smar - RD400

OPERATION, MAINTENANCE AND INSTRUCTIONS MANUAL

Guided Wave Level Transmitter

APR / 11

RD400

RD400ME

smar

www.smar.com

Specifications and information are subject to change without notice.
Up-to-date address information is available on our website.

web: www.smar.com/contactus.asp

INTRODUCTION

The **RD400** is an intelligent HART level transmitter designed to detect various liquid or solid levels in vessels using a probe type flexible lead, rigid lead or coaxial terminal. The **RD400** sends and receives radio frequency pulses through the probe using Guided Wave Radar (GWR) techniques for the purpose of level detection.

These pulses travel down the probe until the product surface is reached and are then reflected and received back at the device. Using Time Domain Reflectometry (TDR) principles, the **RD400** is able to effectively calculate the level of the measured product from these received pulses.

The **RD400** level information can be output as a user configurable 4-20mA signal and can be viewed locally on the included LCD display or remotely via the HART protocol. The **RD400** is bus powered via the two-wire 24V HART line.

The **RD400** offers many advanced features that enhance its functionality:

Level Measurement
Liquid and solid, semi-liquids levels up to 14m can be accurately measured under a variety of process conditions.

Volume Calculation
The **RD400** can automatically calculate the volume of typical tank shapes such as vertical cylinder, horizontal cylinder, vertical bullet, horizontal bullet and sphere tanks. The volume of tanks of other shapes can also be calculated using the 10 point custom strap table.

Several Probe Types
The **RD400** supports coaxial, single flexible, dual flexible, single rigid (polished or not) and double rigid probes allowing greater flexibility on the properties of the measured process.

Angle Mounted Probes
Applications may require the mounting of the probe flexible cable type at an angle off vertical. The **RD400** fully supports these applications via a user selectable probe angle in software.

Upper and Lower Blocking
The **RD400** can be configured to ignore a selectable distance at the top and bottom of the of the probe length. This is useful in applications where the tank has internal perturbances such as agitators which could potentially give false readings.

Local Adjustment
Many of the features of the **RD400**, such as lower and upper range values can be configured locally.

Alarms
The 0 and 100% alarms mode can be configured for intermittence condition. There is also the *Retain Last Value* mode, where the equipment indicates the output as saturated, maintaining the value from last measured point.

Waiver of responsibility

The contents of this manual abides by the hardware and software used on the current equipment version. Eventually there may occur divergencies between this manual and the equipment. The information from this document are periodically reviewed and the necessary or identified corrections will be included in the following editions. Suggestions for their improvement are welcome.

Warning

For more objectivity and clarity, this manual does not contain all the detailed information on the product and, in addition, it does not cover every possible mounting, operation or maintenance cases.

Before installing and utilizing the equipment, check if the model of the acquired equipment complies with the technical requirements for the application. This checking is the user's responsibility.

If the user needs more information, or on the event of specific problems not specified or treated in this manual, the information should be sought from Smar. Furthermore, the user recognizes that the contents of this manual by no means modify past or present agreements, confirmation or judicial relationship, in whole or in part.

All of Smar's obligation result from the purchasing agreement signed between the parties, which includes the complete and sole valid warranty term. Contractual clauses related to the warranty are not limited nor extended by virtue of the technical information contained in this manual.

Only qualified personnel are allowed to participate in the activities of mounting, electrical connection, startup and maintenance of the equipment. Qualified personnel are understood to be the persons familiar with the mounting, electrical connection, startup and operation of the equipment or other similar apparatus that are technically fit for their work. Smar provides specific training to instruct and qualify such professionals. However, each country must comply with the local safety procedures, legal provisions and regulations for the mounting and operation of electrical installations, as well as with the laws and regulations on classified areas, such as intrinsic safety, explosion proof, increased safety and instrumented safety systems, among others.

The user is responsible for the incorrect or inadequate handling of equipments run with pneumatic or hydraulic pressure or, still, subject to corrosive, aggressive or combustible products, since their utilization may cause severe bodily harm and/or material damages.

The field equipment referred to in this manual, when acquired for classified or hazardous areas, has its certification void when having its parts replaced or interchanged without functional and approval tests by Smar or any of Smar authorized dealers, which are the competent companies for certifying that the equipment in its entirety meets the applicable standards and regulations. The same is true when converting the equipment of a communication protocol to another. In this case, it is necessary sending the equipment to Smar or any of its authorized dealer. Moreover, the certificates are different and the user is responsible for their correct use.

Always respect the instructions provided in the Manual. Smar is not responsible for any losses and/or damages resulting from the inadequate use of its equipments. It is the user's responsibility to know and apply the safety practices in his country.

This manual contains information destined to aid in the installation, operation, configuration and maintenance of **RD400.** The information is organized in the following way:

SECTION 1 - INSTALLATION

Show assembly instructions of **RD400**.

SECTION 2 - OPERATION

Show details about operation of **RD400**.

SECTION 3 – TECHNICAL CHARACTERISTICS

Describe the specifications of **RD400** and other related information.

SECTION 4 - CONFIGURATION

Detail configuration instructions of **RD400**.

SECTION 5 – PROGRAMMING USING LOCAL ADJUST

Show programming instruction for local adjustment of **RD400**.

SECTION 6 - MAINTENANCE

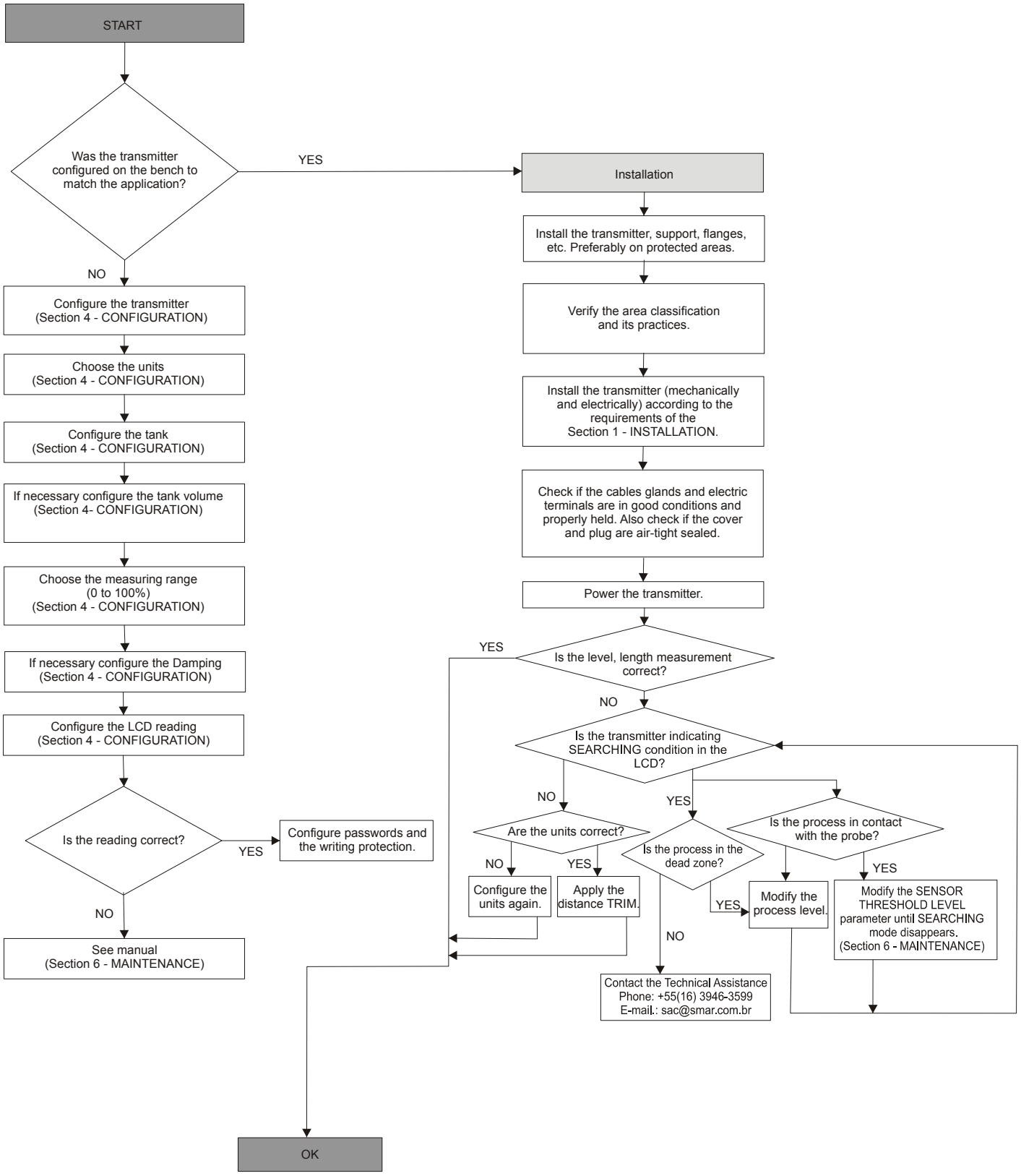
Information about troubleshooting and maintenance procedures of **RD400**.

SECTION 7 – ORDERING CODE AND SPARE PARTS

List the pieces and spare parts of **RD400**.

TABLE OF CONTENTS

Installation Flowchart



Section 1

INSTALLATION

Applications

Because the **RD400** uses guided wave radar principles and can be used with a rage of different probe types, it has the unique ability to be used in a broad range of level applications. The **RD400** is an ideal solution for accurate measurements in harsh chemical environments under large variations of temperature and pressure. With a maximum detection distance of 14 meters in vessels with temperatures up to 150° C and pressures from -1 to 40 bar, the **RD400** is ideal for almost any application (See Table 3.1, page 3.2 for more details).

Because the **RD400** has no moving parts, it far outlasts other mechanical methods of level detection in dirty or corrosive applications. The **RD400** can be installed and measure level and volume in various types of tanks, including those in which the probe must be angled due to internal perturbances.

The **RD400**'s ability to accurately and reliably measure level essentially independent of density, conductivity, temperature, pressure, pH or viscosity makes it an excellent candidate for traditionally difficult applications. The TDR (Time Domain Reflectometry) technique of level measurement enables the **RD400** to excel versus other transmitters in the following application conditions:

Foam/Bubbles - The coaxial probe of the **RD400** acts as a stilling well, essentially isolating the probe from unwanted measurement influences such as foam/bubbles or debris. Examples: cooling tower basins, soap and black liquor.

Dust - Because the waves of the **RD400** are guided down a probe, any dust involved with the measured product will not interfere with the level measurement.

Density - Many measurable products will undergo density variations within the tank due to various temperature or pressure changes. Because the **RD400** is immune to these variations, it can measure much more accurately in these situations versus a load cell or differential pressure solution.

Accessibility to the bottom of Vessels – For the process where is not possible to install a level meter for hydrostatic pressure, as in underground reservoirs, the **RD400** is indicated, because its installation is of top.

Components

The **RD400** consists of three main parts:

• **Main Housing** - The body of the transmitter that contains all the transmitter electronics. This includes the 2 housing covers which screw into the main housing and provide access to the field terminals, LCD and electronics.

• **Isolator** - Isolates the **RD400** electronics from the tank and carries the radar pulse to/from the probe. Also enables the probe to freely rotate and ensures high probe tensile strength.

• **Probe** - Connects the **RD400** to the process. See the *Technical Specification* section for more information.

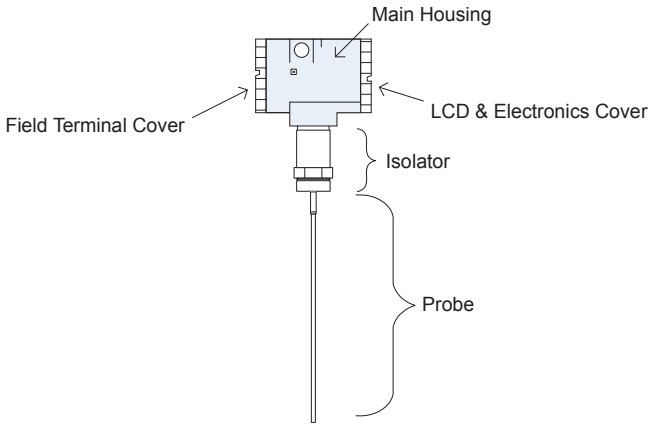


Figure 1.1 – RD400 Component Diagram

Installation

Mounting

The selection of a proper mounting position shall consider the following guidelines:

The **RD400** can be mounted in many different ways for use with various types of vessels. The **RD400** can be supplied with a selection of various sized threaded and flanged process connections to be used in different types of vessels and applications. The correct seal type and housing type should also be selected depending on the temperature and corrosive properties of the application environment and measured product. For more information on these options, see the Ordering Code section of this document.

The **RD400** must be mounted in a location that is easily accessible and able to be serviced. The LCD display can be rotated into four 90° positions for easy viewing no matter how the instrument is positioned. When installing cables, be sure to lead the connection cable downward from the point of connection. This protects against water damage from rain and condensation. This is especially important in outdoor installations and high humidity environments.

It is important to select a mounting position that will allow the **RD400** to measure the entire level range required. It should be noted that there is an immeasurable section from the seal surface of the thread (reference plane) to the electrode end on the **RD400**.

The **RD400** must be installed in such a way that the product to be measured must never rise above this point. In similar fashion, the 0% level must not be lower than the end of the rod or cable. In the case of cable installations, the 0% measured level must not be in or below the gravity weight area of the cable.

These principles can be seen in Figures 1.2 and 1.3. The exact lengths of these zones can be found in the Technical Specifications section of this document.

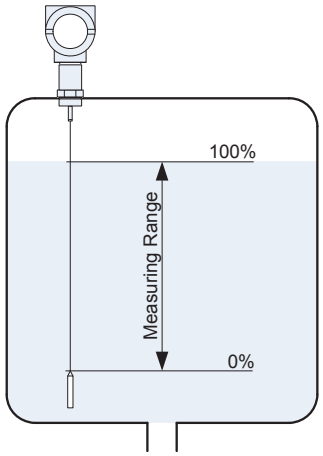


Figure 1.2 – Minimum and Maximum Measuring Distances

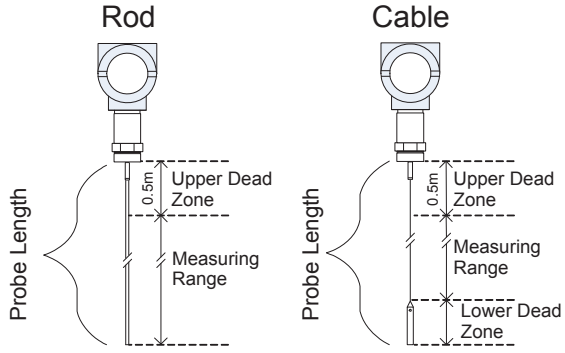


Figure 1.3 – Dead Zones

As the installation is complete, be sure that the distance of the probes to any obstacles complies with the Table 3.1, *Technical Characteristics* section. There is no distance limitations for coaxial probes, but it is recommended that only the product (whose level is measured) is in contact with the probe, like in the other probe types.

If there is a chance of contact due to turbulent product movement, another mounting position should be selected or the cable should be secured in place to assure no contact will be made. The counter weight of the cable includes a thread for attaching an anchor ring. The anchor ring should be used to secure the probe to the bottom of the tank.

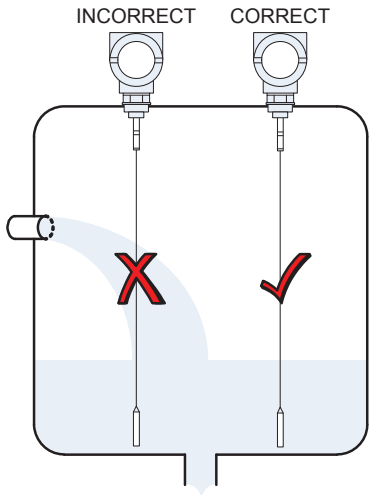


Figure 1.4 – Avoiding Inflowing Product

The vessel type will play a great role in how the **RD400** is mounted. In general it is suggested to mount the **RD400** flush to the ceiling of the vessel or as close as possible. This will ensure the most accurate measurements from the **RD400**. The following is a list of special vessel types that require special consideration:

Conical Bottomed Vessels

When using the **RD400** with a conical bottomed vessel, the greatest range of level can be measured when the transmitter cable/rod is mounted above the lowest point of the tank. This is generally in the center of the tank, but may differ dependant on the application. Mounting at this point ensures the level of the product can be measured to the lowest point possible by the **RD400**.

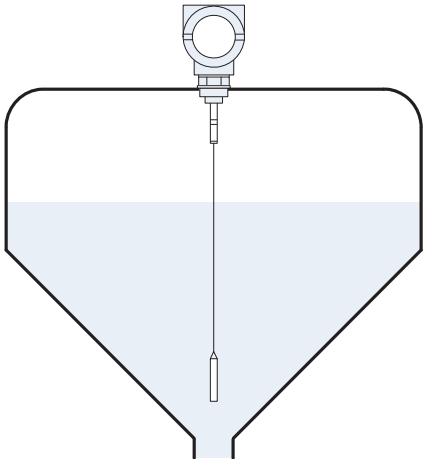


Figure 1.5 – Conical Bottomed Vessel - Ideal Mount Position

Socket Vessels

In applications where a socket mount is the only option, select a socket with the smallest height and diameter possible.

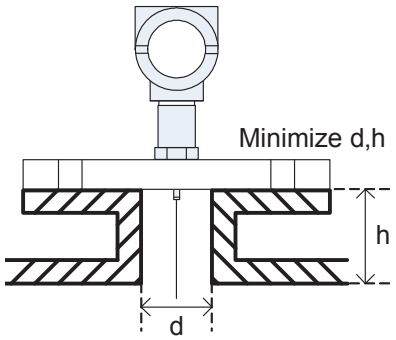


Figure 1.6 – Socket Mounting

Plastic Vessels

The **RD400** process connection must be connected to a metal surface to function properly. This is due to the properties of the guided wave radar circuitry. When installing in plastic or other non conducting vessels, the **RD400** must be used with a flange or a metal sheet of a minimum diameter of 200mm must be placed beneath the process connection. Failure to provide a metal surface will result in inaccurate readings. See the *Ordering Code* section of this document for additional information on flange options.

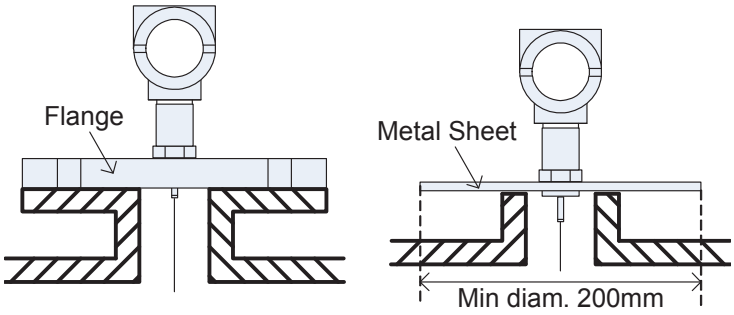


Figure 1.7 – Plastic Vessel Mounting Options

Concrete Vessels

When mounting the **RD400** on concrete vessels a few precautions should be taken. The distance from the vessel wall to the **RD400** probe must be a minimum of 500 mm. Failure to follow these precautions may result in inaccurate level measurements.

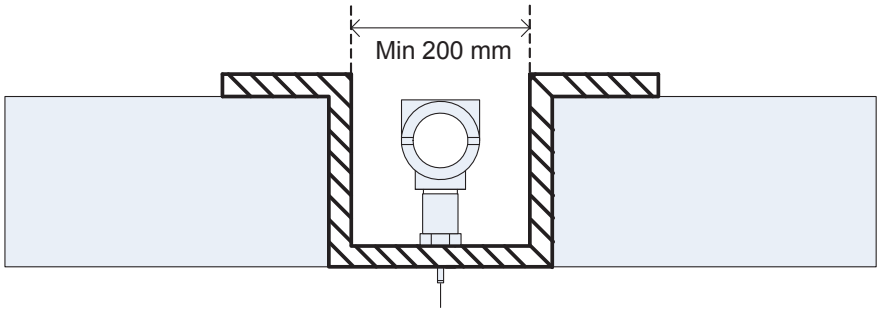


Figure 1.8 – Concrete Vessel Mounting

Electronics Housing Rotation

The electronics housing can be rotated in order to better position the digital display. To rotate it, loosen the Housing Rotation Set Screw and rotate the housing. For more information on changing the LCD orientation, see the LCD Display Rotation section.

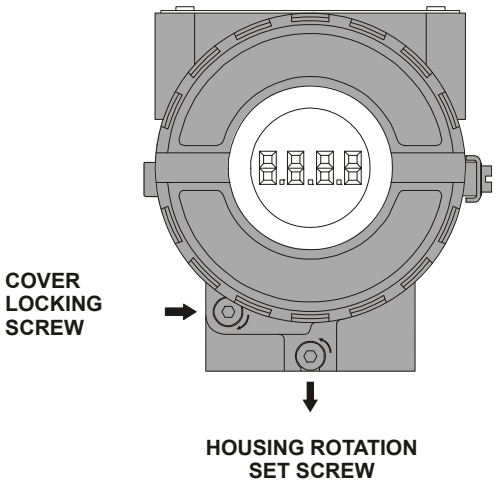


Figure 1.9 – Cover Locking and Housing Rotation Set Screw

WARNING
Do not rotate the electronic housing more than 180° regarding original position.

Wiring

Before wiring the **RD400**, be sure to observe the proper precautions:

- The device must be connected with no voltage on the line.
- Ensure the **RD400** meets any hazard specifications of the area of installation.
- Voltage arrestors should be installed if over voltages are expected.

The **RD400** can be connected using standard two-wire cable. An outer cable diameter of 5 to 9 mm will ensure a proper seal of the cable entry. In applications where electromagnetic interference may be a problem, it is recommended to use shielded cable. Quick connect terminal ends may optionally be fitted to the **RD400** to ensure a proper seal and protect the internal electronics from humidity and moisture.

Below is a diagram of the **RD400** connectors. These connectors are located underneath the electrical connection cover. To remove the cover, first ensure the cover locking screw is loosened, then begin turning the rear housing cover counter-clockwise until it disconnects. The terminals labeled “+” and “-” connect directly to the appropriate HART line. All power for the device is derived directly from the power supply of the HART line. The current output, power and digital communication are all transmitted and received from the same two-wire connection.

The Test terminals shown at Figure 1.10 allow the measuring of the current in the 4-20 mA loop, without opening it. To measure the current, connect a multimeter directly to the “TEST+” and “-TEST” terminals. The Communication terminals allow for direct communication with the **RD400** via the HART protocol. Connect a HART configurator to the “COMM” and “-TEST” terminals to communicate. For convenience there are two ground terminals: one inside the cover and on external, located close to the conduit entry. Use of twisted pair (22 AWG or greater) cables are recommended. Avoid routing signal wiring close to power cables or switching equipment. Any unused output connection should be plugged and sealed accordingly.

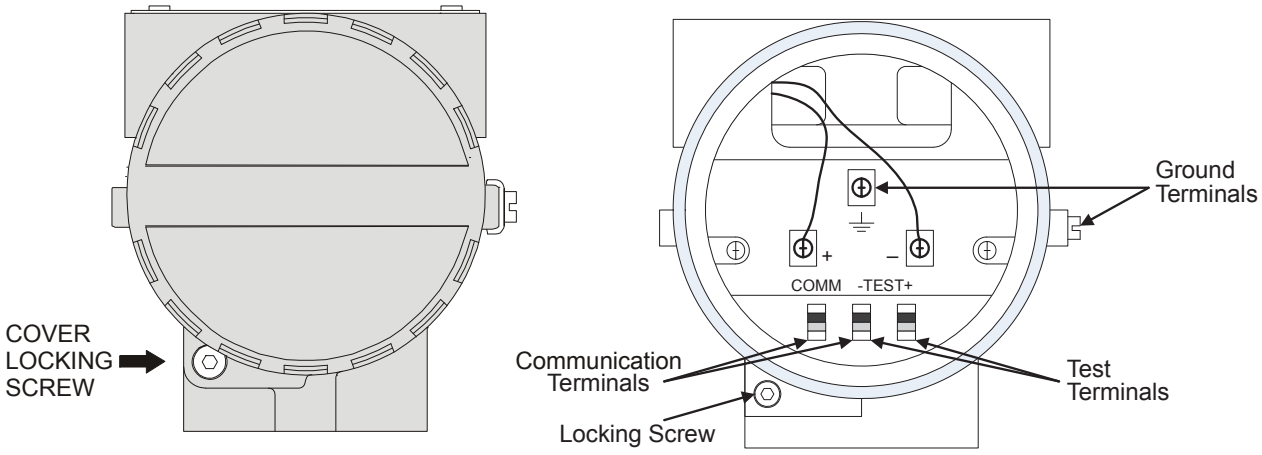


Figure 1.10 – RD400 Electrical Connections

As shown in the figure below, the electrical wiring conduit must be installed correctly to avoid penetration of water or other substances, which may cause equipment malfunction. Be sure to follow these guidelines during installation to assure proper functionality.

