PULSAR®
R96 RADAR

HART® Installation and Operating Manual for Pulsar® Model R96

Software Version 1.x

High Performance 6 GHz

Pulse Burst Radar

Level Transmitter



MAGNETROL® / AMETEK®

LEVEL MEASUREMENT SOLUTIONS

Read this Manual Before Installing
This manual provides information on the Pulsar® Model R96 Radar transmitter. It is important that all instructions are read carefully and followed in sequence. The *QuickStart Installation* instructions are a brief guide to the sequence of steps for experienced technicians to follow when installing the equipment. Detailed instructions are included in the *Complete Installation* section of this manual.

Conventions Used in this Manual
Certain conventions are used in this manual to convey specific types of information. General technical material, support data, and safety information are presented in narrative form. The following styles are used for notes, cautions, and warnings.

NOTES
Notes contain information that augments or clarifies an operating step. Notes do not normally contain actions. They follow the procedural steps to which they refer.

Cautions
Cautions alert the technician to special conditions that could injure personnel, damage equipment, or reduce a component's mechanical integrity. Cautions are also used to alert the technician to unsafe practices or the need for special protective equipment or specific materials. In this manual, a caution box indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

WARNINGS
Warnings identify potentially dangerous situations or serious hazards. In this manual, a warning indicates an imminently hazardous situation which, if not avoided, could result in serious injury or death.

Safety Messages
The Pulsar Model R96 system is designed for use in Category II, Pollution Degree 2 installations. Follow all standard industry procedures for servicing electrical and computer equipment when working with or around high voltage. Always shut off the power supply before touching any components. Although high voltage is not present in this system, it may be present in other systems.

Electrical components are sensitive to electrostatic discharge. To prevent equipment damage, observe safety procedures when working with electrostatic sensitive components.

This device complies with Part 15 of the FCC rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

FCC ID: LPN R96

Any unauthorized changes or modifications not expressly approved by the party responsible for compliance could void user's authority to operate this equipment.

WARNING! Explosion hazard. Do not connect or disconnect designs rated Explosion-proof or Non-incendive unless power has been switched off and/or the area is known to be non-hazardous.

Low Voltage Directive
For use in Installations Category II, Pollution Degree 2. If equipment is used in a manner not specified by the manufacturer, protection provided by equipment may be impaired.

Warranty
All AMETEK LMS electronic level and flow controls are warranted free of defects in materials or workmanship for eighteen months from the date of original factory shipment.

If returned within the warranty period; and, upon factory inspection of the control, the cause of the claim is determined to be covered under the warranty; then, AMETEK LMS will repair or replace the control at no cost to the purchaser (or owner) other than transportation.

AMETEK LMS shall not be liable for misapplication, labor claims, direct or consequential damage or expense arising from the installation or use of equipment. There are no other warranties expressed or implied, except special written warranties covering some AMETEK LMS products.

Quality Assurance
The quality assurance system in place at AMETEK LMS guarantees the highest level of quality throughout the company. AMETEK LMS is committed to providing full customer satisfaction both in quality products and quality service.

The AMETEK LMS quality assurance system is certified to ISO 9001, affirming our commitment to internationally recognized quality management standards and continuous improvement.

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Performance specifications are effective with date of issue and are subject to change without notice. AMETEK LMS reserves the right to make changes to the product described in this manual at any time without notice. AMETEK LMS makes no warranty with respect to the accuracy of the information in this manual.

MAGNETROL® / AMETEK®
LEVEL MEASUREMENT SOLUTIONS

Pulsar® Model R96
Pulse Burst Radar Level Transmitter

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1.0 QuickStart Installation

The QuickStart Installation procedures provide an overview of the key steps for mounting, wiring, and configuring the Pulsar Model R96 radar level transmitter. These procedures are intended for experienced installers of electronic level measurement instruments.

See Complete Installation, Section 2.0, for detailed installation instructions.

1.1 Getting Started

Before beginning the QuickStart Installation procedures, have the right equipment, tools, and information available.

1.1.1 Equipment and Tools

No special tools are needed. The following items are recommended:

- Threaded antenna and process connection . . . . . 2" (50 mm)
- Transmitter/antenna connection . . . . . 1¾" (44 mm) wrench
- Transmitter adjustment . . . . . 1⅛" (28 mm) wrench
  ⅜₂" Hex wrench
- Torque wrench . . . . . highly desirable
- Flat-blade screwdriver
- Digital multimeter or volt/ammeter . . . . . Optional
- 24 VDC (23 mA) power supply . . . . . Optional

1.1.2 Configuration Information

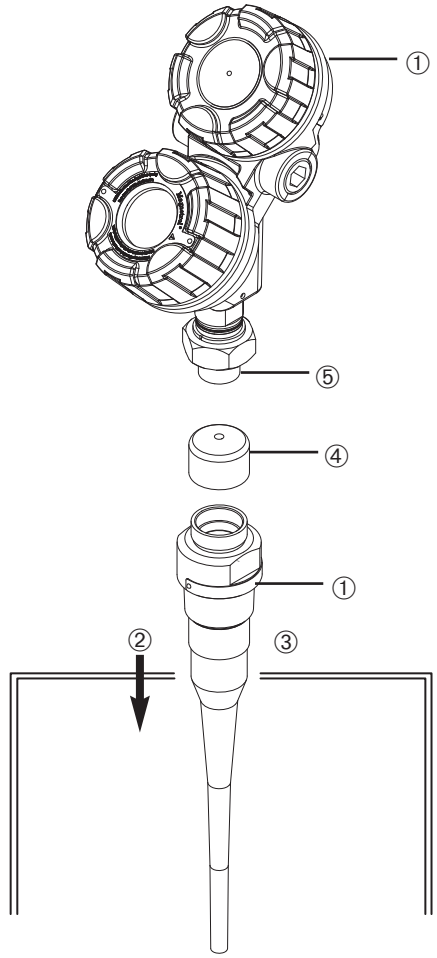
To utilize the QuickStart menu available on the Pulsar Model R96, some key information is required for configuration.

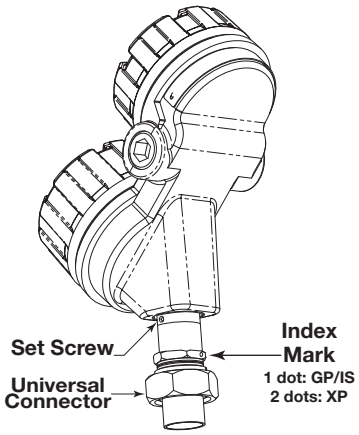
Gather the information and complete the following operating parameters table before beginning configuration.

NOTES: The QuickStart menu is available for Level Only applications.

1. Refer to Section 2.6.5 for configuration menus for Volume applications.
2. These configuration steps are not necessary if the transmitter was pre-configured prior to shipment.

Display	Question	Answer
Level Units	What units of measurement will be used?	_____
Tank Height	What is the tank height?	_____
Antenna Model	What type of antenna is being used? Select first 7 digits of Model number. (See nameplate on side of antenna)	_____
Antenna Extension	What is maximum nozzle length for which the antenna can be used? Select last 3 digits of Model number. (See nameplate on side of antenna)	_____
Antenna Mount	Is the antenna mounting NPT, BSP, or flanged?	_____
Dielectric	What is the dielectric of the process medium?	_____
4 mA Setpoint (LRV)	What is the 0% reference point for the 4.0 mA value?	_____
20 mA Setpoint (URV)	What is the 100% reference point for the 20.0 mA value?	_____
PV Alarm Selection	What output current is desired when a failure indicator is present?	_____





1.2 QuickStart Mounting

NOTE: Confirm the configuration style and process connection (size and type) of the PULSAR Model R96 radar transmitter. Ensure it matches the requirements of the installation before continuing with the QuickStart installation.

① Confirm the model and serial numbers on the name-plates of PULSAR Model R96 electronics and antenna are identical.

1.2.1 Antenna

② Carefully place the antenna into the vessel. Mount in a location equal to ½ the radius of tank top. Do not mount in center of vessel nor closer than 18" (45 cm) of tank wall.

③ Secure the antenna to the vessel.

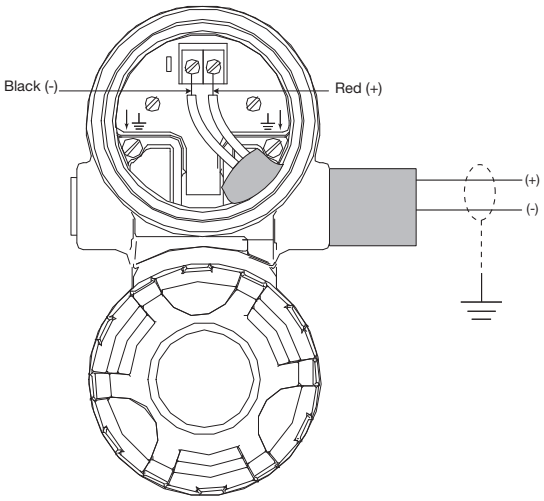
④ Leave the protective plastic cap in place until ready to install the transmitter.

NOTE: Do not use sealing compound or TFE tape on antenna connection to transmitter. This connection is sealed by a Viton® O-ring.

1.2.2 Transmitter

1. Remove the protective plastic cap from the top of the antenna and store for future use. Make sure the bottom of the Universal connector (Teflon®) ⑤ and inside of the antenna are clean and dry. Clean with isopropyl alcohol and cotton swabs if necessary.
2. Place the transmitter on the antenna.
3. Ensure the housing/launcher set screw is loose and the housing can be turned. Align the antenna index mark so it is at an angle of 45° to a line from the radar unit to the nearest tank wall.
4. Rotate the transmitter so that it is in the most convenient position for wiring, configuring, and viewing.
5. While keeping the housing and launcher aligned, tighten both the housing/launcher set screw and large Universal connector Hex nut. Tighten the universal connector to 30 ft./lbs (40 Nm) of force. A torque wrench is highly desirable.
   DO NOT LEAVE HAND TIGHT.

- Do not place insulating material around any part of the Radar transmitter including the antenna flange.



1.3 QuickStart Wiring

WARNING! Explosion hazard. Do not remove covers unless power has been switched off or the area is known to be non-hazardous.

NOTE: Ensure that the electrical wiring to the Pulsar Model R96 radar transmitter is complete and in compliance with all regulations and codes.

1. Remove the cover of the upper wiring compartment.
2. Attach a conduit fitting and mount the conduit plug in the spare opening. Pull the power supply wire through the conduit fitting.
3. If present, connect cable shield to an earth ground at the power supply.
4. Connect the positive supply wire to the (+) terminal and the negative supply wire to the (-) terminal. For Explosion Proof Installations, see Wiring, Section 2.5.3.
5. Replace the cover and tighten.



1.4 QuickStart Configuration

If requested, the Pulsar Model R96 transmitter is shipped fully pre-configured for the application and can be installed immediately. Otherwise it is shipped configured with default values from the factory and can be easily reconfigured in the shop. The minimum configuration instructions follow. Use the information from the operating parameters table before beginning configuration. See Configuration Information, Section 1.1.2.

The Quick Start menu offers a very simple two screen overview showing the basic parameters required for a typical “Level Only” application.

1. Apply power to the transmitter.

   The graphic LCD display can be programmed to change every 2 seconds to show pertinent Measured Values on the Home Screen. For example: Level, %Output, and Loop current can all be displayed on a rotating screen.

   The LCD can also be programmed to always show just one of the Measured Variables at all times. For example: Level can be the only value displayed on the screen.

2. Remove the cover of the electronics compartment.

STEP 4



STEP 5



STEP 6



3. The push buttons offer multiple forms of functionality for menu navigation and data entry. (See Section 2.6 for complete explanation.)

   ⇧ **UP** moves up through the menu or increases a displayed value.

   ⇩ **DOWN** moves down through the menu or decreases a displayed value.

   ⇦ **BACK** exits a branch of the menu or exits without accepting entered value.

   ⇨ **ENTER** enters a branch of the menu or accepts a displayed entry.

NOTE: Holding down ENTER when any menu or parameter is highlighted will show help text in reference to that item.

The default User Password = 0. (If a password is requested, enter it at that time.)

The following configuration entries are the minimum required for a QuickStart configuration. Refer to figures at left.

4. Press any key at the Home Screen to access the Main Menu.
5. Press ⇨ ENTER with the DEVICE SETUP menu item highlighted.
6. Press ⇨ ENTER with the QUICKSTART menu item highlighted.

   The QuickStart shows the basic parameters, with the present value of the highlighted parameter shown at the bottom of the screen.

   One can now quickly and easily scroll through the QuickStart configuration items, changing those parameters as required:

   - Scroll to the parameter to be changed.
   - Press ⇨ ENTER at the highlighted parameter.
   - Scroll to the desired option, then press ⇨ ENTER.
   - Scroll to next parameter or press ⇦ BACK when finished to exit the QuickStart menu.

   Section 1.4.1 lists and describes the nine parameters in the QuickStart menu.

7. After making all of the necessary changes in the QuickStart menu, press the BACK button three times to return to the Home Screen.
8. The QuickStart configuration is complete. If properly configured, the Model R96 transmitter is measuring level and is ready for service.

1.4.1 QuickStart Menu Options

Level Units		Select the Units of measurement for the level readout: • Inches • Feet • Millimeters • Centimeters • Meters
Tank Height		Enter tank height (in Level Units selected)
Antenna Model		Select the Antenna Model to be used with Model R96 (refer to antenna nameplate): • RAA-x — TFE rod • RAC-x — Halar rod • RA3-x — 3" horn • RA4-x — 4" horn • RA6-x — 6" horn
Antenna Extension		0 For nozzle height ≤1" (25 mm) (for threaded process connection only) (refer to antenna nameplate): 1 For nozzle height ≤4" (100 mm) 2 For nozzle height ≤8" (200 mm) (ESP designation for TFE rod only) 3 For nozzle height ≤12" (300 mm)
Antenna Mount		Select the type of Antenna Mounting to the vessel (refer to antenna nameplate): • NPT (National Pipe Thread) • BSP (British Standard Pipe) • Flange (ANSI or DIN)
Dielectric Range		Enter the Dielectric Range for the material to be measured. Below 1.7 (Light Hydrocarbons like Propane and Butane) — (stillwell only) 1.7 to 3.0 (Most typical hydrocarbons) 3.0 to 10 (Varying dielectric, for example: mixing tanks) Above 10 (Water-based media)
HART Only	**4 mA Set Point (LRV)**	Enter the level value (0%-point) for the 4 mA point. Lower Range Value (LRV). Refer to Section 1.4.1.1.
	20 mA Set Point (URV)	Enter the level value (100%-point) for the 20 mA point. Upper Range Value (URV). Refer to Section 1.4.1.1.
	PV Alarm Selection	Enter the desired output state when a Failure Indicator is active. • High (22 mA) • Low (3.6 mA) • Hold (Hold last value is not recommended for standard configuration). Consult factory for use.

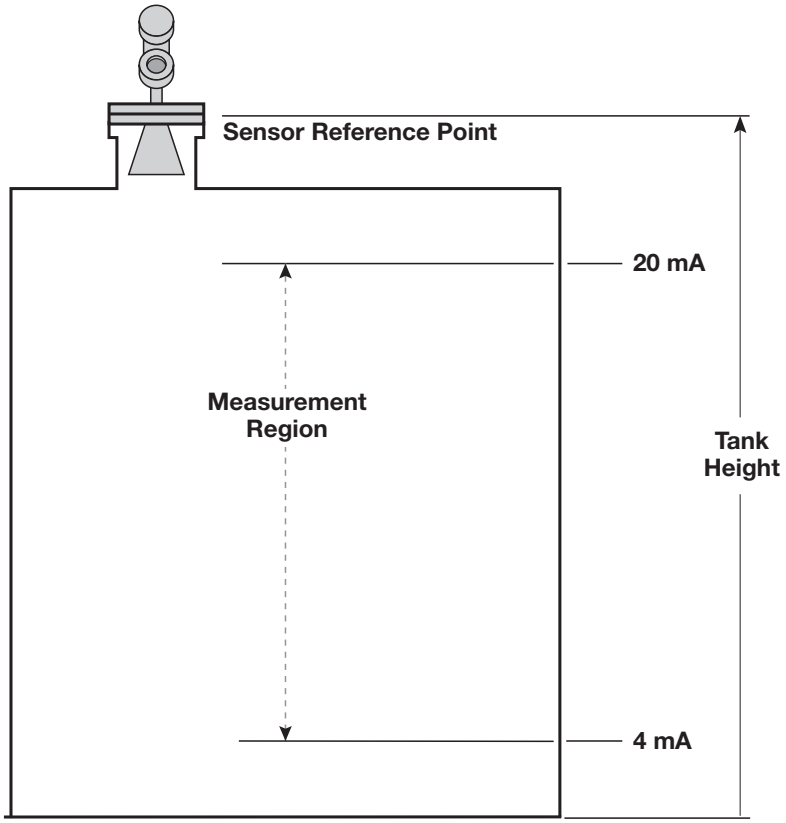
1.4.1.1 QuickStart Numerical Data Entry

To make numerical entry changes to Tank Height:

- **UP** moves up to the next highest digit (0,1,2,3,....,9 or the decimal point). If held down the digits scroll until the push button is released.
- **DOWN** moves up to the next lowest digit (0,1,2,3,....,9 or the decimal point). If held down the digits scroll until the push button is released.
- **BACK** moves the cursor to the left and deletes a digit. If the cursor is already at the leftmost position, then the screen is exited without changing the previously saved value.
- **ENTER** Moves the cursor to the right. If the cursor is located at a blank character position, the new value is saved.

Scrolling further DOWN in the QuickStart menu results in the remaining parameters appearing one by one, with the present highlighted value shown at the bottom of the screen.

- **BACK** returns to the previous menu without changing the original value, which is immediately redisplayed.
- **ENTER** accepts the displayed value and returns to the previous menu.



2.0 Complete Installation

This section provides detailed procedures for properly installing, wiring, configuring, and, as needed, troubleshooting the Pulsar Model R96 Radar Level Transmitter.

2.1 Unpacking

Unpack the instrument carefully. Make sure all components have been removed from the packing material. Check all the contents against the packing slip and report any discrepancies to the factory.

Before proceeding with the installation, do the following:

- Inspect all components for damage. Report any damage to the carrier within 24 hours.
- Make sure the nameplate model number on the antenna and transmitter agree with the packing slip and purchase order.
- To avoid moisture ingress in the housing, covers should be fully tightened at all times. For the same reason, plugs should remain properly installed in the cable entries until replaced with a cable gland
- Record the model and serial numbers for future reference when ordering parts.

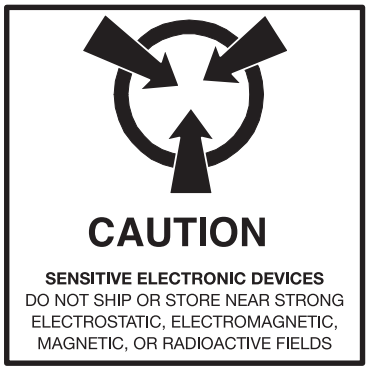
Model Number

Serial Number

2.2 Electrostatic Discharge (ESD) Handling Procedure

Magnetrol electronic instruments are manufactured to the highest quality standards. These instruments use electronic components that may be damaged by static electricity present in most work environments.

The following steps are recommended to reduce the risk of component failure due to electrostatic discharge.



WARNING!
Potential electrostatic charging hazard. Do not rub with dry cloth.

- Ship and store circuit boards in anti-static bags. If an anti-static bag is not available, wrap the board in aluminum foil. Do not place boards on foam packing materials.
- Use a grounding wrist strap when installing and removing circuit boards. A grounded workstation is recommended.
- Handle circuit boards only by the edges. Do not touch components or connector pins.
- Make sure that all electrical connections are completely made and none are partial or floating. Ground all equipment to a good, earth ground

2.3 Before You Begin

2.3.1 Site Preparation

Each Pulsar Model R96 Radar transmitter/antenna is built to match the physical specifications of the required installation. Ensure that the probe process connection is correct for the threaded or flanged mounting on the vessel where the transmitter will be placed. See Mounting, Section 2.4.

Ensure that all local, state, and federal regulations and guidelines are observed. See Wiring, Section 2.5.

Ensure that the wiring between the power supply and Pulsar Model R96 Radar transmitter is complete and correct for the type of installation. See Specifications, Section 3.7.

2.3.2 Equipment and Tools

No special tools are needed. The following items are recommended:

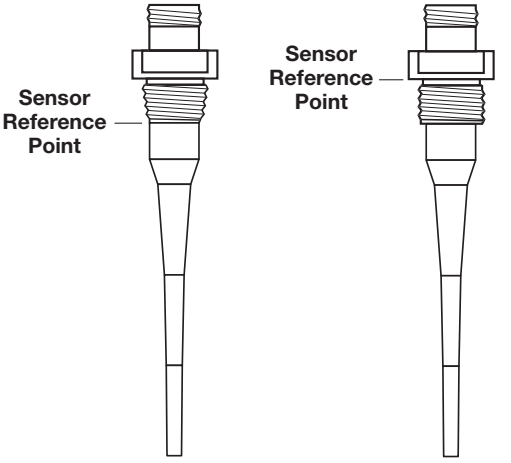
- Threaded antenna and process connection . . . . . 2" (50 mm)
- Transmitter/antenna connection . . . . . 1¾" (44 mm) wrench
- Transmitter adjustment . . . . . 1⅛" (28 mm) wrench
  . . . . . 3/32" Hex wrench
- Torque wrench . . . . . highly desirable
- Flat-blade screwdriver
- Digital multimeter or volt/ammeter . . . . . Optional
- 24 VDC (23 mA) power supply . . . . . Optional

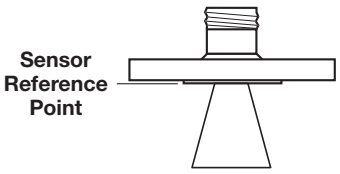
2.3.3 Operational Considerations

Radar applications are characterized by three basic conditions; Dielectric (process medium), Distance (measuring range) and Disturbances (turbulence, foam, false targets, multiple reflections and rate of change). The Pulsar Model R96 Radar transmitter is offered with two antenna configurations—Horn (3", 4", 6") and Dielectric Rod. Ideally, the 6" (DN150) Horn antenna should be used to ensure the best possible performance in all operational conditions.

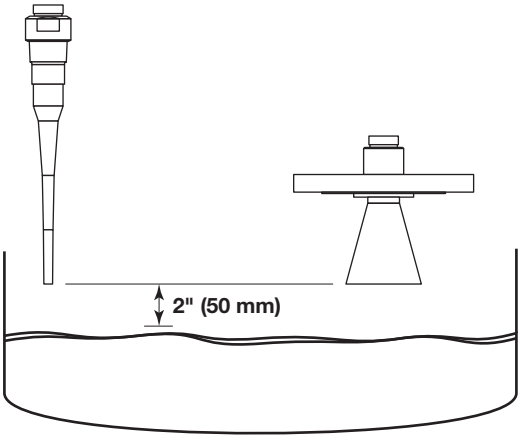
2.3.3.1 Maximum Distance

The chart on the following page shows the maximum measuring range (Distance) of each antenna based on fundamental conditions of Dielectric, Distance and Turbulence. Distance is measured from the Sensor Reference Point (bottom of NPT thread, top of BSP thread or face of a flange).





