SIEMENS

SITRANS LR 400

Instruction Manual September 2001

SITRANS LR 400

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.

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

Note: Always use product in accordance with specifications.

Contact Technical Publications at the following address:

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General Information

The Manual

Refer to this manual for proper installation, operation and maintenance of the SITRANS LR 400 Radar Level Instrument.

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

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

Note means important information about the actual product or that part of the operating manual to which particular attention should be paid.

- These instructions do not claim to cover all details or variations in equipment, not to provide for every possible contingency that may arise during installation, operation, or maintenance.
- For further information or to resolve issues not covered in the manual, consult your Siemens Milltronics representative.
- The contents of the manual shall not become part of or modify any prior or existing agreement, commitment or relationship. The Sales Contract contains the entire obligation of Siemens. The warranty contained in the contract between the parties is the sole warranty of Siemens Milltronics.

Note: This equipment has been tested and found to comply with the limits for a Class A digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

WARNING: Changes or modifications not expressly approved by Siemens Milltronics could void the user's authority to operate the equipment.

IMPORTANT: All specifications are subject to change without notice. Please ensure that any safety-related information is confirmed with a qualified Siemens Milltronics representative.

Warning:

- Installation shall only be performed by qualified personnel and in accordance with local governing regulations
- The SITRANS LR 400 is to be used only in the manner outlined in this manual or protection provided by equipment may be impaired.

Qualified personnel

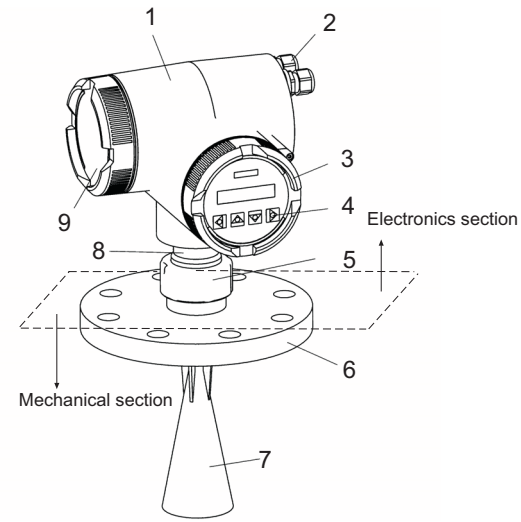
Qualified personnel are familiar with the installation, commissioning, and operation of this equipment. In addition the person must be:

- trained and authorized to operate and service equipment/systems in accordance with established safety procedures relating to electrical circuits, high pressures and aggressive media.
- trained in the proper care and use of protective equipment in accordance with established safety practices.
- trained in rendering first aid.

SITRANS LR 400

The SITRANS LR 400 Radar Level Instrument is designed for level measuring of liquids and solids in storage vessels. SITRANS LR 400 operates reliably with its high microwave frequency even with poorly reflecting measuring media. The narrow antenna beam results in a sharp radiation cone, therefore SITRANS LR 400 is quite insensitive to vessel interferences.

Structure



1 Housing
2 Cable gland
3 Electronics cover
4 Operating and monitoring module
5 Threaded ring
6 Process Flange
7 Antenna
8 Intermediate flange
9 Connection cover

The terminals for the power cable and the signal cable are behind the connection cover (9) on the left hand side of the housing (1). The signal cable must be fed in from the right through the cable glands (2).

The device can be separated into electronic and mechanical sections at the threaded ring (5).

An optional temperature extension is positioned between the threaded ring (5) and the flange (6). Refer to Dimension diagram on page 8.

The end of the antenna (7) must reach inside the vessel through the vessel nozzle (see page 12).

Return the orientation of the housing to the same position with reference to the flange after any servicing to ensure similar performance.

Specifications

Note: Siemens Milltronics makes every attempt to ensure the accuracy of these specifications, but reserves the right to change them at any time. Please ensure these are the most recent specifications. Contact your representative, or check our website at www. milltronics.com for the most up-to-date information.

SITRANS LR 400

Power

- Power Supply: 120 to 230 Vac, ±15%, 50/60 Hz, 6W (12VA)
  or
  24 Vdc, +25/-20%, 6W
  Power failure: bridge of at least 1 mains period (> 20 ms)

Fuse

- Fuse (both ac and dc versions)

SI1	Fast acting ceramic, 4 x 20 mm, 1A, 250 Vac
SI2	Slow-Blow, 4 x 20 mm, 0.63 A, 250 Vac

Interface

- Analog output (Not applicable to Profibus PA option)

Signal range	4 to 20 mA
Upper Limit	20 to 22.5 mA adjustable
Fail signal	3.6 mA; 22 mA; 24 mA or last value
Load	Max. 600 Ω, for HART communication min. 230 Ω

- Digital Output

Function	Configurable as a device status or limit value (level, volume)
Signal type	Relay, either NCC or NOC function max. DC 50 V, max. 200 mA, rating max. 5 W. Self-resetting fuse, R_i = 9 Ω

- Electrical Isolation: Outputs electrically isolated from the power supply and from each other
- Display: LCD, two lines of 16 characters each, configurable for the following displays: level, volume, amplitude, digital output, temperature, validity, signal-to-noise ratio

  Multi–display: 2 freely selectable measured values are displayed simultaneously
- Operation: 4 optical control elements, finger activated, menu-guided

Mechanical

- Nominal sizes

DIN	DN 80	DN 100	DN 150
ANSI	3"	4"	6"
JIS	80 mm	100 mm	150 mm

- Pressure classes

DIN	PN16	PN40
ANSI	150 lb	300lb
JIS	10K	

Flange

- Process Connection: Flange DIN 2527, ANSI B16.5, or JIS B2238 equivalent bolt pattern
- Materials of the wetted parts –in contact with the process: Stainless steel, material–no. 1.4571 and 1.4581, PTFE (or glass/PTFE, Zone 0 and Zone 20 devices)

Enclosure

- construction: Die-cast aluminum, painted
- conduit: M20 (cable diameter 6 to 9.5 mm[0.24 to 0.37"]) or ½"-14 NPT
- ingress protection: Type 4X/NEMA 4X, Type 6/NEMA 6, IP 67[1]

Weight

- Weight of unit and flange

Flange	Pressure Class	Size	Weight
DIN 2527	PN 16	DN 80	11.9 kg (26.1 lbs)
		DN 100	13.2 kg (28.9 lbs)
		DN 150	19.2 kg (42.1 lbs)
	PN 40	DN 80	12.9 kg (28.4 lbs)
		DN 100	15.5 kg (34.1 lbs)
		DN 150	24.1 kg (43.1 lbs)
ANSI B 16.5	150 lb	3"	12.2 kg (26.8 lbs)
		4"	14.8 kg (32.5 lbs)
		6"	20.1 kg (44.2 lbs)
	300 lb	3"	14.3 kg (31.5 lbs)
		4"	20.2 kg (44.4 lbs)
		6"	31.8 kg (69.9 lbs)
JIS B2238	10K	80 mm	11.9 kg (26.1 lbs)
		100 mm	13.2 kg (28.9 lbs)
		150 mm	19.2 kg (42.1 lbs)

[1] Use only approved, suitable sized hubs for **watertight** applications.

