon \times L}{Log(D/d)}$

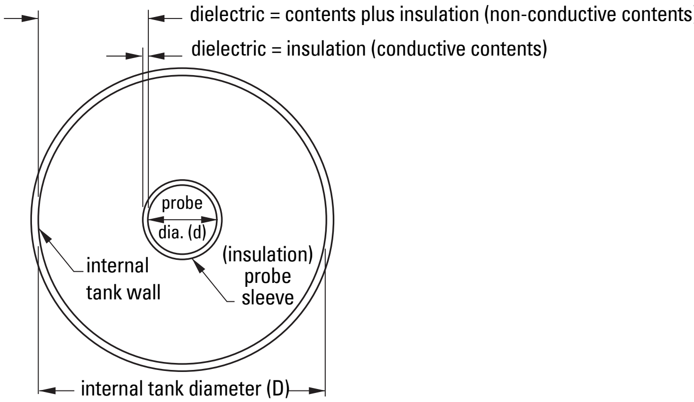
where C = capacitance
K = constant
ε = dielectric constant
L = active measurement length
D = diameter of tank
d = probe diameter.

(For detailed application examples, see page 100.)

The transmitter measures the capacitance of the measurement electrode relative to the tank wall (reference electrode) and transforms it to a 4-20 mA signal. Any material that covers the probe will cause an increase in capacitance relative to an uncovered probe surrounded by air. As the product level rises the capacitance will increase.

Non-conductive or conductive contents

In practice, the SITRANS LC500 probe is usually insulated. If the vessel contents are non-conductive, the dielectric is composed of the vessel contents and the insulation, and the separation distance is from the probe to the tank wall. The tank wall is the reference electrode, and it must be connected to the ground point on the instrument.



Note: For simplicity, the probe is shown centrally mounted. If it is to be mounted off-centre, take care to ensure the electrode remains parallel to the tank wall.

If the vessel contents are conductive, the electrode must be insulated. In this case the dielectric is the insulation layer and the interface between the conductive contents and the insulating sleeve acts as the reference electrode. This reduces the separation distance for the filled portion of the tank to the thickness of the insulation. It also creates a linear reference electrode independent of the tank wall.

1. This formula applies to a centrally mounted probe: for a probe mounted off-centre, the formula must be adjusted.

In a non-conductive or irregular tank

Where the vessel contents are non-conductive:

- a reference electrode parallel to the measurement electrode is required
- the reference electrode must be grounded to the instrument
- a stilling well can form the reference electrode.

Where the vessel contents are conductive:

- the interface between the contents and the electrode insulation acts as the reference electrode
- a connection from the vessel contents to the instrument ground is required
- a stilling well can provide a means of connecting the contents to the instrument ground.

The stilling well

The stilling well is a metal tube concentric with the electrode, with vent openings to facilitate level equalization. Its diameter is somewhat larger than that of the electrode, depending on the application. The stilling well can either be integral to the SITRANS LC 500, or it may be part of the tank[1].

The SITRANS LC500 electrode

The SITRANS LC500 electrode, comprising a measurement section and an active shield section, is the primary sensor of the system. It supplies the electrical capacitance value of the measurement section relative to the environment (tank wall or stilling well).

The SITRANS LC500 patented Active-Shield Technology electrically isolates the measurement section and prevents any non-measurement capacitance from interfering with the measurement. (Capacitance changes could result from uncontrolled variations occurring in the connection cable, process connection, and non-active parts of the probe). This results in a better ratio of initial capacitance to total capacitance, resulting in higher accuracy.

1. The tank wall, or the stilling well if it is part of the tank, must be grounded.

Conventional Capacitance Measurement

$$R = \frac{(C1 + C2 + C3) + Ca}{(C1 + C2 + C3) + Ca + Cm}$$

SITRANS LC500 with Active Shield

$$R = \frac{Ca}{Ca + Cm}$$

R = Ratio between initial capacitance and total capacitance

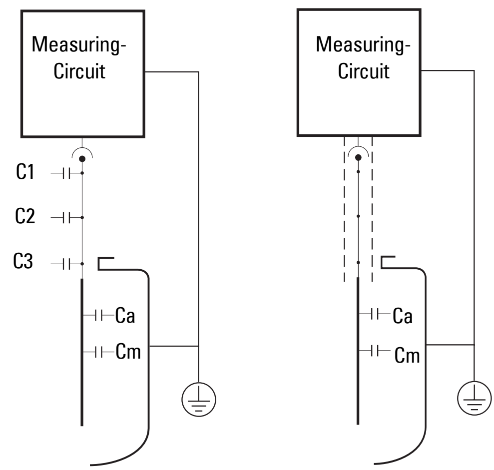
Ca = Initial capacitance (air)

Cm = Capacitance Increase (product)

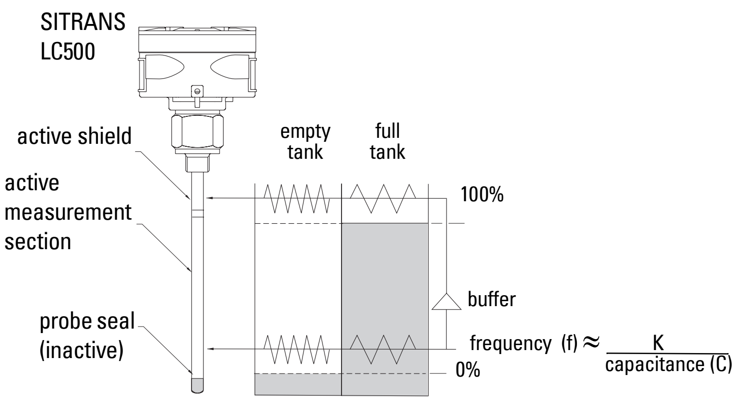
C1 = Capacitance connection point

C2 = Capacitance connection cable

C3 = Capacitance Process connection (includes active part)



The measurement is further protected from interference by a buffer, which applies the frequency signal from the measurement section to the active shield section. This effectively eliminates any electrical potential difference between the shield and the measurement section and prevents additional changes in capacitance occurring.



The relative lengths of the measurement section and active shield section can be specified to suit a particular application. If the measured range will be short relative to the total length of the electrode, specify a short measurement section. This increases the achievable resolution of the measurement, since any change in level will be greater relative to the length of the measurement section.

The entire SITRANS LC500 transmitter is potted in epoxy resin as part of the intrinsic safety protection. The potting also protects the electronics against mechanical vibration and moisture influences.

The transmitter is connected to the electrode by a mini coaxial cable, and grounded to a connection point inside the enclosure. The external ground lug on the enclosure provides a means of connecting the instrument system ground to a grounded tank or stilling well[1]. (For more detailed information on grounding requirements, please see Grounding Examples, page 29.)

The measuring range of the SITRANS LC500 is 3300 pF (1.0 pF $\cong 10^{-12}$F).

Note: For safety purposes, and to ensure reliable measurement signals, the external ground lug provided on the SITRANS LC500 enclosure must be firmly connected by an adequate cable to the grounded vessel or stilling well[1].

Application: SITRANS LC500

The SITRANS LC500 provides an analog and a solid-state output. The analog output can be either a continuous signal proportional to the reading, or in 2-state mode, a mA signal operating according to NAMUR recommendations for fault signalling[2].

0% (LRV) and 100% (URV) can be set anywhere within the measurement range.

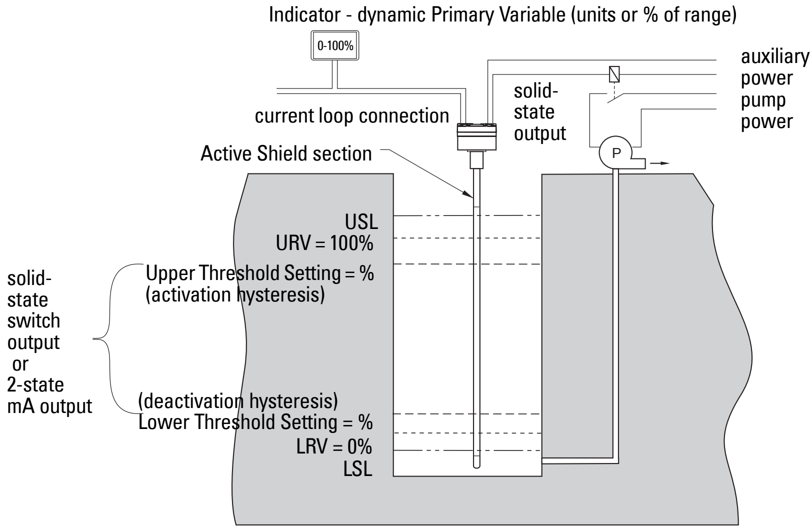
1. The loop current provides either:
   a. an analog signal:
      - a reading proportional to level (PV) under normal conditions
      - an out-of-limits display, '**ooL**', alternating with PV, in fault conditions (if the process level exceeds the limit settings [USL] or [LSL])

   or:

   b. in 2-state mode, provides a mA output:
      - 4 mA or 20 mA output for 0% and 100%, under normal conditions
      - a 3.6 or 22 mA output in fault conditions (when 2-state fault signalling [menu 08] is enabled, if the process level exceeds the limit settings [USL or LSL])
2. The solid-state output can be set to 'contact open' or 'contact closed', relative to a covered probe: it can be wired to an external relay and used to activate an external alarm or a pump via an auxiliary power circuit. It can be activated under normal conditions by the threshold settings, or Fault signalling can be enabled at menu 18.

Operation & Application

1. Where the stilling well is welded to the tank.
2. See page 101 for detailed examples.



3. Upper Threshold Setting and Lower Threshold Setting activate and deactivate the 2-state output, and/or the solid-state output: the settings can be modified to adjust the hysteresis (the window within which the probe is considered 'covered').
4. The speed of response to activation and deactivation of the solid-state and/or 2-state output can be modified by Upper and/or Lower Threshold delays.
5. The PV reading can be stabilized if necessary by applying Damping.
6. Overfill or underfill protection can be set in the absence of those conditions by applying the Delta Range Setting.
7. Analog Fault Signalling (menu 08) and Digital Fault Signalling (menu 18) take precedence over the threshold settings (menus 07 and 17).

Level Measurement

The continuous 4-20 or 20-4 mA signal is proportional to the surface level of the product, with an accuracy of 0.1% of the actual measurement (for example, 1mm/m).

Typically, Lower Range Value (LRV - 0%) is set to 4 mA and Upper Range Value (URV - 100%) is set to 20 mA: but the reverse is possible if required. The measurement takes place anywhere within that range. The LCD displays the value as mA, or pF, or percent, depending on the setting for the transmitter variable (TV). If you are using HART, you have the option to define the units.

Interface Measurement

The capacitance of the electrode system is dependent on the dielectric constant of the product surrounding the probe. By comparing the capacitances resulting from different products with different dielectric constants, it is possible to determine which product is surrounding the probe.

For miscible products:
Contamination of one product by another can be measured:

100% product A	4 mA
100% product B	20 mA

Values in between 4 and 20 mA represent the ratio of the two products.

For immiscible products:
The interface between two products can be detected by the change in capacitance from one to the other. (See example, *For Vessels filled with Oil* on page 100.)

Switch action

2-state Switch

The mA output can be used as a 2-state switch set to either 4 or 20 mA. It can be set to go to 4 mA if the probe is covered and 20 mA if the probe is uncovered, or the reverse.

Solid-state Switch

The solid-state output can be set to ‘contact open’ or ‘contact closed’ with a covered probe.

Adjustable hysteresis and time delay

The adjustable hysteresis and time delay settings allow you to adjust the switch action for applications with a lot of surface movement.

Examples:
With a moving surface that fluctuates between 79% and 80%, if the hysteresis is set so that 80 is on and 79 is off, the alarm will constantly alternate between on and off. Either set a time delay, or adjust the hysteresis:

- Set the time delay to 10 seconds (for example): the alarm will be on only after the surface has been at 80% for at least 10 seconds.
- Reset the hysteresis for 70 (for example): the unit will ignore small surface fluctuations between 79 and 80%.

Fault Signalling

The SITRANS LC500 has three fault signalling options:

- via the loop-current
- via HART
- via the solid-state output or solid-state relay.

Via the loop current

When using the mA signal, the SITRANS LC500 operates according to NAMUR standards[1] for fault signalling. The fault/failure signal can be triggered by a failure in the measuring system, such as:

- a checksum error
- a loss of signal caused by a defect in the module
- a short circuit in the sensor
- a process failure if the level exceeds the limit settings and if the unit is programmed to detect this

You can set the Upper and Lower Sensor Limits (menus 0B and 0C) outside the Upper and Lower Range Value settings. In this case, if the process value is outside its nominal range (the span between LRV and URV), but still not at a fault/failure level, the continuous mA output will saturate to 3.8 mA or 20.5 mA. If the process value is outside the Upper or Lower Sensor Limits, this will be registered as a fault/failure.

Depending on the setting chosen for 2-state Fault Signalling (menu 08), the signal will go to either 3.6 mA (F: Lo) or to 22 mA (F:Hi). If you do not use communications to receive status information, we recommend enabling analog fault signalling (menu 08), in order to be warned if a fault or failure occurs. (This feature is disabled by default.)

Via HART

See page 75 for *HART Response Code Information*. Each HART message is accompanied by a response code. It is then up to the Host to decide what to do in the case of a fault situation. The Host may decide to issue Command 48, which returns more detailed information.

Via the solid-state output

The solid-state switch can be wired up to an external relay, to provide a second level of protection. It can then be used to activate a failure alarm, or a level switch. (See page 101 for details of an application using SITRANS LC500 as a level indicator, with the two-state output connected to a relay that activates a pump.)

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1. See *NAMUR recommendation NE 43* on page 104 for more details.

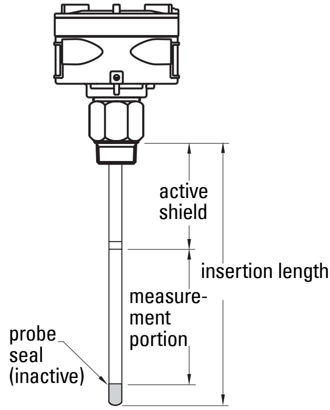
Probe Configuration

The probe (electrode) comprises a measurement section and an active shield section. This electrode connects to the capacitance detector portion of the two-wire loop powered electronic transmitter. The transmitter module is mounted in a powder-coated aluminum enclosure which provides reliable operation in environments with dust, moisture, and high-frequency interference.

SITRANS LC500 Electrode (Probe) Characteristics

Apply to all general connection configurations:

- The standard SITRANS LC500 insulated electrode is designed for use in both conducting and non-conducting liquid applications.
- Most electrodes consist of an active shield portion and a measurement portion, which combine to form the complete electrode. (This is not the case for cable electrodes or electrodes with ceramic/enamel insulation.)
- The sum of the active shield length and the measurement length is the total insertion length.
- The active shield design provides continuous immunity from changes in conditions at the top of the vessel where levels of vapors, dust, and condensation may be constantly changing.
- The design of the active shield isolates the starting capacitance of the electrode from the effects of changes in capacitance due to temperature and pressure fluctuations that could cause small changes in the seal geometry.
- The carefully-controlled diameter of the electrodes and insulation produces a linear output over a wide range of capacitance values (1 pF to 3300 pF).
- The end seal is formed as an integral part of the electrode insulation, giving smooth and uniform characteristics (tested to 55 kV).
- Standard single cone seal



Electrode Assembly

Process Connections

The standard threaded process connection (S-Series) with PFA insulated electrode, including the active shield, provides good results in all measurement situations within the temperature, pressure, and corrosive capabilities of the materials and seals. This remains true over a wide range of dielectric constants in both non-conducting and conducting materials.

Any standard process connection is available with the SITRANS LC500, and special versions can be fabricated to match the mounting and application requirements. A wide range of threaded and flanged fittings is available. (Contact your local Siemens Milltronics representative for details, or check our website at: www.siemens-milltronics.com.)

Seal Types

The basic internal seal for the SITRANS LC500 has a conical-shaped, preloaded pressure/leak resistant construction. Up to three levels of seal protection are implemented depending on the integrity requirements of the application. A single or double cone internal seal forms one or two barriers against leaking, and a third flange face gasket is also available in the D and DD seal construction. The flange face seal also provides a design with no metal wetted parts if required.

Process Connection and Seal Configuration of SITRANS LC500

Process Connection	Seal Type	Seal Description
Threaded	S	Single Cone
Welded Flange	S	Single Cone
Solid Machined Flange	S	Single Cone
	D	Single Cone + Teflon flange seal
	DD	Double Cone + Teflon flange seal. (Consult your local Siemens Milltronics representative.)
	SD	Double Cone (used for stilling well applications)

Probe Configuration

Pressure and Temperature Considerations

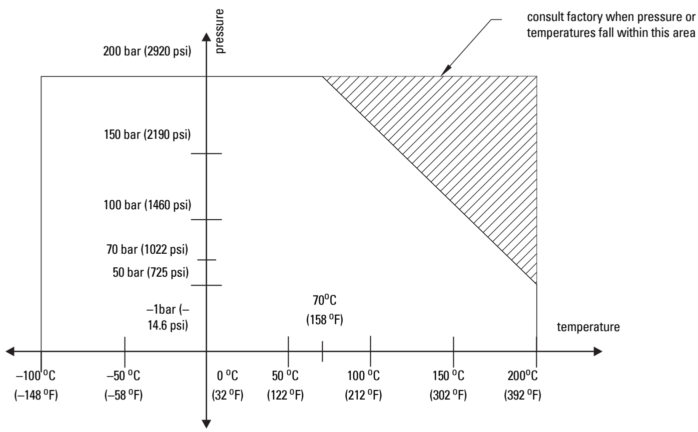
The maximum temperature and pressure of operation for the standard SITRANS LC 500 level probe is 200°C (392°F) and 200 bar (2900 psi). Please consult the pressure curve on page 19 for qualifications that must be applied to these maximums.

Enamel probes are recommended when the process temperature exceeds 200 °C, and/or in combination with very high pressure.

Note: Consult your Siemens Milltronics representative if the material to be measured may be incompatible with the SITRANS LC500 materials of construction.

Temperature Versus Pressure Curve for SITRANS LC500 PFA-insulated Level Probe

As the temperature approaches 75°C (167°F), the maximum pressure must be derated[1]. When the temperature reaches 200°C (392°F), the maximum pressure is limited to 50 bar (725 psi). This curve is typical for water only. For other, more aggressive chemicals the derating curve will be more severe.



Reference Product: Water

Notes:

- For high temperature and pressure ratings for the Enamel probe, please contact your Siemens Milltronics representative.

1. Decreased within the limits specified in the diagram (maximum 200 bar).

Non-standard applications

Applications outside the standard capabilities of the S-Series require a different design configuration. These non-standard applications include:

Non-Standard Application	SITRANS LC500 Configuration
Non-metallic tanks with both conducting and non-conducting liquids.	Use stilling well for second electrode reference.
Non-conducting liquids in spherical and horizontal-cylindrical tanks.	Use a stilling well as linearizer.
Highly corrosive materials requiring no metallic wetted parts.	Use flange mount with PFA Facing (7ML5517).

For more details on alternate configurations, see, *Appendix E: SITRANS LC500, alternate versions and application details on* page 83.

Installation

Notes:
- Installation shall only be performed by qualified personnel and in accordance with local governing regulations.
- This product is susceptible to electrostatic discharge. Follow proper grounding procedures.

! **WARNINGS:**
- **Disconnect the device before any welding is carried out in the vicinity of the instrument.**
- **Provide protection when the solid-state switch is activating an external relay to prevent possible switch/relay damage resulting from inductive spikes generated by the relay coil. (See *Protection for solid-state switch* on page 22 for details.)**

Handling Electrodes

! **WARNINGS:**
- **Do not scratch or gouge the PFA electrode insulation since this could reduce the integrity of the insulation and the useful life of the electrode.**
- **Be careful with an enamel-insulated electrode[1].**
- **Do not damage the insulation jacket on the electrode during shipping, packing, and installation[2]. Any damage to the electrode can prevent proper performance.**
- **(ATEX 95): Precautions MUST be taken to avoid ignition due to hazardous electrostatic discharges:**
  - **a. Where an isolated probe is used in gas, vapor, or a non-conductive liquid that is potentially explosive, requiring apparatus group IIC equipment.**
  - **b. Where the probe is used in a potentially explosive dusty atmosphere.**

1. Normally the enamel insulation is protected by a stilling well, which is part of the design.
2. Most electrodes use PFA insulation, a very dense and reliable type of Teflon® that prevents leakage and corrosion of the metal electrode and acts as an insulator when conductive materials are being measured.

Mounting Instructions

The SITRANS LC500 is easily installed: simply mount the instrument on the process connection of the vessel.

Notes:

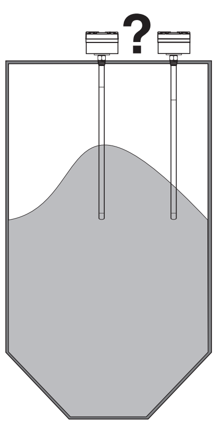
- The transmitter is specified for use at temperatures ranging from –40 °C to 85 °C (–40 °F to 185 °F): if your process temperature is outside this range, a standard option is available with a thermal isolator.
- Before mounting the SITRANS LC500, check to ensure the threads are matching to avoid damaging them.

Protection for solid-state switch

- for dc circuits: connect protection diodes in the correct polarity across the relay coil
- for ac circuits: connect a Voltage Dependent Resistor (VDR) or other ac compatible component (such as zeners and protection diodes in combination) in the correct polarity across the relay coil

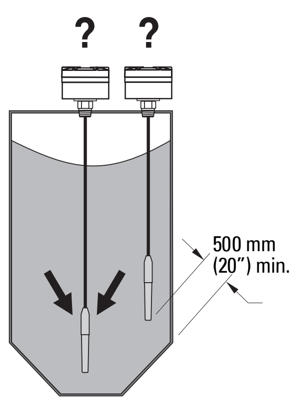
Process Cautions

CAUTION: Consider material surface configuration when installing unit.