ANSI or DIN Welded Flange



R96 Maximum Recommended Measuring Range in feet (meters)						
	Turbulence None or Light			Turbulence Medium or Heavy		
Dielectric >	1.7 - 3	3 - 10	10 - 100	1.7 - 3	3 - 10	10 - 100
Antenna Type						
Dielectric Rod	16 (5)	39 (12)	66 (20)	10 (3)	29 (9)	39 (12)
4" Horn						
6" Horn	33 (10)	82 (25)	131 (40)	16 (5)	39 (12)	52 (16)

2.3.3.2 Minimum Distance

If the liquid level is allowed onto the antenna, noise and media build-up drastically decrease reliable measurement. Liquid should not be allowed closer than 2 inches (50 mm) from the bottom of the antenna.

2.3.3.3 Problematic Applications; GWR Alternative

Some application concerns can be problematic for Non-Contact Radar. For these, Guided Wave Radar is recommended:

- Extremely low dielectric media (ε_r<1.7)
- Stillwells, standpipes, bridles, cages and bypass columns.
- Very weak reflections from the liquid surface (particularly during turbulence) can cause poor performance.
- Tanks heavily cluttered with false targets (mixers, pumps, ladders, pipes, etc.)
- During times of very low liquid levels of low dielectric media, the metal tank bottom may be detected which can deteriorate performance.
- Foam can either absorb or reflect the microwave energy depending upon the depth, dielectric, density and wall thickness of the bubbles. Due to typical variations in the amount (depth) of foam, it is impossible to quantify performance. It may be possible to receive most, some or none of the transmitted energy.
- When measurement close to flange is critical

  Extremely high liquid levels (Overflow) conditions when liquid very near the antenna can cause erroneous readings and measurement failure.

Refer to ECLIPSE Model 706 bulletin 57-106 for additional information.

2.4 Mounting

The Pulsar Model R96 Radar transmitter can be mounted to a vessel using a variety of process connections. Generally, either a threaded or flanged connection is used. For information about the sizes and types of connections available, see Antenna Model Numbers, Section 3.8.2.

2.4.1 Installing the Antenna

Before installing, ensure that:

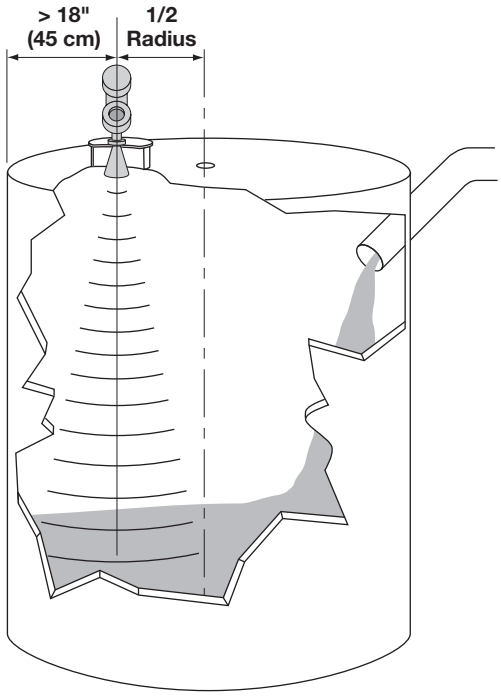
- Model and serial numbers on the nameplates of the Model R96 transmitter and antenna are identical.
- Process temperature, pressure, dielectric, turbulence and distance are within the antenna specifications for the installation.
- Rod of a Dielectric Rod antenna is protected from bending or breaking; there is no metal sub-structure.
- Insulating material is not placed around any part of the Radar transmitter including the antenna flange.
- Protective cap is kept on the antenna if the transmitter is to be installed at a later time.
- Antenna is being mounted in the optimal location. See following sections: Location, Beam Angle, Obstructions and Nozzles for specific information.
- If the liquid level is allowed onto the antenna, noise and media buildup drastically decrease reliable measurement. Liquid should not be allowed closer than 2 inches (50 mm) from the bottom of the antenna.

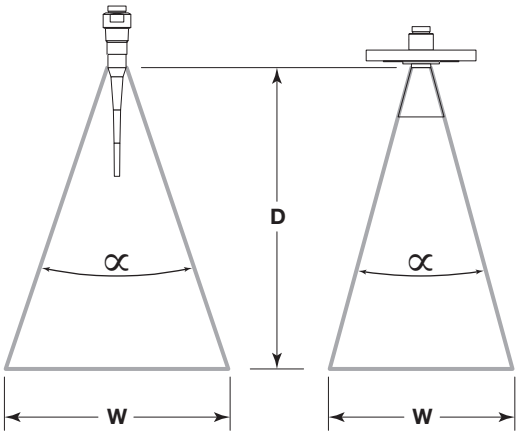
2.4.1.1 Location

Ideally, the Radar transmitter should be mounted providing an unobstructed signal path to the liquid surface where it should illuminate (with microwave energy) the largest, possible surface area. See Section 2.4.1.2, Beam Angle. Unavoidable obstacles will produce reflections that must be minimized during field configuration. See Section 3.3.2, Echo Rejection. Mount in a location equal to ½ the radius of tank top. Do not mount in center of vessel nor closer than 18" (45 cm) of tank wall.

2.4.1.2 Beam Angle

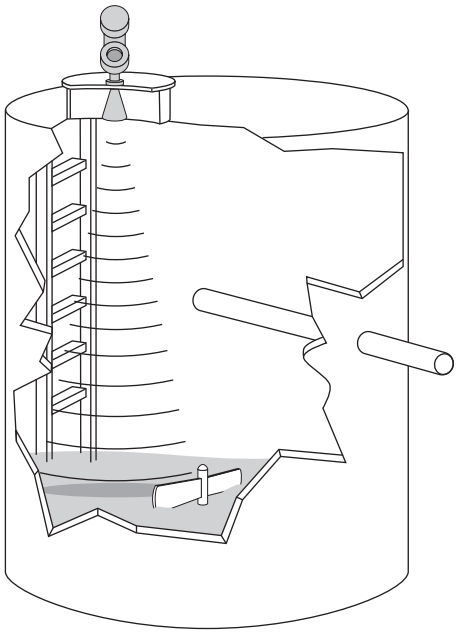
The various antenna designs exhibit different beam patterns. Ideally, the beam pattern should illuminate with microwave beam the maximum liquid surface with minimum contact with other objects in the vessel including the tank wall. Use the drawings at left to determine the optimum installation location.





	Beam Spread, W @-3dB; ft (m)		
Antenna Beam Angle (∝)	Dielectric Rod 25°	4" Horn 25°	6" Horn 17°
Distance, D			
10 (3)	4.5 (1.4)		3.0 (0.9)
20 (6)	8.9 (2.7)		6.0 (1.8)
30 (9)	13.3 (4.1)		9.0 (2.7)
40 (12)	17.8 (5.4)		12.0 (3.7)
50 (15)	22.2 (6.8)		15.0 (4.6)
60 (18)	26.6 (8.1)		18.0 (5.5)
65 (20)	28.9 (8.8)		19.5 (6.0)
98 (30)	*		29.3 (9.0)
130 (40)	*		39.0 (12.0)

*Dielectric Rod and 4" horn not recommended beyond 65 feet (20 meters).



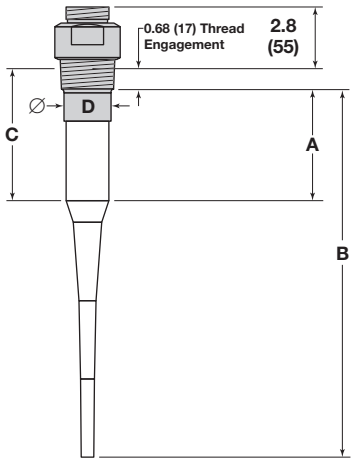
2.4.1.3 Obstructions

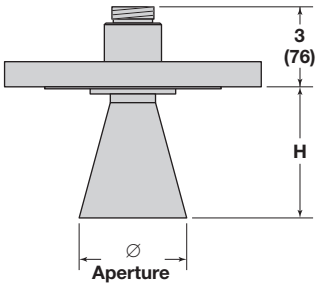
Almost any object that falls within the beam pattern will cause reflections that may be misinterpreted as a false liquid level. Although Pulsar Model R96 has a powerful Echo Rejection routine, all possible precautions should be taken to minimize false target reflections with proper installation and orientation. Refer to section 2.4.2.3 for additional information.

2.4.1.4 Nozzles

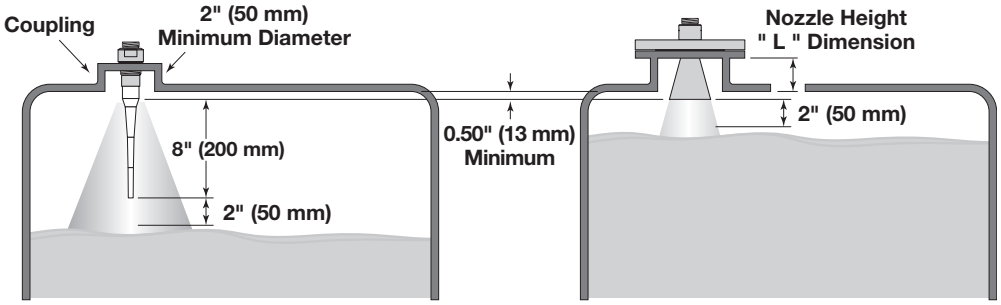
Improper installation in a nozzle creates “ringing” that will adversely affect measurement. The antenna should always be mounted so the active section of the antenna is a minimum of 0.5" (12mm) outside the nozzle. Antenna extensions are offered to allow the Pulsar Model R96 transmitter to work reliably in nozzles with “L” dimensions of 1" (25 mm), 4" (100mm), 8" (200mm) or 12" (300mm). Standard antennas (no extension) are shown below for reference. See Section 3.7.6 for dimensional drawings of all antenna designs including nozzle extensions.

Dielectric Rod Antenna





Horn Antenna



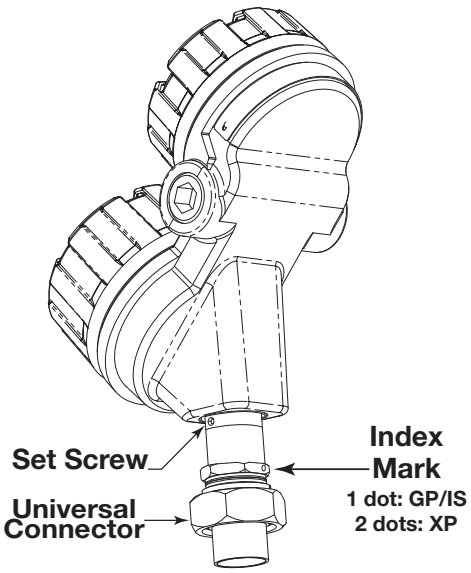
DIELECTRIC RODS – inches (mm)

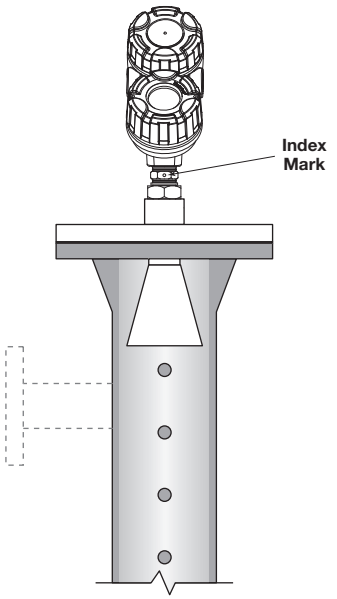
Model #	Antenna Extension (maximum “L” dimension)	All	All	BSP
8th Digit		Dim A	Dim B	Dim C
0	1 (25)	2.2 (56)	11.1 (282)	3.0 (76)
1	4 (100)	6.3 (160)	15.3 (389)	7.3 (185)
2	8 (200)	10.5 (267)	19.4 (493)	11.3 (287)
3	12 (300)	14.5 (368)	23.4 (594)	15.3 (389)

Antenna Extension O.D. Dimension D	
TFE Rod	∅ 1.50 (38)
PP Rod	∅ 1.50 (38)

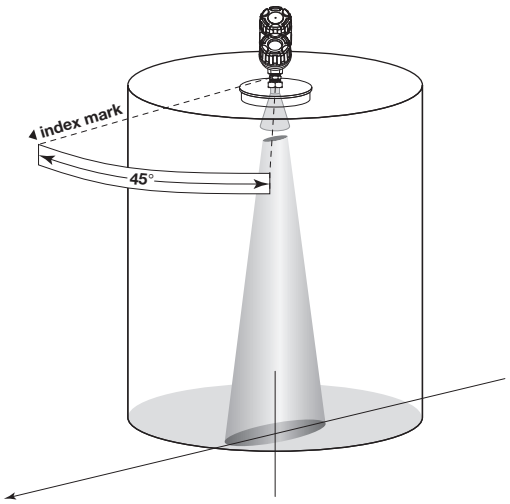
HORNS – inches (mm)

Model #	Antenna Extension (maximum “L” dimension)	4" Horn	6" Horn
8th Digit		Dim H	Dim H
1	4 (100)	4.6 (117)	↓
2	8 (200)	8.4 (213)	8.3 (211)
3	12 (300)	12.4 (315)	12.4 (315)
Aperture		3.75 (95)	5.75 (146)





PULSAR Model R96 Mounted in Stillwell (Bridle)



Polarization Pattern

2.4.1.5 Standpipes and Stillwells

The Model R96 can be mounted in a standpipe or stillwell but certain items must be considered:

- Metal stillwells only: Sizes 4–8 inches (100–200 mm). (Beyond 8", effects are negligible.)
- Diameter must be consistent throughout length; no reducers.
- Use only horn antennas sized to pipe inside diameter (ID); 4–6" (100–150mm); 8" pipe can use a 6" horn.
- Stillwell length must cover complete range of measurement (i.e., liquid must be in stillwell).
- Welds should be smooth.
- Vents: holes <0.5" diameter, slots <0.5" width.
- If an isolation valve is used, it must be a full port ball valve with an I.D. equal to the pipe diameter.
- Bridles/Bypass Installations: The launcher (index mark) should be rotated 90° from process connections.
- Configuration must include an entry for the STILWELL I.D parameter. See Section 2.6.5.
- There will be some increased dielectric sensitivity; system gain will be reduced when STILWELL ID >0.

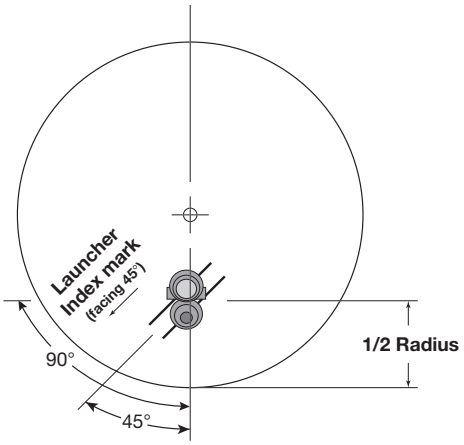
2.4.2 Installing the Transmitter

- Remove the protective plastic cap from the top of antenna. Store the cap in a safe place in case the transmitter has to be removed later.
- Carefully place the transmitter on the antenna.
- Rotate the transmitter to face the most convenient direction for wiring, configuration and viewing. Do not tighten the universal connector (large hex nut) nor the set screw on the housing base. The transmitter launcher must be oriented properly for optimal performance.
- Do not place insulating material around any part of the radar transmitter including the antenna flange.

2.4.2.1 Orientation

The Pulsar Model R96 transmitter utilizes a linearly polarized, microwave beam that can be rotated to improve its performance. Proper orientation can minimize unwanted target reflections, decrease sidewall reflections (multipath) and maximize direct reflections from the liquid surface. The index mark located on the side of the launcher is oriented in the same direction as the polarization.

The index mark is also present for reference(1 dot: GP/IS or 2 dots: XP). The launcher is considered to be at 0° when the index mark is closest to the tank wall. *(See figures at left.)*



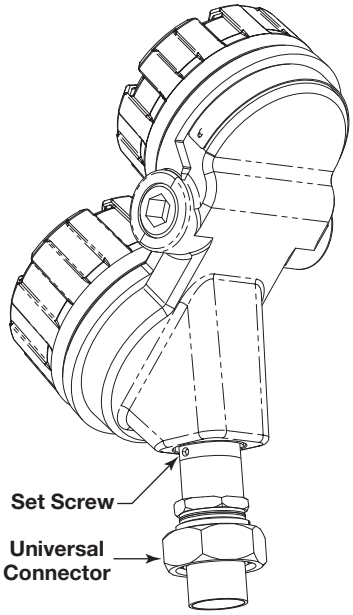
Top View
Mounted ½ radius

2.4.2.2 Initial Installation

Ideally, the transmitter should be mounted half the radius from the tank wall. Align the index mark so it is at an angle of 45 degrees to a line from the radar unit to the nearest tank wall. For horizontal cylindrical vessels, align the launcher (index mark) so it is facing along the long axis of the vessel. Once properly oriented, tighten set screws and Universal connector (30 ft-lbs (40 Nm) of force).

A transmitter mounted within 18" (45 cm) of a tank wall may demand orientation adjustments to limit multipath and optimize performance. See Section 2.4.2.3 Low Echo Margin.

NOTE: ALWAYS RUN THE ECHO REJECTION ROUTINE AFTER MAKING CHANGES TO MENU CHOICES (**Antenna Model**, **Antenna Extension**, **Antenna Mount, Tank Height, Blocking Distance, Dielectric, Turbulence, Rate Change, Foam**) or when launcher is repositioned.



2.4.2.3 Low Echo Margin

Low Echo Margin has many potential causes. Following are two initial areas for investigation.

Launcher Orientation: Initial launcher orientation is always 45 degrees (see Sections 2.4.1 & 2.4.2). In tall vessels and when antenna is mounted close to the tank wall, improvement in Echo Margin (signal quality) may be attained by rotating the launcher to 90 degrees.

Echo Loss: If the Level signal is lost repeatedly at a specific point in the vessel, it is usually a symptom that multipath (side-wall) reflections are causing cancellation by returning to the transmitter exactly 180° out of phase with the actual Level signal. This can be improved by utilizing the following procedure:

- Scroll to Display Config Menu under Device Setup. This menu shows both Level and Echo Margin.
- Bring the Level up (or down) to the exact point where the signal is repeatedly lost. Monitor the Echo Margin value as this point is being approached. The Echo Margin value will degrade to a low point before it begins to increase.
- When the Echo Margin reaches this low point, loosen both the Universal connector and the set screw. Slowly rotate the launcher clockwise approximately 10–20° (the transmitter can be rotated independently). Allow the unit to stabilize for approximately 1 minute. Repeat this process until the Echo Margin value is optimized.
- Without disturbing the position of the launcher, position the transmitter head back to its most convenient location.
- Tighten both the Universal connector (30 ft-lbs (40 Nm) of force) and Launcher set screw.

NOTE: ALWAYS RUN THE TARGET REJECTION ROUTINE AFTER MAKING CHANGES TO MENU CHOICES (**Antenna Model**, **Antenna Extension, Antenna Mount, Tank Height, Blocking Distance, Dielectric, Turbulence, Rate Change, Foam**) or when launcher is repositioned.

2.5 Wiring

Caution: HART versions of the PULSAR Model R96 transmitter operate at voltages of 11–36 VDC. FOUNDATION fieldbus™ versions operate at 9–17.5 VDC. Higher voltages will damage the transmitter.

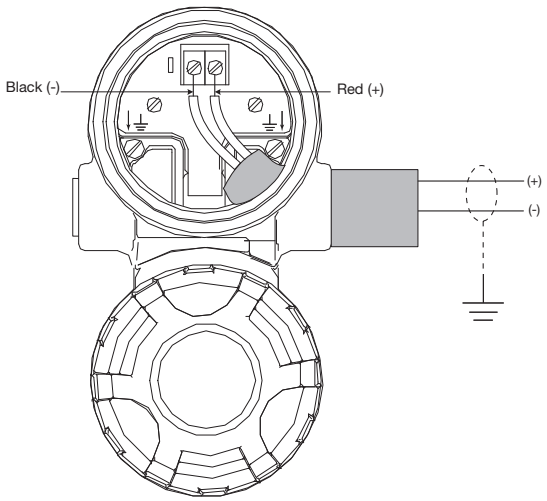
Wiring connections between the power supply and the Pulsar Model R96 Radar Transmitter should be made using 18–22 AWG (0.5–1mm^2) shielded twisted pair instrument cable. Connections are made to the terminal strip and the ground connections within the top enclosure compartment.

The directions for wiring the Pulsar Model R96 transmitter depend on the application:

- General Purpose or Non-Incendive (Cl I, Div. 2)
- Intrinsically Safe
- Explosion Proof

WARNING! Explosion hazard. Do not disconnect equipment unless power has been switched off or the area is known to be non-hazardous.

To avoid moisture ingress in the housing, covers should be fully tightened at all times. For the same reason, cable gland and plugs should be properly installed in the cable entries.



2.5.1 General Purpose or Non-incendive (Cl I, Div. 2)

A general purpose installation does not have flammable media present.

Areas rated Non-Incendive (Cl I, Div. 2) have flammable media present only under abnormal conditions.

No special electrical connections are required.

Caution: If flammable media is contained in the vessel, the transmitter must be installed per Class I, Div 1 standards of area classification.

To install General Purpose or Non-Incendive wiring:

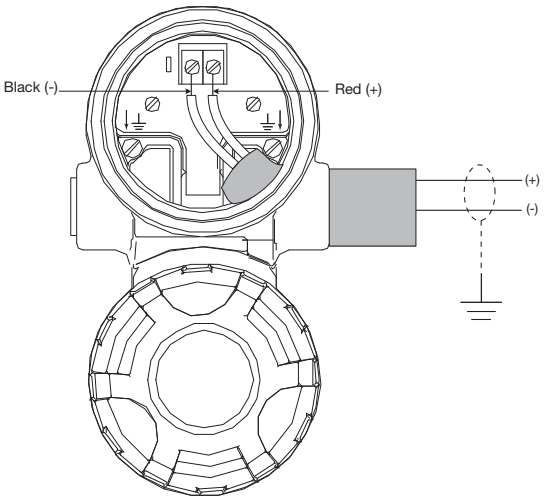
1. Remove the cover from the wiring compartment of the transmitter. Install the conduit plug in the unused opening and use PTFE tape/sealant to ensure a liquid-tight connection.
2. Install a conduit fitting and pull the supply wires.
3. Connect shield to an earth ground at power supply.
4. Connect an earth ground wire to the nearest green ground screw (not shown in illustration).