Environmental

location:	indoor/outdoor
altitude:	2000 m max
ambient temperature:	-40 to 65°C (-40 to 149°F)
relative humidity:	suitable for outdoor (Type / Nema 4X, 6/ IP67)
installation category	II
pollution degree	4

- *Process Temperature -40 to 140°C (-40 to 284°F),optional -40 to 240°C (-40 to 482°F)
- Electromagnetic compatibility
  - Spurious emission according to EN 50 081
  - Interference strength according to EN 50 082 and NAMUR
- *Perm. ambient temperature -40 to 65°C (-40 to 149°F) (non-hazardous version)
  -20 to 65°C (-4 to 149°F) (hazardous version)
  LCD: -10 to 55 °C (14 to 131°F)
  Observe the temperature classes in hazardous areas!
- Perm. storage temperature -30 to 80°C (-22 to 176°F),

Approvals (verify against device nameplate)

- Explosion Protection
  ** Refer to device nameplate
  Certificate No. PTB 00 ATEX 1024
  II 1/2G EEx d IIC T6II 2G EEx d IIC T6
  II 1/2G EEx dem IIC T6II 2G EEx dem IIC T6
  II 1/2G EEx dem [ib] IIC T6II 2G EEx dem [ib] IIC T6
  II 1/2G EEx dem [ia] IIC T6II 2G EEx dem [ia] IIC T6

  Certificate No. DMT 01 ATEX E 038
  II 1/2 D IP 65 (dust zone 20, zone 21 approval)
- General FM, CSA
  approval pending
- Radio FCC, Industry Canada, European Radio
  approval pending

Comunication

- Communication:HART
  - Load 230 to 600 Ω, 230 to 500 Ω when connecting a coupling module
  - Line two-wire shielded: ≤ 3 km
    multi-wire shielded: ≤ 1.5 km

Protocol HART, Version 5.1

***Note:** Refer to Process/Ambient de-rating curves in Appendix III.

Communication: Profibus PA

Protocol	Layer 1 and 2 Profibus PA, technology: IEC 61158-2, slave-functionality
Device Class	B
Device Profile	3.0

- PC/Laptop requirements: IBM-compatible; RAM ≥ 64 Mbytes; Hard disk ≥ 100 Mbytes; RS 232-C interface; VGA graphic card (≥ 640 x 480)
- Software for PC/Laptop: Windows 95/98 or NT 4.0; SIMATIC PDM

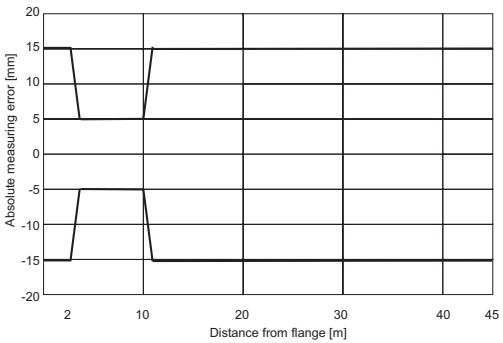
Performance

Measured value error (under reference conditions)

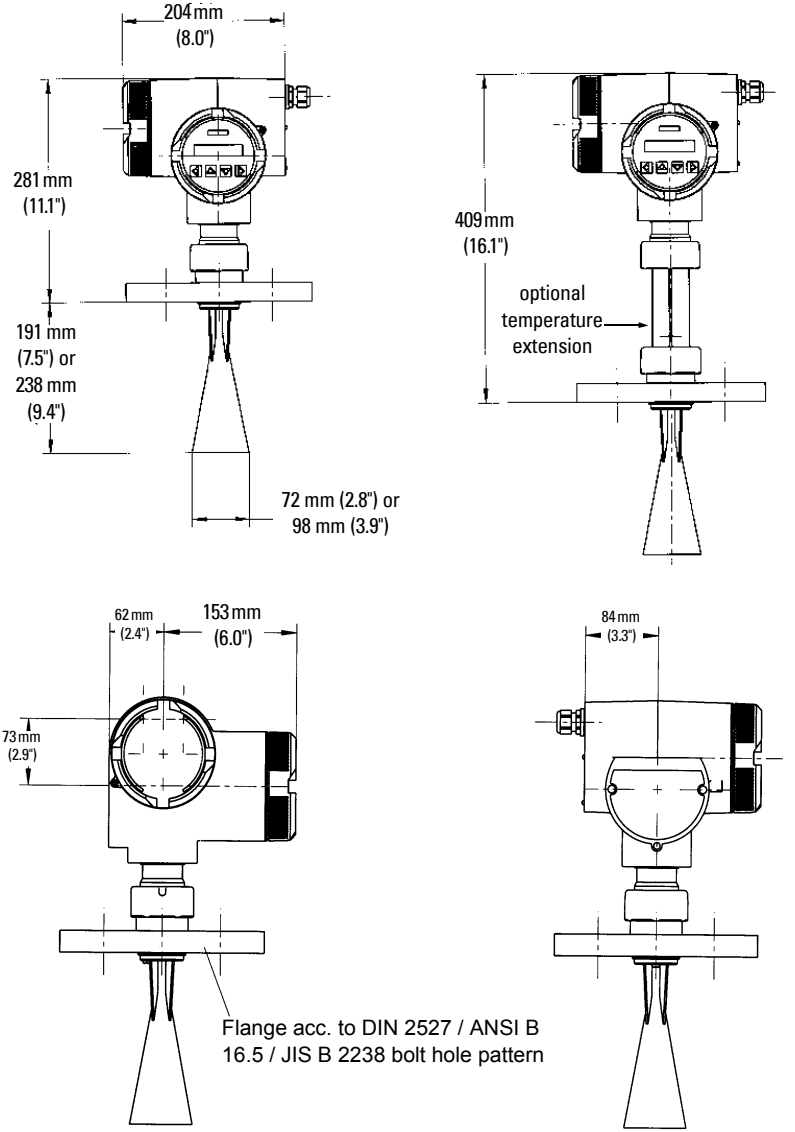
- Measuring error: ≤ ± 15 mm at 0.26 to 2 m distance; ≤ ± 5 mm at 2 to 10 m distance; ≤ ± 15 mm at 10 to 45 m distance (see diagram below)
- Dead zone: 0-26 cm from bottom edge of flange
- Additional contribution of Analog Output: ≤ 0.1 % of the measured value; ≤ 0.05 % of full scale
- Additional Contribution of the Supply Voltage: ≤ 0.05 % per 10 % deviation of UN
- Influence of pressure (air, 20°C): ≤ 0.3 % to 10 bar without pressure correction; ≤ 2 % at 10 to 64 bar without pressure correction
- Long-term stability: ≤ ± 1 mm/year
- Repetitive accuracy: ≤ ± 1 mm at 0 to 45 m, damping ≥ 1 s
- Reference conditions

Medium	Triple reflector on the main axis of the antenna main lobe
Ambient temperature	25 ± 5°C (77 ± 9°F)
Ambient pressure	1050 mbar ± 10 %

Absolute Measuring Error

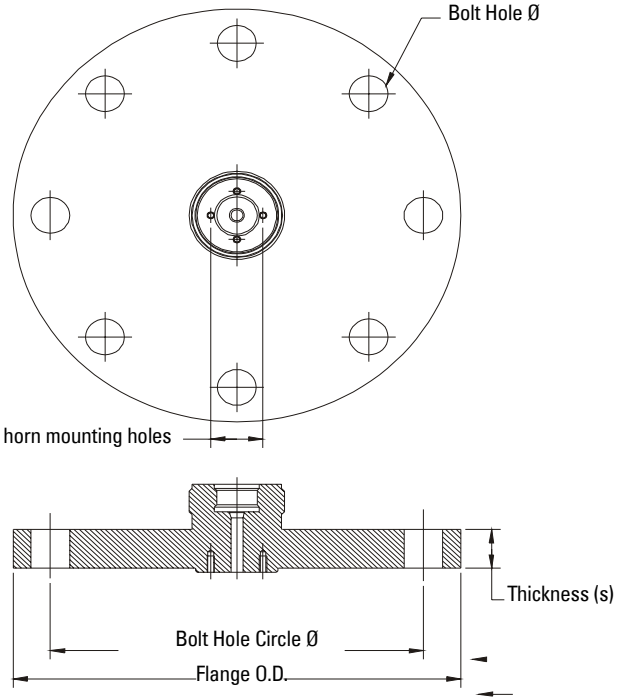


Dimensions



Customer to provide adequate bolting and gasket to retain vessel pressure and provide sufficient seating.

