

# pulsar<sup>®</sup>

## Model RX5

RX5 software v2.1a

Installation and Operating Manual

*Pulse Burst Radar  
Level Transmitter*



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## Read this Manual Before Installing

This manual provides information on the Pulsar® 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 Through-Air Radar 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.

### 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.

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 R95

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

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

### Warranty

All MAGNETROL electronic level and flow controls are warranted free of defects in materials or workmanship for one full year 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, MAGNETROL will repair or replace the control at no cost to the purchaser (or owner) other than transportation.

MAGNETROL 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 MAGNETROL products.

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

The MAGNETROL quality assurance system is registered to ISO 9001 affirming its commitment to known international quality standards providing the strongest assurance of product/service quality available.





# Pulsar® Pulse Burst Radar Level Transmitter

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## 1.1.2 Configuration Information

Some key information is needed to configure the PULSAR radar transmitter. Complete the following operating parameters table before beginning configuration.

NOTE: The transmitter will already be configured if this information was provided with the order.

Display	Question	Answer
Units	What units of measurement will be used?	_____
Antenna Type	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 that 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?	_____
Sensor Offset	What is the distance from the top (100%) of the tank and the Sensor Reference point (bottom of NPT thread, top of BSP thread, or face of flange?)	_____
Tank Top	Is the Tank Top Flat, Horizontal Cylinder, Dome, Irregular or other (non-metallic)?	_____
Tank Height	What is the tank height? NOTE: $Sensor\ Offset + Tank\ Height = Distance\ from\ process\ connection\ to\ tank\ bottom$	_____
Blocking	What is the distance from Sensor Reference point to Maximum Level? Maximum level should never be less than 2" (50 mm) from bottom of antenna.	_____
Level Offset	Is there a region at the very bottom of the vessel that cannot be measured due to heating coils, angle tank bottom, etc.?	_____
Dielectric	What is the dielectric of the process medium?	_____
Turbulence	Is turbulence a consideration?	_____
Rate of Change	What is the maximum rate the level will rise or fall?	_____
Foam	Will there be foam on the surface?	_____
Set 4.0 mA	What is the 0% reference point for the 4.0 mA value?	_____
Set 20.0 mA	What is the 100% reference point for the 20.0 mA value?	_____

## 1.2 QuickStart Mounting

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

- ① Confirm the model and serial numbers on the nameplates of PULSAR electronics and antenna are identical.

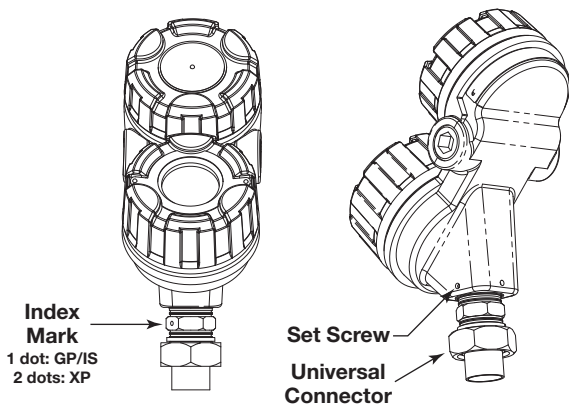
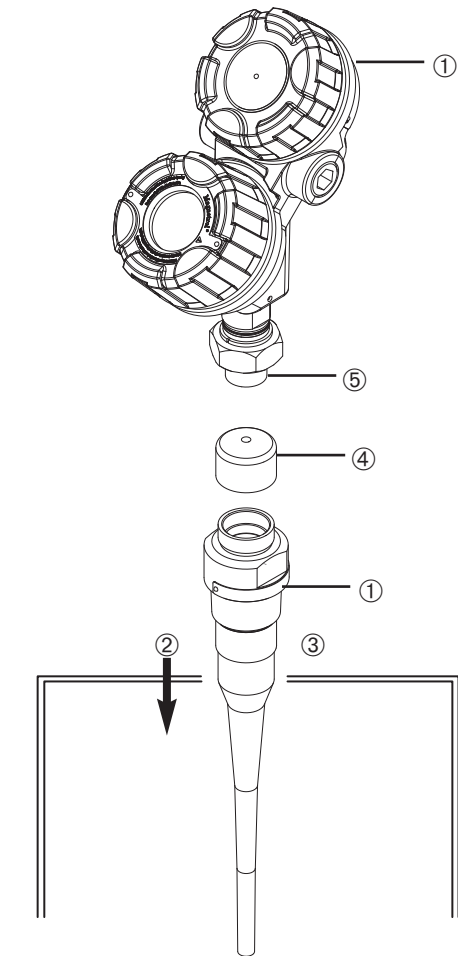
### 1.2.1 Antenna

- ② Carefully place the antenna into the vessel. Mount in a location equal to  $\frac{1}{2}$  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

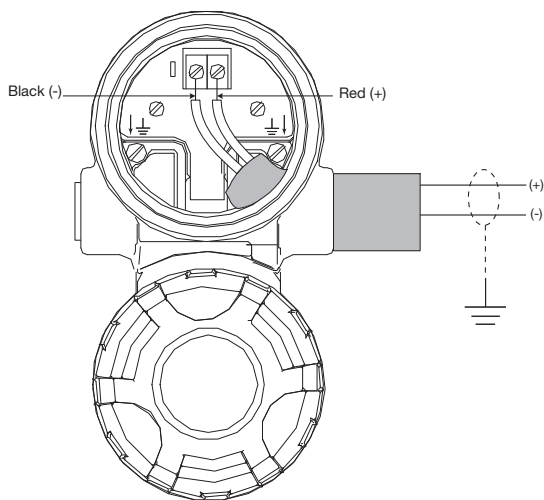
1. Remove the protective plastic cap from the top of the antenna and store for future use. Make sure the bottom of the Universal connector (TFE) ⑤ and inside of the antenna are clean and dry. Clean with isopropyl alcohol and cotton swabs if necessary.
  2. Place the transmitter on the antenna.
  3. Ensure 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. Do not optimize the Quality (signal strength) at one level in the vessel.
  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 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.