CAUTIONS:

- With a centrally mounted cable version, take care that the tensile load does not exceed probe or vessel rating
- With a cable version mounted close to the tank wall, take care that the product does not push the cable against the tank wall: a spring can be used as a retainer.



SITRANS LC500: Standard Level Version

Available with the following features:

- Threaded flanges, welded flanges, and single-piece flanges
- S series process seals
- Selections of standard ANSI and DIN flanges
- The most common electrode is insulated with PFA. Enamel (HP seal) is also available (rigid design only).
- Various process connection materials
- Both Rod and Cable versions

See *Appendix E: SITRANS LC500, alternate versions and application details*, page 83 onward, for details on dimensions, and for application examples.

Interconnection

Wiring

⚠ **WARNING:**

- **The DC input terminals shall be supplied from a source providing electrical isolation between the input and output, in order to meet the applicable safety requirements of IEC 61010-1.**
- **Observe the specifications of the examination certificate valid in your country.**
- **Observe the laws and regulations valid in your country for electrical installations in potentially explosive atmospheres.**
- **Ensure that the available power supply complies with the power supply specified on the product nameplate and specified in the examination certificate valid in your country.**
- **Dust-proof protection caps in the cable inlets must be replaced by suitable screw-type glands or dummy plugs, which are appropriately certified for transmitters with explosion-proof protection.**
- **The lid must not be opened in wet locations while the unit is powered. (A wet location is a location where water or another conductive fluid may be present and is likely to increase the risk of electric shock.)**

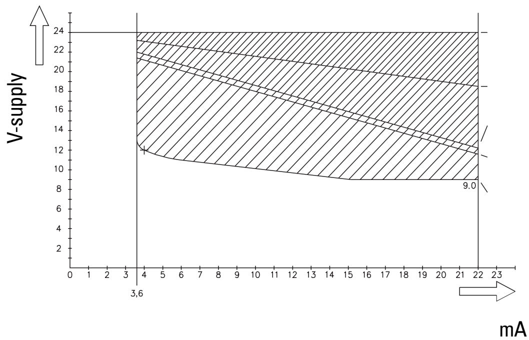
Supply

Notes:

- The transmitter is powered by the current loop and needs at least 9.5-13 Volt on the terminals: 9.5 V at 22 mA or 12 V at 3.6 mA.
- The maximum supply is 33 Volt. If the voltage is higher the device will shut down.
- The loop-circuit will withstand voltages up to 250 Vac/Vdc without any damage.

The SITRANS LC500 uses a switched power supply circuit, which makes the most efficient use of the available power present on the terminals. If the signal current is low, (4mA), the terminal voltage will be high, and if the signal current is high, (20 mA), the terminal voltage may be low, due to all the resistive elements in the loop, such as the barrier and sense resistor.

Voltage drop versus mA for current transmitter operation



Examples:

- With a 250 Ohm sensing resistor, no barrier and negligible cable resistance, the overall supply voltage should be at least 15.0 V.
- With a 250 Ohm sensing resistor, a barrier of 280 Ohm, and 20 Ohm cable resistance (500 m), the total resistance is 550 Ohm, so the overall supply voltage should be at least 20.5 Volts.
- For a multi-drop application, where the measuring supply is fixed to 4 mA, the voltage on the terminals of the SITRANS LC500 should be at least 12 Volts.

The loop circuit is completely isolated from the measurement circuit. It is designed so that the internal capacitance and inductance on the terminals are isolated and do not factor in safety calculations.

Cable

Notes:

- To maintain reliable transfer of the HART modem signals, the RC[1] time constant of the connections should be less than 65 µSec. .
- For output signals (from the SITRANS LC500), only the cable and barrier resistance are relevant. For input signals the measurement resistance is also relevant.
- Use twisted pair cable, screened as a pair.[2]

1. RC = Resistance * Capacitance
2. Or, if you use a common screen over a cable containing multiple twisted pairs, do not use other pairs for signals that could interfere with HART signals.

Selecting the correct instrumentation cable

- you need to know the cable length, the barrier type (if applicable), and the measurement resistance
- select a cable that will give you a capacitance time constant of less than 65 µSec

1. Calculate the capacitance for a time constant of 65 µSec, using the following formula:
   $t = R \times C$ (time constant = Resistance * Capacitance)
   R is the sum of the load resistor and cable resistance.
   C is the sum of the cable capacitance and the capacitances of the connected device/devices.
2. Determine the cable length allowed, by subtracting the capacitance value of the device (or devices) on the loop from the total capacitance, and using the maximum allowable limit of 100 pF per meter (or 1 nF per 10 meters).

Example

1. Calculate the cable capacitance which will give a time constant of 65 µSec:
   A twisted pair cable with a conductor cross-section of 1 mm^2 (AWG 18 equivalent) has a copper resistance of 73.6 Ohm/km and a capacitance of 100 pF/m (or 1 nF/10m).

   For a standard 28 V 280 Ohm barrier and a 250 Ohm measuring resistance, with a 100 meter cable:

   Resistance = 280 (barrier) + 250 (sensing device) + 7.36 (cable)= 537.36

   $t = R \times C$

   $C = t/R$

   65×10^{-6} s = $537.36 \times C$ nF

   $C = (65 \times 10^{-6}/537.36) = 121$ nF
2. Calculate the length of cable allowed, by subtracting the capacitance value that the device presents on the loop from the total capacitance. SITRANS LC500 has no measurable capacitance value, but assume 5 nF. Then use the maximum capacitance limit (1 m /10 nF) to determine the cable length.

   $121 - 5 = 116$ nF

   $116 \times 10 = 1160$ m

IIB type/class hazardous area applications: maximum cable length

In IIB type/class hazardous area applications the maximum allowed capacitance value is 330 nF, as long as you are not using HART. If you are using HART, the maximum cable length will be limited. Depending on cable specifications, the maximum length lies between 1 and 3 km.

Multi-drop applications: maximum cable length

In a multi-drop application, the total capacitance of all the devices must be calculated. With five devices, at 5 * 5 nF, the allowable cable length will be considerably limited.

Notes:

- If the device is part of a multi-drop setup, the SITRANS LC500 sets the current to 4 mA, which inhibits analog signalling, including fault signalling.
- Multi-drop is a HART mode where devices are set to a fixed current, and the device is interrogated periodically. The maximum number of devices on one loop is 15, one of which can be an analog mode device.

Terminals

The SITRANS LC500 is equipped with two terminal blocks, both insensitive to polarity.

One terminal block is intended for connecting the instrument cable (loop power).

The other terminal block provides the solid-state switch output.

Connecting SITRANS LC500

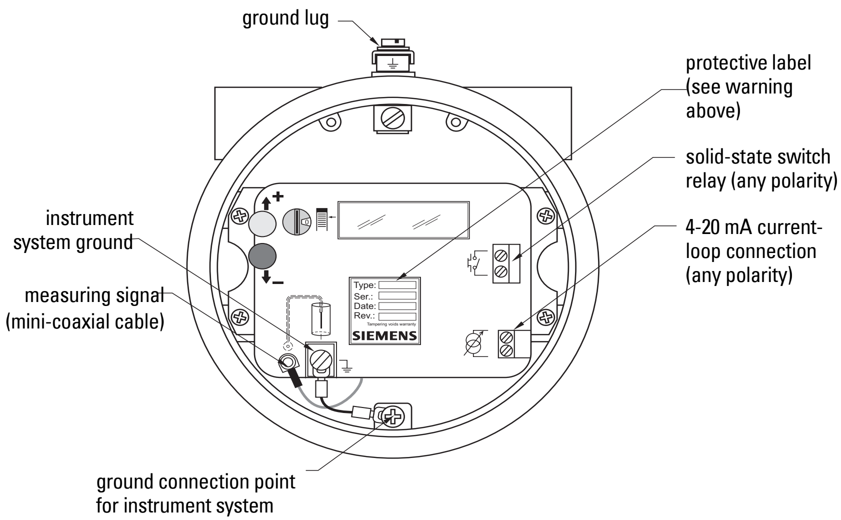
The processor integrated circuit is covered by a label which contains product information and which also acts as a protective seal against moisture.

> ! **WARNING: Damage or removal of the protective label voids the warranty for the SITRANS LC500.**

1. Loosen the retaining set-screw and remove the enclosure cover.
2. Loosen the cable gland and thread the cable through it.
3. Connect the power / signal conductor wires to the current loop terminal block (any polarity).
4. Ground the enclosure: (see instructions on next page for details).
5. Check to ensure all connections are good.
6. Tighten the cable gland to form a good seal.
7. Replace the enclosure cover and tighten the retaining set-screw.

> **Note:** If you plan to calibrate the unit using push-button adjustment, do so before replacing the cover.

Connection Diagram



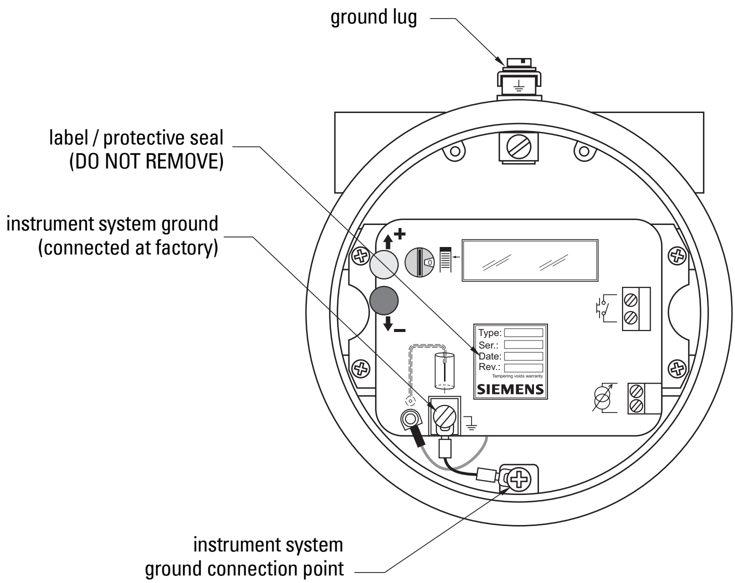
Protection for solid-state switch

- For dc circuits: connect protection diodes in the correct polarity across the relay coil.
- For ac circuits: connect a Voltage Dependent Resistor (VDR) or other ac compatible component (such as zeners and protection diodes in combination) in the correct polarity across the relay coil.

Grounding instructions

Notes:
- Since the measurement occurs between the Measurement and Ground connections, it is important to have good, low-resistance, reliable connections in this circuit.
- Use a ground connection wire with a sufficiently large diameter relative to its length, and not less than 1 mm^2.
- The SITRANS LC500 measurement circuit is completely isolated from the loop circuitry: this allows either line of the loop circuit to be grounded if requirements for Ex safety are followed and if the power supply voltage is less than 33 Vdc.

Connect the housing and the process connection with either the stilling well[1] and/or tank wall, using the ground lug on the housing.



WARNING: When connecting the probe, do not leave moisture or metal scrap (from the cable shielding, for example) inside the housing. This could interfere with transmitter operation, or cause a short circuit.

1. Where the stilling well is welded to the tank.

Grounding Examples: SITRANS LC500

Grounding is important for two reasons:

1. To prevent interference to the signal: system grounding
2. For safety purposes: safety grounding

Several common applications are illustrated. They are separated into two groups: the first group illustrates System Grounding and the second illustrates Safety Grounding.

System Grounding (referencing)

For the measuring system to function correctly, the reference electrode must be properly grounded. Make sure that there is a reliable connection from the instrument housing to the reference electrode (usually a metal tank). Some common applications involving system grounding include:

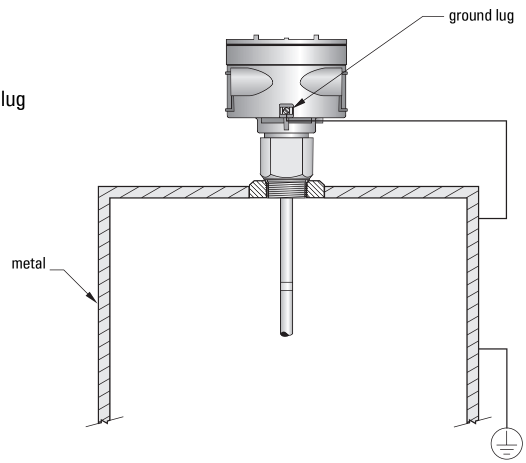
- metal tanks
- metal tanks, cathodically protected
- non-conductive tanks

Interconnection

Metal Tanks

If the metal tank is reliably grounded, connect the ground lug on the SITRANS LC 500 to the earth ground on the tank as shown.

(See page 27 for connection diagram.)

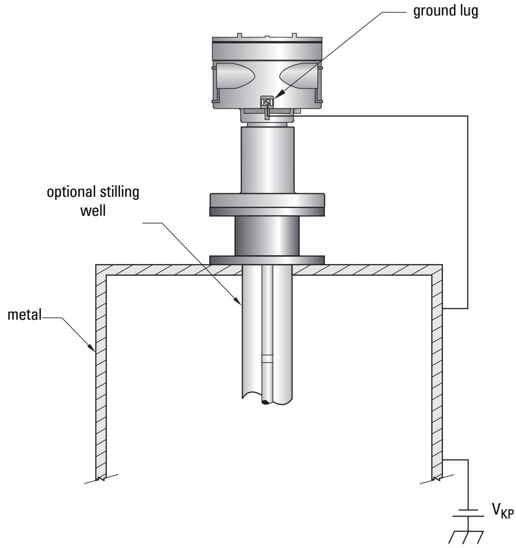


Cathodically Protected Metal Tanks

Cathodically protected metal tanks are never directly grounded. However, the impedance of the supply source is so low that it will not cause any problems. The shielding of the loop cable should be grounded at one end only (the tank end) to avoid short-circuiting the cathode protection voltage.

The ground lug on the SITRANS LC 500 can be connected to the tank as shown.

(See page 28 for further grounding details.)



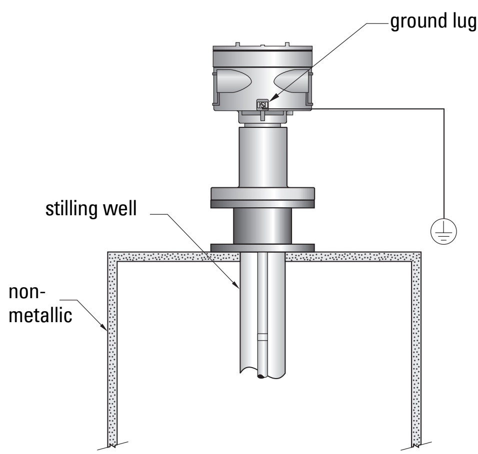
Note: Grounding the SITRANS LC500 as illustrated above provides only system grounding for referencing purposes: it does not provide safety grounding.

Non-Conductive Tanks

Non-metallic tanks always require a stilling well or proper grounded conductive medium.

Connect the ground lug on the SITRANS LC 500 to earth ground. If the stilling well is integral to the SITRANS LC500, it is now grounded.

If the vessel has a stilling well provided, make sure that the metal parts of the stilling well are properly grounded.



Safety Grounding

The safety grounding requirements are determined by the application and the connected instruments. The SITRANS LC500 transmitter does not have any special requirements due to the galvanic separation between the measurement section and the loop section.

Depending on the DCS characteristics, there are three possible grounding options:

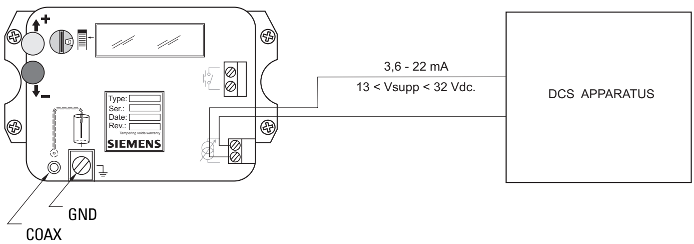
Interconnection

- If the DCS measures the current through the loop compared to a common zero Volt point, do not ground the negative side of the current loop because measurement inputs can be short-circuited.
- If the DCS measures the current in the positive wire or connector, the negative side of the current loop can be grounded.
- If the DCS has galvanically separated inputs for each measurement channel the grounding method can be chosen as required.

In hazardous applications a Stahl-type barrier is required, and it is typically mounted on a DIN rail inside a customer-supplied enclosure located in the non-hazardous area.

Example 1

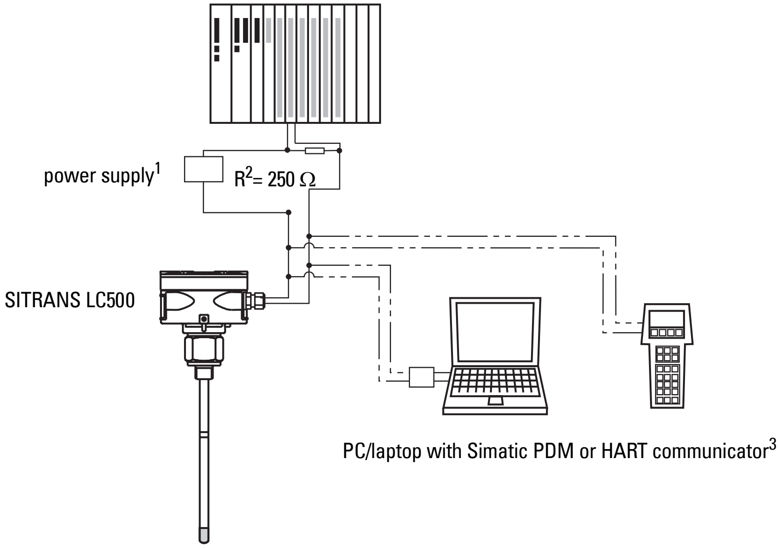
If no specific Ex conditions apply, the SITRANS LC500 can be directly connected to the DCS. The supply voltage, however, should remain within the limits set by the SITRANS LC 500. Connecting a SITRANS LC500 to a DCS does not influence that equipment. One of the connection cables can be grounded if desired.



Communications

The SITRANS LC500 is equipped with HART communication protocol so that settings and values can be obtained and altered locally or remotely.

Typical PLC configuration with HART



Diagnostics

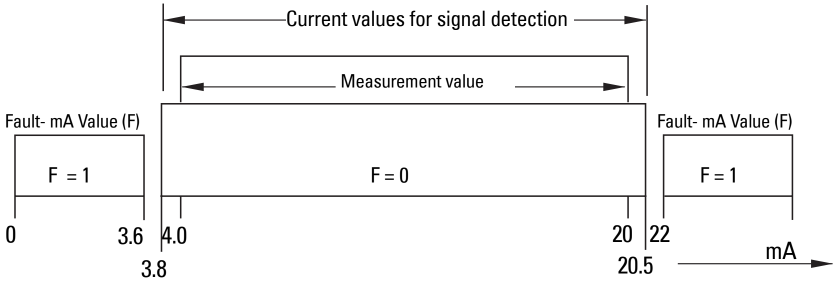
The internal diagnostic functions continuously monitor the operation of the transmitter. An error signal is generated if a failure or irregularity occurs.

The SITRANS LC500 sends the signal current according to the NAMUR NE 43 recommendation. During normal operation the current remains within the range from 3.8 to 20.5 mA. If the process exceeds its normal limits but is not in a fault or failure situation, the signal current will be outside the measurement range (4 to 20 mA) but will be limited to either 3.8 or 20.5 mA.

If a fault or a failure is detected, the signal current is set to either 3.6 mA or 22 mA, depending on the settings you have chosen. (This feature may be disabled by the user.)

1. Depending on the system design, the power supply may be separate from the PLC, or it may be part of the PLC.
2. A 250 Ohm resistor is required only when the PLC is connected to a HART modem or a HART communicator.
3. The HART communicator and a PCL/laptop computer cannot both be connected to the 4-20 mA loop simultaneously.

Current values used as signals from digital transmitters



Whenever the local situation allows, the zero adjustment and the full scale can be set using the push-button feature and the appropriate menu selection. In most cases it is possible to do a one point calibration[1] by using the push-buttons to input the actual level in %.

The total isolation between the measurement circuit and the current- loop circuit provides immunity during the use of cathode protected measuring tanks. Connection to PLC equipment is possible without any difficulty.

- The Upper Range Value (URV) and Lower Range Value (LRV) should be within the USL to LSL range, but can be set anywhere within that range.
- An interruption of the measuring connection will be detected: a loose or interrupted connection results in up to 0.5 pF capacitance, which is below the adjusted LSL and thus signals a FAULT condition.

Applications for Solid-state Output

The solid-state output is a polarity independent switch output. The solid-state switch has two possible functions.

- it can be activated/deactivated when the product level reaches the upper/ lower threshold settings (set in menus 15 and 16)
- or it can be activated if a fault or failure is detected[2] (set in menu 18)

See page 101 for an illustration of a typical application using SITRANS LC 500 as a level indicator, with the solid-state output connected to a relay which activates a pump.

The solid-state switch has its own parameter set: menu items 13 to18, (see *Menu Levels 00 to 0F and 10 to 1F* on page 37, and *Rotary Switch Positions – Quick Reference* chart on page 41).

In menu 0E and menu 0F, you set the Upper and Lower Range Values (URV and LRV) for relay operation. Within that range, the solid-state switch has independent settings for

1. See *Calibration using push-button adjustment* on page 43.
2. See *Fault Signalling* on page 16 for details of fault conditions.

Upper and Lower Threshold, (menus 13 and 14) and the accompanied delays (menus 15 and 16).

Initially the solid-state output is disabled for both signal output and fault/failure output (menu 17). When the solid-state switch is to be operated as fault/failure output (for example, for a separate shutdown system), we recommend disabling the operation for signal output (select Disabled Mode in menu 17 on page 70). There is no delay in the operation for fault/failure output.

Notes:
- The solid-state output should only be used in circuits where the current is limited by a proper load.
- Due to the limited switching capabilities of the solid-state switch component, an auxiliary relay must be applied when switching high-current/high-voltage apparatus.

Interconnection

Switch Protection (Diode)

WARNING: When the solid-state switch is activating an external relay, protection diodes must be connected in the correct polarity across the relay coil to prevent possible switch/relay damage resulting from inductive spikes generated by the relay coil.