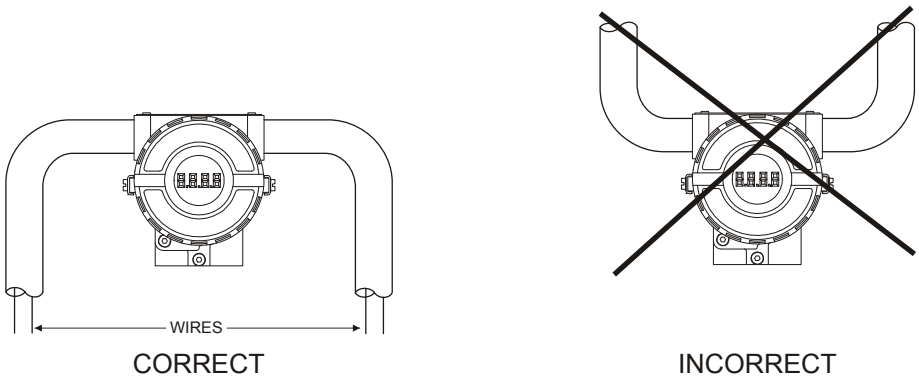


Figure 1.11 – Conduit Installation Diagram

Connection of the **RD400** working as a transmitter should be as indicated in figure 1.11. Connection of the **RD400** working as a controller (Optional) should be as indicated in figure 1.12.

Connection of the **RD400** in multidrop configuration should be as in figure 1.13. Note that a maximum of 15 transmitters can be connected on the same line and that they should be connected in parallel. When many transmitters are connected to the same line, calculate the voltage drop through the 250 Ohms resistor and verify if the voltage of the power supply is sufficient. See the load diagram in the Technical Specifications section of this document for more information.

As can be seen in the following figures, the **RD400** can be configured using a HART compliant Hand-Held Terminal or PC software package such as the HPC401* Palm configurator, the CONF401* HART configurator for the PC and DDCON100*. The configurator can be connected to the communication terminals of the transmitter or at any point of the signal line by using an interface with alligator clips.

ATTENTION
For proper operation, the Hand-Held Terminal and PC HART modem require a minimum load of 250 Ohms between it and the power supply.

* This softwares are available at www.smarresearch.com

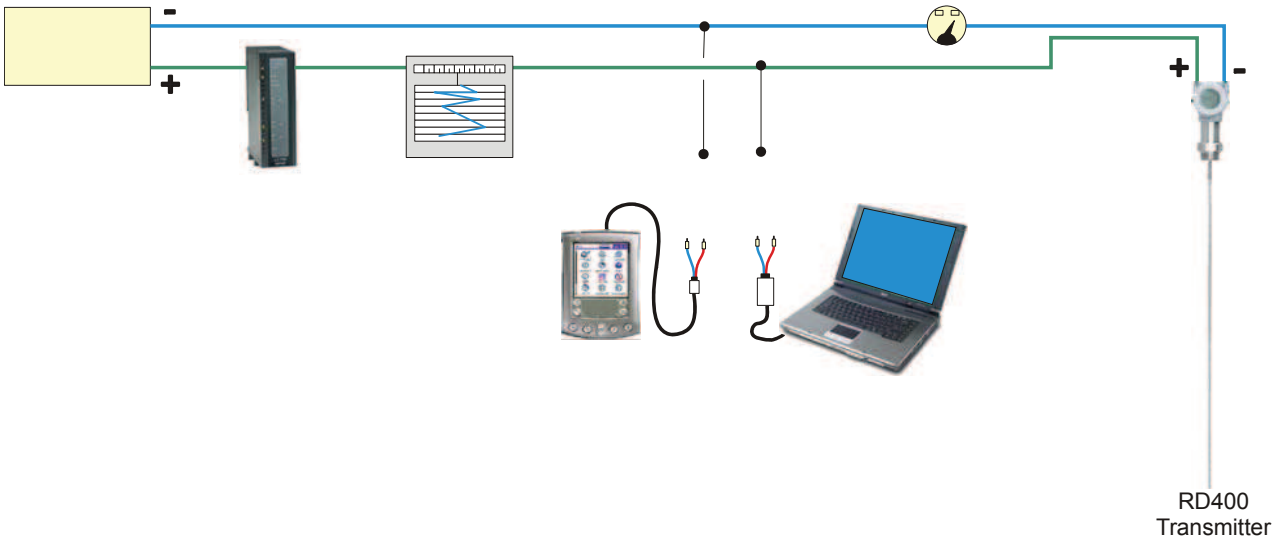


Figure 1.12 – RD400 Multidrop Wiring Diagram

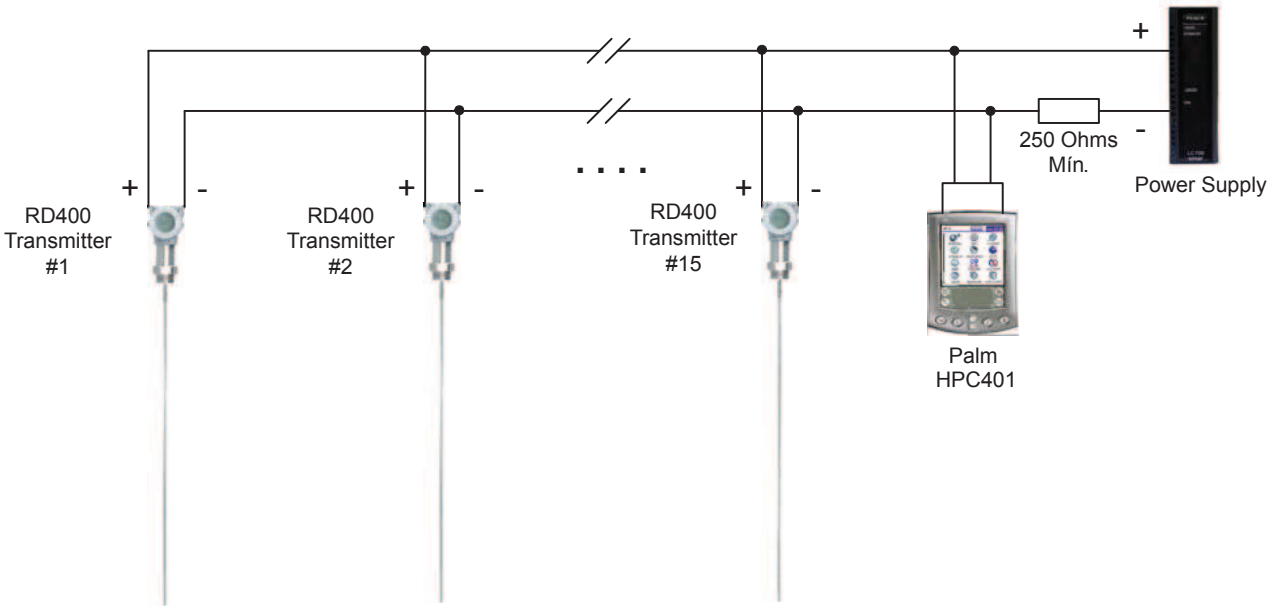


Figure 1.13 – RD400 Transmitter Wiring Diagram

LCD Display Orientation

The LCD display of the **RD400** can be rotated into 4 positions to enable proper viewing from any orientation. This can easily be accomplished by following the steps below.

1. Disconnect the power from the **RD400**
2. Loosen the cover locking screw for the electronics housing cover
3. Unscrew and remove the cover
4. Remove the four screws holding the LCD display in place
5. Rotate the LCD display into one of the 4 available positions and re-tighten the 4 screws
6. Screw the housing cover onto the electronics housing and tighten the cover locking screw

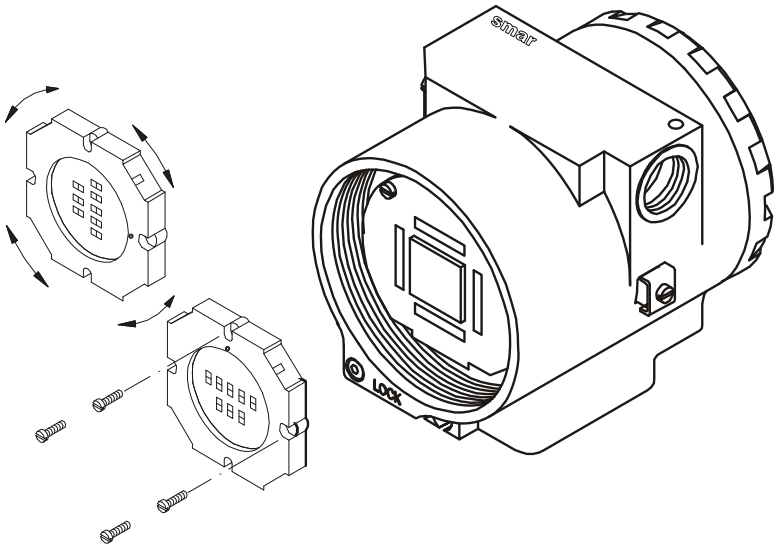


Figure 1.14 – LCD Display Rotation

Installation in Hazardous Areas

WARNING

Explosions could result in death or serious injury, besides financial damage. Installation of this transmitter in explosive areas must be carried out in accordance with the local standards and the protection type adopted .Before continuing the installation make sure the certificate parameters are I n accordance with the classified area where the equipment will be installed.

The instrument modification or parts replacement supplied by other than authorized representative of Smar is prohibited and will void the certification.

The transmitters are marked with options of the protection type. The certification is valid only when the protection type is indicated by the user. Once a particular type of protection is selected, any other type of protection can not be used.

The electronic housing and the sensor installed in hazardous areas must have a minimum of 6 fully engaged threads. Lock the housing using the locking screw (Figure 1.9).

The cover must be tighten with at least 8 turns to avoid the penetration of humidity or corrosive gases. The cover must be tighten until it touches the housing. Then, tighten more 1/3 turn (120°) to guarantee the sealing. Lock the covers using the locking screw (Figure 1.9).

Consult the Appendix A for further information about certification.

Intrinsically Safe

WARNING

In hazardous zones with intrinsically safe requirements, the circuit entity parameters and applicable installation procedures must be observed.

To protect the application the transmitter must be connected to a barrier. Match the parameters between barrier and the equipment (Consider the cable parameters). Associated apparatus ground bus shall be insulated from panels and mounting enclosures. Shield is optional. If used, be sure to insulate the end not grounded. Cable capacitance and inductance plus Ci and Li must be smaller than Co and Lo of the associated Apparatus.

For free access to the Hart bus in the explosive environment, ensure the instruments in the loop are installed in accordance with intrinsically safe field wiring practices. Use only Ex Hart communicator approved according to the type of protection Ex-i (IS).

It is not recommended to remove the transmitter cover when the power is ON.

Section 2

OPERATION

A functional block diagram of the internals of the **RD400** can be seen below. There are three main components: the main board, transmitter/receptor circuit and the LCD display. The main board contains the microprocessor, HART modem controller and power circuitry. The transmitter/receptor circuit contains the ambient temperature sensor and the generator/receptor signal. The LCD display board contains the liquid crystal display and supporting circuitry.

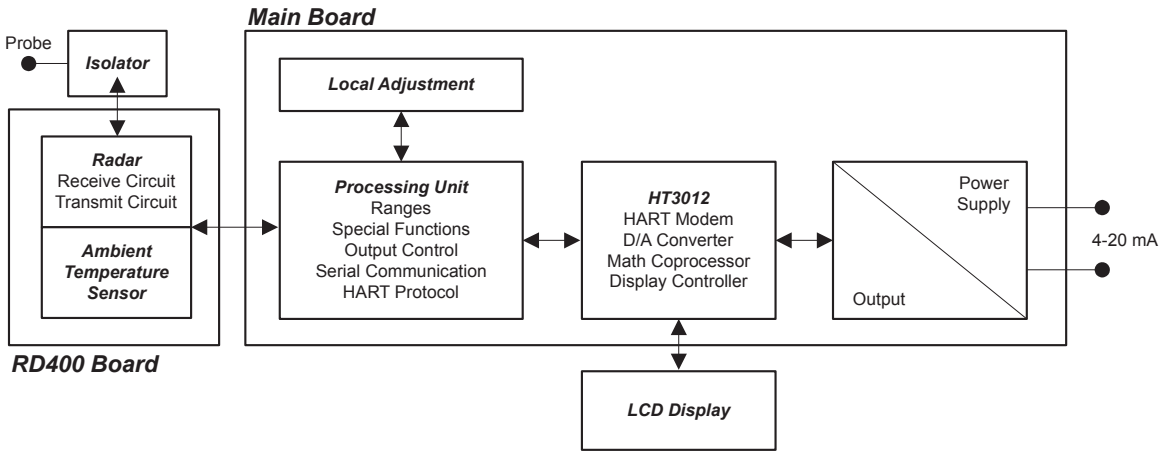


Figure 2.1 – RD400 Function Block Diagram

LCD Display

The **RD400** is available with a local indicator LCD display. This display is useful for quick in-the-field digital readings from the **RD400**. The LCD display also allows the **RD400** to be configured locally with a magnetic tool. The **RD400** LCD indicator is able to display up to two different, user selectable variables.

When two variables are selected, the display will alternate between the two values every 3 seconds. The LCD display includes a field with 4 1/2 numeric digits, a field with 5 alphanumeric digits and various informational fields. The layout of the display can be seen below along with descriptions of each section.

During normal operation, the **RD400** is in the monitoring mode. In this mode, the display alternates between the two selected variables as configured by the user. Engineering units and other status indicators will also be shown. The monitoring mode is interrupted when the user begins a local adjustment. For more information on local adjustment and configuration of the LCD display, see the Configuration section of this manual.

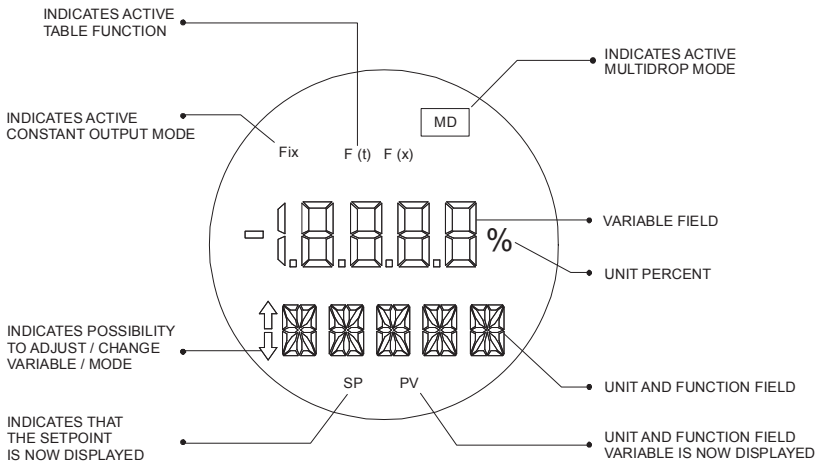


Figure 2.2 - Local Indicator

The **RD400** display is also capable of displaying status and error messages. See the table below for descriptions of each possible message. For additional information on troubleshooting, see the Troubleshooting & Maintenance section of this document.

DISPLAY MESSAGE	DESCRIPTION
"Version#" **RD400**	The **RD400** is in startup mode. This screen will be shown at power up and during any resets. The top line indicates the firmware version of the device.
SAT	The output current is saturated at 3.6 or 21mA. This can be an indication of an out of range condition.
FAIL INIT	The transmitter failed upon initialization. This may be due to a disconnected/failed sensor or a faulty main electronics board.
SEARCHING	The **RD400** is not found the process surface or the level is out of configured range. See the section 4, Configuration, item Range, or the section 6 Troubleshooting & Maintenance, item Sensor Threshold Level.

Section 3

TECHNICAL CHARACTERISTICS

Safety Information

The **RD400** is a continuous level transmitter for use in applications within the range of technical specifications as outlined in the Technical Specifications section of this document.

The **RD400** must be installed and operated by trained personnel with proper authorization. All instructions in this manual should be performed by such personnel only. Any internal work on the **RD400** not covered in this manual must be performed by Smar and its authorized partners only.
If the instructions of this manual are not correctly followed, it can cause damages on the equipment, and its warranty will be lost. Please, be aware to the specific company regulations and guidelines before installing the **RD400**.

Technical Data

The Table 3.1 below describes the technical specifications of the **RD400**.

Functional Specifications	
Power Supply	
Non-Ex Instrument	14 – 36 Vdc
Ripple (AC Signal) Permissible Residual	
< 100 Hz	Uss < 1V
100 Hz – 10 kHz	Uss < 10mV
Output	
Two wire, 4-20 mA with superimposed digital communication (HART Protocol V5.1/Transmitter Poll-response mode/Common 4-20 mA).	
Resolution	1.6 µA
Current Limit	22 mA
Load	See Figure 3.1
Turn-on Time	Aprox. 10 sec.
Burnout / Failure Alarm	3.6 or 21 mA selectable
Update Time	Aprox. 1 sec.
Load Limitation	

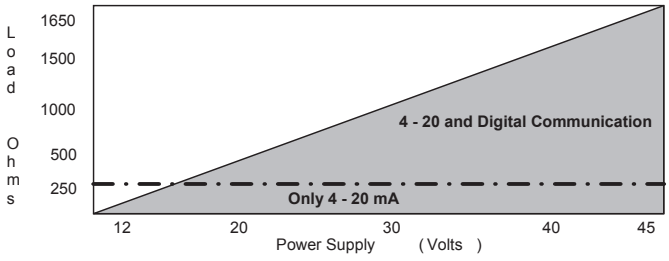
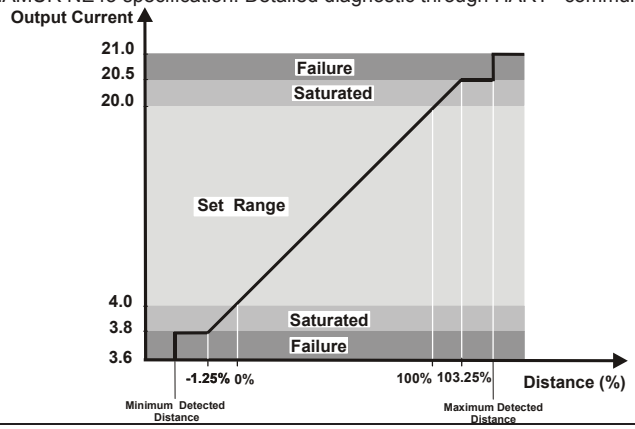


Figure 3.1 – Load Limitation Curve

Failure Alarm (Diagnostics)
In case of sensor or circuit failure, the self-diagnostics drives the output to 3.6 or 21.0 mA, according to the user's choice and NAMUR NE43 specification. Detailed diagnostic through HART® communication.



Temperature Limit	
Ambient (Housing and Electronics)	-40 to 85°C
Ambient (Probe and Internal Sealing)	-28 to 150°C (Viton O-Ring)
	-34 to 135°C (Buna N O-Ring)
	-57 to 121°C (EPDM O-Ring)
Storage	-40 to 80°C
Digital Display (LCD Indicator)	-20 to 85°C
Transport	-40 to 80°C
Pressure Limit	
Process Pressure	-1 to 40 bar

Flange ANSI B 16.5		
Class	**150**	**300**
Temperature	**Limit Pressure**	
-29 to 38 °C	1893 kPa (18.9 bar)	4962 kPa (49.6 bar)
93 °C	1618 kPa (16.2 bar)	4275 kPa (42.8 bar)
149 °C	1481 kPa (14.8 bar)	3864 kPa (38.6 bar)

Flange DIN EN 1092-1 / DIN 2501				
Temperature	**- 10 to 50 °C**	**50 °C**	**100 °C**	**150 °C**
PN	**Limit Pressure**			
16	1230 kPa (12.3 bar)	1180 kPa (11.8 bar)	1020 kPa (10.2 bar)	930 kPa (9.3 bar)
40	3060 kPa 30.6 bar	2960 kPa (29.6 bar)	2550 kPa (25.5 bar)	2310 kPa (23.1 bar)

Tri-Clamp (TC) (Bar)		
DN	**Normal Pressure**	
	20°C (68ºF)	**120°C (248ºF)**
2”	28	17
3”	22	13

Humidity Limits
0 to 100% (Relative Humidity)
Damping Adjustment
User configurable from 0 to 32 seconds (via digital communication)
Certification
Weather proof and intrinsically safe. Tests accomplished in organs certifiers such as CEPEL and FM.

Performance Specifications	
Performance	
Accuracy	Up to ± 7mm for rigid and flexible probes (for values within the configured measurement range).
Temperature Drift	Negligible
Range	500 mm - 14000 mm* (Flexible Lead)
	500 mm - 8000 mm (Rigid Lead)
	300 mm - 6000 mm (Coaxial)
Repeatability	± 3 mm

Minimum Dielectric Constant (ε)

Probe	**ε Minimum**
Dual Rigid Lead	2.4
Dual Flexible Lead	2.5
Single Rigid Lead	3.0
Single Flexible Lead	3.0
Coaxial	1.7

Minimum Distance to Obstacles	
Coaxial	0 mm
Single Probe	200 mm
Dual Probe	100 mm

*Probes for measurements above 14m (up to 30m) are available only under consult.

Measurement Limits (if ε > 10**)	
Single Rod Dead Zone	Top: 500 mm
	Bottom: 30 mm
Dual Rod Dead Zone	Top: 500 mm
	Bottom: 20 mm
Single Cable Dead Zone	Top: 500 mm
	Bottom: Counter weight length + 30 mm
Dual Cable Dead Zone	Top: 500 mm
	Bottom: Counter weight length + 20 mm
Coaxial Dead Zone	Top: 500 mm
	Bottom: 26 mm

** If ε < 10, the bottom dead zone will be 200 mm. For values of Upper Dead Zone less than 500 mm, contact our representative.

Physical Specifications	
Materials	**Wetted Parts**
Insulator O-Ring	Viton, Buna-N, EPDM
Probe	316 SST
Materials	**Non-Wetted Parts**
Housing	Aluminum or 316 SST
Seal Ring (Cover and Neck)	Buna-N
LCD Window	Polycarbonate
Ground Terminal	316 SST
Probes	
Single Flexible Lead	1000 mm - 14000 mm*
Dual Flexible Lead	1000 mm - 14000 mm*
Single Rigid Lead	1000 mm - 8000 mm
Dual Rigid Lead	1000 mm - 8000 mm
Coaxial	1000 mm - 6000 mm
Lateral Strength	
Single Rigid Lead	3 Nm, 0.1 kg to 4 m
Dual Rigid Lead	6 Nm, 0.2 kg to 4 m
Flexible Probe Angle	0 to 90° from vertical axis
Tension Strength	
Single Flexible Lead	9 kN (Collapse Load)

*Probes for measurements above 14m (up to 30m) are available only under consult.

Viton and Teflon are trademarks of E.I. DuPont de Nemours & Co.
HART® is a trademark of HART® Communication Foundation.

