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Installation and Operating Instructions

Series DR1000 (TDR)
Guided Micropulse Instrument
for
Level Control Systems

(215) 674-1234 Outside North America
(800) 527-6297 US and Canada
http://www.drexelbrook.com
e-mail:Service@Drexelbrook.com

The DR1000 level gauge is designed solely for measuring the distance, level, volume and reflection of liquids, solids and particulate materials. The DR1000 level gauge does not form part of an overfill protection system. Special codes and regulations apply to its use in hazardous areas. Responsibility as to suitability and intended use of these level gauges rests solely with the user. Improper installation and operation of our level gauges may lead to loss of warranty.

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EDO 7-01-249
DR1000-LM

Series DR1000 (TDR)
Guided Micropulse Instrument
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Level Control Systems

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An ISO 9001 Certified Company

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SECTION 1
INTRODUCTION

1.1 Product Description

The DR1000 Guided Micropulse Level Instrument measures the surface level and interface level of liquids as well as the surface level of powders and bulk solids in tanks, silos, and bins. It uses the Time Domain Reflectometry (TDR) principle that is well known in continuity testing of communication testing.

A low voltage electromagnetic pulse is sent on a conductor (probe) to the surface of the liquid or powder in the vessel. The pulse is reflected by the surface back to the instrument. The time required for the pulse to travel from the instrument to the surface and back enables the electronics to determine the precise level in the vessel. The probe(s) guide the pulses, which means the tank shape and internals have no effect on the accuracy of the measurement as long as the recommended free space of 4 inches (100 mm) is respected.

Temperature, pressure, dust, vapors, dielectric constant variations (for surface level measurement) and tank shape and internals have no influence on the accuracy of the measurement.

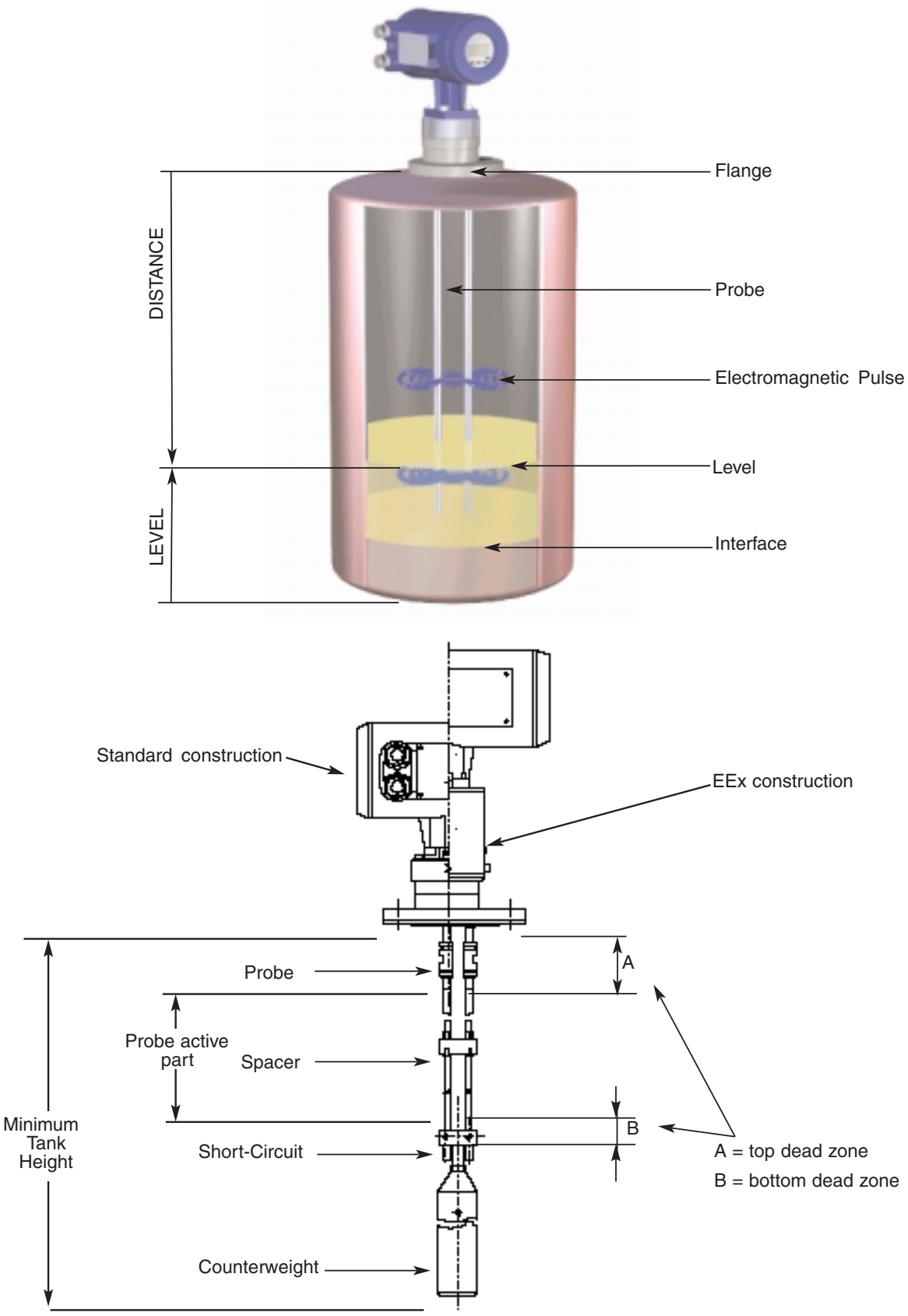


Figure 1-1
Definition of Terms

Table 1-1
Table of Terms

Term	Definition
Counterweight	Weight at end of cable probe.
Dead Zone	Area to the top/bottom of the probe where measurement is not possible or not linear.
Distance	Distance from the flange to the level or interface.
Electromagnetic Pulse	Electromagnetic pulse emitted by the electronics and guided by the probe.
Interface	Surface of the heaviest product.
Interface Level	Distance from the bottom of the tank to the surface of the heaviest product.
Layer	The thickness of the lightest product. (level — interface level).
Level	Distance from the bottom of the tank to the surface of the lightest product. Also surface of the lightest product.
Probe	Static sensor conductors attached to the flange (single or twin version).
Short Circuit	Shunt at the bottom of the twin probe only.
Spacer	Plastic bar between the twin probes to keep their distance constant.

1.2 Model Number

DR1000 4

Measuring system

A Twin Rod maximum length ≤20 feet (6 m)
B Twin Cable maximum length ≤200 feet (60 m)
D Coaxial maximum length ≤20 feet (6 m)
E Single Cable maximum length 70 feet (6 mm OD)
F Single Rod maximum length 10 feet (3 m)
G Reversed maximum length 20 feet (6 m)
K Single Cable solids 70-200 feet lengths (8 mm OD)

Software

1 Liquids (Direct and TBF mode)
2 Interface and Total Level
3 Solids (Direct and TBF mode)

Base length in feet (m)

0 0 (0)
1 33 (10)
2 66 (20)
3 99 (30)
4 132 (40)
5 165 (50)
6 200 (60)
Maximum length for twin cable.
Maximum length for single cable is 100 feet.

Incremental length in feet (m) or inches

0 0 (0) or 0 inches
1 3.3 (1) or 39 inches
2 6.6 (2) or 79 inches
3 9.9 (3) or 118 inches
4 13.2 (4) or 157 inches
5 16.5 (5) or 197 inches
6 19.8 (6) or 236 inches
7 23.1 (7) or 276 inches
8 26.4 (8) or 315 inches
A 29.7 (9) or 354 inches

Connection

A 1½", 150 lb
B 2", 150 lb
C 3", 150 lb
D 4", 150 lb
E 6", 150 lb
F 2", 300 lb
G 3", 300 lb
H 4", 300 lb
K 6", 300 lb
L 1" NPT
W 8", 150 lb

Flange facing

0 Raised Face

Material

1 316 L SS
2 Hastelloy C22 (Single Cable or Rod version only.)
3 Tantalum (Rod version only.)
4 Hastelloy C276 (Rod version only.)
5 Hastelloy B2 (Rod version only.)
A FEP Coating (Flexible Single Cable part only.)

Gasket

1 Viton
2 Kalrez

Device approval

0 Without
2 FM Div 1 / Div 2

Housing approval

0 Without
1 Explosionproof (NEMA 7 /Ex d)

Housing material

1 Aluminum
2 Stainless steel 316 L SS (not FM approved)

Cable gland

1 ½ inch Cable gland
2 ½ inch NPT

Indication (Note 1)

0 Without
1 With indication

Power supply

1 100 to 240 V AC
2 24 V AC / V DC

Current Output

2 2 Passive 4-20 mA
3 1 Active 4-20 mA (can also be wired passive, not IS)
5 2 Passive (IS)
6 1 Active (can also be wired passive IS)
7 RS485
A RS485, 1 Passive 4-20 mA (can also be wired passive-IS)
C PROFIBUS-PA

Protocol

1 HART®

Standard

Counter weight

0 Without
2 D 2" x L 12" (standard for Twin Cable)
3 D 3.5" x L 4" (optional for Single Cable)
4 Turnbuckle
5 D 2" x L 10" (standard for Single Cable)
6 D 3.5" x L 5" (optional for Twin Cable)
7 D 0.5" x 60" (optional for Single Cable)

DR1000	4																		1	0

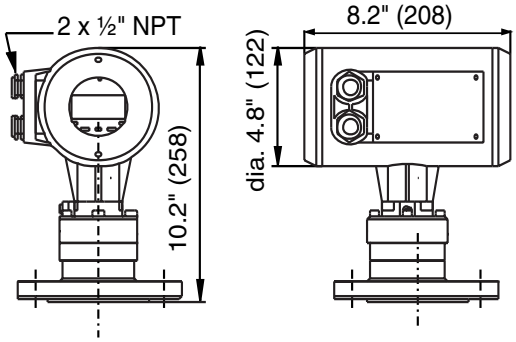
1.3 Probe Selection Guide

Recommended Applications			
Single Cable or Rod	**Coax**	**Twin Cables**	**Twin Rods**
•Cement, limestone, flyash, alumina. •Highly viscous liquids. •Plastic powder, e.g. PVC. •Plastic granular silos.	•Tank height 20 feet (≤ 6 m). •LPG, LNG, solvents, NH_3, foam, alcohol, oil/water separators.	•Plastic granular silos. •LPG, LNG, NH_3, spheres, alcohol. •Water storage level.	•Tank height 20 feet (≤ 6 m). •All liquid applications; NH_3, solvents, oil, LPG, etc. •For multifluid storage tank.
Especially for fine powder applications:	**Only for clean liquids level and interface levels:**	**For high silo or tank with liquid interface or granulars:**	**For liquid, interface and powder or granular level:**
•For all fine powder applications > 20 feet. •For all viscous liquids. •To create a coax version using an existing stilling well (calibration required). •Crystallizing products with FEP coating. •To see through highly conductive foams. •High temperature applications without spacers (temperature limit at the flange). •Tank height 133 feet (< 40 m).	•Liquid agitation or flow. The coax acts as a stilling well. •Liquid or vapors spray near the probe. •Can be heat-treated. •Contact possible with metallic object or tank wall. •Very low εr liquids.	•Same as twin rods, but up to 200 feet / 60 m. •For smaller tanks with no head clearance. •For light solids such as plastic granulars or fluff; products with $\varepsilon r < 1.8$ and lengths < 60 feet (20 m).	•Same as *Coax* for all other applications. •Sensor in special materials available (e.g. tantalum). •Where probe is not straight. •For minimum bottom dead zone in small tanks (no counterweight).
Non-Recommended Applications			
•Small nozzle diameters. •High nozzle heights.	•Crystallizing liquids. •Liquids with solid particles. •Scaling products. •Powders. •Viscous fluids (e.g. crude oil).	•Agitated tank without anchoring. •Product temperature 464˚F (240˚C)(maximum limit with optional PTFE spacers).	•Contact with objects inside tank •Product temperature 464˚F (240˚C)(maximum limit with optional PTFE spacers).

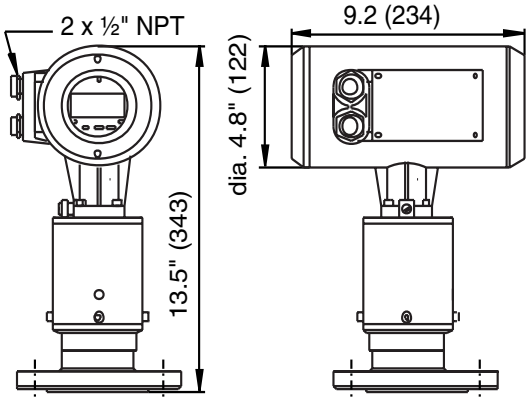
1.4 Types of Probes

HOUSINGS

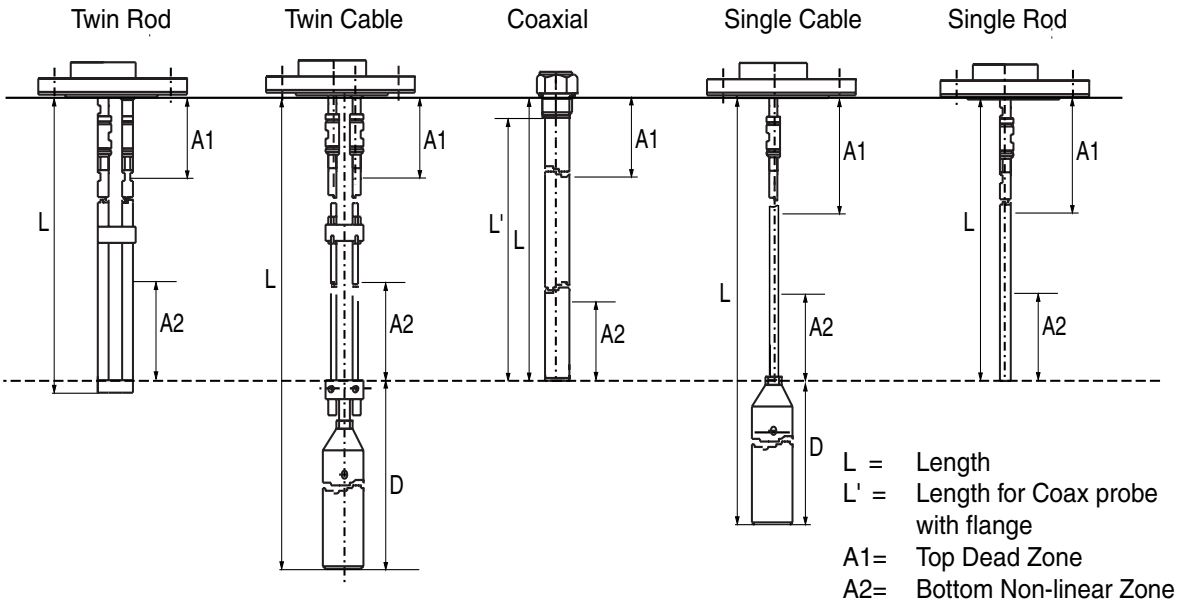
Standard



Ex/FM



PROBES



L = Length
L' = Length for Coax probe with flange
A1= Top Dead Zone
A2= Bottom Non-linear Zone
D = Non-measurement Zone

Dimensions in inches (mm).

εr	Zone	Twin Rod	Twin Cable	Coaxial[1]	Single Cable	Single Rod
80	A1	11.8" (300)	11.8" (300)	0"	15.7" (400)	15.7" (400)
80	A2	0.4" (10)	0.4" (10)	1.8" (45)	4" (100)	4" (100)
2	A1	13.0" (330)	13.0" (330)	0"	19.7" (500)	19.7" (500)
2	A2	3.9" (100)	3.9" (100)	5.3" (135)	7.9" (200)	7.9" (200)
-	D	-	11.8" (300)	0"	11.8"[2] (300)	-

[1]Optional Coax construction available with no top dead zone.
[2]or less on request. Minimum value is 3.0" (75).

SECTION 2 INSTALLATION

2.1 Unpacking

Carefully remove the contents of the shipping carton and check each item against the packing list before destroying any packing material. If there is a shortage or damage, report it to the factory immediately.

When handling the DR1000 TDR instrument avoid hard blows, jolts, impacts.

2.2 Installation Considerations

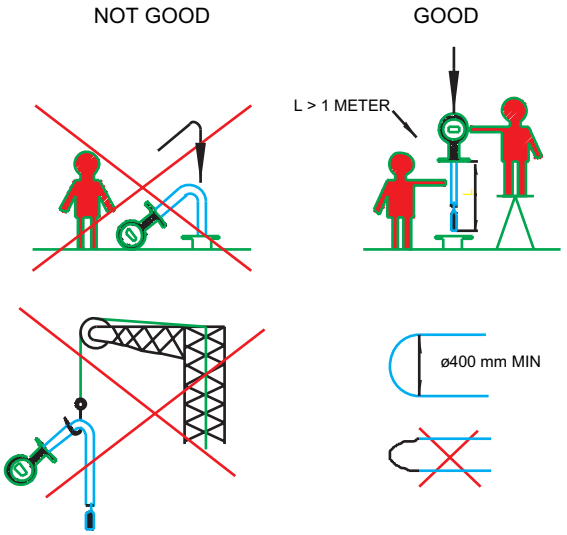


Figure 2-1
General Installation Recommendations

- Installation requires two service personnel.
- Do not expose DR1000 instrument to direct sunlight. Install a sunshade if necessary.
- The ambient temperature on the instrument must be between -20°F and 140°F (-30°C and +60°C).
- The minimum temperature for the display is -4°F (-20°C). Lower temperatures may cause the display to disappear. However, the electronics will continue to work and access the indication via PC-STAR software.
- The operating temperature (at the flange) must be between -20°F (-30°C) and +302°F (150°C).

2.2 Installation Considerations (cont.)

- For non Ex/FM applications the temperature at the flange can attain 392°F (200°C).
- The maximum process temperature for probes with standard Tefzel spacers is 302°F (150°C); for probes with optional PTFE spacers is 404°F (240°C).
- Do not expose to intense vibration.
- Always handle the probe with care.
- Do not kink the cable probes smaller than a 4-inch radius or bend the probe rods.