Factory Settings

The SITRANS LC500 has a number of default factory settings. If the required settings for the application are known, the settings can be modified during final testing.

Note: To restore factory settings, use menu item 12 (see *Factory Settings* on page 72 for details).

Settings:

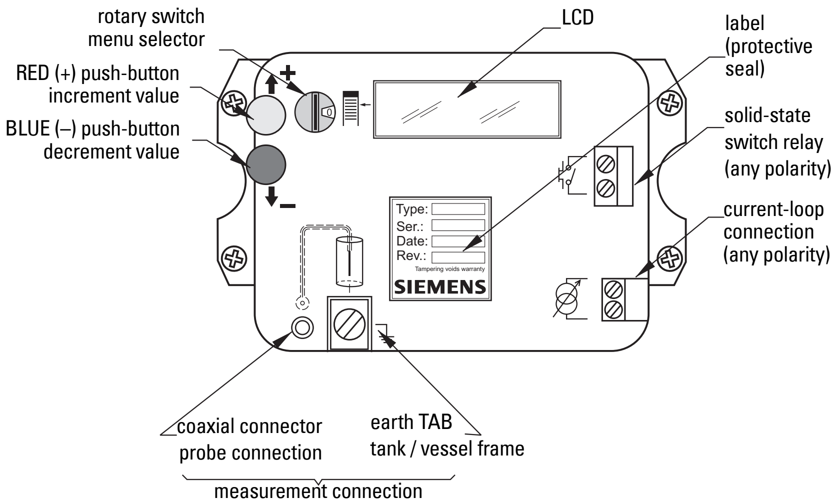
Setting	Description
ID	Has a unique serial number
TV0 Units	PF
TV0 UL	3300 pF [switch position (0)C]
TV0 LL	1.666 pF [switch position (0)B]
TV0 URV	3300 pF [switch Position (0)F]
TV0 LRV	0.00 pF [switch Position (0)E]
AO1	4-20 mA is 0-100% [position (0)8]
TAG	"customer input data via HART"
DESCRIPTOR	"customer input data via HART"
MESSAGE	"Siemens Milltronics P I"
DATE	"customer input data via HART"
SENSOR SERIAL NUMBER	"customer input data via HART"
FINAL ASSEMBLY NUMBER	"customer input data via HART"

Setting	Description
TV1 Units	UNDEFINED
TV1 LRV	0 [switch position (0)E, TV1]
TV! URV	1.0 [switch position (0)F, TV1]

- The Upper Sensor Limit (USL) and Lower Sensor Limit (LSL) are set to 3300 and 1.666 pF respectively, and the following conditions apply: the Upper Range Value (URV) and Lower Range Value (LRV) should be within the USL to LSL range, but can be set anywhere within that range.
- An interruption of the measuring connection will be detected: a loose or interrupted connection results in up to 0.5 pF capacitance, which is below the adjusted LSL and thus signals a FAULT condition.

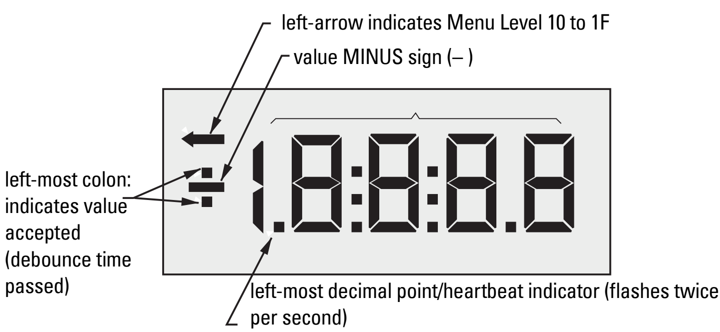
The SITRANS LC500 User Interface

The SITRANS LC500 user interface consists of the display (LCD), the rotary switch, and two push-buttons. The rotary switch enables you to select a particular item and/or variable for read-out and/or adjustment: the push-buttons allow you to select and/or alter a read-out or a value.



The LCD (display)

The seven-segment LCD (display) shows the value and/or diagnostic information. It is mainly for numeric data, but there are also a number of indicators which use alphabetic characters. A list of these LCD displays, together with the associated menu items, is shown in *Appendix B: LCD display examples* on page 74.



The LCD will hold information for a long time even when not refreshed (for example, if there is a loss of power). The heartbeat indicator blinks continuously whenever the device is working. A still heartbeat signals that the device has stopped working.

How to access the data:

Access data in the transmitter from 28 menu items divided between two menu levels: **00** to **0F** and **10** to **1F**. Use the rotary switch and push-buttons in combination to select an item and adjust the value.

The functions of each menu item are illustrated in application examples on page 101 to 102. Details on using each menu item are given in *Appendix A: Menu Groups* on page 54. (See also *Rotary Switch Positions – Quick Reference* on page 41 showing the switch position and button press combinations used to carry out different functions.)

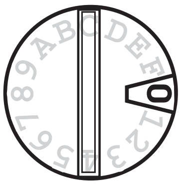
Menu Levels 00 to 0F and 10 to 1F

Menu 00 to 0F	Description	Menu Group	Details
09	Stepsize Update Value	Transmitter Variable Settings	page 55
0A	Damping		page 56
0B	Lower Sensor Limit		page 56
0C	Upper Sensor Limit		page 57
0D	Delta Range Setting		page 57
0E	Lower Range Value		page 58
0F	Upper Range Value		page 59
00	Dynamic Value (PV)	Transmitter Variable Value	page 59
02	Max./Min. Recorded Value		page 60
01	Transmitter Variable select for PV		page 60
03	Upper Threshold Delay: 2-state mode	Analog Output Signalling (loop-current)	page 62
04	Lower Threshold Delay: 2-state mode		page 62
05	Upper Threshold Setting: 2-state mode		page 63
06	Lower Threshold Setting: 2-state mode		page 64
07	Analog Signalling Mode		page 64
08	Analog Fault Signalling		page 66

Menu 10 to 1F	Description	Menu Group	Details
10	Dynamic Value (PV)	Transmitter Variable Values	page 59
1C	Transmitter Variables Dynamic Value		page 61
13	Upper Threshold Delay: solid-state output	Digital Output Signalling	page 67
14	Lower Threshold Delay: solid-state output		page 68
15	Upper Threshold Setting: solid-state output		page 68
16	Lower Threshold Setting: solid-state output		page 69
17	Digital Signalling Mode		page 70
18	Digital Fault Signalling		page 71
11	Output Signal Processing Test	Miscellaneous	page 72
12	Factory Settings		page 72
19	Range Inversion		page 73
1F	Keylock Level		page 73
1A	Non-operational	Spare	
1B			
1D			
1E			

The rotary switch

The rotary switch gives you access first to the menu level and then to the menu item.



The rotary switch has a small slot where the current position can be read. The positions are read clockwise, and in increasing order: 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, A, B, C, D, E, and F. The position wraps from F to 0.

The switch can be turned in either direction. When it is turned to a new position, the LCD displays the new menu selection for 1 second, followed by the data for that position.

Certain menu selections return more than one piece of information per item: in that case the display alternates between the two values, for example, PV Value / Fault status.

The push-buttons

The push-buttons allow you to change the value of a menu item. Use the RED (+) button to adjust a value up; the BLUE (–) button to adjust a value down; or press both simultaneously for special applications. For a table showing the combinations of rotary switch positions and button presses used to carry out different functions, see page 41.

Access to a menu item:

Notes:

- For a detailed description of each menu item, see Appendix A, page 54: the functions of each menu item are illustrated in application examples on page 101 to 102.
- Change over from Menu LEVEL 0 to Menu LEVEL 1 is only possible at position 0, from menu item 00 to 10 or vice-versa. (See page 42 for detailed instructions.)

1. First select Menu LEVEL 0 or Menu LEVEL 1.
2. Turn the rotary switch to the number of the desired item.

Adjusting the value

Notes:

- The push buttons are preset with a delay called the debounce time.
- Keeping one or both buttons pressed continuously will trigger an auto-repeat in some menus.

1. Select a menu item.
2. Press the RED (+) or BLUE (–) push button to adjust the value up or down: acceptance is indicated when the left-most colon on the LCD appears. (You have to press longer than the debounce time to have the action accepted: the debounce time varies according to the menu item selected.)

Transmitter Variables

- Transmitter Variable 0 (TV0) is the capacitance as measured by the device.
- Transmitter Variable 1 (TV1) is a computed variable: the dynamic value is a computed derivative from the range settings for TV0.

<table>
<tr><th>Transmitter Variable</th><th>User-defined Functions</th><th>Units</th></tr>
<tr><td>TV0</td><td rowspan="2">URV, LRV, Damping, USL and LSL</td><td>pF</td></tr>
<tr><td>TV1</td><td>Can be user-defined</td></tr>
</table>

Start-up: SITRANS LC500

Capacitance measurement systems require the instrument to be calibrated for a particular application. Two methods of calibration are available:

- push-button (for instructions, see page 43).
- HART (for instructions, see page 46).

Quick Start

We strongly recommend you read the full manual to use your device to its fullest potential. However, if it is possible to adjust the level of the tank to the 0% and 100% levels, you can use the quick start sequence below to calibrate the instrument and get started.

Notes:
- Change over from Menu LEVEL 0 to Menu LEVEL 1 is only possible at position 0, from menu item 00 to 10 or vice-versa. (See page 42 for detailed instructions.)
- For a table showing all the combinations of rotary switch positions and button presses used to carry out different functions, see page 41.
- For a detailed description of each menu item, see Appendix A, page 54.

Quick Start Sequence		
1	**Calibrate the 0% setting (LRV - lower range value): menu 0E**	
		For instruments without a stilling well, the 0% setting needs to be calibrated after the device is installed, and with the tank/vessel empty. Calibration is also sometimes necessary after installing a SITRANS LC500 fitted with a stilling well, although in most cases the 0% setting is calibrated at the factory.
	Set value for 0% (LRV): units must be pF (Menu 01 must read Pv = 0).	
	a	Bring the product level to the height that corresponds to 0%.
	b	Turn the rotary switch to E (Empty).
	c	Press **both** buttons and hold for about 1 second: the 0% point is now set.
2	**Calibrate the 100% setting (URV - upper range value): menu 0F**	
	Set value for 0% (LRV): units must be pF (Menu 01 must read Pv = 0).	
	a	Raise the product level to the height that corresponds to 100%.
	b	Turn the rotary switch to F (Full).
	c	Press **both** buttons and hold for about 1 second: the 100% point is now set.
3	**View primary variable (PV): menu 00**	
		Turn the rotary switch to 0. The LCD displays the actual pF reading.
4	**The SITRANS LC500 is now ready to operate.**	

Rotary Switch Positions – Quick Reference

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
	Menu LEVEL 0 (00 to OF)															
Units	**PV Units**	**Num. Selection**	**PV Units**	**Seconds**	**Seconds**	**%**	**%**	**mA**	**mA**	**Numeri-cal**	**Numeri-cal**	**PV Units**	**PV Units**	**PV Units**	**PV Units**	**PV Units**
NO KEYS Value read-out	PV Value or Fault	Show select PV variable	Highest/ Lowest PV Memory	Activation Time Delay Current sig-nal	De-Activation Time Delay Current signal	Upper Thresh-old Activation Current signal	Lower Thresh-old De-Activation Current signal	Loop Current in mA	Fault signal 22 or 3.6 mA	Actual Step Size	Damping Value	LOWER limit PV	UPPER limit PV	Delta Value PV for 4 c.q. 20 mA	LRV Value PV for 4 mA	URV Value PV for 20 mA
Up Key-RED (+)	Set Menu Level 00 to 0F	Step TV0 to TVmax	Highest PV Memory Read-out	Increase Delay Time	Increase Delay Time	Increase Upper Threshold Point	Increase Lower Threshold Point	Set Covered: 20 mA (Hi)	Set FAULT: 22 mA	Increase Step Size to 10000	Increase Damping Value	Increase PV LOWER limit	Increase PV UPPER limit	Increase PV Delta	Increase PV LRV	Increase PV URV
Down Key-BLUE (–)	Set Menu Level 10 to 1F	Step TVmax to TV0	Lowest PV Memory Read-out	Decrease Delay Time	Decrease Delay Time	Decrease Upper Thresh-old Point	Decrease Lower Thresh-old Point	Set Covered: 4 mA (Lo)	Set FAULT: 3.6 mA	Decrease Step Size to 0.01	Decrease Damping Value	Decrease PV LOWER limit	Decrease PV UPPER limit	Decrease PV Delta	Decrease PV LRV	Decrease PV URV
Both Keys	Show-Menu Level	Set % Mode	Reset Hi/Lo memories to actual PV	Toggle Delay Time 00 < – > 100	Toggle Delay Time 00 < – > 100	Preset Upper Threshold Point to 75%	Preset Lower Threshold Point to 25%	Set Analog Range 4 to 20 mA (Anl)	Fault signal Disable	Set to 1	Set to 1	Preset Lower Limit to Actual (PV)	Preset Upper Limit to Actual (PV)	URV– LRV = Min.	LRV = Actual Value (PV)	URV = Actual Value (PV)
Default	*****	**TVO**	*****	**00**	**00**	**75%**	**25%**	**Analog**	**Disabled**	**1.0**	**1**	**1.666 pF**	**3300 pF**	**3300 pF**	**0 pF**	**3300 pF**
	Menu LEVEL 1 (10 to 1F)															
Units	**PV Units**	**Numerical**	**Factory Settings**	**Seconds**	**Seconds**	**%**	**%**	**O/ C**	**O/C**	**nor / inv**			**Resp. Units**			**Keylock**
NO KEYS Value read-out	PV Value or Fault	Display check Fault code	FAC (factory set-tings)	Activation Time Delay Transistor Switch	De-Activation Time Delay Transistor Switch)	Upper Thresh-old Activation Transistor Switch	Lower Thresh-old De-Activa-tion Transistor Switch	Status Solid-state Output	Fault signal (Solid-state Output)	MODE Normal / Inverse	— Spare	— Spare	Transmitter Var 0 Read-Out	— Spare	— Spare	Keylock Level
Up Key-RED (+)	Set Menu Level 00 to 0F		FAC (factory set-tings)	Increase Delay Time	Increase Delay Time	Increase Upper Thresh-old Point	Increase Lower Thresh-old Point	Set Covered = Solid-state ON	Set FAULT = Solid-state ON	MODE Normal / Inverse			Transmitter Var 1 Read-Out			Increase Keylock Level
Down Key-BLUE (–)	Set Menu Level 10 to 1F		FAC (factory set-tings)	Decrease Delay Time	Decrease Delay Time	Decrease Upper Thresh-old Point	Decrease Lower Thresh-old Point	Set Covered = Solid-state OFF	Set FAULT = Solid-state OFF	MODE Normal / Inverse			Transmitter Var 2 Read-Out			Decrease Keylock Level
Both Keys	Show Menu Level	Invert Sig-nalling Sta-tus	do it	Toggle Delay Time 00 < - > 100	Toggle Delay Time 00 < - > 100	Preset Upper Threshold Point to 75%	Preset Lower Threshold Point to 25%	Disable Switch for Solid-state	Disable Fault for Solid-state	Toggle Operating Mode			Transmitter Var 3 Read-Out			
Default	*****	*****	*****	**00**	**00**	**75%**	**25%**	**Disabled**	**Disabled**	**nor**	*****	*****	*****	*****	*****	**0**

Menu levels 0 and 1

Menu level 00 to 0F is the default start-up setting after power is applied or after a reset. Menu Level 10 through 1F is flagged in the LCD by an left-arrow indicator in the upper left corner of the LCD.

To change from menu 00 to menu 10:

1. Set the rotary switch to 0.
2. Press and hold the BLUE (–) button.
3. While the button is pressed, the display shows : M 10 followed by : SEL 1, indicating that the current menu level is now 10 to 1F: a left-arrow is displayed in the top left corner of the LCD.
4. When the button is released, the LCD displays PV (primary variable): the left-arrow remains visible.

To change from menu 10 to menu 00:

1. Make sure the rotary switch is set to 0.
2. Press and hold the RED (+) button.
3. While the button is pressed, the display shows: M 00 followed by : SEL 0, indicating that the current menu level is 00 to 0F: no left-arrow is displayed in the top left corner of the LCD.
4. When the button is released, the LCD displays PV.

In menu 00 or 10, to see the current menu level selection, briefly press one of the buttons (less than a second): the current selection is momentarily displayed.

Notes:

- Check the menu level when using the rotary switch to select a menu item: the left-arrow in the top left corner of the LCD indicates menu level 1.
- The rotary switch must be set to 0, in order to change from one menu to the other.
- Hold the RED (+) or BLUE(–) buttons for longer than the preset delay, or debounce time, when altering a value: the debounce time is generally about a second, but varies from one menu item to another.
- Keylock level (menu 1F) must be set to 0 (no restrictions) to enable you to change settings.

Start up using push-button calibration: (overview)

- Check that Keylock level is set to enable calibration
- If required, change the transmitter variable: select units as pF, units user-defined, or values as percent
- Calibrate value for 0%
- Calibrate value for 100%
- Set display for dynamic PV (primary variable): select values displayed as percent or units
- SITRANS LC500 is ready to operate

Calibration using push-button adjustment

Notes:
- To toggle between menu level 0 and menu level 1, set rotary switch to 0, and use RED (+) or BLUE (–) push-button to select menu.
- To reset values to factory settings, select menu 12. Press and hold both buttons: the LCD displays do it, followed by FAC A when the buttons are released.
- For a complete list of menu items, see *Appendix A: Menu Groups*, page 54.

Reset keylock level if necessary to enable settings to be changed: menu 1F

(no change is necessary if the factory setting has not been changed)

1. Select menu 10, then set the rotary switch to F.
2. Use the BLUE (–) push-button to decrease the value to 0: display reads PL 0 (no restrictions).

Reset selection for transmitter variable if necessary to TV0 (units are pF): menu 01

(no change is necessary if the factory setting has not been changed)

1. Select menu 00, then turn the rotary switch to 1.
2. Use the BLUE (–) button to adjust the value to 0: the display reads Pv = 0.

Calibrate the 0% setting (LRV - lower range value): menu 0E

For instruments without a stilling well, the 0% setting needs to be calibrated after the device is installed, and with the tank/vessel empty. Calibration is also sometimes necessary after installing a SITRANS LC500 fitted with a stilling well, although in most cases the 0% setting is calibrated at the factory.

1. Set value for 0% (LRV): units must be pF (Menu 01 must read Pv = 0)
   a. Bring the product level to the height that corresponds to 0%.
   b. Set the rotary switch to E (Empty).
   c. Press **both** buttons and hold for about 1 second: the 0% point is now set.

Calibrate the 100% setting (URV - upper range value): menu 0F

- method 1: if it is possible to bring the actual product level to 100%
- method 2: if the current product level is known, you can calculate the percentage value, and calibrate for full scale in %. The closer the actual level is to 100%, the more accurate this result will be.

Method 1. Set value for 100% (URV): units must be pF, (at Menu 01, Pv = 0)

a. Raise the product level to the height that corresponds to 100%
b. Set the rotary switch to F (Full).
c. Press **both** buttons and hold for about 1 second: the 100% point is now set.

Method 2. Set value for 100% (URV): values must be displayed as percent (at menu 01, Pv = P)

a. Calculate the percentage value of the current level.
b. Set rotary switch to 1, and press **both** buttons to adjust the value to P.
c. Set the rotary switch to F (Full).
d. Press the RED (+) or BLUE (–) button to increase or decrease the reading on the LCD until it matches the known (actual) percentage. The push-buttons appear to work in reverse for this function[1]. You may need to decrease the stepsize value (menu 09) in order to reach the desired value.
e. 100% value is set.

Example:
Set LRV in capacitance mode, then set menu 01 to Pv = P (percent mode) and immerse the probe in the product (values shown below are arbitrary example values only):

0% (LRV)	=14.20 pF
100% (URV)	= 34.20 pF
Span	= 20 pF
Current level	= 28.20 pF
Change in capacitance	= 28.20 – 14.20 = 14
Current percent of span	= 14/20 = 70%
LCD displays 78.00 (percent)	

In this example, to decrease the reading to 70.00, you need to press (+) to increase the span, which will reduce the percentage, until the value reaches 70.00. If the steps are too big you need to change the stepsize (menu 09) to a lower value.

Changing stepsize value: menu 09

The factory setting is 1: the LCD displays U: 1.0

Set rotary switch to 09, and press BLUE (–) button to reduce stepsize: values range from 0.01 to 1,000.

Example:

LCD displays 78.00 (percent)
Known percent of span = 70%
Decrease needed is 8, but setting for stepsize is 10: menu 09 set to U: 10.
Press BLUE (–) button to reduce stepsize to 1: LCD displays U: 1.0.
Return to OF, and decrease value to 70.00 (percent).

You may still need to reduce the stepsize further. If changing the stepsize value has no apparent effect, press both buttons simultaneously to change the reading to 100%. From there you may adjust it until the correct percentage reading is reached.

1. In capacitance mode, the display for menu 0F shows the actual URV, but in percent mode, when you adjust the reading, you are in fact stepping the capacitance value. As you step the capacitance down, you decrease the range and reduce the span, so the percentage increases in relation to the smaller span. Therefore the (+) and (–) buttons appear to function in reverse.

Select capacitance or percent mode for dynamic primary variable (PV): menu 01

a. To see the value displayed as percent, select menu 01 and press both buttons to set Pv = P.
b. To see the value displayed as pF, select menu 01 and increase or decrease the value till Pv = 0.

The SITRANS LC500 is now ready to operate. For a table showing the different functions available, and the combinations of switch position and button presses used to carry out these functions, see page 41. For a detailed list of menu items, see *Appendix A: Menu Groups* on page 54.

Notes:

- During normal operation, the 4 and/or 20 mA point can be calibrated at any time.
- If the difference in the capacitance value between the 4 mA point and the 20 mA point is smaller than the minimum span value (3.3 pF), the new value will not be accepted.
- To revert to factory settings, select menu 12 and press both buttons: the display will read FAC A.