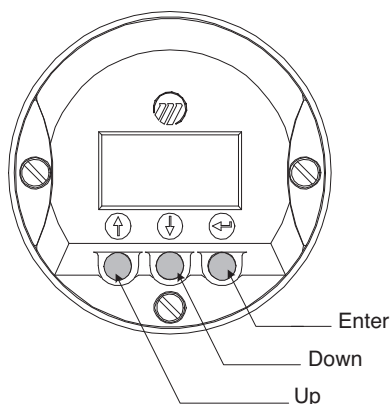
NOTE: Make sure the electrical wiring to the PULSAR radar transmitter is complete and in compliance with all regulations and codes.



1. Remove the cover of the 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. Connect shield to an earth ground at power supply and leave floating at the transmitter.
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

The Radar transmitter comes factory-calibrated and can be configured in minutes for specific applications. Bench configuration provides a convenient and efficient way to set up the transmitter before going to the tank site to complete the installation (disregard Fault messages due to unattached antenna). The minimum configuration instructions follow. Use the information from the operating parameters table before beginning configuration. See Configuration Information, Section 1.1.2.

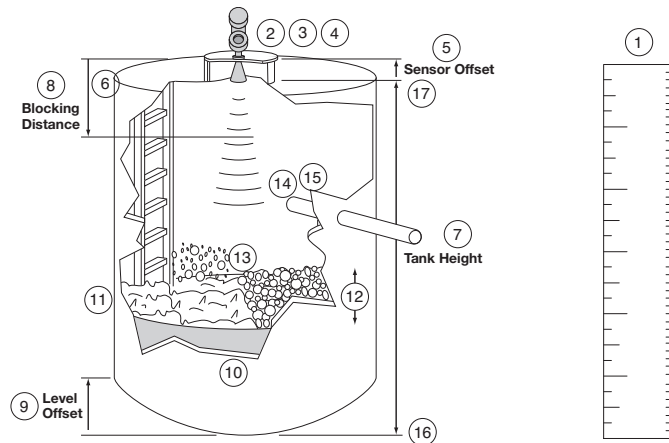


1. Power-up the transmitter.
 

Upon initial start-up, NO FALSE TARGET REJECTION error message will be displayed. Once in the vessel the FALSE TARGET routine must be run for proper operation. During normal operation the display changes every 5 seconds to show one of the four measured values: Level, Quality, %Output, and Loop.
2. Remove the cover of the electronic compartment.
3. Use the Up or Down Arrow ( ) keys to move from one step of the configuration program to the next step.
4. Press the Enter Arrow ( ) key. If a PASSWORD is active, enter it here. The default=0 (no password necessary). The last character in the first line of the display changes to an exclamation point (!).
 

Units!
xxx
5. Use the Up or Down Arrow ( ) keys to increase or decrease the value in the display or to scroll through the choices.
6. Press the Enter Arrow ( ) key to accept a value and move to the next step of the configuration program.

The following configuration entries are the minimum required for configuration. The default password is 0.



- |   |                       |  |    |                       |   |
|---|-----------------------|--|----|-----------------------|---|
| 1 | Units<br>(select)     | Select the <b>Units</b> of measurement for the level readout (cm, inches, meters, feet).   | 9  | LevlOfst<br>xxx.x     | Enter the <b>Level Offset</b> ; the distance at the bottom of the vessel where measurement may be unreliable due to heating coils, irregular bottom, etc.                         |
| 2 | Antna Typ<br>(select) | Select the <b>Antenna Type</b> to be used as printed on the transmitter nameplate; first 7 digits of model number.   | 10 | Dielectrc<br>(select) | Select the proper <b>Dielectric</b> range for the process medium.   |
| 3 | Antna Ext<br>(select) | Select the <b>Antenna Extension</b> to be used as printed on the antenna nameplate; last 3 digits of model number.   | 11 | Turbulnc<br>(select)  | Select the value of <b>Turbulence</b> that corresponds to the application.  |
| 4 | Antna Mnt<br>(select) | Select the type of <b>Antenna Mounting</b> to be used.   | 12 | RateChg<br>(select)   | Select the <b>Rate of Change</b> value that corresponds to the maximum rate the level will rise or fall.  |
| 5 | SnsrOfst<br>xxxx      | Enter the <b>Sensor Offset</b> value; the distance from the top (100%) point of the vessel to the Sensor Reference point (bottom of an NPT thread, top of a BSP thread, face of a flange). | 13 | Foam<br>(select)      | Select the <b>Foam</b> value that corresponds to the application.   |
| 6 | Tank Top<br>(select)  | Select the type of <b>Tank Top</b> ; choices are Flat, Horizontal cylinder, Dome, Irregular, or Other (non-metallic).  | 14 | Targets               | Examine the list of reflections detected by the transmitter to ensure the actual level reflection is present. It may be necessary to rotate the launcher for optimum performance. |
| 7 | Tank Ht<br>xxxx       | Enter the exact <b>Tank Height</b> ; inaccurate values will create inaccurate level readings.  | 15 | TargRej<br>(status)   | Run the <b>Target Rejection</b> routine by choosing the correct LEVEL thereby cancelling all false reflections in the vessel; ideally with tank empty.                            |
| 8 | BlockDis<br>xxxx      | Enter the <b>Blocking Distance</b> ; the distance close to the antenna where measurement is unreliable due to antenna ringing.<br>Minimum value = antenna length + 2" (50 mm)              | 16 | Set 4mA<br>xx.x       | Enter the minimum level value (0%) for the 4 mA point.  |
|   |                       |  | 17 | Set 20mA<br>xx.x      | Enter the maximum level (100%) for the 20 mA point.   |

Note: Clear all diagnostic messages upon completion of configuration. See screens 41 and 42 on page 24.