2.3 Twin Rod or Twin Cable

The position of the instrument on a tank or other storage vessel can be centered or off-center as long as there is 4 inches (100 mm) of free space around the probes. Place the probes 4 inches (100 mm) from the tank wall or obstacles such as cooling or heating tubes or a dip pipe.

If necessary, position the negative probe (the one that is welded to the flange) as close as 2 inches (50 mm) to the tank wall.

For mounting in stilling wells of less than 4 inches (100 mm) in diameter, on-site calibration is required to ensure accuracy (modification of the Er of air in the Factory Menu 2.3).

2.4 Coax Probe

The coax probe is not affected by the installation environment, assuming the liquid is compatible in terms of viscosity, etc. The measurement is made inside the tube, which acts as a stilling well. Any conductive contact on the outside of the tube has therefore no effect on the measurement, and there are no limitations as with the other probe types for the nozzle size and free space.

2.5 Single Cable or Single Rod

The position of the instrument on a tank or other storage vessel can be centered or off-center as long as there is 20 inches (500 m) of free space around the probes. Installation on a stilling well down to 2 inches (50 mm) diameter is possible as long as the probe does not touch the inside of the stilling well. For installation in a stilling well it is advised to use a centralizing probe end (rod with 'T' end, or cable with pancake weight) as a means of ensuring no contact between the probe and the stilling well. On-site calibration is required for best accuracy and performance.

Place the probes 20 inches (500 m) from the tank wall or obstacles such as cooling/heating tubes. For the full function of TBF mode in low dielectric applications over 15m, ensure there is 20 inches (500 m) between the underside of the counterweight and the tank bottom.

Tank nozzles should be avoided if possible. If there is a tank nozzle, it must have a diameter at least its height. Mounting directly on the manhole is preferred.

Mounting of the single cable or rod probe on a non-conductive tank is possible and does not affect the measurement function.

2.6 Fixing End of Probes

Avoid installations too close to an agitator, which may cause the rods or cables to become entangled. It is recommended that in an agitated tank or other turbulence, the bottom end of the probe be fixed. This can be done as follows:

- Twin rod probe: Weld a 1.77 in (45 mm) I.D. tube on the bottom of the vessel and insert the two rods.
- Twin cable probe: Remove the counterweight and use the M12 threading to fix a tightening device such as a turnbuckle, spring, or ring and hook.

CAUTION

Avoid over torquing the thread and excessive tension in the probe. Maximum torque is 6 N·m (53 ·lb in.).

-Coaxial type probe: Weld a 1.2 in (30 mm) I.D. tube at the bottom of the vessel and insert the coaxial tube. The coaxial tube can also be fixed with a brace at any point along its length.

2.6 Fixing End of Probes (cont.)

- Single cable probe: Be aware of excessive traction forces when fixing the probe end in solid applications. Remove the counter-weight and use the M10 threading to fix a tightening device such as a turnbuckle, spring, or ring and hook. Fixing the probe to the tank bottom with an electrical conductor can help reduce the level of static build-up in applications with high static.

- Single rod probe: Weld a 0.5 in (12 mm) I.D. tube at the bottom of the vessel and insert rod.

-Cable probes for FM/Ex applications: To avoid the cable swinging inside the vessel, it is recommended to fix the end securely at the bottom of the vessel.

-Nozzles / Standoffs: No contact between the nozzle shoulder and the probe. Avoid nozzle heights (h) greater than the nozzle's diameter (d).

-Specification of probe length: The probe length (L) specified when ordering the DR1000 instrument is always considered the extremity of the probe (bottom of short-circuit, bottom of counterweight).

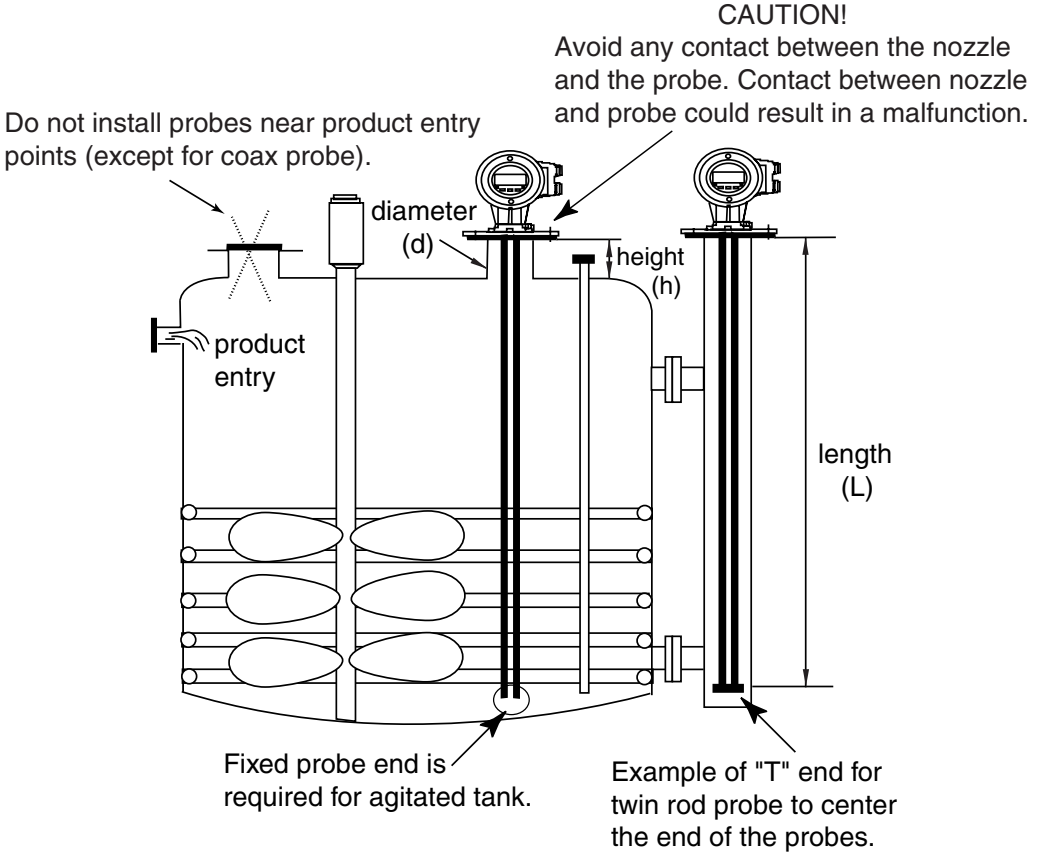


Figure 2-2
Installation Guidelines for Probe

2.7 Installation in Applications with Solids

2.7.1 Traction

Before installation it is important to consider the possible traction loads on the silo roof. The traction load depends on the height of the tank, density of the product, product particle size, shape of the silo and rate of emptying. Typically fine powder products exert the highest level of traction. The cable probes of the DR1000 are designed to fail at specific traction loads as follows:

0.2 in (6 mm) diameter single cable[1] 4000 lbs (18 kN)
0.3 in (8 mm) diameter single cable 7700 lbs (35 kN)
[1]In the case of twin probe application, the total load on the roof will be twice that of a single probe.

2.7.2 Electrostatic discharges

In certain solids silos, high levels of static can be found. To reduce the chances of discharges, install the DR1000 instrument as close to 20 inches (500 m) from the silo wall as possible, and as far away from the entry point of the product. Selecting a twin conductor probe (if compatible with the product) or connecting a conductor from the end of the probe to the tank earth can help reduce static levels. Ensure that the tank and product entry pipes are grounded correctly.

2.7.3 Probe anchoring

It is not recommended to anchor the probe in solid applications due the resulting increase in traction force. However it is possible for shorter heights, but with high silos or tanks, an anchored probe could cause the instrument to fail.

2.7.4 Deposits underneath the Flange

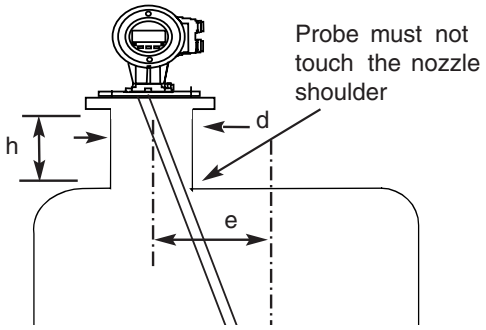
NOTE

It is strongly recommended to use a flange of at least 4" ANSI for all solids applications.

Avoid mountings where build-up of conductive product can collect under the flange (e.g. humid particles, carbon dust etc.). The strength of the return reflection of the true level could be weakened. If necessary, install an air-purge or insulate the top section of the probe and underside of flange.

2.7.5 Emptying Cycle in Conical SIlos

For those solids applications using twin probes or single probes (e.g. plastic granules), use the following installation guidelines to ensure that during the emptying cycle the probe is not pulled across and into contact with the nozzle shoulder. The following calculation can be used.

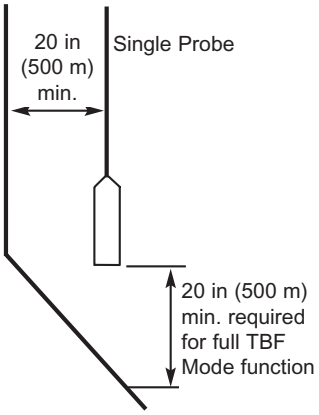


Maximum height of the nozzle is: $\mathbf{H_{max} = dxl/4e}$
where: d = Diameter of nozzle
l = Length of rod or cable
e = Eccentricity from center of tank

NOTE
Avoid mounting in a tank nozzle, if possible. Mounting directly on the manhole is preferred.

2.7.6 Single Probe in Solids

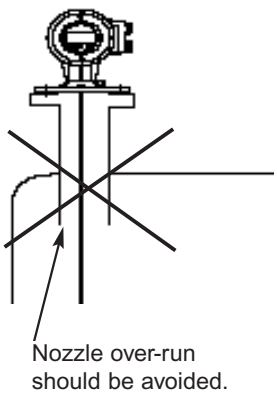
In solids applications using a single probe, the preferred mounting is either directly onto a flush manway or if a nozzle is used ensure that the nozzle has a diameter at least the height. In all cases the nozzle should not exceed 12 inches (300 mm). For all applications, the probe should never come in into contact with the nozzle (e.g. due to agitation).



For those solids applications over 100 feet (30 m), be sure to use the 0.3 in (8 mm) diameter cable with rod counterweight.

Detection Delay
In certain cases where the single probe is installed on a conical roof or with a nozzle, it is recommended to enter a detection delay in the User Menu. Enter a value which is slightly greater than the depth of the conical roof to filter any noise at the top end of the probe.

For the single probe, it is recommended to have at least 20 inches (500 m) distance between the probe and silo wall. Severe irregularities in the inner silo wall, or reduction in this distance can cause reflections.



Additionally for all applications where the probe length is >15m and the dielectric of the product is <2.1 (i.e. where TBF Negative Mode is required), 20 inches (500 m) underneath the counterweight is required.

In all cases, avoid nozzles with an over-run into the silo or tank.

2.8 Mounting Dimensions

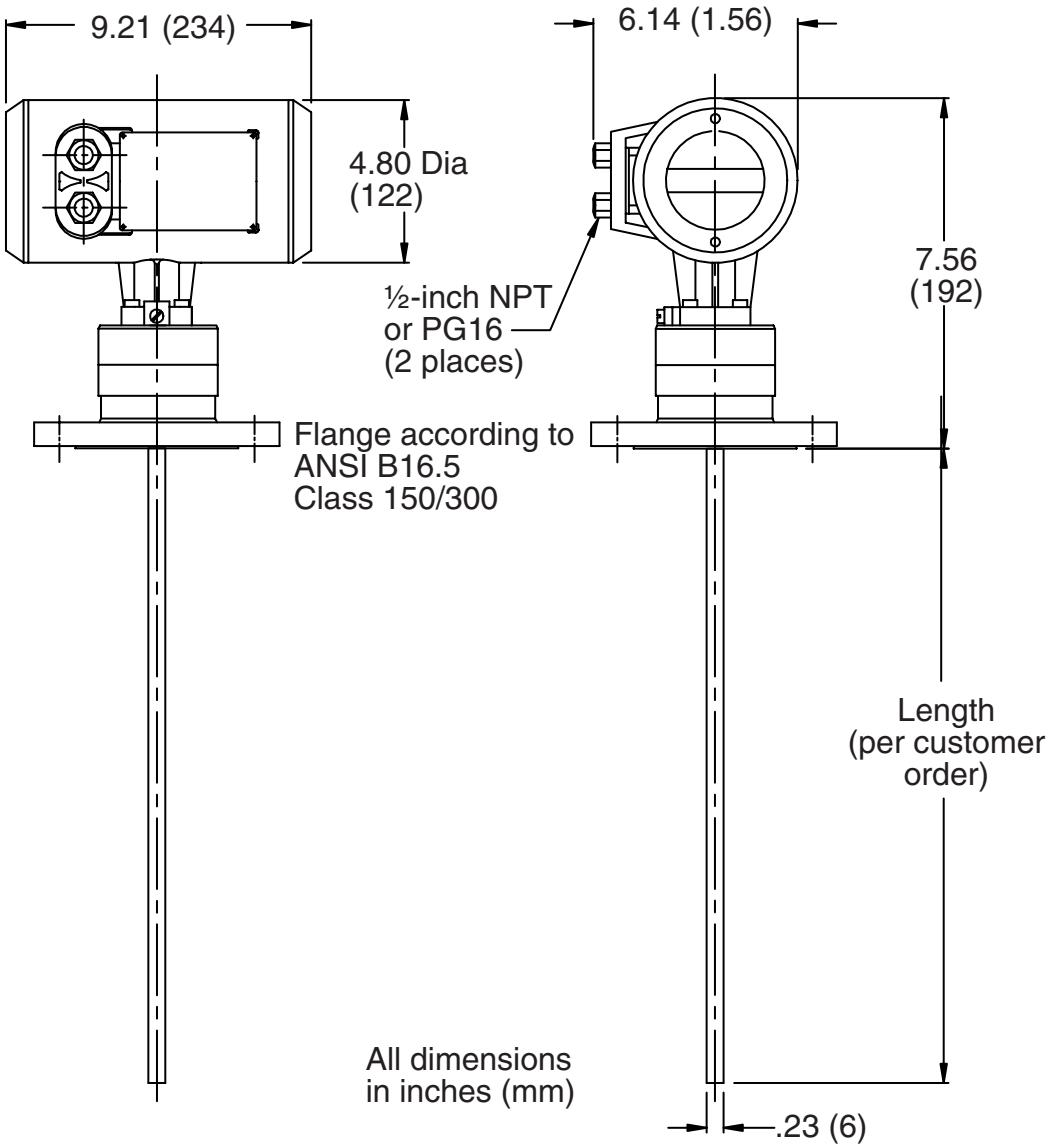
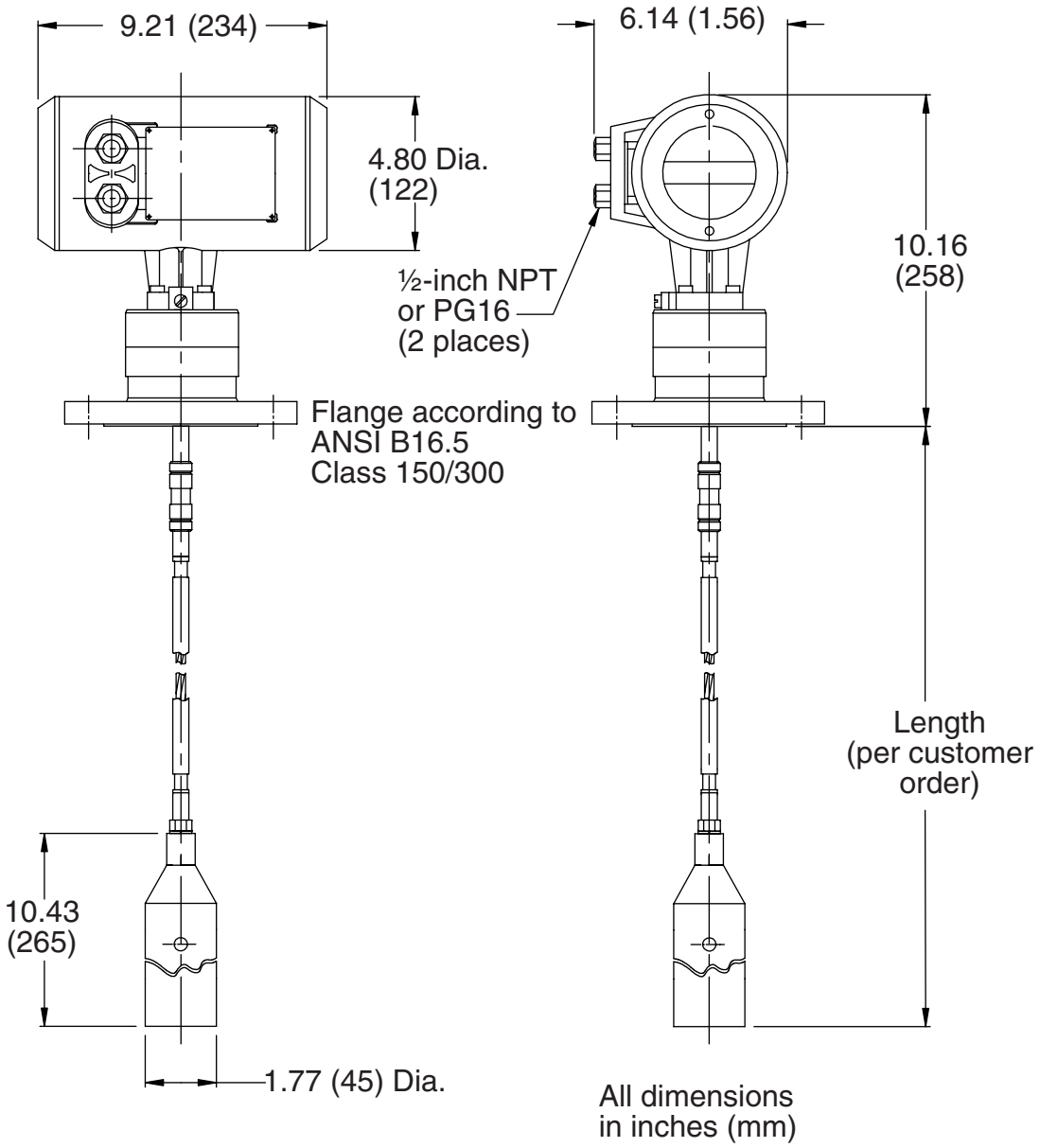