DIN / JIS Flat Face Flange Diagram



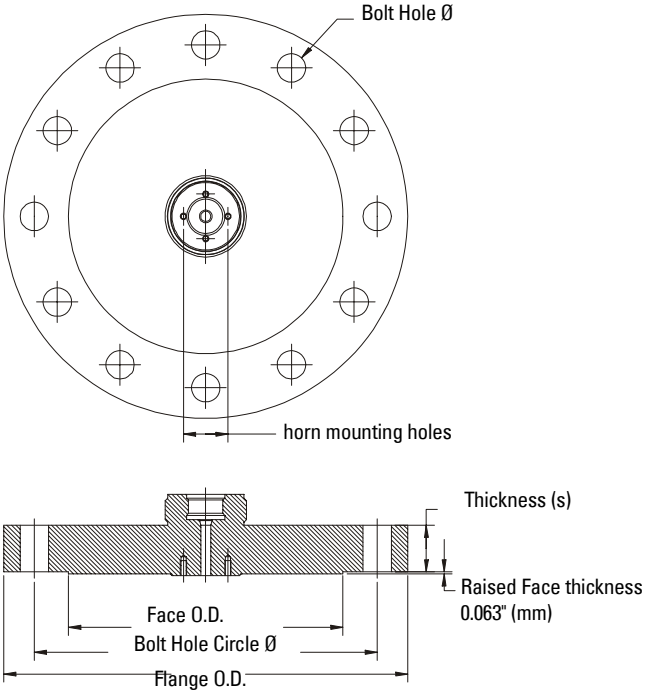
Flange according to DIN 2527 (see Flange Diagram on page 9)

Pipe Size	Flange Size	Flange O.D.	Thickness (s)	Bolt Hole Circle Ø	Bolt Hole Ø	Number of Bolts
80 mm	PN 16	200 mm	20.0 mm	160 mm	18.0 mm	8
100 mm	PN16	220 mm	20.0 mm	180 mm	18.0 mm	8
150 mm	PN 16	285 mm	22.0 mm	240 mm	22.0 mm	8
80 mm	PN 40	200 mm	24.0 mm	160 mm	18.0 mm	8
100 mm	PN 40	230 mm	24.0 mm	190 mm	22.0 mm	8
150 mm	PN 40	300 mm	28.0 mm	250 mm	26.0 mm	8

Flange according to JIS B 2238

Pipe Size	Flange Size	Flange O.D.	Thickness (s)	Bolt Hole Circle Ø	Bolt Hole Ø	Number of Bolts
80 mm	10 K	185 mm	20.0 mm	150 mm	19.0 mm	8
100 mm	10 K	210 mm	22.0 mm	175 mm	19.0 mm	8
150 mm	10 k	280 mm	24.0 mm	240 mm	23.0 mm	8

ANSI Raised Face Flange Diagram



Flange according to ANSI B 16.5 (see Flange Diagram on page 9)

Pipe Size	Flange Size	Flange O.D.	Thickness (s)	Face O.D.	Bolt Hole Circle Ø	Bolt Hole Ø	Number of Bolts
3"	150 #	7.50"	0.941"	5.0"	6.00"	0.74"	4
4"	150 #	9.00"	0.941"	6.19"	7.50"	075"	8
6"	150 #	11.00"	1.00"	8.5"	6.62"	0.88"	8
3"	300 #	8.25"	1.12"	5.0"	6.62	0.88"	8
4"	300 #	10.00"	1.25"	6.19"	7.88"	0.88"	8
6"	300 #	12.51"	1.44"	8.5"	10.62"	0.88"	12

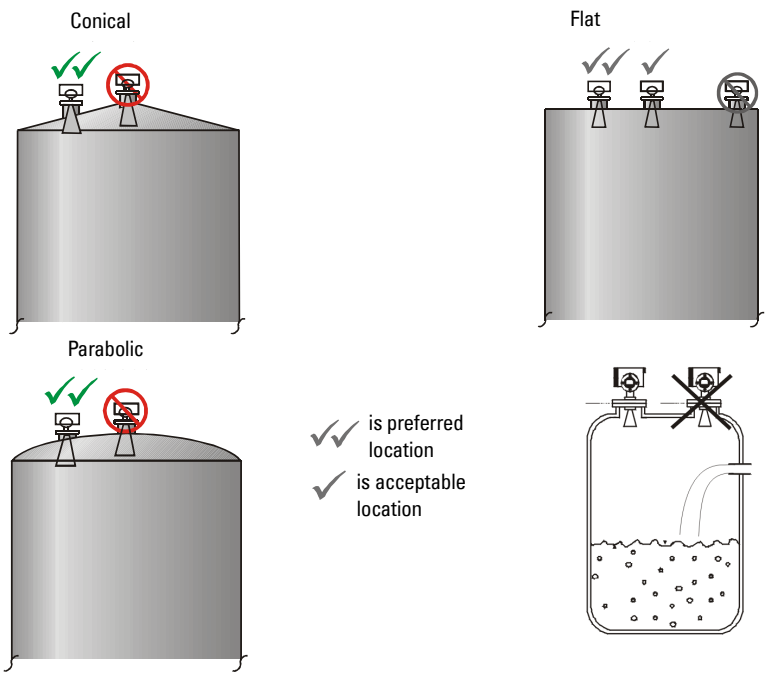
Note:

- The SITRANS LR 400 is rated for Type 4X/NEMA 4X, Type 6/NEMA 6, IP 67. Follow all installation and operating instructions to meet the requirements of this type of protection. Use only approved, suitable sized hubs for **watertight** applications.
- Observe all maximum permissible ambient and process temperatures. Refer to Appendix III (Ambient/Operating Temperature Specification).
- Provide a warning sign and/or touch guard if the surface of the measuring instrument can get hotter than 70°C in use.

Mounting Location

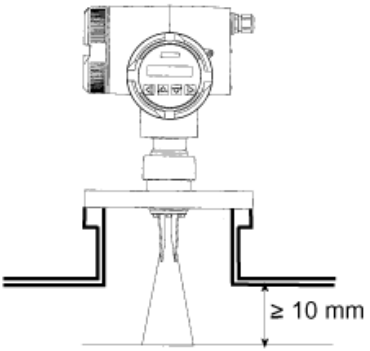
- Do not mount in direct sunlight without the use of a sun shield. Refer to Appendix III (Ambient/Operating Temperature Specfication) on page 77.

Warning: For vessels with conical or parbolic tops, avoid mounting the unit at the center. The concavity of the top can focus echoes into the centre, giving false readings.
Mount the unit more than 1 m away from the vessel walls, pipes and other assemblies as well as the filling stream because all these influences will become noticeable as reflective interference. Align the antenna so that the radar cone hits the surface of the measuring medium as vertically as possible



Correct Installation in Mounting Nozzle

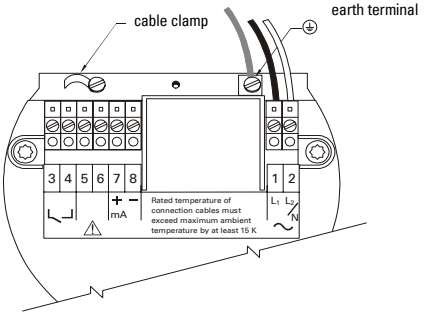
The bottom edge of the antenna must reach inside the vessel to avoid reflective interference at the wall of the nozzle. Above flange size DN 150/6 inch, the antenna may end in the nozzle unless the radiation cone (the extension of the antenna's angle) touches the nozzle wall.