Table 3.1 – RD400 Technical Specification

Mechanical and Dimensional Drawings

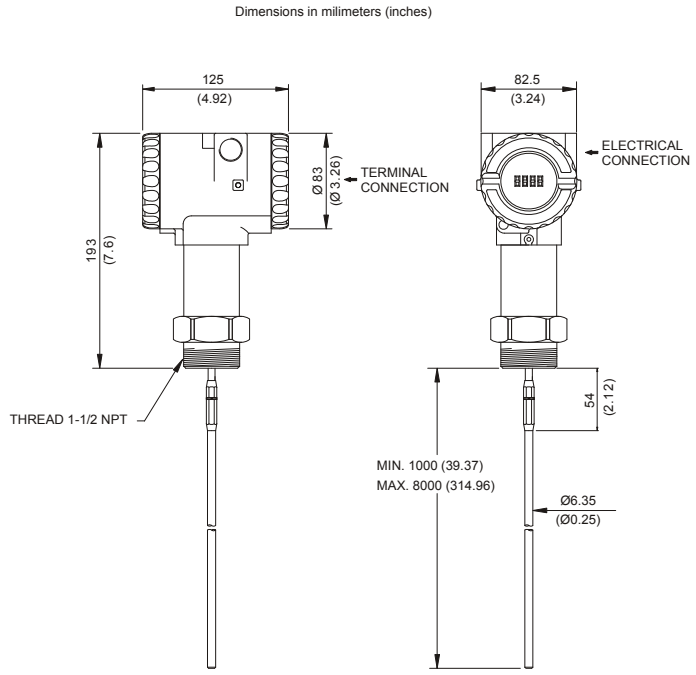


Figure 3.2 – Single Rigid Lead

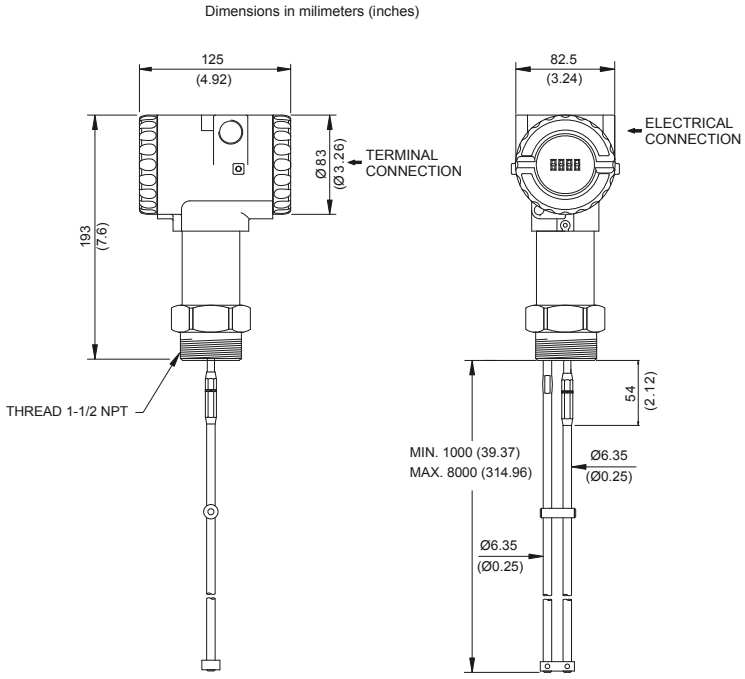


Figure 3.3 – Dual Rigid Lead

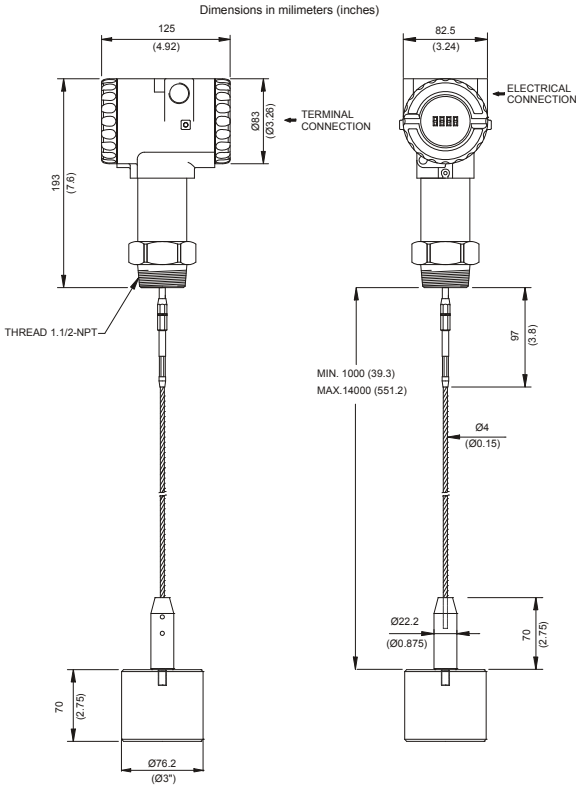


Figure 3.4 – Single Flexible Lead

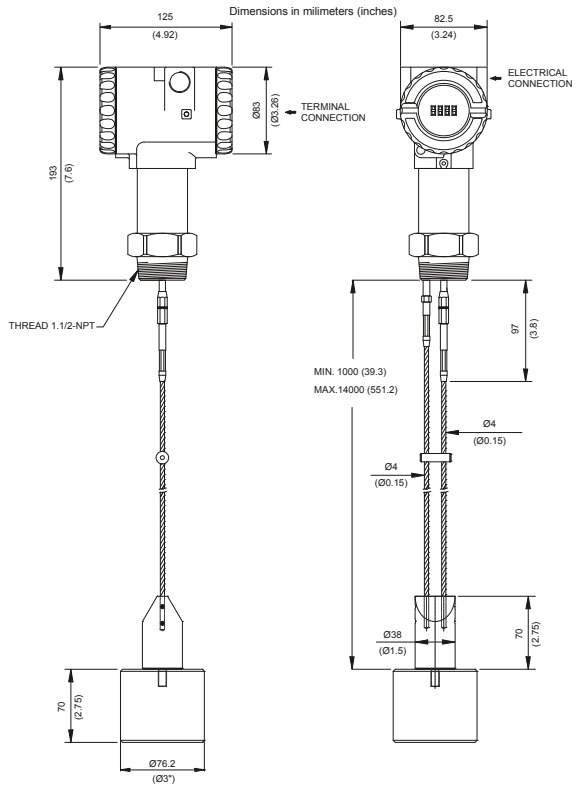


Figure 3.5 – Dual Flexible Lead

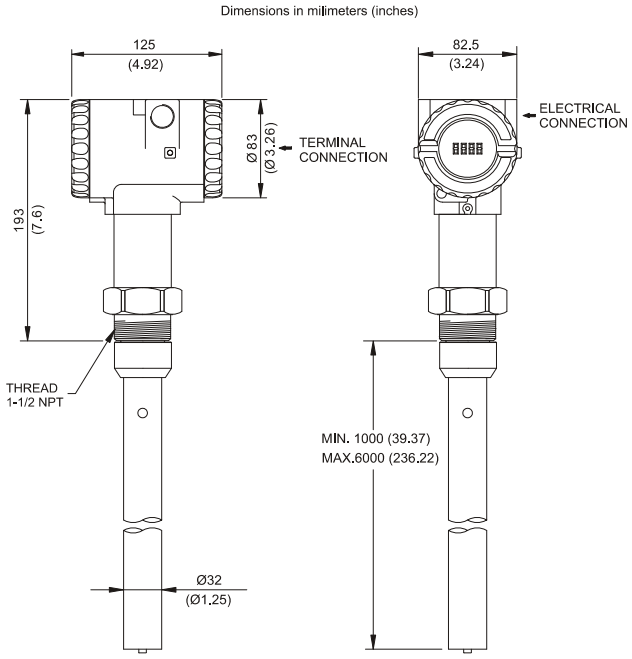


Figure 3.6 – Coaxial Probe

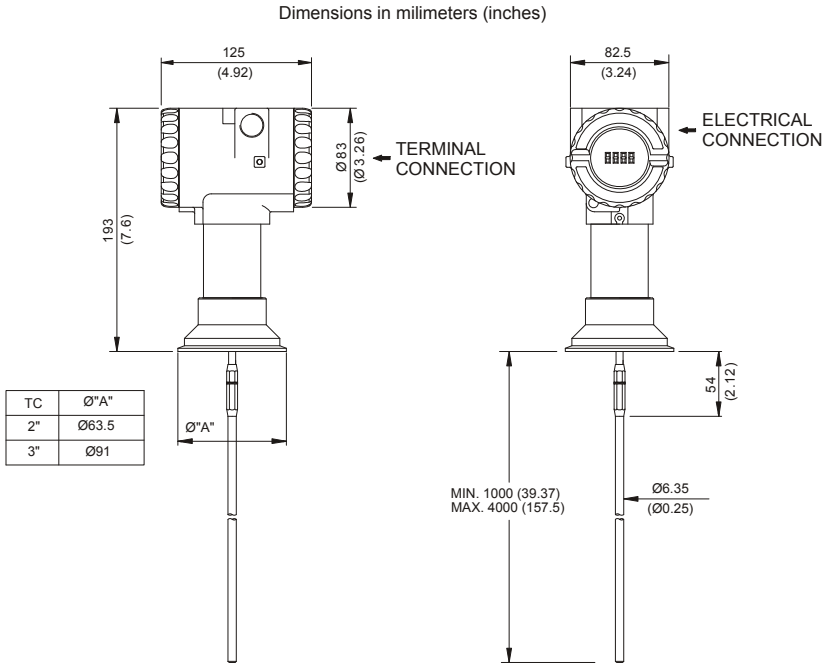
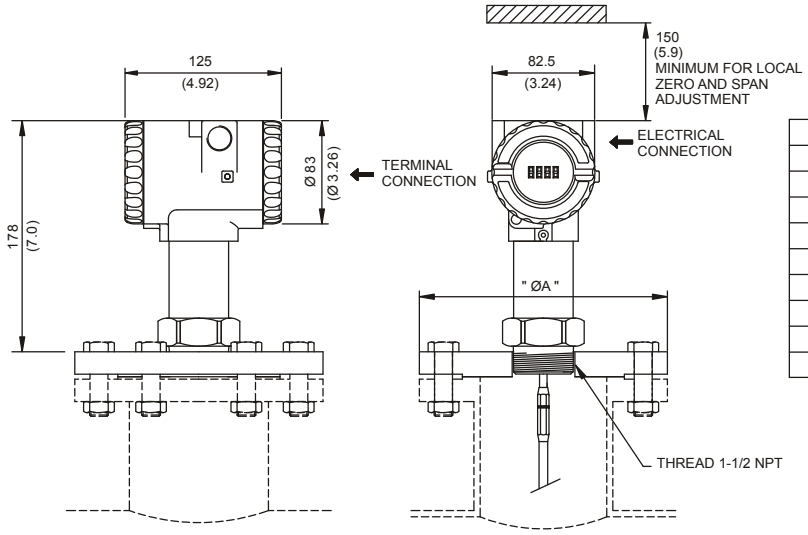


Figure 3.7 – Polished Single Rigid Lead and Tri-Clamp Connection

Dimensions in milimeters (inches)



ANSI-B 16.5			
DN	CLASS	"ØA"	"ØA"
2"	150 lb.	152.4	(6)
2"	300 lb.	165.1	(6.5)
3"	150 lb.	190.5	(7.5)
3"	300 lb.	209.5	(8.25)
4"	150 lb.	228.6	(9)
4"	300 lb.	254	(10)
6"	150 lb.	279.4	(11)
6"	300 lb.	318	(12.5)

DIN 2501/2528			
DN	CLASS	"ØA"	"ØA"
50	PN 10/40	165	(6.5)
80	PN 10/40	200	(7.8)
100	PN 10/16	220	(8.6)
100	PN 25/40	235	(9.25)
150	PN 16	285	(11.2)

Figure 3.8 – Flange Mounting

NOTE
Probes for measurements above 14m (up to 30m) are available only under consult.

Section 4

CONFIGURATION

The **RD400** is an intelligent transmitter with the most up to date features available. The HART digital communication protocol enables the **RD400** to be connected to a computer or handheld device for quick, easy and robust configuration. This section will discuss the various features of the **RD400** and how to access them both locally and remotely. The parameters and menus associated with the **RD400** will be explained in the following section. The CONF401, HPC401 (Palm HART configuration package) and DDCON100 configurators are the recommended configuration tools for the **RD400**. For more information on the HPC401, CONF401 or DDCON100 softwares, including how to poll for devices, access www.smarresearch.com. A typical setup procedure is discussed in this section.

The operations, which take place between the configurator and the transmitter do not interrupt the level measurement and do not disturb the output signal. The configurator can be connected on the same pair of wires as the 4-20 mA signal, up to 2 km away from the transmitter.

RD400 Parameters

By means of the DDCON100 and CONF401 softwares, the **RD400** firmware allows the following configuration features to be accessed:

- Transmitter identification and manufacturing data
- Distance, current and temperature trim
- Primary variable ranging
- Tank configuration
- Volume calculation configuration
- Engineering unit selection and variable mapping
- LCD display configuration
- Monitoring of primary and other specific variables
- Device configuration and status
- Maintenance functions

WARNING
All transmitters are factory configured with no passwords. To avoid operation by non-authorized persons in some critical levels of the Programming Tree, it is recommended to configure all passwords and configuration levels prior to operation.

On Line Single Unit Configuration
To configure the transmitter on line, certify that it is correctly installed, with a suitable power supply and the minimum 250Ω load required. Poll for the device and open it by double clicking. The parameters of the **RD400** are accessed via HART configurator in a tree-shaped menu structure as shown in Figure 4.1.

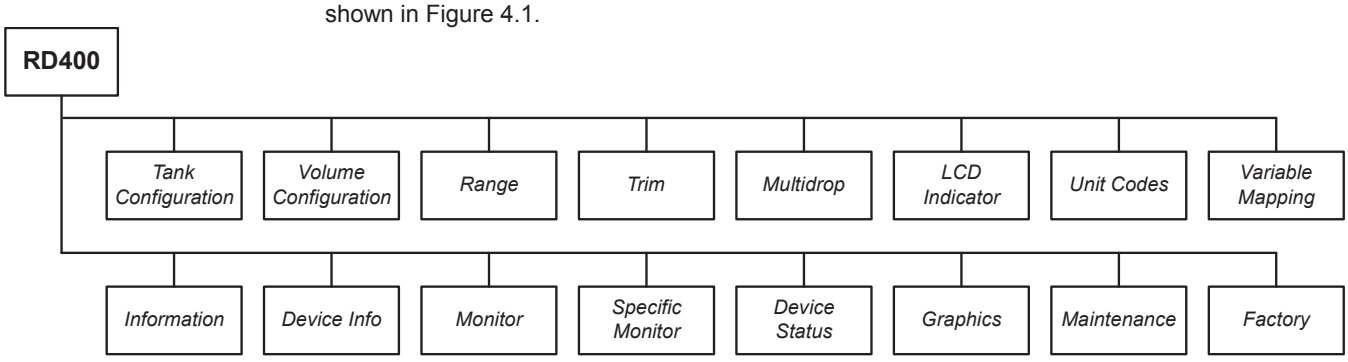


Figure 4.1 – RD400 Menu Tree Structure

Each of the various menus shown in Figure 4.1 will be explained in detail in the following sections along with their corresponding variables, functions and options. While all these parameters can be accessed and used via CONF401 or DDCON100 only a few main parameters must be set to have the **RD400** start reading accurate level measurements.

Tank Configuration

This menu contains all the parameters required to initially setup the **RD400** for the tank and installation conditions.

Probe Type - The **RD400** supports 5 different probe types: Coaxial, Single Flexible, Dual Flexible, Single Rigid and Double Rigid. Select the appropriate type from this drop down list. This will allow the **RD400** to configure itself internally for correct level measurement.

Distance Unit - This field shows the current unit of measure selected. All variables of distance are to be entered and displayed using this unit. To change the Distance Unit, see the Unit Codes menu section.

Reference Height - This is the distance from the bottom of the tank to the top of the tank. It is used frame of reference by the **RD400** to accurately determine the level.

Sensor Offset - This is the distance between the top of the tank and the beginning of the probe (the bottom of the threaded connection of the isolator) due to tank flanges, etc. This allows the **RD400** to be installed in positions other than directly flush with the top of the tank and remain accurate.

Probe Length - This is the measurement of the entire probe length. This distance helps calibrate the **RD400** and ensures the entire line will be scanned.

Probe Angle - The **RD400** can be installed at angles other than vertical. This is advantageous in applications where the inflow of product or internal tank perturbantions do not allow for complete vertical installations. The angle measurement must be entered with a reference of perfect vertical. All angles are to be entered in degrees and as positive values. If the probe is completely vertical, the probe angle must be 0°.

Lower Blocking Distance - The **RD400** can be configured to ignore a portion of the bottom of the probe. This section is referred to as the Lower Blocking Distance. Level measurements in this specified range will be ignored. This can be advantageous in various applications where, for instance, internal tank parts in the lower portion of the tank may interfere with accurate readings. If no Lower Blocking Distance is desired, this value must be 0.

Upper Blocking Distance - The **RD400** can be configured to ignore a portion of the top of the probe. This section is referred to as the Upper Blocking Distance. Level measurements in this specified range will be ignored. This can be advantageous in various applications where, for instance, internal tank parts in the upper portion of the tank may interfere with accurate readings. If no Upper Blocking Distance is desired, this value must be 0.

Upper Dielectric Constant - In applications where the gas above the measured product is of a type other than air, the dielectric constant of the material should be specified. If that, **RD400** can determine the product level and reduces errant readings. Note: This parameter is not the dielectric constant of the measured material.

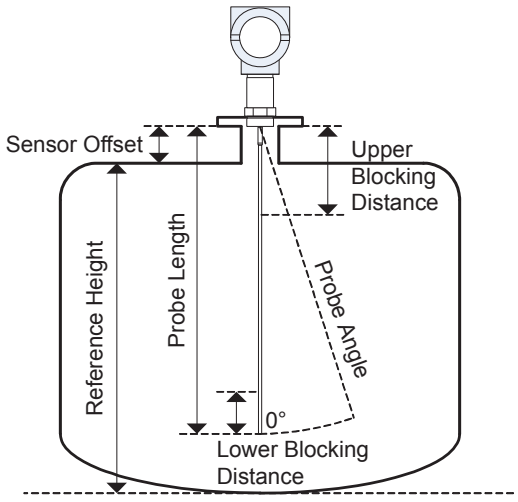


Figure 4.2 – RD400 Tank Parameters Diagram

Volume Configuration

The **RD400** can calculate the volume of many standard tank shapes as well as up to 10-point customized strap tables for irregularly shaped tanks. Refer to Figure 4.3 for a visual representation of the various tanks explained below. Figure 4.4 shows an example of a customized strap table for an irregularly shaped tank.

Tank Type - The **RD400** can calculate the volume of the following tank shapes:
- Vertical Cylinder
- Horizontal Cylinder
- Vertical Bullet
- Horizontal Bullet
- Sphere
- Strap Table (Custom linearized table of up to 10 points)

To accurately calculate the volume, select the tank type the **RD400** is installed into and input the Tank Height and Tank Diameter variables (described below). For a sphere tank, only the diameter is required. For irregularly shaped tanks, the **RD400** offers a 10-point strap table. Selecting Strap Table from the Tank Type list allows the user to enter up to 10 points in a customized strap table. By entering known level measurements along with their corresponding volume, the **RD400** can effectively extrapolate the volume from any measured level within range. To accomplish this, the number of table entries must be selected (1-10) from the drop down list and the level and volume at each point must me entered.

Tank Height - Enter the height of the standard shaped tank into this field. Units are displayed as set in the Unit Codes menu section. Note: This variable is used for standard type tanks only (except Sphere). Custom strap tables must be entered in the volume table.

Tank Diameter - Enter the diameter of the standard shaped tank into this field. Units are displayed as set in the Unit Codes menu section. Note: This variable is used for standard type tanks only. Custom strap tables must be entered in the volume table.

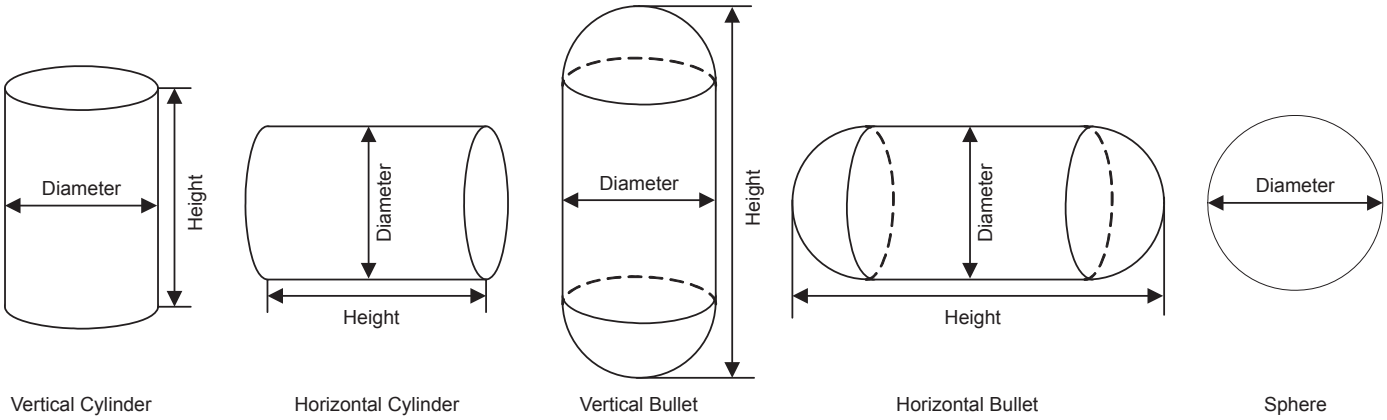


Figure 4.3 – RD400 Standard Tank Types

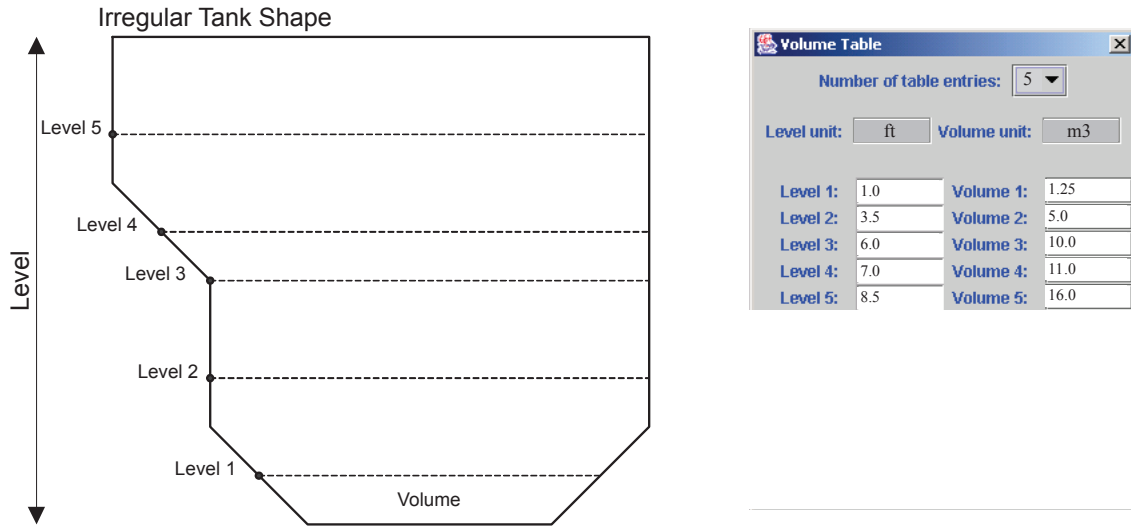


Figure 4.4 – Example Irregular Tank and Custom Strap Table

Range

The Range menu contains the parameters relating to the 4-20 mA output signal of the **RD400**. Here the transmitter can be re-ranged and have the damping adjusted. To re-range a transmitter is to change the primary variable (PV) values related to the 4 mA and 20 mA output points. Upper and lower range values can be set here digitally or via applied references. The primary variable (PV) unit can also be changed here. It will change the unit of measure for all applicable variables.

URL - The Upper Range Limit is the maximum value of the PV the **RD400** can currently measure. This parameter is read only and is based upon the variable mapped as the primary variable and the Tank Configuration parameters.

URV - The Upper Range Value is the PV measurement that corresponds with an output of 20mA. This value can be set anywhere between the URL and the LRV taking into the account the minimum span.

LRV - The Lower Range Value is the PV measurement that corresponds with an output of 4mA. This value can be set anywhere between the LRL and the URV considering the minimum span.

LRL - The Lower Range Limit is the minimum PV the **RD400** can currently measure. This parameter is read only and is based upon the Tank Configuration parameters.

Minimum Span - This read only parameter is the minimum span that can be between the URV and LRV. The difference between the URV and LRV must always be greater than the minimum span.

Damping - This parameter controls the electronic damping level of the **RD400**. Damping allows an averaged value over a specified period to be output as the primary variable. This is desired for applications in which quick unwanted pulses in the level may occur due to turbulence or other reasons. The damping can be adjusted from 0 to 32 seconds.

PV Unit - This parameter displays the current primary variable unit. This unit can be changed by adjusting the Unit parameter in the Unit Codes menu.

Unit Family - This parameter allows selection of various unit families. The only valid unit families for the primary variable are Length, Volume and Temperature, depending on the primary variable selection in the Variable Mapping menu.

Unit - This parameter allows variable units changing. The available variable units of length, volume and temperature are:

- Length - ft, m, in, cm, mm
- Volume - gal, l, Gal, m3, bbl, yd3, ft3, in3
- Temperature - °C, °F, °R, Kelvin

Re-ranging can be done in two ways by configuration software: digitally via keyboard, or via applied reference.

The **RD400** may be adjusted to give 4 mA and 20 mA corresponding to given level measurements. The **RD400** has been calibrated from the factory, therefore the zero and span input does not have to be generated when the **RD400** is re-ranged. To re-range digitally via keyboard simply enter the URV and LRV and send them to the **RD400**. The 4 mA and 20 mA points will be adjusted accordingly.

To re-range the more conventional way, using applied reference, simply follow these steps.

1) Apply the input level to the **RD400** to which you want to set the 4mA point.
2) Select the “Lo-” button of the Applied Reference section.
3) Apply the input level to the **RD400** to which you want to set the 20mA point.
4) Select the “Hi+” button of the Applied Reference section.

Observe that both the URV and LRV are completely independent. Adjustment of one does not affect the other. Although, the following rules must be observed:

a) Both LRV and URV should not be inferior than the lower range value, or greater than the upper range value.
b) The span, URV-LRV, must be greater than the minimum span.
Although the 4-20 mA setpoints will operate properly within these applied settings, the transmitter reading, in Engineering Units, may indicate a slightly different value. The trim parameters can be used to match the transmitter reading in Engineering Units to your plant standard, eliminating any eventual differences. See the Trim menu section for more details.