Figure 2-3
DR1000 Single Rod Probe

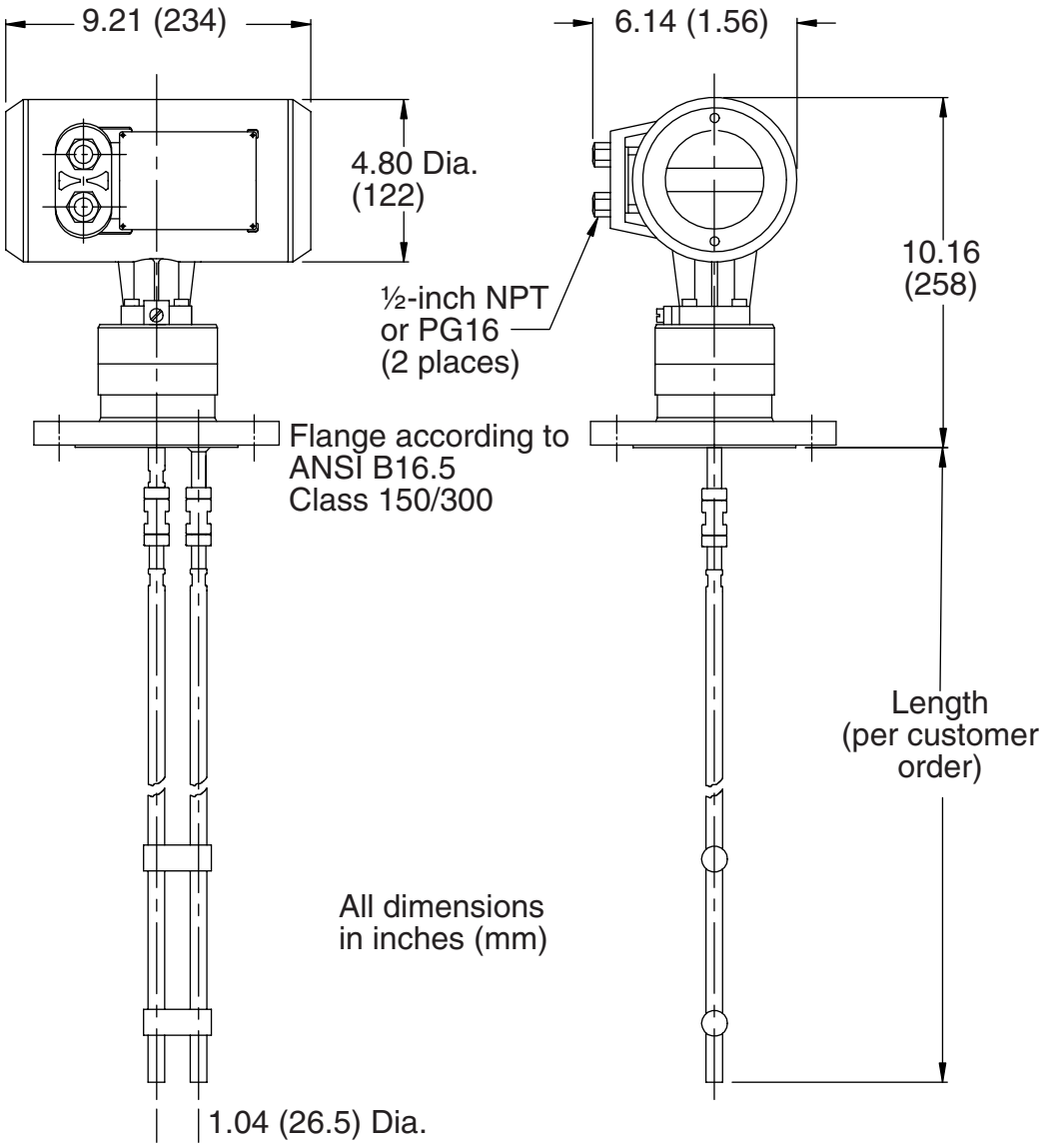
2.8 Mounting Dimensions (cont.)

Figure 2-4
DR1000 Single Cable Probe



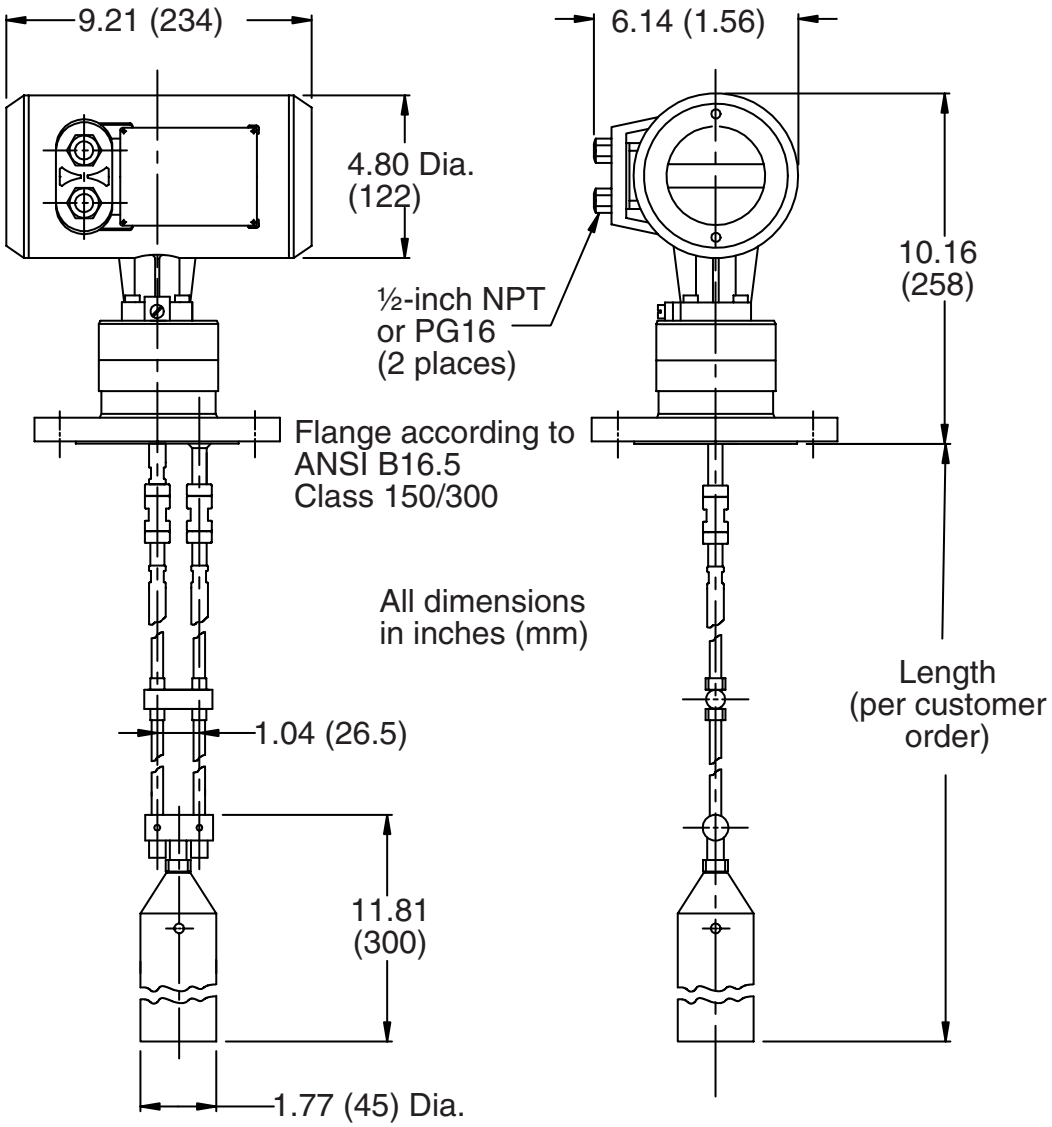
2.8 Mounting Dimensions (cont.)

Figure 2-5
DR1000 Twin Rod Probe



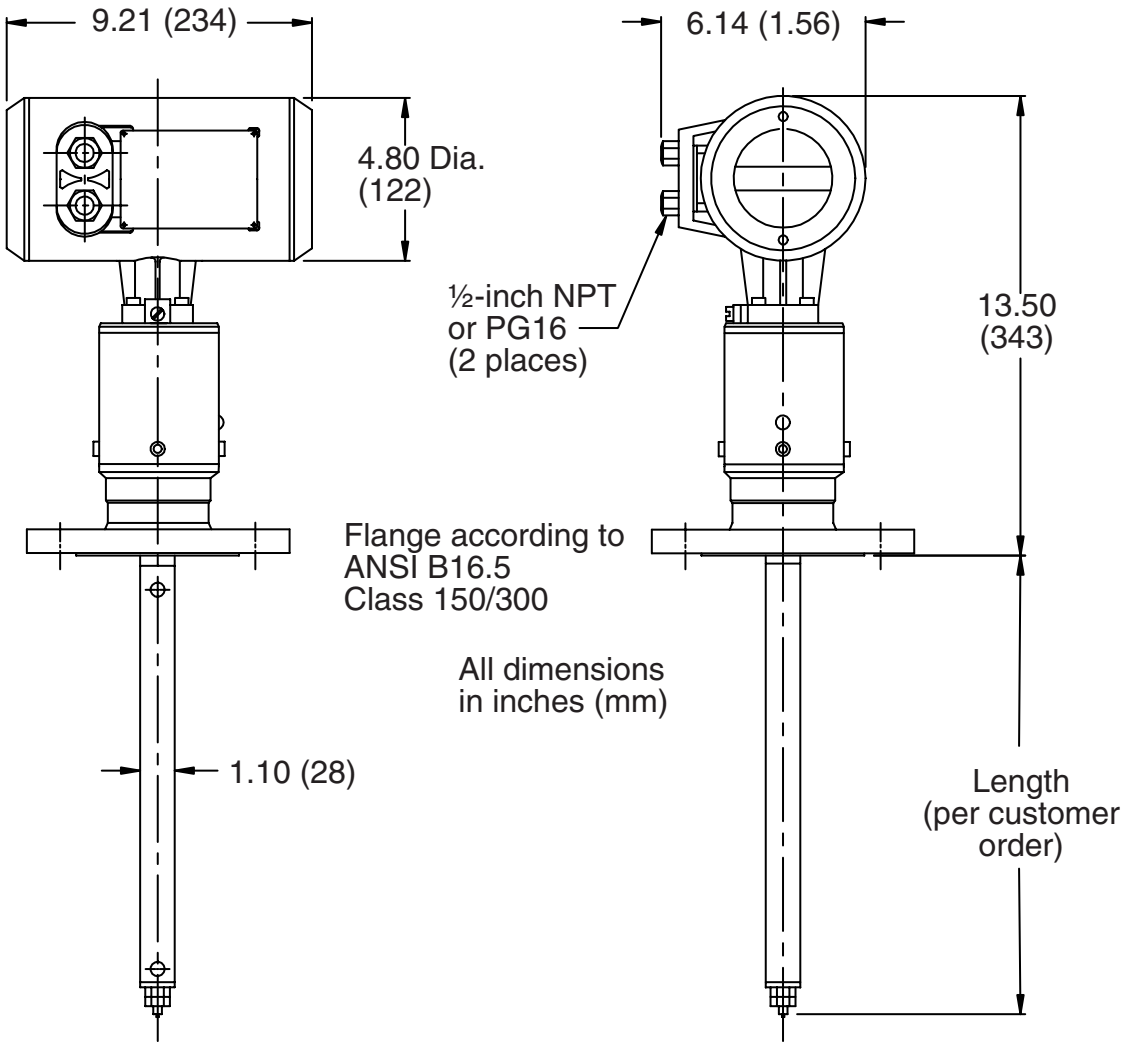
2.8 Mounting Dimensions (cont.)

Figure 2-6
DR1000 Twin Cable Probe



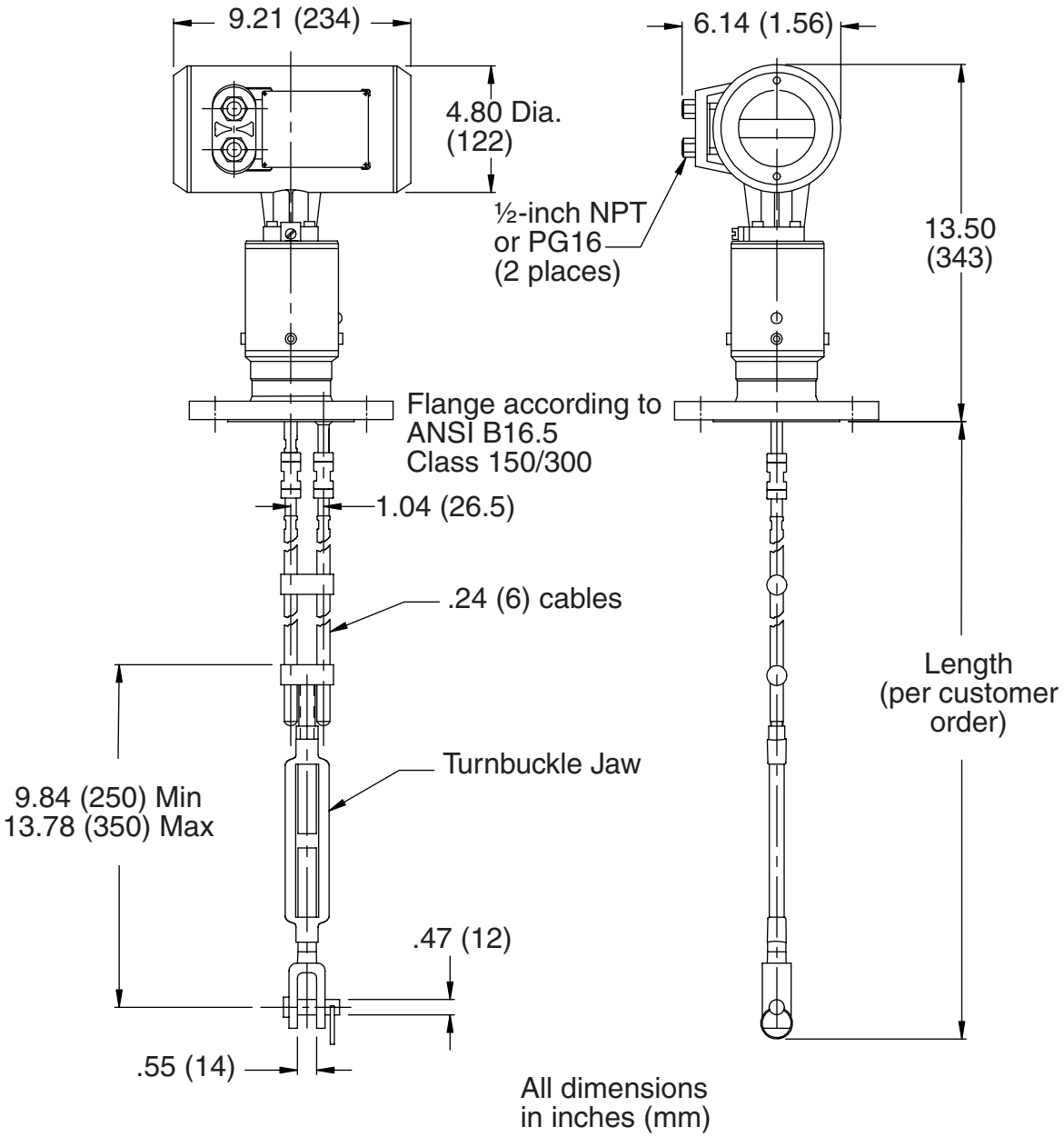
2.8 Mounting Dimensions (cont.)

Figure 2-7
DR1000 Coax Cable Probe



2.8 Mounting Dimensions (cont.)

Figure 2-8
DR1000 Cable Probe with Turnbuckle



2.9 Wiring

WARNING

Wiring must comply with local regulations.

CAUTION

To maintain a rating of NEMA 4 or IP67, use appropriate wiring methods, conduit, and fittings.

CAUTION

To minimize RFI/EMI effect, use grounded metal cable gland on input power leads (option).

NOTE

The outputs of the DR1000 instrument are galvanically isolated.

2.9.1 Insulation rating

The insulation of the DR1000 instrument is rated in conformity with IEC 1010-1: 1990 and takes into account the following ratings:

1) overvoltage category for the power line circuit: III
DR1000 instruments do not feature any internal device for switching or disconnecting. In conformity with operating regulations, these devices must be provided near the instrument for safety insulation or disconnection of the equipment when the system is installed. External recommended fuses value are 4 to 6.3 A Time Lag type. The active phase conductor (L) of the incoming line circuit is protected inside the instrument by a fuse but not the neutral conductor (N). It is necessary, to add fuse protection on both lines in conformity with above regulations.

2) overvoltage category for the output circuit: II
No fuse required.

3) insulation contamination level: 2
The contamination level applied to the inside of the instrument, the complete unit is protected against ingress of water and solid foreign bodies (> IP65, equivalent to Nema 4 and 4X) and assuming proper installation, is thus dimensioned to operate under contamination 4 conditions.

4) protection class: I
DR1000 level and interface gauge is designed for safety class 1, in conformity with IEC 1010-1: 1990

2.9.2 FM/Ex Wiring Requirements

General

Do not cross or loop cables in the wiring compartment of the signal converter. Use separate cable glands for power and current output cables.