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## 2.0 Complete Installation

This section provides detailed procedures for properly installing, configuring, and, as needed, troubleshooting the PULSAR 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:

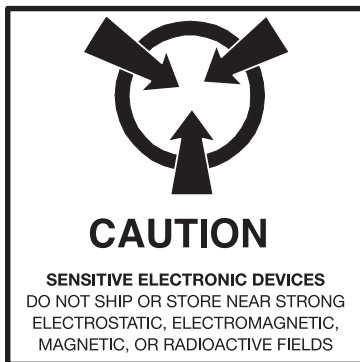
- Inspect all components for damage. Report any damage to the carrier within 24 hours.
- Make sure the nameplate model number on the antenna and transmitter agree with the packing slip and purchase order.
- Record the model and serial numbers for future reference when ordering parts.

### 2.2 Electrostatic Discharge (ESD) Handling Procedure

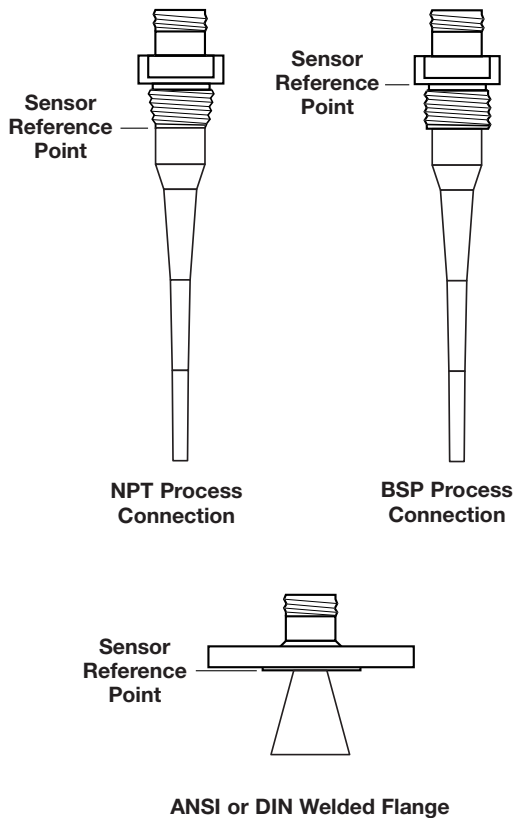
MAGNETROL electronic instruments are manufactured to the highest quality standards. These instruments use electronic components that may be damaged by static electricity present in most work environments.

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

- 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.







**2.3.3.1** The chart below shows the maximum measuring range (Distance) of each antenna based on fundamental conditions of Dielectric, Distance and Turbulence. Maximum distance is calculated as Tank Height + Sensor Offset (see page 20). It is measured from the Sensor Reference Point (bottom of NPT thread, top of BSP thread or face of a flange).

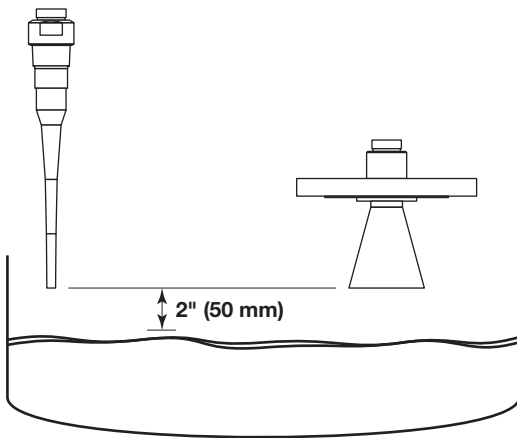
**MAXIMUM DISTANCE** feet (meters)

Dielectric	Turbulence	Dielectric Rod (1½")	4" Horn	6" Horn
1.7-3.0	None	35 (10.7)	40 (12.2)	45 (13.7)
	Light, < 0.5"	28 (8.5)	33 (10.1)	37 (11.3)
	Moderate, < 1.0"	21 (6.4)	26 (7.9)	29 (8.8)
	Heavy, > 1.0"	15 (4.6)	17 (5.2)	20 (6.1)
3.0-10.0	None	50 (15.2)	55 (16.8)	60 (18.3)
	Light, < 0.5"	40 (12.2)	44 (13.4)	48 (14.6)
	Moderate, < 1.0"	30 (9.1)	33 (10.1)	35 (10.7)
	Heavy, > 1.0"	20 (6.1)	22 (6.7)	25 (7.6)
10.0-100	None	65 (20)	65 (20)	65 (20)
	Light, < 0.5"	52 (15.8)	52 (15.8)	53 (16.2)
	Moderate, < 1.0"	39 (11.9)	39 (11.9)	41 (12.5)
	Heavy, > 1.0"	25 (7.6)	27 (8.2)	30 (9.1)

Dielectric rod minimum dielectric = 2.0

**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 Radar. For these, Guided Wave Radar is recommended:

- Extremely low dielectric media ( $\epsilon_r < 2.0$ )
- 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 deteriorating 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.
- Extremely high liquid levels (Overflow) conditions when liquid very near the antenna can cause erroneous readings and measurement failure.