5. Connect the positive supply wire to the (+) terminal and the negative supply wire to the (-) terminal.
6. Replace and tighten the cover to the transmitter wiring compartment before applying power.

2.5.2 Intrinsically Safe

An Intrinsically Safe (IS) installation potentially has flammable media present. An approved IS barrier must be installed in the non-hazardous (safe) area to limit the available energy out to the hazardous area.

See Agency Drawing – Intrinsically Safe Installation, Section 3.5.1.



To install Intrinsically Safe wiring:

1. Ensure that the IS barrier is properly installed in the safe area (refer to local plant or facility procedures). Complete the wiring from the power supply to the barrier and from the barrier to the Pulsar Model R96 transmitter.
2. Remove the cover from the wiring compartment of the transmitter. Install the conduit plug in the unused opening and use PTFE tape/sealant to ensure a liquid-tight connection.
3. Install a conduit fitting and pull the supply wires.
4. Connect shield to an earth ground at power supply.
5. Connect an earth ground wire to the nearest green ground screw (not shown in illustration).
6. Connect the positive supply wire to the (+) terminal and the negative supply wire to the (-) terminal.
7. Replace and tighten the cover to the wiring compartment of the transmitter before applying power.

2.5.3 Explosion Proof

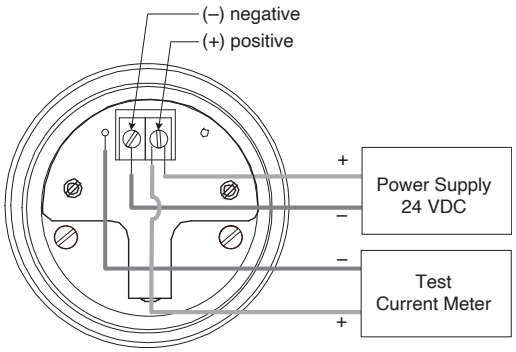
Explosion Proof (also referred to as XP or flameproof) is another method of designing equipment for installation into hazardous areas. A hazardous location is an area in which flammable gases or vapors are (or may be) present in the air in quantities sufficient to produce explosive or ignitable mixtures.

The wiring for the transmitter must be contained in Explosion Proof conduit extending into the safe area.

- Due to the specialized design of the Pulsar Model R96 transmitter, no Explosion Proof conduit fitting (EY seal) is required within 18" of the transmitter.
- An Explosion Proof conduit fitting (EY seal) is required between the hazardous and safe areas. See Agency Specifications, Section 3.5.

To install an Explosion Proof transmitter:

1. Install Explosion Proof conduit from the safe area to the conduit connection of the PULSAR Model R96 transmitter (refer to local plant or facility procedures).
2. Remove the cover from the wiring compartment of the transmitter.
3. Connect shield to an earth ground at the power supply.
4. Connect an Earth ground wire to the nearest green ground screw per local electrical code (not shown in illustration).
5. Connect the positive supply wire to the (+) terminal and the negative supply wire to the (-) terminal.
6. Replace and tighten the cover to the wiring compartment of the transmitter before applying power.



G.P./I.S./Explosion Proof Model

2.6 Configuring the Transmitter

Although the PULSAR Model R96 transmitter can be delivered pre-configured from the factory, it can also be easily reconfigured in the shop or at the installation using the local LCD/Keypad or PACT*ware*/DTM. Bench configuration provides a convenient and efficient way to set up the transmitter before going to the tank site to complete the installation.

Before configuring any transmitter, collect all operating parameters information (refer to Section 1.1.2).

Apply power to the transmitter and follow the step-by-step procedures for the menu-driven transmitter display. Refer to Sections 2.6.2 and 2.6.4.

Information on configuring the transmitter using a HART communicator is given in Section 2.7, Configuration Using HART.

Refer to I/O manual 58-640 for information on FOUNDATION fieldbus output.

2.6.1 Bench Configuration

The PULSAR Model R96 transmitter can be easily configured at a test bench by connecting a standard 24 VDC power supply directly to the transmitter terminals as shown in the accompanying diagram. An optional digital multimeter is shown in the event that mA current measurements are desired.

NOTE: Current measurements taken at these test points are an approximate value. Accurate current readings should be taken with the digital multimeter directly in series with the loop.

NOTE: When using a HART communicator for configuration, a minimum 250-ohm line load resistance is required. Refer to your HART communicator manual for additional information.

NOTE: The transmitter can be configured without the antenna attached. Disregard any diagnostic indicators that may appear.

2.6.2 Menu Traversal and Data Entry

The four push buttons offer various forms of functionality for navigation and data entry.

The Pulsar Model R96 user interface is hierarchical in nature, best described as a tree structure. Each level in the tree contains one or more items. Items are either menu labels or parameter names.

- Menu labels are presented in all capital letters
- Parameters are capital words

2.6.2.1 Navigating the Menu

⇧ **UP** moves to the previous item in the menu branch.

⇩ **DOWN** moves to the next item in the menu branch.

⇦ **BACK** moves back one level to the previous (higher) branch item.

⇨ **ENTER** enters into the lower level branch or switches to the entry mode. Holding the ENTER down on any highlighted menu name or parameter will show help text for that item.



2.6.2.2 Data Selection

This method is used for selecting configuration data from a specific list.

⇧ **UP** and ⇩ **DOWN** to navigate the menu and highlight the item of interest

⇨ **ENTER** allows modification of that selection

⇧ **UP** and ⇩ **DOWN** to choose new data selection

⇨ **ENTER** to confirm selection

Use ⇦ **BACK** (Escape) key at any time to abort the procedure and escape to previous branch item

2.6.2.3 Entering Numeric Data Using Digit Entry

This method is used to input numeric data, e.g., Tank Height, 4 mA setpoint and 20 mA setpoint.

Push button		Keystroke Action
	Up	Moves up to the next highest digit (0,1,2,3,....,9 or decimal point). If held down the digits scroll until the push button is released.
	Down	Moves up to the next lowest digit (0,1,2,3,....,9 or decimal point). If held down the digits scroll until the push button is released.
	Back	Moves the cursor to the left and deletes a digit. If the cursor is already at the leftmost position, then the screen is exited without changing the previously saved value.
	Enter	Moves the cursor to the right. If the cursor is located at a blank character position, the new value is saved.

All numeric values are left-justified, and new values are entered from left to right. A decimal point can be entered after the first digit is entered, such that .9 is entered as 0.9.

Some configuration parameters can have a negative value. In this case, the leftmost position is reversed for the sign (either "-" for a negative value, or "+" for a positive value).

2.6.2.4 Entering Numeric Data Using Increment/Decrement

Use this method to input the following data into parameters such as Damping and Failure Alarm.

Push button		Keystroke Action
	Up	Increments the displayed value. If held down the digits scroll until the push button is released. Depending on which screen is being revised, the increment amount may increase by a factor of 10 after the value has been incremented 10 times.
	Down	Decrements the displayed value. If held down the digits scroll until the push button is released. Depending on which screen is being revised, the decrement amount may increase by a factor of 10 after the value has been decremented 10 times.
	Back	Returns to the previous menu without changing the original value, which is immediately redis-played.
	Enter	Accepts the displayed value and returns to the previous menu.

2.6.2.5 Entering Character Data

This method is used for parameters requiring alphanumeric character entry, such as for entering tags, etc.

General Menu Notes:

Push button		Keystroke Action
↑	Up	Moves to the previous character (Z...Y...X...W). If held down, the characters scroll until the push button is released.
↓	Down	Moves to the next item character (A...B...C...D). If held down, the characters scroll until the push button is released.
←	Back	Moves the cursor back to the left. If the cursor is already at the leftmost position, then the screen is exited without changing the original tag characters.
→	Enter	Moves the cursor forward to the right. If the cursor is at the rightmost position, then the new tag is saved.

2.6.3 Password Protection

The PULSAR MODEL R96 transmitter has three levels of password protection to restrict access to certain portions of the menu structure that affect the operation of the system. The user password can be changed to any numerical value up to 59999. When the transmitter is programmed for
password protection, a password is required whenever configuration values are changed.

User Password

The User Password allows the customer to limit access to the basic configuration parameters.

The default User Password installed in the transmitter at the factory is 0. With a password of 0, the transmitter is no longer password protected and any value in the basic user menus can be adjusted without entering a confirming password.

NOTE: If a User Password is not known or has been misplaced, the menu item New Password in the DEVICE SETUP/ADVANCED CONFIG menu displays an encrypted value representing the present password. Contact Technical Support with this encrypted password to retrieve the original User Password.

Advanced Password

Certain portions of the menu structure that contain more advanced parameters are further protected by an Advanced Password.

This password will be provided, when necessary, by Factory technical support.

Factory Password

Calibration-related and other factory settings are further protected by a Factory Password.

2.6.4 Model R96 Menu: Step-By-Step Procedure

NOTE: Context-sensitive HELP is available for all menu items. With the menu item highlighted, hold down the ➪ **ENTER** key for two seconds. Use ⇧ **UP** and ⇩ **DOWN** for navigation.

The following tables provide a complete explanation of the software menus displayed by the PULSAR Model R96 transmitter. The menu layout is similar between the local Keypad/LCD interface, the DD, and the DTM.

Use these tables as a step-by-step guide to configure the transmitter based on the desired measurement type from the following selections:

- **Level Only**
- **Volume & Level**

HOME SCREEN

The Home Screen consists of a “slide show” sequence of Measured Values screens which are rotated at 2-second intervals. Each Home Measured Value screen can present up to four information items:

- **HART® Tag**
- **Measured Value**
  Label, Numerical Value, Units
- **Status**
  Will be displayed as text or optionally with NAMUR NE 107 symbol
- **Primary Value Bar Graph** (shown in %)

The Home Screen presentation can be customized by viewing or hiding some of these items. See DISPLAY CONFIG under the DEVICE SETUP menu in Section 2.6.5 — Configuration Menu.

At left is an example of a Home Screen for a Model R96 configured for a Level Only application.





MAIN MENU

Pressing any key on the Home Screen will present the Main Menu, consisting of three basic menu labels shown in all capital letters.

- **DEVICE SETUP**
- **DIAGNOSTICS**
- **MEASURED VALUES**

As shown, the reverse video represents a cursor identifying the selected item, which will appear in reverse video on the LCD. The actions of the keys at this point are:

Push button		Keystroke Action
↑	Up	No action as the cursor is already at the first item in the MAIN MENU
↓	Down	Moves the cursor to DIAGNOSTICS
←	Back	Moves back to HOME SCREEN, the level above MAIN MENU
→	Enter	Presents the selected item, DEVICE SETUP

NOTES:
1. Items and parameters that are shown in lower level menus will depend on the Measurement Type chosen. Those parameter not applicable to the present Measurement Type will be hidden.
2. Holding down the Enter key when the cursor is highlighted over a parameter or menu will provide additional information about that item.



DEVICE SETUP

Choosing DEVICE SETUP from the MAIN MENU will result in an LCD presentation as shown at left.

The small down arrow shown at the right hand side of the screen is the indication that more items are available below and can be accessed by pressing the DOWN key.

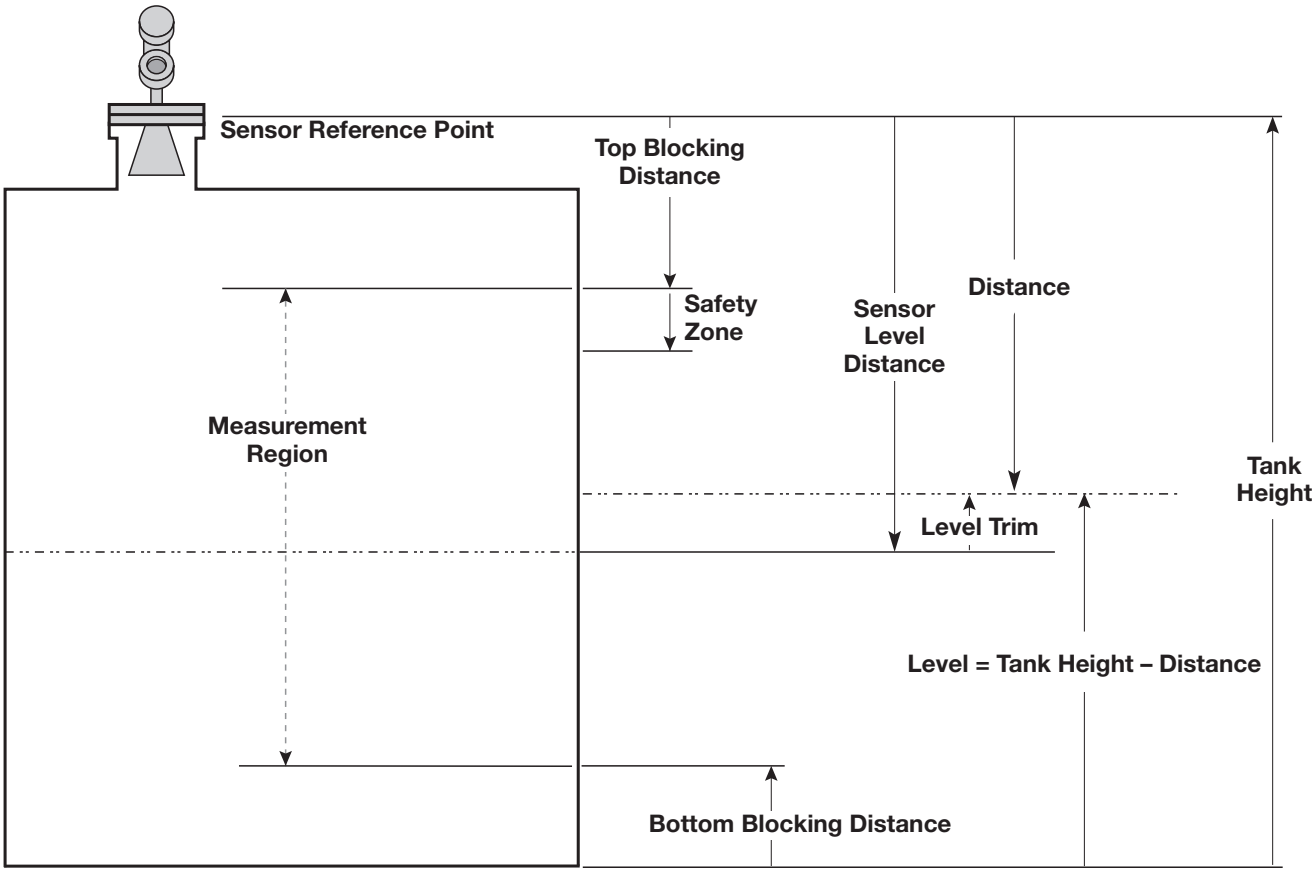
Section 2.6.5 shows the entire tree menu for the Model R96 DEVICE SETUP Menu.

DIAGNOSTICS

Refer to Section 3.4

MEASURED VALUES

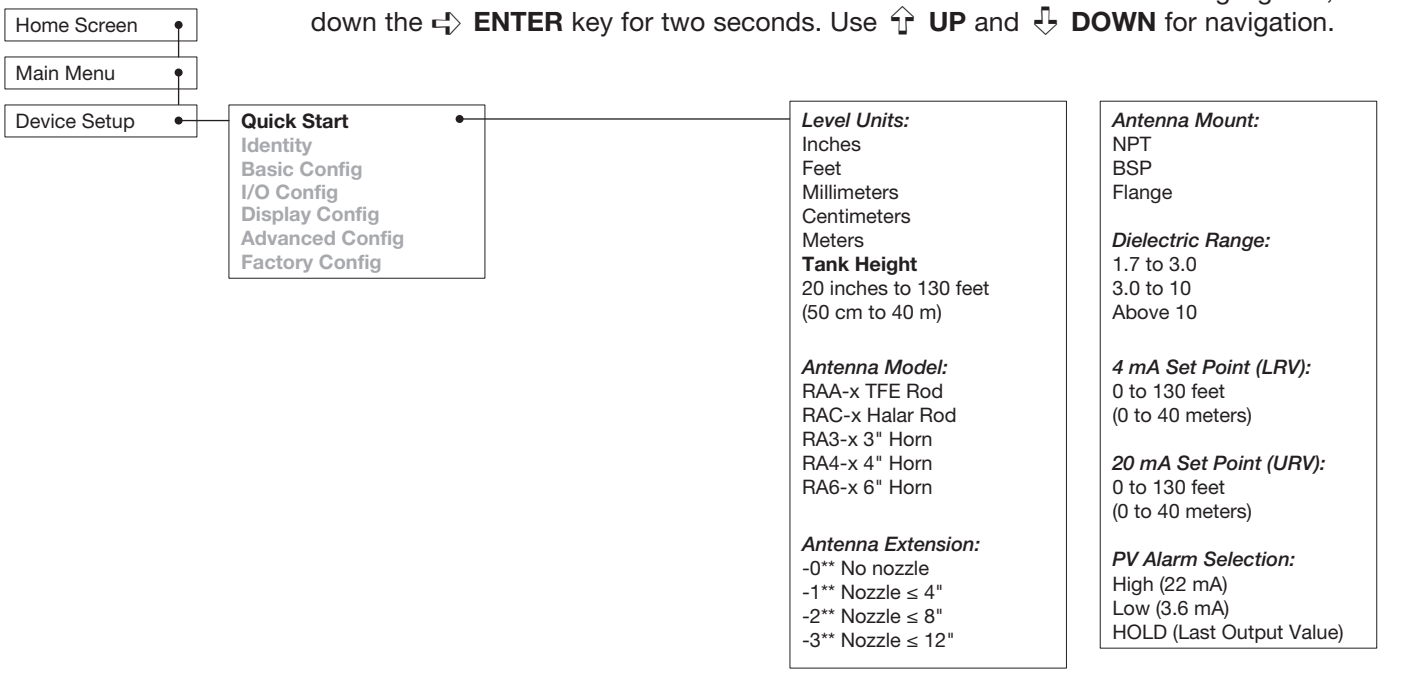
Allows the user to scroll through all of the available measured values for the measurement type chosen.

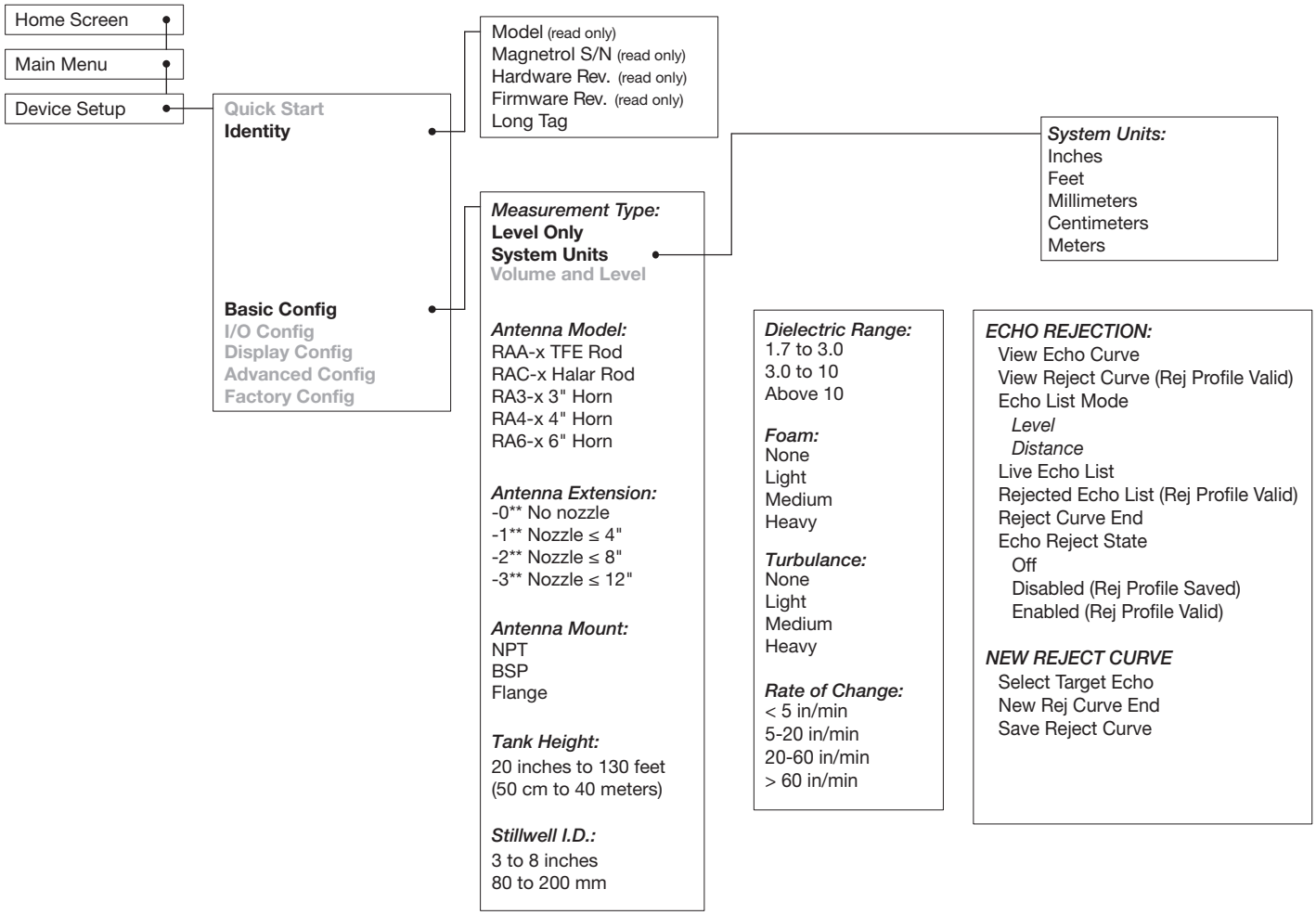


R96 Level Model

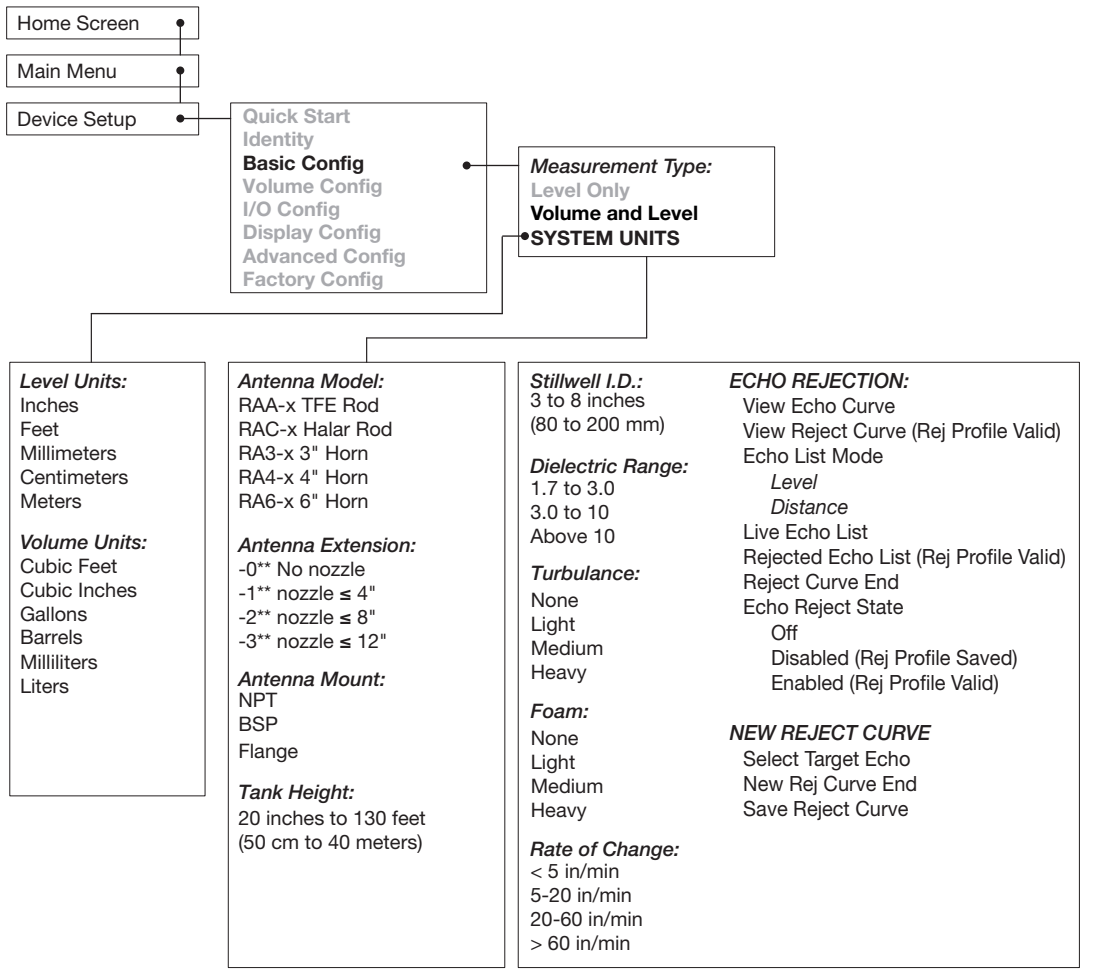
2.6.5 Model R96 Configuration Menu — Device Setup