- For an FM/Ex instrument with optional FM/Ex i outputs, install properly the metallic separation between current outputs and power supply terminals.
- Always close and open housing covers with the delivered wrench.
- For FM/Ex installations install a rigid 10 gauge connection between the instrument and the vessel flange.
- For the installation of the DR1000, national lightening protection requirements have to be respected.
- For all power supply higher than 50V it is also required to wire the internal earth connection, of the instrument.

High temperature application

For process fluid temperature above 212°F (100°C), the cables used for the power and the current outputs, have to be specified for a continuous operating temperature of 167°F (75°C).

Cable Gland (½-inch NPT)

- Do not add any plastic film on the threading and make sure the connectors are tightened securely.
- Do not bend cables close to the entries, if possible use a metallic protection sheath (pipe).
- Provide water drip points on all conduits leading to the instrument.

Communication Compatibility

The wiring should be done according to the intrinsically safe regulation. Use adapted barriers only with Hart® protocol compatibility to access the DR1000 remote configuration function. If not, use an EExi Hart® handheld terminal. An active barrier including 24 Vdc power supply for the loop is recommended. With the two passive analog output configuration, use four wires for the barrier connection.

The maximum values of the equipment have to satisfy the values of the DR1000 outputs are as follows: (for more information refer to the certificates of conformity).

Ui < 30 V Ii < 300 mA Ci < 5 nF Li ~ 0 mH

2.9.2 FM/Ex Wiring Requirements (cont.)

In active mode, the maximum electrical values for terminal 4, which is the source for the output, are:

Category / Group	U o	I o	P o	L o	C o
FM/Ex ia IIC / FM/Ex ib IIC	24V	100mA	0.6 W	4 mH	115 nF

For each FM/Ex application, the DR1000 is to be assigned to a certain temperature class, which depends on the maximum process fluid temperature (see table below).

Temperature Class	Maximum process temperature	Maximum ambient temperature
T6	185°F (85°C)	50 °C
T5	212°F (100°C)	50 °C
T4	266°F (130°C)	50 °C
T3	302°F (150°C)	50 °C

2.9.3 Power

The DR1000 instrument has two types of power supply boards, a 24 Vac/dc power supply board with automatic detection or a 100-230 Vac universal power supply board. Check the data plate on the instrument to determine the specific voltage of the unit. Bring the power leads in through either of the two electrical cable glands on the side of the housing: a ½-inch cable gland or a ½ NPT connection (customer-specified). Access the terminal connections by removing the cover on the rear of the housing with the special wrench provided and attach the L, N, (terminals 11,12) and earth (ground) wires to terminals shown in Figure 2-10.

2.9.4 Output Signal

The DR1000 instrument is equipped with one or two (option) current outputs, I1 and I2. A connection diagram is located inside the cover of the terminal compartment. In active mode, short cut terminals 6 and 4; Connect to 5 and 6 for I1 or 4 and 4.1 for I2. The maximum load is 350 ohms for a standard output.
Using PC-STAR communication software, the instrument can be used remotely and out of a hazardous area. This requires at least a 250 ohms loop resistance. The output must be connected to analog output 1.

NOTE

The active output construction is made up of a passive output board and an internal power supply. If the active output option is ordered, it is still possible to wire the output in a passive configuration.

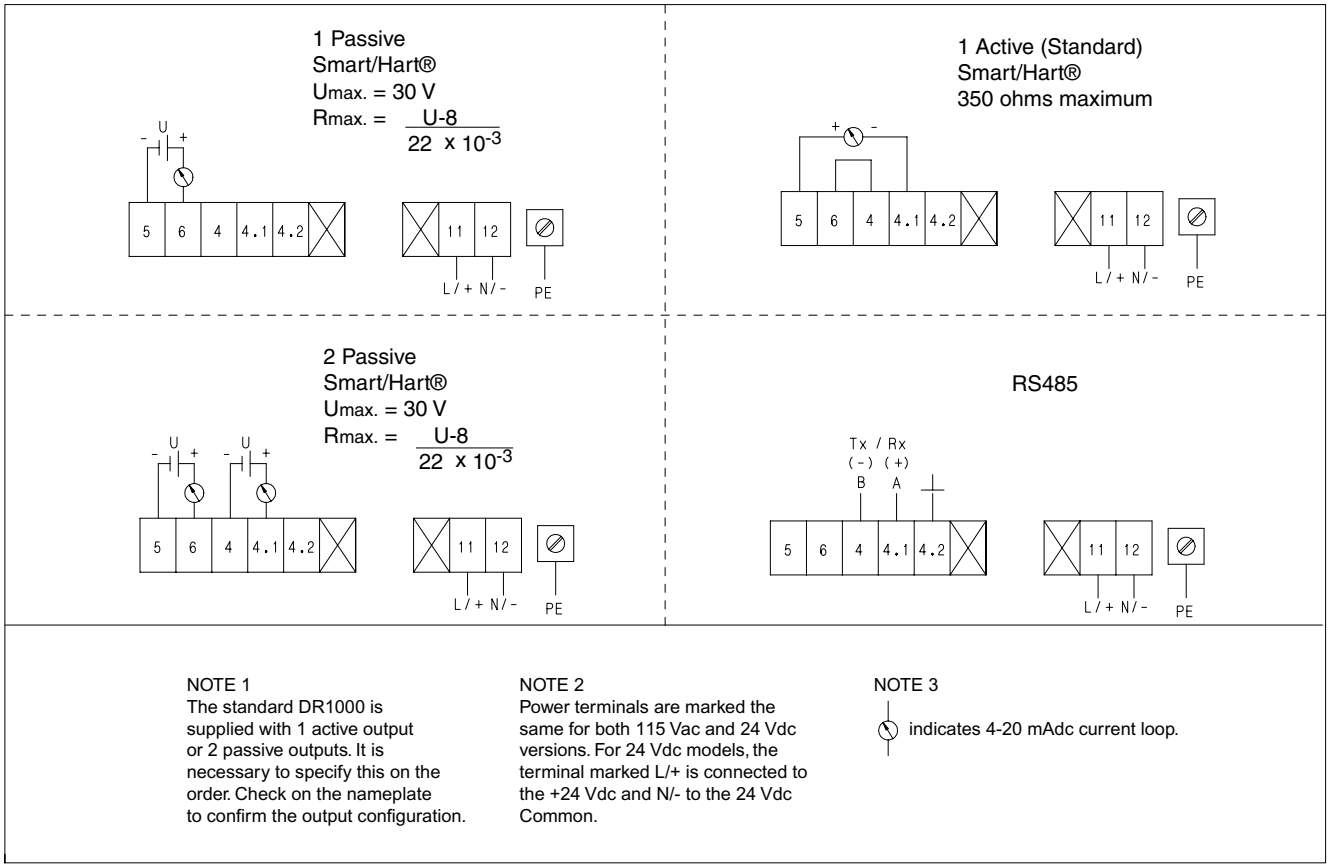


Figure 2-10
DR1000 Output Wiring

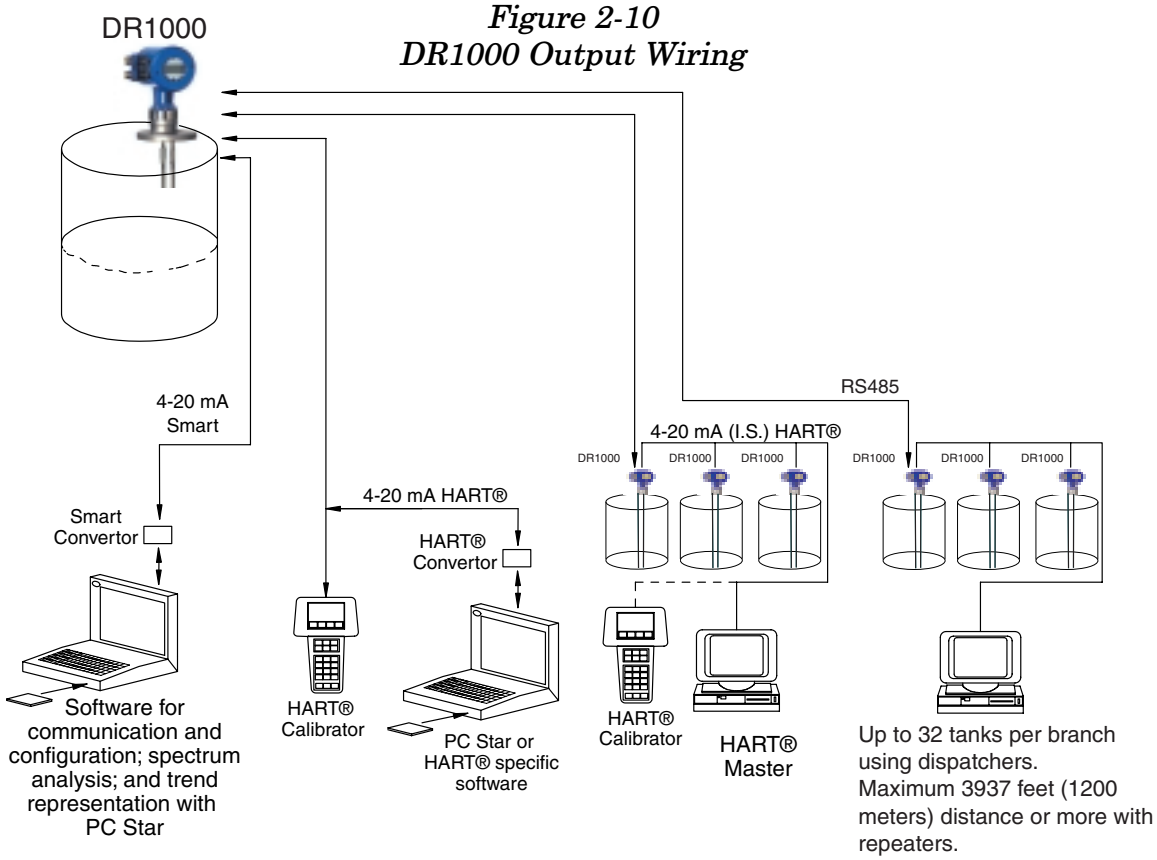


Figure 2-11
DR1000 Network Communications

SECTION 3
OPERATION

3.1 Start-up

When the instrument is powered-up and the test procedure is successfully passed, the DR1000 instrument automatically goes into measurement mode. The test duration varies from 20 seconds to 1.5 minutes. The display indicates the reading in the selected measuring unit. If the cyclical display is selected, the display alternates the displays specified. For example, if you are doing a level measurement, you may have specified alternate display of level and distance. Status markers appear at the bottom of the display if an error occurs.

3.2 Calculation of the Measured Value

Refer to Figure 3-1. The DR1000 instrument measures time between reflections and converts it to a distance or a level information with the following formulas:

Delta T	Time between Initial Pulse and Level Pulse (mS).
Calspeeds	(Electronic Calspeed) x (Mechanic Calspeed) (mS/mm).
Offset	Distance between Initial pulse and bottom surface of the flange (mm).
Epsilon R	Dielectric constant of first medium under the flange, normally 1.00.

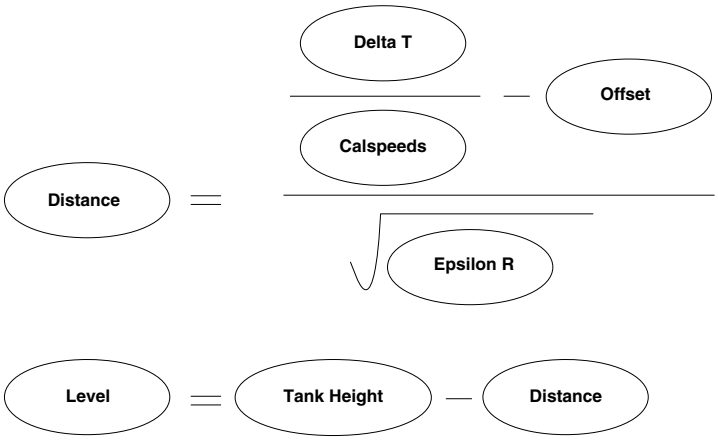


Figure 3-1
Calculation of the Measured Value

The measured time between the initial pulse and the level pulse is translated in millimeters by the Calspeed setting. This primary distance is corrected by the offset and then standardized to the reference point (= flange). This primary distance is divided by the Epsilon R square root (if there is only one product in the tank, the Epsilon R is 1.00 [air]). The level is calculated as the difference between tank height and distance. All parameters (excepted Delta T) are accessible via the digital communication menus.

3.3 Controls and Display

The DR1000 instrument is easy to use. It has three tactile pushbuttons and a three-line LCD display. A general description of the controls and display is shown in Figure 3-2.

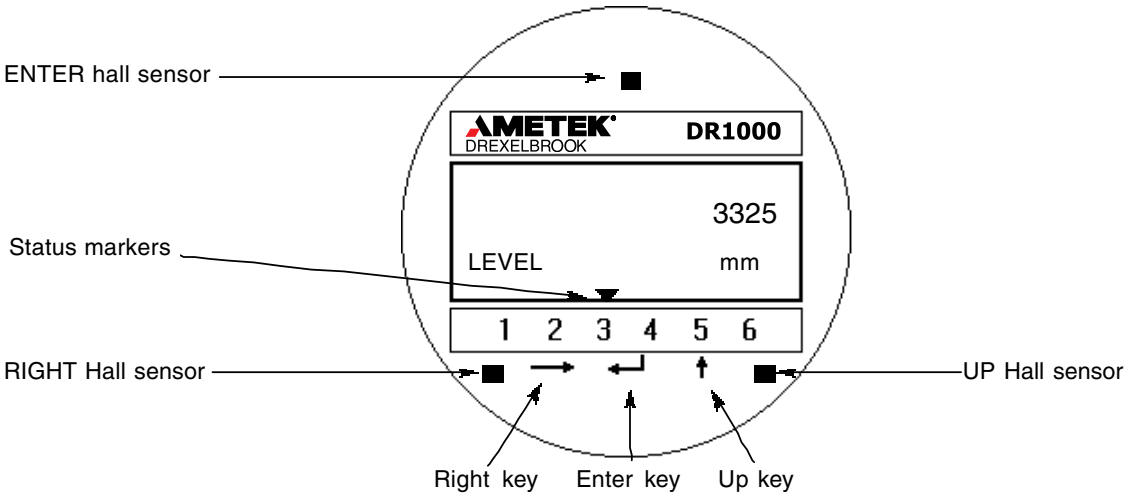


Figure 3-2 Controls and Display

Table 3-1 Display Functions

Controls/Display	Function
Display First Line	Value of measurement in Operating mode. Function (Fct) number in Configuration mode.
Display Second Line	Item measured and unit of measurement in Operating mode. Function definition in Configuration mode.
Status Markers	Identify six types of errors with triangular indication over the number. 1. No initial pulse detected. See Troubleshooting section. 2. No level reflection found. See Troubleshooting section. 3. Level reflection loss; output and indication frozen; research initiated; if no reflection found, Status #2 is activated. 4. No interface reflection found. See Troubleshooting section. 5. Interface reflection loss; output and indication frozen; research initiated; if no reflection found, Status #4 is activated. 6. Output communication failure. Contact Factory Service.
Right Key	Enables entering Configuration mode. Moves cursor to right in Configuration Mode. Used with other keys in password definition.
Enter Key	Goes back one step in Configuration mode. Validates data entered. Used with other keys in password definition
Up Key	Increases the value of a selected digit. Used with other keys in password definition.
Hall Sensors	Sensors for configuring through the window with the supplied bar magnet.

SECTION 4
PC STAR COMMUNICATION

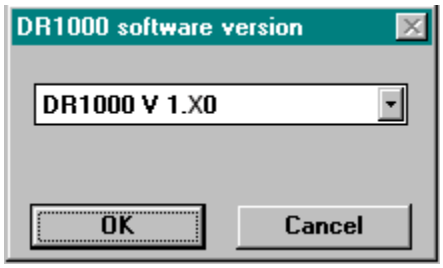
4.1 Description

PC Star is a unique Windows®-based software for remote communication and configuration of the DR1000 instrument. PC Star is compatible with Windows 3.1 and 95 (Windows NT can run and read recorded PC Star files, but not communicate).

If the DR1000 instrument is set in HART mode, in order to communicate with PC Star, it is necessary to enter the Factory Menu 1.3.1 and select SMART. The change can be done remotely in either direction (HART to SMART to HART) at a distance using a HART communicator (when in HART mode) or PC Star (when in SMART mode). Communication will be lost with the original protocol as soon as the change is made.

4.2 Installation and Connection

Before installing PC Star, uninstall any previous versions and copy the 'Records' files to another directory. Only one version of PC Star can be installed at any one time. Once installed, the PC Star software requires the VIATOR HART/RS232 module for connection between the PC and the DR1000. The connection of the interface should be across a 250 ohm resistor. The resistor must be wired in series in the loop.

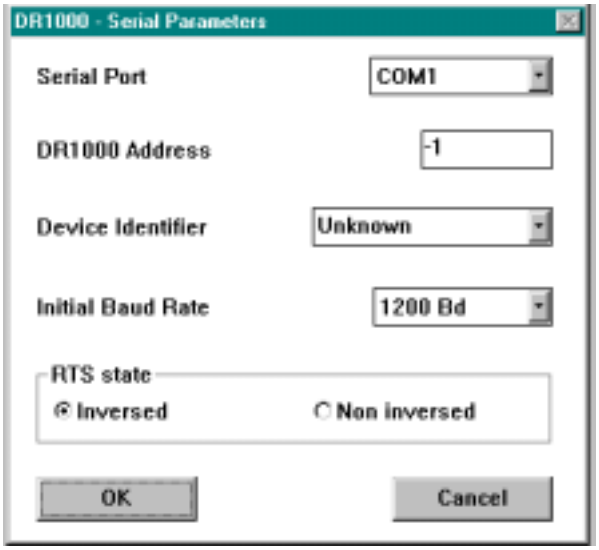


Before pressing 'F2 Connection', set the correct 'DR1000 Software Version in Menu 'F7 Configuration' (i.e. to version 1.20 or above).