Calibration using HART

The SITRANS LC500 transmitter can be calibrated using HART, with a HART communicator[1]; a laptop running Simatic PDM, or with the Host system (DCS). The local circumstances determine the manner in which calibration takes place. If the circumstances allow the product to be brought to the 0% and 100% point level, calibration is simple.

Notes:
- Use the arrow keys, up, down, forward and back, to navigate within the menus.
- Use the back arrow to return to previous screens.

Examples of calibration using a Rosemount 275 hand-held communicator, fitted with the GENERIC device descriptor:

Example 1

For situations where the level of the product can be easily adjusted to 0 and 100%.

1. Switch on the 275 and request connection with the SITRANS LC500.
   a. Select: Online
   b. Select: Device setup
   c. Select: Diag service
   d. Select: Calibration
   e. Select: Apply values
   (Display reads: Loop should be removed from automatic control. Select: Ok)
   f. Select: 4 mA
   g. Select: Apply new 4 mA input
2. Bring the level of the product to the level which corresponds with 4 mA.
   a. Select: Read new value
   b. Select: Set as 4 mA value: the 4 mA point has now been set.
   c. Select: 20 mA
   d. Select: Apply new 20 mA input
3. Bring the level of the product to the level which corresponds with 20 mA.
   a. Select: Read new value
   b. Select: Set as 20 mA value: the 20 mA point has now been set.
   c. Select: Exit
   (Display reads: Loop may be returned to automatic control. Select: Ok)

Calibration is complete.

Start Up

1. For a diagram showing how to connect the HART communicator, see *Typical PLC configuration with HART* on page 32.

Example 2

For situations where the capacitance values are known in advance.

1. Switch on the 275 and establish connection with the SITRANS LC500.

   a. Select: Online
   b. Select: Device setup
   c. Select: Diag service
   d. Select: Calibration
   e. Select: Enter values
   f. Select: PV LRV

2. Enter required capacitance value for 0% of the range.

   a. Select: PV URV

3. Enter required capacitance value for 100% of the range.

   a. Select: Send (the values are now sent)
   b. Select: Put loop in manual
   c. Select: Return loop to auto

Example 3

For situations where the capacitance values are unknown, and the level of the product cannot be easily adjusted to 0% and 100%. In this case it is necessary to measure the capacitance value at various levels. These values can be read in % with the 275 communicator.

> **Note:** The more accurately the values are measured at 0% and100%, the more accurate the final result will be.

1. Switch on the 275 and establish connection with the SITRANS LC500.

   a. Select: Online
   b. Select: PV
   c. The measured value can be read continuously, even if the current loop value is min. or max.

2. Write down the measured value in pF, and record the corresponding level.

Example:

- the measured PV value is 181 pF at 79%
- the measured PV value is 52 pF at 17%

$$\frac{(181-52)\text{pF}}{(79-17)\%} = 2.08 \text{ pF per \%.}$$

Start Up

The capacitance value for a 17% change in level is 17 * 2.08 = 35.37 pF.

The capacitance value for 0% is 52 – 35.37 = 16.62 pF (initial capacitance value).

The capacitance value for 100% is (100 * 2.08) + 16.62 = 208 + 16.62 = 224.6 pF.

3. Enter the calculated values for 0% and 100%, to calibrate the SITRANS LC500 as described in **Example 2**.

Example 4

For situations involving the re-adjustment of the LRV where the actual value is determined to be one value but the measurement shows a different value.

1. Switch on the 275 and establish connection with the SITRANS LC500.

   a. Select: Online

   b. Select: PV

   The measured value can now be read continuously.

2. Write down the measured value in pF: assume it is 80 pF.

   Example:
   Assume that the URV is set to 240 pF, that the actual value is 17%, but the measurement is showing a different value.

   the measured value = 80 pF

   (100 – 17) % = 83%

   (240 – 80) pF = 60 pF

   $\frac{160 \text{ pF}}{83\%}$ = 1.927 pF per %

   The capacitance value for 100% (URV) is 100 * 1.927 = 192.7pF

   The new LRV should be 240 –192.7 = 47.22 pF.

3. Adjust URV and LRV by following the steps in **Example 2**.

If the DCS and/or the 275 are fitted with the Device Descriptor for the SITRANS LC500, more functions can be used.

The available functions are:

Number	Description
(48)	Read Additional Transmitter Status
(38)	Reset Configuration Changed Flag
(128)	Set Alarm Select
(129)	Adjust for Product Build-up on Sensor

Start Up

Number	Description
(130)	Read Failsafe Mode selection
(131)	Return device configuration info
(132)	Set Variable Upper Limit
(133)	Set Variable Lower Limit
(134)	Write keylock value
(135)	Read keylock value
(138)	Write simulation time and value
(139)	Read simulation time and value
(140)	Write TV1 Units, URV and LRV
(141)	Read TV1 Units, URV and LRV
(144)	Reset Max/Min recorded PV
(145)	Read Max/Min recorded PV
(150)	Write analog signalling mode
(151)	Read analog signalling mode
(152)	Write digital signalling mode
(153)	Read digital signalling mode
(154)	Write analog threshold settings
(155)	Read analog threshold settings
(156)	Write digital threshold settings
(157)	Read digital threshold settings
(160)	Write timers analog signalling
(161)	Read timers analog signalling
(162)	Write timers digital signalling
(163)	Read timers digital signalling

Maintenance

Test function

Auto Self-testing

SITRANS LC500 continuously performs a variety of tests to verify that the device is functioning correctly. These include a test where a known capacitor is applied to the input of the device. The internal results must match the known capacitance value. If a deviation is detected the Fault/Failure can be flagged with a pre-set loop-current (user configurable) and as a status in each HART message.

Manual testing

In order to test the proper processing of signals in PLC/DCS equipment, SITRANS LC 500 allows you to invert the output signal status. In Menu 11, when both buttons are pressed simultaneously, the signal outputs switch to their opposite state. When the buttons are released, the outputs revert to the initial state.

Note: If a Fault or Failure is present, its signal will take precedence over the test function.

If no Fault/Failure is present and no buttons are pressed, the display for menu 11 alternates between two test patterns which together illuminate all the segments of the display. If the loop-current control is in analog mode the loop current will hold the last value, during this test.

Inspections

Under normal circumstances, the SITRANS LC500 transmitter requires no maintenance. However, we recommend that you schedule periodic inspections of SITRANS LC500.

The inspection can be subdivided into two parts:

1. Visual Inspection: confirm the following conditions:
    a. Inside enclosure is clean and dry.
    b. Enclosure sealing is intact and functioning properly (not hardened).
    c. All screw connections are tight.
    d. Ground connections inside the housing are solid.
    e. Ground connections outside the housing are solid.

f. The coaxial connector is free of dirt or deposits.

g. No cables or wires are jammed under the cover.

2. Functional Checks

a. Check for required minimum terminal voltage (see page 24 for supply voltage requirements).

b. Confirm that Menu 08 is set to enable analog fault signalling: display should read F: Hi or F: Lo. (If there is a fault condition, it will read F= Hi or F= Lo, when buttons are released.)

c. Check that the current goes to the alarm position (3.6 or 22 mA) if the coaxial plug is unplugged: at menu 00, the LCD should display 'ooL' After the test, replace the coaxial plug.

d. Confirm that Menu 18 is set to enable digital fault signalling: the LCD should display F= cc or F= co, when buttons are released.

e. Check that the solid-state output goes to the alarm position (open/close) if the coaxial plug is unplugged. After the test, replace the plug.

f. Via HART:
Check that the PV goes to 0 pF when the coaxial plug is unplugged, ($\pm$0.15 pF is allowed). If it does, switch the output current to 4 mA and check the current through the loop, then to 20 mA and check the current through the loop. After the test, replace the plug.

Troubleshooting: SITRANS LC500

If you are unable to change settings:

- check that keylock level (menu 1F) is set to **0**: the display should read PL = 0
- check that menu 01 is set appropriately: if Pv = 1, changes can only be made via HART

If you can change settings:

- reset menu 12 to factory settings: press both buttons, and the display should read FAC A

If the LCD displays a negative reading, typically around minus 300 pF, this often indicates a short circuit in the probe assembly:

- check the enclosure and make sure no water has got in
- check that all the connections in the probe assembly are solid

Error Messages and Error Codes

Error Messages (push-button operation)

Error Message	Description	Cause
Flt[a]	Fault/failure has been detected	• Device is faulty • Possible short circuit in the probe or the device wiring • Possible fault in the device, or lack of sufficient energy at the device terminals
ooL[a]	Output out-of-limits	The product level has risen above the Upper Sensor LImit, or fallen below the Lower Sensor Limit

a. Alternates with the primary variable (PV).

Error Codes (HART)

Error Code	Description	Cause
32	program memory checksum error	Device is faulty
16	signal error: the measurement circuitry stopped functioning	Possible short circuit in the probe or the device wiring
8	DAC drive failure: the current as set by the DAC does not match the value measured by the ADC	Possible fault in the device, or lack of sufficient energy at the device terminals
0	PV value is outside the limits set (USL and LSL)	Usually indicates a fault in the connection between the transmitter module and the probe (the coaxial connector is off)

Appendix A: Menu Groups

The data in the transmitter is accessible as 28[1] menu items divided between two menu levels: **00** to **0F** and **10** to **1F**. You can switch between the two levels at position **00** and **10**.

The menu items are grouped according to function, with a detailed description of each item. The menu groups are shown below.

Transmitter – Variable Settings						
Stepsize Update Value	Damping	Lower Sensor Limit	Upper Sensor Limit	Delta Range Setting	Lower Range Value	Upper Range Value
Menu 09	Menu 0A	Menu 0B	Menu 0C	Menu 0D	Menu 0E	Menu 0F
see page 55	see page 56	see page 56	see page 57	seepage 57	see page 58	see page 59

Transmitter – Variable Values			
Dynamic Value: Primary Variable (PV)	Highest Lowest Recorded Value	Transmitter Variable – select for PV	Transmitter Variables Dynamic Value
Menus 00 and 10	Menu 02	Menu 01	Menu 1C
see page 59	see page 60	see page 60	see page 61

Analog Output Signalling (loop current)					
Upper Threshold Delay	Lower Threshold Delay	Upper Threshold Setting	Lower Threshold Setting	Analog Signalling Mode	Analog Fault Signalling
Menu 03	Menu 04	Menu 05	Menu 06	Menu 07	Menu 08
see page 62	see page 62	see page 63	see page 64	see page 64	see page 66

Digital Output Signalling (solid-state output)					
Upper Threshold Delay	Lower Threshold Delay	Upper Threshold Setting	Lower Threshold Setting	Digital Signalling Mode	Digital Fault Signalling
Menu 13	Menu 14	Menu 15	Menu 16	Menu 17	Menu 18
see page 67	see page 68	see page 68	see page 69	see page 70	see page 71

Miscellaneous			
Output Signal Processing Test	Factory Settings	Range Inversion	Keylock Level
Menu 11	Menu 12	Menu 19	Menu 1F
see page 72	see page 72	see page 73	see page 73

1. Only 28 of the possible 32 items are currently used.

Menu Items

Notes:
- Check that you are at the correct menu level before selecting a menu item.
- Hold the RED or BLUE buttons for longer than the preset delay, or debounce time to change a setting: this debounce time is generally around a second, but varies from one menu item to another.
- Protection is set at keylock level, menu 1F: make sure the setting is appropriate.
- The transmitter variable, units as pF, units user-defined, or values as percent, is set at menu 01; make sure the setting is appropriate.
- Reset to factory settings at menu 12: factory settings are indicated with an asterisk in the tables, unless explicitly described.

Transmitter: Variable Settings: menu level 0

Notes:
- You must select menu level **0** before you can access the items at that level.
- The transmitter variable must be set for units in pF to enable settings to be changed by push-button adjustment: (menu 01 must be set to **PV = 0**).

Stepsize Update Value

This menu selection controls the increment/decrement step-size for the menus 0B, 0C, 0D, 0E, 0F, and 03.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Description	Values
09	01	9	Off	Stepsize Update Value	Range: **0.01** to **1000**
				Factory setting	**U: 1.0**

1. Set the rotary switch to **9**.
2. Press the RED (+) or BLUE (–) button to increase or decrease this value in decades: you can step the value up to **10**, **100,** and **1000** (1E3), or down to **0.1** and **0.01**.
3. Press and hold both buttons simultaneously to restore the value to **U:1.0**

Damping

Damping slows the measurement response to a change in level, and is used to stabilize the reading[1]. The Damping Value is not in seconds but is a factor that controls the rate of change for the dynamic value of the TV currently selected.

The increment/decrement step size is subject to the setting on Menu 09.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Description	Values
0A	01, 09	A	Off	Damping	Range: **1** to **10,000**
				Factory setting	**1.00**

1. Set the rotary switch to **A**.
2. Press the RED (+) or the BLUE (–) button to alter the value between **1** and **10,000**.
   or: Press and hold a button to start a repeat function,
   or: Press and hold both buttons simultaneously to reset the value back to **1.00**.

Lower Sensor Limit

The Lower Sensor Limit (LSL) is the lower of two limit settings. Whenever the PV value (Menu level 0) drops below the Lower Sensor Limit, the measurement is considered at fault and the LCD displays **ooL**, alternating with PV.

If the display mode is in %, this selection is disabled and the LCD displays **- - - -**.
The transmitter variable on which this menu selection operates is chosen in Menu 01.

The increment/decrement step size is subject to the setting from Menu 09.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Description	Values
0B	01, 09	B	Off	Lower Sensor Limit	Range **0** to **3300**
				Factory setting	**1.66**

1. Set the rotary switch to **B**.
2. Press the RED (+) or BLUE (–) buttons to alter this value.
   or: Press and hold a button to start a repeat function,
   or: Press and hold both buttons simultaneously to take the current PV reading as the new setting.

1. For example, in an application with an agitated surface.

Upper Sensor Limit

The Upper Sensor Limit (USL) is the upper of two limit settings. Whenever the PV value (Menu Level 0) rises above the upper limit setting, the measurement is considered at fault and the LCD displays **ooL**, alternating with PV.

If the display mode is in %, this selection is disabled and the LCD displays **- - - -**. The transmitter variable on which this menu selection operates is chosen in Menu 01.

The increment/decrement step size is subject to the setting from Menu 09.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Description	Values
0C	01, 09	C	Off	Upper Sensor Limit	**3300** to **0**
				Factory setting	**3300**

1. Set the rotary switch to **C**.
2. Press the RED (+) or BLUE (–) button to increase or decrease this value.
   or: Press and hold a button to start a repeat function.
   or: Press and hold both buttons simultaneously to take the current PV reading as the new setting.

Delta Range Setting

The Delta Range Setting allows you to commission the unit for overfill or underfill protection where it is impossible to bring the product to those levels in normal process conditions. This feature is not normally used for the SITRANS LC500.

Overfill protection is used in applications where the probe is normally uncovered. Delta Range Setting adds the minimum span to the Lower Range Value: the result is used to update the Upper Range Value. If the process level exceeds the new URV, a fault is signalled.

Underfill protection would be used in applications where the probe is normally covered. In this case, Delta Range Setting subtracts the minimum span from the Upper Range Value and uses the result to update the Lower Range Value. If the process value drops below the new LRV, a fault is signalled.

The loop-current control must be in 2-state mode (Menu 07) for Menu 0D to display the Delta Range Setting. When the loop-current control is in Analog mode, Menu 0D displays **- - - -**.

The transmitter variable on which this selection is based is chosen in Menu 01. The increment/decrement step size is set at Menu 09.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode		Description	Values
0D	01, 07, 09	D	Off	2-state		Delta Range Setting (enabled)	Span setting
				Analog	*		Display shows - - - -

Lower Range Value

Lower Range Value (LRV) is the setting for 0% of the operating range, in most cases an empty vessel/tank. If the display mode is in % this selection is disabled and the LCD displays - - - -.

The transmitter variable on which this menu selection operates is chosen in Menu 01. For TV0 the LRV is in most cases Factory Set to the probe capacitance in free air.

The increment/decrement step size is subject to the setting from Menu 09.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode	Description	Values
0E	01, 09, 0B, 0C	E	Off	Analog	Lower Range Value	Range: **0.00** to **3300**
					Factory setting	Probe capacitance in air
					Display percent	Display shows - - - -

1. Set the rotary switch to **E**.
2. Press and hold both buttons simultaneously to take the current PV reading as the new setting.
   or: Press the RED (+) or BLUE (–) button to step the value up or down.
   or: Press and hold a button for a prolonged time to start a repeat function.

When the new setting exceeds that of the Limit Settings (Menu 0C and 0B), the new value is rejected and the previous value remains unchanged.

Upper Range Value

Upper Range Value (URV) is the setting for 100% of the operating range, in most cases a full vessel/tank. The transmitter variable on which this menu selection operates is chosen in Menu 01. For TV0, the URV is in most cases Factory Set to the probe capacitance in water.

The increment/decrement step size is subject to the setting from Menu 09.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode	Description	Values
0F	01, 09, 0B, 0C	F	Off	Analog	Upper Range Value	Range: **3300** to **0**
					Factory setting	Probe capacitance in water
					Display percent	Display shows - - - -

1. Set the rotary switch to **F**.
2. Press and hold both buttons simultaneously to take the current PV reading as the new setting.
   or: Press the RED (+) or BLUE(–) button to step this value up or down.
   or: Press and hold a button for a prolonged time to start a repeat function.

When the new setting exceeds that of the Limit Settings (Menu 0C and 0B), the new value is rejected, and the previous value remains unchanged.

Transmitter Variable Values: menu level 0

Dynamic Value, Primary Variable (PV): menu 00 and menu 10

Note: Menus 00 and 10 are the only locations where you can change from level 1 to level 0, or vice versa.

The value for the Primary Variable is displayed as either units or percent of range, selected in menu 01. When 2-state mode is selected in menu 07 the LCD display indicates the probe status:

- blinking for an uncovered probe
- steady for a covered probe

If the internal diagnostics detect a fault or failure, the display alternates between the PV value and the fault/failure message '**Flt**'. If the product level goes outside the limit settings, then the display alternates between the PV value and '**ooL**'. Alternatively, if the simulation

(SIM) function has been selected via HART, the LCD alternately displays the text **SIM** or the applied simulation value for the duration of the simulation.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Description	Values
00	01	0	Off	Dynamic Value (PV)	Units or % of range, selected in menu 01
10			On		

To change from menu 10 to menu 00:

1. Set the rotary switch to 0.
2. Press the RED (+) button for about a second. The LCD briefly displays **: M 00** followed by **: SEL 0**, to indicate that menu 00 is selected. When the button is released the LCD displays the current PV value. No left-arrow is displayed at the top left corner of the LCD in menu 00.

To change from menu 00 to menu 10:

1. Set the rotary switch to **0**.
2. Press the BLUE button for more than one second. The LCD briefly displays **: M 10** followed by **: SEL1**, to indicate that menu level 1 is selected. Then the LCD displays PV, and a left-arrow is visible in the top left corner of the LCD, indicating menu level 1.

Display the Highest / Lowest Recorded Value

Menu Item	Rotary Switch Position	Left Arrow	Description
02	2	Off	Highest / Lowest Recorded Value

1. Set the rotary switch to **2**. The Highest / Lowest recorded values for TV currently selected are displayed alternately.
2. Press the RED (+) button to select the Highest recorded value for display,
   or: Press the BLUE (–) button to select the Lowest recorded value for display,
3. Press both buttons simultaneously for more than one second to reset the recorded values back to the dynamic value of this TV. (This will also occur after a reset [power-down] of the device.)

Select the Transmitter Variable (TV) for the Primary Variable (PV).

Menu Item	Rotary Switch Position	Left Arrow	Description	Values		
01	1	Off	Transmitter Variable selection for PV	0	*	TV0 (units are pF)
				1		TV1 (units are user definable only via HART)
				P		TV0 (values displayed as %)

1. Set the rotary switch to **1**. The LCD displays **Pv = 0**, **1**, or **P**.
2. Press the RED (+) or BLUE (–) button to select a higher or lower value.
3. Press both buttons to select **Pv = P**.

Notes:
- When PV is set to **1**, settings cannot be changed using push-button adjustment.
- Many settings cannot be changed using push-button calibration when **PV = P**.

If PV = 0, TV0 is selected for PV, URV, LRV, USL, LSL, Damping, and Highest/Lowest recorded value. The units are implicitly[1] pF.

If PV = 1, TV1 is selected for PV, URV, LRV, USL, LSL, Damping, and Highest/Lowest recorded value. The units are user definable but only by HART.

If PV = P, TV0 is selected: however, the values for PV and URV are displayed in %; LRV, USL, LSL, are blanked out with **- - - -**; all other fields are identical to that of TV0.

Transmitter Variables Dynamic Value: menu level 1

This menu selection allows you to read the values of the dynamic variables TV0, TV1, TV2[2], and TV3. When no buttons are pressed, the LCD displays the dynamic value for TV0.

Menu Item	Rotary Switch Position	Left Arrow	Mode		Description	Action	Values
1C	C	On	TV0	*	Transmitter Variables Dynamic Value	No buttons pressed	Dynamic value for TV0
			TV1		Transmitter Variables Dynamic Value	Press and hold RED (+) button	Dynamic value for TV1
			TV2[2]		Transmitter Variables Dynamic Value	Press and hold BLUE(–) button	Dynamic value for TV2
			TV3[2]		Transmitter Variables Dynamic Value	Both buttons pressed simultaneously	Dynamic value for TV3
			Invalid selection				Display shows **0.00**

1. The units are pF: there is no other option.
2. TV2 and TV3 are not currently used, but are available for future development.

Analog Output Signalling (proportional or 2-state): menu level 0

Analog mode (the loop-current) can provide either:

- a 4 to 20 / 20 to 4 mA output proportional to the percent of the range

or

- a 4 or 20 / 20 or 4 mA output, when 2-state mode is selected

> **Note:** To set values for Upper and Lower Threshold Delay, and Upper and Lower Threshold Setting (2-state mode), the loop-current menu (07) must be in 2-state mode. When the loop-current control is in analog mode, the LCD displays only - - - - for these menu selections.