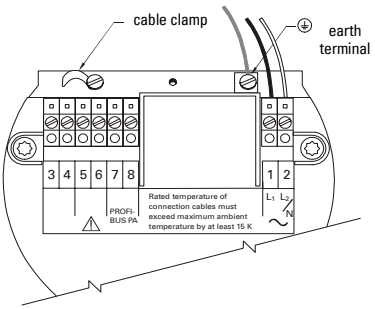
Electrical connection

AC version:

Hart Wiring



Profibus Wiring

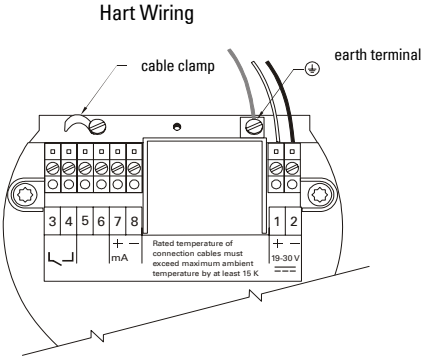


- The equipment must be protected by a 15A fuse or circuit breaker in the building installation.
- A circuit breaker or switch in the building installation, marked as the disconnect switch, shall be in close proximity to the equipment and within easy reach of the operator.

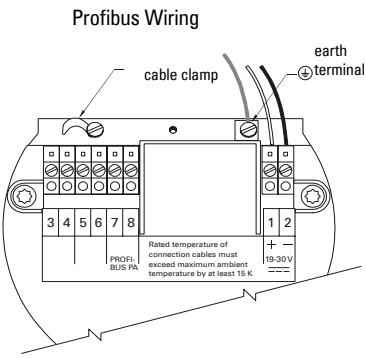
⚠ All field wiring must have insulation suitable for at least 250 V.

DC version:

Hart Wiring



Profibus Wiring



- DC input terminals shall be supplied from an SELV source in accordance with IEC 1010-1 Annex H.

Note (AC and DC versions):

- 4-20 mA, Profibus PA, DC input circuits, 14 - 20 AWG, shielded copper wire
- AC input circuit, min 14 AWG copper wire
- Recommended torque on terminal clamping screws, 0.5 - 0.6 Nm

Make the electrical connections as follows:

1. Release the cover lock on the connection box with a 3 mm Allen key.
2. Unscrew the cover from the connection box.
3. Push the power cable and signal cable through the cable gland on the right of the unit., up to the terminal strip. Lay the cable in a bend before the cable gland so that moisture cannot enter the connection box.
4. Connect the earth conductor of the power supply to the earth terminal ⏚ in the connection box. Choose a length of cable so that the earth conductor is disconnected last when you pull the cable.
5. In devices with ignition protection types II 1/2G EEx dem [ia] IIC T6 and II 1/2G EEx dem [ib] IIC T6 or II 2G EEx dem [ia] IIC T6 and II 2G EEx dem [ib] IIC T6, mount the cover for the power supply terminals.
6. Tighten the cable screw gland and check the strain relief (pull and turn).
7. In devices with ignition protection type II 1/2G EEx D IIC T6 or II 2G EEx d IIC T6, replace unused screw-type cable glands with a certified dummy plug.
8. Screw the cover onto the housing and tighten it without using a tool. The sealing ring must be clean and undamaged.
9. Mount the cover lock of the connection box cover.
10. Connect the earth terminal located between the screw-type cable glands to a ground connection at your vessel by using a cable of a cross-section at least 2.5 mm^2 wide.

For error-free communication via the HART protocol, a load of at least 230 Ω must be available in the signal circuit.

Warning: To avoid short-circuits, do not connect a load resistance with bare wires in the connection box.

The housing cover may not be unscrewed in a hazardous area when the device is under voltage (power supply, digital outputs on external supply).

In devices with ignition protection types II 1/2G EEx dem [ia] IIC T6 and II 1/2G EEx dem [ib] IIC T6 II 2G EEx dem [ia] IIC T6 and II 2G EEx dem [ib] IIC T6, only the cover of the connection box may be unscrewed for test purposes. The cover on the power supply terminals may not be removed!

Start Up

Self-test

The device performs a self-test after switching on the power supply. It is ready for operation and programming when the LCD displays the multi-display and the control elements can be operated.

Note: Frequent switching off and on of the devices causes aging of the electronics (see Parameter 3.1).

Multi-display

The multi-display shows on the LCD after a successful self-test with the output of the level in the first line and the signal-to-noise ratio in the second line (factory setting):

+	1	2	.	3	0	0		m						
+	3	0		d	b									

Local Programming

When the mult-display shows on the LCD, you are ready to begin local programming using the optical control elements. To access the parameter settings, touch the ◁ element once. "Main Menu" is displayed in the first line of the LCD. Then program the unit beginning with the Auto-Setup parameters.

Auto-Setup

After switching on the SITRANS LR 400, and after a successful self test, set the Auto-Setup parameters to make the system operational.: (see page 25).

- The language of the local user interface (English or Deutsch)
- The unit of length of the measured level
- The nozzle height in the selected unit of length
- The vessel height in the selected unit of length)
- The LRV as a distance from the bottom of the vessel
- The URV as a distance from the bottom of the vessel
- The damping of the measured level in s.
- The application type
- The bus-address by Profibus PA communication (on Profibus models)

Enter the necessary values as described in "Parmeters" on page 25.

If the multi-display does not appear or displays incorrect measured values after Auto-Setup, proceed as described in “Troubleshooting” on page 62.

Refer to the Parameter section that begins on page 25 for a list of available parameters.

Operation

General information

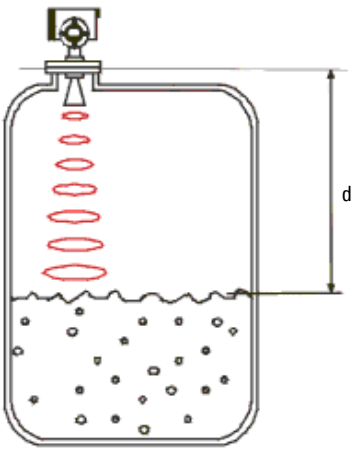
You can operate the SITRANS LR 400 with:

- Local operating and monitoring module
- HART-Communicator or Profibus PA
- PC/Laptop and SIMATIC PDM software (recommended)

Note: The device can be operated and programmed most comfortably with the SIMATIC PDM software. This software gives you the added possibility of saving and archiving your application-specific parameters and copying them back into the device if necessary.
It is best to perform the operations described in the following sections directly on the device to familiarize yourself with the operation.

Measuring principle

The SITRANS LR 400 operates according to the FMCW (Frequency Modulated Continuous Wave) method. Its antenna sends microwaves to the surface of the measuring medium, the frequency of which is modulated continuously (see "Determining the Differential Frequency on page 17). A receiver registers the reflection at the surface of the measuring medium and links it with the simultaneously radiated signal.