*Refer to Eclipse® bulletin 57-101*

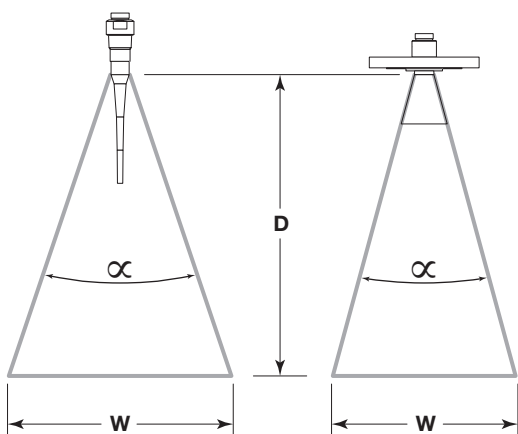
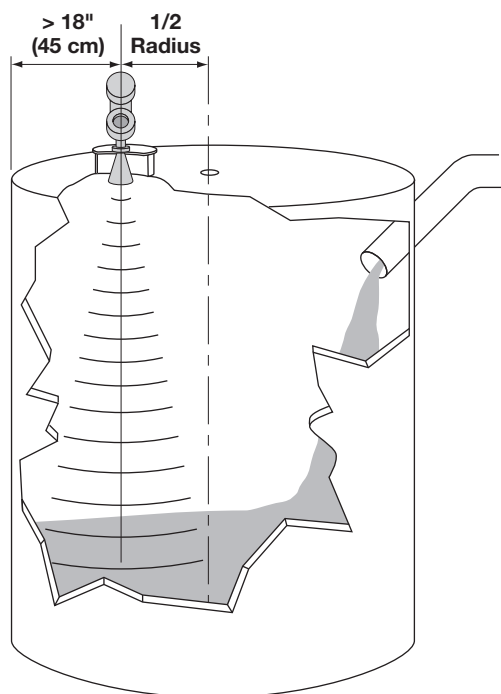
## 2.4 Mounting

The PULSAR Radar transmitter can be mounted to a vessel using a variety of process connections. Generally, either a threaded or flanged connection is used.

### 2.4.1 Installing the Antenna

Before installing, make sure:

- Model and Serial numbers on the nameplates of the PULSAR antenna and transmitter 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 2.6.5.1, Target Rejection. Mount in a location equal to  $\frac{1}{2}$  the radius of tank top. Do not mount in center of vessel nor closer than 18" (45 cm) of tank wall.

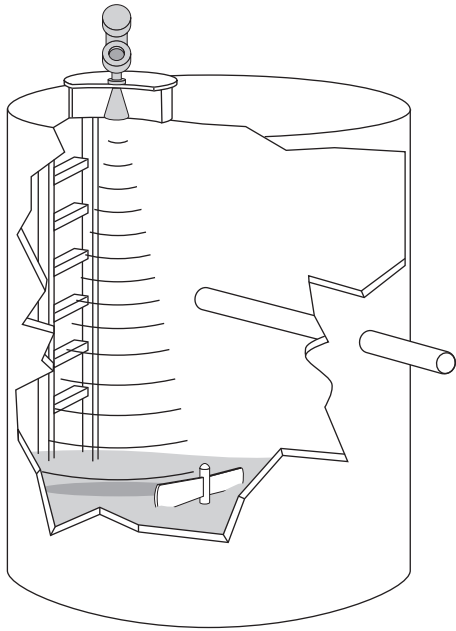
#### 2.4.1.2 Beam Angle

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

Antenna	Beam Spread, W @-3dB; ft (m)		
	Dielectric Rod	4" Horn	6" Horn
Beam Angle ( $\alpha$ )	25°	25°	17°
Distance, D			
10 (3)	4.5 (1.37)	4.5 (1.37)	3.0 (0.91)
20 (6)	8.9 (2.71)	8.9 (2.71)	6.0 (1.83)
30 (9)	13.3 (4.05)	13.3 (4.05)	9.0 (2.74)
40 (12)	17.8 (5.43)	17.8 (5.43)	12.0 (3.66)
50 (15)	22.2 (6.77)	22.2 (6.77)	15.0 (4.57)
60 (18)	26.6 (8.11)	26.6 (8.11)	18.0 (5.49)
65 (20)	28.9 (8.81)	28.9 (8.81)	19.5 (5.95)

### 2.4.1.3 Obstructions

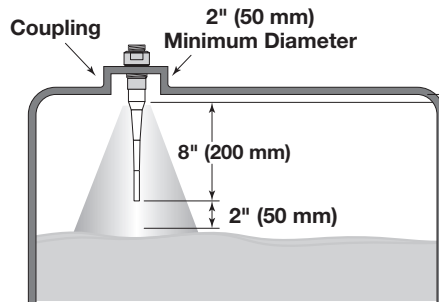
Almost any object that falls within the beam pattern will cause reflections that may be misinterpreted as a false liquid level. Although PULSAR has a powerful False Target Rejection routine, all possible precautions should be taken to minimize false target reflections with proper installation and orientation.