Upper Threshold Delay (2-state mode)

The Upper Threshold Setting controls the Activation delay: the amount of time that has to pass uninterrupted with the probe covered to a level above the Upper Threshold Setting before the timer expires. When the timer expires, the output signal complies with the setting from Menu 08 for a covered probe. Whenever the level drops below the Upper Threshold Setting before the timer expires, the timer is restarted.

As an extra identifier, an upward running **A** is displayed to the right of the value.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode		Added Indicator	Description	Values
03	07	3	Off	2-state		Upward running **A** at right of value	Upper Threshold Delay	in seconds
				Analog	*			Display shows - - - -

1. Set the loop-current control (Menu 07) to 2-state mode.
2. Set the rotary switch to **3**.
3. Press the RED (+) or BLUE(–) button to increase or decrease the value.
   or: Press and hold a button to start a repeat function.
   or: Press and hold both buttons simultaneously to toggle the value between minimum (0) and maximum (100).

Lower Threshold Delay (2-state mode)

The Lower Threshold Setting controls the Deactivation delay: the amount of time that has to pass uninterrupted with the probe covered to a level below the Lower Threshold Setting before the timer expires. When the timer expires, the output signal will comply with the setting from Menu 08 for an uncovered probe. Whenever the level rises above the Lower Threshold Setting before the timer expires, the timer is restarted.

As an extra identifier, a downward running **A** is displayed to the right of the value.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode		Added Indicator	Description	Values
04	07	4	Off	2-state		Downward running **A** at right of value	Lower Threshold Delay	in seconds
				Ana-log	*			Display shows - - - -

1. Set the loop-current control (Menu 07) to 2-state mode.
2. Set the rotary switch to **4**.
3. Press the RED (+) or BLUE(–) buttons to increase or decrease the value.
   or: Press and hold a button to start a repeat function.
   or: Press and hold both buttons simultaneously to toggle the value between minimum (0) and maximum (100).

Upper Threshold Setting (2-state mode)

The Upper Threshold Setting is the % of range above which the probe is considered covered. In order to switch the output signal, the corresponding delay time has to be met (Menu 03).

The loop-current control (Menu 07) must be in 2-state mode for this menu to display the Upper Threshold Setting in percent. As an extra identifier, an upward ramp is displayed to the right of the value.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode		Added Indicator	Description	Values
05	07	5	Off	2-state		Upward ramp at right of value	Upper Threshold Setting	% of range
				Analog	*			Display shows - - - -

1. Set the loop-current control (Menu 07) to 2-state mode.
2. Set the rotary switch to **5**.
3. Press the RED (+) or BLUE (–) button to increase or decrease the value.
   or: Press and hold a button to start a repeat function.

Lower Threshold Setting (2-state mode)

The Lower Threshold Setting is the % of range below which the probe is considered uncovered. In order to switch the output signal, the corresponding delay time has to be met (Menu 04).

The loop-current control (Menu 07) must be in 2-state mode for this menu to display the Upper Threshold Setting in percent. As an extra identifier, a downward ramp ↳ is displayed to the right of the value.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode		Added Indicator	Description	Values
06	07	6	Off	2-state		Downward ramp at right of value	Lower Threshold Setting	% of range
				Analog	*			Display shows - - - -

1. Set the loop-current control (Menu 07) to 2-state mode.
2. Set the rotary switch to **6**.
3. Press the RED (+) or BLUE (–) button to increase or decrease the value.
   or: Press and hold a button to start a repeat function.

Analog Signalling Mode (2-state): menu level 0

Note: Menu 08 has precedence over the settings in Menu 07.

The factory setting is for Analog mode (the loop-current is proportional with the percentage of the range). When no buttons are pressed, the LCD displays the current mA value.

2-state Signalling Mode provides a 4 mA or 20 mA output. The settings are relative to a covered probe:

- C: Hi selects a 20 mA signal for a covered probe, which switches to 4 mA if the probe becomes uncovered.
- C: Lo selects a 4 mA signal for a covered probe, which switches to 20 mA if the probe becomes uncovered.

Menu selections 03, 04, 05, and 06 set the criteria for delay and threshold that have to be met for a change in output signal.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode		Description	Action	Values
07	03, 04, 05, 06, 08	7	Off	Analog	*	Signal proportional to % of range	Press both buttons simultaneously	Display shows C: An
				2-state		2-state High	Press RED (+)	Display shows C: Hi[a]
						2-state Low	Press BLUE (–)	Display shows C: Lo[b]

a. While button is pressed, display reads **C: Hi**. When button is released, display shows 20.00 if the probe is covered, or 4.00 if it is uncovered.

b. While button is pressed, display reads **C: Lo**. When button is released, display shows 4.00 if the probe is covered, or 20.00 if it is uncovered.

Set the rotary switch to **7**. To change the mode to 2-state High, press the RED (+) button for more than one second: the LCD displays **C: Hi.** When the button is released, the loop-current will switch to **20 mA** if the probe is covered, or **4 mA** if it is uncovered.

To change the mode to 2-state Low, press the BLUE (–) button for more than one second: the LCD displays **C: Lo**. When the button is released, the loop-current will switch to **4 mA**, and if the probe is uncovered, or **20 mA** if the probe is covered.

Analog Mode may be restored at any time by pressing both buttons simultaneously for more than one second. The LCD displays **C: An** while the two buttons are pressed, and displays the current reading when the buttons are released.

The loop-current will be between 3.8 and 20.5 mA, and will saturate to one of these values if the level goes beyond the Upper or Lower range settings.

Analog Fault Signalling (2-state)

Note:
- 2-state mode must be selected at menu 07.
- This menu selection controls the current-loop fault/failure signal output. This signal has precedence over the settings on Menu 07.

When 2-state fault signalling is enabled, in the case of a fault the mA output is 3.6 mA or 22 mA[1], depending on the setting. The mA output is viewed at menu 07.

Menu Item	Rotary Switch Position	Left Arrow	Description		Action	Values
08	8	Off	2-state Fault Signalling (disabled)	*	Press both buttons simultaneously	Display shows F: - -
			2-state High Fault Signalling (enabled)		Press RED (+)	Display shows F: Hi[a]
			2-state Low Fault Signalling (enabled)		Press BLUE (–)	Display shows F: Lo

a. If the LCD displays an equal sign (=) in place of the colon (:) this indicates that the loop-current **is** at fault/failure level. For example **F: Hi** becomes **F= Hi**.

Set the rotary switch to **8**.

- To change the mode to 2-state High, press the RED (+) button for more than a second: the display reads **F: Hi**. In the case of a fault/failure the loop-current goes to 22.0 mA.
- To change the mode to 2-state Low, press the BLUE (–) button for more than a second: the display reads **F: Lo**. In the case of a fault/failure the loop-current goes to 3.6 mA.

1. For detailed information, see *Fault Signalling* on page 16.

Digital Output Signalling (solid-state output): menu level 1

To set values for Upper and Lower Threshold Delay, and Upper and Lower Threshold Setting, the solid-state switch output must be enabled (menu 17). When solid-state switch output is disabled these menu selections display only **- - - -**.

Upper Threshold Delay (solid-state output)

The Upper Threshold Delay controls the Activation delay: the amount of time that has to pass uninterrupted with the probe covered to a level above the Upper Threshold Setting before the timer expires. After the timer expires, the output signal will comply to the setting from Menu 18 for a covered probe. Whenever the level drops below the Upper Threshold Setting before the timer expires, the timer is restarted.

When the solid-state switch control (Menu 17) is disabled, menu 13 displays - - - -. When the solid-state switch control is enabled, menu 13 displays the Activation delay in seconds. As an extra identifier, an upward running **d** is displayed to the right of the value.

<table>
<tr><th>Menu Item</th><th>Affected by:</th><th>Rotary Switch Position</th><th>Left Arrow</th><th colspan="2">Mode</th><th>Identifier</th><th>Des-cription</th><th>Values</th></tr>
<tr><td rowspan="2">13</td><td rowspan="2">17</td><td rowspan="2">3</td><td rowspan="2">On</td><td>Solid-state switch con-trol enabled</td><td></td><td>Upward running d at right of value</td><td>Upper Threshold Delay</td><td>Range: 0 to 100 (seconds)</td></tr>
<tr><td>Solid-state switch con-trol disabled</td><td>*</td><td></td><td></td><td>Display shows - - - -</td></tr>
</table>

First select the solid-state switch output at menu 17 (**contact open** or **contact closed**).

1. Set the rotary switch to **3**.
2. Press the RED (+) or BLUE (–) button to increase or decrease the value.
   or: Press and hold a button to start a repeat function.
   or: Press both buttons simultaneously to toggle the value between minimum (**0**) and maximum (**100**).

Lower Threshold Delay (solid-state output)

The Lower Threshold Delay controls the Deactivation delay: the amount of time that has to pass uninterrupted with the probe covered to a level below the Lower Threshold Setting before the timer expires. After the timer expires, the output signal will comply to the setting from Menu 18 for an uncovered probe. Whenever the level rises above the Lower Threshold Setting before the timer expires, the timer is restarted.

When the solid-state switch control (Menu 17) is disabled, menu 14 displays only **- - - -**. When the solid-state switch control is enabled, this menu displays the Deactivation delay in seconds. As an extra identifier, a downward running **d** is displayed to the right of the value.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode		Identifier	Des-cription	Values
14	17	4	On	Solid-state switch con-trol enabled		Downward running **d** at right of value	Lower Threshold Delay	Range: **0 to 100** (seconds)
				Solid-state switch con-trol disabled	*			Display shows - - - -

First select the solid-state switch output at menu 17 (**contact open** or **contact closed**).

1. Set the rotary switch to **4**.
2. Press the RED (+) or BLUE(–) button to increase or decrease the value.
3. or: Press and hold a button to start a repeat function.
4. or: Press both buttons simultaneously to toggle the value between minimum (**0**) and maximum (**100**).

Upper Threshold Setting: (solid-state output)

The Upper Threshold Setting is the % of range above which the probe is considered covered. In order to switch the output signal, the corresponding delay time has to be met (Menu 13).

When the solid-state switch control (Menu 17) is disabled, menu 15 displays only **- - - -**. When the solid-state switch control is enabled, menu 15 displays the Upper Threshold setting in percent. As an extra identifier, an upward ramp  is displayed to the right of the value.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode		Identifier	Des-cription	Values
15	17	5	On	Solid-state switch con-trol enabled		Upward ramp at right of value	Upper Threshold Setting	% of range
				Solid-state switch con-trol disabled	*			Display shows - - - -

First select the solid-state switch output at menu 17 (**contact open** or **contact closed**).

1. Set the rotary switch to **5**.
2. Press the RED (+) or BLUE (–) button to increase or decrease the value.
   or: Press and hold a button for a prolonged time start a repeat function.

Lower Threshold Setting: (solid-state output)

The Lower Threshold Setting is the % of range below which the probe is considered uncovered. In order to switch the output signal, the corresponding delay time has to be met (Menu 14).

If the solid-state switch control (Menu 17) is disabled, menu 16 displays - - - -. When the solid-state switch control is enabled, menu 16 displays the Lower Threshold Setting in percent. As an extra identifier, a downward ramp is displayed to the right of the value.

Menu Item	Affected by:	Rotary Switch Position	Left Arrow	Mode		Added indicator	Des-cription	Values
16	17	6	On	Solid-state switch con-trol enabled		Downward ramp at right of value	Lower Threshold Setting	% of range
				Solid-state switch con-trol disabled	*			Display shows - - - -

First select the solid-state switch output at menu 17 (**contact open** or **contact closed**).

1. Set the rotary switch to **6**.
2. Press the RED (+) or BLUE (–) button to increase or decrease the value.
   or: Press and hold a button to start a repeat function.

Digital Signalling Mode (solid-state output)

> **Note:** Menu 18 has precedence over menu 17.

Controls the solid-state switch output and allows you to set the switch to **contact open** or **contact closed**. The settings are relative to a covered probe, and the criteria are set in menu 15 and 16. With **contact closed**, the switch is **on**: with **contact open** the switch is **off**.

While a button is pressed, the LCD displays **S: cc**[1] (contact closed) or **S: co** (contact open). When the button is released an equal sign (=) indicating status replaces the colon, and the reading depends on the status of the probe[2].

Example: S = cc is selected (contact closed with a covered probe)

- If the probe is uncovered when the button is released, the display changes from **S: cc** to **S = co**.
- If the probe is covered when the buttons are released, the display changes to **S = cc.**
- If you press either button briefly, the LCD displays the current setting, in this case, **S: cc.**

<table>
<tr><th>Menu Item</th><th>Affected by:</th><th>Rotary Switch Position</th><th>Left Arrow</th><th colspan="2">Mode</th><th>Des-cription</th><th>Action</th><th>Values</th></tr>
<tr><td rowspan="3">17</td><td rowspan="3">18</td><td rowspan="3">7</td><td rowspan="3">On</td><td>Disabled</td><td>*</td><td></td><td>Press and hold both buttons</td><td>Display shows **S: - -**</td></tr>
<tr><td rowspan="2">Digital Signal-ling Mode</td><td rowspan="2"></td><td>Contact Closed: switch **on**</td><td>Press and hold RED (+) button</td><td>Display shows[a] **S: cc**</td></tr>
<tr><td>Contact Open: switch **off**</td><td>Press and hold BLUE (–) button</td><td>Display shows[a] **S: co**</td></tr>
</table>

a. While the button is pressed: when released the display depends on the probe status.

1. Set the rotary switch to **7**.
2. Press and hold the RED (+) or BLUE (–) button to select **contact open** or **contact closed.**
   or: Press and hold both buttons to disable this function.

Menu selections 13, 14, 15 and 16 set the criteria for delay and threshold that have to be met for a change in output signal.

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1. A colon at the extreme left of the display appears while the button is pressed to indicate when a setting is accepted, for example : **S: cc.**
2. If digital fault signalling is enabled at menu 18, it takes precedence, and no equal sign will appear in the display for menu 17 if the device is responding to a fault.

Digital Fault Signalling

Note: This signal has precedence over the settings on Menu 17.

Controls the solid-state switch response to a fault/failure and allows you to select either **contact open** or **contact closed**. With **contact closed** the solid-state switch will be **on:** with **contact open** the solid-state switch will be **off**.

While a button is pressed, the LCD displays **F: cc**[1] (contact closed) or **F: co** (contact open). When the button is released an equal sign (=) indicating status replaces the colon, and the reading depends on the status of the probe.

Example: F = cc is selected (contact closed when fault is detected)

- If a fault condition exists when the button is released, the display changes from **F: cc** to **F = cc**.
- If no fault condition exists when the button is released, the display shows **F: cc**.
- If you press either button briefly, the LCD displays the current setting, in this case, **F: cc.**

Menu Item	Rotary Switch Position	Left Arrow	Mode		Description	Action	Values
18	8	On	Disabled	*		Press and hold both buttons	Display shows **F: - -**
			Digital Signalling Mode		Contact Closed: switch **on**	Press and hold RED (+) button	Display shows **F: cc**
					Contact Open: switch **off**	Press and hold BLUE (–) button	Display shows **F: co**

Set the rotary switch to **8**. Press the RED (+) or BLUE (–) button to change the setting. The disabled mode can be restored at any time by pressing both buttons simultaneously for more than one second.

1. A colon at the extreme left of the display appears while the button is pressed to indicate when a setting is accepted, for example **: S: cc**.

Miscellaneous

Output Signal Processing Test

Displays the Fault/Failure information. If operation is normal, two test displays alternate, which light up all the LCD segments in a cycle. If there is a fault or failure, an error code is displayed. See the detailed list of error codes and their meanings, page 53.

Menu Item	Rotary Switch Position	Left Arrow	Description
11	1	On	Output Signal Processing Test

Set the rotary switch to **1**.

To change the state of the output signals, press and hold both buttons simultaneously: the digital mode outputs (the solid-state switch and the loop-current control in digital mode) change to their opposite state. Thus 4mA becomes 20mA and **contact open** becomes **contact closed**. This feature allows you to verify that the output signals are properly processed further on in the PLC/DCS system: if the normal state is non-alarm, changing the state should generate an alarm.

The outputs stay in the opposite state as long as both buttons are pressed.

Factory Settings

Displays whether the factory settings are still in place, or how much they have been changed, and allows you to restore the factory settings.

Menu Item	Rotary Switch Position	Left Arrow	Description	LCD Display	Meaning
12	2	On	Factory Settings	FAC A	No parameters changed from factory setting
				FAC P	Range settings altered: timers and thresholds unchanged
				FAC ?	More parameters have been changed

Set the rotary switch to **2**. To restore the factory settings, press both buttons simultaneously to change the LCD to 'do it' and hold both buttons for more than one second. When the buttons are released, the LCD displays **FAC A**.

Range Inversion

Displays whether the device is operating with a **normal** or **inverted** range setting.
A normal range setting is where LRV (Menu 0E) is lower in value than URV (Menu 0F): the LCD displays **nor.** An inverted range is where LRV (Menu 0E) is higher in value than URV (Menu 0F): the LCD displays **inv**.

Menu Item	Rotary Switch Position	Left Arrow	Description	Mode		Values
19	9	On	Range Inversion	normal	*	Display shows **nor**
				inverted		Display shows **inv**

1. Set the rotary switch to **9**.
2. Press both buttons simultaneously for more than one second to toggle between the two modes, effectively switching the values for LRV and URV.

Keylock Level

Controls the access protection level for the device. The factory setting is a local protection level of **0,** which places no restriction on modifying settings locally.

> **Note:** HART settings override local settings:
> - If the HART setting is 0, there are no restrictions, and you cannot change the protection to a higher level locally.
> - If the HART setting is 3, no changes can be made, and this protection level cannot be changed locally.

- Protection level **1** disables the ability to set a value by pressing two buttons simultaneously.
- Protection level **2** disables the ability to change a value by stepping it up or down.
- Protection level **3** completely disables all changing of values.

Menu Item	Rotary Switch Position	Left Arrow	Protection			Display	
			Level		Description	local settings	HART settings
1F	F	On	**0**	*	No restrictions	**PL 0**	
					No restrictions		**PH 0**
			1		Disables 2-button adjustments	**PL 1**	**PH 1**
			2		Disables 1-button adjustments	**PL 2**	**PH 2**
			3		Disables all changes	**PL 3**	**PH 3**

1. Set the rotary switch to **F**.
2. Press the RED (+) or BLUE (–) button to change the setting.

Appendix B: LCD display examples

LCD: alphanumeric display examples

Menu Item Indicator:

M 00

Menu Level Indicator:

SEL 1

Internal diagnostics detects anomaly:

FLt

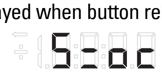
Solid-state switch output closed when probe is covered (displayed while button pressed):

S: oc

Solid-state switch output open when probe is covered (displayed while button pressed):

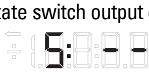
S: oo

Solid-state switch output closed and probe covered, = sign indicates current probe status (displayed when button released):



S= oc

Solid-state switch output disabled:



S: – –

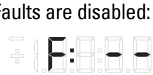
Solid-state switch output open when Fault detected:

F: oo

Solid-state switch output closed when Fault detected:

F: oc

Solid-state switch / current-loop output functions due to Faults are disabled:



F: – –

Current-loop, current goes to 22 mA when Fault detected:

Hi

Current-loop, current goes to 3.6 mA when Fault detected:

Lo

Current-loop, output in Analog (proportional) mode:

An

Indicator for range operation, normal (URV > LRV):

nor

Indicator for range operation, inverted (URV < LRV):

inv

Output out of limits, PV outside Variable Limits:

ooL

Indicator for Factory Set, all parameters are original:

FAC A

Indicator for Factory Set, range settings have been changed:

FAC P

Indicator for Factory Set, other settings have been changed also:

FAC?

Indicator for Factory Set, reset all variables back to factory setting:

do it

Function test indicator, all outputs in digital mode invert their output status:

0 = /o

Transmitter variable selected for PV:

Pv=0

Keylock protection level:

PL 0

Simulation is active. Transmitter Variable TV0 driven by simulation value:

SIM

Appendix C: HART Documentation

HART[1] Communications for the SITRANS LC500

Highway Addressable Remote Transducer (HART) is an industrial protocol that rides on top of a 4-20 mA signal. It is an open standard, and full details about HART can be obtained from the HART Communication Foundation at www.hartcomm.org

The SITRANS LC500 can be configured over the HART network using either the HART Communicator 275 by Fisher-Rosemount, or a software package. There are a number of different software packages available.The recommended software package is the Simatic Process Device Manager (PDM) by Siemens.

HART Device Descriptor (DD)

In order to configure a HART device, the configurator must have the HART Device Descriptor for the unit in question. HART DD's are controlled by the HART Communications Foundation. The HART DD for the SITRANS LC500 will be released in 2003. Please check availability with the HART Communications Foundation. Older versions of the library will have to be updated in order to use all the features in the SITRANS LC500.

Simatic Process Device Manager (PDM)

This software package is designed to permit easy configuration, monitoring, and troubleshooting of HART and Profibus PA devices. The HART DD for the SITRANS LC500 was written with Simatic PDM in mind and has been extensively tested with this software.