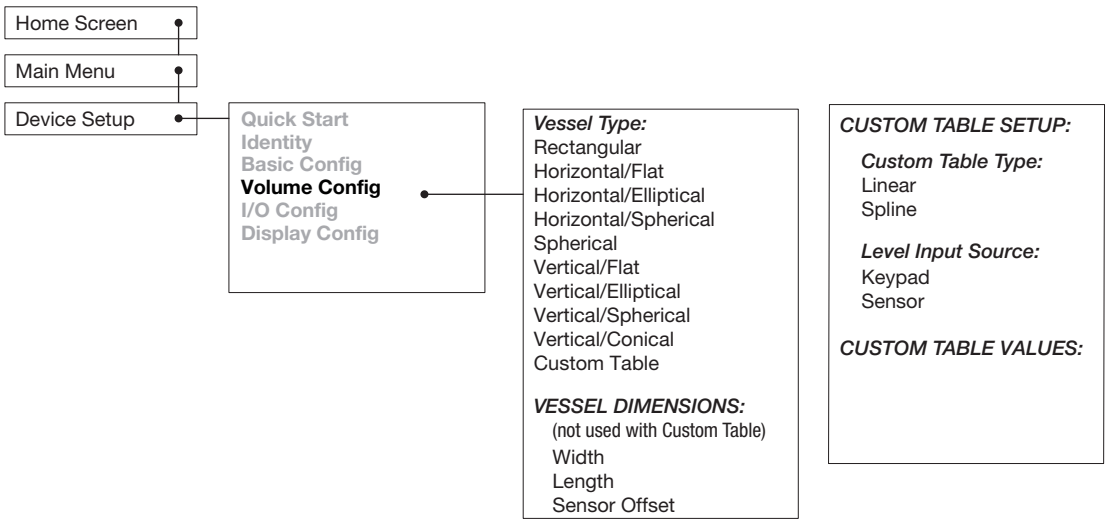
NOTE: Context-sensitive HELP is available for all menu items. With the menu item highlighted, hold down the ⇨ **ENTER** key for two seconds. Use ⇧ **UP** and ⇩ **DOWN** for navigation.



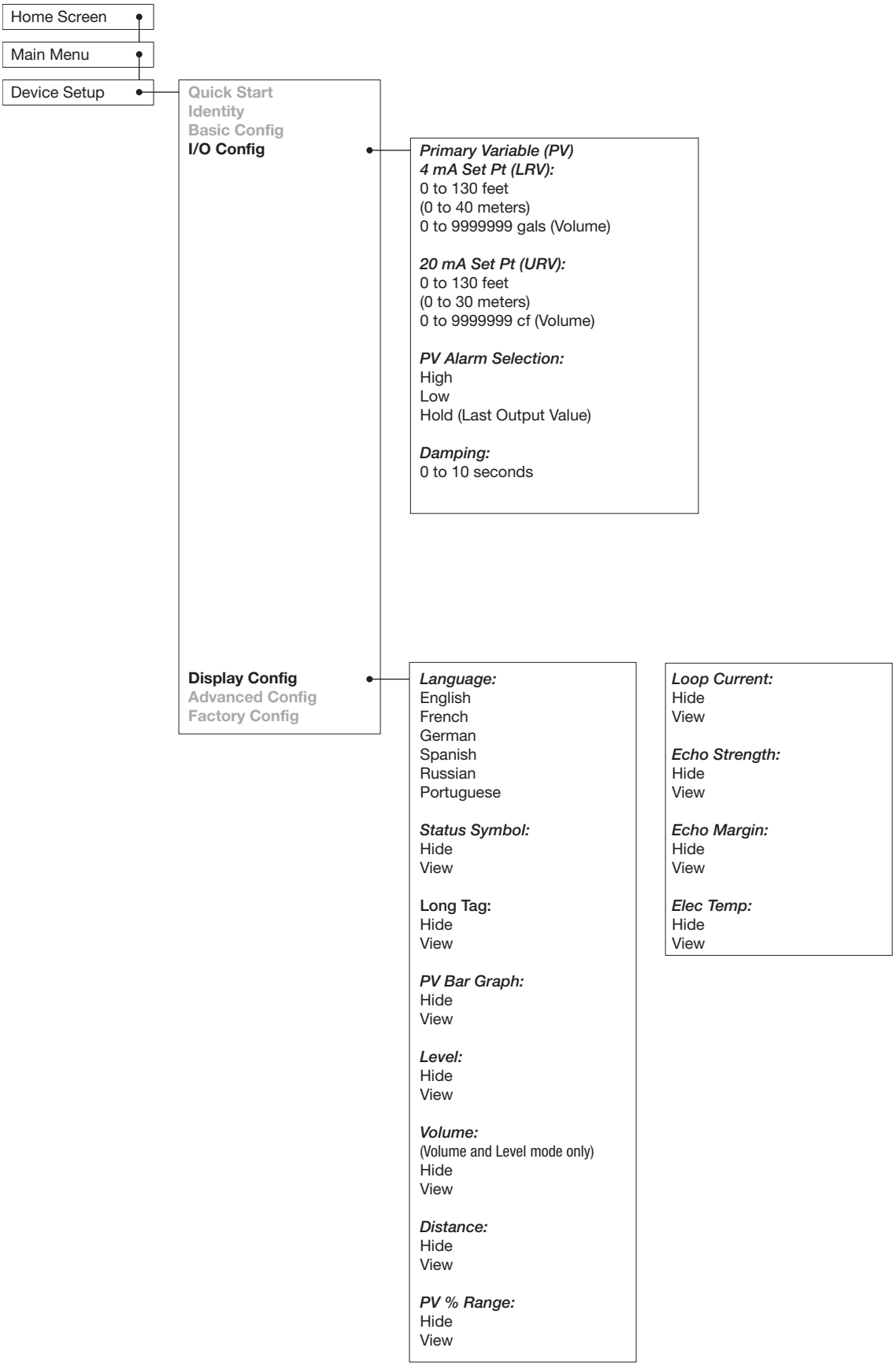


2.6.5 Model R96 Configuration Menu — Device Setup

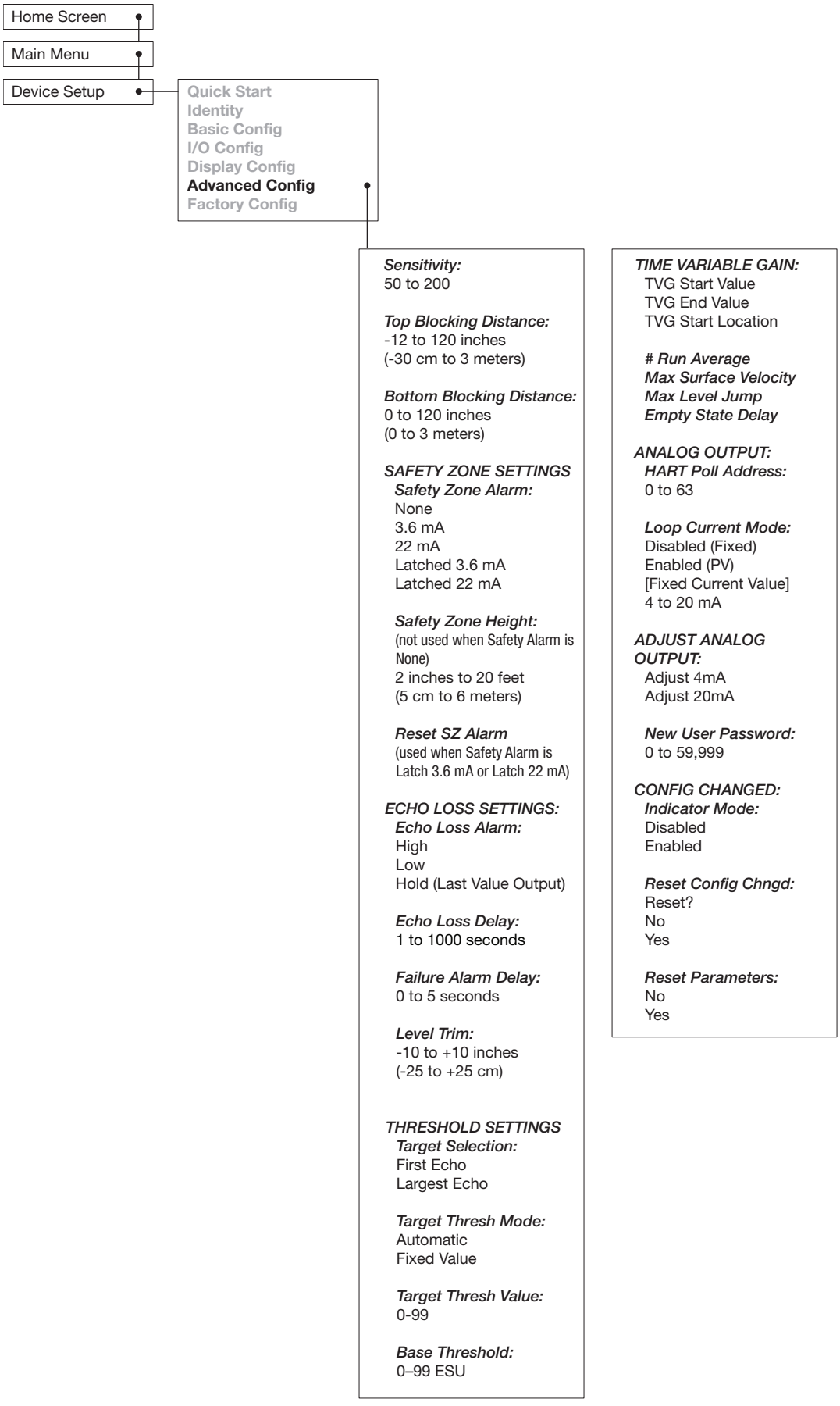




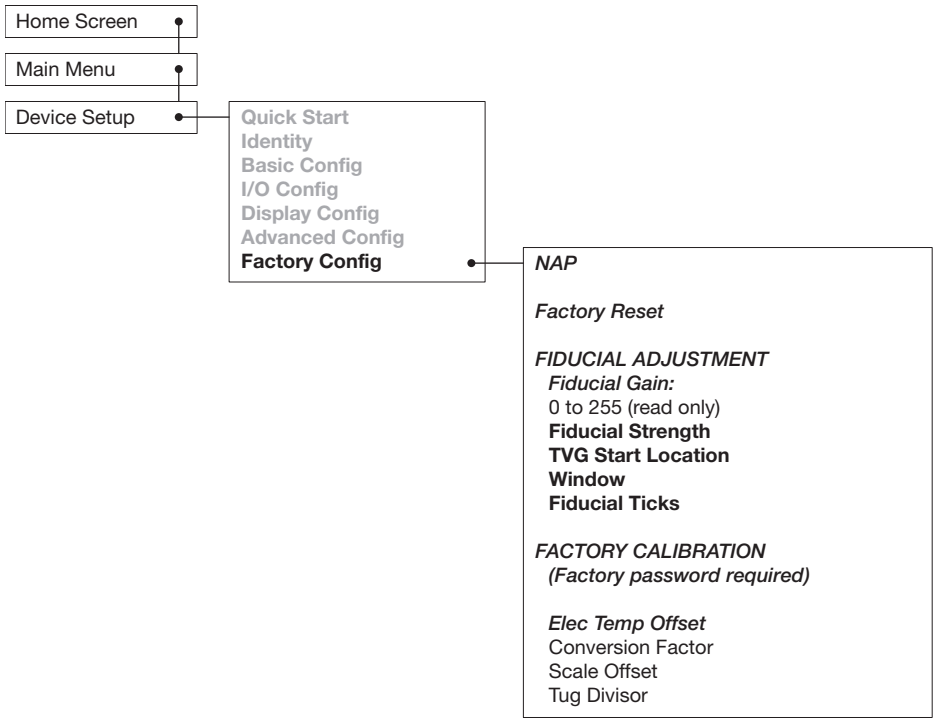
2.6.5 Model R96 Configuration Menu — Device Setup



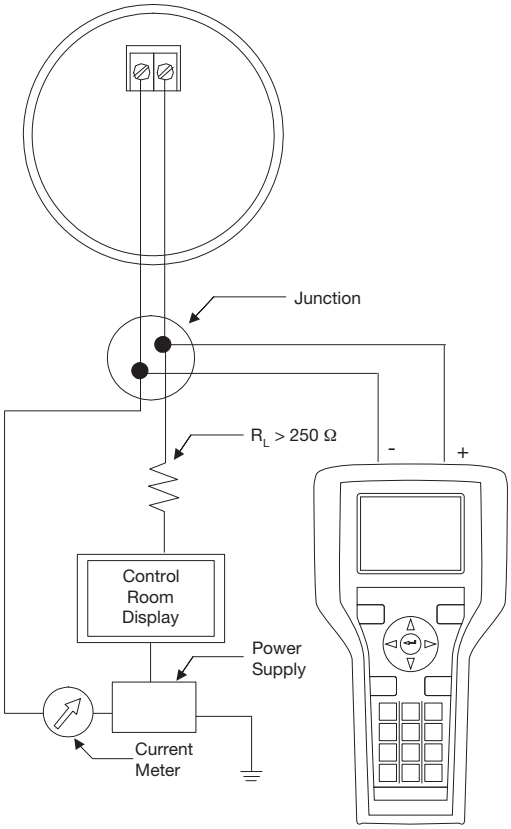
2.6.5 Model R96 Configuration Menu — Device Setup



2.6.5 Model R96 Configuration Menu — Device Setup



2.7 Configuration Using HART®



A HART (Highway Addressable Remote Transducer) remote unit, such as a HART communicator, can be used to provide a communication link to the PULSAR Model R96 transmitter. When connected to the control loop, the same system measurement readings shown on the transmitter are also shown on the communicator. The communicator can also be used to configure the transmitter.

The HART communicator may need to be updated to include the PULSAR Model R96 software (Device Descriptions). Refer to your HART Communicator Manual for update instructions.

One can also access configuration parameters using PACT*ware* and the Model R96 DTM, or using the AMS with EDDL.

2.7.1 Connections

A HART communicator can be operated from a remote location by connecting it to a remote junction or by connecting it directly to the terminal block in the electronics housing of the PULSAR Model R96 transmitter.

HART uses the Bell 202 frequency shift key technique of high-frequency digital signals. It operates on the 4–20 mA loop and requires 250 Ω load resistance. A typical connection between a communicator and the PULSAR Model R96 transmitter is illustrated.

2.7.2 Display Menu

A typical communicator display is an 8-line by 21-character LCD. When connected, the top line of each menu displays the model (Model R96) and its tag number or address. For detailed operating information, refer to the instruction manual provided with the HART communicator.

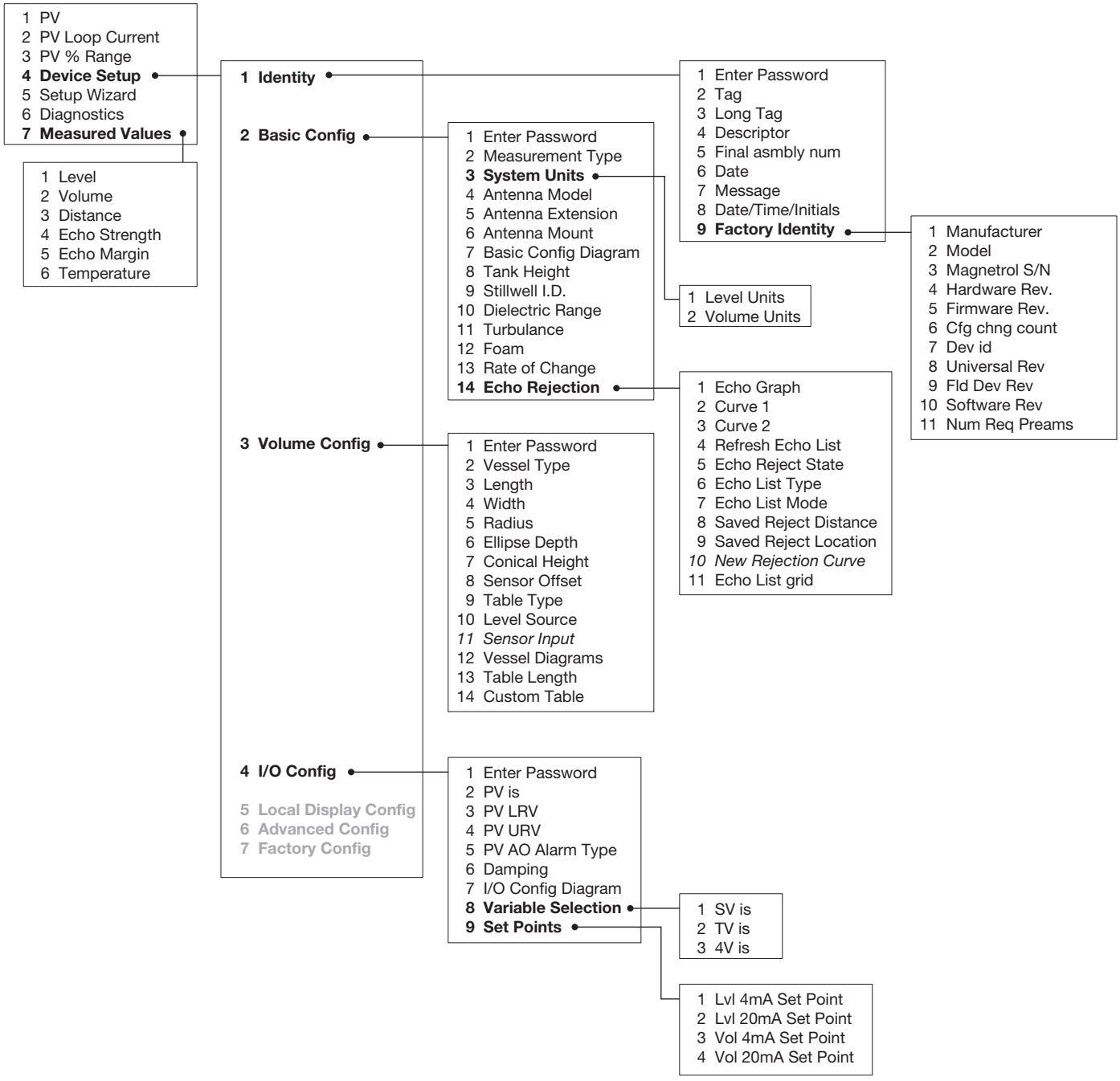
The Pulsar Model R96 transmitter online menu trees are shown in the following illustration. Open the menu by pressing the alphanumeric key 4, Device Setup, to display the second-level menu.