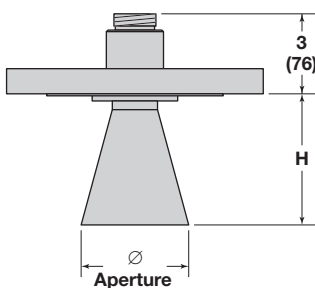
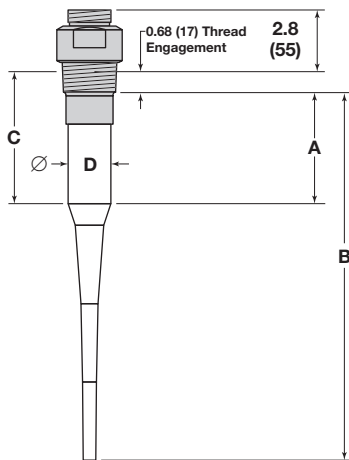
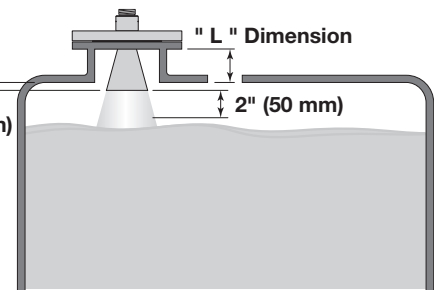
### 2.4.1.4 Nozzles

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 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 3.6.5 for dimensional drawings of all antenna designs including nozzle extensions.

Dielectric Rod Antenna



Horn Antenna



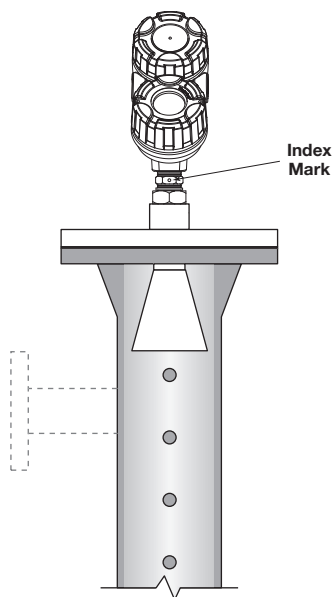
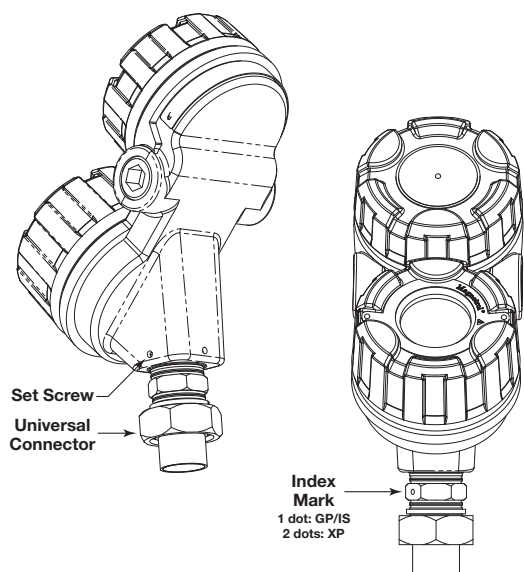
### DIELECTRIC RODS

Model #	Antenna Extension (maximum "L" dimension)	All	All	BSP
8th Digit		Dim A	Dim B	Dim C
0	1" (25 mm)	2.2 (56)	11.1 (282)	3.0 (76)
1	4" (100 mm)	5.1 (130)	14.0 (356)	5.9 (150)
2	8" (200 mm)	9.1 (231)	18.0 (457)	9.9 (251)
3	12" (300 mm)	13.1 (333)	22.0 (559)	13.9 (353)

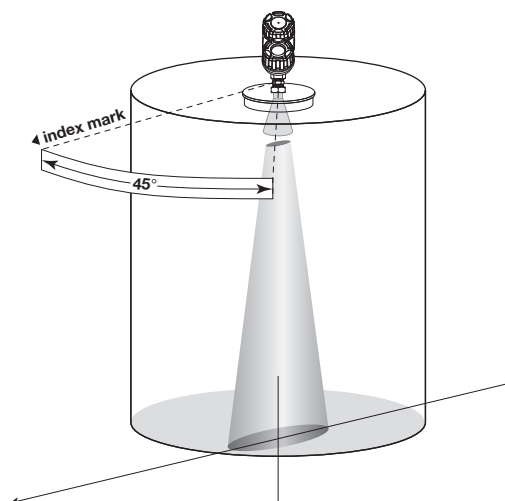
Antenna Extension O.D. Dimension D	
TFE Rod	Ø 1.625 (41)
PP Rod	Ø 1.50 (38)
All-Plastic Rod	Ø 1.625 (41)

### HORNS

Model #	Antenna Extension (maximum "L" dimension)	3" Horn	4" Horn	6" Horn	
8th Digit		Dim H	Dim H	Dim H	
0	1" (25 mm)	2.7 (51)	↓	↓	
1	4" (100 mm)	N/A	4.6 (117)	↓	
2	8" (200 mm)		8.4 (213)		8.3 (211)
3	12" (300 mm)		12.4 (315)		12.4 (315)
Aperture		2.95" (75 mm)	3.75" (95 mm)	5.75" (146 mm)	



**PULSAR Mounted in Stillwell (Bridle)**



**Polarization Pattern**

### 2.4.1.5 Standpipes and Stillwells

PULSAR can be mounted in a standpipe or stillwell but certain considerations should be given:

- Metal stillwells only: Sizes 3–8 inches (80–200 mm).
- Diameter must be consistent throughout length; no reducers.
- Use only horn antennas sized to pipe ID; 3–6" (80–150mm); 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 PIPE I.D. See Section 2.6.5.1, Item 35- PIPE I.D.
- There will be some increased dielectric sensitivity; system GAIN will be reduced when PIPE ID >0.