The propagation speed of microwaves in gases corresponds to the speed of light. The distance *d* is therefore proportional to the propagation time *t*:

$$d = \frac{c \cdot t}{2}$$

d= distance, t = measured time, c = speed of light

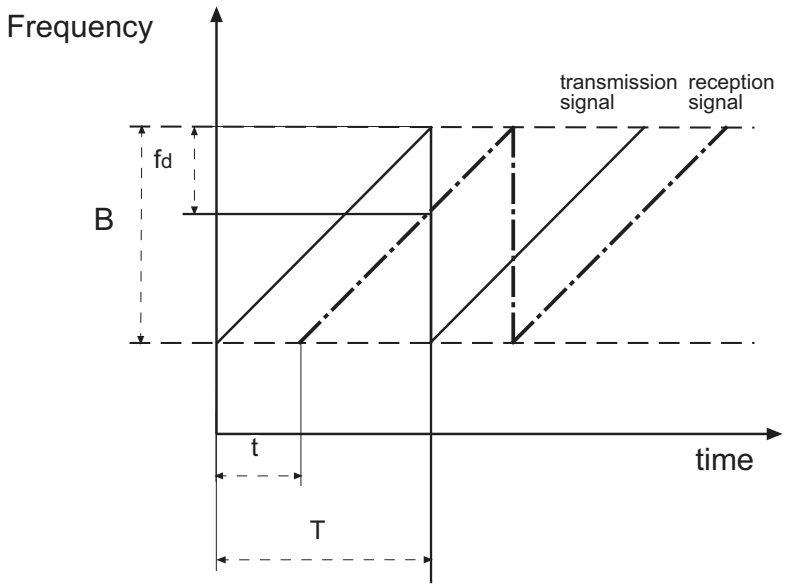
Since the transmission signal has changed its frequency until the reception signal arrives, the link gives a differential frequency f_d, which is proportional to the distance d from the reflecting surface.

The distance d is given by the ratio of the differential frequency f_d to the frequency deviation B and the duration of a frequency modulation phase T (see "Determining the Differential Frequency" on page 17):

$$f_d = \frac{2 \cdot B \cdot d}{T \cdot c}, \; d = \frac{f_d \cdot T \cdot c}{2B}$$

B = bandwidth (frequency deviation), d = distance, T = modulation duration,
c = speed of light

Determining the Differential Frequency



Example

The linear frequency deviation is 200 MHz at a modulation duration of 10 ms. The surface of the measuring medium is 10 m away from the transmitting antenna. The difference signal then has a frequency of:

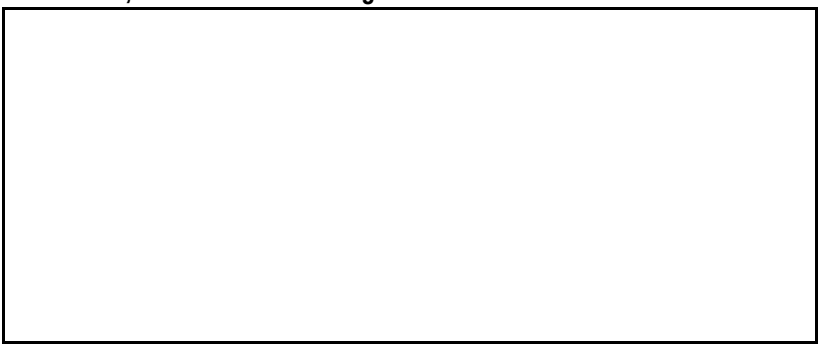
$$f_d = \frac{2 \cdot 2 \cdot 10^8 \cdot 10}{10^{-3} \cdot 3 \cdot 10^8} = 13,333 kHz$$

Every reflection at a surface generates a different frequency. The reception signal therefore consists of a frequency mix from which the disturbance frequencies must be filtered which are caused by fixed targets such as struts inside the vessel.

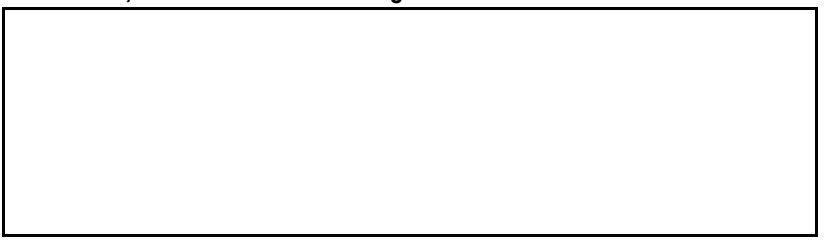
Warning: The coupling module (shown below) may not be used in areas where there is an explosion hazard and may not be connected to intrinsically safe circuits.

The electrical connection of the PC/Laptops and the HART-Communicator to the 4-20-mA signal cable is shown below.

Connection, HART Schematic Diagram



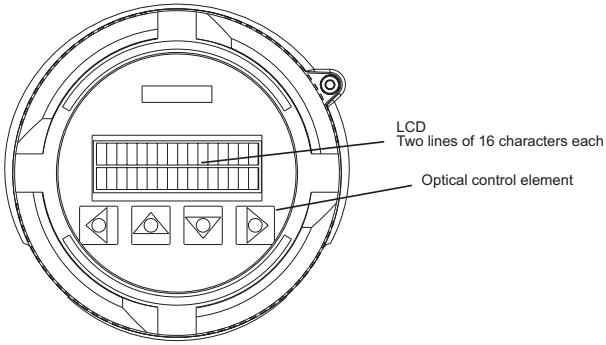
Connection, Profibus Schematic Diagram



Operating the SITRANS LR 400

To access parameters, use the optical control elements on the operating and monitoring module (shown below). Touch the glass in the appropriate place with your fingertips like on a touch screen. The two-line LCD displays the parameters. You can alter the setting or change to other parameters using the controls.

Operating and Monitoring Module



Selecting a Parameter

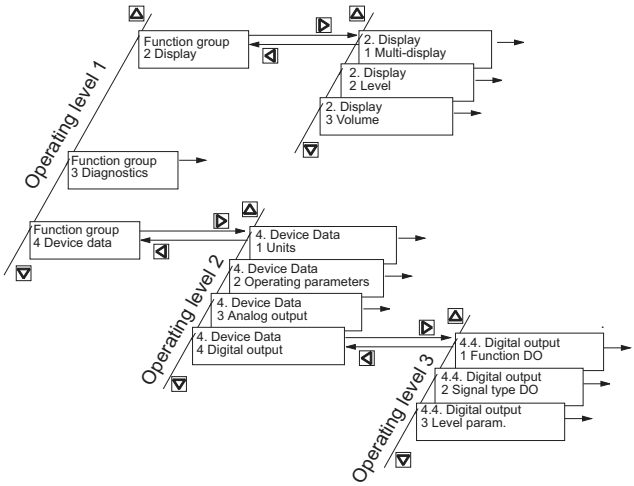
The first line of the display tells you the current operating level. The second line indicates one of the parameters you can access under the parameter group. If the level offers more than one parameter, you can have them displayed in cyclic order by using the control elements ▽ (forwards) and △ (backwards). The control element ▷ accesss the parameter currently displayed on the second line. The fourth control element, ◁, closes this parameter and moves up one level until you return to the multi-display.

When you select a parameter, the device displays the parameter's current value in the second line. When the value flashes, the device programming is enabled (see "Disabling and enabling programming" on page 22) and you can change the current setting. There are two different ways of changing the settings, which are explained in the following sections.

Note: The background illumination of the LCD switches on automatically as soon as you use a control element. It goes out about three minutes after last use of a control element.

Structure of Parameters

Operation is hierarchically structured: The parameters are arranged in logical parameter groups and assigned a numerical menu identification (see below).



Changing a Parameter Value

Entering Value from Selection List

In many cases, the device offers a number of entries in a selection list which you can assign to a parameter. For these functions, you cannot enter anything other than a selection from the displayed list.

You will see a single item of the selection list in the second line of the display.