Trim

The Trim menu contains methods for trimming the current, distance and temperature. These trimming operations are only needed when the calibrated current, level or temperature indicated by the **RD400** are different from that which is applied. All **RD400** are calibrated from the factory; however environmental conditions or differences in standards can make a trim necessary. After selecting a trim operation, the configuration software will go through a series of user prompted steps to complete the trim.

Current Trim - When the **RD400** generates a 0% signal, the D/A converter and associated electronics will provide a 4 mA output. If the signal is 100%, the output will be 20 mA. In some cases there may be differences between Smar current standards and your plant standard. In these cases, the current trim shall be used, with a precision ammeter as a measurement reference. Two current trim types are available, 4 mA and 20 mA.

The 4 mA trim is used to adjust the output current value corresponding to 0% of the measurement, while the 20 mA trim is used to adjust the output current value corresponding to 100% of the measurement.

The Current Trim shall be carried out per the following procedure:
1) Connect the transmitter to the precision ammeter.
2) Select one of the trim types.
3) Wait a moment for the current to stabilize and input the current readout of the precision ammeter at the prompt.
4) Repeat until measured and read values are identical.

NOTE
The transmitter presents a resolution that makes it possible to control currents as low as microamperes. Therefore, when informing the current readout to the transmitter, it is recommended that the data input consider values up to tenths of a microampere.

Distance Trim - In rare cases, after the **RD400** has been setup and all tank configuration parameters have been set, the indicated level may be somewhat off your plant reference measurements. The distance trim allows the end user to change the level measurement reading to an applied, known and accurate level measurement.
The Distance Trim shall be carried out per the following procedure:
1) Apply the known level measurement to the **RD400**.
2) Select the Distance Trim.
3) Input the known reference level value at the prompt.

Temperature Trim - This trim allows for the integrated ambient temperature sensor of the **RD400** to be adjusted. This trim will rarely be required.

The Temperature Trim shall be carried out per the following procedure:
1) Measure the ambient temperature with a precision digital thermometer as close to the transmitter as possible in a temperature stable environment.
2) Select the Temperature Trim.
3) Input the temperature readout of the precision thermometer at the prompt.

Multidrop

The **RD400** supports multidrop operation. As per the HART specification, multidrop instruments can have an address value between 1 and 15. The device's anolog output in this case is fixed to 4 mA, and it communicates digitally only. Address 0 is reserved for non multidrop operation. When the **RD400** is set to address 0, the 4-20 mA analog output will correspond to the primary variable as configured. The **RD400** can be placed into multidrop operation by selecting an address value for the Polling Address variable in the Multidrop menu and then selecting the "Change Polling Address" button. Each device on the same HART network must have a unique address.

Polling Address - This parameter allows the selection of the **RD400** polling address. Any address from 0 to 15 can be chosen and then sent to the device by selecting the "Change Polling Address" button. Note: All multidrop addresses (1-15) will fix the output current of the **RD400** to 4 mA, only address 0 will allow the **RD400** to output a variable 4-20 mA signal in proportion with the primary variable.

LCD Indicator

RD400 LCD indicator can be used to display many different parameters. In addition, the indicator can be set to toggle between displaying two different variables, switching every few seconds.

Display 1st - This parameter allows the selection of the first variable you wish to display on the LCD indicator. The following variables can be selected:
- Level - Measured product level
- Volume - Measured product volume
- Length - Distance from top of probe to the measured product level
- Temperature - Ambient temperature reading from internal sensor
- Output (mA) - Current output in mA
- Output % - Output in percentage of range

Display 2nd - This parameter allows the selection of the second variable you wish to display on the LCD indicator. The list of available variables is identical to Display 1st, seen above. There is also the "None" option, where no variable will be displayed.

Unit Codes

This menu contains the parameters for configuring the three primary unit types used by the **RD400**: distance, volume and temperature. Changing the units here will change all the corresponding variables units within the **RD400**.

Distance Unit - This parameter allows the selection of the unit of length that all corresponding **RD400** variables and calculations will be in. The following units are available: ft, m, in, cm, mm.

Volume Unit - This parameter allows the selection of the unit of volume that all corresponding **RD400** variables and calculations will be in. The following units are available: gal, l, Gal, m3, bbl, yd3, ft3, in3.
Temperature Unit - This parameter allows the selection of the unit of temperature that all corresponding **RD400** variables and calculations will be in. The following units are available: °C, °F, °R, Kelvin.

Variable Mapping

The variables that are mapped to the primary, secondary, tertiary and quaternary variables of the **RD400** can be selected via this menu. The variables available for mapping are listed below.

Primary Variable - The primary variable of the **RD400** can be selected from 4 different variables: Length, Level, Volume or Temperature. The variable mapped to the primary variable will be reflected in the 4-20mA output of the **RD400**. When changing the primary variable, be sure to make the appropriate changes in the Range menu to adjust the 4-20mA output to the new variable.

Secondary Variable - The secondary variable of the **RD400** can be selected from 6 different variables: Output (mA), Output % (range), Length, Level, Volume or Temperature.

Tertiary Variable - The tertiary variable of the **RD400** can be selected from 6 different variables: Output (mA), Output % (range), Length, Level, Volume or Temperature.

Quaternary Variable - The quaternary variable of the **RD400** can be selected from 6 different variables: Output (mA), Output % (range), Length, Level, Volume or Temperature.

Information

RD400 generic HART information are accessed and configured from this menu. It includes the Tag, Descriptor, Message, Date and Unique ID of the **RD400**. For more information on each, see their descriptions below.

Tag - This eight character alphanumeric field is used as identification on the HART network per the HART specification. It can be viewed, edited and sent to the **RD400**.

Descriptor - This 16 character alphanumeric field is used as additional identification of the transmitter on the HART network. This field is generally used to give a brief description of the location or service of the instrument. It can be viewed, edited and sent to the **RD400**.

Message - This 32 character alphanumeric field is for any additional device comments, such as the name of the person who last calibrated the instrument, or any special instructions. It can be viewed, edited and sent to the **RD400**.

Date - The date field may be used to identify an important date, such as last calibration, next calibration or date of installation. This field is to be input in a month, day, year format (mm/dd/yyyy).

Unique ID - This read only field contains the unique long address of the transmitter.

Device Info

The read only device information such as manufacturer, device type and various hardware/software revisions can be viewed from this menu. The parameters included are discussed below.

Manufacturer - The manufacturer of the transmitter can be viewed here. This field will always be “Smar”.

Device Type - The device type or model number can be viewed here. This will always be read as “**RD400**”.

Serial Number - The unique device serial number of **RD400** can be viewed here. This serial number must be referenced to Smar for technical support or warranty issues.

Main Board Serial Number - The unique serial number of the main electronics board of the **RD400** can be viewed here.

Software Version Number - The **RD400** internal software version can be viewed here.
HART Universal Code - This value represents the version of the HART communication specification supported.

Specific Revision - This value is the product revision number of the **RD400**. This number must be referenced in relation to the device description files of the **RD400**.

Hardware Revision - The hardware revision number of the **RD400** can be viewed here.

Physical Signal Code - The physical communication type of the **RD400** can be viewed here. This field should always read as “Bell 202 Voltage”.

Monitor

RD400 variables can be monitored in real-time on this menu. The loop current, percentage range (output %) and the primary, secondary, tertiary and quaternary variables can be monitored here. The variables mapped to the primary, secondary, tertiary and quaternary variables can be set in the Variable Mapping menu. The units related to these variables will be displayed as set in the Unit Codes menu. See below for more information on setting up these variables.

Loop Current - Displays the real-time value of the output current, as specified in the Range menu.

Percentage Range - Displays the real-time output percentage (0-100%) of the range, as specified in the Range menu.

Primary Variable - Displays the real-time value of the primary variable, as specified in the Variable Mapping menu. See section 4.1.8 for more details.

Secondary Variable - Displays the real-time value of the secondary variable, as specified in the Variable Mapping menu. See section 4.1.8 for more details.

Tertiary Variable - Displays the real-time value of the tertiary variable, as specified in the Variable Mapping menu. See section 4.1.8 for more details.

Quaternary Variable - Displays the real-time value of the quaternary variable, as specified in the Variable Mapping menu. See section 4.1.8 for more details.

Specific Monitor

The specific monitor menu allows the monitoring of any **RD400** dynamic variable, including those not mapped to the primary, secondary, tertiary or quaternary variables. Up to four variables can be selected at once and monitored in real-time. Selecting a variable is as simple as choosing it from the drop down menu. The following variables can be selected:

- *Level* - Measured product level
- *Volume* - Measured product volume
- *Length* - Distance from the top of the probe to the measured product level
- *Temperature* - Ambient temperature reading from internal sensor
- *Output (mA)* - Current output in mA
- *Output %* - Output in percentage of range

Device Status

The **RD400** has many device status indicators which can be monitored via the Device Status menu. These indicators alert to certain conditions within the **RD400**. Each device status variable will display a true or false condition. A list of device status variables is below.

- Primary Variable Out of Limits
- Non-Primary Variable Out of Limits
- Primary Variable Analog Output Saturated
- Primary Variable Analog Output Fixed
- Cold Start
- Configuration Changed
- Field Device Malfunction

Graphics

The **RD400** variables can be trended graphically over time via this menu. Up to four variables can be trended simultaneously and the resulting data can be exported into a comma delineated file for offline analysis. The graphics menu is available only in the CONF401 configuration software and is not supported in other configuration packages. The variables that can be trended are as follows:

- Level - Measured product level
- Volume - Measured product volume
- Length - Distance from top of probe to the measured product level
- Temperature - Ambient temperature reading from internal sensor
- Output (mA) - Current output in mA
- Output % - Output in percentage of range

For more information about graphic capabilities of CONF401 and DDCON100, consult their manuals.

Maintenance

This menu contains functions related to the maintenance of the **RD400**. Functions such as device resets, loop tests, and password setting can be done here. Performing these functions is as simple as selecting the function and following the prompts. A list of available maintenance functions is below.

Device Reset - Selecting this function will reset the device. Be sure it is safe to reset the device before using this function.

Loop Test - This allows the user to output any desired value between 3.6 and 21 mA regardless of input. Take caution when using this feature and ensure the **RD400** is not controlling a critical process.

Passwords - This function sets the passwords and access level of the **RD400**.

Ordering Code - Contains the factory ordering code of the **RD400**. This ordering code specifies the particular configuration of the **RD400** and can be used to re-ordering purposes.

Factory

The factory menu is for manufacturing purposes only. This menu is password protected and to be used only by authorized Smar personnel.

Monitoring & Configuration

RD400 can be monitored and configured in several different ways. Levels can be monitored locally using the included LCD display, or remotely via a HART configurator. Configuration can be done locally via the included magnetic tool or through a HART compliant configuration tool such as Smar Research CONF401 and DDCON100 configurators for PC or HPC301 and HPC401 configurators for Palm. These software/hardware packages will allow access to all the **RD400** device parameters for monitoring and configuration. For more information see the configuration section of this manual. For more information on any of these Smar Research products, please visit our web site at www.smarresearch.com.

CONFIGURATION USING LOCAL ADJUSTMENT

When provided with a display, the **RD400** may be configured locally using a magnetic tool. This is a quick and effective way to configure the basic parameters of **RD400** and have it running in a short amount of time. In very basic applications, the local adjust eliminates the need for a configuration tool. However, to get the most out of the **RD400** and for complex applications, the CONF401, DDCON100 and HPC401 configuration tools are recommended.

RD400 can be configured to enable or disable the local adjustment mode. When disabled, the magnetic tool input will be ignored and no changes can be made locally. A write protect mode is also featured which will enable the **RD400** to be fully write protected, disallowing any changes locally or remotely via a software tool. These features allow for flexibility in the level of protection of the **RD400**. By default, the Write Protect jumper is set to disabled. The default Local Adjustment jumper setting is enabled for **RD400** equipped with an LCD display and disabled for those not equipped with an LCD display. Table below shows the location and settings of these jumpers.

JUMPERS	WRITE PROTECT	LOCAL ADJUSTMENT
	Disabled	Disabled
	Disabled	***Enabled***
	***Enabled***	Disabled
	***Enabled***	***Enabled***

Table 5.1 – Main Board Jumper Settings

To configure **RD400** locally, two holes are located underneath identification plate of the housing. Loosen the identification nameplate screw and slide the nameplate to uncover the holes. They are marked with “Z” and “S” which for the remainder of this manual will be identified as (Z) and (S) respectively. Figure 5.1 shows how to correctly insert the magnetic tool into the local adjust switches and the corresponding action performed by the magnetic tool when inserted into (Z) and (S).

Browsing the functions and adjusting their values works as follows:

1) Inserting the handle of the magnetic tool in (Z). **RD400** will change from normal measurement state to the local adjust configuration state. The **RD400** software automatically starts to display the available options in a cyclical routine.

2) In order to access a specific option, browse through the options list until the desired option is displayed and move the magnetic tool from (Z) to (S). This will enter into the specific option.

3) The various options have different behaviors. Refer to the following section for detailed information on how to adjust the parameters of each option.

SWITCH	ACTION
Z	Moves between options of current menu.
S	Activates the selected functions.

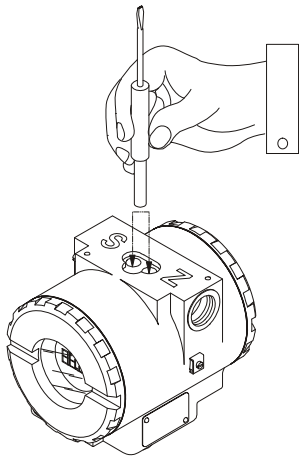


Figure 5.1 – Local Adjustment Switches

Local Adjust Programming Menu

The local adjust feature is based upon a series of cyclical functions, each of which can be configured. By placing the magnetic tool in (Z), it is possible to browse through these functions. Each function will be shown in series, changing approximately every 3 seconds. By moving the magnetic tool into (S), the function currently shown will be chosen and the details of the function will be displayed. Figure below shows the **RD400** available functions and the order in which they are displayed.

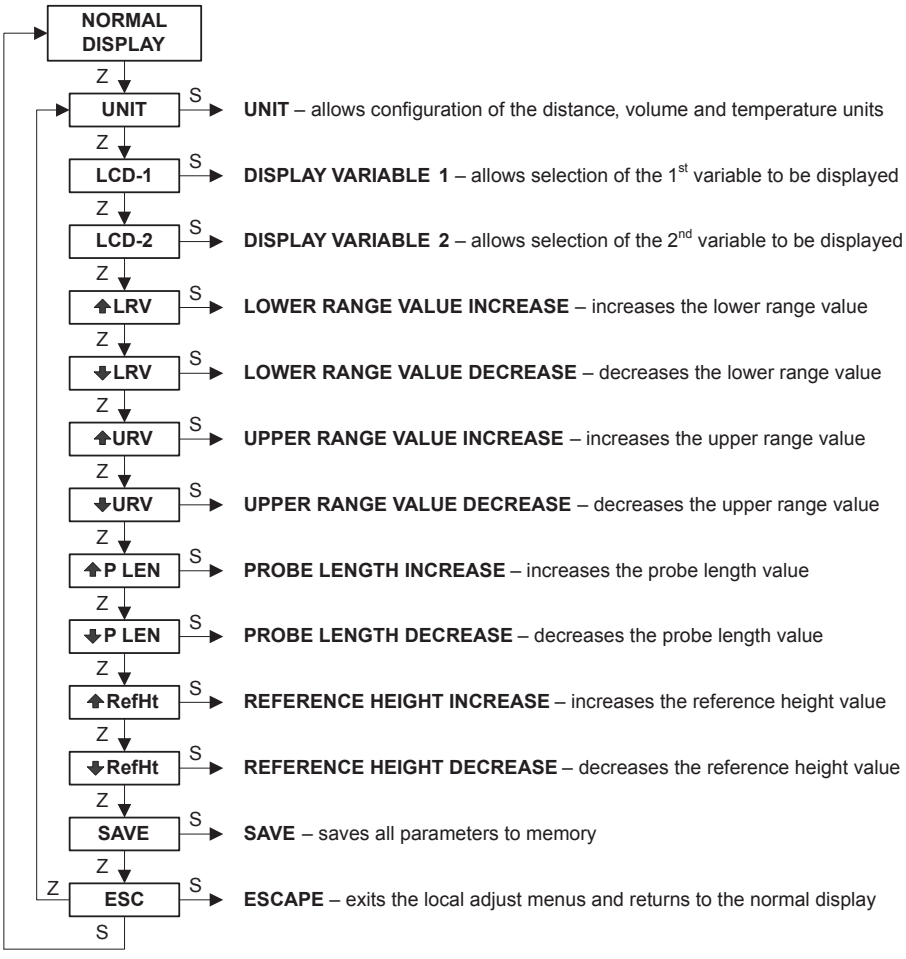


Figure 5.2 – Local Adjust Programming Menu Structure

Unit (UNIT)

The Unit menu allows the selection of the engineering units used for all **RD400** distance, volume and temperature calculations. All variables in these categories will be displayed in the selected units. Figure below shows the unit menu branches and available options.

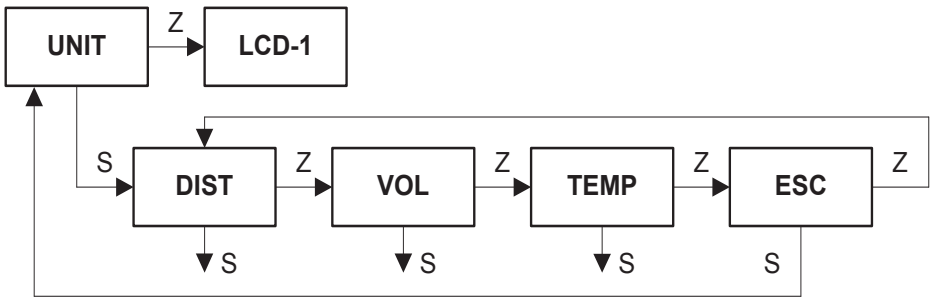
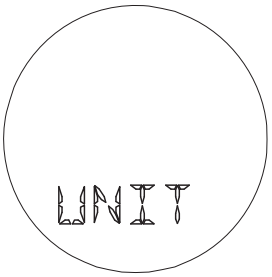
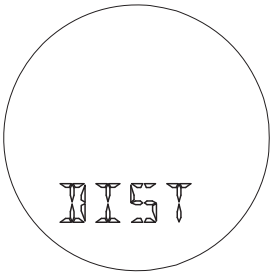


Figure 5.3 – UNIT menu



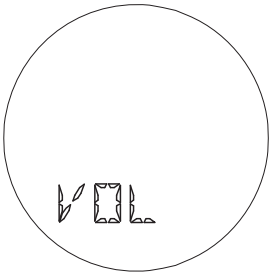
Z: Moves to the Display Variable 1 (LCD-1) function.

S: Enters the UNIT branch, enabling selection of the unit family. After selecting (S), the available unit family menus for distance (DIST), volume (VOL) and temperature (TEMP) can be browsed cyclically by selecting (Z). When the desired unit family menu is displayed, select (S) again to enter the menu. The escape (ESC) option will return to the main menu without registering any changes.



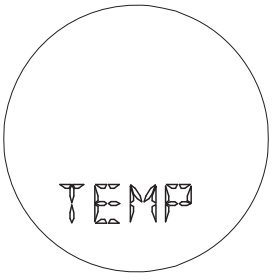
Z: Moves to the Volume Units (VOL) function.

S: Enables selection of the engineering unit for all **RD400** distance calculations and measurements. After selecting (S), the available units can be browsed cyclically by selecting (Z). When the desired unit is displayed, select (S) again to enable the unit. The available **RD400** distance units are shown in the Table 5.2.



Z: Moves to the Temperature Units (TEMP) function.

S: Enables selection of the engineering unit for all **RD400** volume calculations and measurements. After selecting (S), the available units can be browsed cyclically by selecting (Z). When the desired unit is displayed, select (S) again to enable the unit. The available **RD400** volume units in the **RD400** are shown in the Table 5.2.



Z: Moves to the Escape (ESC) function.

S: Enables selection of the engineering unit for all **RD400** temperature calculations and measurements. After selecting (S), the available units can be browsed cyclically by selecting (Z). When the desired unit is displayed, select (S) again to enable the unit. The available **RD400** temperature units in the **RD400** are shown in the Table 5.2.

DIST UNITS	DESCRIPTION
ft	Feet
m	Meters
in	Inches
cm	Centimeters
mm	Millimeters

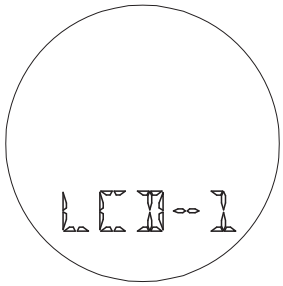
VOL UNITS	DESCRIPTION
gal	Gallons (US)
l	Liters
Gal	Gallons (British Imperial)
m3	Cubic Meters
bbl	Barrels
yd3	Cubic Yards
ft3	Cubic Feet
in3	Cubic Inches

TEMP UNITS	DESCRIPTION
°C	Degrees Celsius
°F	Degrees Fahrenheit
°R	Degrees Rankine
°K	Kelvin

Table 5.2 – Available Distance Engineering Units

Display Variable 1 (LCD-1)

When equipped with the LCD indicator, **RD400** can alternately display up to 2 different variables. The Display Variable 1 function allows the selection of the first **RD400** variable to be displayed on the LCD indicator. The available display variables are indicated in figure below.



Z: Moves to the Display Variable 2 (LCD-2) function.

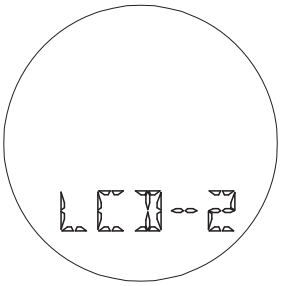
S: Enables selection of the first LCD display variable. After selecting (S), the available variables can be browsed cyclically by selecting (Z). When the desired variable is displayed, select (S) again to set it for display on the LCD indicator. The available LCD-1 display variables are shown below.

DISPLAY VARIABLES	DESCRIPTION
L1 mA	Output Current (mA)
L1 %	Output % of Range
L1 LEN	Distance from top of probe to measured product level
L1 LVL	Level of measured product
L1 VOL	Volume of measured product
L1 TMP	Ambient Temperature

Table 5.3 – Available LCD-1 Display Variables

Display Variable 2 (LCD-2)

When equipped with the LCD indicator, **RD400** can alternately display up to 2 different variables. The Display Variable 2 function allows the selection of the second **RD400** variable to be displayed on the LCD indicator. The available display variables are indicated in figure below.



Z: Moves to the Lower Range Value Increase (▲LRV) function.

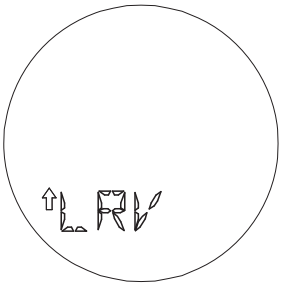
S: Enables selection of the second LCD display variable. After selecting (S), the available variables can be browsed cyclically by selecting (Z). When the desired variable is displayed, select (S) again to set it for display on the LCD indicator. The available LCD-2 display variables are shown below.

DISPLAY VARIABLES	DESCRIPTION
L2 mA	Output Current (mA)
L2 %	Output % of Range
L2 LEN	Distance from top of probe to measured product level
L2 LVL	Level of measured product
L2 VOL	Volume of measured product
L2 TMP	Ambient Temperature
NONE	No variable will be displayed for LCD-2

Table 5.4 – Available LCD-2 Display Variables

Lower Range Value Increase (▲LRV)

This function allows the Lower Range Value (LRV) to be increased. The LRV will be displayed in the numeric section of the display.

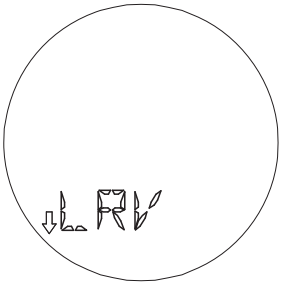


Z: Moves to the Lower Range Value Decrease (▼LRV) function.

S: Increases the LRV until the magnetic tool is removed or the maximum LRV is reached.

Lower Range Value Decrease (▼LRV)

This function allows the Lower Range Value (LRV) to be decreased. The LRV will be displayed in the numeric section of the display.

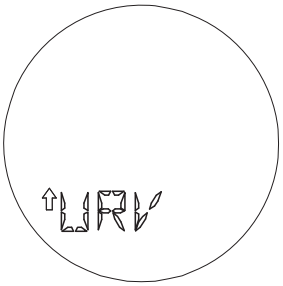


Z: Moves to the Upper Range Value Increase (▲URV) function.

S: Decreases the LRV until the magnetic tool is removed or the minimum LRV is reached.