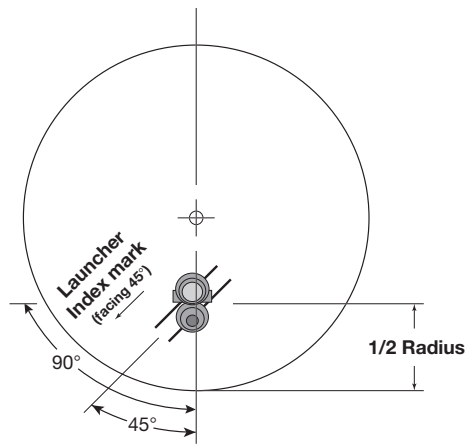
### 2.4.2 Installing the Transmitter

- Remove the protective plastic cap from the top of antenna.
- 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 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.



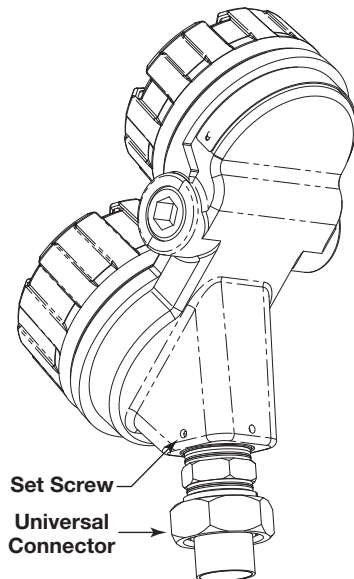
**Top View**  
**Mounted 1/2 radius**

### 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. Do not optimize the Quality (signal strength) at one level in the vessel. Once properly oriented, tighten set screws and Universal connector (30 ft-lbs 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 Signal Loss.

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



### 2.4.2.3 Poor Signal Quality

Poor signal quality 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 signal quality may be attained by rotating the launcher to 90 degrees.

**Signal 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 Level signal. Utilize the following procedure:

- Go to transmitter screen #4 which shows both Level and signal Quality.
- Bring the Level up (or down) to the exact point where the signal is repeatedly lost. Monitor the Quality value as this point is being approached. The Quality value will degrade to a low point before it begins to increase.
- At the point of poorest Quality, 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 signal Quality 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 of force) and Launcher set screw.

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

## 2.5 Wiring

**Caution** The PULSAR Radar transmitter operates at voltages of 16–36 VDC (GP), 16–28.6 VDC (IS) and 16–36 VDC (XP). Higher voltage will damage the transmitter.

Wiring between the power supply and the Radar transmitter should be made using 18–22 AWG shielded twisted pair instrument cable. Within the transmitter enclosure, connections are made to the terminal strip and the ground connections. The directions for wiring the Radar transmitter depend on the application:

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

NOTE: For ATEX/IEC installation guidelines refer to bulletin BE 58-601.

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

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

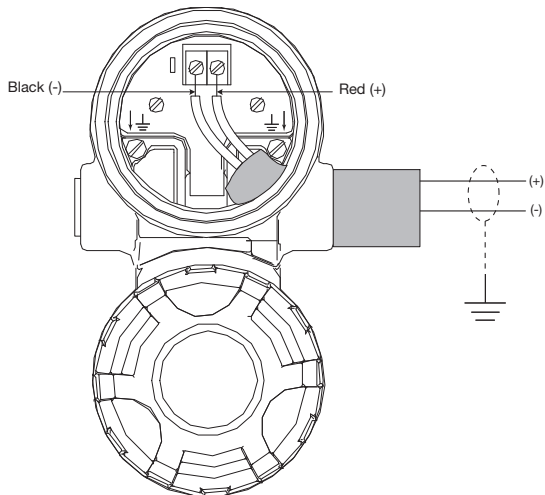
A general purpose installation does not have flammable media present. Areas rated non-incendive (CI I, Div. 2) have flammable media present only under abnormal conditions. No special electrical connections are required. If flammable media is contained in the vessel, the transmitter must be installed per CI I, Div. 1 standards of area classification.

**To install General Purpose or Non-incendive wiring:**

1. Remove the cover to the wiring compartment of the transmitter. Install the conduit plug in the unused opening.
2. Install a conduit fitting and pull the supply wires.
3. Connect shield to an earth ground at power supply and leave floating at the transmitter.
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 cover to the wiring compartment of transmitter.

### 2.5.2 Intrinsically Safe

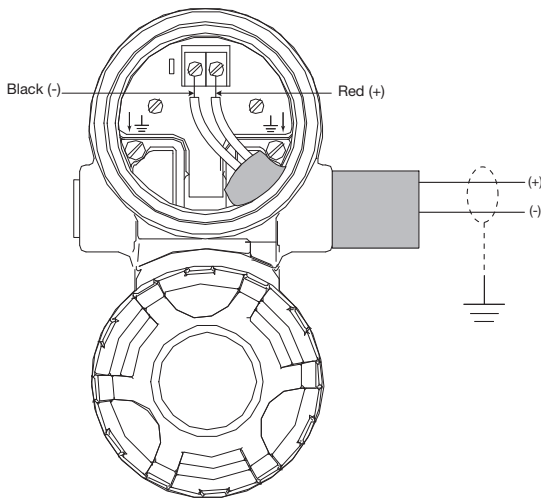
An intrinsically safe (IS) installation potentially has flammable media present. An approved IS barrier must be installed in the non-hazardous (safe) area.





### To install Intrinsically Safe wiring:

1. Make sure the IS barrier is properly installed in the safe area (refer to local plant or facility procedures). Complete the wiring from the barrier to the Radar transmitter.
2. Remove the cover to the wiring compartment of the transmitter. Install the conduit plug in the unused opening.
3. Install a conduit fitting and pull the supply wires.
4. Connect shield to an earth ground at power supply and leave floating at the transmitter.
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 the cover to the wiring compartment of the transmitter.