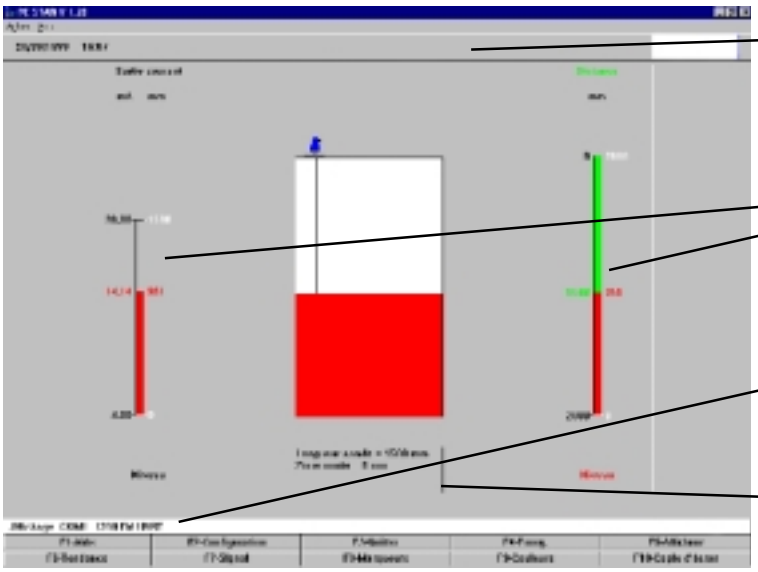
For any installation or connection problems with PC Star refer to the Section 5 for troubleshooting information.

4.3 PC Star Functions

Before connection the 'F7 Configuration' settings as default are:



Once connected, the following functions are displayed:



Opening Window
Date, time, and DR1000 version

Current and Distance/Level bars

Status bar (Communication COM 1 / Recording / Record Reading)

Display of Factory Menu 1.1.1

F2 Configuration: Displays all configuration parameters.
F5_Display: Graphically represents the display of the DR1000 in real time with active buttons.
F6 Trend: Historic for the duration of the connection or recording, showing the change in level.
F7 Signal Screen: Graphical representation of product reflections.
F8 Markers: Historic for the duration of the connection or recording, showing the error flags and error messages.

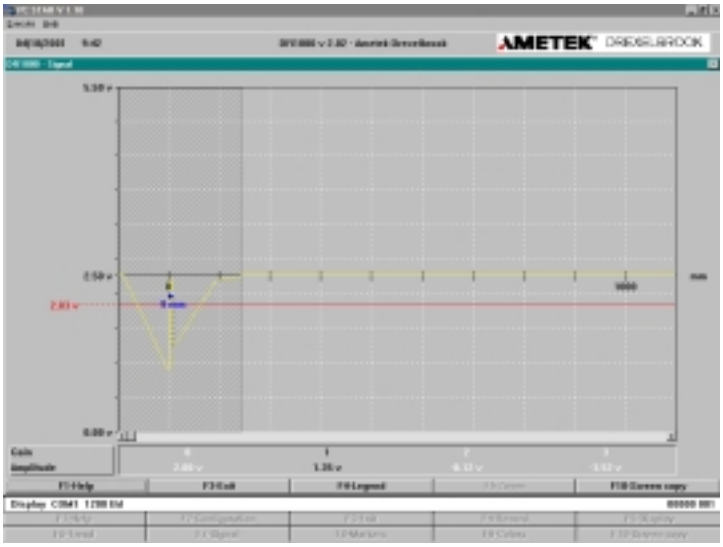
4.3.1 F7 Signal Screen PC STAR

On the keyboard of the computer the equivalent keys of the display are:

Display Key	Keyboard Touch
	'E'
	'R'
	'U'

The analysis of the signal screen has to follow certain rules according to how PC-Star shows the information:

- The scale of the graphic is shown according to the largest peak's gain.
- The threshold values (in red or green for interface) are shown in the same gain as above.
- The only method of establishing the true scale of each peak is by selecting it with the cursor (which moves the blue arrow), and recording the highlighted gain value given under the graph. Comparison between reflections has to be done in a common gain, in order to achieve an accurate comparison.
- The F7 screen only shows a maximum of the four largest peaks.



Current Gain and amplitude of the peak selected with the blue arrow is shown in black. Equivalent value for the same reflection shown in white for all the other Gain stages.

4.3.2 F4 Record

The '.dat' record file created by PC Star software incorporates operating information including trending, error flags, product reflection graphic view, and the complete configuration data of the instrument. Recorded files are useful for archiving information, troubleshooting, and for service.

Once connected to the DR1000 instrument, the communications port number through which the PC is communicating is displayed in the bottom left hand corner of PC Star communications screen. By pressing F4, the options for the recording are displayed (length of recording, interval between updates etc.). It is recommended to select a specific file name each time a recording is made, to avoid overwriting the default ':/pcstar/records/record.dat'. A recording can be interrupted at any stage, without jeopardizing the record file.

4.3.3 Resetting the DR1000 Instrument

The DR1000 instrument can be reset from PC Star. Communication is re-established automatically. To force a reset, press Control + Alt + 'R', and wait for at least 30 seconds for the reset to take place. Communication is lost, and will be reestablished automatically once the DR1000 has completed its test cycle.

4.4 Function Parameters

Basic Functions
Function Number/Parameter

1.1.1 Tank Height

This function is the base of the indication and current outputs reference. It is the distance from the flange to the bottom of the tank. It can be configured as the probe length. The minimum and maximum values are 3.3 feet (1 m) and 197 feet (60 m) respectively. The factory default value is per the sales order.

NOTE

The DR1000 instrument does not measure beyond its probe length. If the Tank Height is set to less than the Probe Length, then a lower 4-20mA setting than the Tank Height will not be accepted.

1.1.2 Dead Zone

Measurements near the flange may not be precise or reliable. Dead Zone parameter prevents the output from rising into this area. However, tracking of reflections within the Dead Zone is still performed. Use Detection Delay 1.5.3 to suppress any non-product reflections in this area. The minimum value is equal to that shown in the table below. Measurement may not be precise in an area less than this recommended value. The factory default value is 0.45 m. Refer to Section 1.3 Types of Probes for the Dead Zone values according to probe type and product dielectric.

1.1.3 Time Constant

The Time Constant allows filtering of possible signal fluctuations when the tank is turbulent. The minimum and maximum values are 1 and 100 seconds respectively. The factory default value is 5 seconds.

Basic Functions (cont.)

1.1.4 Window Frozen

This function causes the instrument to freeze or open its search window if it loses the product reflection. If configured "No", and the reflection is lost, the search window is opened to the whole length of the probe. If configured "Yes", it continues to search for the signal only within the region of the window. The factory default setting of "No" should be used. The size of the window in set in Function 1.1.5 Level Window and 1.1.6 Interface Window.

1.1.5 Level Window

This function sets the operating window for level measurement. While the instrument is tracking a product reflection, the window is centered around this point and moves with the product change in level. As long as the instrument receives the product reflection, it will ignore any extraneous reflections outside of this window. If the product reflection is lost, the features of Function 1.1.4 are activated.

The value configured represents the total window. Therefore, a value of 20 in (500 m) denotes a window of +/- 9.84 in (250 mm) around the last measurement. The minimum and maximum values are 7.9 in (20 mm) and the probe length respectively. The factory default value is 19.69 in (0.5 m). Increase this value to half the probe length for powder applications in case of loss of reflection.

1.1.6 Interface Window

This function is similar to Function 1.1.5, Level Window except that it pertains to the interface measurement. This function does not appear unless your instrument was ordered to measure interface.

Display Functions

These functions allow you to configure the display. They are independent of the current output.

1.2.1 Display Mode

This function enables selection of single or cyclic display mode. The factory default setting is single.

Display Functions (cont.)

1.2.2 Display Item

This function allows selection of parameter to be displayed. More than one may be displayed if Function 1.2.1 is configured as cyclical. Possible choices are level, distance, volume interface level*, layer*, interface distance*, interface volume*, and ullage volume. The factory default setting is Level.

NOTES

1. Asterisk (*) selections do not appear unless the instrument was ordered to measure interface.
2. Mass replaces volume in menu if ton, GB ton, or US ton is selected in Function 1.2.5 or 1.7.1.

1.2.3 Cycle Time

This function sets the rate of the display cycling discussed in Functions 1.2.1 and 1.2.2. The rate may be set in 1 second increments from 1 to 10 seconds. The factory default value is 8 seconds. This function does not appear if Function 1.2.1 is set to Single.

1.2.4 Length Unit

This function sets the linear units (for parameters such as tank height, level, and distance). Possible choices are m, cm, mm, inch, and feet. The factory default setting is mm.

1.2.5 Volume Unit

This function sets the volume units. Possible choices are m3, liter, US gallon, GB gallon, feet3, barrel, kg, metric ton, GB ton, and US ton. The factory default setting is m3.

NOTES

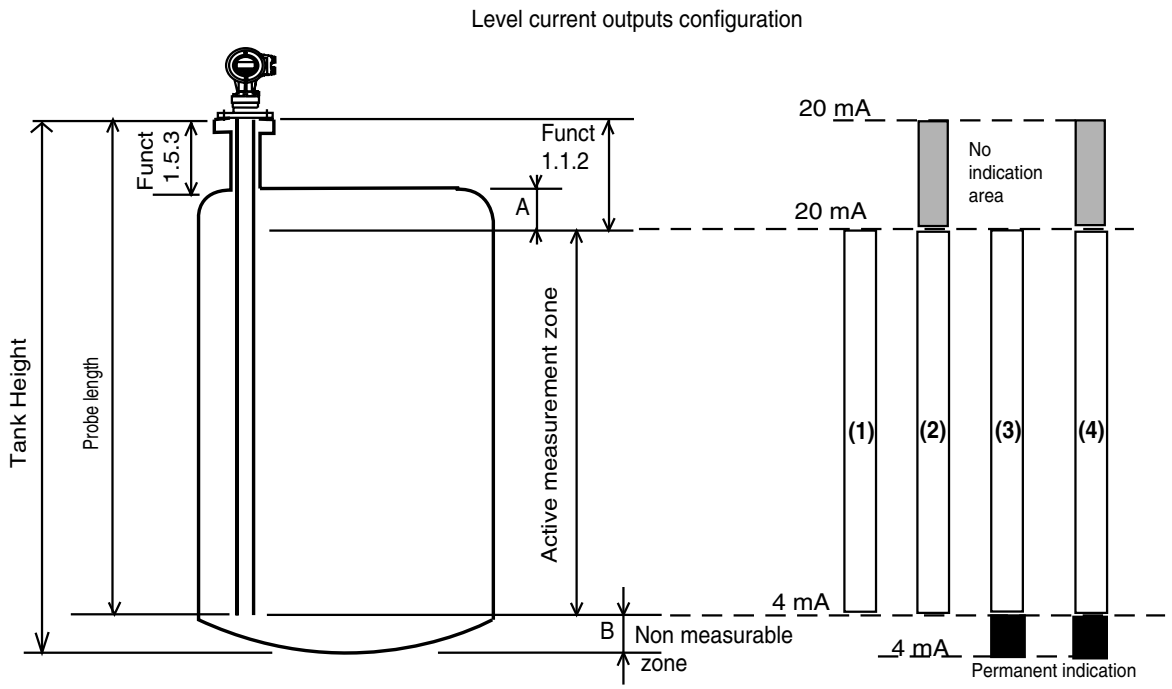
1. Set strapping table in Function 1.7.2 before selecting volume (otherwise selection will be refused).
2. Selecting a different unit in Function 1.7.1 changes this setting.

1.2.6 Error Message

This function enables or disables display of error messages. If configured "yes", the display flashes if an error occurs. Configure Yes or No. The factory default setting is No.

Current Functions

These function configure the current output. They are independent of the display. See Figure 4-a for a level current output configuration and Figure 4-b for a current output configuration.

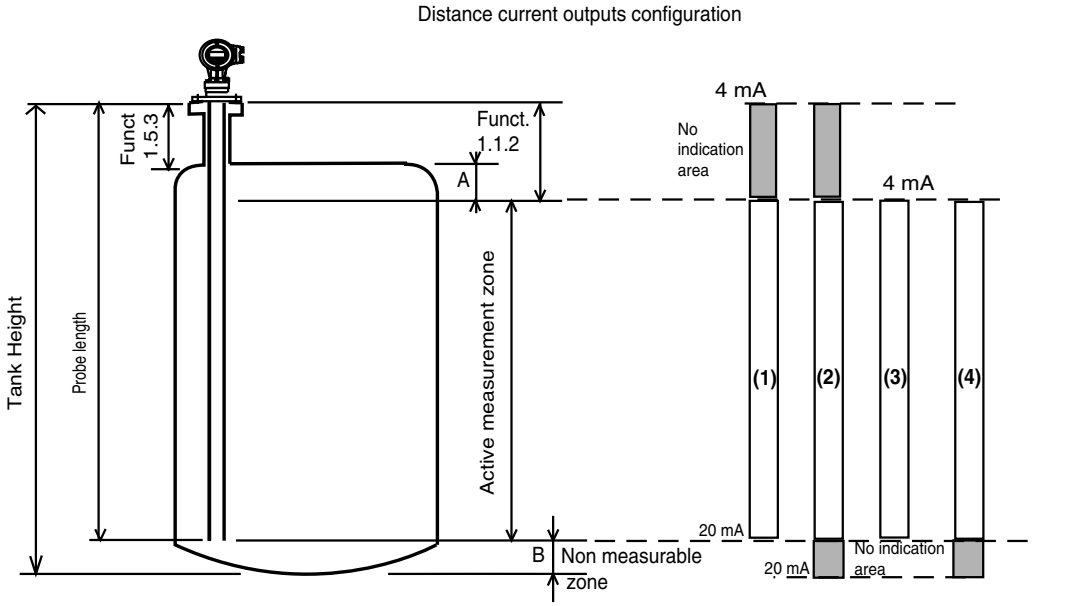


Funct = Parameter N°
A = Min dead zone value
Funct 1.1.2 - Funct 1.5.3 (150 mm)

Examples of level configuration:(1) Funct 1.3.1 = Level
Funct 1.1.1 = Probe length
4 mA (Funct 1.3.3) = 0.0
20 mA (Funct 1.3.4) = Funct 1.1.1-1.1.2
(2) Funct 1.3.4 = Funct 1.1.1
(3) Funct 1.1.1 = Tank Height
4 mA (Funct 1.3.3) = 0.0
20 mA (Funct 1.3.4) = Funct 1.1.1-1.1.2
(4) Funct 1.3.4 = Tank Height

	FCT 1.1.1	FCT 1.3.1	FCT 1.3.3	FCT 1.3.4
Example 1	Probe length	Level	0	Fct 1.1.1-1.1.2
Example 2	Probe length	Level	0	Fct 1.1.1
Example 3	Tank height	Level	0	Fct 1.1.1-1.1.2
Example 4	Tank height	Level	0	Fct 1.1.1

Figure 4-a
Level Configuration



Funct. = Parameter N°
A = Min dead zone value
Funct. 1.1.2 - Funct. 1.5.3 (150 mm)

Examples of distance configuration:(1) Funct. 1.3.1 = Distance
4 mA (Funct. 1.3.3) = 0.0
20 mA (Funct. 1.3.4) = Probe length
(2) Funct. 1.3.4 = Tank Height
(3) 4 mA (Funct. 1.3.3) = 1.1.2
20 mA(Funct. 1.3.4) = Probe length
(4) Funct. 1.3.4 = Tank Height

	FCT 1.1.1	FCT 1.3.1	FCT 1.3.3	FCT 1.3.4
Example 1	Probe length	Distance	0	Probe length
Example 2	Tank height	Distance	0	Tank height
Example 3	Probe length	Distance	0	Probe length
Example 4	Tank height	Distance	0	Tank height

Figure 4-b
Distance Configuration

Current Functions (cont.)

1.3.1 Function I1

This function assigns a parameter to analog output number 1. Choices are off, level, distance, volume, interface level*, layer*, interface distance*, interface volume*, or ullage volume. The factory default setting is Level.

NOTES

1.Set strapping table in Function 1.7.2 before configuring volume here.

2. Asterisk (*) selections do not appear unless the instrument was ordered to measure interface.

1.3.2 Range I1

This function allows setting the analog output as 4-20 mA, 4-20 mA with a failsafe output of 3.7 mA, or 4-20 mA with a failsafe output of 22 mA. The factory default setting is 4-20 mA.

1.3.3 Scale I1 Minimum

This function assigns the value of the measurement corresponding to 4 mA. The factory default value is 0.0.

1.3.4 Scale I1 Maximum

This function assigns the value of the measurement corresponding to 20 mA. The factory default value is the tank height.

1.3.5 Function I2 (optional)

Same as Function 1.3.1 except for the second current output.

1.3.6 Range I2

Same as Function 1.3.2except for the second current output.

1.3.7 Scale I2 Minimum

Same as Function 1.3.3 except for the second current output.

1.3.8 Scale I2 Maximum

Same as Function 1.3.4 except for the second current output.

User Data Functions

1.4.1 Language

Select a language for the display.

1.4.2 Entry code 1

Select “YES” to require the user to enter a password in order make changes to the system configuration. Select “NO” to allow easy entry into the system menu.

1.4.3 User Code

Enter a nine-digit code to secure the menu items (default = UUUEEERRR).

1.4.4 Device Number

Enter Tag-ID (10 characters max).

Current Functions (cont.)

1.4.5 Serial Number

Factory programmed with the transmitter serial number. This field cannot be modified.

1.4.6 French command number

Factory programmed data. This field cannot be modified.

1.4.7 German command number

Factory programmed data. This field cannot be modified.

1.4.8 Option (15 char.)

Use as a "scratchpad" to record pertaining to this device or application.

1.4.9 Probe type

Select the type of sensing element (A = twin rod, B = twin cable, C = coaxial, E = single cable, F = single rod).

Application Functions

1.5.1 Level gain / threshold

Allows the user to make changes to the gain and threshold settings.

CAUTION

Make sure you understand the values you are changing before doing so.

1.5.2 Distance Input

Forces the DR1000 instrument to search for the product in a specific area. If there is no level signal, you can enter an estimated value. If you are sure of what the indication should be and there is still no reading, call Drexelbrook Service about decreasing the Threshold value Function 1.5.1 or 1.5.4.