HART information

Expanded Device Type Code:

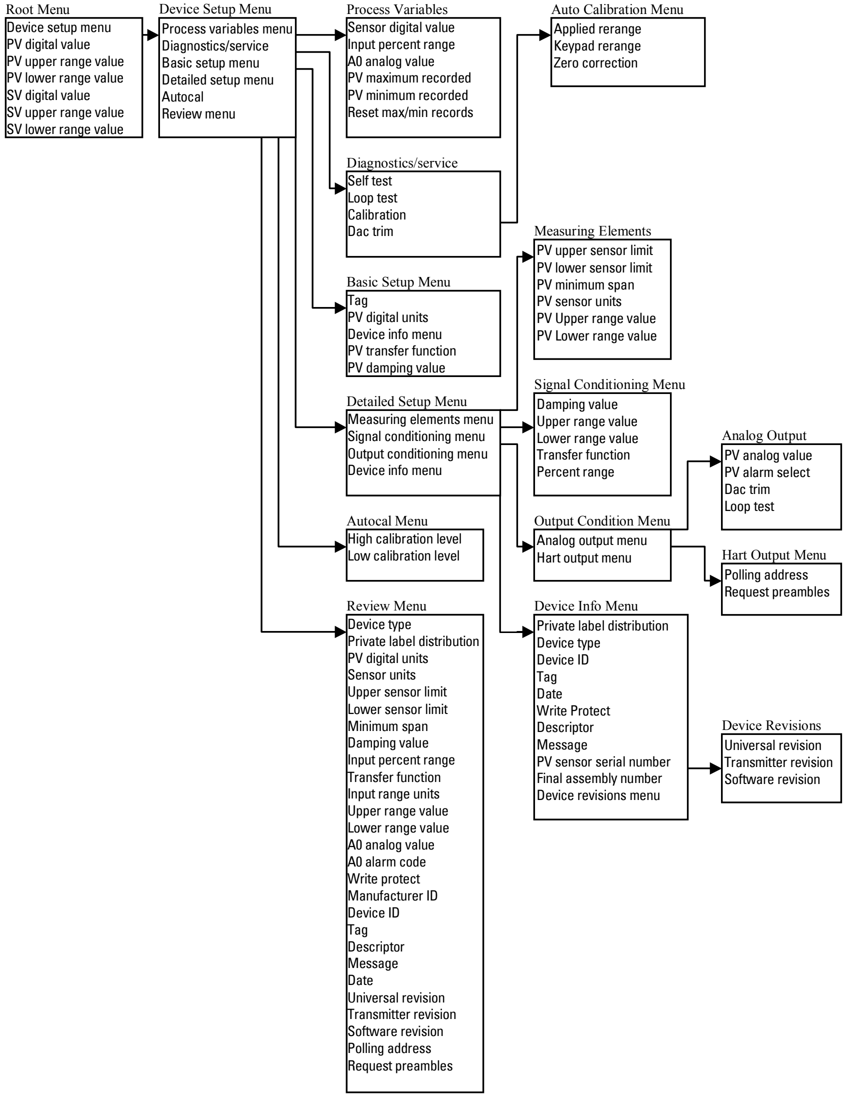
Manufacturer Identification Code	=	84
Manufacturer Device Type Code	=	248
Expanded Device Type Code	=	21752

Physical Layer Information

Field Device Category	=	A
Capacitance Number (CN)	=	1

1. HART® is a registered trademark of the HART Communications Foundation.

SITRANS LC500 DD Menu/Variable Organization



HART Response Code Information

Additional response code information, Second Byte.

Bit #7: Field Device Malfunction

When the transmitter detects a malfunction, the Analog Output will be set in a fault state.

Bit #6: Configuration Changed

When any of the settings in EEROM is changed either by a write command or by manual ZERO or SPAN adjust, this bit is set. Use command 38 to reset.

Bit #5: Cold Start

This bit is issued once after an initialisation cycle is complete; this can occur after a power loss or as a result of a (watchdog) reset.

Bit #4: Extended Status Available

When any of the extended status bits is set this flag is raised. Use command 48 to get detailed status information.

Bit #3: Output Current Fixed

This bit is set as long as the Primary Variable Analog Output is set to a fixed value.

Bit #2: Primary Variable Analog Output Saturated

Flag is set when the Primary Analog Output saturates below 3.8 mA and above 20.5 mA.

Bit #0: Primary Variable Out of Limits

This flag is set whenever the Transmitter Variable #0 (in pF), the Primary Variable exceeds the Sensor Limits returned with Command 14, Read Primary Variable Sensor Limits.

HART Conformance and Command Class

SITRANS LC500 transmitter Conformance and Command Class summary.

Command Number	Description	Usage
Conformance Class #1		
0	Return Unique Identifier	Universal
1	Read Primary Variable	

Command Number	Description	Usage
Conformance Class #1A		
0	Return Unique Identifier	Universal
2	Read PV Current and Percent of Range	

Command Number	Description	Usage
Conformance Class #2		
11	Read Unique Identifier Associated with Tag	Universal
12	Read Message	
13	Read Tag, Descriptor, and Date	
14	Read Primary Variable Sensor Information	
15	Read Primary Variable Output Information	
16	Read Final Assembly Number	

Command Number	Description	Usage
Conformance Class #3		
3	Read Dynamic Variables and PV Current	Universal
33	Read Selected Dynamic Variables	Common Practice
48	Read Additional Transmitter Status	Common Practice
50	Read Dynamic Variable Assignments	Common Practice
Conformance Class #4		
34	Write PV Damping Value	Common Practice
35	Write Primary Variable Range Values	
36	Set Primary Variable Upper Range Value	
37	Set Primary Variable Lower Range Value	
38	Reset Configuration Changed Flag	
40	Enter/Exit Fixed Primary Var. Current Mode	

Command Number	Description	Usage
Conformance Class #5		
6	Write Polling Address	Universal
17	Write Message	
18	Write Tag, Descriptor and Date	
19	Write Final Assembly Number	
44	Write Primary Variable Units	Common Practice
45	Trim Primary Variable Current DAC Zero	
46	Trim Primary Variable Current DAC Gain	
49	Write Primary Variable Sensor Serial Number	
59	Write Number of Response Preambles	

Command Number	Description	Usage
128	Set Alarm Select	Transmitter Specific
129	Adjust for Product Build-up on Sensor	
130	Read Failsafe Mode selection	
131	Return Device Config. Info.	
132	Write Variable Upper/Lower Limit Values	
133	Read Variable Upper/Lower Limit Values	
134	Write Keylock Value	
135	Read Keylock Value	
138	Write Simulation Timer and Value	
139	Read Simulation Timer and Value	
140	Write S.V. Units and Range Values	
141	Read S.V. Unites and Range Values	
144	Reset recorded PV min./max. values back to PV	
145	Return recorded PV min./max. values	
150	Write Analog Signalling Mode	
151	Read Analog Signalling Mode	
152	Write Digital Signalling Mode	
153	Read Digital Signalling Mode	
154	Write Analog Threshold Settings	
155	Read Analog Threshold Settings	
156	Write Digital Threshold Settings	
157	Read Digital Threshold Settings	
160	Write Delay Timers Analog Signalling	
161	Read Delay Timers Analog Signalling	
162	Write Delay Timers Digital Signalling	
163	Read Delay Timers Digital Signalling	

General Transmitter Information

Damping information

The SITRANS LC500 transmitter implements damping on most of the transmitter variables. The damping setting may vary from 1 (shortest value) to 10000 (longest value).

Non-volatile Memory Data Storage

The flags byte of Command #0 referenced in the Universal Command Specification document will have Bit #1 (Command #39, EEPROM Control Required) set to 0, indicating that all data sent to the transmitter will be saved automatically in the non-volatile memory upon receipt of the Write or Set Command. Command #39, EEPROM Control, is not implemented.

MultiDrop operation

The SITRANS LC500 transmitter supports MultiDrop Operation.

Burst mode

The SITRANS LC500 transmitter does not support Burst Mode.

Units conversions

The Transmitter Variable #0 Units are in pF and cannot be changed.

The Transmitter Variable #1 Values may be set to any Units and Value with Command #140. The Transmitter Variable Range Values may be read at any time with Command #141.

The value returned as Secondary Variable (S.V.) is the result of the following calculation:

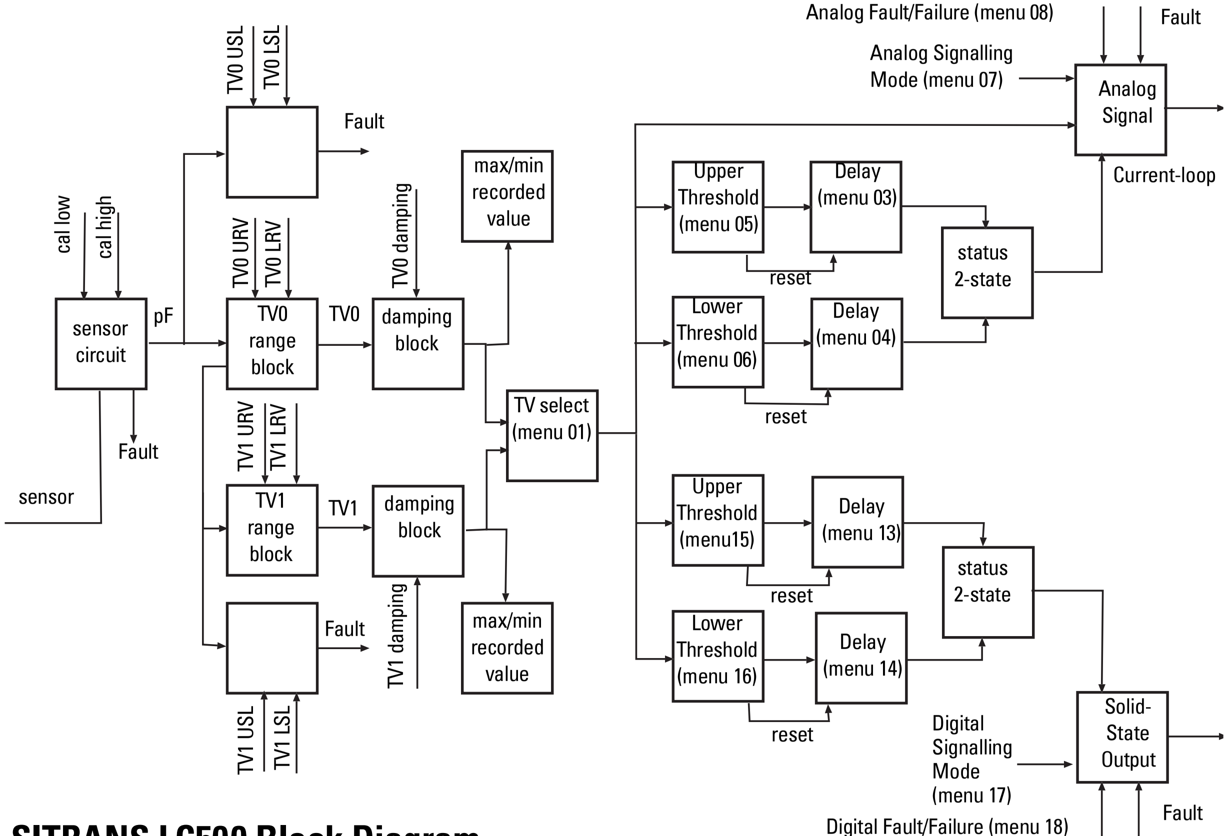
TV1 = TV0 Dynamic Range Value in percent x ({TV#1}URV – {TV#1}LRV) + {TV#1}LRV.

This method provides a means of converting TV#0, which is always in pF, to alternative units (level or volume).

Additional Universal Command Specifications

For a document listing the additional Universal Command Specifications, please contact Technical Publications at techpubs@siemens-milltronics.com

Appendix D: Block Diagram, and Correlation table, mA to %



SITRANS LC500 Block Diagram

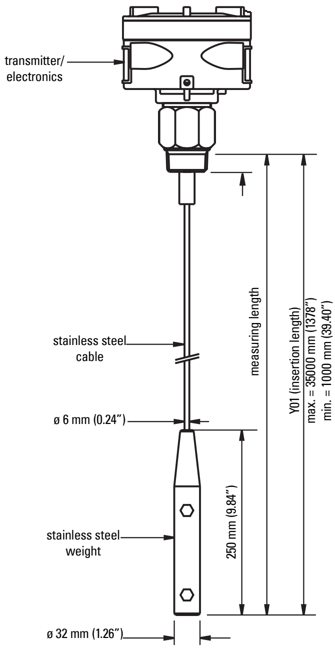
Correlation Table: 0% - 100% to 4-20 mA or 20-4 mA

Range 0 - 100 %	Current in mA	Range 100 - 0 %
0	4.0	100
5	4.8	95
10	5.6	90
15	6.4	85
20	7.2	80
25	8.0	75
30	8.8	70
35	9.6	65
40	10.4	60
45	11.2	55
50	12.0	50
55	12.8	45
60	13.6	40
65	14.4	35
70	15.2	30
75	16.0	25
80	16.8	20
85	17.6	15
90	18.4	10
95	19.2	5
100	20.0	0

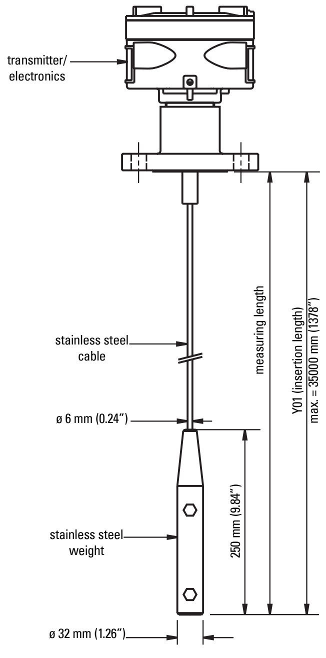
Appendix E: SITRANS LC500, alternate versions and application details

Cable version (non-insulated)(7ML5513)[1]

Threaded



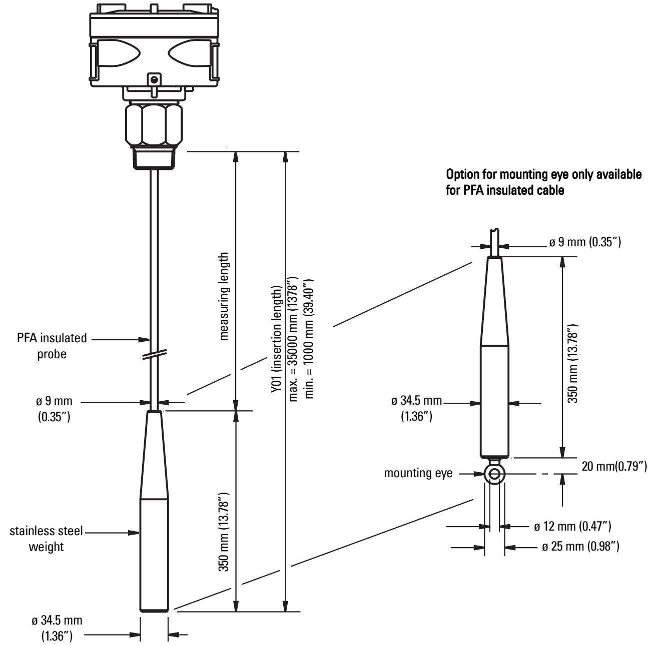
Flanged



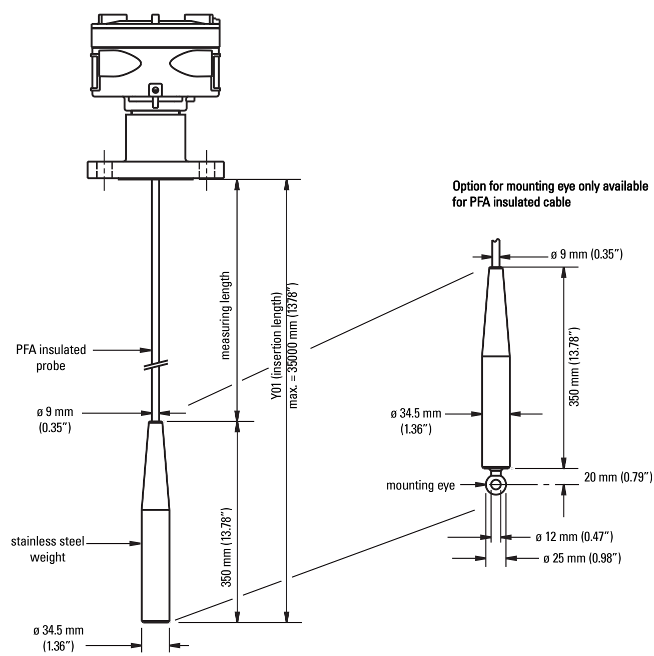
1. Applicable for non-conductive media only. Cable can be shortened on site. Weight is included in measuring length.

Cable version (insulated)(7ML5513)[1]

Threaded



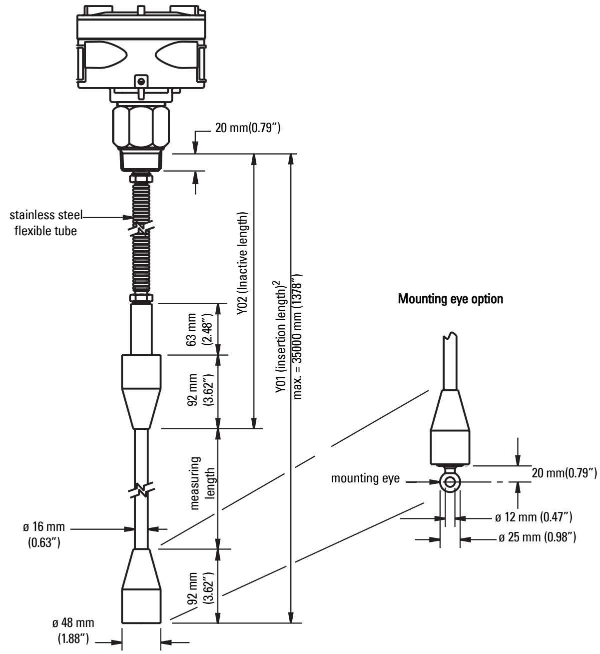
Flanged



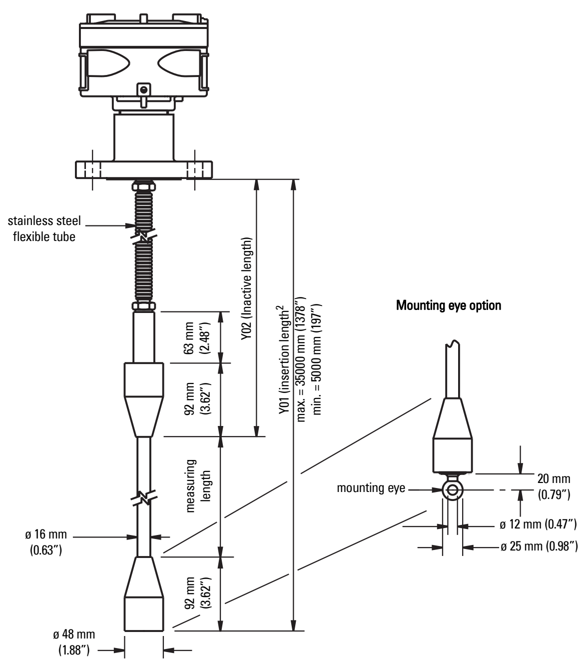
1. Applicable for both liquids and solids. Cable cannot be shortened. Weight is not part of measuring length.

Extended cable version with rod sensor (7ML5523)[1]

Threaded



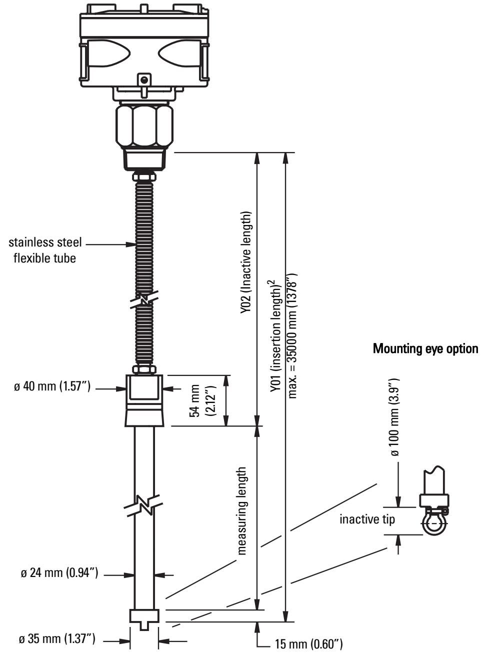
Flanged



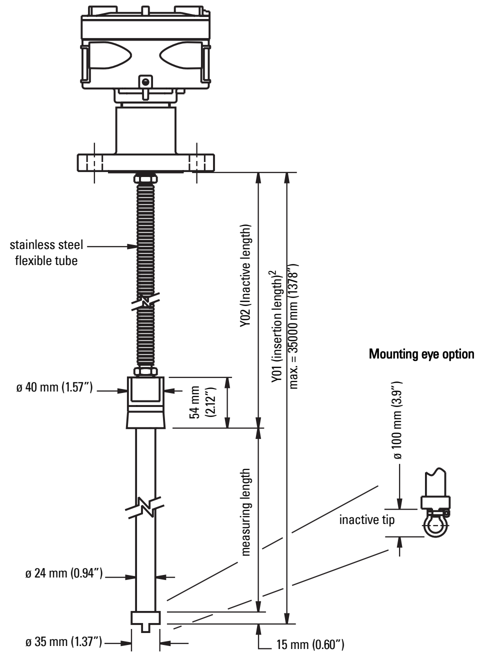
Appendix E

Extended cable version with rod sensor (7ML5523)[1]

Threaded



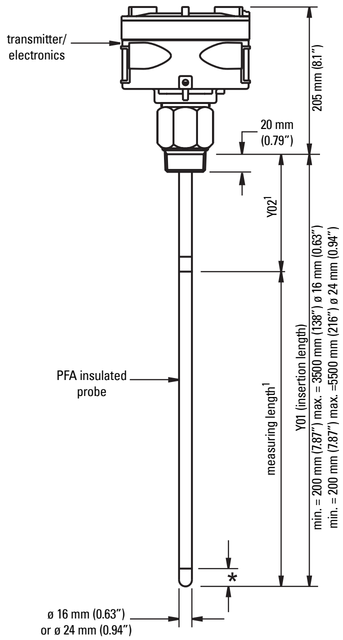
Flanged



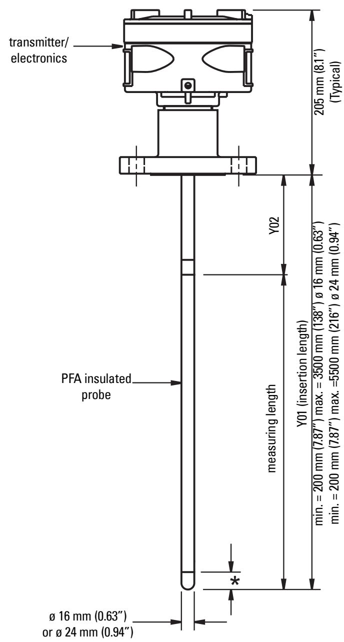
1. For Y02 lengths greater than 5000 mm (1.97"), cable is inactive and is not atively shielded.
2. Insertion length Y01 = Y02 + measuring length + 92 mm (3.62")