2.7.3 HART Revision Table

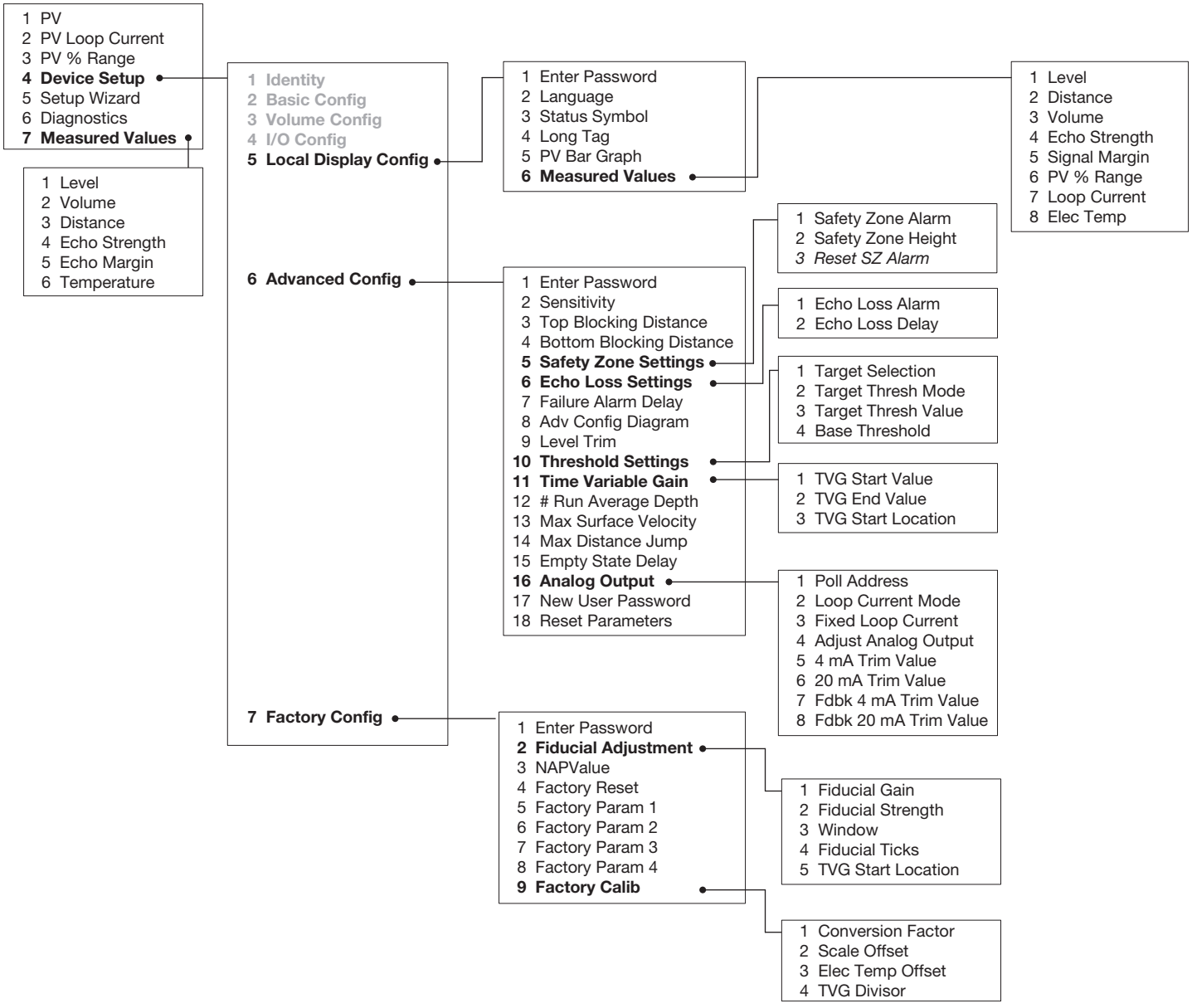
2.7.3.1 Model R96

HART Version	HCF Release Date	Compatible with R96 Software
Dev V1 DD1	December 2015	Version 1.0a and later

2.7.4 HART Menu



2.7.4 HART Menu (continued)



3.0 Reference Information

This section presents an overview of the operation of the PULSAR Model R96 Radar Level Transmitter, information on troubleshooting, common problems, listings of agency approvals, lists of replacement and recommended spare parts, and detailed physical, functional and performance specifications.

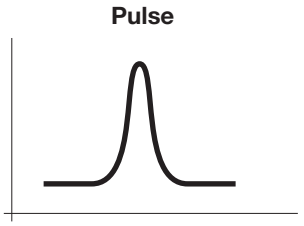
3.1 Description

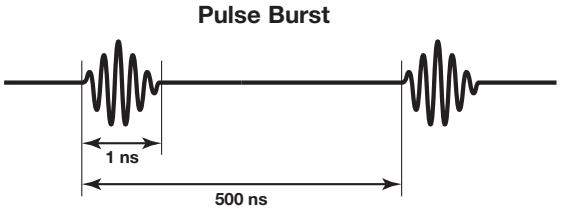
PULSAR Model R96 is a two-wire, 24 VDC, level transmitter based on the concept of pulse burst radar. The electronics are housed in an ergonomic housing comprised of two tandem compartments angled at a 45 degree angle for ease of wiring and calibration. These two compartments connect via a watertight feedthrough.

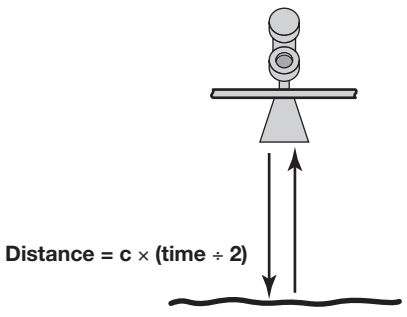
3.2 Theory of Operation

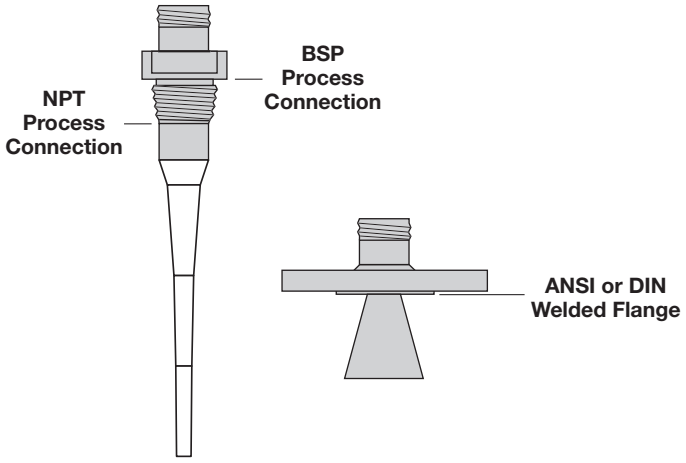
3.2.1 Pulse Burst Radar

Pulsar Model R96 is a top-mounted, downward-looking pulse burst radar operating at 6 GHz. Unlike true pulse devices (GWR, for example) that transmit a single, sharp (fast rise-time) waveform of wide-band energy, PULSAR Model R96 emits short bursts of 6 GHz energy and measures the transit time of the signal reflected off the liquid surface. Distance is calculated utilizing the equation: Distance = C × Transit time/2, then developing the Level value by factoring in application-specific configuration. The exact reference point for distance and level calculations is the Sensor Reference Point—bottom of an NPT thread, top of a BSP thread or face of a flange.









Sensor Reference Point

The exact level measurement is extracted from false target reflections and other background noise via the use of sophisticated signal processing. The new Pulsar Model R96 circuitry is extremely energy efficient so no duty cycling is necessary to accomplish effective measurement.

3.2.2 Equivalent Time Sampling

ETS, or Equivalent Time Sampling, is used to measure the high speed, low power EM (electromagnetic) energy. ETS is a critical key in the application of Radar to vessel level measurement technology. The high speed electromagnetic energy (1000 ft/µs) is difficult to measure over short distances and at the resolution required in the process industry. ETS captures the EM signals in real time (nanoseconds) and reconstructs them in equivalent time (milliseconds), which is much easier to measure with today's technology.

ETS is accomplished by scanning the tank to collect thousands of samples. Approximately three scans are taken per second; each scan gathers more than 50,000 samples.

3.3 Configuration Information

This section is intended to offer additional configuration-related details with respect to some of the parameters shown in the Menu in Section 2.6.

3.3.1 Bottom Blocking Distance Description

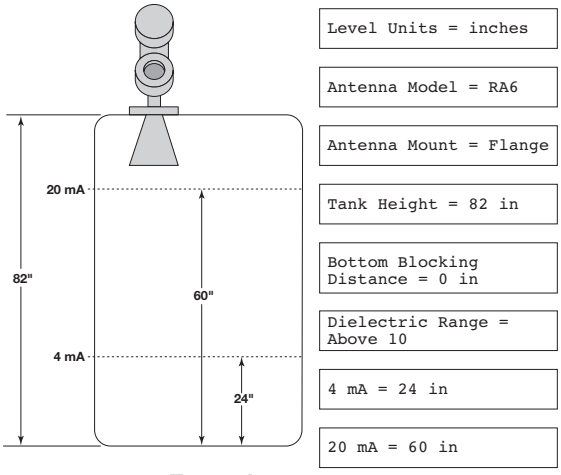
The parameter referred to as Bottom Blocking Distance in the Pulsar Model R96 DEVICE SETUP/ADVANCED CONFIG menu is defined as the distance from the bottom of the tank to the lowest valid level reading. (The level reading will never be lower than the Bottom Blocking Distance.)

The Pulsar Model R96 transmitter is shipped from the factory with Bottom Blocking Distance set to 0. With this configuration, level measurements are referenced from the bottom of the tank. See Example 1.

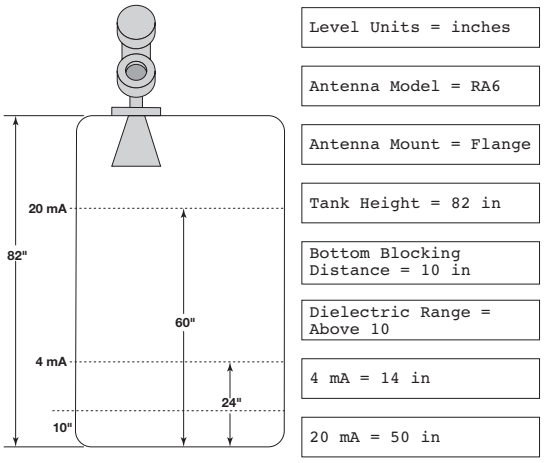
Example 1 (Bottom Blocking Distance = 0 as shipped from factory):

Application calls for a Model R96 antenna in an 82-inch tank with a flanged process connection. The process medium is water.

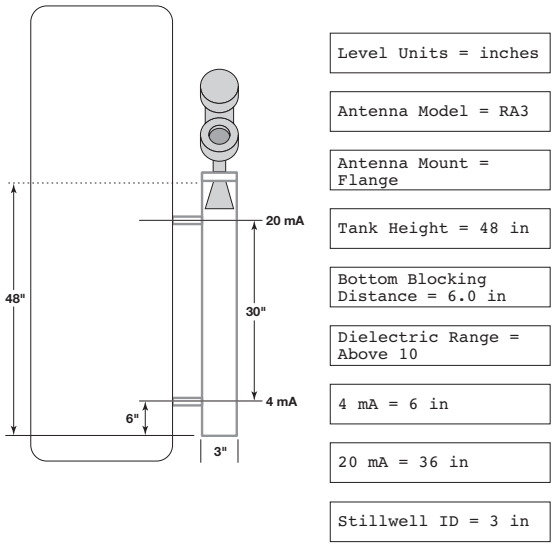
The user wants the 4 mA Set Point (LRV) at 24 inches and the 20 mA Set Point (URV) at 60 inches **as referenced from the bottom of the tank**.



Example 1



Example 2



Example 3

Example 2 (Bottom Blocking Distance = 10 inches):

Application calls for a Model R96 antenna in an 82-inch tank with a flanged process connection.

The user wants the 4 mA Set Point (LRV) at 24 inches and the 20 mA Set Point (URV) at 60 inches **as referenced from the bottom of the tank**.

When the Pulsar Model R96 transmitter is mounted in a stillwell, it is usually desirable to configure the unit with the 4 mA Set Point (LRV) at the lower process connection and the 20 mA Set Point (URV) at the upper process connection. The measuring range then becomes the center-to-center dimension.

Example 3:

Application calls for a Model RA3 flanged antenna measuring water in a 3-inch ID. The user wants the 4 mA point to be 6 inches at the bottom process connection and the 20 mA point to be 36 inches at the top process connection.

3.3.2 Echo Rejection

Since all Non-Contact radar transmitters are application/installation dependent, Echo Rejection (ignoring false targets) is necessary.

The Model R96 transmitter Echo Rejection feature is located in the DEVICE SETUP/BASIC CONFIG menu, and requires the User Password to activate. It is highly recommended that this feature be used with the waveform capture capability of the Model R96 DTM and PACT*ware*™.

Refer to Section 4.0 “Advanced Configuration/ Troubleshooting Techniques” or contact AMETEK LMS Technical Support for additional instructions.

3.3.3 Volumetric Capability

Selecting Measurement Type = Volume and Level allows the Model R96 transmitter to measure volume as the Primary Measured Value.

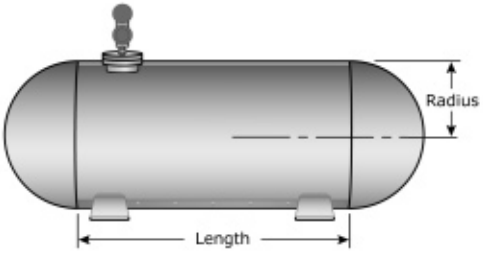
3.3.3.1 Configuration using built-in Vessel Types

The following table provides an explanation of each of the System Configuration parameters required for volume applications that use one of the nine Vessel Types.

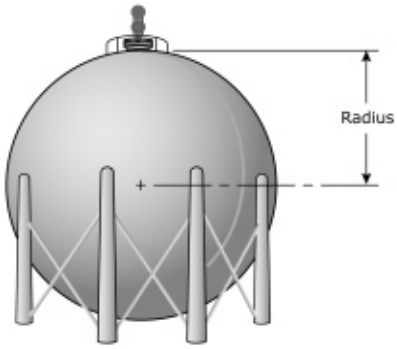
MEASUREMENT TYPE = LEVEL & VOLUME

Configuration Parameter	Explanation
System Units	A selection of Gallons, Barrels, Milliliters, Liters, Cubic Feet, or Cubic Inches, is provided. (Factory default is Cubic Feet)
Vessel Type	Select either Vertical/Flat (factory default Vessel Type), Vertical/Elliptical, Vertical/Spherical, Vertical/Conical, Rectangular, Horizontal/Flat, Horizontal/Elliptical, Horizontal/Spherical, Spherical, or Custom Table. Note: Vessel Dims is the next screen only if a specific Vessel Type was selected. If Custom Table was selected. Refer to page 48 to select the Cust Table Type and Cust Table Vals.
Vessel Dims	See the vessel drawings on the following page for relevant measuring areas.
Radius	Used for all Vessel Types with the exception of Rectangular.
Ellipse Depth	Used for Horizontal and Vertical/Elliptical vessels.
Conical Height	Used for Vertical/Conical vessels.
Width	Used for Rectangular vessels.
Length	Used for Rectangular and Horizontal vessels.

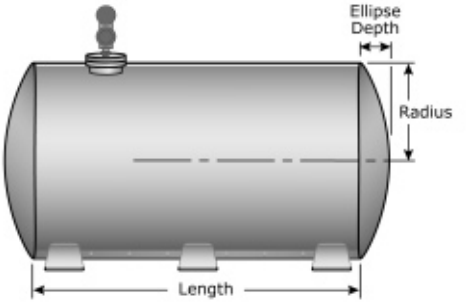
Vessel Types



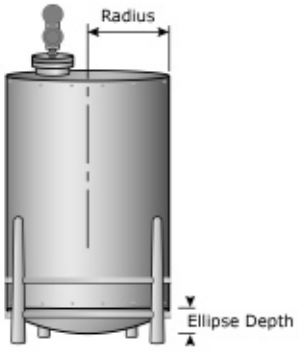
HORIZONTAL/SPHERICAL



SPHERICAL



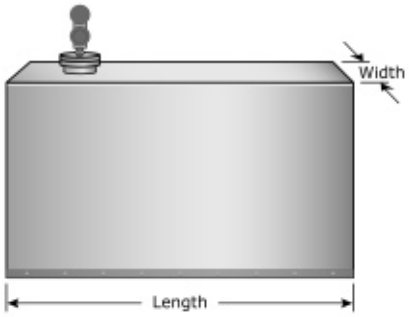
HORIZONTAL/ELLIPTICAL



VERTICAL/ELLIPTICAL



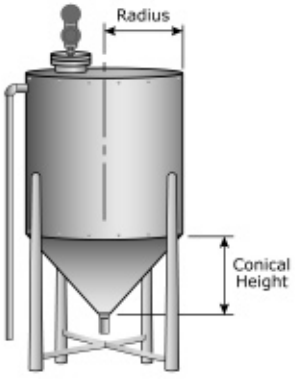
VERTICAL/SPHERICAL



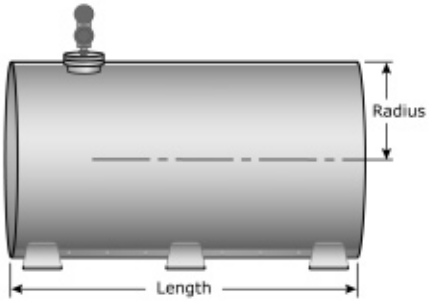
RECTANGULAR



VERTICAL/FLAT



VERTICAL/CONICAL

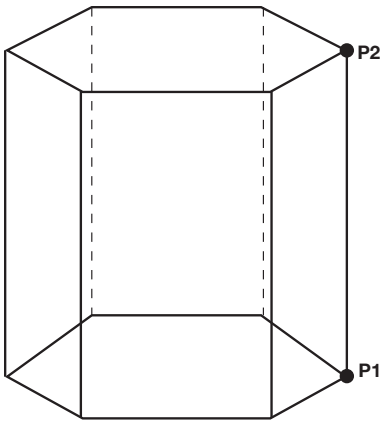


HORIZONTAL/FLAT

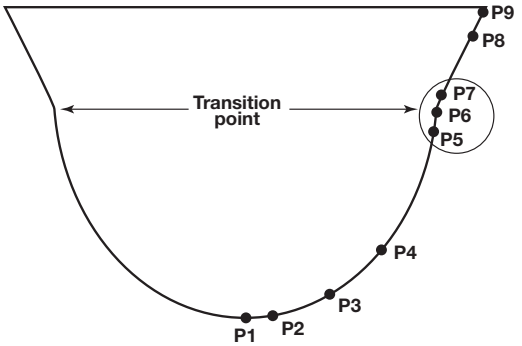
3.3.3.2 Configuration using Custom Table

If none of the nine ***Vessel Types*** shown can be used, a ***Custom Table*** can be created. A maximum of 30 points can be used to establish the level to volume relationship. The following table provides an explanation of each of the System Configuration parameters for volume applications where a Custom Table is needed.

Configuration Parameter	Explanation (Custom Volumetric Table)
Volume Units	A selection of **Gallons, Barrels, Milliliters**, **Liters**, **Cubic Feet**, or **Cubic Inches**, is provided.
Vessel Type	Select **Custom Table** if none of the nine *Vessel Types* can be used.
Cust Table Type	The *Custom Table* points can be a **Linear** (straight line between adjacent points) or **Spline** (can be a curved line between points) relationship. See drawing below for more information.
Cust Table Vals	A maximum of 30 points can be used in building the *Custom Table*. Each pair of values will have a level (height) in the units chosen in the *Level Units* screen, and the associated volume for that level point. The values must be monotonic, i.e., each pair of values must be greater than the previous level/volume pair. The last pair of values should have the highest level value and volume value associated with the level in the vessel.



LINEAR



Use where walls are not perpendicular to base.

Concentrate at least two points at beginning (P1) and end (P9); and three points at either side of transition points.

SPLINE

3.3.4 Reset Function

A parameter labeled “Reset Parameter” is located at the end of the DEVICE SETUP/ADVANCED CONFIG menu. In the event a user gets confused during configuration or advanced troubleshooting, this parameter gives the user the ability to reset the Model R96 transmitter configuration.

Unique to the Model R96 transmitter is the ability for Magnetrol to fully “pre-configure” devices to customer requests. For that reason, the Reset function will return the device back to the state **at which it left the factory**.

It is recommended that AMETEK LMS Technical Support be contacted as the Advanced User password will be required for this reset.

3.4 Troubleshooting and Diagnostics

The Pulsar Model R96 transmitter is designed and engineered for trouble-free operation over a wide range of operating conditions. The transmitter continuously runs a series of internal self-tests and displays helpful messages on the large graphic liquid crystal display (LCD) when attention is required.

The combination of these internal tests and diagnostics messages offer a valuable proactive method of troubleshooting. The device not only tells the user what is wrong, but also, and more importantly, offers suggestions on how to solve the problem.

All of this information can be obtained directly from the transmitter on the LCD, or remotely by using a HART communicator or PACT*ware* and the Pulsar Model R96 DTM.

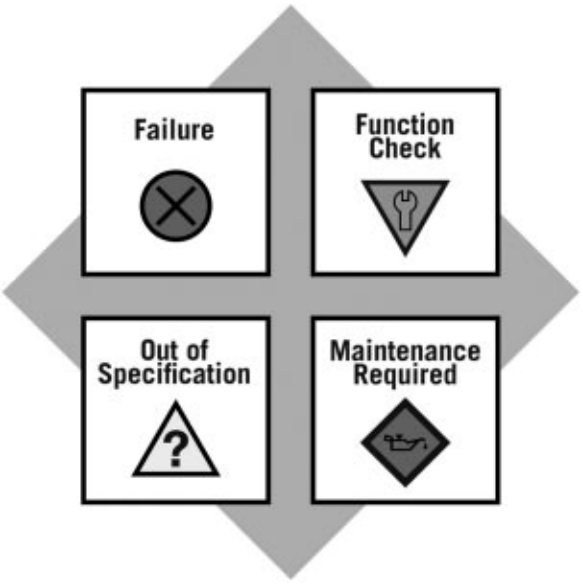
PACTware™ PC Program

The PULSAR Model R96 offers the ability to perform more advanced diagnostics such as Trending and Echo Curve analysis using a PACT*ware* DTM. This is a powerful troubleshooting tool that can aid in the resolution of any diagnostic indicators that may appear.

Refer to Section 4.0 “Advanced Configuration/ Troubleshooting Techniques” for additional information.

3.4.1 Diagnostics (Namur NE 107)

The Pulsar Model R96 transmitter includes an exhaustive list of Diagnostic Indicators which follow the NAMUR NE 107 guidelines.



NAMUR is an international user association of automation technology in process industries, whose goal is to promote the interest of the process industry by pooling experiences among its member companies. In doing so, this group promotes international standards for devices, systems, and technologies.

The objective of NAMUR NE 107 was essentially to make maintenance more efficient by standardizing diagnostics information from field devices. This was initially integrated via FOUNDATION fieldbus, but the concept applies regardless of the communication protocol.

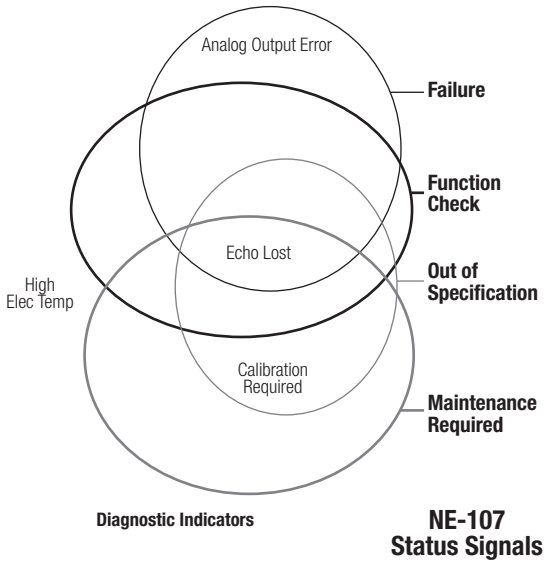
According to the NAMUR NE107 recommendation, "Self Monitoring and Diagnosis of Field Devices," fieldbus diagnostic results should be reliable and viewed in the context of a given application. The document recommends categorizing internal diagnostics into four standard status signals:

- Failure
- Function Check
- Out of Specification
- Maintenance required

These categories are shown by both symbols and colors, depending on the display capability.

In essence, this approach ensures that the correct diagnostic information is available to the correct person-at the correct time. In addition, it allows diagnostics to be applied, as most appropriate, for a particular plant application (such as process control engineering or asset management maintenance). Customer specific mapping of diagnostics to these categories allows for flexible configuration depending on the user's requirements.