1.5.3 Detection delay

Equals "Dead Zone" minus 6.

1.5.4 Interface Level Threshold

Real time gain and reflection amplitude are displayed along with threshold value. The factory default value is 2.86 at a gain of 1. For setting different values, contact Drexelbrook Service Dept.This function requires that the instrument be ordered for interface measurement.

1.5.5 Epsilon R

This function, which configures the Epsilon R value is only used for interface calculation and in TBF mode. Values of 1.05 through 99 can be entered. The factory default value is 2.5.This function requires that the instrument be ordered for interface measurement.

Application Functions (cont.)

1.5.6 Interface Distance Input

Same as Function 1.5.2, but for interface measurement. This function requires that the instrument be ordered for interface measurement.

1.5.7 Settling

The Settling function is either activated or non-activated (default) ('YES'/'NO'). This function is used for mixed products that settle and separate over a period of time. When activated, the DR1000 tracks a rising product from zero level which has a high dielectric, as the top product. It then looks for the appearance of the interface level underneath the top product. When non-activated, the first entry of product would be tracked as being the interface product, with a default of 4 inches of top product above. This function requires that the instrument be ordered for interface measurement.

Serial I/O Functions

1.6.1 Transmission rate with RS485 Option

If RS485 output is used, enter the Baud rate of 1200, 2400, 4800, 9600, or 19200. The factory default is 1200.

1.6.2 Address

Enter the device address (0-255). Factory Default setting is 0.

Volume Table Functions

1.7.2 Strap Table Input

Configures the strap table. Maximum number of points is 50. The 4 mA current output in volume is the point value in the table. Each subsequent value must be greater than the previous one. Length and volume units can be changed without affecting the settings in the table. Calculations are automatically done in the instrument.

NOTE

The strapping table must be configured before setting volume (Function 1.2.5) or output (Functions 1.3.1 and 1.3.5).

Make entries in the table as follows:

1. At Function 1.7.2 display, press the RIGHT key.
2. Go to point 01 and press ENTER.
3. Enter the first length value (the length unit was set in Function 1.2.4) and press ENTER.
4. Enter the first volume value (the volume unit was set in Function 1.7.1) and press ENTER. Function 1.7.2 is displayed.
5. Repeat steps 1 through 4 for each point.
6. You can change any strap line entry at any time.

Volume Table Functions (cont.)

1.7.3 Strap table delete

Allows an entry to be deleted from the strapping table. Respond Yes or No. The factory default setting is No.

Test Display Functions

2.1.0 Test Display

Will activate all segments of the LCD display. (Available via keypad only).

2.2.1 Value I1

Displays the ACTUAL value of output #1.

2.2.2 Test I1

Forces output #1 to 4, 12, 20, or 22mA.

2.2.3 Value I2

Displays the ACTUAL value of output #2.

2.2.4 Test I2

Forces output #2 to 4, 12, 20, or 22mA (optional).

4.5 Configuration

For the majority of applications the settings included in this section are preset by the factory based upon the application information provided at the time of order. This section includes configuration instructions for the following modes:

1. Direct Mode
2. TBF Mode
3. Interface Function

NOTE

The switch between Direct and TBF mode can be made on all units. If Interface mode is required but was not ordered, please consult the factory.

4.5.1 Choosing the Appropriate Measurement Mode for Level Measurement

The guidelines for choosing the operating mode according to the dielectric for simple level measurement are shown below. Direct Mode is recommended in cases that do not require calibration and accuracy. In case of doubt of the exact dielectric value of your product, a value can be calculated in Direct Mode using a reading of the amplitude of the product reflection.

Twin Probe[1]		Single Probe[1]	
Dielectric	Mode	Dielectric	Mode
> 1.6	Direct Mode	>2.1	Direct Mode
< 1.6	TBF Mode	<2.1	TBF Positive Mode (if L<20m); TBF Negative Mode (if 100 ft (30 m) <L>20m).

[1]For the correct selection of probe type refer to the Probe Selection Guide in Section 2.

Warning for Interface Product

If there are two liquid products in the tank and the lower dielectric is on top, then it is necessary to use a DR1000 interface version in all cases, *even if it is only the surface level that is required* as an output. If Interface Mode is not used, the reading will not be consistent with the top surface value.

4.5.2 Direct Mode Measurement

In those applications with dielectrics close to 1.6 (for the twin probe) or 2.1 (for the single probe), test to see if at the low product levels (i.e. the last 10%) the DR1000 instrument is still able to track the product reflection. If after having lowered the threshold the DR1000 still does not work (and all other installation parameters are in order), then it is necessary to switch to TBF Mode.

4.5.2.1 Essential Direct Mode parameters

The following settings are the most important for correct Direct Mode operation:

- 1.5.1 Threshold
- 1.1.5 Level Window
- 1.5.3 Detection Delay

—Threshold

If the product reflection is lost (markers 2 and 3), then the Threshold may be lowered with caution. The Threshold acts as a filter, and lowering this value too far may expose non-product reflections. Figure 4-1 shows the Threshold and the product reflection as seen by the DR1000 instrument. The same representation can be seen in PC Star, providing the best method of adjusting the Threshold value in relation to the complete signal return.

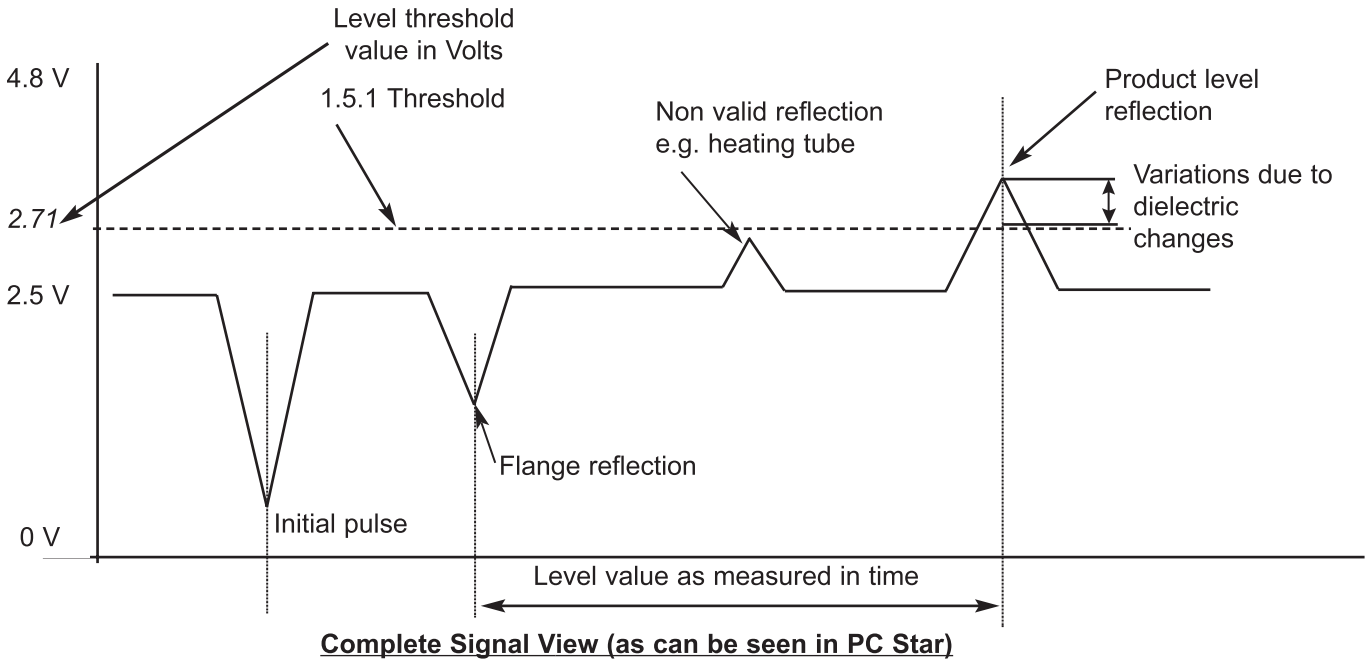


Figure 4-1
Complete Signal View

—Threshold (cont.)

•The scale of all voltage values relating to the product reflection or Threshold has an absolute value in Gain 0, with no amplification.
•There are three amplification stages:
Gain 1, Gain 2, Gain 3.
•When stating a voltage value, the associated Gain factor is also listed to ascertain its amplitude.
•The table to the right shows the standard Threshold value of 2.71, Gain 1 in the other Gain stages:

Gain	Volts
0	2.59
1	2.71
2	2.99
3	3.62

The Gain associated to a product reflection is set automatically in real time by the DR1000. The only parameter that can be changed by the user (Figure 4-1) is the Voltage value of the Threshold (which is then translated into the appropriate Gain stage according to the Gain of the product reflection).

When looking at display User Menu 1.5.1 the amplitude of the product reflection is shown first. Press the **Enter** key to see the voltage value of the Threshold (with its Gain). If there is no product reflection (markers 2 and 3), then the first view in Menu 1.5.1 shows a cycling Threshold through all of the Gain stages i.e. no fixed product reflection value found.

The Threshold is recommended to be 0.4V less than the amplitude of the product reflection. For example if displayed values are Gain = 1 and Level 3.55 V, type the **Enter** key check if Gain is equal to 1 and enter 3.15 V.

The Threshold value can be reduced, but for an absolute comparison of voltages the same Gain has to be used. Use PC Star software for easiest manipulation.

—Level Window

•If the DR1000 is tracking the product reflection, but during filling or emptying there is a loss of reflection, the first parameter to check is 1.1.5. Level Window.
•For liquid applications the value recommended is approximately 1/3 of the probe length.
•For powder applications this should be at least ½ of the probe length.

—Detection Delay

Detection Delay allows a complete blanking of the Dead Zone, preventing the DR1000 from reading any reflection. In the case of there being some reflections from the nozzle mounting (e.g. is nozzle is too narrow), Detection Delay covering the nozzle area will prevent any danger of the level reading fixing at 100%.

—Fine Tuning

In very heavy dust atmospheres, it is recommended to adjust the dielectric of air in the Service Menu to no more than 1.02 (avoid any value higher than this that can show the probe end reflection as if it was a product reflection).

—Parameter 1.5.2 Distance Input

Distance Input forces the distance reading to any value, so that the DR1000 looks for a product reflection in that area. This can be useful after having made a parameter change to unblock the DR1000 from a 0% or 100% reading. Enter your estimated value for where the product is. If you are sure of your product level and there is still no indication, decrease the threshold value. **Never force reading into dead zones.**

4.5.3 Tank Bottom Following (TBF) Mode Measurement

To test for TBF mode applicability, the product has to be close to the high level point because the higher the level in the tank, the less strong the probe end reflection.

—No Top Dead Zone

Using TBF Mode, the DR1000 is effectively ignoring the surface reflection (very weak) and tracking the probe end over time, gradually getting further away as more product is filled into the tank. When the product is at a high level the DR1000 instrument is looking from the probe end where there is no flange negative pulse to cancel the product reflection. For this reason there is no Dead Zone in TBF Mode.

—Measurement of very low Dielectrics (<1.3)

When dealing with very low dielectrics, the slightest offset in time for the pulse to travel to the short-circuit will be read as a product level. Modification to the probe after its delivery requires an accurate resetting of the probe length (i.e. distance to the short-circuit). See Probe Modification in Section 5. Certain cases of very narrow cone tank bottom, or product deposit on probe may create an offset in time for the pulse to

—Measurement of very Low Dielectrics (<1.3) (cont.)

travel to the short-circuit, requiring correction. The simplest correction is to increase the dielectric of air (Factory 2.6) or perform an empty tank measurement of the probe end to reset Factory Menu 1.1.1 (refer to Probe Modification in Section 5 for the procedure). In all cases of very low dielectrics, ensure the Level Window 1.1.5. is at least 50% of the probe length.

—Calculating and Tuning a Correct Dielectric Value

The simplest method for tuning the 1.5.5 dielectric value for the product, is to have an alternative method of measuring the product level, and back tuning 1.5.5. until the DR1000 falls into line. If an alternative method to measure the level is not available, then with a high product level it is possible to switch the DR1000 to Direct Mode to read the level. It is recommended to use PC Star software to view the reflections.

—TBF Mode with Single Cable attached to the Bottom of the Tank (tank heights <15m)

To work in TBF Mode, the DR1000 requires a target at the end of its probe. If the single probe cable is to be anchored to the bottom of the tank (assuming the application is within the traction limitations of the instrument), it is recommended to either use a counterweight as the probe end to which the anchoring system is attached.

—Maximum Probe Length in TBF Mode

Working in TBF mode creates an 'effective' probe length in the domain of time which is longer than the real length because the speed of the pulse travelling through the product is slower, and its time to reach the short-circuit longer. The 'effective' length when the tank is full, working in TBF mode is:

Effective Length = Product Height x Dielectric Constant

The DR1000 is limited to an effective length of 60m. When working with a high dielectric in TBF mode, the maximum possible length is reduced. For example:

The maximum probe length for a TBF application on a product with a dielectric of 1.5 = 60/ sqr 1.5 = 49m

4.5.3.1 TBF Positive Mode

This is the standard TBF mode for the DR1000. It is used for all dielectrics below 2.1 with probe lengths of less than 66 ft (20 m). The TBF positive mode takes as its target the short-circuit (twin probe) or the top of the counterweight (single cable). In the case of the single cable, a gain of 10% in the amplitude of the reflection can be obtained when using the 3.54 in (90 mm) diameter counterweight, instead of the standard 1.77 in (45 mm) diameter counterweight. The parameters concerned in setting TBF positive mode are:
- Application Mode (Factory Menu 1.2.1)
- Dielectric (User Menu 1.5.5.)

4.5.3.2 TBF Negative Mode (Single Probes Only)

Used for installations on solids with dielectrics <2.1 and where lengths are greater than 66 ft (20 m). This mode is only applicable to single probes. To use this mode, there should be a gap of at least 20 in (500 m) underneath the counterweight. TBF Negative Mode is best suited to work with the standard 1.77 in (45 mm) diameter counterweight.

Change the following software parameters when switching to TBF Negative Mode:
- Application Mode (Factory 1.2.1)
- Probe Position (Factory 1.1.4)
- Probe Length (Factory 1.1.1)
- Threshold (User 1.5.1)

1. Application Mode needs to be set to TBF.

2. 'Probe Position' should be set to 'BOTTOM'.

3. 'Probe Length' when in TBF Negative Mode is the distance between the flange and the end of the counter weight. The value is always around 4 in (100 mm) longer for the 3.54 in (90 mm) diameter weight, or 9.65 in (245 mm) longer for the 1.77 in (45 mm) diameter weight.

The most accurate and effective way of determining this value is with an empty tank, to use the 'Direct Negative' mode to detect the negative peak itself. Direct Negative mode is selected by setting 'Application Mode' to Direct, and 'Probe Position' to Bottom. The DR1000outputs the distance value (the probe length at this time needs to be extended by at least 15% to be sure to see the negative peak). This value should then be entered into Factory 1.1.1. The accuracy of this value will effect the reading.

4.5.3.2 TBF Negative Mode (Single Probes Only)

4. Threshold now works inversely. Now that the peak is inverted, the stronger the peak the lower its voltage value will be. The production set threshold is 2.28V in Gain 1, 2.02V in Gain 2, and 1.40V in Gain3.

NOTE

When using PC Star software, use the F5 face-plate view to enter the threshold value. 2.55V is the minimum value that the PC Star F2 'Configuration' menu will accept.

4.5.4 Interface Mode

NOTE

The instrument must be ordered for interface operation for the following functions to be available.

The following settings are the most important for correct Interface Mode operation:

- 1.5.1 Threshold
- 1.1.5 Level Window
- 1.5.3 Detection Delay
- 1.1.6 Interface Level Window
- 1.5.7 Settling
- 1.5.4 Interface Threshold
- 1.5.5 Dielectric

Figure 4-2 shows the additional reflection from the interface. Refer to Section 4.4.2 Direct Mode for an understanding of Threshold. The Interface Threshold is higher than the Level Threshold based upon the stronger reflection from the higher dielectric of the bottom product.

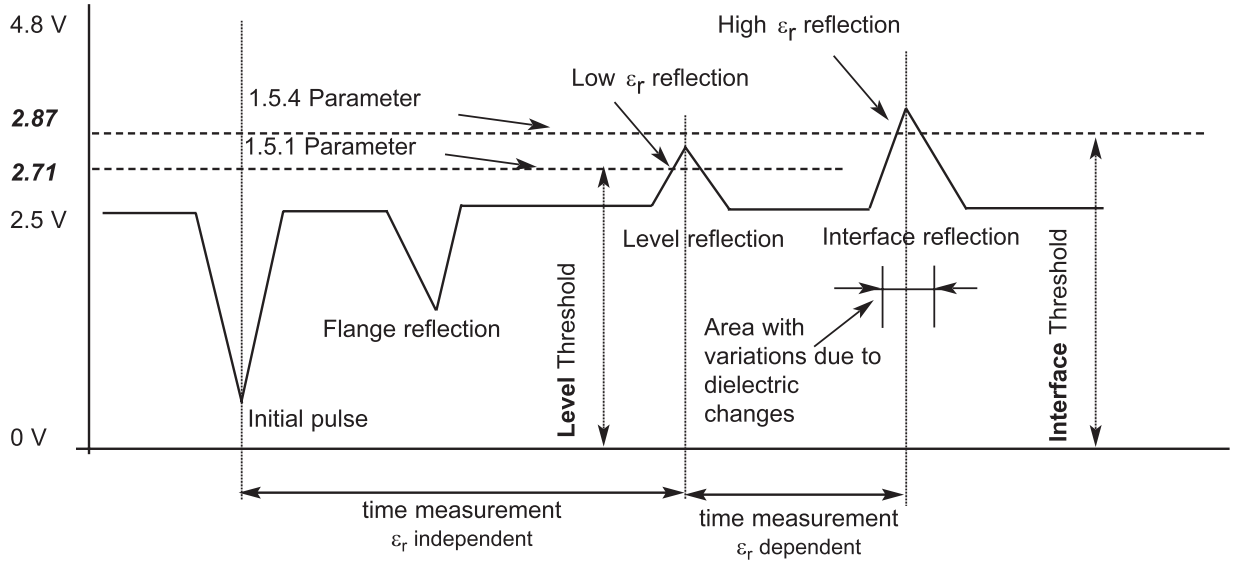


Figure 4-2
Interface Threshold

4.5.4 Interface Mode (cont.)

For those applications where the dielectric is above 10, consult factory. If the level reflection is greater than the interface reflection, then the interface window must be small enough so that it never sees the level reflection.