### 2.5.3 Explosion Proof

Explosion Proof (XP) is a method of designing equipment for installation in 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 Radar 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.

### To install Explosion Proof wiring:

1. Install Explosion Proof conduit from the safe area to the conduit connection of the Radar transmitter (refer to local plant or facility procedures).
2. Remove the cover to the wiring compartment of the transmitter.
3. Connect shield to an earth ground at the power supply and leave floating at the transmitter.
4. Connect an earth ground wire  $\perp$  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 the cover to the wiring compartment of the transmitter.

## 2.6 Configuring the Transmitter

The Radar transmitter comes factory-calibrated and can be configured in minutes for specific applications.

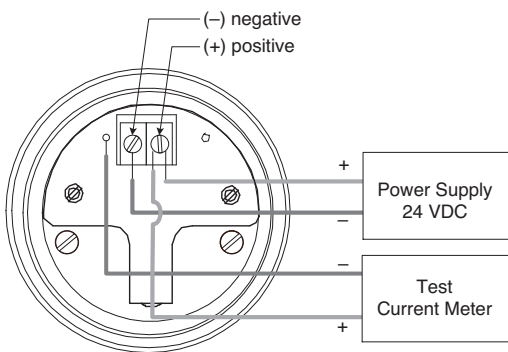
Before configuring the transmitter, collect the operating parameters information. Then, power-up the transmitter on the bench and follow through the step-by-step procedures for the menu-driven transmitter display. Information on configuring the transmitter using a HART communicator is given in Configuration Using HART (Section 2.7).

### 2.6.1 Operating Parameters

Some key information is needed to configure the Radar transmitter. If necessary, complete the configuration information table in Section 1.1.2.

### 2.6.2 Setting Up for Shop Configuration

The Radar transmitter can be configured at a test bench by connecting a 24 VDC power supply directly to the transmitter terminals. The connections are illustrated in the accompanying diagrams. An optional digital multimeter is shown if current measurements are desired.



Explosion Proof Model

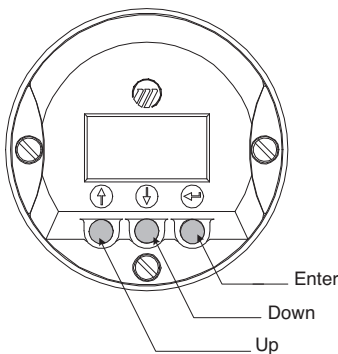
**NOTE:** Current measurements taken at these test points is an approximate value. Accurate current readings should be taken with the digital multimeter in series with the loop.

1. When using a HART communicator for configuration, a minimum 250  $\Omega$  line load resistance is required. See the HART communicator manual for more information.
2. The transmitter can be configured without the antenna, but disregard error messages due to the unattached antenna. Radar transmitter may indicate a LEVEL value >0 when disconnected from antenna.

### 2.6.3 Transmitter Display and Keypad

The Radar transmitter has a liquid-crystal display (LCD) capable of showing two lines of 8 characters each. Transmitter measurements and configuration menu screens are shown on the LCD.

The transmitter default display is the measurement screen. It cycles every 5 seconds to display LEVEL, %OUTPUT, QUALITY, and LOOP information. The transmitter defaults to this display after 5 minutes if no keystrokes are sensed with the exception of LEVEL, DISTANCE, %OUTPUT, QUALITY, and LOOP screens. The display will not return to the default screen if left in one of these screens.



The keypad has three arrows used to scroll through the displays and to calibrate the transmitter – the Up and Down Arrow (↑↓) keys and the Enter (↵) key.

Arrows	Function in Display Mode	Function in Configuration Mode
Up and Down ↑ ↓	Moves forward and backward in the configuration program from one display to another.	Increases or decreases the value displayed or moves to another choice. <i>Note: Hold arrow key for rapid scrolling.</i>
Enter ↵	Enters the configuration mode (noted by an exclamation point as the last character in the top display line).	Accepts a value and moves to the next step of the configuration program.

#### 2.6.4 Password Protection (Default = 0)

The Radar transmitter is password protected to restrict access to certain portions of the menu structure that affect the operation of the system. When the proper password is entered, an exclamation point (!) appears as the last character of the first line of the display. The password can be changed to any numerical value up to 255. The password is required whenever configuration values are changed.

The default password installed in the transmitter at the factory is 0 (password disabled). The last step in the configuration menu provides the option to enter a new password. If 0 is entered as a password, the transmitter is no longer password protected and any value in the menu can be altered (except diagnostic values) without entering a confirming password.

**NOTE:** If the password is not known, the menu item New Password displays an encrypted value representing the present password. Call the factory with this encrypted value to determine the actual password.