From an external Model R96 transmitter perspective, diagnostic information includes measurement of process conditions, in addition to detection of internal device or system anomalies.



As mentioned above, the indicators can be assignable (via the a DTM or host system) by the user to any (or none) of the NAMUR recommended Status Signal categories: Failure, Function Check, Out of Specification, and Maintenance Required.

In the FOUNDATION fieldbus version of the relay, diagnostic indicators can be mapped to multiple categories (e.g., as shown in the diagram at left).

Indicators that are mapped to the Failure category will normally result in a current loop alarm output. The alarm state for HART transmitters is configurable as high (22 mA), Low (3.6 mA), or Hold (last value).

Users will not have the ability to unassign certain indicators from the Failure signal category as the Model R96 user interfaces will prohibit or reject such re-assignment entries). This is to ensure that current loop alarms are asserted in situations where the device is not able to provide measurements due to critical failures. (For example, if the alarm selection has not been set to Hold or a fixed current mode is in effect.)

A default mapping of all diagnostic indicators will be applied initially, and can be re-applied through use of a reset function.

Refer to the Diagnostic Indicator tables in Section 3.4 for a complete listing of the Model R96 diagnostic indicators, along with their explanations, default categories, and recommended remedies.

NOTES: 1) The remedies shown in this table can also be seen on the transmitter LCD by viewing the present status screen when the device is in a diagnostic condition.

2) Those indicators showing failure as the default result in an alarm condition.

3.4.2 Diagnostic Indication Simulation

The DD and DTM allow for the ability to manipulate diagnostic indicators. Intended as a means to verify the configuration of the diagnostic parameters and connected equipment, a user can manually change any indicator to and from the active state.

3.4.3 Diagnostic Help

Selecting DIAGNOSTICS from the MAIN MENU presents a list of five ITEMS from the top level of the DIAGNOSTICS tree.

When Present Status is highlighted, the highest MAGNETROL priority active diagnostic indicator (numerically lowest in Table 3.4) is displayed on the bottom LCD line. Pressing the ENTER key moves the active diagnostic indicator to the top line outdented and presents in the lower area of the LCD a brief explanation of and possible remedies for the indicated condition. A blank line separates the explanation from the remedies. Additional active diagnostic indicators, if any, appear with their explanations in descending priority order. Each additional active indicator name-explanation pair is separated by a blank line from the one above.

If the explanation and remedy text (and additional name-explanation pairs) exceeds the available space, a ⇩ appears in the rightmost column of the last line indicating more text below. In this situation, the DN key scrolls text up one line at a time. Similarly, while text exists above the upper line of the text field, a ⇧ appears in the rightmost column of the top (text) line. In this situation, the UP key scrolls the text down one line at a time. Otherwise the DN and UP keys are inoperative. In all cases the ENT or DEL key reverts to the previous screen.







When the transmitter is operating normally and the highlight cursor is positioned on Present Status, the bottom LCD line displays “OK” because no diagnostic indicators are active.

EVENT HISTORY – This menu displays the parameters related to diagnostic event logging.

ADVANCED DIAGNOSTICS – This menu displays parameters related to some of the advanced diagnostics available within the Model R96.

INTERNAL VALUES – Displays read-only internal parameters.

ELEC TEMPERATURES – Displays temperature information as measured in the electronics module in degrees F or C.

TRANSMITTER TESTS – Allows the user to manually set the output current to a constant value. This is a method for the user to verify operation of the other equipment in the loop.

ECHO CURVES – This menu allows the user to display the live Echo Curve on the LCD.

3.4.4 Diagnostic Indicator Table

Shown below and at right is a listing of the Model R96 diagnostic indicators, showing their priority, explanations and recommended remedies. (Priority 1 is highest priority.)

Priority	Indicator Name	Default Category	Explanation	Remedy (Context Sensitive Help)
1	Software Error	Failure	Unrecoverable error occurred in stored program.	Contact AMETEK LMS Technical Support.
2	RAM Error	Failure	RAM (read/write) memory failing.	
3	ADC Error	Failure	Analog-to-digital converter failure.	
4	EEPROM Error	Failure	Non-volatile parameter storage failing.	
5	Analog Board Error	Failure	Unrecoverable hardware failure.	
6	Analog Output Error	Failure	Actual loop current deviates from commanded value. Analog output is inaccurate.	Perform Adjust Analog Output maintenance procedure.
7	Spare Indicator 1	OK	Reserved for future use.	
8	Default Parameters		Saved parameters are set to default values.	Perform complete Device Configuration.
9	Spare Indicator 2	OK	Reserved for future use.	
10	Spare Indicator 3	OK	Reserved for future use.	
11	No Fiducial	Failure	Reference signal too weak to detect.	Torque HF nut. Check settings: Fiducial Gain Window Increase Fid Gain. Contact AMETEK LMS Technical Support.
12	Too Many Echoes	Failure	Excessive number of possible echoes detected	Check Settings: Dielectric, Sensitivity. Check Polarization.
13	Safety Zone Alarm	Failure	Risk of echo loss if liquid rises above Blocking Distance.	Ensure that liquid cannot reach Blocking Distance.
14	Echo Lost	Failure	No signal detected anywhere on probe.	Check settings: Dielectric Range Increase Sensitivity. View Echo Curve.
15	Spare Indicator 4	OK	Reserved for future use	
16	Config Conflict	Failure	Measurement type and primary variable selection parameters are inconsistent.	Confirm proper configuration. Check Measurement Type.
17	High Volume Alarm	Failure	Volume calculated from Level reading exceeds capacity of vessel or custom table.	Check settings: Vessel Dimensions, Custom Table entries

Priority	Indicator Name	Default Category	Explanation	Remedy
18	Spare Indicator 5	OK	Reserved for future use.	
19	Initializing	Function Check	Distance measurement is inaccurate while internal filters are settling.	Standard start-up message. Wait for up to 10 seconds.
20	Config Changed	Function Check	A parameter has been modified from the User Interface.	If desired, reset Config Changed indicator in ADVANCED CONFIG menu.
21	Spare Indicator 6	OK	Reserved for future use.	
22	Ramp Slope Error	Failure	Internal signal timing out of limits causing inaccurate distance measurement.	Check accuracy of Level reading. Replace transmitter electronics. Contact Magnetrol Technical Support.
23	High Elec Temp	Out of Spec	Electronics too hot. May compromise level measurement or damage instrument.	Shield transmitter from heat source or increase air circulation. Locate transmitter remotely in a cooler area.
24	Low Elec Temp	Out of Spec	Electronics too cold. May compromise level measurement or damage instrument.	Insulate transmitter. Locate transmitter remotely in a warmer area.
25	Calibration Req'd	Out of Spec	Factory calibration has been lost. Measurement accuracy may be diminished.	Return transmitter to factory for recalibration.
26	Echo Reject Invalid	Out of Spec	Echo Rejection inoperative. May report erroneous Level readings. Upr Echo may be lost near top of probe.	Save a fresh Echo Rejection Curve.
27	Spare Indicator 7	OK	Reserved for future use.	
28	Inferred Level	Out of Spec	Level inferred to have entered Blocking Region if echo lost within Max Distance Jump of Top or Bottom Blocking Region.	Verify level reading; if incorrect, check configuration.
29	Adjust Analog Out	Out of Spec	Loop current is inaccurate.	Perform Adjust Analog Output maintenance procedure.
30	Low Supply Voltage	Out of Spec	Loop current may be incorrect at higher values. Analog output is inaccurate.	Verify loop resistance. Replace loop power supply.
31	Spare Indicator 8	OK	Reserved for future use.	
32	Max Jump Exceeded	Maintenance Required	Transmitter has jumped to an echo at location that exceeds "Max Level Jump" from previous echo location.	Check settings: Dielectric Range Sensitivity View Echo Curve.
33	Low Echo Margin	Maintenance Required	Signal Margin is less than allowable minimum.	Check settings: Dielectric Range Sensitivity View Echo Curve.
34	High Surface Velocity	Maintenance Required	Measured Surface Velocity greater than Max Surface Velocity derived from configured Rate of Change.	Confirm actual rate of change. Adjust rate of change setting, if needed.
35	Spare Indicator 9	OK	Reserved for future use.	
36	Spare Indicator 10	OK	Reserved for future use.	
37	Sequence Record	OK	A Sequence Record number has been stored in Event Log.	If desired, report Sequence Record number to factory.

3.4.5 Additional Diagnostic/Trouble Shooting Capabilities

3.4.5.1 Echo History Setup

The Model R96 contains the unique and powerful feature that allows waveforms to be automatically captured based on Diagnostic Events, Time or both. This menu contains those parameters that configure that feature.

Eleven (11) waveforms can be saved directly into the transmitter.

- Nine (9) Troubleshooting Curves
- One (1) Echo Rejection Curve
- One (1) Reference Curve

3.4.5.2 Event History

As a means for improved troubleshooting capability, a record of significant diagnostic events is stored with time and date stamps. A real time on board clock (which must be set by the operator), will maintain the current time.

3.4.5.3 Context-sensitive Help

NOTE: Context-sensitive HELP is available for all menu items. With the menu item highlighted, hold down the ⇨ **ENTER** key for two seconds. Use ⇧ **UP** and ⇩ **DOWN** for navigation.

Descriptive information relevant to the highlighted parameter in the menu will be accessible via the local display and remote host interfaces. This will most often be a parameter-related screen, but could also be information about menus, actions (for example, Loop [Analog Output] Test, resets of various types), diagnostic indicators, etc.

For example: Dielectric Range — Selects the range bounding the dielectric constant of the medium in vessel. Some ranges may not be selectable depending on the antenna model.

3.4.5.4 Trend Data



Another feature of the Model R96 is the ability to log several measured values (selectable from any of the primary, secondary, or supplemental measured values) at a configurable rate (for example, once every five minutes) for a period ranging from several hours to a number of days (depending on the configured sample rate and number of values to be recorded). The data will be stored in non-volatile memory in the transmitter with date and time information for subsequent retrieval and visualization using the associated Model R96 DTM.

TREND DATA – A 15-minute trend of the PV can be displayed on the LCD.

3.5 Agency Approvals








These units are in compliance with the RED-directive 2014/53/EU, the PED-directive 2014/68/EU and the ATEX directive 2014/34/EU.

Explosion Proof **US/Canada:** Class I, Div 1, Group B, C, D, T4 Class I, Zone 1 A Ex db ia IIB+H2 T4 Class I, Zone 1 Ex d ia IIB+H2 T4 Ta = -40º C to +70º C Type 4X, IP67 **Flame Proof** **ATEX – FM14ATEX0058X** II 1/2 G Ex db ia IIB + H2 T4… T1 Ga/Gb Ta = -40º C to +70º C IP67 **IEC- IECEx FMG 15.0034X** Ex db ia IIB + H2 T4…T1 Ga/Gb Ta = -40º C to +70º C IP67	**Non- Incendive** **US/Canada:** Class I, II, III, Div 2, Group A, B, C, D, E, F, G, T4 Class 1, Zone 2 AEx ec ia IIC T4 Class 1, Zone 2 Ex ec ia IIC T4 Ta = -40º C to +70º C Type 4X, IP67 **Non-Sparking** **ATEX – FM14ATEX0059X** II 3 G Ex ec IIC T4 Gc Ta = -15º C to +70º C IP67 **IEC – IECEx FMG 15.0034X** Ex ec IIC T4 Gc Ta = -15º C to + 70º C IP67
Intrinsically Safe **US/Canada:** Class I, II, III, Div 1, Group A, B, C, D, E, F, G, T4 Class I, Zone 0 AEx ia IIC T4 Class I, Zone 0 Ex ia IIC T4 Ga Ta =-40º C to + 70º C Type 4X, IP67 **ATEX – FM14ATEX0058X:** II 1 G Ex ia IIC T4 Ga Ta = -40º C to +70º C IP67 **IEC – IECEx FMG 15.0034X:** Ex ia IIC T4 Ga Ta = -40º C to +70º C IP67	

This equipment with chargeable non-conductive parts, e.g. enclosure's paint and antenna use PTFE, Co-polymer Polypropylene or Noryl En265, is provided with a warning label referring to the safety measures that must be taken if there is electrostatic charging during operation. For use in hazardous area, the equipment and side to be installed, e.g. tank, must be connected to earth and be attention to not only the measuring object, e.g. liquids, gases, powders and etc., but also the related conditions, e.g. tank container, vessel and etc. (According to IEC 60079- 32-1).

FCC (ID# LPN-R96) Compliance Statement:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications.

Telecommunications Approvals

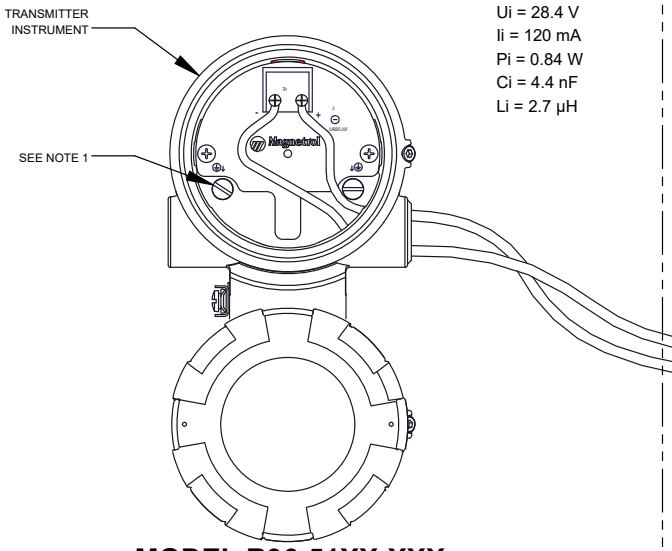
Agency	In-Tank	Out of Tank
FCC	47 CFR, Part 15, Subpart C, Section 15.209 Unintentional Radiators	47 CFR, Part 15, Subpart C, Section 15.256
ISED	RSS-211	RSS-211

3.5.1 Agency (FM/CSA) Drawing and Entity Parameters

HAZARDOUS LOCATION
MODEL R96 LEVEL TRANSMITTER

INTRINSICALLY SAFE FOR:
CLASS I, II, III DIV. I GROUPS A, B, C, D, E, F, G & T4
CLASS I, ZONE 0 AEx ia IIC
T4 Ga Ta = -40°C TO 70°C

ENTITY
Ui = 28.4 V
Ii = 120 mA
Pi = 0.84 W
Ci = 4.4 nF
Li = 2.7 µH

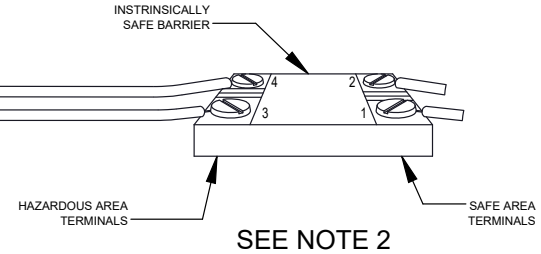


MODEL R96-51XX-XXX

NON-HAZARDOUS LOCATION
LIMITING VALUES

Voc ≤ 28.6V Ca ≥ 4.4nF
Isc ≤ 140 mA La ≥ 2.7µH

THE VOLTAGE (V max) AND CURRENT (I max), WHICH THE TRANSMITTER CAN RECEIVE MUST BE EQUAL TO OR GREATER THAN THE MAXIMUM OPEN. CIRCUIT VOLTAGE (Voc OR V+) AND THE MAXIMUM SHORT CIRCUIT CURRENT (Isc OR IE), WHICH CAN BE DELIVERED BY THE SOURCE DEVICE. IN ADDITION, THE MAXIMUM CAPACITANCE (Ci) AND INDUCTANCE (Li) OF THE LOAD AND THE CAPACITANCE AND INDUCTANCE OF THE INTERCONNECTING WIRING, MUST BE EQUAL TO LESS THAN THE CAPACITANCE (Ca) OR THE INDUCTANCE (La), WHICH CAN BE DRIVEN BY THE SOURCE DEVICE.



SEE NOTE 2

SPECIFIC CONDITIONS OF USE:

1. THE ENCLOSURE CONTAINS ALUMINUM AND IS CONSIDERED TO PRESENT A POTENTIAL RISK OF IGNITION BY IMPACT OR FRICTION. CARE MUST BE TAKEN DURING INSTALLATION AND USE TO PREVENT IMPACT OR FRICITON.
2. TO MAINTAIN THE T4 TO T1 TEMPERATURE CODES, CARE SHALL BE TAKEN TO ENSURE THE ENCLOSURE TEMPERATURE DOES NOT EXCEED 70 ºC.
3. THE RISK OF ELECTROSTATIC DISCHARGE SHALL BE MINIMIZED AT INSTALLATION, FOLLOWING THE DIRECTIONS GIVEN IN THE INSTRUCTIONS.
4. CONTACT THE ORGINAL MANUFACTURER FOR IMFORMATION IN THE DIMENSIONS OF THE FLAMEPROOF JOINTS.
5. FOR IMFORMATION WITH AMBIENT TEMPERATURE OF 70°C, REFER TO THE MANUFACTURER'S INSTRUSTIONS FOR GUIDANCE ON PROPER SELECTION OF CONDUCTORS.
6. PROVISIONS SHALL BE MADE TO PROVIDE TRANSIENT OVERVOLTAGE PROTECTION TO A LEVEL NOT EXCEEDING 119 Vdc.
7. THE SENSOR PROBES MAINTAIN A CATEGORY 1G RATING.
8. TEMPERATURE CODES FOR THE RATINGS Ex db ia IIB=H2, Ex nA IIC AND Ex ic IIC ARE DEFINED BY THE TABLE BELOW.

Process Temperature (PT)	Temperature Code-TCG(GAS)
From 0°C to 110°C	T4
From 110°C to 175°C	T3
From 175°C to 275°C	T2
From 275°C to 425°C	T1

NOTES:

1. FOR EXPLOSIONPROOF OR DUST-IGNITIONPROOF INSTALLATIONS. THE I.S. GROUND TERMINAL SHALL BE CONNECTED TO APPROPRIATE INTRINSICALLY SAFE GROUND INACCORDANCE WITH THE CANADIAN ELECTRICAL CODE [CEC] [FOR CSA] OR THE NATIONAL ELECTRINCAL CODE [NEC, ANSI/NFPA 70] [FOR FMRC]. FOR INTRINSICALLY SAFE INSTALLATIONS. THE I.S. GROUND TERMINAL DOES NOT REQUIRE GROUNDING.
2. MANUFACTURER'S INSTALLATION INSTRUCTIONS SUPPLIED WITH THE PROTECTIVE BARRIER AND THE CEC [FOR CSA] OR THE NEC AND ANSI/ISA RP 12.6 [FOR FMRC] MUST BE FOLLOWED WHEN INSTALLING THIS EQUIPMENT. BARRIER MUST BE CSA CERTIFIED FOR CANADIAN INSTALLATIONS & FM APPROVED FOR U.S. INSTALLATION.
3. CONTROL EQUIPMENT CONNECTED TO PROTECTIVE BARRIERS MUST NOT USE OR GENERATE MORE THAN 250 VDC OR VRMS.
4. NRTL LISTED DUST-TIGHT SEALS MUST BE USED WHEN TRANSMITTER IS INSTALLED IN CLASS II & III ENVIRONMENTS.
5. NO REVISIONS TO THIS DRAWING WITHOUT CSA AND FMRC APPROVAL.
6. FOR CSA: EXIA INTRINSICALLY SAFE/SECURITE INTRINSEQUE.
7. FOR CSA: WARNING - EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABLITY FOR HAZARDOUS LOCATIONS.
8. FOR SUPPLY CONNECTIONS, USE WIRE SUITABLE FOR THE OPERATING TEMPERATURE. FOR 80º C AMBIENT, USE WIRE WITH A MINIMUM TEMPERATURE RATING OF 85º C.
9. THE TRANSMITTER CAN ALSO BE INSTALLED IN:
   CLASS I, DIVISION 2, GROUPS A, B, C & D
   CLASS II, DIVISION 2, GROUPS E, F & G (F & G ONLY FOR FMRC)
   CLASS III, DIVISION 2, HAZARDOUS LOCATIONS AND DOES NOT REQUIRE CONNECTION TO A PROTECTIVE BARRIER WHEN INSTALLED PER THE CEC (FOR CSA) OR THE NEC (FOR FMRC) AND WHEN CONNECTED TO A POWER SOURCE NOT EXCEEDING 36 VDC.
10. FM APPROVED AND CSA CERTIFIED BARRIERS WITH LINEAR OUTPUT CHARACTERISTICS **MUST BE USED**.

099-5076-B

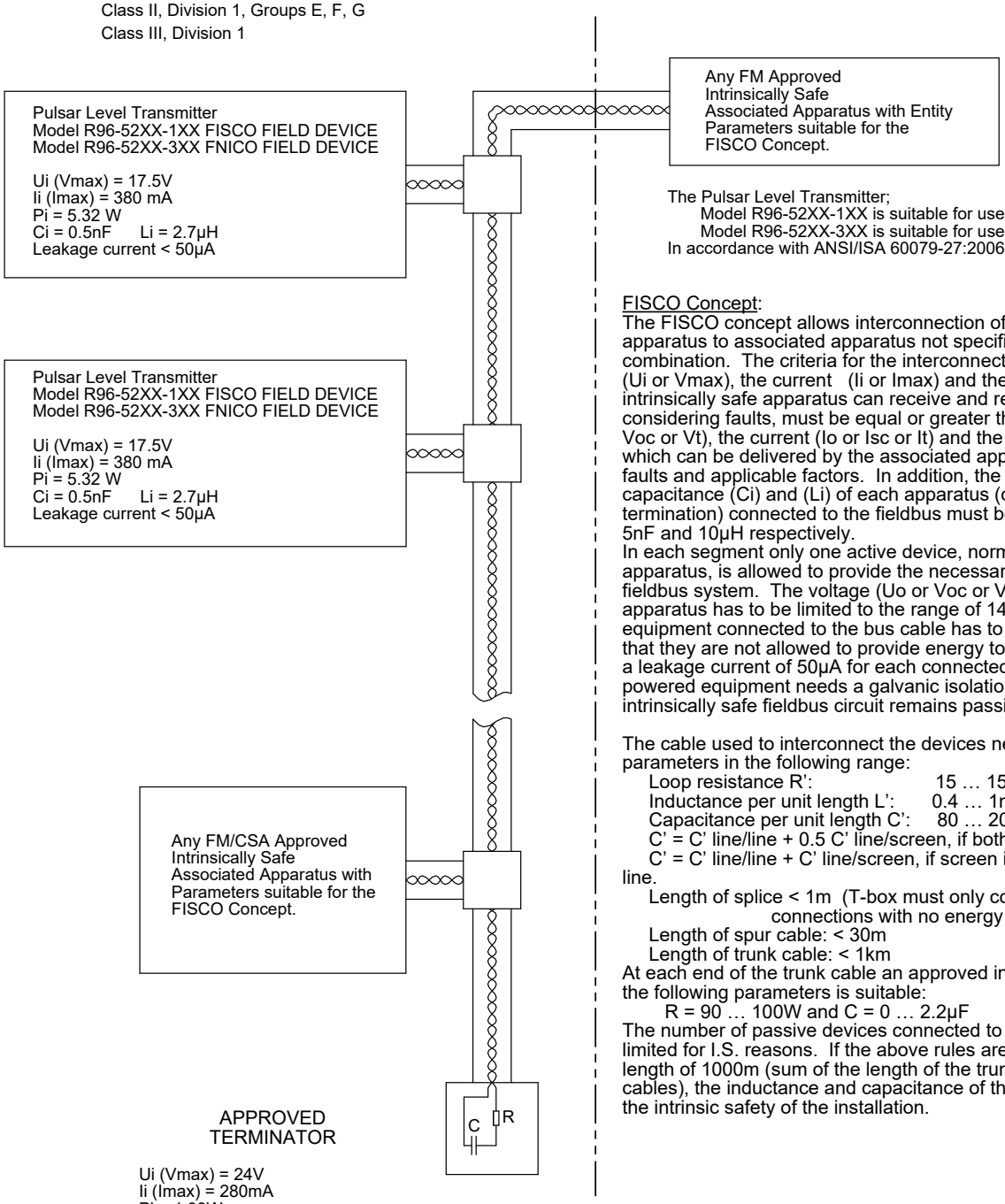
SHEET 2 OF 3

3.5.1 Agency (FM/CSA) Drawing and Entity Parameters

HAZARDOUS (CLASSIFIED) LOCATION

Class I, Division 1, Groups A, B, C, D
Class II, Division 1, Groups E, F, G
Class III, Division 1

UNCLASSIFIED LOCATION



The Pulsar Level Transmitter;
Model R96-52XX-1XX is suitable for use in a FISCO system
Model R96-52XX-3XX is suitable for use in a FNICO system
In accordance with ANSI/ISA 60079-27:2006.