4.5.4.1 Tuning of dielectric value for Interface Mode

The dielectric value can be tuned when configuring the instrument. An alternative measurement of the interface value can be used in order to back tune the dielectric value until the DR1000 falls into line. The voltage amplitude of the product's reflection in association with its distance from the flange can also be used to calculate the dielectric value.

SECTION 5
MAINTENANCE

5.1 Identifying a Problem

·Use the Troubleshooting Table in this section to help find and correct a problem if it occurs.

·It is important to be methodical when tracking down a problem.

·If you have questions about the DR1000 TDR Level instrument, call Drexelbrook Factory Service at 1-800-527-6297 or e-mail at ***service@drexelbrook.com***.

·Be prepared to provide the Service Engineer with the model number, application requirement, and the materials being measured.

·In standard applications, maintenance is not necessary. However, if the sensor is strongly contaminated, or coating on the sensor is heavy, the DR1000 instrument might produce an erroneous output or can fail. Consult factory.

5.2 Modifying the DR1000 Probe

WARNING

Always disconnect power before removing the probe.

Before replacing the probe in a hazardous location, ensure that there is no danger of explosion.

In certain cases, modification of the probe below the flange is necessary for correct installation. The cables and rods can be cut accordingly.

• For cable probes, a replacement sleeve should be welded or attached to the cable ends in case the counterweight clamp begins to slide. The collars are crimped at 40 tons pressure.

• For powder applications, a spot weld at the open end of the sleeves is necessary.

• For the rods, it is important to weld on a short-circuit at the end.

• When modifying the single cable probe, consult Drexelbrook factory service for further information. The crimped threaded sleeve can be replaced by a U-clamp, turning the cable back on itself (not compatible for TBF mode).

5.2 Modifying the DR1000 Probe (cont.)

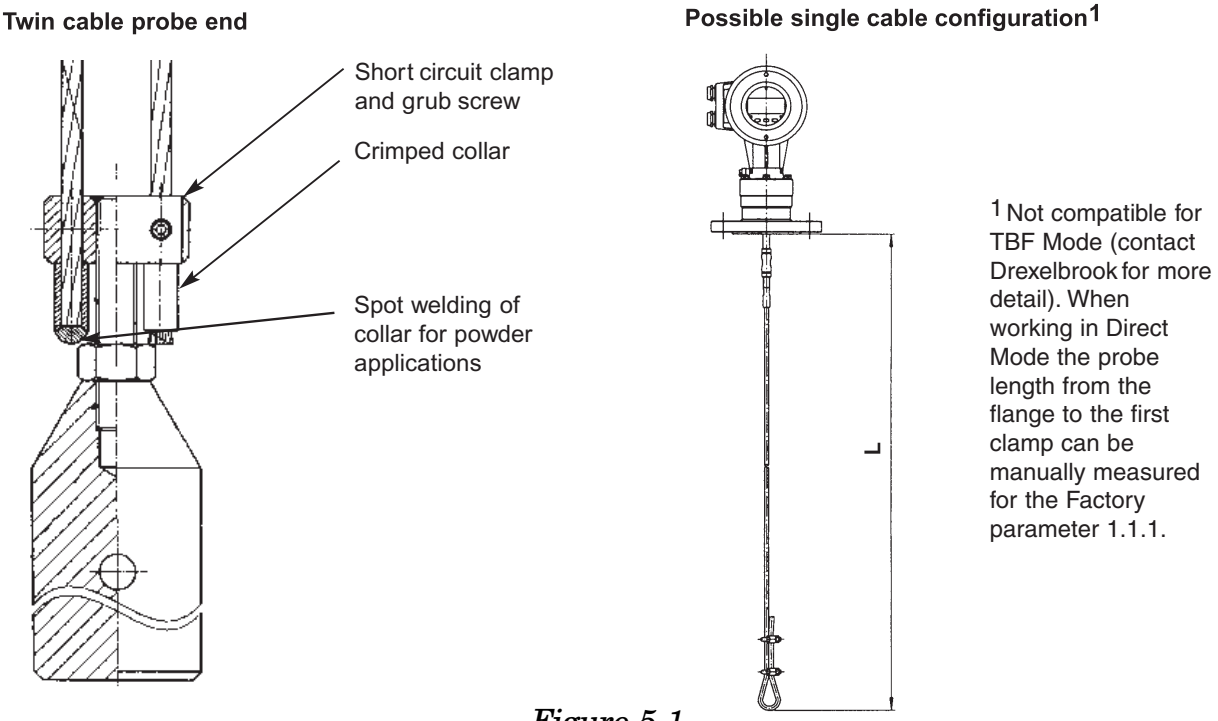


Figure 5-1
Modifying theDR1000 Probe

Once the probe has been modified, the following parameters need to be reprogrammed:

Factory 1.1.1 **Probe Length** (length to the short circuit). The value entered here has to be accurate to +/- 0.04 in (1mm) and is best measured by the DR1000 itself (critical for TBF Mode). Turning the instrument back on when the tank is empty, with a value in Factory 1.1.1 greater than the real probe length allows the DR1000 to read the probe end as if it was a product. Record the 'Distance' reading and enter this into Factory 1.1.1.

Factory 1.1.3 **Bottom Short Circuited, Yes or No** (for interface mode short-circuit is required).

User 1.1.1 **Tank Height**.

User 1.3 **Current Output** (all settings to be modified according to customer's specification).

The mechanical speed constant remains the same.

In the case of an extension of the probe length, there will be a greater offset off the accuracy of measurement along the added section. Extension of probe length is not recommended for solids applications due to the traction forces.

5.3 Removing a Reference Probe from a Twin Probe

To switch from a twin probe to a single probe, remove the negative probe. By removing the negative probe the accuracy of the instrument decreases. In addition, when the probe is switched to a single probe, the installation requirements (Section 2) must be met for a single probe installation.

To remove the negative probe:

- Cut the spacers,
- Clean off their securing pins (for the rod version) or remove the crimped collars (for the cable version). For the cable version it is possible to re-use the counter-weight, but extreme caution must be taken in solid applications to ensure resistant method of attaching the counterweight.
- For a short-circuited rod version, it is recommended that the short-circuit bridge be cleanly cut, leaving no protruding metal.
- Even if the probe hasn't changed length, use the configuration parameter Change of Probe Length to ascertain the new probe length.

5.4 Jumpers

For the longer lengths of probe, the DR1000 uses a different time frame for the analysis of the pulse. A set of four jumper connections on the CCL circuit board on the opposite side of the electronics from that of the power/output board designates the time frame. See Figure 5-2.

The connection selection of the jumpers, zero (0) denotes that the connection is open (i.e. without a jumper), and one (1) denotes the placement of a jumper (see following table):

Length	Jumper Configuration			
	A	B	C	D
3-75 feet (default)	0	1	0	0
75-92 feet	0	1	1	1
92-105 feet	0	1	1	0
105-121 feet	1	0	0	1
121-151 feet	1	0	1	1
151-168 feet	1	0	1	0
168-184 feet	1	1	0	1
184-200 feet	1	1	0	0
200-230 feet	1	1	1	0

When using TBF mode, double the length of the probe. For example, when using a 92 foot probe, the configuration of the jumpers will fall into the 184-200 feet category. Refer to Figure 5-2.

5.4 Jumpers (cont.)

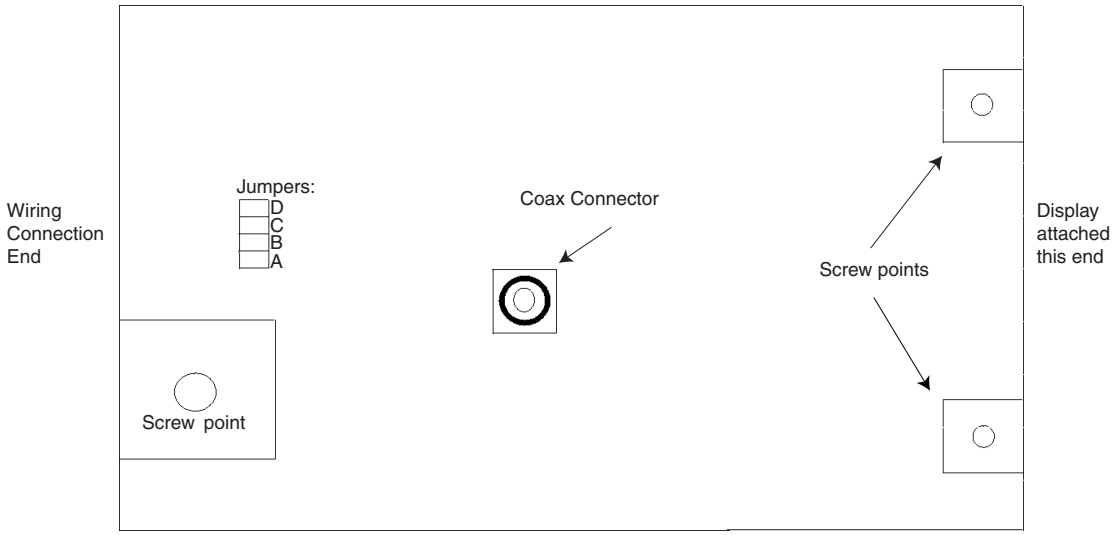


Figure 5-2
CCL Board Jumper Locations

5.5 Fuse Replacement

Warning

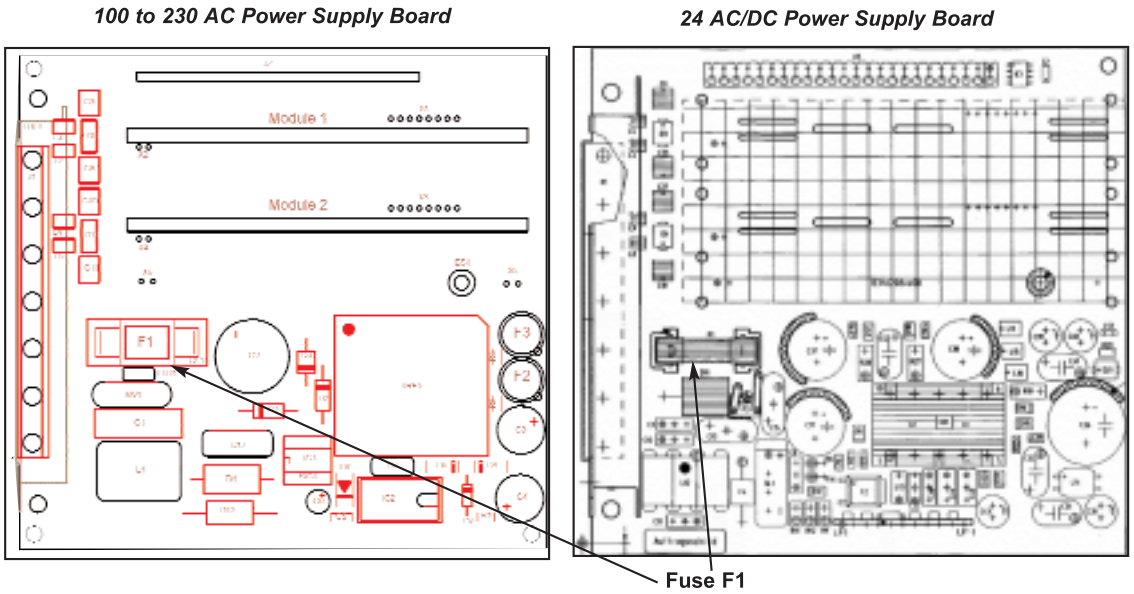
Before opening the electronics housing, first remove power from the instrument. Then wait 30 minutes if the instrument is located in a Division 1 hazardous area.

1. For an instrument with standard outputs, disconnect the connector in the terminal compartment (if the unit is Ex or FM, the wiring terminals are fixed within the housing and there is no need to disconnect the wiring).

2. Unscrew the two (Phillips) screws to the side of the display holding the electronics in place.

3. Remove the electronics package from the housing and unplug the coaxial cable by pulling it straight out on its axis.

4. When remounting the electronics module, ensure that the coaxial cable is not pinched between the housing and the rear electronic connector.



Fuse	Power supply	Fuse rating	Part Number
F1	24V AC/DC	1.25A/250V/Temporized	A5062320000
F1	110/220 AC	400mA/250V/Temporized	F5041140000

To replace the power supply fuses use only fuses according to IEC 127-2/1.

Figure 5-3
Fuse Replacement

5.6 Replacing the Electronics

When replacing the electronics, we recommend that PC Star be used to save the original User and Factory configuration.

- Connect PC Star with the DR1000 by either recording the configuration menus individually (User and Factory) or by making a '.dat' file recording (option F4).
- Once the new electronics have been installed, check whether the electronics have been configured.
- Enter the Factory configuration of the new electronics, and note the Electronics Speed Constant Menu 2.4(unique to the electronics). The original configuration for both the User and Factory menus can be then uploaded.
- Enter the Electronics Speed Constant as noted to complete the transfer of configuration to the new electronics.

5.7 Troubleshooting and Questions

General Operation

Symptom/Question	Reason/Answer
Status Marker 1 Showing.	This means that the High Frequency board is not sending a pulse. Since repair of the board is not possible in the field, replace the electronics package. Check parameter 1.2.2 in Factory menu; amplitude value must be between 0.6 and 0.9V gain 0. Press enter to check threshold value must be 1.48 gain 0. Possible cause is electrostatic discharge.
Status Marker 2 or 4 Showing.	•The instrument has lost the level (marker 2) or interface pulse (marker 4), has opened the window, and has still not found the pulse. •The product has risen into the dead zone and has dropped below the threshold because of flange pulse, or the product level is at zero (i.e. no product is in the tank).
Status Marker 3 or 5 Showing.	•The pulse has dropped below the threshold. The instrument opens the operating window (if Window Frozen is 'No') and if no reflection is found, will displaystatus marker 2 (or 4 for interface). •Marker 3: PC-STAR is connected and F7 for the graphic has been selected.
Instrument does not see my hand when I place it on the probe.	The instrument has been turned on with no target, and is therefore reading an empty tank. It is in Tank Empty Status and is searching for the return of the pulse in the bottom 12 in (300 mm) of the probe.
In a solids application, DR1000 is not accurate even when working has a high dielectric.	•If there is deposit on the probe or a heavy dust atmosphere, adjust the dielectric of air to 1.02 in the Factory Menu in Direct Mode with a product that •Ensure the Factory calibration parameters have not been changed (Mechanical Speed Constant, Offset) dielectric.
Can I measure installations where there is no air gap?	Yes, but a factory setting must be changed. Consult factory.
What is the maximum length of twin rod probe without the need for a spacer?	2m (6.5 ft)
Can I calibrate a powder application when the dielectric is not known?	This is possible if there is method of determining the real surface level. Start with the default dielectric value of 2.5. If the level reading is too high, increase the Er value until the correct level value is obtained. Do this with the tank at least 50% full.
If I have a Direct mode instrument and later want to use TBF mode, what should I do?	This requires a factory setting software change. outlined in Section 4 Configuration. If your probe length is over 10m (33ft), a jumper change is required.
Can I change the length of the rod probes?	To shorten the probe requires a factory setting software change. Refer to Section 2 Installation. To lengthen the probe requires sending the instrument to an authorized service center. Consult factory representative. The length of a Coaxial probe cannot be changed.
When must the probe be fixed to the bottom of the tank?	In an agitated tank, other turbulence, or in high nozzle installations.

5.7 Troubleshooting and Questions

Electrical Connection and Communication Output

Symptom/Question	Reason/Answer
Instrument was wired to the wrong voltage. How do I know if it has been damaged?	If the display is still working, the fuses were not blown.
As soon as I connect the DR1000 to our DCS unit, the output current of the instrument drops to 2 mA or lower.	The load in the active loop is limited to 350 ohms.If the DCS load is higher, then the current output will drop.
Output remains at the same value: 16 mA.	A power supply has been connected to the active output terminal. See Section 5.7 Equipment Return.

PC STAR

I see the following messages when loading PC-Star: 'There is not enough disk space!'	The Serial Number is incorrect. Make sure you are using the new serial code which corresponds to the latest version (i.e. 1.10) of PC Star.
"Fatal error message: Read error on serial number"	This means that the compressed original file of PC Star has been unzipped into the same directory as the program files (i.e. those generated by the 'Install.exe' file). Make sure that the decompression is assigned to a diskette or C:\Temp directory; anything other than C:\PCSTAR.
"This application will close as it has carried out a non-conform operation ".	This appears when trying to read a '.dat' pre-recorded file. This is due to the EEPROM or "program" selection in the F7 'Configuration' menu (from the opening window of PC Star) being set incorrectly (i.e. corresponding to the EEPROM of the DR1000).
Not possible to communicate.	1. If you have the intrinsically safe output version of the previous generation of DR1000, use the passive output with at least 250 ohm loop resistance. 2. Check that you are using the correct output terminals for I1. 3. Check that the correct version of software has been chosen in the serial menu before connection (‘F7’ Configuration). 4. Ensure that there are no communication address conflicts in the setup of the PC (especially with infrared ports). Disable those ports which conflict in the Windows System menu. 5. Try a slightly lower loop resistance (e.g., 220 ohms). 6. If the instrument was specified to be HART in the order, select ‘SMART’ in the Factory Menu 1.3.1.
How do I enter another line in the strapping table using PC-STAR?	Use Ctrl + Insert.
Why does the threshold line in PC-STAR descend with length?	The pulse becomes weaker with distance traveled along the probe. The threshold is therefore programmed to take this into account in 2m (6ft) steps. In TBF mode however, the threshold always remains the same as it deals with the short-circuit pulse, which only gets stronger as the product descends.