Rod version (7ML5515)

Threaded



Flanged



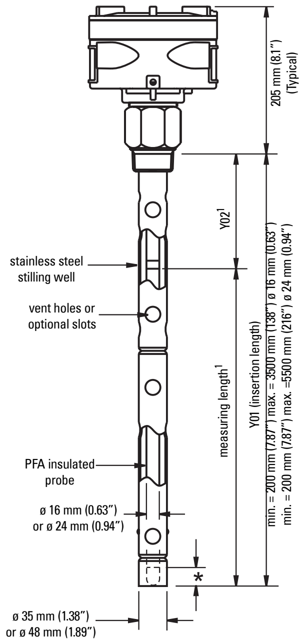
1. Minimum Y02 (active shield length) = 50 mm (1.96"), minimum measuring length = 200 mm (7.87")

Appendix E

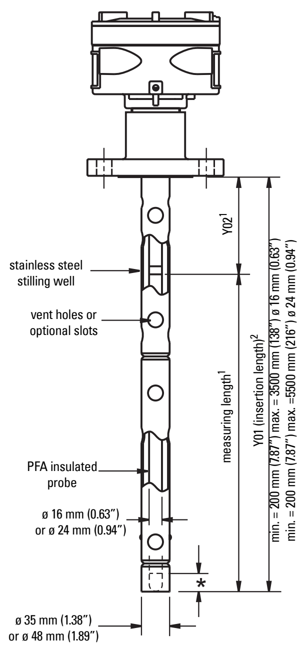
1. For Y02 lengths greater than 5000 mm (197"), cable is inactive and is not actively shielded.
2. Insertion length Y01 = Y02 + measuring length + 15 mm (0.59")

Rod version with stilling well (7ML5515)

Threaded



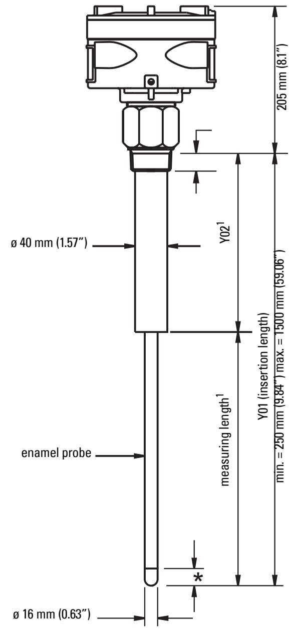
Flanged



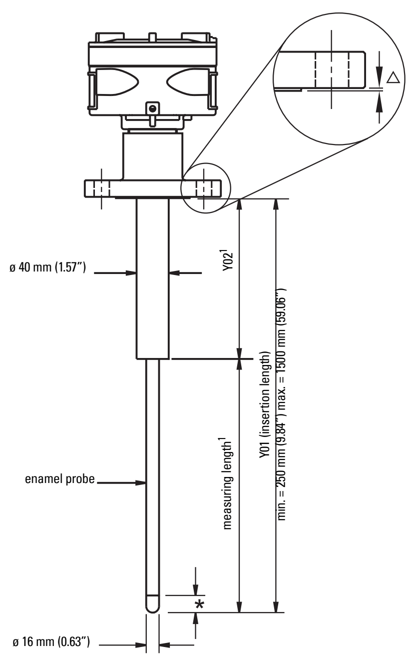
1. Minimum Y02 (active shield length) = 50 mm (1.96"), minimum measuring length = 200 mm (7.87")
2. Insertion length does not include any raised face/gasket face dimension.

Enamel rod version (7ML5515)

Threaded



Flanged

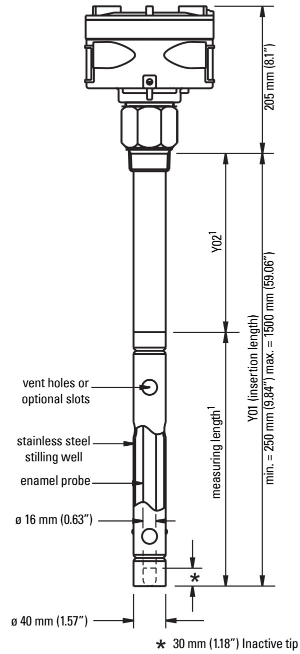


1. Minimum Y02 (active shield length) = 100 mm (3.94"), minimum measuring length = 250 mm (9.84")

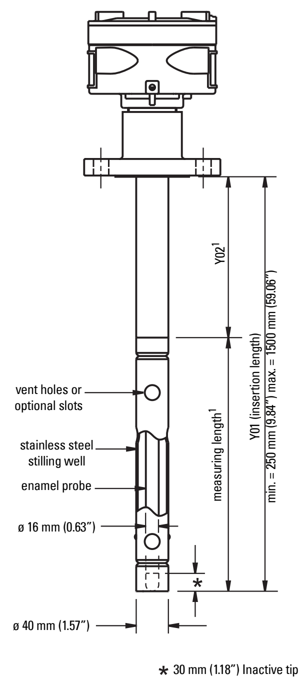
Appendix E

Enamel rod version with stilling well

Threaded



Flanged

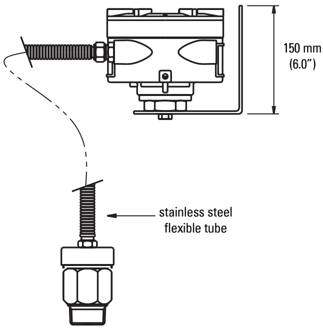


1. Minimum Y02 (active shield length) = 100 mm (3.94"), minimum measuring length = 250 mm (9.84")

Appendix E

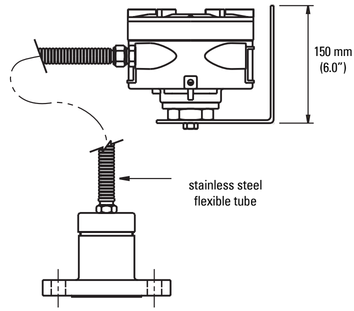
Remote electronics with mounting bracket option

Threaded



general purpose approval only.

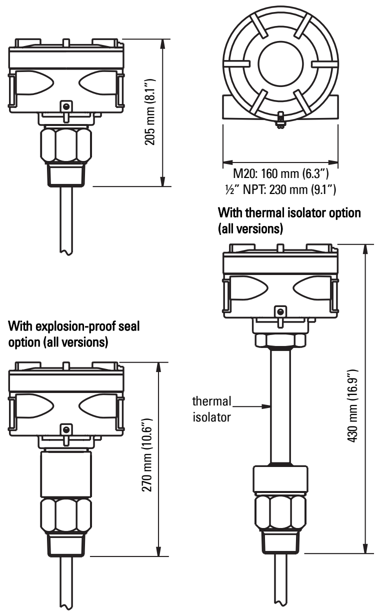
Flanged



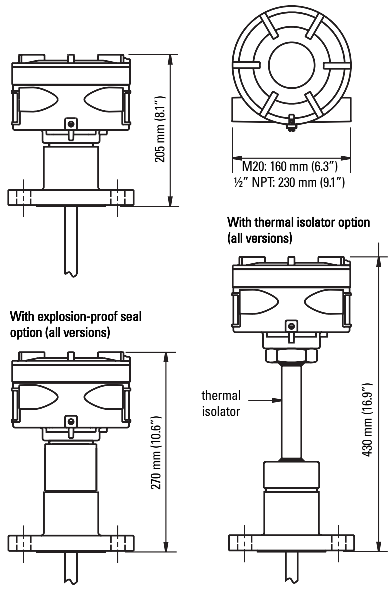
general purpose approval only.

Standard configuration (all versions)

Threaded

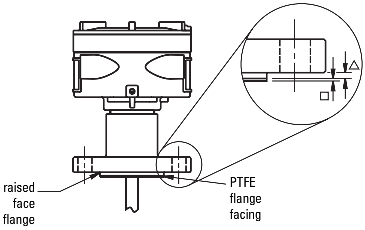


Flanged



Flanges

PTFE flange facing option
Single piece flange only (7ML5517)



No stilling well or enamel probe available with this option.

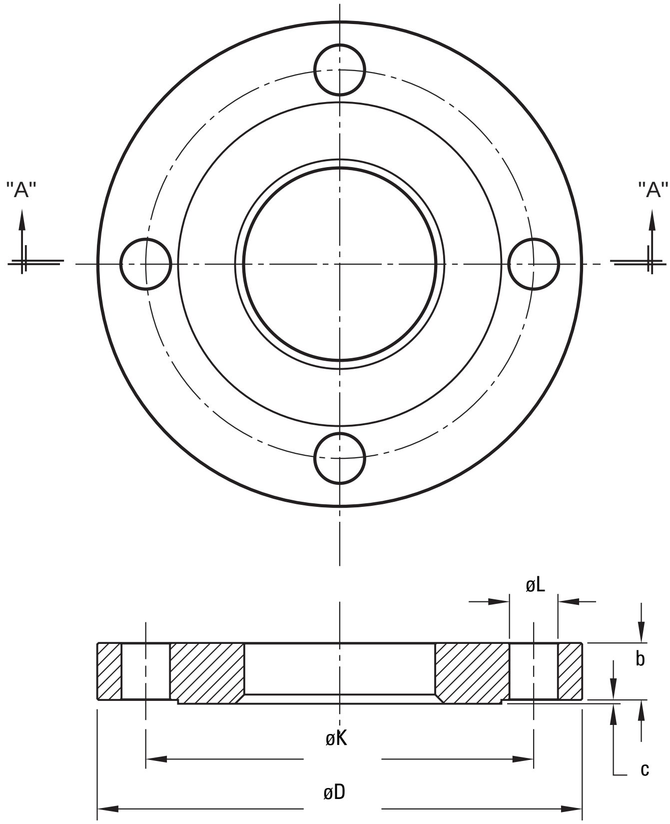
Flange Standards

Notes:

- All measurements are given in mm
- One (1) inch = 25.4 mm
- For details, see drawings, technical data, and measuring probe details on pages 83 to 99.

Appendix E

Welded Raised Face Flange (7ML5513, 7ML5515, 7ML5523)

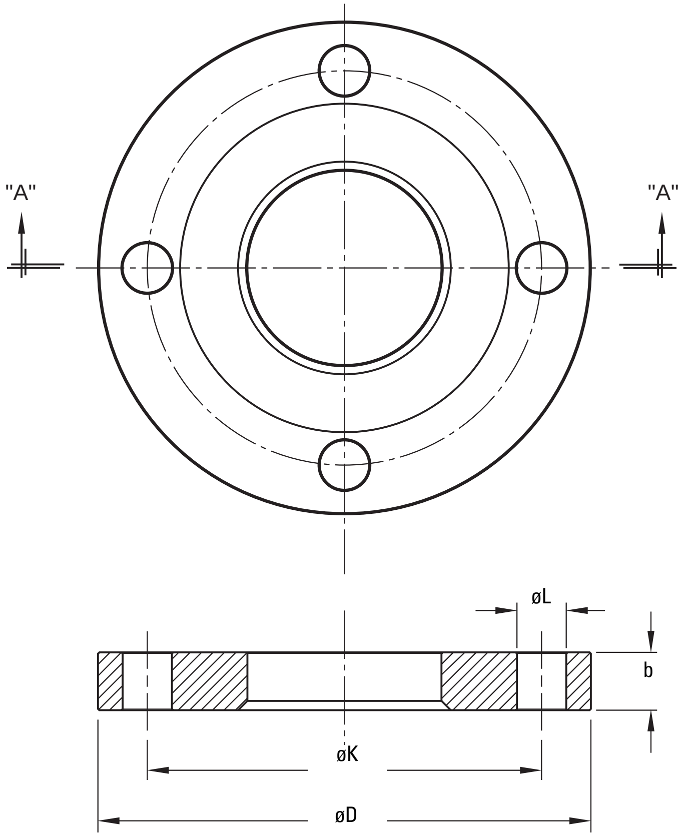


SECTION "A-A"

Welded Raised Face Flange							
Flange class	Nominal pipe size	Outside diameter øD (±2.0)	Bolt hole Circle øK (±0.80)	Bolt hole diameter øL (±0.30 x N)	Number of bolt holes N	Flange thickness b (+3.00/ -0.00)	Face thickness c (±0.5)
150 lb	1″	107.95	79.25	15.88	4	14.29	2.0
	1½″	127.00	98.55	15.88	4	17.46	2.0
	2″	152.40	120.65	19.05	4	19.05	2.0
	3″	190.50	152.40	19.05	4	23.85	2.0
	4″	228.60	190.50	19.05	8	23.85	2.0
	6″	279.40	241.30	22.22	8	25.40	2.0
300 lb	1″	123.95	88.90	19.05	4	15.75	2.0
	1½″	155.45	114.30	22.22	4	19.05	2.0
	2″	165.10	127.00	19.05	8	20.57	2.0
	3″	209.55	168.15	22.22	8	26.92	2.0
	4″	254.00	200.15	22.22	8	30.23	2.0
	6″	317.50	269.75	22.22	12	35.05	2.0

Welded Raised Face Flange cont'd							
Flange class	Nominal pipe size	Outside diameter øD (±2.0)	Bolt hole Circle øK (±0.80)	Bolt hole diameter øL (±0.30 x N)	Number of bolt holes N	Flange thickness b (+3.00/ -0.00)	Face thickness c (±0.5)
600 lb	1″	123.95	88.90	19.05	4	17.53	7.0
	1½″	155.45	114.30	22.22	4	22.35	7.0
	2″	165.10	127.00	19.05	8	25.40	7.0
	3″	209.55	168.15	22.22	8	31.75	7.0
	4″	273.05	215.90	25.40	8	38.10	7.0
	6″	355.60	292.10	28.58	12	47.75	7.0
900 lb	2″	215.90	165.10	25.40	8	38.10	7.0
	3″	241.30	190.50	25.40	8	38.10	7.0
	4″	292.10	234.95	31.75	8	44.45	7.0
	6″	381.00	317.50	31.75	12	55.63	7.0

Welded Flat Face Flange (7ML5513, 7ML5515, 7ML5523)

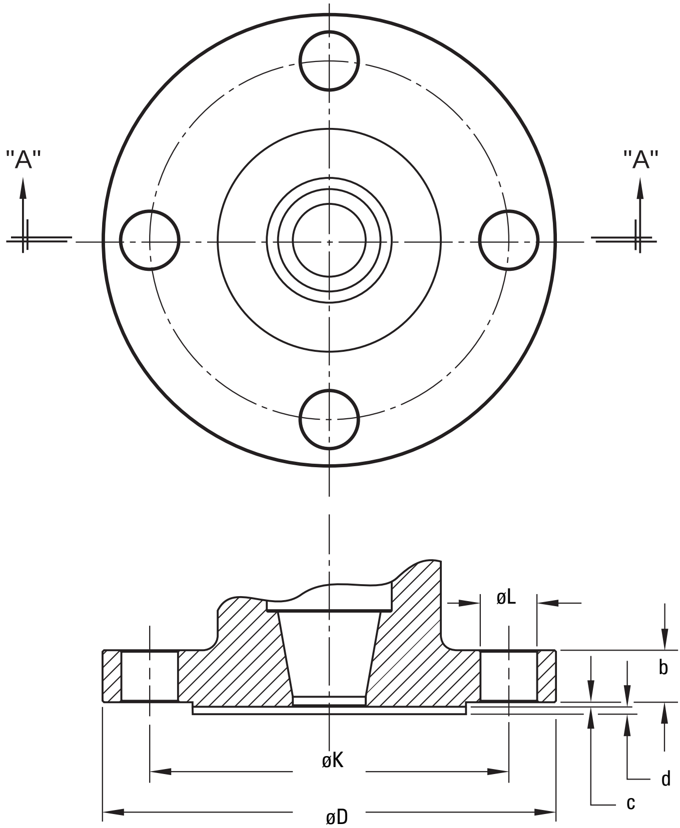


SECTION "A-A"

Welded Flat Face Flange						
Flange class	Nominal pipe size	Outside diameter øD (±2.0)	Bolt hole Circle øK (±1.0)	Bolt hole diameter øL (±0.3 x N)	Number of bolt holes N	Flange thickness b (+1.0/-0.0)
PN16	DN25	115.0	85.0	14.0	4	18.0
	DN40	150.0	110.0	18.0	4	18.0
	DN50	165.0	125.0	18.0	4	18.0
	DN80	200.0	160.0	18.0	8	20.0
	DN100	220.0	180.0	18.0	8	20.0
	DN125	250.0	210.0	18.0	8	22.0
PN40	DN25	115.0	85.0	14.0	4	18.0
	DN40	150.0	110.0	18.0	4	18.0
	DN50	165.0	125.0	18.0	4	20.0
	DN80	200.0	160.0	18.0	8	24.0
	DN100	235.0	190.0	22.0	8	24.0
	DN125	270.0	220.0	26.0	8	26.0

Welded Flat Face Flange cont'd						
Flange class	Nominal pipe size	Outside diameter øD (±2.0)	Bolt hole Circle øK (±1.0)	Bolt hole diameter øL (±0.3 x N)	Number of bolt holes N	Flange thickness b (+1.0/-0.0)
PN63	DN50	180.0	135.0	22.0	4	26.0
	DN80	215.0	170.0	22.0	8	28.0
	DN100	250.0	200.0	26.0	8	30.0
	DN125	295.0	240.0	30.0	8	34.0

Single Piece, Raised Face Flange (7ML5517)



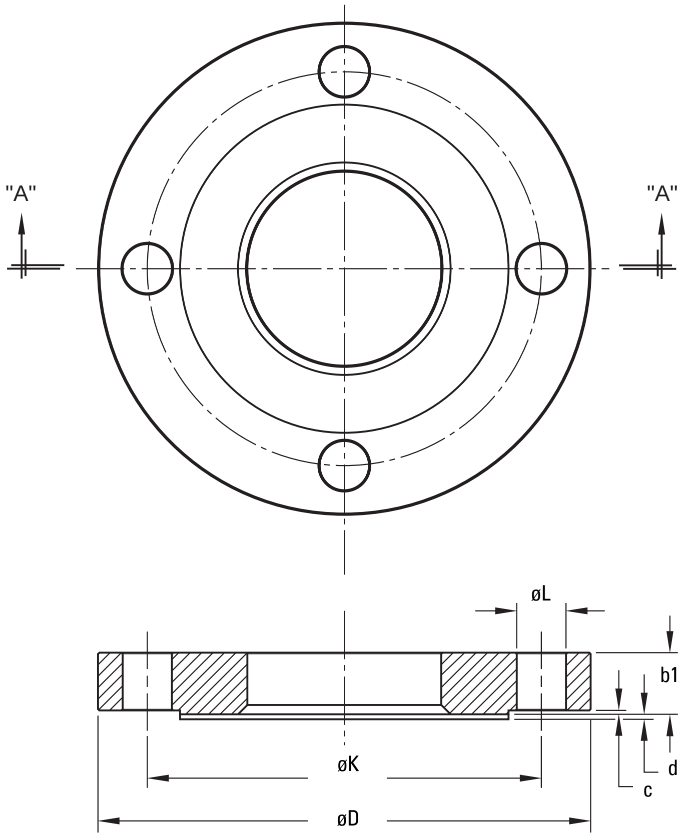
SECTION "A-A"

Single Piece, Raised Face Flange							
Flange class	Nominal pipe size	Outside diameter øD (±1.0)	Bolt hole Circle øK (±0.8)	Bolt hole diameter øL (±0.3)	Flange thickness b (+3.0/-0.0)	Face thickness c (+0.0/-0.5)	PTFE facing thickness d
150 lb	1½″	127.0	98.55	15.88	15.75	2.0	2.0
	2″	152.40	120.65	19.05	17.53	2.0	2.0
	3″	190.50	152.40	19.05	22.35	2.0	2.0
	4″	228.60	190.50	19.05	22.35	2.0	2.0
	6″	279.40	241.30	22.22	23.88	2.0	2.0

Appendix E

Single Piece, Raised Face Flange cont'd							
Flange class	Nominal pipe size	Outside diameter øD (±1.0)	Bolt hole Circle øK (±0.8)	Bolt hole diameter øL (±0.3)	Flange thickness b (+3.0/-0.0)	Face thickness c (+0.0/-0.5)	PTFE facing thickness d
300 lb	1½"	155.45	114.30	22.22	19.05	2.0	2.0
	2"	165.10	127.00	19.05	20.57	2.0	2.0
	3"	209.55	168.15	22.22	26.92	2.0	2.0
	4"	254.00	200.15	22.22	30.23	2.0	2.0
	6"	317.50	269.75	22.22	35.05	2.0	2.0
600 lb	1½"	155.45	114.30	22.22	22.35	7.0	2.0
	2"	165.10	127.00	19.05	25.40	7.0	2.0
	3"	209.55	168.15	22.22	31.75	7.0	2.0
	4"	273.05	215.90	25.40	38.10	7.0	2.0
	6"	355.60	292.10	28.58	47.75	7.0	2.0

Single Piece, Raised Face Flange (7ML5517)



SECTION "A-A"

Single Piece, Raised Face Flange							
Flange class	Nominal pipe size	Outside diameter øD (±1.0)	Bolt hole Circle øK (±0.8)	Bolt hole diameter øL (±0.3)	Flange thickness b1 (+1.0/-0.0)	Face thickness c (+0.0/-0.5)	PTFE facing thickness d
PN16	DN40	150.0	110.0	18.0	18.0	2.0	2.0
	DN50	165.0	125.0	18.0	18.0	2.0	2.0
	DN80	200.0	160.0	18.0	20.0	2.0	2.0
	DN100	220.0	180.0	18.0	20.0	2.0	2.0
	DN125	250.0	210.0	18.0	22.0	2.0	2.0
PN40	DN40	150.0	110.0	18.0	18.0	2.0	2.0
	DN50	165.0	125.0	18.0	20.0	2.0	2.0
	DN80	200.0	160.0	18.0	24.0	2.0	2.0
	DN100	235.0	190.0	22.0	24.0	2.0	2.0
	DN125	270.0	220.0	26.0	26.0	2.0	2.0

Applications Examples

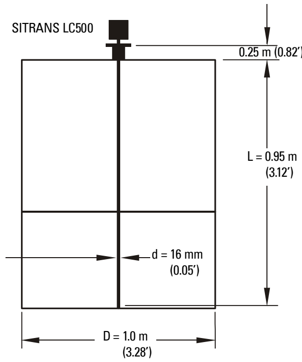
Generic Application Calculations

The capacitance expected in a cylindrical tank with a probe centrally mounted is estimated using the following formula:

$C = \varepsilon\frac{24 \times L}{Log(D/d)}pF$ (L in meters) or $C = \varepsilon\frac{7.32 \times L}{Log(D/d)}pF$ (L in feet)

Where:

C = capacitance value in pF
ε_r = relative dielectric constant
L = active measurement length
D = internal tank diameter
d = electrode diameter
24 = a K constant for dimensions in meters
7.32 = a K constant for dimensions in feet or inches
ε_r = 1 (air)
ε_r = 2 (oil)



Examples (using dimensions above):

Capacitance in air:

Dimensions in meters: $C_{air} = \varepsilon_{air}\left[\frac{24 \times 0.95}{Log(1/0.016)}\right]pF = 12.7pF$

Dimensions in feet: $C_{air} = \varepsilon_{air}\left[\frac{7.32 \times 0.82}{Log(1/0.06)}\right]pF = 12.7pF$

Capacitance in oil:

If the same vessel is filled with oil, relative dielectric constant for oil (2) replaces the relative dielectric constant for air (1), and the resulting calculation is:

$C_{oil} = \varepsilon_{oil}\left[\frac{24 \times 0.95}{Log(1/0.016)}\right]pF = 25.4pF$ (dimensions in meters)

or

$C_{oil} = \varepsilon_{oil}\left[\frac{7.32 \times 3.12}{Log(3.28/0.05)}\right]pF = 25.4pF$ (dimensions in feet)

The initial capacitance value at 0% (probe in air) is 12.7 pF, and the capacitance value for 100% (tank filled with oil) is 25.4 pF.