Upper Range Value Increase (▲URV)

This function allows the Upper Range Value (URV) to be increased. The URV will be displayed in the numeric section of the display.

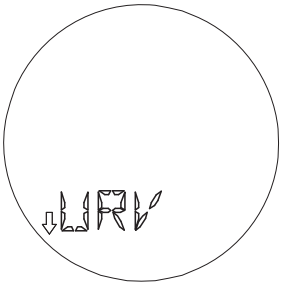


Z: Moves to the Upper Range Value Decrease (▼URV) function.

S: Increases the URV until the magnetic tool is removed or the maximum URV is reached.

Upper Range Value Decrease (▼URV)

This function allows the Upper Range Value (URV) to be decreased. The URV will be displayed in the numeric section of the display.

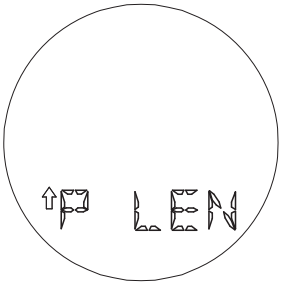


Z: Moves to the Probe Length Increase (▲P LEN) function.

S: Decreases the URV until the magnetic tool is removed or the minimum URV is reached.

Probe Length Increase (▲P LEN)

This function allows the Probe Length value to be increased. The Probe Length will be displayed in the numeric section of the display.

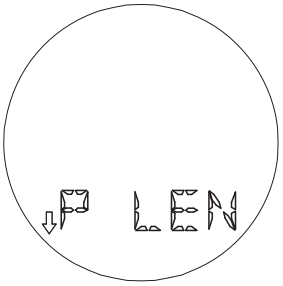


Z: Moves to the Probe Length Decrease (▼P LEN) function.

S: Increases the Probe Length until the magnetic tool is removed or the maximum probe length is reached.

Probe Length Decrease (▼P LEN)

This function allows the Probe Length value to be decreased. The Probe Length will be displayed in the numeric section of the display.



Z: Moves to the Reference Height Increase (▲RefHt) function.

S: Decreases the Probe Length until the magnetic tool is removed or the minimum probe length is reached.

Reference Height Increase (▲RefHt)

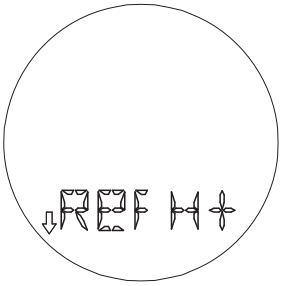
This function allows the Reference Height value to be increased. The Reference Height will be displayed in the numeric section of the display.

Z: Moves to the Reference Height Decrease (▼RefHt) function.

S: Increases the Reference Height until the magnetic tool is removed or the maximum reference height is reached.

Reference Height Decrease (▼RefHt)

This function allows the Reference Height value to be decreased. The Reference Height will be displayed in the numeric section of the display.



Z: Moves to the Save (SAVE) function.

S: Decreases the Reference Height until the magnetic tool is removed or the minimum reference height is reached.

Save (SAVE)

This function allows all previous changes done in the local adjust mode to be saved to solid state memory. Please note: The changes made to the various local adjustment functions will be implemented in the **RD400** immediately. However, the changes will not be saved permanently (in the event of a loss of power) unless the save function is activated after you have made the changes.

Z: Moves to the Escape (ESC) function.

S: Saves the current values for UNIT, LCD-1, LCD-2, LRV, URV, P LEN and RefHt to EEPROM.

Escape (ESC)

This function allows the Probe Length value to be decreased. The Probe Length will be displayed in the numeric section of the display.

Z: Moves back to the Unit (UNIT) function.

S: Exits from the local adjust menu and returns the **RD400** back to the normal display mode.

Section 6

TROUBLESHOOTING & MAINTENANCE

Diagnostics

The **RD400** level transmitters are extensively tested and inspected before delivery to the end user. In general, it is recommended that the end user do not try to repair printed circuit boards. Instead he should contact Smar for repair or have spare circuit boards, which may be ordered from Smar whenever necessary.

If any problem related to transmitter's ouput is noticed, there must be an investigation via HART communication software, such as the Smar HPC401 Palm configuration software or the CONF401 PC based configuration software. These software packages can be used to diagnose any errors as long as power is supplied to the transmitter and the communication and processing unit of the **RD400** are operating normally. The communicator should be connected to the transmitter in accordance with the wiring diagram shown in figures in Section 1 of this document.

When communicating using the CONF401, HPC401 or DDCON100 configurators, the user will be informed of any problem found by the transmitters self diagnostics. The messages are always alternated with the information on the top line. The table below lists the error messages.

DIAGNOSTIC MESSAGES	POTENTIAL SOURCE OF PROBLEM
PARITY ERROR OVERRUN ERROR CHECK SUM ERROR FRAMING ERROR	• The line resistance is not in accordance with load curve • Excessive noise or ripple in the line • Low level signal • Interface damaged • Power supply with inadequate voltage
NO RESPONSE	• The line resistance is not in accordance with load curve • Transmitter not powered • Interface not connected or damaged • Repeated bus address • Transmitter polarity is reversed • Inadequate power supply voltage
LINE BUSY	• Other device using the line
CMD NOT IMPLEMENTED	• Software version not compatible between communicator and transmitter • Communicator is trying to carry out a **RD400** specific command in a transmitter from another manufacturer
TRANSMITTER BUSY	• Transmitter carrying out an important task, e.g., local adjustment
COLD START	• Start-up or Reset due to power supply failure
OUTPUT FIXED	• Output in Constant Mode • Transmitter in Multi-drop mode
OUTPUT SATURATED	• Primary variable out of calibrated Span (Output current in 3.8 or 20.5 mA)
PV OUT OF LIMITS	• Signal out of operating limits • Sensor damaged • Incorrect configuration of transmitter • PV out of range limits
LOWER RANGE VALUE TOO HIGH	• Lower value exceeds 24% of the Upper Range Limit
LOWER RANGE VALUE TOO LOW	• Lower value exceeds 24% of the Lower Range Limit
UPPER RANGE VALUE TOO HIGH	• Upper value exceeds 24% of the Upper Range Limit
UPPER RANGE VALUE TOO LOW	• Upper value exceeds 24% of the Lower Range Limit
UPPER AND LOWER RANGE VALUES OUT OF LIMITS	• Lower and Upper values are out of the sensor range limits
SPAN TOO SMALL	• The difference between the Lower and Upper values is less than the minimum span
PASSED PARAMETER TOO LARGE	• Parameter above operating limits
PASSED PARAMETER TOO SMALL	• Parameter below operating limits
EXCESS CORRECTION	• The trim value entered exceeded the factory-characterized value by more than 10%

Table 6.1 – Diagnostic Message Table

Troubleshooting

Diagnostic: NO LOOP CURRENT

Probable Source of Trouble:

Transmitter Connections
- Check wiring polarity and continuity
- Check for shorts or ground loops
- Check if the power supply connector is connected to the main board

Power Supply
- Check power supply output: voltage at the terminals must be between 12 and 45 Vdc, with ripple less than 0.4V

Electronic Circuit Failure
- Check the main board for defect by replacing with a spare

Diagnostic: NO COMMUNICATION

Probable Source of Trouble:
Terminal Connection
- Check terminal interface connections
- Check if the interface is connected into the line between the transmitter and the load resistor

Transmitter Connections
- Check if connections are according to wiring diagram
- Check line resistance: must be equal to or greater than 250 Ohm between the transmitter and power supply

Power Supply
- Check power supply output: voltage at the terminals must be between 12 and 45 Vdc, with ripple less than 0.4V

Electronic Circuit Failure
Locate the failure by alternately replacing the transmitter circuit and the interface with spare parts

Transmitter Address
- Check if the transmitter address is the same as the address the configurator is polling

Diagnostic: CURRENT OF 21.0 mA OR 3.6 mA

Probable Source of Trouble:
Transmitter/Sensor Connection
- Check if the sensor is correctly connected to the **RD400** process fitting

Sensor
- Check sensor type; it should be in accordance with the **RD400** specifications
- Check if process is inside the range of the sensor
- Check the sensor operation; it shall be in accordance with its characteristics

NOTE
A 21.0 or 3.6 mA current indicates the transmitter is in burnout.

Diagnostic: INCORRECT OUTPUT

Probable Source of Trouble:
Transmitter Connections
- Check power supply voltage
- Check for intermittent short circuits, open circuits and grounding problems

Noise, Oscillation
- Adjust damping
- Check grounding of the transmitters housing
- Check the terminal block for moisture
- Check that the shielding of the wires between sensor/transmitter and transmitter/panel are grounded in one end

Sensor
- Check the sensor operation; it shall be within its characteristics
- Check sensor type; it should be in accordance with the **RD400** specifications

Electronic Circuit Failure
- Check the integrity of circuit replacing it with a spare

Calibration
- Check calibration of transmitter

Maintenance

The customer may wish to remove, replace or shorten the probe in some cases. This can be done simply by following the steps below (See Figure 6.1):

Replacing probe

1. Loosen the probe using 2 wrenches on the flat surfaces of the process connector and the probe connector. Use the wrench connected to the **RD400** side as a counterforce to unscrew the probe connection.

2. Once the connection is loosened, the remainder of the thread may be unscrewed by hand. Be sure to keep the double washer on the thread as you are unscrewing to avoid losing the part.

3. Screw in the new probe and hand tighten. Be sure that the double washer is on the thread between the **RD400** and the probe.

4. Tighten to the probe using 2 wrenches on the flat surfaces of the process connector and the probe connector. Use the wrench connected to the **RD400** side as a counterforce to tightly screw in the probe.

Shortening the cable/rod

1. If using a cable type probe, remove the Allen pins on the gravity weight and pull the cable out of the gravity weight.

2. Use an appropriate cutting tool to shorten the cable/rod to the desired length. (Note: In the case of a cable type probe, be sure to leave an extra 50 mm to be inserted into the gravity weight.)

3. If using a cable type probe, reinsert the end of the cable into the gravity weight and screw the Allen pins into the gravity weight to fasten to the cable.

4. Reconfigure the **RD400** with the new probe length and reset the minimum and maximum adjustments. See Section 4 Configuration for more information.

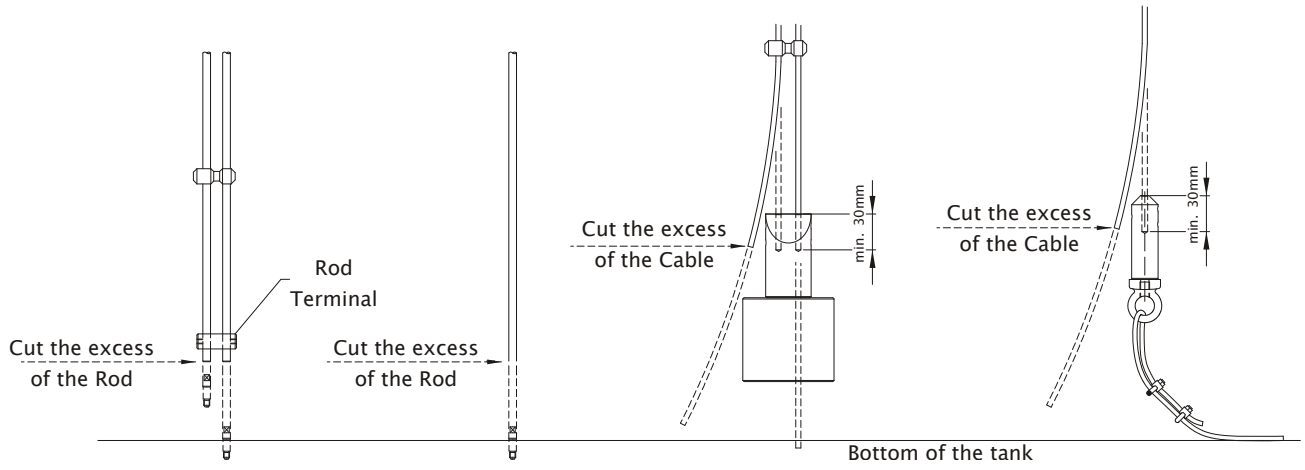


Figure 6.1 – Instruction to Cut the Probes

Sensor Threshold Level

The Threshold of **RD400** to a certain process depends exclusively of its dielectric constant and noises around the probe.

During the installation of the equipment the method describes below is used. The threshold value should not be changed but there are cases where the process eventually can change the concentration, its temperature to be modified in relation to conventional and the type of process can e changed.

Where that happens, the threshold should be readjusted therefore the **RD400** can present SEARCHING condition (shown in the display).

Through CONF401 or DDCON100 softwares do the online communication with the equipment and access the option “Maintenance” to adjust the threshold value of the **RD400** (*Sensor Threshold Level*).

In that option, access the “Derivative Voltage”. Thus, a window will be open with the options: PV Units or Digital Length. Opt for PV Units. See Figures 6.2 and 6.3 below.

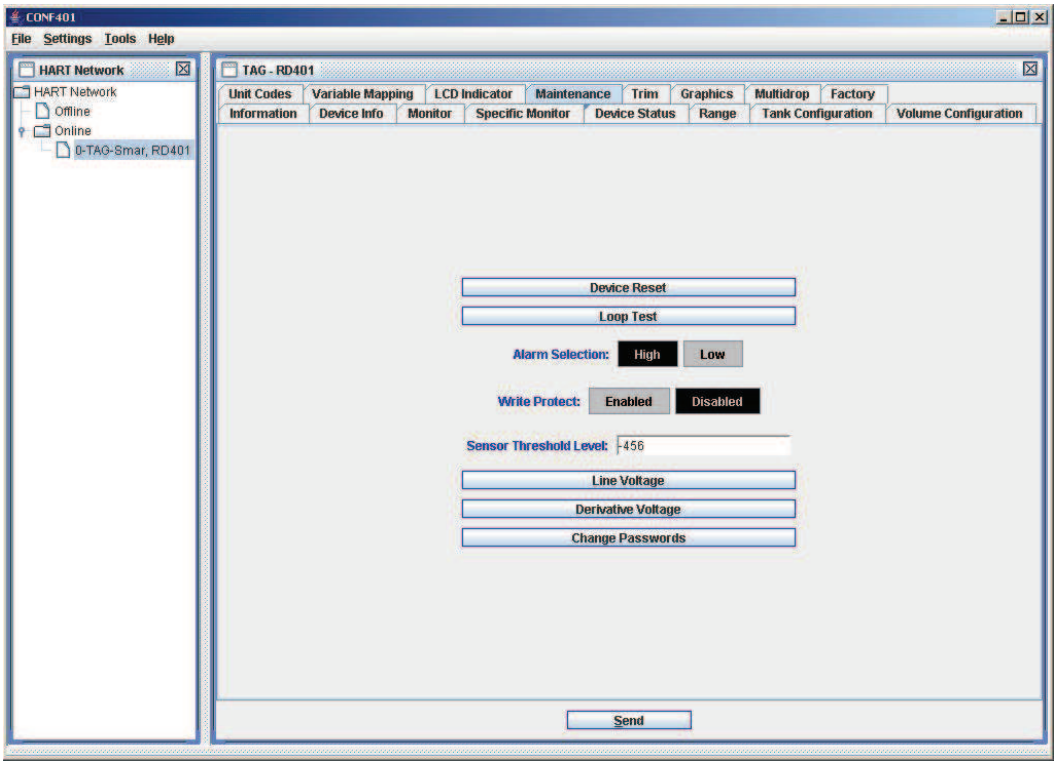


Figure 6.2 – Maintenance

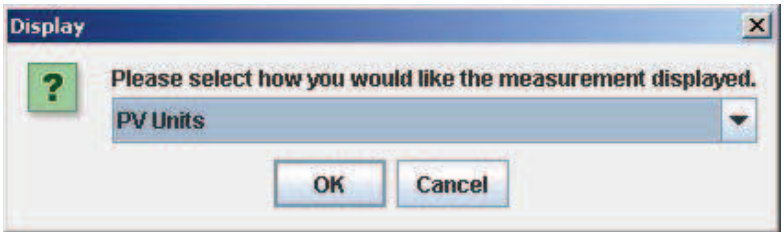


Figure 6.3 – Maintenance

Thus, the threshold graphic of the **RD400** can be visualized. Choose the option **"**Settings" to define the graphic scale. For example, if the probe's length is 2m, a larger scale or equal to 2m in **X Max Value (mm)** field is recommended. Click in Done and, to start the graphic, choose the option "Start". See Figures 6.4 and 6.5.

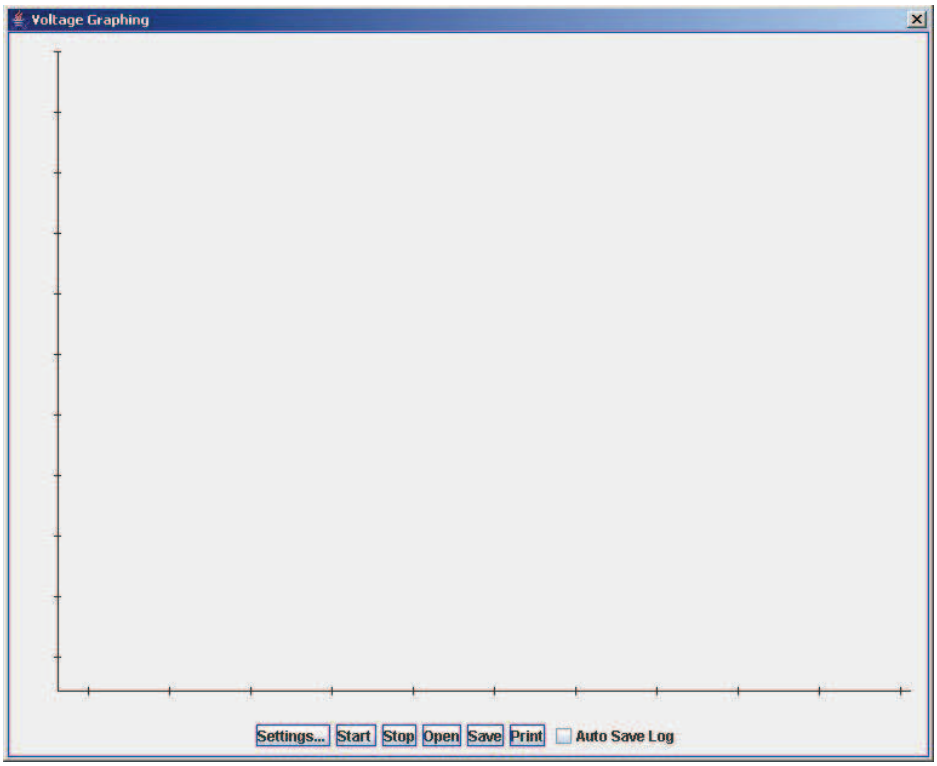


Figure 6.4 – Maintenance – Derivative Voltage

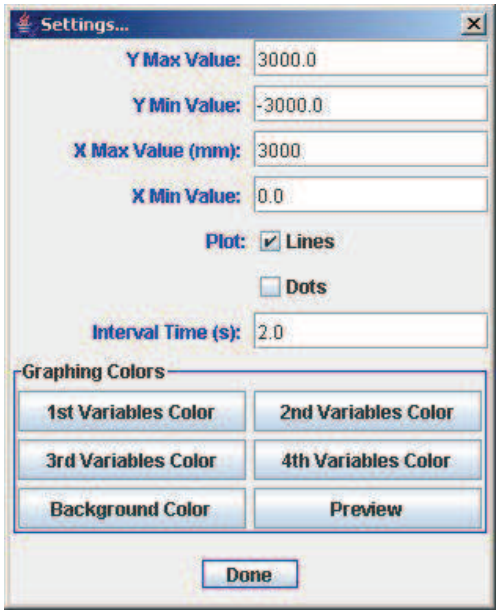


Figure 6.5 – Maintenance – Derivative Voltage – Settings

Concluded the graphic, the **RD400** refection signal should be verified and the threshold value should be defined, superposing the horizontal bar on the negative cycle of the reflection, as show the Figure 6.6 below. Attention: the bar should be only put upon in reflection signal.

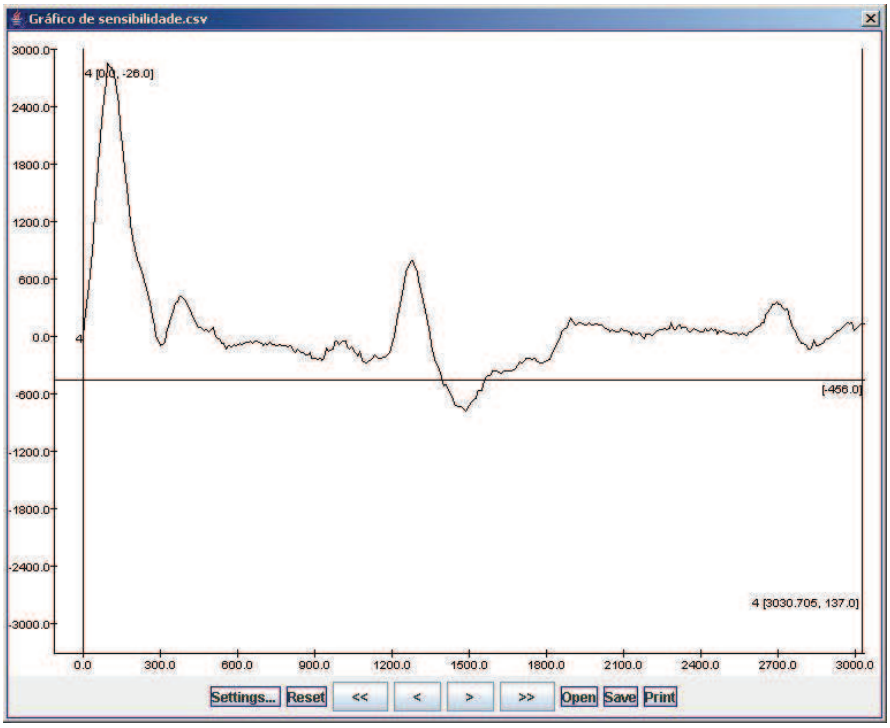


Figure 6.6 – Threshold Graphic
(Maintenance – Derivative Voltage – Settings – Start)

Observe in the graphic the value indicated in the horizontal bar, and configure this value on “Sensor Threshold Level” field. In this example the value is -456.

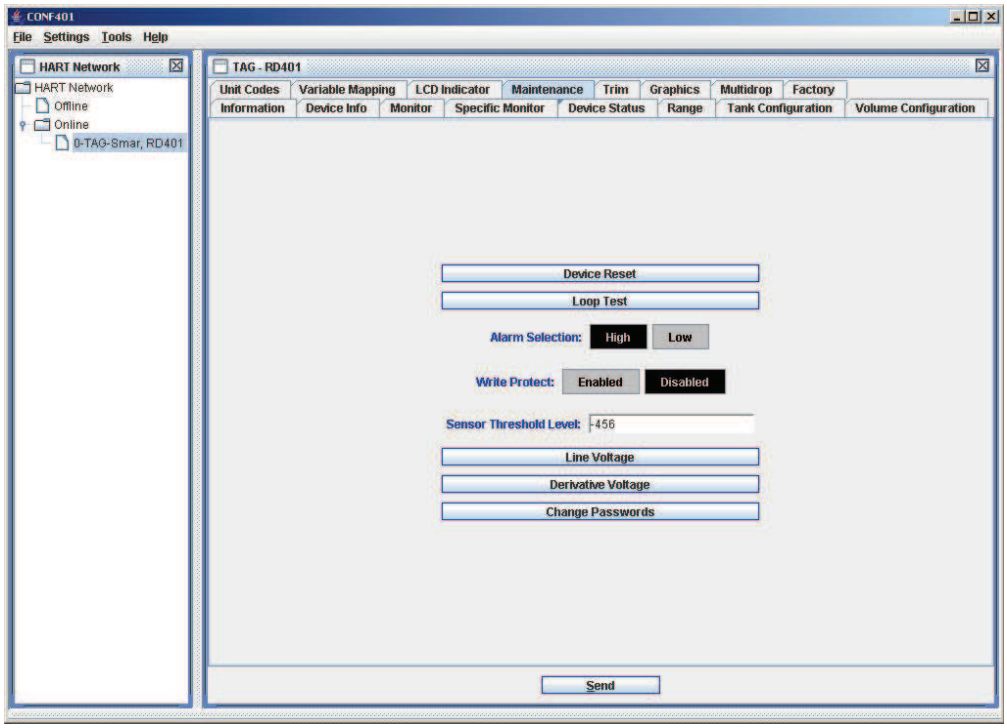


Figure 6.7 – Maintenance – Sensor Threshold Level

The chosen value is not the only one. There is a range of options between the maximum and minimum point of the negative cycle. Always choose an intermediate value between these two points, as for example, in the Figure 6.8 below, the suggested value is é -540.