5.7 Troubleshooting and Questions

PC-STAR (cont.)

Symptom/Question	Reason/Answer
In TBF mode with an empty tank, PC-STAR doesn't show the short circuit.	PC-STAR only shows those pulses beyond the end of the probe in terms of time. PC-STAR then maps the pulse in its real relation to the flange, according to the TBF principle. Therefore, it is normal not to see the short circuit when the tank is empty.
Why does Status Marker 3 show while using PC-STAR?	For the instrument to send the pulse information to PC-STAR, it interrupts its measurement mode and displays Marker 3 during the instant of non measurement.
When the tank is nearly full, the PC-STAR graphic display shows 2 or 3 reflections.	These multiple reflections are often seen with products having high dielectrics. Recommend the top dead zone be above 12 in (300 mm) for products with dielectrics above 50.
With PC-STAR in Direct mode, why can I see four peaks even if the tank is empty?	These are ghosts peaks or spacers, and should be small enough to be ignored by the threshold value. They will not, therefore, affect the level measurements. If there are peaks in anything from Gain 2 above, then there may be a mechanical installation problem (i.e. probe in contact with nozzle).

5.8 Telephone Assistance

If you are have a question about your Drexelbrook equipment, call your local Drexelbrook representative, or the factory toll free 1-800-527-6297.

Please provide the following information:
Instrument Model # _____
P.O. #_____
Date_____
Insertion Length_____
Application_____
Material being measured_____
Temperature_____
Pressure_____
Agitation_____
Brief description of the problem _____
Checkout procedures that failed _____

5.9 Equipment Return

In many applications, sensing elements are exposed to hazardous materials.

- OSHA mandates that our employees be informed and protected from hazardous chemicals.
- Material Safety Data Sheets (MSDS) listing the hazardous materials that the sensing element has been exposed to **must** accompany any repair.
- It is your responsibility to fully disclose all chemicals and decontaminate the sensing element.

To obtain a return authorization (RA#), contact the Service department at 1-800-527-6297 (US and Canada) or 1-215-674-1234 (International). Please provide the following information:

Model Number of Return Equipment _____
Serial Number _____
Original Purchase Order Number _____
Process Materials that equipment has been exposed to _____
MSDS sheets for any hazardous materials.
Billing Address _____
_____
Shipping Address _____
_____
Purchase Order Number for Repairs _____
Please include a purchase order even if the repair is under warranty. If repair is covered under warranty, you will not be charged.

Ship equipment freight prepaid to:
AMETEK Drexelbrook
205 Keith Valley Road Horsham, PA 19044
COD shipments will not be accepted.

SECTION 6
SPECIFICATIONS

Application Range: Distance, level, volume measurement of liquids and liquid interface measurement, storage of granular and bulk products.

Measurement Range:

Twin Cable Probe:	≤ 200 feet (60 m).
Twin Rod and Coaxial Probes:	≤ 20 feet (6 m).
Single Cable Probe:	≤ 133 feet (40 m).
Single Rod Probe:	≤ 10 feet (3 m).

Accuracy:

Direct Mode: L≤20 feet (6 m): ± 0.12 inches (3 mm) (0.2 inches [5 mm] for E/F) out of dead zone.

L> 20 feet (6 m): add ±0.01% of reading.

Powders: ±0.4 inches (±10 mm).

TBF Mode: ±4 inches (±100 mm) or ±0.8 inches (±20 mm) when εr is constant.

Resolution/repeatability: 0.04" (1 mm).

Dielectric Constant: ≥1.6 for interface measurement.
≥1.05 for other measurements.

Sensor Types/Materials:

1 or 2 rods:	ANSI 316 L, hastelloy, titanium, tantalum.
1 or 2 flexible cables:	ANSI 316, FEP coated 316SS or Hastelloy C 22.
Coax:	ANSI 316 L or Hastelloy C 276.

Dead Zone: See *Dimensions*, optional no top dead zone (coax version).

Operating Pressure: –14.5 to 580 psig (–1 to +40 bar).
1450 psig (100 bar) (optional).

Operating Temperature:

Flange temperature: –22 to +298°F (–30 to +150°C) for Ex; ≤ +392°F (+200°C) for non-Ex.

Product temperature: –58 to +298°F (–50 to +150°C) for Ex; ≤ +300°F (+150°C) non-Ex for twin probes with Tefzel spacers.
≤ +465°F (+240°C) non-Ex for twin probe with PTFE spacers.

Temperature Drift: 0.01%/°C.

Ambient Temperature: –22 to 122°F (–30 to +50°C), –4°F (–20°C) for the LCD indicator.

Connection Flanges:

Standard:	4-inch, 150 lb.
Coax:	1-inch NPT or 150/300 lb. flanges 2-6 inches.

Protection: IP67.

Power Supply: 24 VAC / DC or 100 to 230 VAC +10%, –15%, maximum consumption 9 VA.

Current Outputs: 1 active current output with maximum 350 Ω load (standard).
1 passive current output (option).
2 passive current outputs (option).

Communication: HART® selectable on the first output or PC software (option).

Field Bus: RS485 with protocol (optional with 1 passive 4 to 20 mA output), PROFIBUS-PA, Modbus, Foundation Fieldbus (pending).

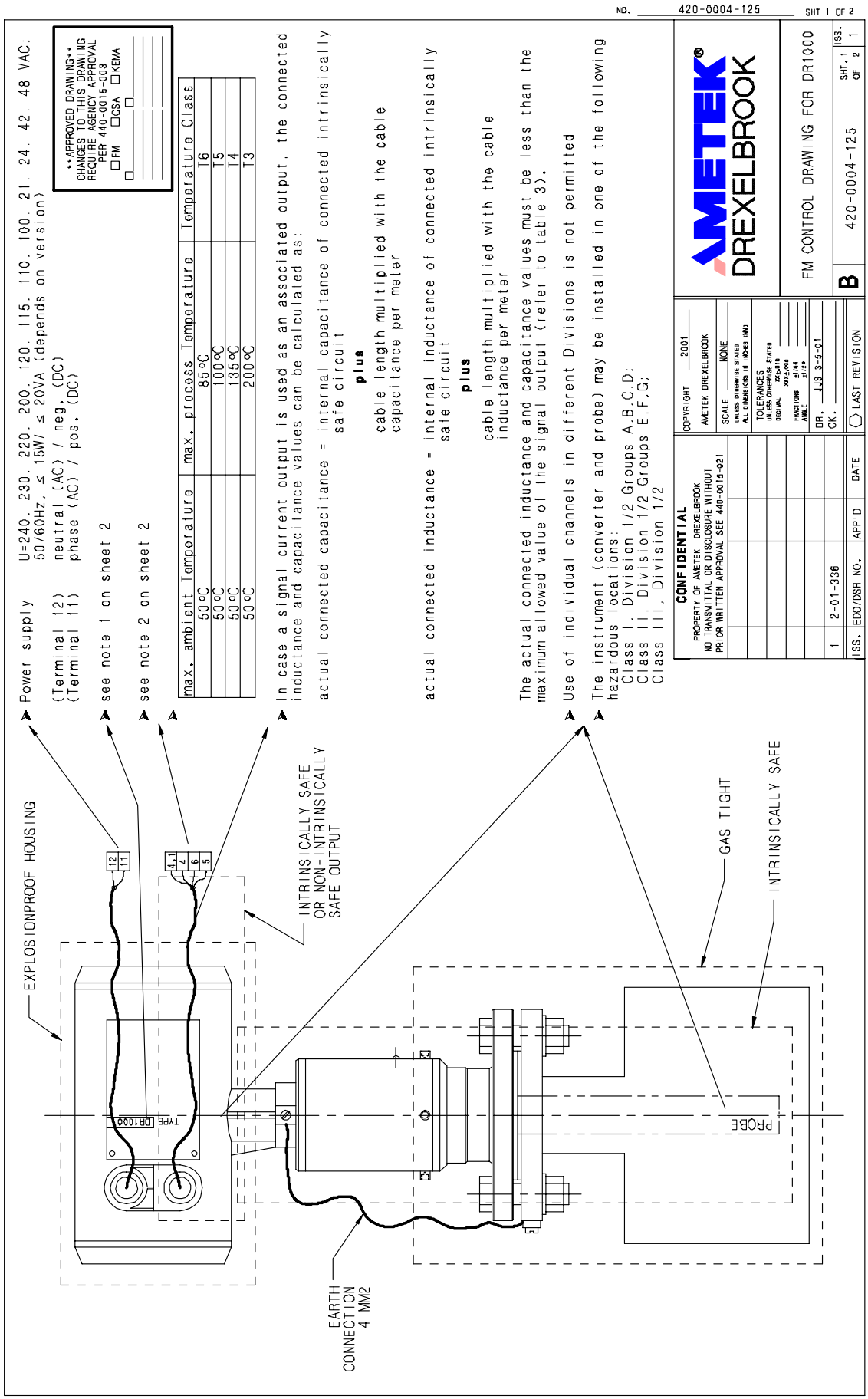
SECTION 6
SPECIFICATIONS (cont.)

Approvals:

FM Class I, Div. 1, Gr. B/C/D:	Intrinsically safe outputs as option (FM/CSA).
EMC:	EN 50 082-2 EN 50081-1.
Display:	Backlit LCD with three magnetic sensors for programming with a magnetic pointer.
1st line:	8 digits
2nd line:	10 characters
3rd line:	6 markers
Languages:	English, French, German
Weight:	Without sensors non-EEx: 17.6 lb (8 kg). EEx/FM with standard flange: 19.8 lb (9 kg). Rods: 0.84 lb/ft (1.24 kg/m). 6 mm cables: 0.19 lb/ft (- 0.28 kg/m) + 6.6 lb (3 kg) for 2-inch counter weight. Coax: 0.72 lb/ft (1.1 kg/m).

Materials:

Housing:	Aluminum with epoxy coating.
Wetted parts:	Stainless steel 316 L/316, PTFE, ceramic, hastelloy, titanium, tantalum.
Gaskets:	Viton, optional Kalrez 4079.


NO. 420-0004-125 SHT 1 OF 2
Power supply U=240, 230, 220, 200, 120, 115, 110, 100, 21, 24, 42, 48 VAC: 50/60Hz, ≤ 15W/ ≤ 20VA (depends on version)
(Terminal 12) neutral (AC) / neg. (DC)
(Terminal 11) phase (AC) / pos. (DC)
see note 1 on sheet 2
see note 2 on sheet 2
APPROVED DRAWING CHANGES TO THIS DRAWING REQUIRE AGENCY APPROVAL PER 440-0015-003 FM CSA KEMA
max. ambient Temperature | max. process Temperature | Temperature Class
50 oC | 85 oC | T6
50 oC | 100 oC | T5
50 oC | 135 oC | T4
50 oC | 200 oC | T3
In case a signal current output is used as an associated output, the connected inductance and capacitance values can be calculated as:
actual connected capacitance = internal capacitance of connected intrinsically safe circuit
plus
cable length multiplied with the cable capacitance per meter
actual connected inductance = internal inductance of connected intrinsically safe circuit
plus
cable length multiplied with the cable inductance per meter
The actual connected inductance and capacitance values must be less than the maximum allowed value of the signal output (refer to table 3).
Use of individual channels in different Divisions is not permitted
The instrument (converter and probe) may be installed in one of the following hazardous locations:
Class I, Division 1/2 Groups A,B,C,D;
Class II, Division 1/2 Groups E,F,G;
Class III, Division 1/2
CONFIDENTIAL
PROPERTY OF AMETEK DREXELBROOK NO TRANSMITTAL OR DISCLOSURE WITHOUT PRIOR WRITTEN APPROVAL SEE 440-0015-021
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SCALE NONE
UNLESS OTHERWISE STATED ALL DIMENSIONS IN INCHES (MM)
TOLERANCES UNLESS OTHERWISE STATED DECIMAL XX±.010 XXX±.005
FRACTIONS ±1/64 ANGLE ±1°
DR. JJS 3-9-01
CK.
ISS. 1 EDD/DSR NO. 2-01-336 APP'D DATE
B LAST REVISION
AMETEK DREXELBROOK
FM CONTROL DRAWING FOR DR1000
420-0004-125
SHT. 1 OF 2
ISS. 1
EXPLOSIONPROOF HOUSING
INTRINSICALLY SAFE OR NON-INTRINSICALLY SAFE OUTPUT
TYPE DR1000
12 11
4- 4 6 5
EARTH CONNECTION 4 MM2
PROBE
GAS TIGHT
INTRINSICALLY SAFE

➤ note 1.) Identification of apparatus

DR1000 ./ ./ ./ ./ ./ ./ ./ ./ ./ ./ ./ ./ ./ ./ ./ ./ ./ ./
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

1. Probe type
   A: Double rod <= 6m
   B: Twin Cable <= 60m
   D: Coax <= 6m
   E: Single Cable <= 60m
   F: Single Rod <= 6m
   G: Reversed <= 6m
   K: Single Cable d = 8mm

2. Software
   : One character for different software options

3. Probe length (10 meters)
   : One character for probe length

4. Probe length (meter)
   : One character for probe length

5. Process Connection
   : One character for the process connection (e.g. DIN, SMS, ANSI, BST, TRICLAMP, 1" NPT, 1" G etc).

6. Flange facing
   : One character for different types of process flange surfaces (e.g. male, female, tongue, groove, feder, nut, RTJ etc.)

7. Material
   1. 316/316L
   2. HC 22
   3. Tantal
   4. HC 276
   5. HB 2 ou 3
   A. FEP coated
   : other materials according to table 1

8. Sealing
   : One character for different O-ring materials

9. Approval
   2. FM Div. 1/Div. 2

10. Housing protection
    1. Ex d Explosionproof

11. Housing
    1. Aluminum

12. Cable Gland
    : One character for different cable feed through types

13. Display
    : One character for different display options

14. Power supply
    1. 100 - 240 VAC
    2. 24 VAC / VDC

15. Output
    1. 1x passive non Exi
    2. 2x passive non Exi
    3. 1x active non Exi
    4. 1x passive Exi
    5. 2x passive Exi
    6. 1x active Exi
    7. 1x RS485 non Exi
    A. 1x RS485 non Exi + 1x passive non Exi
    C. 1x passive non Exi + PROFIBUS non Exi
    D. 1x passive Exi + PROFIBUS Exi
    E. PROFIBUS non Exi
    F. PROFIBUS Exi
    T. TIWAY non Exi

16. Protocol
    : One character for different types of software protocols

17. Customer
    0. KROHNE

18. Counter weight
    : One character for different types of counter weights

➤ note 2.) Signal outputs

1 or 2 intrinsically safe (passive) signal current outputs
(Terminal 6+, 5- and 4,1+, 4-)....Each output has the maximum Ci and Li as listed in Table 1 and each output must be connected to **one single** HART optional **apparatus** with its own individual cable pair. Vmax and Imax as listed in Table 1 must be respected.

Class I, II, III Division 1/2 Groups	Max. input voltage Vmax	Max. input current Imax	Max. input power Pmax	Max. internal capacitance Ci	Max. internal inductance Li
A, B, C, D, E, F, G	30V	250mA	1.0W	10nF	20uH

Table 1

or

1 intrinsically safe (passive) communication output
(Terminal 4,1, 4)....The output has the maximum Ci and Li as listed in Table 2 and the output must be connected to **one single** PA or FF bus **apparatus** with its own individual cable pair. Vmax and Imax as listed in Table 2 must be respected.

Class I, II, III Division 1/2 Groups	Max. input voltage Vmax	Max. input current Imax	Max. input power Pmax	Max. internal capacitance Ci	Max. internal inductance Li
A, B, C, D, E, F, G	30V	300mA	4.2W	10nF	20uH

Table 2

or

1 intrinsically safe (passive) signal current output and 1 intrinsically safe (passive) communication output
(Terminal 6+, 5-)....The output has the maximum Ci and Li as listed in Table 3 and the output must be connected to **one single** **apparatus** with its own individual cable pair. Vmax and Imax as listed in Table 3 must be respected.

Class I, II, III Division 1/2 Groups	Max. input voltage Vmax	Max. input current Imax	Max. input power Pmax	Max. internal capacitance Ci	Max. internal inductance Li
A, B, C, D, E, F, G	30V	250mA	1.0W	10nF	20uH

Table 3

and Terminal 4,1, 4)....The output has the maximum Ci and Li as listed in Table 4 and the output must be connected to **one single** PA or FF bus **apparatus** with its own individual cable pair. Vmax and Imax as listed in Table 4 must be respected.

Class I, II, III Division 1/2 Groups	Max. input voltage Vmax	Max. input current Imax	Max. input power Pmax	Max. internal capacitance Ci	Max. internal inductance Li
A, B, C, D, E, F, G	30V	300mA	4.2W	10nF	20uH

Table 4

or

1 intrinsically safe (passive) signal current output and 1 intrinsically safe associated (active) output
(Terminal 6+, 5-)....The output has the maximum Ci and Li as listed in Table 5 and the output must be connected to **one single** HART optional **apparatus** with its own individual cable pair. Vmax and I max as listed in Table 5 must be respected.

Class I, II, III Division 1/2 Groups	Max. input voltage Vmax	Max. input current Imax	Max. input power Pmax	Max. internal capacitance Ci	Max. internal inductance Li
A, B, C, D, E, F, G	30V	250mA	1.0W	10nF	20uH

Table 5

and one signal circuit....associated (active)
(Terminal 4,1-, 4+)....to be connected only to **one single** intrinsically safe circuit with the following maximum values:

Class I, II, III Division 1/2 Groups	Max. output volatge Voc	Max. output current Isc	Max. output power Pmax	Max. allowed capacitance Ca	Max. allowed inductance La
Class I, Div 1, Group A & B	23.1V	98mA	0.57W	220nF	3.7mH
Class I & II, Div 1, Group C & E	"	"	"	660nF	15mH
Class I, II, III, Div 1, Group D, F & G	"	"	"	1760nF	30mH

Table 6

or

Signal circuits.....not intrinsically safe (active or passive)
(Terminal 4,1, 4, 5, 6)
HART optional $U_N \leq 35$ VDC, $I_N \leq 50$mA
Um = 250V

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