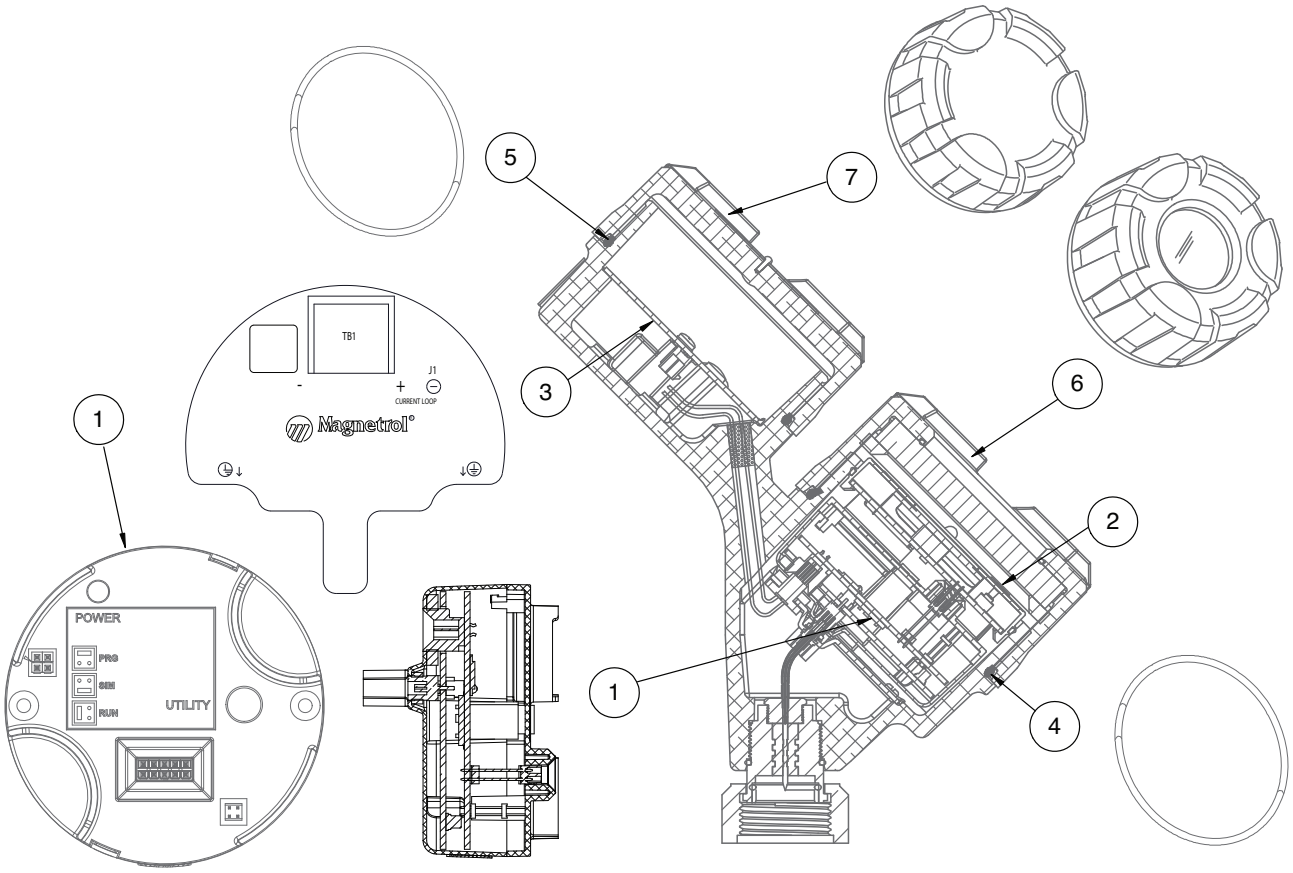
FISCO Concept:
The FISCO concept allows interconnection of intrinsically safe apparatus to associated apparatus not specifically examined in such combination. The criteria for the interconnection is that the voltage (Ui or Vmax), the current (Ii or Imax) and the power (Pi) which intrinsically safe apparatus can receive and remain intrinsically safe, considering faults, must be equal or greater than the voltage (Uo or Voc or Vt), the current (Io or Isc or It) and the power (Po or Pt) levels which can be delivered by the associated apparatus, considering faults and applicable factors. In addition, the maximum unprotected capacitance (Ci) and (Li) of each apparatus (other than the termination) connected to the fieldbus must be less than or equal to 5nF and 10µH respectively.
In each segment only one active device, normally the associated apparatus, is allowed to provide the necessary energy for the fieldbus system. The voltage (Uo or Voc or Vt), of the associated apparatus has to be limited to the range of 14V to 24V d.c. All other equipment connected to the bus cable has to be passive, meaning that they are not allowed to provide energy to the system, except to a leakage current of 50µA for each connected device. Separately powered equipment needs a galvanic isolation to assure that the intrinsically safe fieldbus circuit remains passive.

The cable used to interconnect the devices needs to have the parameters in the following range:
Loop resistance R': 15 … 150W/km
Inductance per unit length L': 0.4 … 1mH/km
Capacitance per unit length C': 80 … 200nF/km
C' = C' line/line + 0.5 C' line/screen, if both lines are floating or
C' = C' line/line + C' line/screen, if screen is connected to one line.
Length of splice < 1m (T-box must only contain terminal connections with no energy storage capability)
Length of spur cable: < 30m
Length of trunk cable: < 1km
At each end of the trunk cable an approved infallible termination with the following parameters is suitable:
R = 90 … 100W and C = 0 … 2.2µF
The number of passive devices connected to the bus segment is not limited for I.S. reasons. If the above rules are followed, up to a total length of 1000m (sum of the length of the trunk cable and all spur cables), the inductance and capacitance of the cable will not impair the intrinsic safety of the installation.

099-5076-B

SHEET 3 OF 3

3.6 Replacement Parts



Electronics:

Digit: 1 2 3 4 5 6 7 8 9 10

Part Number: R 9 6 — 5 — —

X = product with a non-standard customer requirement

Serial Number:

See nameplate, always provide complete part number and serial number when ordering spares.

(1) Electronic Module		
Digit 5	**Digit 6**	**Replacement Part**
1	1	Z31-2890-001
2	0	Z31-2890-002

(2) Display Module		
Digit 5	**Digit 7**	**Replacement Part**
1 or 2	0	N/A
	A	089-9136-001

(3) Wiring PC Board		
Digit 5	**Digit 6**	**Replacement Part**
1	1	Z30-9165-001
2	0	Z30-9166-003

	Replacement Part
(4) and (5) O-ring	012-2201-237

(6) Housing Cover			
Digit 7	**Digit 8**	**Digit 9**	**Replacement Part**
0	all	1	004-9225-002
		2	004-9225-003
A	0, 1 or A	1	036-4413-005
	3, B, C or D		036-4413-001
	all	2	036-4413-002

(7) Housing Cover	
Digit 9	**Replacement Part**
1	004-9225-002
2	004-9225-003

3.7 Specifications

3.7.1 Functional – Transmitter

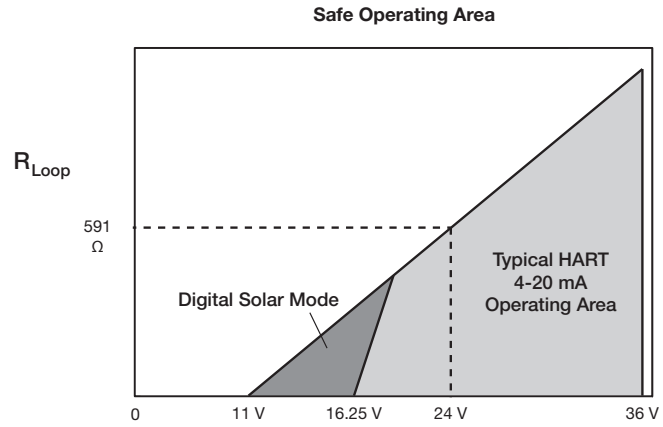
System Design		
Measurement Principle		Pulse burst radar 6 GHz
Input		
Measured Variable		Level, determined by the time-of-flight of radar pulse reflections
Span		0.5 to 130 feet (0.2 to 40 meters)
Output		
Type		4 to 20 mA with HART: 3.8 mA to 20.5 mA useable (per NAMUR NE43)
		FOUNDATION fieldbus™: H1 (ITK Ver. 6.1.2)
Resolution		Analog .003 mA
		Digital Display 1 mm
Loop Resistance		591 ohms @ 24 VDC and 22 mA
Diagnostic Alarm		Selectable: 3.6 mA, 22 mA (meets requirements of NAMUR NE 43), or HOLD last output
Diagnostic Indication		Meets requirements of NAMUR NE107
Damping		Adjustable 0-10
User Interface		
Keypad		4-button menu-driven data entry
Display		Graphic Liquid Crystal Display
Digital Communication		HART Version 7–with Field Communicator, FOUNDATION fieldbus™, AMS, or FDT
		DTM (PACTware™), EDDL
Menu Languages		Transmitter LCD: English, French, German, Spanish, Russian
		HART DD: English, French, German, Spanish, Russian, Chinese, Portuguese
		FOUNDATION fieldbus Host System: English
Power (Measured at instrument terminals)		HART: General Purpose (Weather proof)/Intrinsically Safe/Explosion-proof:
		11 VDC minimum under certain conditions (refer to I/O Manual 58-602)
		FOUNDATION fieldbus™: 9 to 17.5 VDC
		FISCO, FNICO, Explosion Proof, General Purpose and Weather Proof
Housing		
Material		IP67/die-cast aluminum A413 (<0.6% copper); optional stainless steel
Net/Gross Weight	Aluminum:	4.5 lbs. (2.0 kg)
	Stainless Steel:	10.0 lbs. (4.50 kg)
Overall Dimensions		H 8.34" (212 mm) x W 4.03" (102 mm) x D 7.56" (192 mm)
Cable Entry		½" NPT or M20
SIL 2 Hardware (Safety Integrity Level)		Safe Failure Fraction = 92.7% (HART only)
		Functional Safety to SIL 2 as 1oo1 in accordance with IEC 61508
		(Full FMEDA report available upon request)

3.7 Specifications

3.7.2 Functional – Environment

Operating Temperature		-40 to +175 °F (-40 to +80 °C); LCD viewable -5 to +160 °F (-20 to +70 °C)
Storage Temperature		-50 to +185 °F (-45 to +85 °C)
Humidity		0–99%, non-condensing
Electromagnetic Compatibility		Meets CE requirement (EN 61326) and NAMUR NE 21
Surge Protection		Meets CE EN 61326 (1000V)
Shock/Vibration		ANSI/ISA-S71.03 Class SA1 (Shock); ANSI/ISA-S71.03 Class VC2 (Vibration)
Reference Conditions		Reflection from ideal reflector at +70 °F (+20 °C)
Linearity		±0.3 inch (8 mm) or 0.1% of tank height (whichever is greater)
Measured Error		±0.3 inch (8 mm) or 0.1% of tank height (whichever is greater) (Performance will degrade slightly within 60" (1.5 m) of antenna)
Resolution		0.1 inch or 1 mm
Repeatability		±0.2 inch (5 mm) or 0.05% of tank height (whichever is greater)
Response Time		< 2 seconds (configuration dependent)
Initialization Time		< 30 seconds
Ambient Temperature Effect	Digital	Horn Antenna: Average 0.12 inch (3 mm) / 10 K, max of ±0.4 inch (10 mm) over the entire temperature range -40 to +175 °F (-40 to +80 °C)
		Rod Antenna: Average 0.2 inch (5 mm) / 10 K, max of ±0.59 inch (15 mm) over the entire temperature range -40 to +175 °F (-40 to +80 °C)
	Analog Current Output (additional error with reference to 16 mA span)	
		Average 0.03% / 10 K. max 0.45% over entire temperature range -40 to +175 °F (-40 to +80 °C)
Process Dielectric Effect		< 0.3 inch within selected range
Maximum Rate of Change		180 inches (450 cm)/minute
FOUNDATION™ fieldbus:		
ITK Version		6.1.2
H1 Device Class		Link Master (LAS) — selectable ON/OFF
H1 Profile Class		31PS, 32L
Function Blocks		(6) AI, (2) Transducer, (1) Resource, (1) Arithmetic, (1) Signal Characterizer, (2) PID, (1) Input Selector
Quiescent Current		17 mA
Execution Time		15 ms (30 ms PID Block)
Device Revision		01
DD Version		0x01

3.7.2.1 Safe Operating Area



3.7.2.2 Transmitter Terminal Voltage

Operational Mode	Current Consumption	Vmin	Vmax
HART			
General Purpose	4mA 20mA	16.25V 11V	36V 36V
Intrinsically Safe	4mA 20mA	16.25V 11V	28.6V 28.6V
Explosion Proof	4mA 20mA	16.25V 11V	36V 36V
Fixed Current-Solar Power Operation (PV transmitter via HART)			
General Purpose	10mA①	11V	36V
Intrinsically Safe	10mA①	11V	28.6V
HART Multi-Drop Mode (Fixed Current)			
Standard	4mA①	16.25V	36V
Intrinsically Safe	4mA①	16.25V	28.6V
FOUNDATION fieldbus™ (Future)			
Supply Voltage	9V to 17.5V	9V to 17.5V	9V to 17.5V

① Start-up current 12 mA minimum

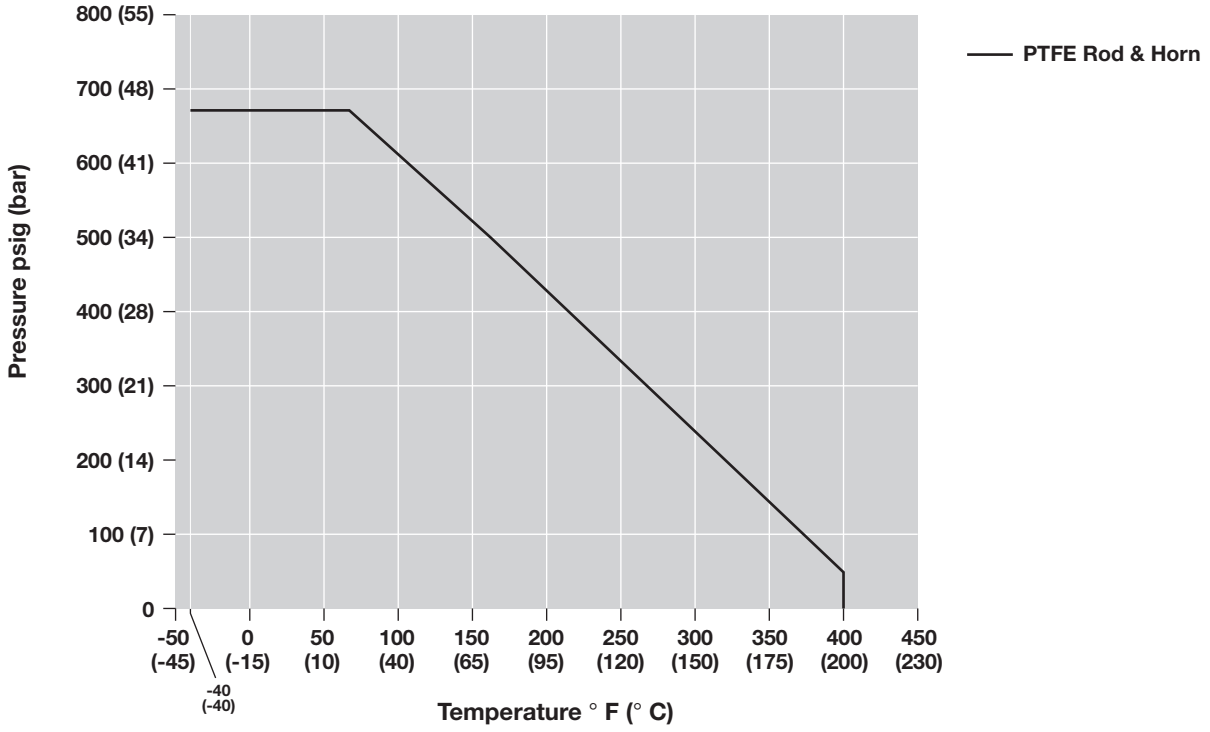
3.7.3 O-ring (seal) Selection Chart

Material	Code	Maximum Temperature	Maximum Pressure	Min. Temp.	Recommended For Use In	Not Recommended For Use In
Viton® GFLT	0	+400 °F @ 232 psig (+200 °C @ 16 bar)	750 psig @ +70 °F (50 bar @ +20 °C)	-40 °F (-40 °C)	General purpose, ethylene	Ketones (MEK, acetone), skydrol fluids, amines, anhydrous ammonia, low molecular weight esters and ethers, hot hydrofluoric or chlorosulfuric acids, sour HCs
EPDM	1	+250 °F @ 200 psig (+125 °C @ 14 bar)	750 psig @ +70 °F (50 bar @ +20 °C)	-60 °F (-50 °C)	Acetone, MEK, skydrol fluids anhydrous ammonia	Petroleum oils, di-ester base lubricants, propane, steam
Simriz SZ485 (formerly Aegis PF128)	8	+400 °F @ 232 psig +(200 °C @ 16 bar)	750 psig @ +70 °F (50 bar @ +20 °C)	-4 °F (-20 °C)	Inorganic and organic acids (including HF and nitric), aldehydes, ethylene, glycols, organic oils, silicone oils, vinegar, sour HCs, steam, amines, ethylene oxide, propylene oxide	Black liquor, Freon 43, Freon 75, Galden, KEL-F liquid, molten sodium, molten potassium
Kalrez (4079)	2	+400 °F @ 232 psig +(200 °C @ 16 bar)	750 psig @ +70 °F (50 bar @ +20 °C)	-40 °F (-40 °C)	Inorganic and organic acids (including HF and nitric), aldehydes, ethylene, glycols, organic oils, silicone oils, vinegar, sour HCs	Black liquor, hot water/steam, hot aliphatic amines, ethylene oxide, propylene oxide, molten sodium, molten potassium

3.7.4 Functional – Antenna

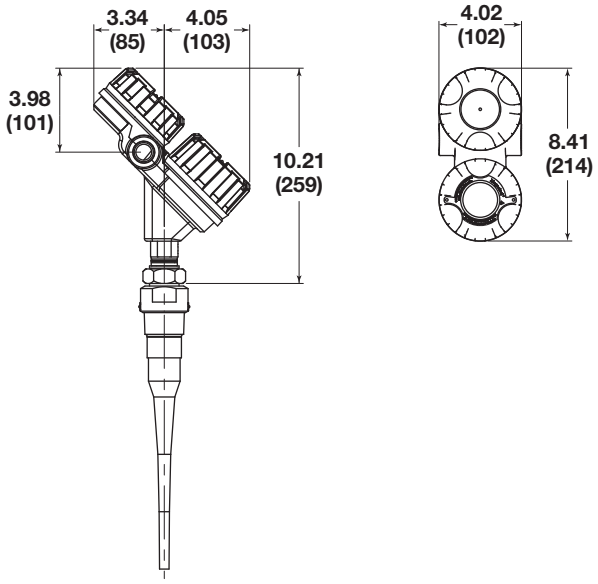
Model	Dielectric Rod TFE	4" and 6" Horn
Materials	316 SS (Hastelloy® C optional), Viton® O-rings	316 SS (Hastelloy C and Monel optional), Viton® O-rings
Process Connection	1½" NPT and BSP, ANSI or EN flanges	ANSI or EN flanges
Maximum Process Temperature	+400 °F @ 50 psig (+200 °C @ 3.5 bar)	+400 °F @ 50 psig (+200 °C @ 3.5 bar)
Maximum Process Pressure	-14.7 to 675 psig @ +70 °F (-1.0 to 46.5 bar @ +20 °C)	-14.7 to 675 psig @ +70 °F (-1.0 to 46.5 bar @ +20 °C)
Minimum Dielectric (application dependent)	2.0	1.7 (1.4 with stillwells)