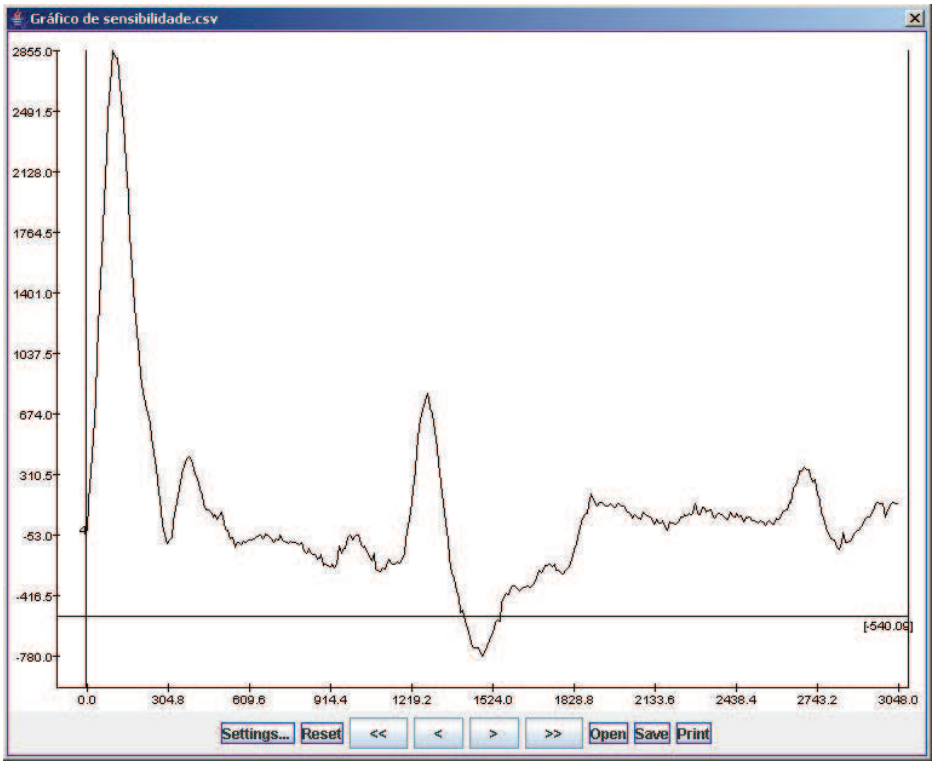


Figure 6.8 – Threshold Graphic

Final Adjust – Wave Sweep

Superior Blocking Adjust

If the process variable is oscillating, the signal is next of noises. Thus, reading blocks are necessary to eliminate such noises. The following steps should be followed in the sequence.

1° - With the graphic Derivative Voltage (threshold), Figure 6.9, move the vertical line from left to right, so that all noise is eliminated, the noise should be necessarily on the left side of the vertical line.

2° - Verify the found value in the vertical line. In the example of Figure 6.9, the found value is 502.458mm.

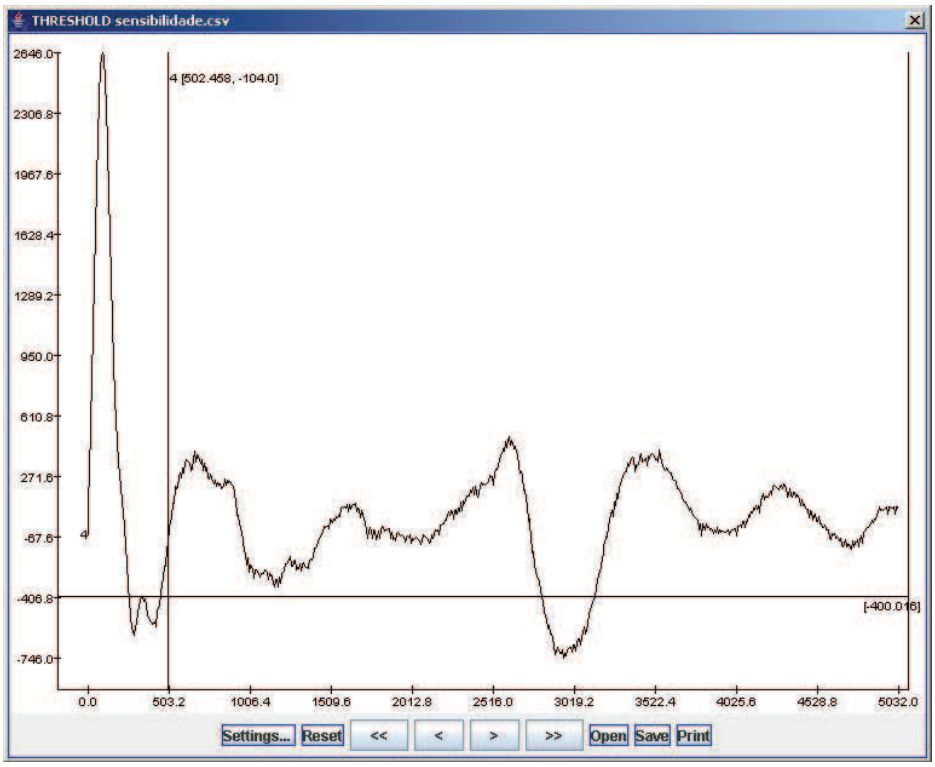


Figure 6.9 – Maintenance – Sensor Threshold Level with Superior Blocking

3° - Access the “Tank Configuration” parameter, and on field “Upper blocking distance” inserts the found value in the Figure 6.9.

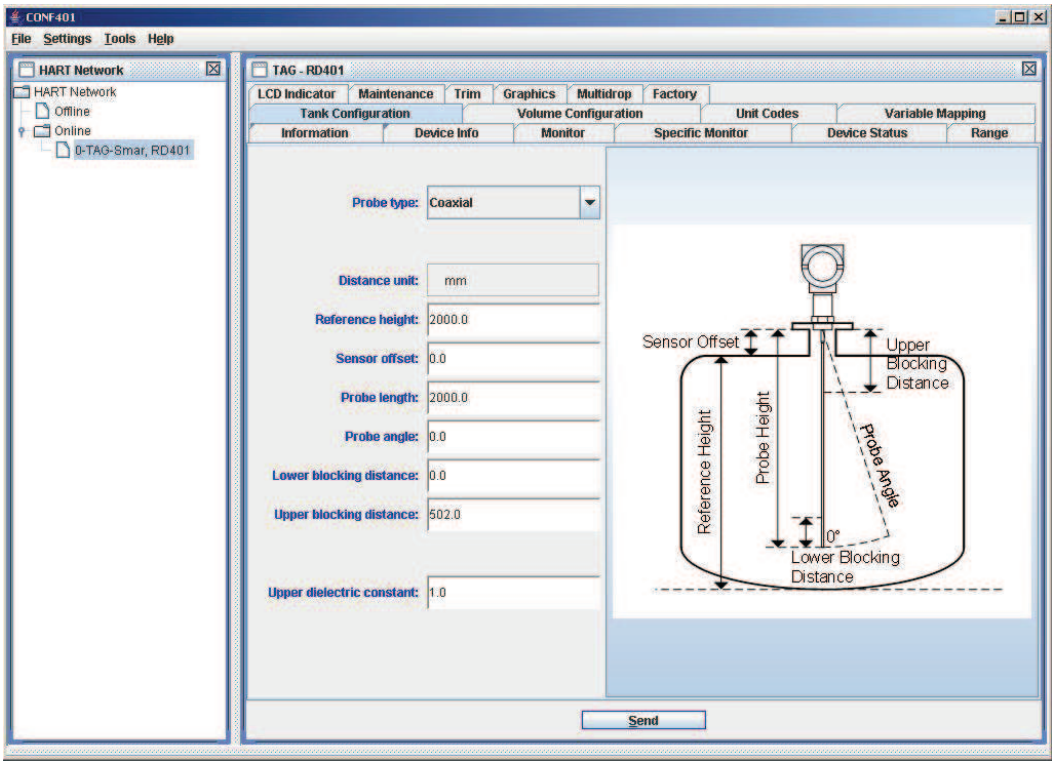


Figure 6.10 – Tank Configuration – Upper Blocking Distance

4° - Configured this field, the **RD400** will begin your measurement of free area and from this value the RD400 will ignore any reading from 0 to 502mm. Therefore, is necessary certified that the blocked value do not interfere the wanted range.

Superior and Inferior Blocking Adjust

In process where the dielectric constant is low, the **RD400** has a reflection of small amplitude, and a big reflection in bottom of the vessel. When this happen, the inferior blocking adjust should be configured to RD400 not consider this signal.

The inferior blocking is applied also in vessels with agitators, pumps or any equipment which can generate noises in the bottom of the vessel, and consequently in the inferior part of the probe, that can interfere in the **RD400** measurement.

To accomplish the superior blocking the steps from previous item should be followed: Superior Blocking Adjust. For the inferior blocking see the steps below.

1° - With the threshold graphic (Figure 6.11), move the second vertical line from right to left , so that all reflection from bottom of the vessel is eliminated, the reflection from bottom of the vessel should be necessarily on the right side of the vertical line.

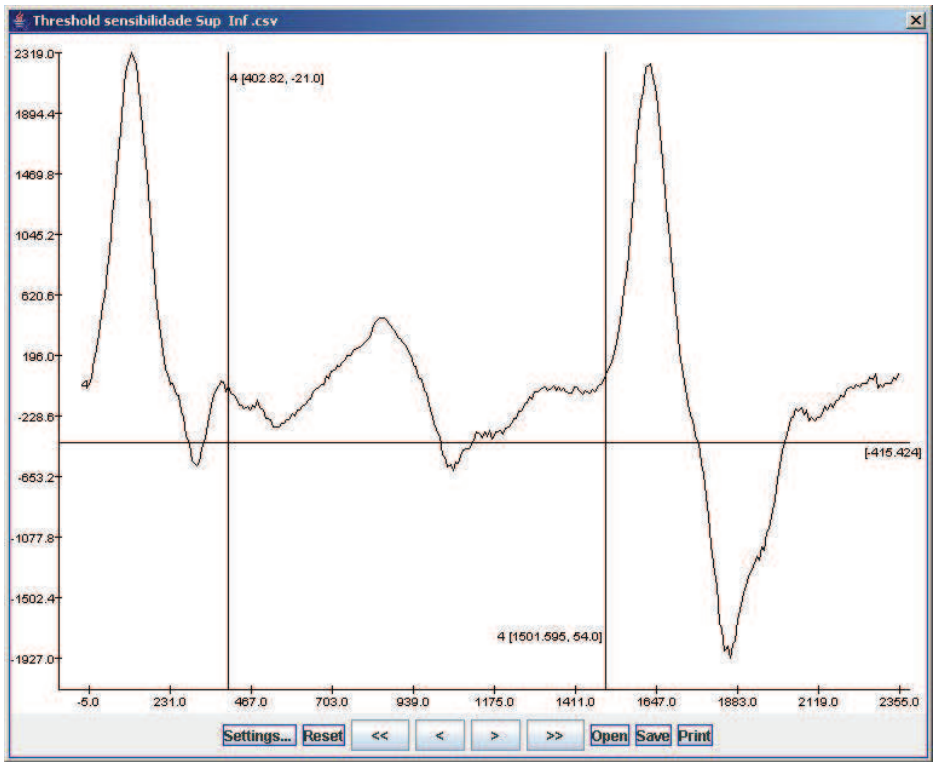


Figure 6.11 – Maintenance – Sensor Threshold Level with Superior and Inferior Blocking

2° - Verify the found value in the vertical line. In the example of Figure 6.11, the found value is 1501mm;

3° - Subtract the found value in the vertical line from probe length.
For example: Probe Length (2000) – Found Value (1500) = 500mm (inferior blocking value)

4° - Access the “Tank Configuration” parameter. In the field “Lower blocking distance” inserts the found value. In the field “Upper blocking distance” inserts the superior blocking value. See Figure 6.12.

Therefore, the radar measurement range will be between these two values, eliminating any noise which can interfere in the measurement.

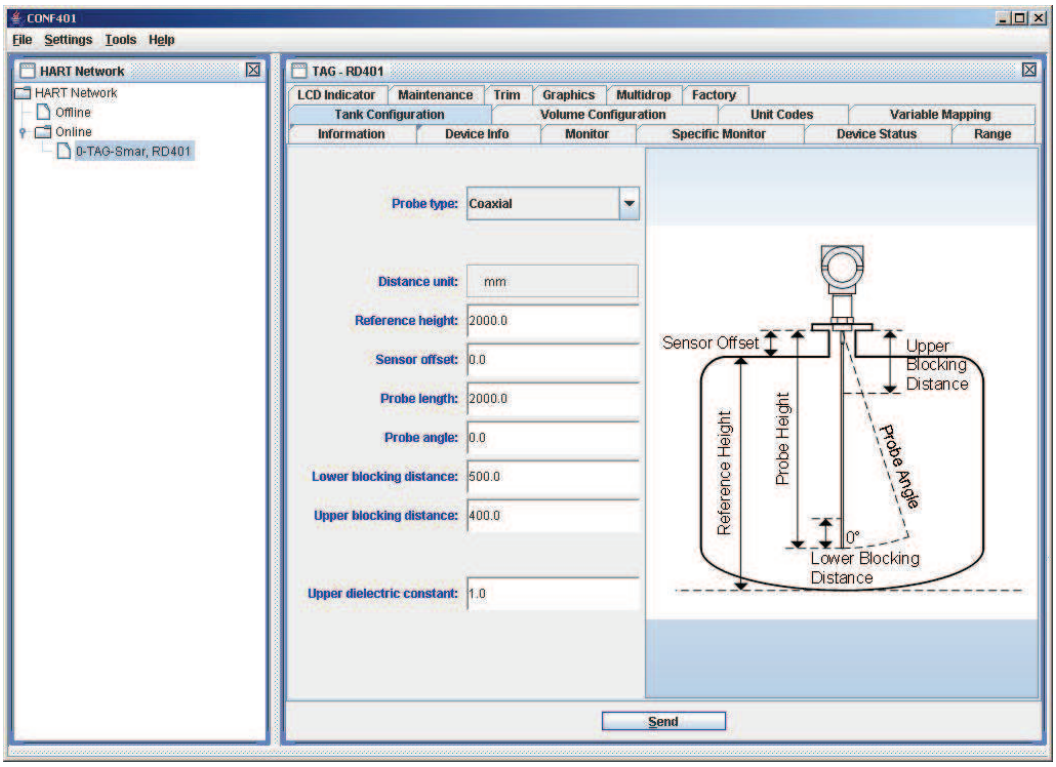


Figure 6.12 – Tank Configuration – Upper and Lower Blocking Distance

Section 7

ORDERING CODE

Ordering Codes

Customize your **RD400** using the ordering codes below.

MODEL	GUIDED WAVE RADAR LEVEL TRANSMITTER
RD400	Guided Wave Radar Level Transmitter

CODE	Communication Protocol
H	HART®
P	PROFIBUS PA

CODE	Safety Option
0	Standard – For use in measurement and control

CODE	Process Connection
1	1 ½ NPT for Probe Type Rigid Lead and Probe Type Flexible Lead
2	1 ½ NPT Special for Probe Type Coaxial
3	2" Tri-Clamp
4	3" Tri-Clamp

ODE	Probe Type	Length (m) Max
1	Single Flexible Lead	14*
2	Dual Flexible Lead	14*
3	Single Rigid Lead	8
4	Dual Rigid Lead	8
5	Coaxial **(1)**	6
6	Polished Single Rigid Lead	4

CODE	Probe Material
I	316 SST

CODE	Probe Length (2)
0	Up to 1 m
1	Up to 2 m
2	Up to 3 m
3	Up to 4 m
4	Up to 6 m
5	Up to 8 m **(14)**
6	Up to 10 m **(14)**
7	Up to 12 m **(14)**
8	Up to 14 m * **(14)**

CODE	Weight for Flexible Leads – Weight and Material (3)
0	Without Weight
1	2.5Kg in 316 SST
2	2.5Kg in Plated Carbon Steel
3	5.0Kg in 316 SST
4	5.0Kg in Plated Carbon Steel

CODE	O-Ring Material (Wet Part)
B	Buna N
E	EPDM
V	Viton

CODE	Local Indicator
0	Without Indicator
1	With Indicator

CODE	Electrical Connection		
0	1/2 – 14 NPT **(11)**	A	M20 X 1.5 **(11)**
1	3/4 – 14 NPT (with 316SST adapter for ½-14NPT) **(11)**	B	PG 13.5 DIN **(13)**
2	3/4 – 14 BSP (with 316SST adapter for ½-14NPT) **(12)**		
3	1/2 – 14 BSP (with 316SST adapter for ½-14NPT) **(12)**		

CODE	Electrical Connection Plug
I	304 SST
C	Carbon Steel (Only available for ½" NPT process connection) **(7)**

CODE	Housing Material (9) (10)		
A	Aluminum (Default) (IP/Type)	I	316 SST − CF8M (ASTM − A351) (IP/Type)
B	Aluminum for Saline Atmosphere (IPW/TypeX) **(8)**	J	316 SST for Saline Atmosphere (IPW/TypeX) **(8)**
H	Copper Free Aluminum (IPW/TypeX) **(8)**		

CODE	Painting
0	Gray Munsell N 6,5 Polyester
8	Without Painting **(4)**
9	Safety Blue Epoxy – Electrostatic Painting
C	Safety Blue Polyester – Electrostatic Painting

CODE	Certification Type
0	Without Certification
I	Intrinsic Safety

CODE	Certification Body		
0	Without Certification Body	5	CEPEL
1	FM		

CODE	Tag Plate
0	With Tag, when specified (Default)
1	Blank
2	User's Specification

CODE	Optional Items ** (5)
ZZ	User's Specification

RD400	H	0	1	1	I	1	1	B	1	0	I	A	0	0	0	0	*

⬅ TYPICAL MODEL

*Probes for measurements above 14m (up to 30m) are available only under consult.

** Leave it blank if there are no optional items.

OPTIONAL ITEMS	
LCD1 Indication (6)	YO - LCD1: Percentage (default) Y1 - LCD1: Current – I (mA) Y2 - LCD1: Level (Eng. Unit) Y3 - LCD1: Temperature (Unidade Eng.) Y4 - LCD1: Volume (Eng. Unit) Y5 - LCD1: Length (Eng. Unit)
LCD2 Indication (6)	Y0 - LCD2: Percentage (default) Y1 - LCD2: Current – I (mA) Y2 - LCD2: Level (Eng. Unit) Y3 - LCD2: Temperature (Eng. Unit) Y4 - LCD2: Volume (Eng. Unit) Y5 - LCD2: Length (Eng. Unit)

NOTES

(1) The coaxial probe has a squeeze key as show the Figure 7.2.
(2) It is necessary to inform the probe length in meters, respecting the limits established in the field "Probe Length (meters)" of the ordering code table, according to the chosen probe type. For example: 2 correspond to a length up to 3 meters. Order a length immediately superior to the installation and adjust the probe length at the field. For more details consult the Section 6, Figure 6.1.
(3) If the probe needs to be anchored in the bottom of the tank, the RD400 can be supplied with an anchorage ring, without counter-weight. See Figure 7.5.
(4) Not available for Aluminum Housing.
(5) See Table Optional Items.
(6) Only applicable with local indicator.
(7) Not applicable for saline atmosphere.
(8) IPW / TypeX tested for 200 hours according to NBR 8094 / ASTM B 117 standard.
(9) IPX8 tested in 10 meters of water column for 24 hours.
(10) Ingress Protection:

Product	CEPEL	FM
RD400	IP66/68/W	Type 4X/6P IP66/68

(11) Certified for use in Explosive Atmosphere (CEPEL and FM).
(12) Options not certified for Explosive Atmosphere.
(13) Certified for use in Explosive Atmosphere (CEPEL).
(14) Not applicable with coaxial probe.

Spare Parts

For spare parts use the Table 7.1 below.

SPARE PARTS RD400					
PARTS DESCRIPTION			**MATERIAL**	**POSITION** (Figures 7.1, 7.2, 7.3)	**CODE**
Housing	½ - 14 NPT		Aluminum	10	400-0948
			316 SST	10	400-0949
	M20x1,5		Aluminum	10	400-0950
			316 SST	10	400-0951
	PG 13.5 DIN		Aluminum	10	400-0952
			316 SST	10	400-0953
Cover	With Window for Indicator		Aluminum	01	400-0824
			316 SST	01	400-0825
	Without Window for Indicator		Aluminum	15	400-0822
			316 SST	15	400-0823
O-Ring	Cover		Buna-N	02	204-0113
	Neck		Buna-N	18	204-0113
Electrical Connection Insulator			———	13	400-0058
Display Subset			———	03	400-0954
Main Board	SRC120 (Display and Mounting Kit Included)		———	05	400-0955
	SRC120 (Without Display and with Mounting Kit)		———	05	400-0956
	Fixation Kit (Screws in 316SST) GLL1071/SRC120		316 SST	04, 06, 07	400-0560
Socket Plug	½ NPT Internal		Carbon Steel Bichromatized BR Exd.	17	400-0808
			316 SST BR EXd.	17	400-0809
	M20x1,5 External		316 SST BR EXd.	17	400-0810
	PG13,5 External		316 SST BR EXd.	17	400-0811
Local Adjust Protection			Silicone	11	204-0114
Single Flexible Lead		Up to 1 meter	316 SST	29	400-1080
		Up to 2 meters		29	400-0985
		Up to 3 meters		29	400-0986
		Up to 4 meters		29	400-0987
		Up to 6 meters		29	400-0988
		Up to 8 meters		29	400-0989
		Up to 10 meters		29	400-0990
		Up to 12 meters		29	400-0991
		Up to 14 meters*		29	400-0992
Dual Flexible Lead		Up to 1 meter	316 SST	21, 29	400-1081
		Up to 2 meters		21, 29	400-0993
		Up to 3 meters		21, 29	400-0994
		Up to 4 meters		21, 29	400-0995
		Up to 6 meters		21, 29	400-0996
		Up to 8 meters		21, 29	400-0997
		Up to 10 meters		21, 29	400-0998
		Up to 12 meters		21, 29	400-0999
		Up to 14 meters*		21, 29	400-1000
Single Rigid Lead		Up to 1 meter	316 SST	32, 33, 36	400-1082
		Up to 2 meters		32, 33, 36	400-1001
		Up to 3 meters		32, 33, 36	400-1002
		Up to 4 meters		32, 33, 36	400-1065
		Up to 6 meters		32, 33, 36	400-1083
		Up to 8 meters		32, 33, 36	400-1084
Polished Single Rigid Lead		Up to 1 meter	316 SST	45	400-1085
		Up to 2 meters		45	400-1005
		Up to 3 meters		45	400-1006
		Up to 4 meters		45	400-1067
Dual Rigid Lead		Up to 1 meter	316 SST	23, 32, 33, 35, 36	400-1086
		Up to 2 meters		23, 32, 33, 35, 36	400-1003
		Up to 3 meters		23, 32, 33, 35, 36	400-1004
		Up to 4 meters		23, 32, 33, 35, 36	400-1066
		Up to 6 meters		23, 32, 33, 35, 36	400-1087
		Up to 8 meters		23, 32, 33, 35, 36	400-1088
Coaxial		Up to 1 meter	316 SST	23, 30, 38, 39, 40, 41, 42, 43	400-1089
		Up to 2 meters		23, 30, 38, 39, 40, 41, 42, 43	400-1007
		Up to 3 meters		23, 30, 38, 39, 40, 41, 42, 43	400-1008
Coaxial Probe Coupling			316 SST	39	400-0957
Coaxial Pipe Squeeze Key				———	400-0958
Anchorage Weight	2,5Kg		Carbon Steel	28	400-0959
			316 SST	28	400-0960
	5,0Kg		Carbon Steel	28	400-0961
			316 SST	28	400-0962

SPARE PARTS RD400						
PARTS DESCRIPTION				**MATERIAL**	**POSITION** (Figures 7.1, 7.2, 7.3)	**CODE**
Spacer	Flexible Lead Spacer Kit			Teflon	22, 23	400-0963
	Rigid Lead Spacer Kit			Teflon	23, 34	400-0964
	Coaxial			Teflon	40	400-0965
Probe Terminal	Short of the Single Flexible Lead **(1)**			316 SST	23, 31	400-0966
	Single Flexible Lead			316 SST	23, 27	400-0967
	Short of the Dual Flexible Lead **(1)**			316 SST	23, 24	400-0968
	Dual Flexible Lead			316 SST	23, 26	400-0969
	Dual Rigid Lead Terminal Kit			316 SST	23, 35	400-0970
	Coaxial Terminal Kit			316 SST	23, 30, 41, 42	400-0971
Pressure Washer Nominal Diameter 5				316 SST	30	400-0972
Screw	Cover Locking			316 SST	09	204-0120
	Sensor locking cilindric head M4 screw			316 SST	08	204-0121
	Sensor locking without head M6 screw			316 SST	08	400-1121
	External Ground			316 SST	16	204-0124
	Identification Plate			316 SST	12	204-0116
	Terminal Insulator Fixing			Aluminum Housing	14	304-0119
				316 SST Housing	14	204-0119
	Main Board – Unit with Indicator			Aluminum Housing	04	304-0118
				316 SST Housing	04	204-0118
	Main Board – Unit without Indicator			Aluminum	04	304-0117
				316 SST	04	204-0117
Insulator Set	1 ½ 14 NPT	Buna-N		316 SST	19	400-0973
		Viton			19	400-0974
		EPDM			19	400-0975
	Coaxial	Buna-N		316 SST	19	400-0976
		Viton			19	400-0977
		EPDM			19	400-0978
	Tri-Clamp	2”	Buna-N	316 SST	19	400-0979
			Viton		19	400-0980
			EPDM		19	400-0981
		3”	Buna-N	316 SST	19	400-0982
			Viton		19	400-0983
			EPDM		19	400-0984
Screwdriver					____	SD-1

*Probes for measurements above 14m (up to 30m) are available only under consult.