After calibration:

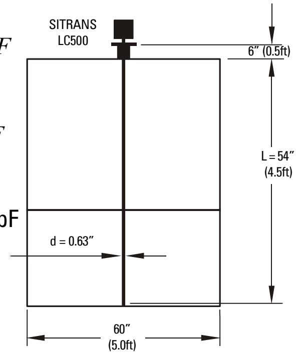
12.7 pF ≅ 0% ≅ 4 mA or 20 mA

25.4 pF ≅ 100% ≅ 20 mA or 4 mA

Larger tank, dimensions in feet:

$$C_{air} = \varepsilon_{air}\left[\frac{7.32 \times 4.5}{Log(60/0.63)}\right]pF = 16.6pF$$

$$C_{oil} = \varepsilon_{oil}\left[\frac{7.32 \times 4.5}{Log(60/0.63)}\right]pF = 33.2pF$$



For this slightly larger tank, the capacitance ranges from 16.6 pF for 0% (probe in air) to 33.2 pF for 100% (tank filled with oil).

After calibration:

16.6 pF ≅ 0% ≅ 4 mA or 20 mA
33.2 pF ≅ 100% ≅ 20 mA or 4 mA

Application: level indicator and solid-state switch output

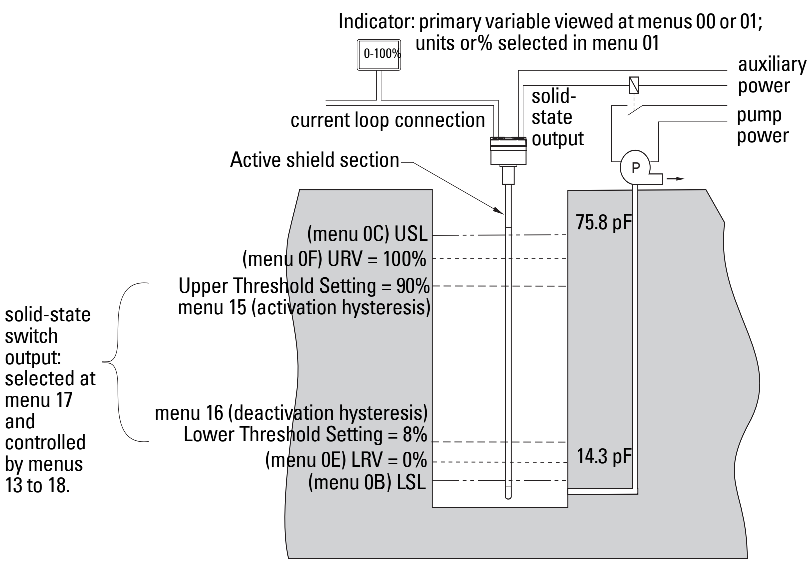
The loop current provides:

- a reading proportional to level, within the 0 - 100% range, at menu 00 or 10 on the device, or at a remote indicator
- an out-of-range signal **ooL** alternating with PV if the level is above URV or below LRV

The solid-state switch is activated at Upper Threshold Setting and deactivated at Lower Threshold Setting. In the diagram below, it is used to activate a pump via an auxiliary power circuit.

- The activation and deactivation can be modified by Upper and/or Lower Threshold delays (menus 13 and 14).
- The reading can be stabilized if necessary by applying Damping (menu 0A): the update value for Damping is controlled by menu 09.

Example: The level is to be held between 90% and 8%.



Appendix E

Device settings:

(The device is first restored to factory settings before being commissioned)

TV0 selected: Transmitter Variable 0 is PV	Menu 01 reads	**Pv = 0**
Lower Range Value (0% of range) is set to 14.3	Menu 0E reads	**14.30**
Upper Range Value (100% of range) is set to 75.8.	Menu 0F reads	**75.80**
Current loop is in analog mode, with both buttons pressed	Menu 07 reads	**C:An**
Solid-state switch enabled, **contact closed** selected	Menu 17 reads	**S:cc**[1]
Activation hysteresis is set to 90.	Menu 15 reads	**90.0**
Deactivation hysteresis is set to 8.	Menu 16 reads	**08.0**.

When the level reaches 90%, the solid-state output is closed and the pump is started via the auxiliary circuit. When the level drops to 8% the solid-state output is opened, the auxiliary circuit is deactivated, and the pump stops.

Application: Analog fault signalling (2-state output)

In 2-state mode, the loop current signals whether the probe is covered or uncovered, and the continuous level measurement is unavailable.

2-state mode provides:

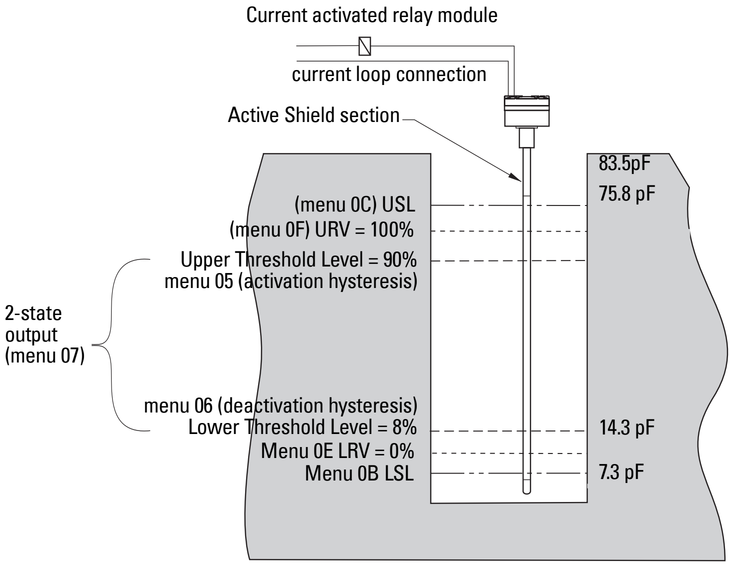
- a 4 mA or 20 mA output to menu 07, when the level reaches one of the threshold settings
- a 3.6 or 22 mA output to menu 07 (if 2-state fault signalling is enabled at menu 08) when the process level exceeds one of the limit settings (menu 0B and 0C).

The above settings can be modified:

- The response time when thresholds are reached can be modified by Upper and/or Lower Threshold delays (menus 03 and 04).
- The mA reading can be stabilized if necessary by applying Damping (menu 0A): the increment value is controlled at menu 09.

1. **S:cc** appears while the button is pressed. See menu 17 on page 70 for more details.

Example:



Device settings:

(The device is first restored to factory settings before being commissioned)

TV0 selected: Transmitter Variable 0 is PV	Menu 01 reads **Pv = 0**
Lower Range Value (0% of range) is set to 14.3	Menu 0E reads **14.30**
Upper Range Value (100% of range) is set to 75.8	Menu 0F reads **75.80**
Current loop is in 2-state mode (**C: Hi** selected)	Menu 07 reads **C:Hi**
2-state fault signalling enabled (**F: Hi** selected	Menu 08 reads **F:Hi**[1]
Activation hysteresis is set to 90	Menu 05 reads **90.0**
Deactivation hysteresis is set to 8	Menu 16 reads **08.0.**
USL is set to 83.50 pF	Menu 0C reads **83.50**
LSL is set to 7.3 pF	Menu 0B reads **7.30**

When the process level reaches 90%, the probe is considered covered and the output will be 20 mA. If the level exceeds USL, the output will be 22 mA. When the process level drops to 8%, the probe is considered uncovered, and the output will switch to 4 mA. If the level drops below LSL, the fault signal will be 22 mA.

1. **F: Hi** appears while the button is pressed. See *Analog Fault Signalling (2-state)* on page 66 for more details.

Appendix F: Approvals

The operation of the SITRANS LC500 conforms to the following:

NAMUR recommendation NE 43

This recommendation describes rules by which analog transmitters transfer their information to DCS equipment. This information can be divided into two types:

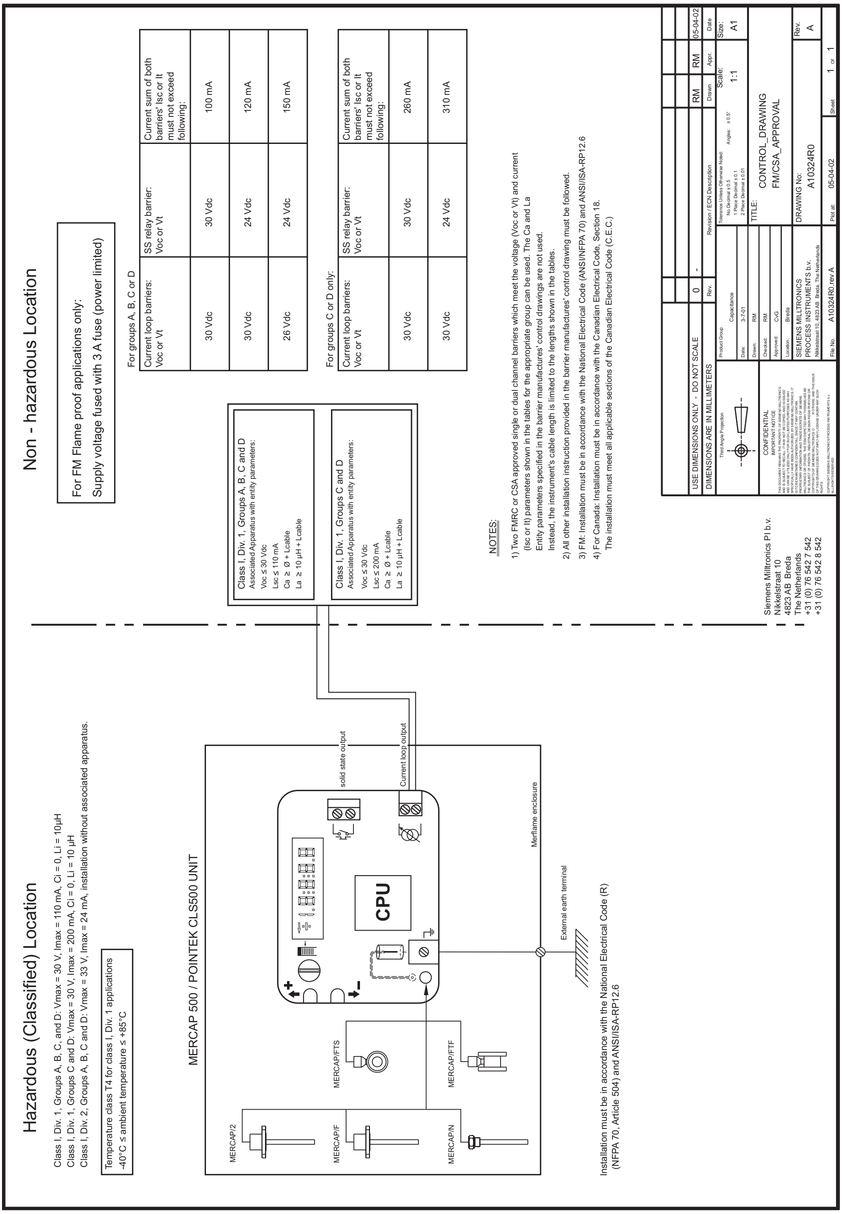
- measurement information
  For **measurement information** the current signal should be within the range of **3.8** to **20.5 mA**.
- failure signalling
  For **failure information** which indicates a failure in the measuring system[1] the current signal should be in the range of either **0** to **3.6 mA,** or **21 mA** or greater.

  The application will determine which of these two ranges is more desirable. The SITRANS LC500 can be set for **3.6 mA,** or **22 mA**, as required[2].

1. It may also signal a process level outside the Upper and Lower Sensor Limits, if the unit has been programmed for this. For more information, see *Fault Signalling* on page 16.
2. See *Analog Fault Signalling (2-state)* on page 66 for details.

Control Drawing FM/CSA Approval

SITRANS LC500



Glossary

capacitance: the property of a system of conductors and dielectrics that permits the storage of electricity when potential differences exist between the conductors. Its value is expressed as the ratio of a quantity of electricity to a potential difference, and the unit is a Farad.

capacitor: a device in a circuit that has the potential to store an electric charge. Typically a capacitor has 2 conductors or electrodes separated by a layer of a nonconducting material called a dielectric. With the conductors on opposite sides of the dielectric layer oppositely charged by a source of voltage, the electrical energy of the charged system is stored in the polarized dielectric.

derating: to decrease a rating suitable for normal conditions according to guidelines specified for different conditions.

dielectric: a nonconductor of direct electric current.[1]

dielectric constant: the ability of a dielectric to store electrical potential energy under the influence of an electric field. This is measured by the ratio of the capacitance of a condenser with the material as dielectric to its capacitance with vacuum as dielectric. The value is usually given relative to a vacuum /dry air: the dielectric constant of air is 1[1].

immiscible: incapable of mixing or attaining homogeneity.

implicit: for example in "the units are implicit in pF," the units are implied, or assumed to be pF, because there is no other option.

miscible: capable of being mixed.

repeatability: the closeness of agreement among repeated measurements of the same variable under the same conditions.

saturation: a condition in which any further change of input no longer results in a change of output. For example, "the loop-current will saturate to 3.8 or 20.5 if the level exceeds the Range settings."

solid-state device: a device whose function is performed by semi-conductors or the use of otherwise completely static components such as resistors and capacitors.

stilling-well: a grounded metal tube with openings.

1. Many conductive liquids/electrolytes exhibit dielectric properties; the relative dielectric constant of water is 80.

Notes

Glossary

Index

Quick Reference: SITRANS LC500

Quick Start

We strongly recommend you read the full manual to use your device to its fullest potential. However, if it is possible to adjust the level of the tank to the 0% and 100% levels, you can use the quick start sequence below to calibrate the instrument and get started.

Notes:

- Change over from Menu LEVEL 0 to Menu LEVEL 1 is only possible at position 0, from menu item 00 to 10 or vice-versa. (See page 42 for detailed instructions.)
- For a table showing all the combinations of rotary switch positions and button presses used to carry out different functions, see next page.
- For a detailed description of each menu item, see *Appendix A: Menu Groups*, page 54.

Quick Start Sequence		
1	**Calibrate the 0% setting (LRV - lower range value): menu 0E**	
		For instruments without a stilling well, the 0% setting needs to be calibrated after the device is installed, and with the tank/vessel empty. Calibration is also sometimes necessary after installing a SITRANS LC500 fitted with a stilling well, although in most cases the 0% setting is calibrated at the factory.
	Set value for 0% (LRV): units must be pF (Menu 01 must read Pv = 0).	
	a	Bring the product level to the height that corresponds to 0%.
	b	Turn the rotary switch to E (Empty).
	c	Press **both** buttons and hold for about 1 second: the 0% point is now set.
2	**Calibrate the 100% setting (URV - upper range value): menu 0F**	
	Set value for 0% (LRV): units must be pF (Menu 01 must read Pv = 0).	
	a	Raise the product level to the height that corresponds to 100%.
	b	Turn the rotary switch to F (Full).
	c	Press **both** buttons and hold for about 1 second: the 100% point is now set.
3	**View primary variable (PV): menu 00**	
		Turn the rotary switch to 0. The LCD displays the actual pF reading.
4	**SITRANS LC500 is now ready to operate.**	

Quick Reference

Rotary Switch Positions – Quick Reference

Menu LEVEL 0 (00 to 0F)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Units	**PV Units**	**Num. Selection**	**PV Units**	**Seconds**	**Seconds**	**%**	**%**	**mA**	**mA**	**Numeri-cal**	**Numeri-cal**	**PV Units**	**PV Units**	**PV Units**	**PV Units**	**PV Units**
NO KEYS Value read-out	PV Value or Fault	Show select PV variable	Highest/ Lowest PV Memory	Activation Time Delay Current sig-nal	De-Activation Time Delay Current signal	Upper Thresh-old Activation Current signal	Lower Thresh-old De-Activation Current signal	Loop Current in mA	Fault signal 22 or 3.6 mA	Actual Step Size	Damping Value	LOWER limit PV	UPPER limit PV	Delta Value PV for 4 c.q. 20 mA	LRV Value PV for 4 mA	URV Value PV for 20 mA
Up Key-RED (+)	Set Menu Level 00 to 0F	Step TV0 to TVmax	Highest PV Memory Read-out	Increase Delay Time	Increase Delay Time	Increase Upper Threshold Point	Increase Lower Threshold Point	Set Covered: 20 mA (Hi)	Set FAULT: 22 mA	Increase Step Size to 10000	Increase Damping Value	Increase PV LOWER limit	Increase PV UPPER limit	Increase PV Delta	Increase PV LRV	Increase PV URV
Down Key-BLUE (–)	Set Menu Level 10 to 1F	Step TVmax to TV0	Lowest PV Memory Read-out	Decrease Delay Time	Decrease Delay Time	Decrease Upper Thresh-old Point	Decrease Lower Thresh-old Point	Set Covered: 4 mA (Lo)	Set FAULT: 3.6 mA	Decrease Step Size to 0.01	Decrease Damping Value	Decrease PV LOWER limit	Decrease PV UPPER limit	Decrease PV Delta	Decrease PV LRV	Decrease PV URV
Both Keys	Show-Menu Level	Set % Mode	Reset Hi/Lo memories to actual PV	Toggle Delay Time 00 < – > 100	Toggle Delay Time 00 < – > 100	Preset Upper Threshold Point to 75%	Preset Lower Threshold Point to 25%	Set Analog Range 4 to 20 mA (Anl)	Fault signal Disable	Set to 1	Set to 1	Preset Lower Limit to Actual (PV)	Preset Upper Limit to Actual (PV)	URV– LRV = Min.	LRV = Actual Value (PV)	URV = Actual Value (PV)
Default	*****	**TVO**	*****	**00**	**00**	**75%**	**25%**	**Analog**	**Disabled**	**1.0**	**1**	**1.666 pF**	**3300 pF**	**3300 pF**	**0 pF**	**3300 pF**

Menu LEVEL 1 (10 to 1F)

	0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F
Units	**PV Units**	**Numerical**	**Factory Settings**	**Seconds**	**Seconds**	**%**	**%**	**O/ C**	**O/C**	**nor / inv**			**Resp. Units**			**Keylock**
NO KEYS Value read-out	PV Value or Fault	Display check Fault code	FAC (factory set-tings)	Activation Time Delay Transistor Switch	De-Activation Time Delay Transistor Switch)	Upper Thresh-old Activation Transistor Switch	Lower Thresh-old De-Activa-tion Transistor Switch	Status Solid-state Output	Fault signal (Solid-state Output)	MODE Normal / Inverse	— Spare	— Spare	Transmitter Var 0 Read-Out	— Spare	— Spare	Keylock Level
Up Key-RED (+)	Set Menu Level 00 to 0F		FAC (factory set-tings)	Increase Delay Time	Increase Delay Time	Increase Upper Thresh-old Point	Increase Lower Thresh-old Point	Set Covered = Solid-state ON	Set FAULT = Solid-state ON	MODE Normal / Inverse			Transmitter Var 1 Read-Out			Increase Keylock Level
Down Key-BLUE (–)	Set Menu Level 10 to 1F		FAC (factory set-tings)	Decrease Delay Time	Decrease Delay Time	Decrease Upper Thresh-old Point	Decrease Lower Thresh-old Point	Set Covered = Solid-state OFF	Set FAULT = Solid-state OFF	MODE Normal / Inverse			Transmitter Var 2 Read-Out			Decrease Keylock Level
Both Keys	Show Menu Level	Invert Sig-nalling Sta-tus	do it	Toggle Delay Time 00 < - > 100	Toggle Delay Time 00 < - > 100	Preset Upper Threshold Point to 75%	Preset Lower Threshold Point to 25%	Disable Switch for Solid-state	Disable Fault for Solid-state	Toggle Operating Mode			Transmitter Var 3 Read-Out			
Default	*****	*****	*****	**00**	**00**	**75%**	**25%**	**Disabled**	**Disabled**	**nor**	*****	*****	*****	*****	*****	**0**

For more information

www.siemens.com/level

www.siemens.com/continuous-weighing

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