- Change the display cyclically forwards or backwards with the control elements △ or ▽ to select the desired entry from the list.
  The control element ▷ operates like an “Enter” key: Use it to assign the displayed list entry to the parameter. The device accepts the new setting, closes the input and switches back to the next operating level up.
- The control element ◁ operates like a “Cancel” key: As soon as you press it, the device closes the parameter input but retains the originally displayed value: It does not save a changed setting!

For an example of assigning a value from a selection list, see “Operating examples” on page 23.

Entering Manual Value

If the device allows manual input of the displayed parameter, the control elements operate like a cursor control. The current input position is marked by flashing of a single character.

- The control elements △ and ▽ change the character's value by one up or down. For numeric values the character changes to the next digit up or down, for signs between + and -, and for text inputs to the next element of the ASCII character set.
- Use the control element ▷ to move the input position to the right. At the extreme right position, press ▷ again: Here the control element operates like an "Enter" key. The device saves the changed value (if it is within the permissible input range – otherwise an error message appears on the operating and monitoring module!) and closes the parameter input.
- Use the control element ◁ to move the input position to the left. At the extreme left position, press ◁ again: The control element now functions as a "Cancel" key. The device close the parameter input without saving the changed value.

If you exceed the representable value range when entering a digit, SITRANS LR 400 automatically places the numeric value at the next highest position. For example, if you see the numeric value "0.9" on the display and press the control element △, the display does not change to "0.0" but to "1.0." Value "9" becomes "10," value "90" or "99," "100" (depending on whether you have set the input position to the second or first "9"), etc. The device adds further places before the decimal point automatically!

This input system also works in the opposite direction: If, for example, the value "100" is displayed and you use the control element ▽ on the first or second "0," the numeric value changes to "90" or "99" and the device cancels the places in front of the decimal point which are no longer required. Leading zeros are not displayed.

You can also set the cursor to the decimal point (unless an integer value is currently being displayed). The control elements △ or ▽ then immediately multiply or divide the displayed value by 10. The necessary additional places in front of the decimal point appear. However, you cannot change the number of displayed decimal places; they always remain the same.

Display text assigned to a parameter may sometimes be longer than the field of the display. An arrow pointing outward on the right or left hand side of the display line indicates that the text continues outside the display. You can move the text with the control elements ▷ and ◁ by moving the pointer past the end of the line allowing you to read the rest of the text.

An example of manual input of a value is described in "Operating examples" on page 23, example 2.

Disabling and enabling programming

To prevent unauthorized personnel causing programming errors via the operating and monitoring module, set a customer code – a personal, freely selectable code number which may be up to 9 characters long. A device protected by a customer code still displays all functions and values but it requests input of the code number before allowing a parameter to be reset.

Programming is enabled when you:

- enter the requested customer code for the current parameter (only the current parameter is enabled for reprogramming. All the others are still waiting for input of the customer code).
- or release the programming lock for all parameters at once in the “Code Input” function (see Parameter 5.1 on page 52).

Both ways will release the programming lock on parameters for approx. 10 min.

When you return to the multi-display or enter a number in the “Code Input” function which is different to the customer code, or do not operate the device for 10 minutes, the programming lock is enabled.

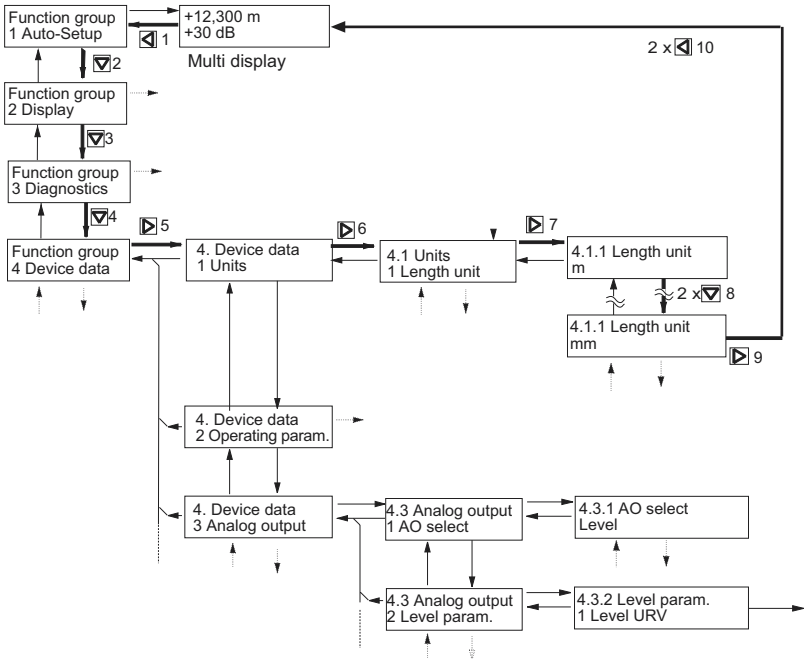
Enter the customer code as described in Parameter 5.2 on page 52.

Note: If the customer code is “0” in Parameter 5.2, programming of parameters is always enabled.

Operating examples

Example 1(HART)

The length unit should be changed from “m” to “mm.”The starting point is the multi-display.



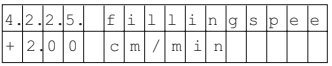
Follow the path traced with a bold line in the diagram above for input. The other paths lead to other device functions and parameters which are not required in this example. Next to the operating path, the control elements which you need to press are indicated and the operating steps are numbered.

Example 2

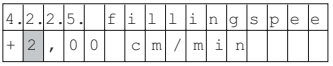
The filling speed should be changed from 2.0 cm/min to 100 cm/min.

Access the “Fill speed” parameter from the multi-display according to instructions on page page 19.

The default setting appears in the display

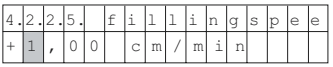


Enable the programming.
The second segment of the second display line flashes.



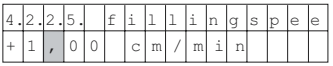
1 x ▽

Set the digit to 1 with the ▽ control element.



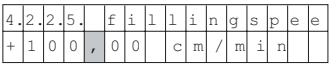
1 x ▷

Select the decimal point with the ▷ control element.



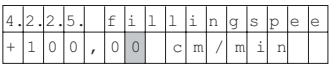
2 x △

Press the △ control element twice so that two other places appear in front of the decimal point.



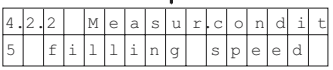
2 x ▷

Select the last decimal place with ▷



1 x ▷

And end the input with the ▷ control element (“Enter” function)

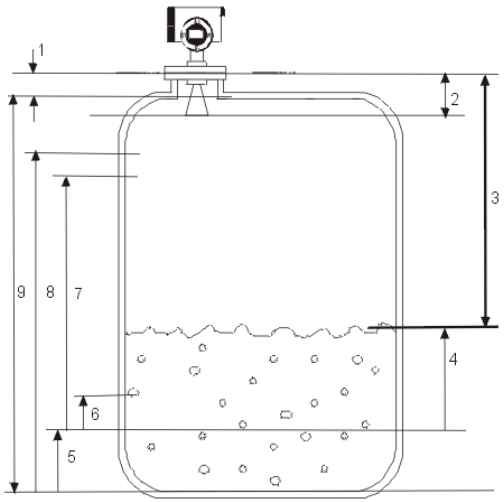


Parameters (HART)

The parameter groups are followed by the parameters within each group. The parameter tables show the values you need to enter in bold type, followed by additional information when necessary. Factory settings are displayed after the parameter name, where applicable.