OBS.: For the dimensions of the probes, consult dimensional drawings - Section 3. **(1)** See Figures 3.4 and 3.5.

Table 7.1 – RD400 Spare Parts

1 - COVER WITH WINDOW FOR INDICATOR
2 - O-RING COVER
3 - DISPLAY
7 - 4 - 6 - FIXATION MAIN BOARD KIT (SCREWS AND SPACERS)
5 - MAIN BOARD - SR120 (DISPLAY AND MOUNTING KIT INCLUDED)
5 - MAIN BOARD - SR120 (WITHOUT DISPLAY AND WITH MOUNTING KIT)
8 - SCREW INSULATOR LOCKING
9 - SCREW COVER LOCKING
10 - HOUSING
11 - LOCAL ADJUST PROTECTION
12 - SCREW IDENTIFICATION PLATE
13 - ELECTRICAL CONNECTION INSULATOR
14 - SCREW TERMINAL INSULATOR FIXING
15 - COVER WITHOUT WINDOW FOR INDICATOR
16 - SCREW EXTERNAL GROUND
17 - SOCKET PLUG
18 - O-RING NECK
19 - INSULATOR SET
20 - FLANGE
21 - PERIPHERIC FLEXIBLE LEAD
22 - LEAD SPACER
23 - ALLEN WITHOUT HEAD SOCKET INT. M5X8 SCREW
24 - SHORT DUAL FLEXIBLE LEAD TERMINAL
25 - ANCHORAGE WITH M8 THREAD
26 - DUAL FLEXIBLE LEAD TERMINAL
27 - SINGLE FLEXIBLE LEAD TERMINAL
28 - ANCHORAGE WEIGHT
29 - CENTRAL LEAD
30 - LOCKING WASHER
31 - SHORT SINGLE FLEXIBLE LEAD TERMINAL
32 - CENTRAL AND PERIPHERIC RIGID LEAD
33 - PROBE COUNTER NUTS
34 - RIGID LEAD SPACER
35 - RIGID LEAD TERMINAL
36 - RIGID LEAD COUPLING

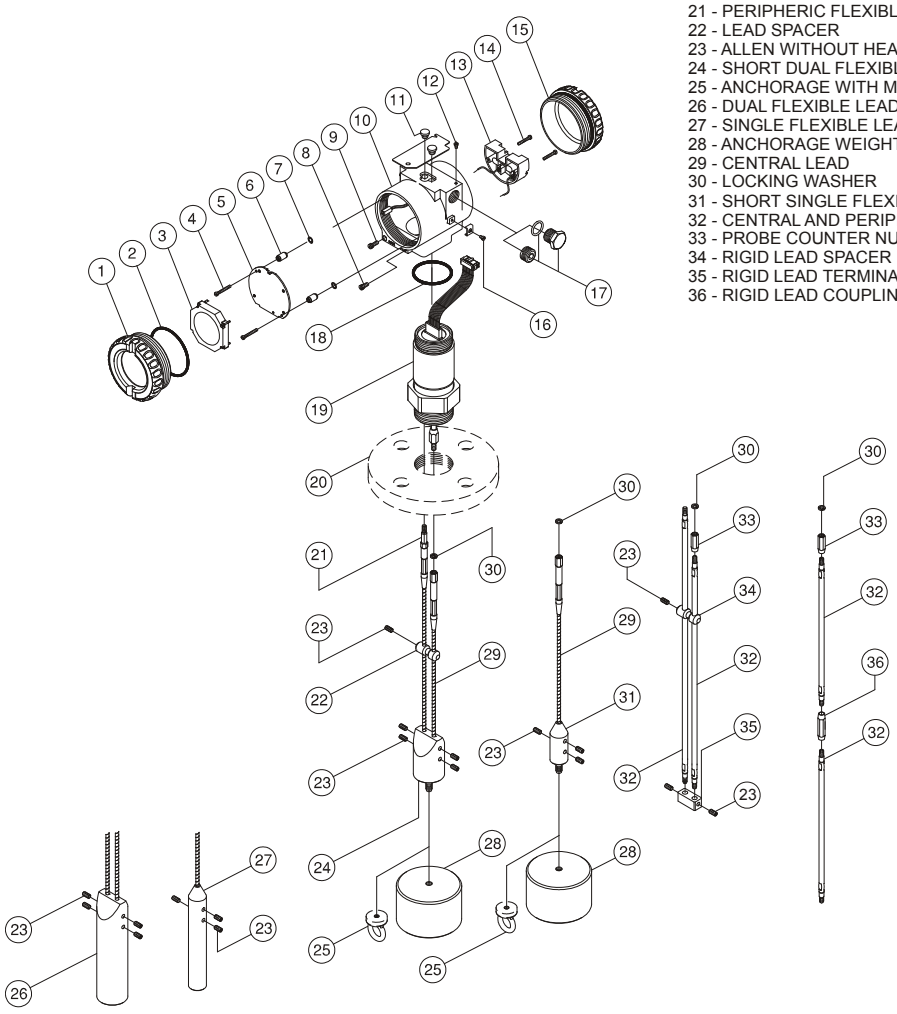
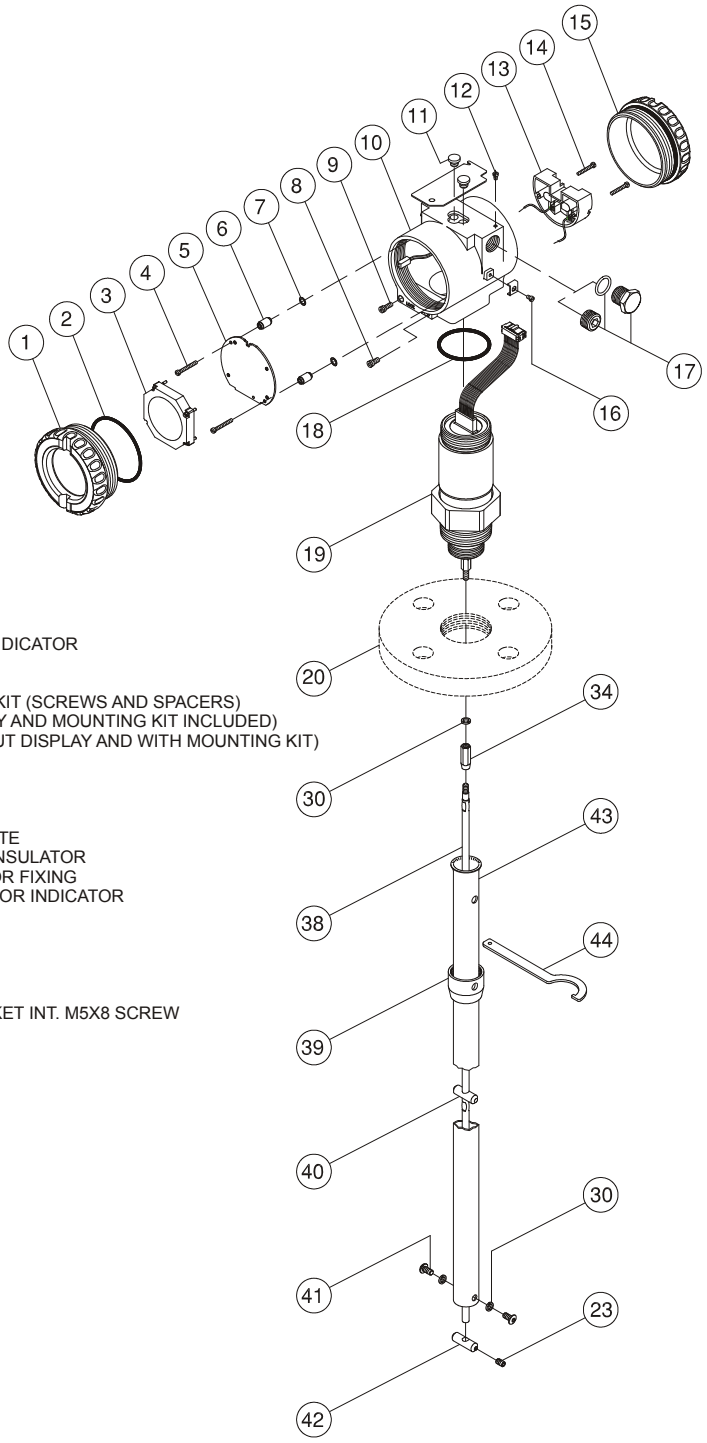
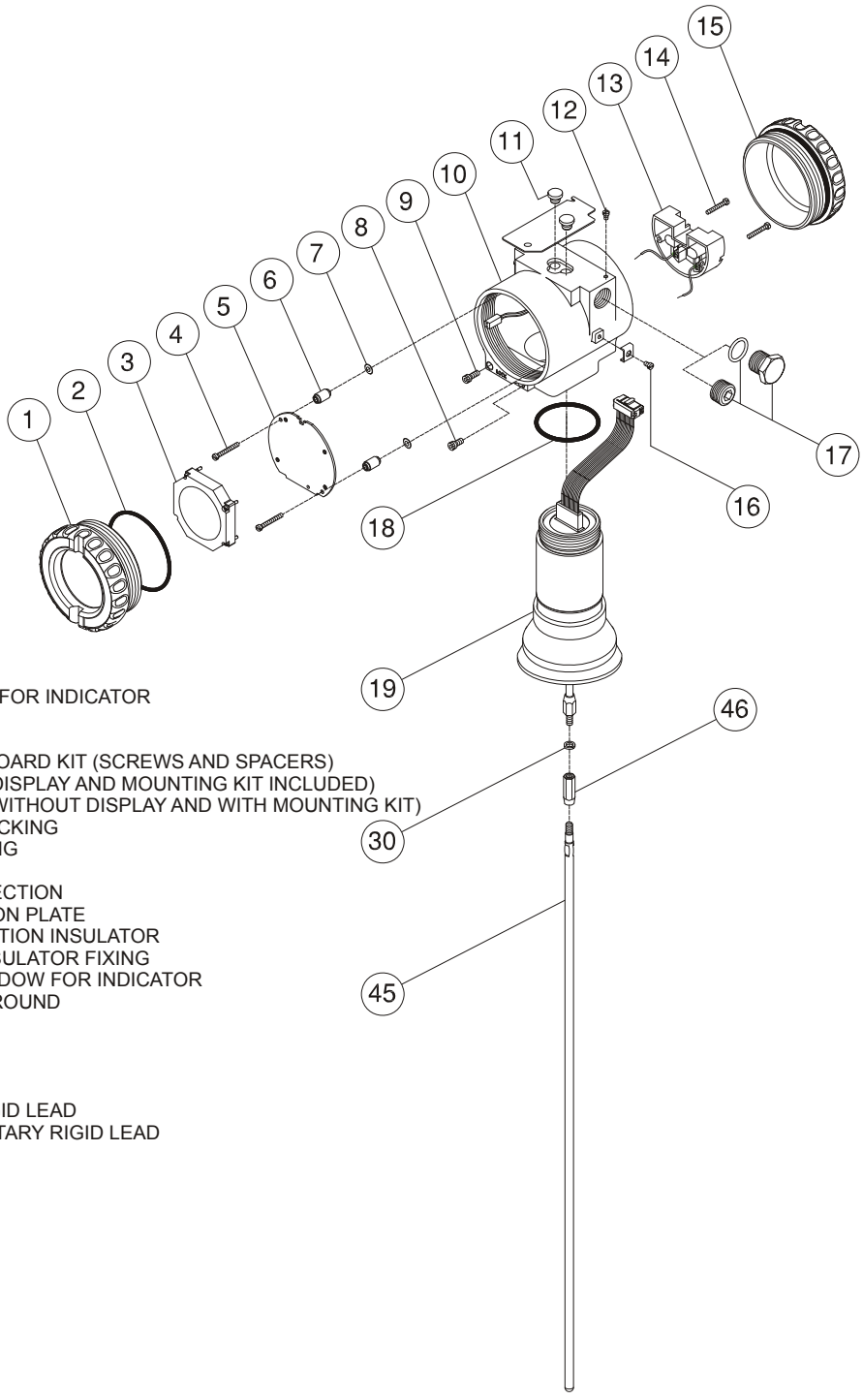


Figure 7.1 – RD400 Exploded View – Rod and Cable



1 - COVER WITH WINDOW FOR INDICATOR
2 - O-RING COVER
3 - DISPLAY
7 - 4 - 6 - FIXATION MAIN BOARD KIT (SCREWS AND SPACERS)
5 - MAIN BOARD - SR120 (DISPLAY AND MOUNTING KIT INCLUDED)
5 - MAIN BOARD - SR120 (WITHOUT DISPLAY AND WITH MOUNTING KIT)
8 - SCREW INSULATOR LOCKING
9 - SCREW COVER LOCKING
10 - HOUSING
11 - LOCAL ADJUST PROTECTION
12 - SCREW IDENTIFICATION PLATE
13 - ELECTRICAL CONNECTION INSULATOR
14 - SCREW TERMINAL INSULATOR FIXING
15 - COVER WITHOUT WINDOW FOR INDICATOR
16 - SCREW EXTERNAL GROUND
17 - SOCKET PLUG
18 - O-RING NECK
19 - INSULATOR SET
20 - FLANGE
23 - ALLEN WITHOUT HEAD SOCKET INT. M5X8 SCREW
30 - LOCKING WASHER
34 - COUNTER NUTS
38 - COAXIAL LEAD
39 - COAXIAL PROBE COUPLING
40 - COAXIAL SPACER
41 - M5 SCREW
42 - COAXIAL PROBE TERMINAL
43 - COAXIAL PROBE PIPE
44 - PIPE SQUEEZE KEY

Figure 7.2 – RD400 Exploded View – Coaxial Probe



1 - COVER WITH WINDOW FOR INDICATOR
2 - O-RING COVER
3 - DISPLAY
7 - 4 - 6 - FIXATION MAIN BOARD KIT (SCREWS AND SPACERS)
5 - MAIN BOARD - SR120 (DISPLAY AND MOUNTING KIT INCLUDED)
5 - MAIN BOARD - SR120 (WITHOUT DISPLAY AND WITH MOUNTING KIT)
8 - SCREW INSULATOR LOCKING
9 - SCREW COVER LOCKING
10 - HOUSING
11 - LOCAL ADJUST PROTECTION
12 - SCREW IDENTIFICATION PLATE
13 - ELECTRICAL CONNECTION INSULATOR
14 - SCREW TERMINAL INSULATOR FIXING
15 - COVER WITHOUT WINDOW FOR INDICATOR
16 - SCREW EXTERNAL GROUND
17 - SOCKET PLUG
18 - O-RING NECK
19 - INSULATOR SET
30 - LOCKING WASHER
45 - SANITARY SINGLE RIGID LEAD
46 - COUNTER NUTS SANITARY RIGID LEAD

Figure 7.3 – RD400 Exploded View – Tri-Clamp Connection and Sanitary Probe

Accessories

For **RD400** accessories use the Tables 7.2 and 7.3.

ACCESSORIES RD400					
DESCRIPTION			**MATERIAL**	**POSITION** (Figure 7.4)	**CODE**
Flanges for Process Connection (1 ½" NPT Connection) (1)	2" 150# ANSI B-16.5		316 SST	01	400-1009
			Plated Carbon Steel	01	400-1010
	2" 300# ANSI B-16.5		316 SST	01	400-1011
			Plated Carbon Steel	01	400-1012
	3" 150# ANSI B-16.5		316 SST	01	400-1013
			Plated Carbon Steel	01	400-1014
	3" 300# ANSI B-16.5		316 SST	01	400-1015
			Plated Carbon Steel	01	400-1016
	4" 150# ANSI B-16.5		316 SST	01	400-1017
			Plated Carbon Steel	01	400-1018
	4" 300# ANSI B-16.5		316 SST	01	400-1019
			Plated Carbon Steel	01	400-1020
	6" 150# ANSI B-16.5		316 SST	01	400-1021
			Plated Carbon Steel	01	400-1022
	6" 300# ANSI B-16.5		316 SST	01	400-1023
			Plated Carbon Steel	01	400-1024
	DN 50 PN10/40 DIN EN 1092-1		316 SST	01	400-1025
			Plated Carbon Steel	01	400-1026
	DN 80 PN10/40 DIN EN 1092-1		316 SST	01	400-1027
			Plated Carbon Steel	01	400-1028
	DN 100 PN10/16 DIN EN 1092-1		316 SST	01	400-1029
			Plated Carbon Steel	01	400-1030
	DN 100 PN25/40 DIN EN 1092-1		316 SST	01	400-1031
			Plated Carbon Steel	01	400-1032
	DN 150 PN16 DIN 2501		316 SST	01	400-1033
			Plated Carbon Steel	01	400-1034
Inferior Flanges for Communicating Vessel (Without Sealing Kit) (1)	2" 150# ANSI B-16.5		316 SST	02	400-1035
			Plated Carbon Steel	02	400-1036
	2" 300# ANSI B-16.5		316 SST	02	400-1037
			Plated Carbon Steel	02	400-1038
	3" 150# ANSI B-16.5		316 SST	02	400-1039
			Plated Carbon Steel	02	400-1040
	3" 300# ANSI B-16.5		316 SST	02	400-1041
			Plated Carbon Steel	02	400-1042
	4" 150# ANSI B-16.5		316 SST	02	400-1043
			Plated Carbon Steel	02	400-1044
	4" 300# ANSI B-16.5		316 SST	02	400-1045
			Plated Carbon Steel	02	400-1046
	6" 150# ANSI B-16.5		316 SST	02	400-1047
			Plated Carbon Steel	02	400-1048
	6" 300# ANSI B-16.5		316 SST	02	400-1049
			Plated Carbon Steel	02	400-1050
	DN 50 PN10/40 DIN EN 1092-1		316 SST	02	400-1051
			Plated Carbon Steel	02	400-1052
	DN 80 PN10/40 DIN EN 1092-1		316 SST	02	400-1053
			Plated Carbon Steel	02	400-1054
	DN 100 PN10/16 DIN EN 1092-1		316 SST	02	400-1055
			Plated Carbon Steel	02	400-1056
	DN 100 PN25/40 DIN EN 1092-1		316 SST	02	400-1057
			Plated Carbon Steel	02	400-1058
	DN 150 PN16 DIN 2501		316 SST	02	400-1059
			Plated Carbon Steel	02	400-1060
Sealing Kit of the Inferior Flange for Communicating Vessel (1, 2)	Process Temperature	-34°C < T < 135°C BUNA N	316 SST and O-Ring material is the chosen according to temperature	03,04, 05, 06, 07, 08, 09, 10, 11, 12 e 13	400-1061
		-28°C < T < 204°C VITON		03, 04, 05, 06, 07, 08, 09, 10, 11, 12 e 13	400-1062
		-57°C < T < 121°C EPDM		03, 04, 05, 06, 07, 08, 09, 10, 11, 12 e 13	400-1063
		-50°C < T < 200°C PTFE		03, 04, 05, 06, 07, 08, 09, 10, 11, 12 e 13	400-1064
Anchorage Ring (3)	M8 x 1.25 Male Thread		316 SST	Figure 7.5	400-1078
	M8 x 1.25 Female Thread		316 SST	Figure 7.5	400-1079
Metal Sheet (4)	For Single Probes		410 SST	Figure 7.6	400-1130
Bracket for Open Tanks			1020 Carbon Steel	Figure 7.6	400-1131

(1) See Figure 7.4 / **(2)** The Sealing Kit is applied with inferior flanges in communicating vessel / **(3)** If the probe needs to be anchored in the bottom of the tank, the RD400 can be supplied with an anchorage ring, without counter-weight. See Figure 7.5. / **(4)** Applicable for open or non-metallic tanks, and also when flanges for process connection are not used. This metal sheet guarantees an appropriate return of the electromagnetic waves to the equipment isolator, when the single probe is used. See Figure 7.6.

Table 7.2 – RD400 Accessories

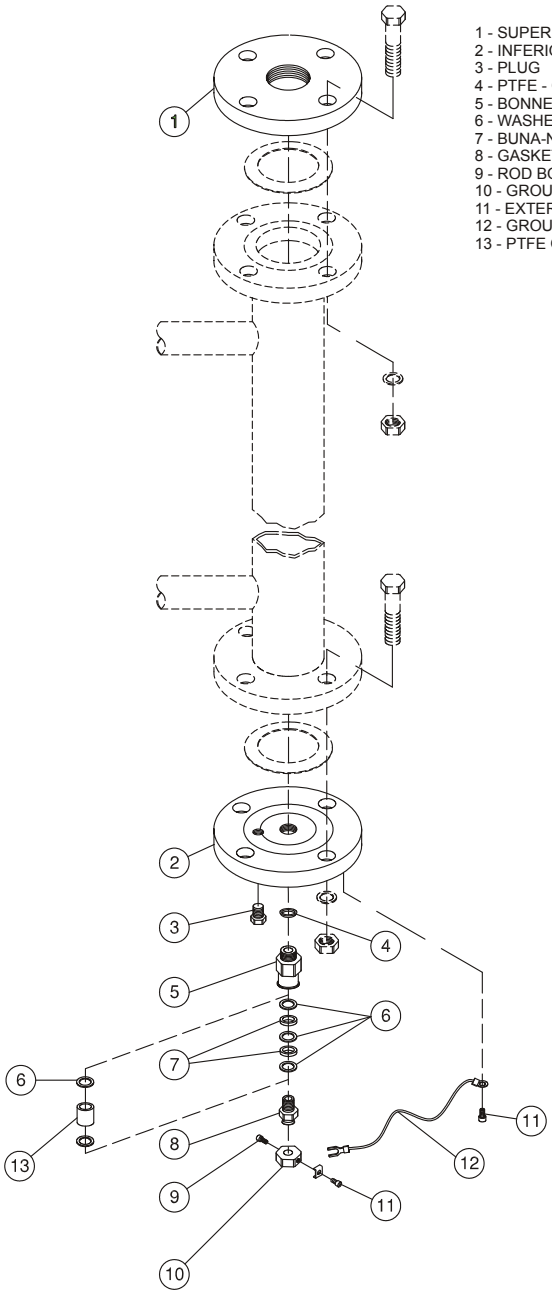


Figure 7.4 – Exploded View – Accessories (Flange/Kit)