3.7.5 Pulsar Model R96 Antenna Pressure / Temperature Ratings

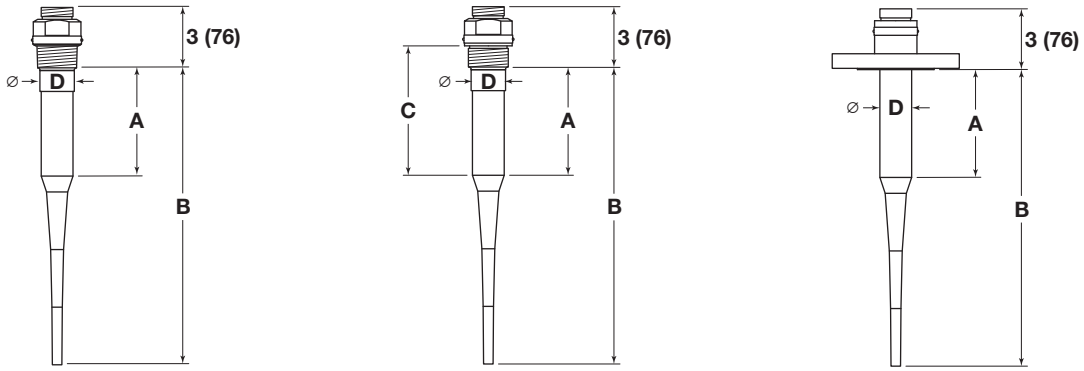


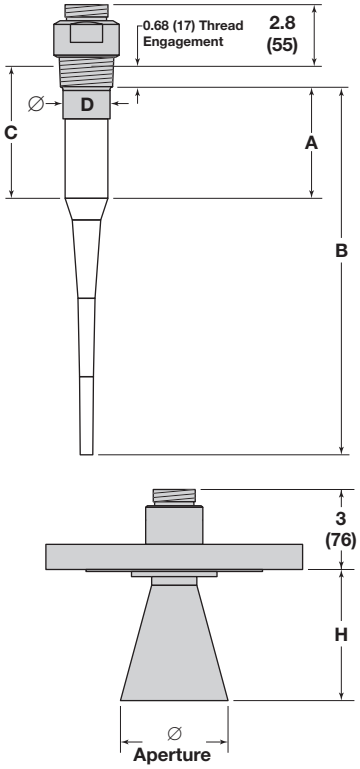
3.7.6 Physical – Inches (mm)

Transmitter



Dielectric Rod





DIELECTRIC RODS – inches (mm)

Model #	Antenna Extension (maximum "L" dimension)	All	All	BSP
8th Digit		Dim A	Dim B	Dim C
0	1 (25)	2.2 (56)	11.1 (282)	3.0 (76)
1	4 (100)	6.3 (160)	15.3 (389)	7.3 (185)
2	8 (200)	10.5 (267)	19.4 (493)	11.3 (287)
3	12 (300)	14.5 (368)	23.4 (594)	15.3 (389)

Antenna Extension O.D. Dimension D	
TFE Rod	∅ 1.50 (38)
PP Rod	∅ 1.50 (38)

HORNS – inches (mm)

Model #	Antenna Extension (maximum "L" dimension)	4" Horn	6" Horn
8th Digit		Dim H	Dim H
1	4 (100)	4.6 (117)	↓
2	8 (200)	8.4 (213)	8.3 (211)
3	12 (300)	12.4 (315)	12.4 (315)
Aperture		3.75 (95)	5.75 (146)

3.8 Model Numbers

3.8.1 PULSAR Radar Transmitter

1 | BASIC MODEL NUMBER AND OPERATING FREQUENCY

R96	Through-Air Radar Level Transmitter- 6 GHz Pulse Radar

4 | POWER

5	24 VDC, Two-wire

5 | SIGNAL OUTPUT

1	4–20 mA with HART
2	FOUNDATION fieldbus

6 | SAFETY OPTIONS

0	None (FOUNDATION fieldbus only) (5th digit = 2)
1	SIL 2 Hardware - HART only (5th digit = 1)

7 | ACCESSORIES

0	No Digital Display and Keypad
A	Digital Display and Keypad

8 | CLASSIFICATION

0	General Purpose, Weatherproof (IP 67)
1	Intrinsically Safe (FM & CSA)
3	Explosion-proof (FM & CSA)
A	Intrinsically Safe (ATEX/IEC)
B	Flame-proof (ATEX/IEC)
C	Non-sparking (ATEX)

9 | HOUSING/CONDUIT CONNECTION

1	Die-cast Aluminum, Dual-compartment, 45-degree
2	Investment Cast, Stainless Steel, Dual-compartment, 45-degree

10 | CONDUIT CONNECTION

0	½" NPT
1	M20
2	½" NPT with sunshade
3	M20 with sunshade

R	9	6	—	5				—			

3.8.2 Radar Antennas – Dielectric Rod

TECHNOLOGY / OPERATING FREQUENCY

R A	Pulsar radar antennas / 6 GHz



CONFIGURATION / STYLE

A	TFE

MATERIAL OF CONSTRUCTION

A	316/316L stainless steel
B	Hastelloy® C
K	316/316L SS; ASME B31.1 and B31.3 (meets CRN specifications)

PROCESS CONNECTION – SIZE/TYPE

Threaded

31	1½" NPT thread
32	1½" BSP (G 1½) thread

ANSI Flanges		EN Flanges		
43	2" 150# ANSI raised face flange	DA	DN 50, PN 16	EN 1092-1 Type A
44	2" 300# ANSI raised face flange	DB	DN 50, PN 25/40	EN 1092-1 Type A
45	2" 600# ANSI raised face flange	DD	DN 50, PN 63	EN 1092-1 Type B2
53	3" 150# ANSI raised face flange	EA	DN 80, PN 16	EN 1092-1 Type A
54	3" 300# ANSI raised face flange	EB	DN 80, PN 25/40	EN 1092-1 Type A
55	3" 600# ANSI raised face flange	ED	DN 80, PN 63	EN 1092-1 Type B2
63	4" 150# ANSI raised face flange	FA	DN 100, PN 16	EN 1092-1 Type A
64	4" 300# ANSI raised face flange	FB	DN 100, PN 25/40	EN 1092-1 Type A
65	4" 600# ANSI raised face flange	FD	DN 100, PN 63	EN 1092-1 Type B2
73	6" 150# ANSI raised face flange	GA	DN 150, PN 16	EN 1092-1 Type A
74	6" 300# ANSI raised face flange	GB	DN 150, PN 25/40	EN 1092-1 Type A
75	6" 600# ANSI raised face flange	GD	DN 150, PN 63	EN 1092-1 Type B2

O-RINGS

0	Viton® GFLT

ANTENNA EXTENSION

0	For nozzle height ≤ 1" (25 mm) (For threaded process connection only)
1	For nozzle height ≤ 4" (100 mm)
2	For nozzle height ≤ 8" (200 mm)
3	For nozzle height ≤ 12" (300 mm)

R	A	A	—				0	—		0	0

OPTIONAL FLANGES – For use with 1½" NPT Antennas (Antenna Extension Codes 1, 2 & 3 only)

Part Number: 004-6852	2" 150#	2" 300#	3" 150#	3" 300#	4" 150#	4" 300#	6" 150#	6" 300#
316/316L stainless steel	-001	-005	-002	-006	-003	-007	-004	-008
304/304L stainless steel	-009	-013	-010	-014	-011	-015	-012	-016
Carbon steel	-017	-021	-018	-022	-019	-023	-020	-024
Hastelloy C	-025	-029	-026	-030	-027	-031	-028	-032
Monel	-033	-037	-034	-038	-035	-039	-036	-040
Kynar	-041	-045	-042	-046	-043	-047	-044	-048
PVC	-049	-053	-050	-054	-051	-055	-052	-056
Polypropylene	-057	-061	-058	-062	-059	-063	-060	-064
TFE	-065	-069	-066	-070	-067	-071	-068	-072

3.8.3 Radar Antennas – Horn



TECHNOLOGY / OPERATING FREQUENCY

R A	PULSAR radar antennas / 6 GHz

CONFIGURATION / STYLE

4	4" horn
6	6" horn

MATERIAL OF CONSTRUCTION

A	316/316L stainless steel
B	Hastelloy C
K	316/316L SS; ASME B31.1 and ASME B31.3 (meets CRN specifications)

PROCESS CONNECTION - SIZE/TYPE (METAL FLANGES WELDED TO ANTENNA)

63	4" 150# ANSI raised face flange	FA	DN 100, PN 16	EN 1092-1 Type A
64	4" 300# ANSI raised face flange	FB	DN 100, PN 25/40	EN 1092-1 Type A
65	4" 600# ANSI raised face flange	FD	DN 100, PN 63	EN 1092-1 Type B2
73	6" 150# ANSI raised face flange	GA	DN 150, PN 16	EN 1092-1 Type A
74	6" 300# ANSI raised face flange	GB	DN 150, PN 25/40	EN 1092-1 Type A
75	6" 600# ANSI raised face flange	GD	DN 150, PN 63	EN 1092-1 Type B2

O-RINGS

0	Viton® GFLT
1	EPDM
2	Kalrez® 4079
8	Simriz SZ485 (formerly Aegis PF128)

ANTENNA EXTENSION

1	For nozzle height ≤ 4" (100 mm) - Configuration Style code 4 only
2	For nozzle height ≤ 8" (200 mm)
3	For nozzle height ≤ 12" (300 mm)

R	A		—					—		0	0

4.0 Advanced Configuration/ Troubleshooting Techniques

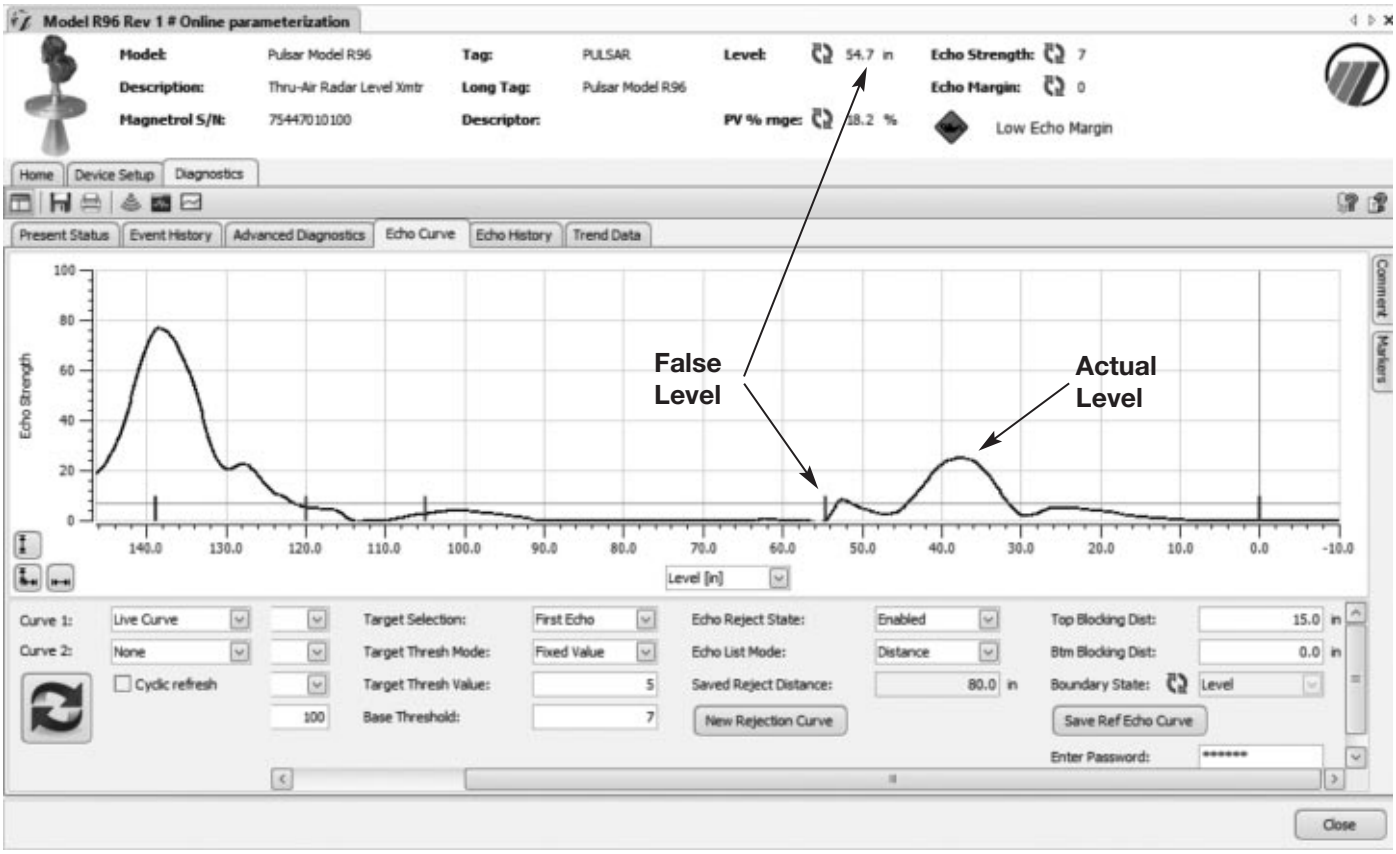
This section contains information regarding some of the advanced configuration and troubleshooting capability contained within the Model R96 transmitter. These diagnostic options are best suited for use with PACTware and the Model R96 DTM, and should be implemented only after contacting AMETEK LMS Technical Support.

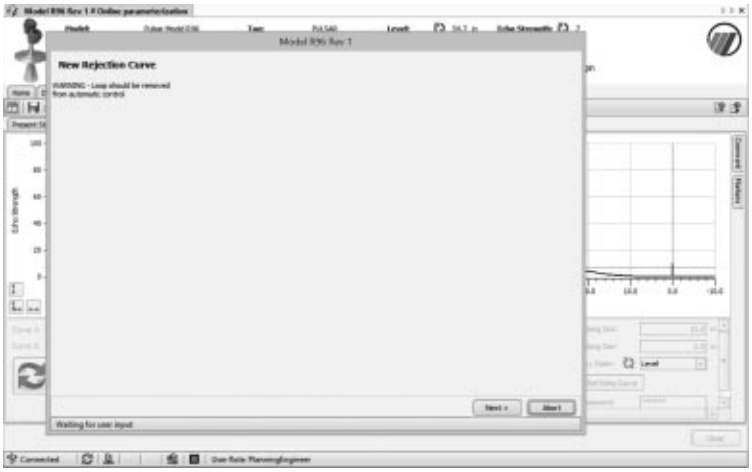
4.1 Echo Rejection

In addition to proper mounting location and antenna polarization, another way to ignore unwanted signals within the measuring range is by utilizing the Echo Rejection feature.

Setup using PACTware

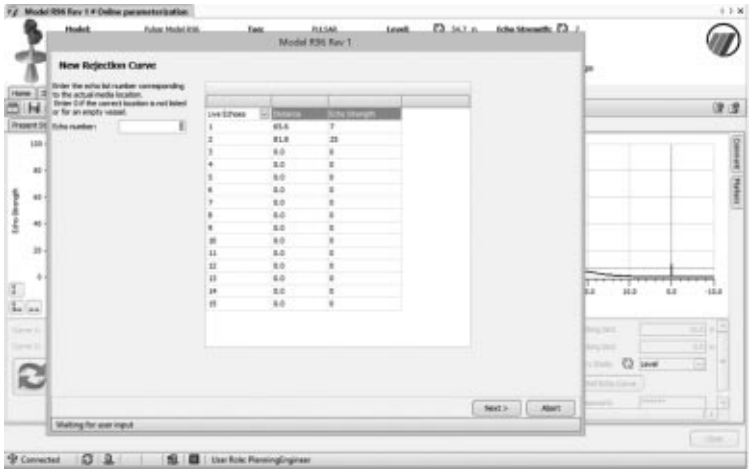
Select the Diagnostics tab and then the Echo Curve tab. Then click on New Rejection Curve

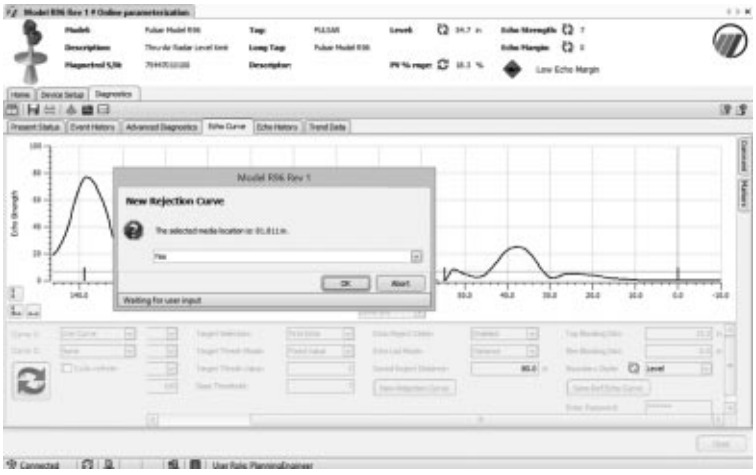




Click on NEXT at the loop warning message.

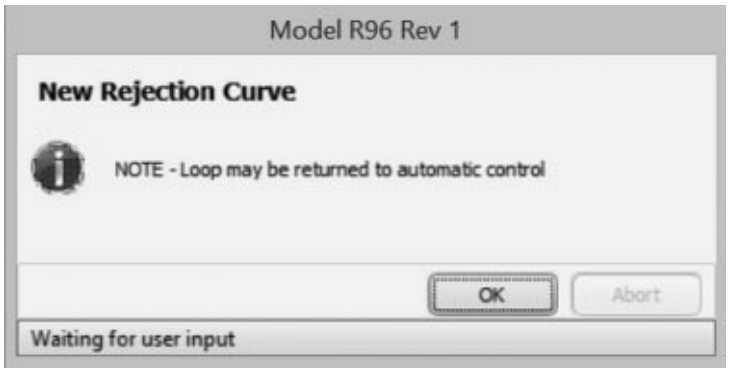
On the next screen, enter the actual location of the level to be measured and then click on NEXT.



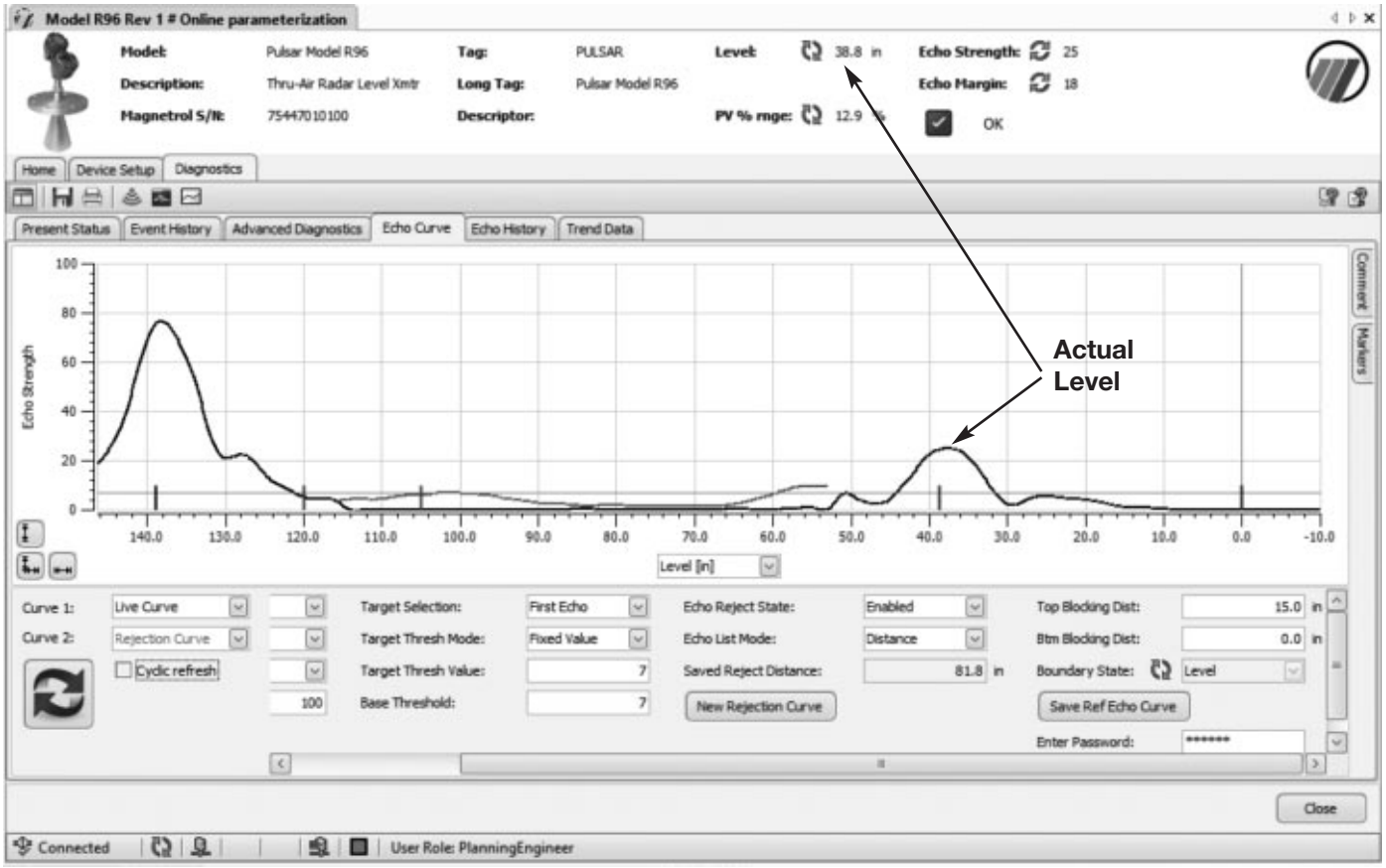


A password window will then appear (unless the password was previously entered). Enter the password and click OK. Then the system calculates the curve, and then saves it. Click OK to confirm.

A warning screen is shown that the loop can be returned to automatic control.



At this point the echo rejection curve can be viewed by selecting Rejection Curve as Curve 2 in the lower left corner of the Echo Curve screen. The Rejection curve will then be displayed as shown in the screenshot below.



Service Policy

Owners of AMETEK LMS controls may request the return of a control or any part of a control for complete rebuilding or replacement. They will be rebuilt or replaced promptly. Controls returned under our service policy must be returned by Prepaid transportation. AMETEK LMS will repair or replace the control at no cost to the purchaser (or owner) other than transportation if:

1. Returned within the warranty period; and
2. The factory inspection finds the cause of the claim to be covered under the warranty.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labor and the parts required to rebuild or replace the equipment.

In some cases it may be expedient to ship replacement parts; or, in extreme cases a complete new control, to replace the original equipment before it is returned. If this is desired, notify the factory of both the model and serial numbers of the control to be replaced. In such cases, credit for the materials returned will be determined on the basis of the applicability of our warranty.

No claims for misapplication, labor, direct or consequential damage will be allowed.

Return Material Procedure

So that we may efficiently process any materials that are returned, it is essential that a "Return Material Authorization" (RMA) number be obtained from the factory, prior to the material's return. This is available through an AMETEK LMS local representative or by contacting the factory. Please supply the following information:

1. Company Name
2. Description of Material
3. Serial Number
4. Reason for Return
5. Application

Any unit that was used in a process must be properly cleaned in accordance with OSHA standards, before it is returned to the factory.

A Material Safety Data Sheet (MSDS) must accompany material that was used in any media.

All shipments returned to the factory must be by prepaid transportation.

All replacements will be shipped F.O.B. factory.

PULSAR Pulse Burst Radar transmitters may be protected by one or more of the following U.S. Patent Nos.:
US 6,062,095; US 6,980,174; US 7,102,584; US 7,106,248; US 7,271,646

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BULLETIN: 58-602.5
EFFECTIVE: May 2026
SUPERCEDES: March 2024