Functional Dimensions

1 Nozzle height
2 Dead band
3 Raw value (measured)
4 Level (= calculated value)
5 Lower range value
6 Lower limit
7 Upper limit
8 Upper range value
9 vessel height



Required Parameters

The following parameters are absolutely essential for proper operation of the device. They apply to all applications and are required to make the system operational.

1. Auto-Setup

Language Local (F = English)

Language of the local user interface

Value	English
	Deustch

Length Unit (F = m)

Units of measurement

Value	cm
	m
	mm
	ft
	in

Nozzle Height (F = 0 m)

Length of nozzle from top of flange to top of vessel (see "Functional Dimensions" on page 25).

Value	numerical value

Tank Height (F = 20 m)

Height of vessel from bottom of nozzle to bottom of vessel (see "Functional Dimensions" on page 25)

Value	numerical value

Level URV (F = 20 m)

Full scale of level (see "Functional Dimensions" on page 25)

Value	numerical value

Set the URV as the level above the bottom of the vessel (see "Functional Dimensions" on page 25) in the units system selected with Function 4.1.1. It corresponds to an output current of 20 mA.

Level LRV (F = 0 m)

Empty scale of level (see "Functional Dimensions" on page 25)

Value	numerical value

Set the LRV as the level above the bottom of the vessel (see "Functional Dimensions" on page 25) in the units system selected with Function 4.1.1. It corresponds to an output current of 4 mA.

Level damping (F = 1 s)

Damping of level in s

Value	numerical value

Set the damping of the level value in seconds. It acts on the analog output, the limit value monitor and the local display. For damping of the sensor signal, set Function 4.2.3:.

Application Type (F - Liquid [store])

Use of the vessel

Value	Liquid (store)
	Liquid (process)
	Silo1 (solids)
	Silo2 (solids)
	User tank1
	User tank2

Select Silo1 (solids) for tall, narrow silos. Select Silo 2 (solids) for large diameter silos typcially used for cement. In most cases you set one of the pre-specified applications here. The user vessels may adopt configurations which deviate from the factory settings. These are designed for special applications loaded at the factory or by service. the following parameters cannot be accessed when you set a user vessel: Parameter 4.2.2.2, Parameter 4.2.2.5, Parameter 4.2.2.6, Parameter 4.2.3.1 and Parameter 4.2.3.5

Additional Parameters

2. Display

2.1: Multi-display (F = level in m
Signal to noise ratio in db)

Display of two measured values. Values determined in Parameter 4.5.1.1 (Line 1 Local) and in Parameter 4.5.1.4 (Line 2 Local).

2.2: Level (F = m)

Current level of measured medium (set unit using Length Unit in Auto-Setup).

2.3: Volume (F = m^3)

Volume of measured medium (set unit using Parameter 4.1.2: Volume Unit).

2.5: Current Output

Value of the analog output in mA

When the device electronics are working properly, the displayed current value will correspond to the measured output current.

2.6: Digital Output

State of digital output

3. Diagnostics

3.1: Status

Here you can access current status messages of the device. Parameter 3.1.1 is always accessible; other parameters (Parameter 3.1.x) appear in the appropriate order if they contain error messages.

3.1.1: Wear

3.1.1.1: Operating Hours

Total previous operating time of the device in hours (approximate value)

3.1.1.2: Maximum Temperature (F = 26°C)

Previous maximum temperature of the device

Note: This temperature must not exceed 85°C (185°F) or warranty may be void.

3.1.1.3: Minimum Temperature (F = 26°C)

Previous minimum temperature of the device

3.1.1.4: Aging

Approximate value for the previous life of the device in % (100% = approx. 10 years)

This parameter outputs a calculated percentage which estimates the wear of the device due to aging.

3.1.1.5: Hours > 85°C

Total time for which the maximum permissible temperature was exceeded, in hours

3.1.x: Sensor, electronics, software, application, parameters, service

These parameters are only displayed if they contain an error message. The number of the menu items matches the number of defective functions and can range in extreme cases from 3.1.2 to 3.1.7.

See"Troubleshooting" on page 62 for the individual error messages and possible remedies.

3.1.x: Sensor

Diagnostic messages of the sensor

and/or

3.1.x: Electronics

Diagnostic messages of the electronics

and/or

3.1.x: Software

Diagnostic messages of the software

and/or

3.1.x: Application

Diagnostic messages to the application

and/or

3.1.x: Parameters

Display of the false parameters

and/or

3.1.x: Service

For service purposes only

3.2: Device Test

3.2.1: Self-test

Check device state

The device integrates the self-test routines in the ongoing measurements; it completes them after approx. 10 seconds. It confirms a successful self-test with the display "OK" – "not OK" signals an error. Read out the error type according to Parameter 3.1.x.

3.2.2: Display test

Visual check of LCD

You can test the LCD with this function. The display first goes blank for 5 seconds and then lights up for another 5 seconds so that you can determine whether individual display points have failed.

3.3: Simulation

This parameter can support testing the correct functions of the connections during commissioning or maintenance of the device. With the two sub-parameters, you can temporarily replace the measured values at the analog and digital output with known simulated output values.

Note: The "Simulation" function influences output to the control system.

3.3.1: Simulate AO (F = 4 mA)

Simulation of the analog output signal

Value	**4 mA**
	10 mA
	12 mA
	20 mA
	Error signal

When this parameter is accessed and a value is entered, the device sets the defined current value which can be validated.

The parameter is ended after pressing ◁ so that the analog output again gives the measured value.

3.3.2: Simulate DO (F = End)

Simulation of the digital output signal

Value	**Relay on**
	Relay off
	End

Select the applied output value "Relay on" or "Relay off."

The function is ended after pressing ◁ so that the digital output again gives an alarm/ limit.

3.4: Sensor Variables

You can read out device-internal data with this function. The displayed values depend on the respective application. You can access the following data:

3.4.1: Raw Value (for service purposes only)

Distance from the flange to measuring medium

The measured distance from the flange to the surface of the measuring medium.

3.4.2: Echo Amplitude

Measure of quality of reflection

This dimensionless value is an absolute measure of the strength of reflection at the measuring medium. Its display can be evaluated as follows:

- **x > 1:** very good
- **1 > x > 0.5:** good
- **0.5 > x > 0.05:** satisfactory
- **x < 0.05:** uncertain

3.4.3: S/N Ratio

Signal-to-noise ratio of the measured value in dB

S/N Ratio provides a relative measure of the strength of reflection of the measuring medium in dB. Its display can be evaluated as follows:

- **x > 20:** very good
- **20 > x > 10:** good
- **x < 10:** satisfactory

3.4.4: Validity

Validity of the measured value in %

This parameter provides a percentage measure of the certainty that the displayed measured value corresponds to the real level and does not represent a multiple echo or a fixed target. Its display can be evaluated as follows:

- **x > 70:** very good
- **70 > x > 50:** good
- **50 > x > 20:** uncertain
- **x < 20:** no plausible measured value

3.4.5: SensorTemp

Sensor temperature

4. Device Data

4.1: Units

4.1.1: Length Unit = Parameter 1.2

4.1.2: Volume unit (F = m^3)

Value	bbl
	yd^3
	ft^3
	in^3
	bush
	bbl (liq)
	l
	m^3
	hL
	Gal
	ImpGal

4.1.3: Temperature Unit (F = °C)

Unit of the sensor temperature

Value	°C
	°F
	K

4.1.4: Other units (F = SI)

Units system for all other units

Value	SI unit
	US/UK unit

With this function you determine whether you want to enter the operating parameters (see Parameter 4.2) in SI or in British Imperial (US/UK) units. The selected units of the measured value output and sensor temperature as well as the decimal point are not influenced by this setting.