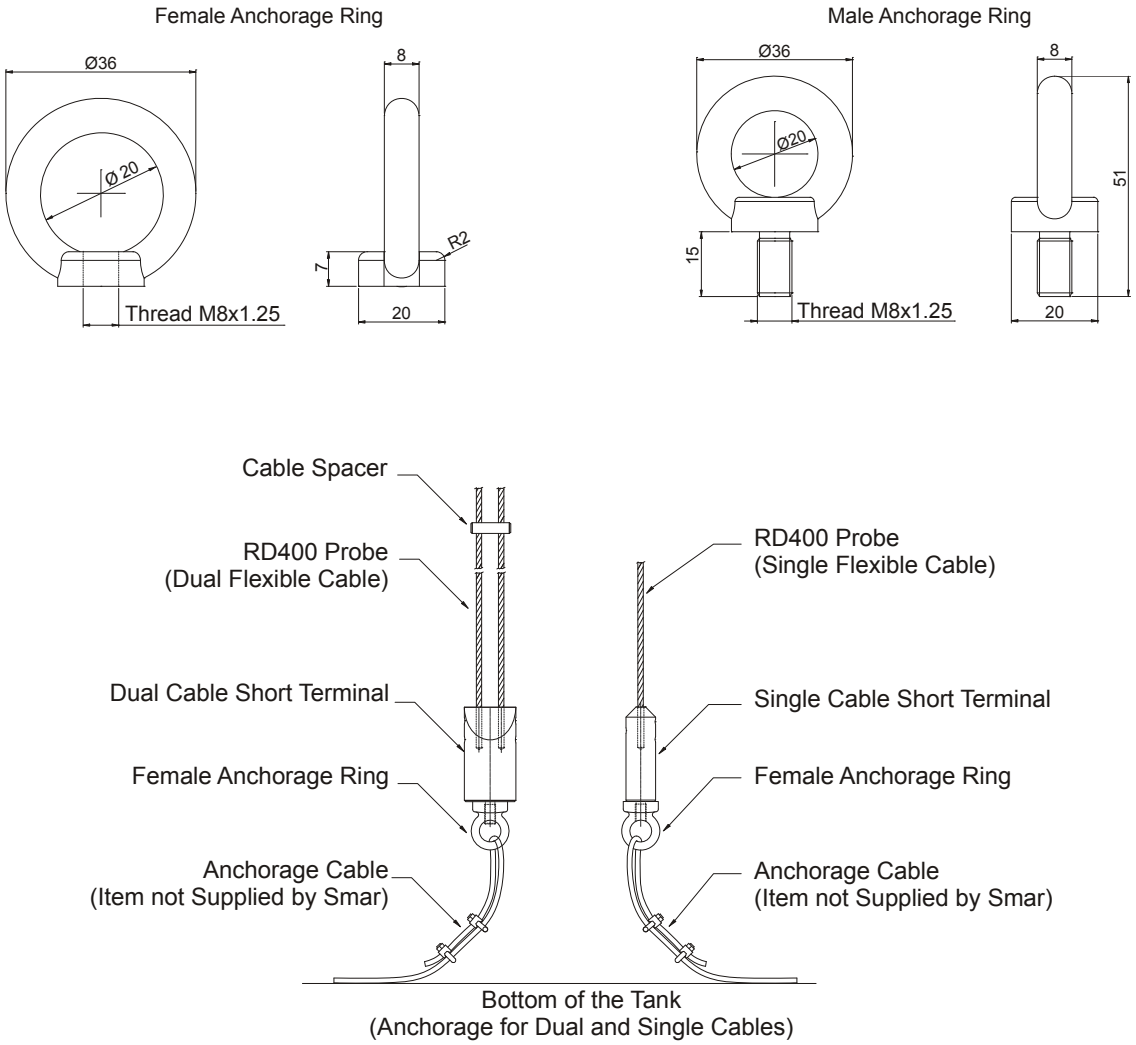
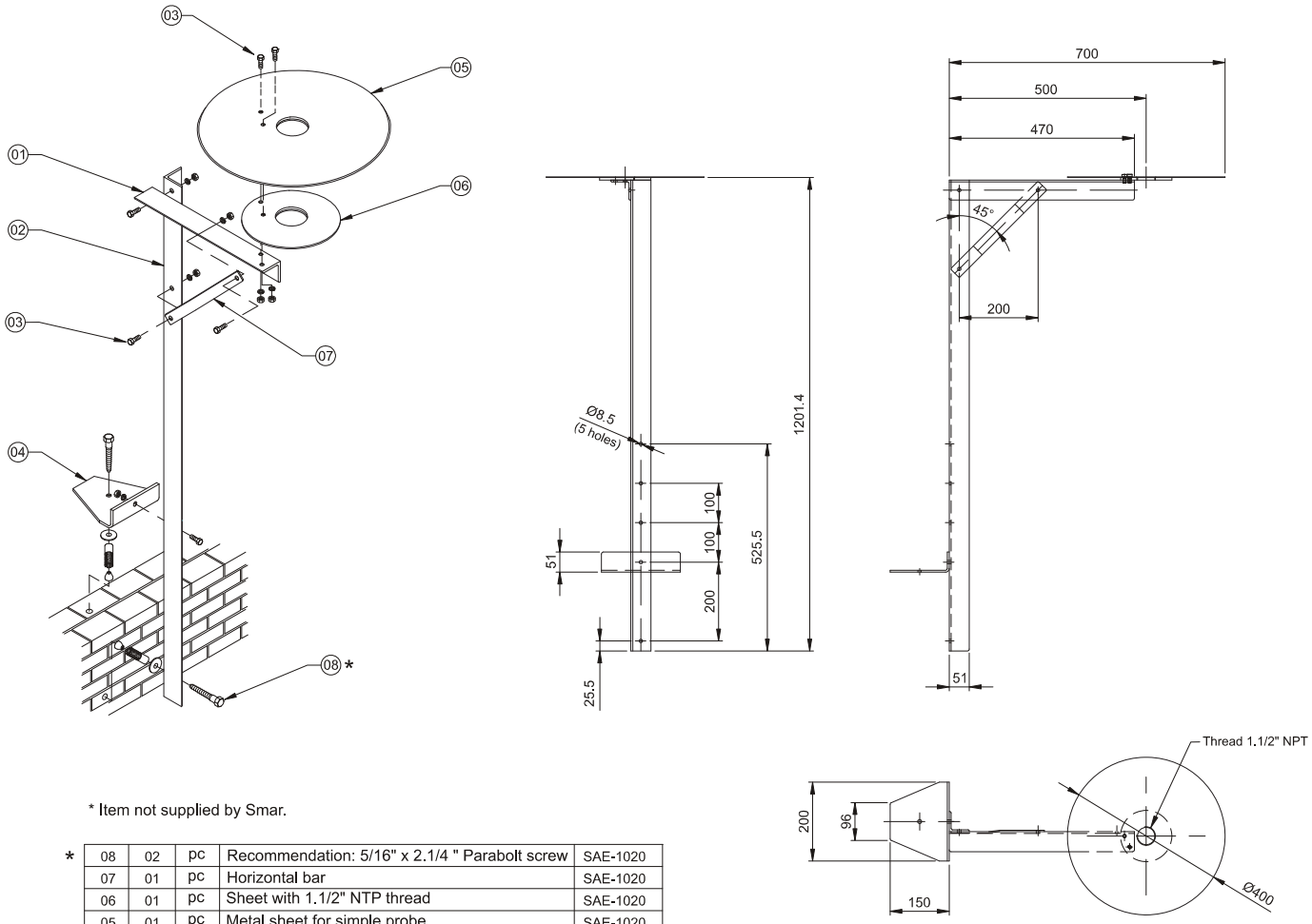


Figure 7.5 – Anchorage Ring



* Item not supplied by Smar.

	Item	Quant.	Unit.	DESCRIPTION	MATERIAL
*	08	02	pc	Recommendation: 5/16" x 2.1/4 " Parabolt screw	SAE-1020
	07	01	pc	Horizontal bar	SAE-1020
	06	01	pc	Sheet with 1.1/2" NTP thread	SAE-1020
	05	01	pc	Metal sheet for simple probe	SAE-1020
	04	01	pc	Bracket base	SAE-1020
	03	06	pc	Screw, washer and M8x30mm nut set	SAE-1020
	02	01	pc	Vertical bar	SAE-1020
	01	01	pc	Sheet base	SAE-1020

Figure 7.6 – Bracket and Metal Sheet for Installations in Open Tanks

Communicating Vessel in Curve

Communicating vessels can be used for many reasons, like tank internal obstacles, foam presence (which brings difficulties to the measurement), accessibility to the equipment, etc. They provide a similar effect to the coaxial probe: a better reflected waves return, and noises elimination.

Probe's length (L on the Figure 7.7) must be equal to the range plus the dead zone (up to 500 mm). This length is directly associated with the centers of vessel connections (R on the Figure 7.7), and this is shown on the table below ("Distance between Centers" field).

It is recommended to use a sealing kit at the bottom of the vessel (see codes at Table 7.2, Figure 7.4).

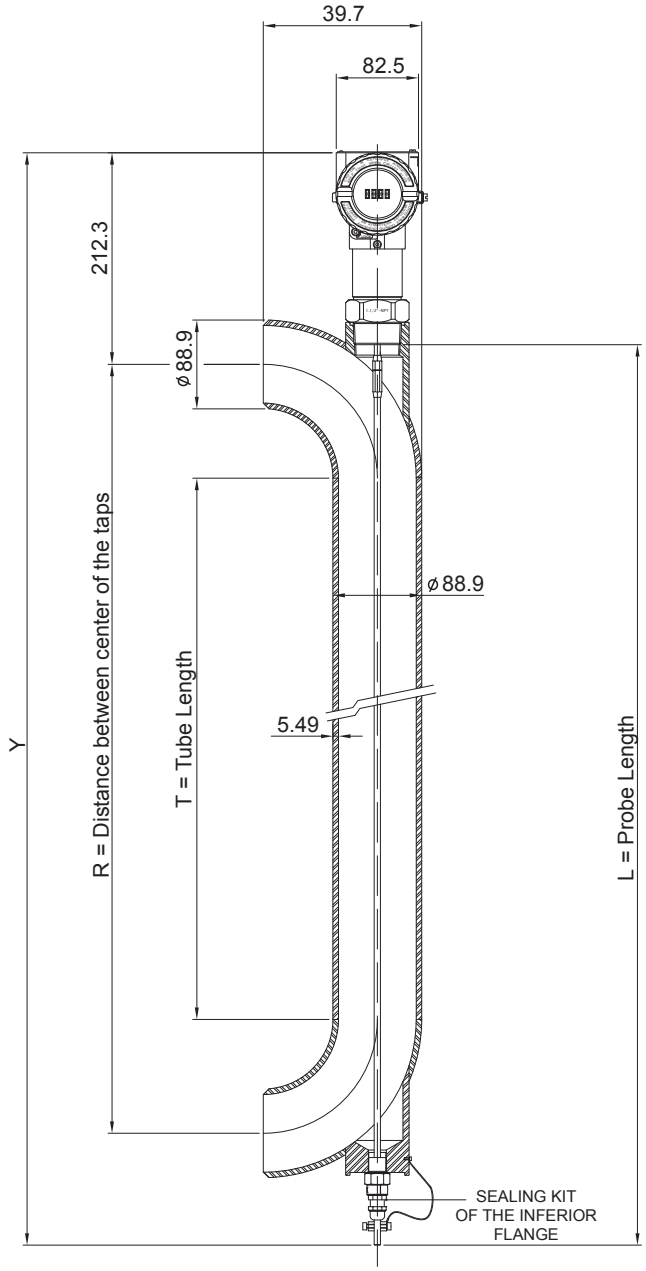
The options of communicating vessels shown on the table below, meet the 150 lbs pressure class and -20 to 200 °C temperature class.

400-1132	COMMUNICATING VESSEL OF 3 " IN PLATED CARBON STEEL

CODE	Inspection
0	Without X-Ray Inspection
1	With X-Ray Inspection

CODE	Distance between Centers (R in mm)
1	2000 (Minimum Probe of 2135 mm (L))
2	3000 (Minimum Probe of 3135 mm (L))
3	4000 (Minimum Probe of 4135 mm (L))
4	5000 (Minimum Probe of 5135 mm (L))
5	6000 (Minimum Probe of 6135 mm (L))
6	7000 (Minimum Probe of 7135 mm (L))
7	8000 (Minimum Probe of 8135 mm (L))

400-1132	-	1	1



R(mm)	T(mm)	Y(mm)	L(mm)
2000	1771.40	2325	2135
3000	2771.40	3325	3135
4000	3771.40	4325	4135
5000	4771.40	5325	5135
6000	5771.40	6325	6135
7000	6771.40	7325	7135
8000	7771.40	8325	8135

Figure 7.7 – Communicating Vessel in Curve

Appendix A

CERTIFICATION INFORMATION

Hazardous Locations Certifications

North American Certification

FM Approvals (Factory Mutual)

Certificate No: FM 3031183
Intrinsic Safety - Class I, Division 1, Groups C and D
Entity parameters: Vmax = 30 Vdc Imax = 110 mA Pmax = 0.83 W C = 8 nF L = 0.24 mH
Temperature Class: T4
Maximum Ambient Temperature: 85 °C
Enclosure Type: 4X/6P and IPX6/IPX7 or Type 4/6P and IPX6/IPX7

*Consult the FM Control Drawing in the page A3.

South American Certification

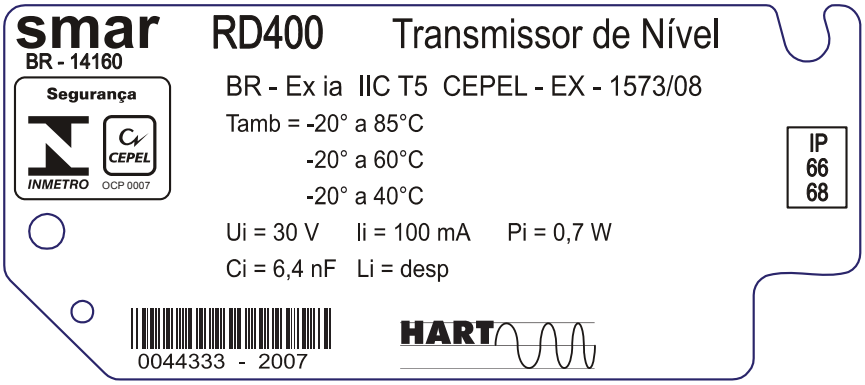
INMETRO approvals

Certificate No: CEPEL-EX-1573/08
Intrinsic Safety - Ex-ia IIC T5
Entity Parameters: Pi = 0.7 W Ui = 30 V Ii = 100 mA Ci = 6.4nF Li = Neg
Ambient Temperature: (-20 ºC ≤ T_{amb} ≤ +85 ºC)
Enclosure Type: IP66/68 W or IP66/68

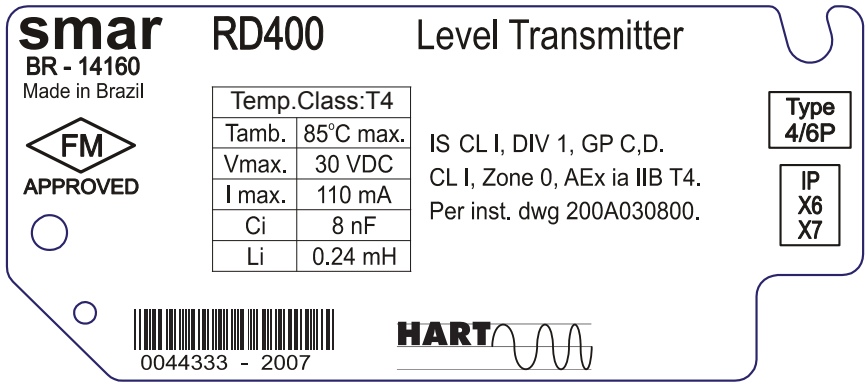
Identification Plate and Control Drawing

- Identification of Intrinsically Safe:

CEPEL

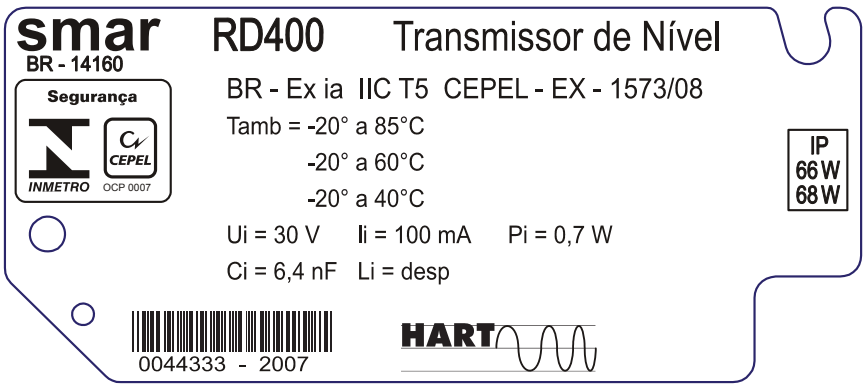


FM

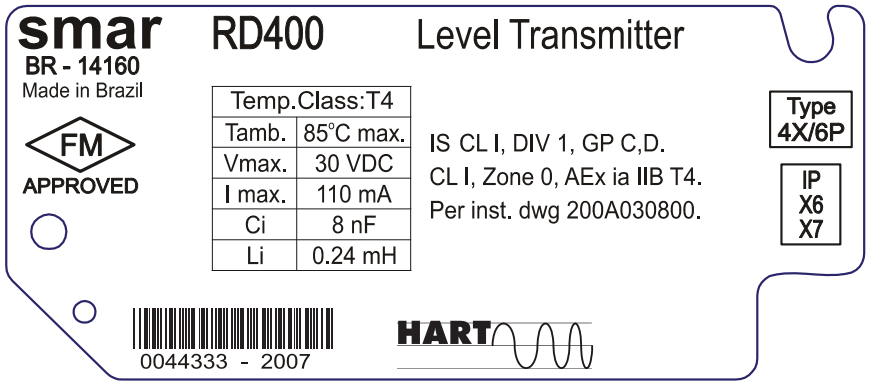


- Identification of Intrinsically Safe for saline atmosphere:

CEPEL

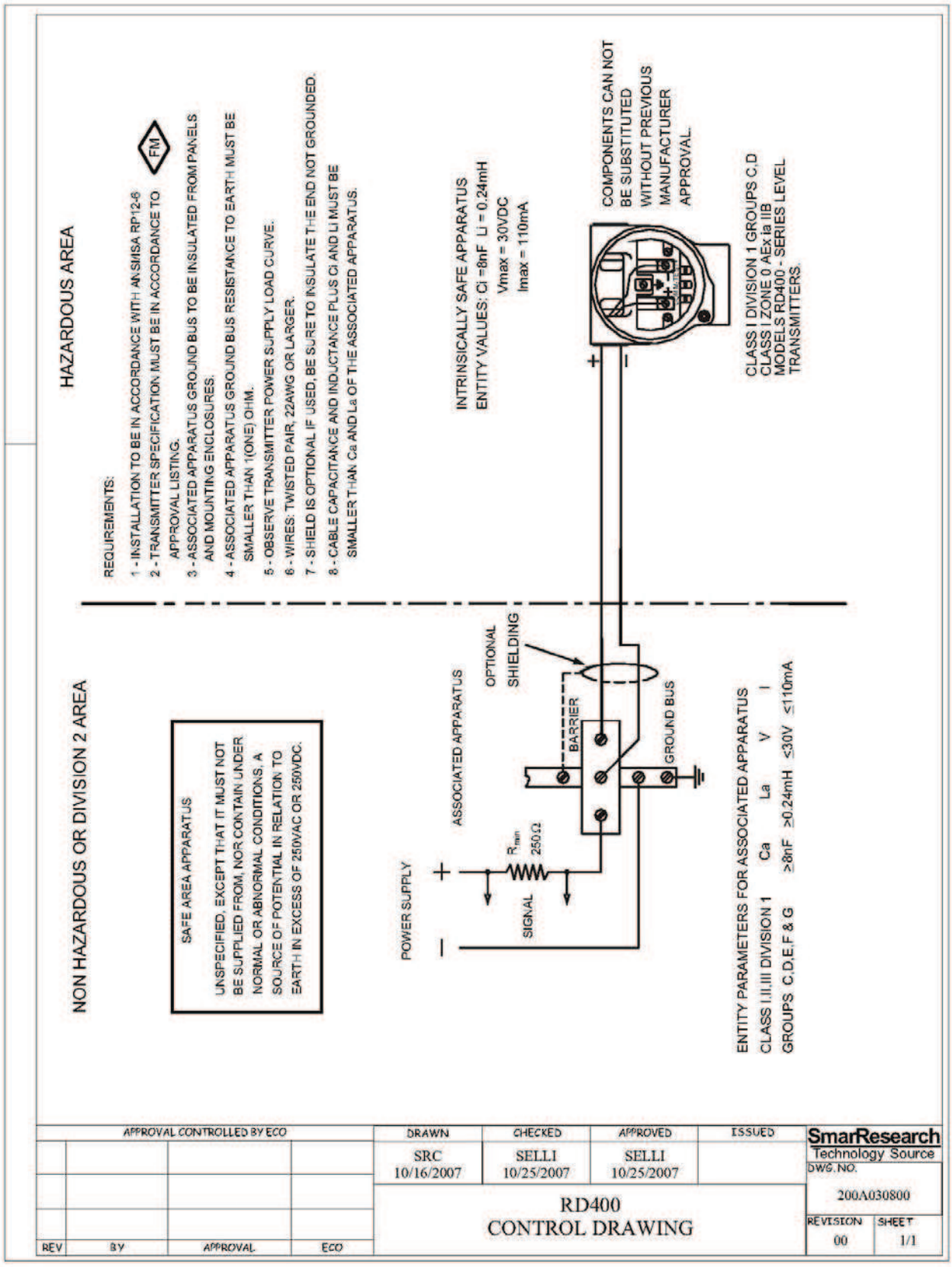


FM



Control Drawing

Factory Mutual (FM)



Appendix B

smar	SRF – Service Request Form Guided Wave Level Transmitter	Proposal No.:

Company:	Unit:	Invoice:

COMMERCIAL CONTACT		TECHNICAL CONTACT	
Full Name:		Full Name:	
Function:		Function:	
Phone:	Extension:	Phone:	Extension:
Fax:		Fax:	
Email:		Email:	

EQUIPMENT DATA

Model (Ordering Code):	Serial Number:	Sensor Number:
Technology: ( ) HART® ( ) FOUNDATION fieldbus™ ( ) PROFIBUS PA		Firmware Version:

PROCESS DATA

Process Fluid:

Probe Length (mm):	Tank Reference Height (mm):	Blockade Distance (mm)		Range (mm)	
		Min:	Max:	LRV (Min):	URV (Max):

Process Temperature (ºC)		Process Pressure (atm)		Ambient Temperature (ºC)	
Min:	Max:	Min:	Max:	Min:	Max:

Normal Operation Time:	Failure Date:

FAILURE DESCRIPTION

(Please, describe the observed behavior in the transmitter, if was had incrustations in the probe, inform about the counterweight and/or anchorage, if the insulator was submerged in the process, etc.)

OBSERVATIONS

USER INFORMATION

Company:

Contact: Title: Section:

Phone: Extension: E-mail:

Date: Signature:

Appendix C

SMAR WARRANTY CERTIFICATE

1. SMAR guarantees its products for a period of 24 (twenty four) months, starting on the day of issuance of the invoice. The guarantee is valid regardless of the day that the product was installed.

2. SMAR products are guaranteed against any defect originating from manufacturing, mounting, whether of a material or manpower nature, provided that the technical analysis reveals the existence of a quality failure liable to be classified under the meaning of the word, duly verified by the technical team within the warranty terms.

3. Exceptions are proven cases of inappropriate use, wrong handling or lack of basic maintenance compliant to the equipment manual provisions. SMAR does not guarantee any defect or damage caused by an uncontrolled situation, including but not limited to negligence, user imprudence or negligence, natural forces, wars or civil unrest, accidents, inadequate transportation or packaging due to the user's responsibility, defects caused by fire, theft or stray shipment, improper electric voltage or power source connection, electric surges, violations, modifications not described on the instructions manual, and/or if the serial number was altered or removed, substitution of parts, adjustments or repairs carried out by non-authorized personnel; inappropriate product use and/or application that cause corrosion, risks or deformation on the product, damages on parts or components, inadequate cleaning with incompatible chemical products, solvent and abrasive products incompatible with construction materials, chemical or electrolytic influences, parts and components susceptible to decay from regular use, use of equipment beyond operational limits (temperature, humidity, etc.) according to the instructions manual. In addition, this Warranty Certificate excludes expenses with transportation, freight, insurance, all of which are the customer's responsibility.

4. For warranty or non-warranty repair, please contact your representative.

   Further information about address and contacts can be found on www.smar.com/contactus.asp

5. In cases needing technical assistance at the customer's facilities during the warranty period, the hours effectively worked will not be billed, although SMAR shall be reimbursed from the service technician's transportation, meals and lodging expenses, as well dismounting/mounting costs, if any.

6. The repair and/or substitution of defective parts do not extend, under any circumstance, the original warranty term, unless this extension is granted and communicated in writing by SMAR.

7. No Collaborator, Representative or any third party has the right, on SMAR's behalf, to grant warranty or assume some responsibility for SMAR products. If any warranty would be granted or assumed without SMAR's written consent, it will be declared void beforehand.

8. Cases of Extended Warranty acquisition must be negotiated with and documented by SMAR.

9. If necessary to return the equipment or product for repair or analysis, contact us.
   See item 4.

10. In cases of repair or analysis, the customer must fill out the Revision Requisition Form (FSR) included in the instructions manual, which contains details on the failure observed on the field, the circumstances it occurred, in addition to information on the installation site and process conditions. Equipments and products excluded from the warranty clauses must be approved by the client prior to the service execution.

11. In cases of repairs, the client shall be responsible for the proper product packaging and SMAR will not cover any damage occurred in shipment.

12. In cases of repairs under warranty, recall or outside warranty, the client is responsible for the correct packaging and packing and SMAR shall not cover any damage caused during transportation. Service expenses or any costs related to installing and uninstalling the product are the client´s sole responsibility and SMAR does not assume any accountability before the buyer.

13. It is the customer's responsibility to clean and decontaminate products and accessories prior to shipping them for repair, and SMAR and its dealer reserve themselves the right to refuse the service in cases not compliant to those conditions. It is the customer's responsibility to tell SMAR and its dealer when the product was utilized in applications that contaminate the equipment with harmful products during its handling and repair. Any other damages, consequences, indemnity claims, expenses and other costs caused by the lack of decontamination will be attributed to the client. Kindly, fill out the Declaration of Decontamination prior to shipping products to SMAR or its dealers, which can be accessed at www.smar.com/doc/declarationofcontamination.pdf and include in the packaging.

14. This warranty certificate is valid only when accompanying the purchase invoice.