4.2: Operating Parameters

With this parameter, you can define the parameters of your vessel, the measuring medium and the calculation of the measured signal. Signal-specific default settings such as the failure signal or the upper current limit of the analog output signal are assigned to the functions of the respective outputs, see Parameters 4.3 and 4.4.

4.2.1: Tank Geometry

4.2.1.1: Nozzle Height = Parameter 1.3

4.2.1.2: Tank Height = Parameter 1.4

4.2.1.3: Stilling Pipe? (F = no)

Stilling pipe available?

Value	yes
	no

By selecting the setting "yes" or "no," you specify whether the device is mounted on a stilling pipe. If you have selected "yes," the Parameter 4.2.1.3.2 is enabled in which you can specify the internal diameter of the stilling pipe.

4.2.1.3: Pipe Diameter (F = 100 mm)

Internal diameter of the stilling pipe

Value	numerical value

4.2.2: Measuring Conditions

4.2.2.1: Application Type (F - Liquid [store])

Use of the vessel

Value	Liquid (store)
	Liquid (process)
	Silo1 (solids)
	Silo2 (solids)
	User tank1
	User tank2

Select Silo1 (solids) for tall, narrow silos. Select Silo 2 (solids) for large diameter silos typically used for cement. In most cases you set one of the pre-specified applications here. The user vessels may adopt configurations which deviate from the factory settings. These are designed for special applications loaded at the factory or by service. the following Parameters cannot be accessed when you set a user vessel: Parameter 4.2.2.2, Parameter 4.2.2.5, Parameter 4.2.2.6, Parameter 4.2.3.1 and Parameter 4.2.3.5.

4.2.2.2: Surface (F = wavy)

Surface structure of the measuring medium. Not displayed if a user vessel is selected in Parameter 4.2.2.1.

Value	smooth
	wavy
	turbulent

This parameter is not displayed when a user vessel is selected in Parameter 4.2.2.1. In the case of poorly reflecting measuring media, you may be able to improve the measuring results by setting a different surface structure here. If your measuring medium forms waves more than 1 cm in height, you should select the “wavy” setting. The ”turbulent” setting is recommended for waves > 10 cm. The default setting is the “wavy” surface structure.

4.2.2.3: Dead band (F = 0.26 m)

Area below the flange in which measured values are ignored.

Value	numerical value, Minimum value = Length of the antenna

Specification of a *dead band in the units system selected according to Parameter 4.1.5 defines a minimum distance from the flange which the measuring medium must have for the device to accept the measured values as valid. This suppresses reflective interference generated by e. g. the nozzle, close obstacles, or the antenna.

Note: The dead band should exceed the antenna's length.

4.2.2.4: Correction Factor (F = 1.0)

Correction factor for physical measuring influences

Value	numerical value

The propagation time of the microwaves between the antenna and the measuring medium changes slightly depending on the pressure inside the vessel. If this pressure is constant, however, it can be included in the evaluation according to the

equation: $$K = \frac{1}{\sqrt{1 + (\varepsilon_{r,\,Gas} - 1) \cdot \frac{273 \cdot p}{T_{Gas} + 273}}}$$

K = correction factor, p = pressure inside the vessel in bar, Tgas = gas temperature in °C, $\varepsilon_{r,\,Gas}$ = dielectric of the overlying gas, e.g. $\varepsilon\rho_{,\,air}$ = 1.00059

Enter the correction factor *K* as a dimensionless value.

4.2.2.5: Filling Speed (F = 200 mm/min)

Typical speed of change of the level. Not displayed if user vessel is selected in Parameter 4.2.2.1.

Value	numerical value

This Parameter is not displayed when a user vessel is selected in Parameter 4.2.2.1. When you determine that the displayed measured value does not follow the change in the height of the level in the vessel, you can enter a value for the speed with which it generally changes. This assigns a greater probability to measuring targets which move at this speed.

If the display does not follow the level height continuously but in abrupt jumps, you should choose a higher filling speed. If multiple echoes are indicated during filling/emptying a vessel, select a lower filling speed. In the case of very low filling speeds (a few mm/min) switch off Parameter 4.2.3.3. If different filling/emptying speeds occur, select the higher speed.

4.2.2.7: Failsafe Level (F = Hold Continuously)

Selects the default measurement in the event that the failsafe timer expires

Values	100 %
	0 %
	Hold Continuously

4.2.2.8: Failsafe Timer (F = 10 min)

Sets the time delay, in minutes, before entering failsafe level.

Values	1 min
	2 min, etc.

The failsafe timer will begin when there is a loss of echo condition. This loss of echo condition will occur when there is no signal avaliable above the Auto False Echo Suppression threshold as defined in Parameter 4.2.3.9.

4.2.2.9: Range Extension (F = 3 m)

Sets the distance below the vessel height included in the evaluation

Values	numerical

4.2.3: Sensor Parameter

Here you can view and change the sensor parameters which you have selected according to parameter 4.2.2.

Note: The factory settings for the user vessels are not editable.

4.2.3.1: Sensor Damping (F = 10 s)

Averaging of measuring signal. Not displayed if a user vessel is selected in parameter 4.2.2.1.

Value	numerical

This parameter is not displayed when a user vessel is selected in parameter 4.2.2.1. The sensor damping influences the evaluation of the measuring signal. If the level generally only changes slowly and continuously, a time constant set here can improve the measuring accuracy and the validity in poorly reflecting measuring media or those with a restless surface. The sensor damping must always be smaller than the interval of the time of change of the level (e.g. 1 mm/10 s), because too high a value would have a negative influence on the measuring result.

Enter the damping in seconds.

Note: Specification of a damping directly influences the evaluation of the measuring signal. If you only want to dampen the calculated outputs at the analog output, you should set the damping of level or volume described in Function 4.2.4.4.

4.2.3.2: Multiple Echo (F = on)

Evaluate multiple echo

Value	on
	off

The multiple echo evaluation suppresses multiple reflections by assigning them a lower probability than the measuring signal.

4.2.3.3: Echo Motion (F = off)

Evaluate echo motion

Value	on
	off

Dynamic processes in the vessel are included in the evaluation of the measuring targets. The typical filling speed can be set in Parameter 4.2.2.5. If, however, the measured value still does not follow the level height, switching off the parameter “echo motion” could possibly improve the result.

4.2.3.4: Window Tracking (F = on)

Value	on
	off

A window follows the measured value which it is forced to track. The window size is calculated from the set filling speed. The parameter “window tracking” would be switched off for applications where the SITRANS LR 400 is unable to keep up to level changes.

4.2.3.5: Tank Empty Detection (F = on)

Value	on
	off

Sometimes in vessels with a parabolic or conical bottom there is no signal reflection when the vessel is empty. The vessel empty detection recognizes this state and displays the measured value for an empty vessel.

If the measuring medium’s signal disappears occasionally (foam, turbulence, etc.), it may help to switch this parameter off.

4.2.3.6: Auto Fix Distance (F = off)

Automatic fixed target detection

Value	on
	off

Fixed targets are set automatically and their echoes suppressed. Automatic setting of the fixed targets depends on the set filling speed. However, the measured value display may trace the level correctly but jump to an incorrect value, i.e. a multiple echo, at constant level after a longer time. In that case you may switch off the automatic fixed target detection. It is suggested that Auto False Echo Suppression (4.2.3.9 and 4.2.3.A) be used instead of Auto Fix Distance (4.2.3.6).

4.2.3.7: Fix Distance List

Manual input of up to nine fixed targets

Value	numerical value

Here you can enter the distances from the flange of up to nine known fixed targets in any order in the units system selected according to parameter 4.1.1. The fixed targets of this list are considered to be accurate within ±15 cm.