## 2.6.5 Menu: Step-By-Step Procedure

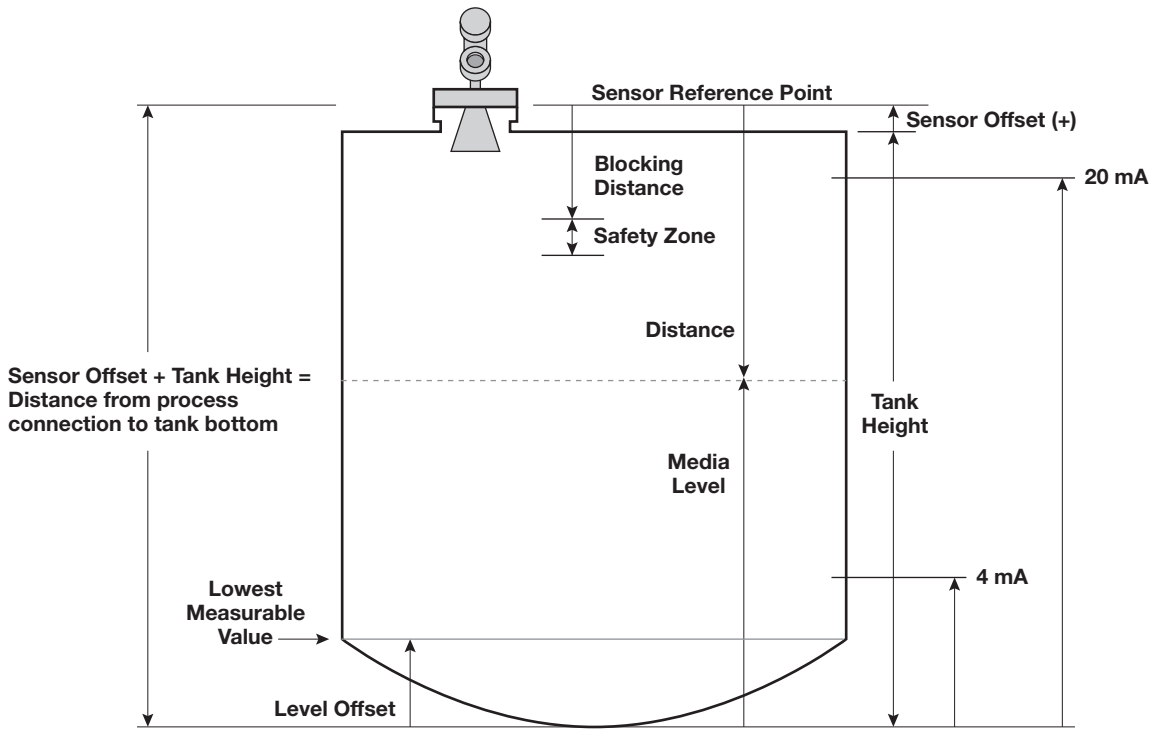
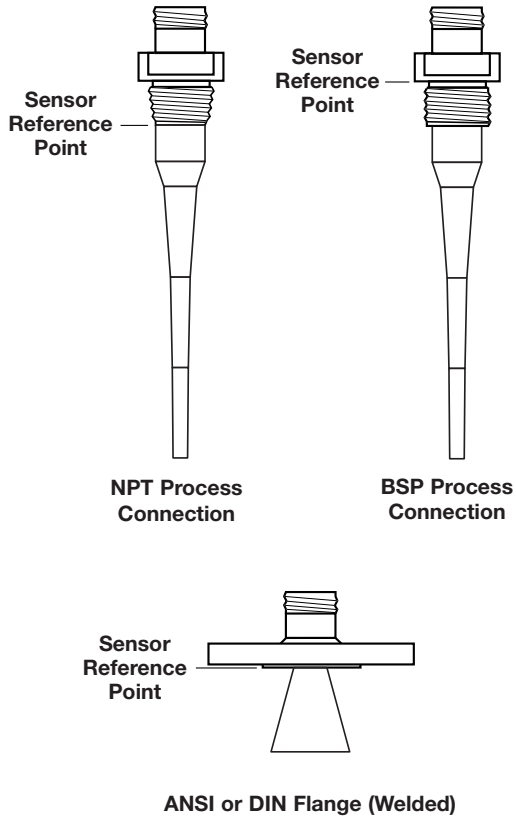
The following table provides a complete explanation of the software menus displayed by the Radar transmitter. Use this table as a step-by-step guide to configure the transmitter.

The first column presents the menus shown on the transmitter display. The displays are in the order they would appear if the arrow keys were used to scroll through the menu. The numbers are not shown on the display. They are provided as a reference.

The second column provides the actions to take when configuring the transmitter. Additional information or an explanation of an action is given in the third column.

The following drawings are provided as reference for the configuration procedure.

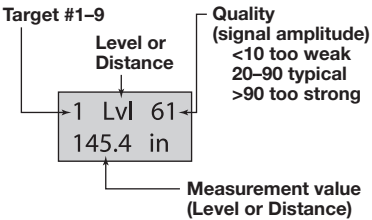
Use of the included PACTware™ PC program is highly recommended and invaluable for troubleshooting and advanced calibration. A HART RS232 or USB modem (purchased separately) is required. See MAGNETROL PACTware™ bulletin 59-101.



## 2.6.5.1 Radar Transmitter Menu Table

Note: Press UP arrow 3 times to reach screen where menu language can be chosen.

	Display	Action	Comment
1	*Level* *Quality* *%Output* *Loop*	Transmitter Display	Transmitter default display. <i>Level</i> , <i>Signal Quality</i> , <i>%Output</i> , and <i>Loop</i> values cycle every 5 seconds. All screens (except 2–6) default to this screen after 5 minutes of no keystrokes or if a Fault or Warning message is displayed.
2	Level xxx.x units	Transmitter Display	Transmitter displays <i>Level</i> measurement in chosen unit of measure.
3	Distance xxx.x units	Transmitter Display	Transmitter displays <i>Distance</i> measurement in chosen unit of measure. Measurement includes <i>Sensor Offset</i> value. Transmitter reports <i>Distance</i> regardless of Blocking <i>Distance</i> and <i>Level Offset</i> settings.
4	Qual xx xxx.x units	Transmitter Display	Transmitter display showing <i>Level</i> and <i>Quality</i> of signal reflection. Good values are 20–90
5	%Output xx.x%	Transmitter Display	Transmitter displays <i>%Output</i> measurement derived from 20 mA span.
6	Loop xx.xx mA	Transmitter Display	Transmitter displays <i>Loop</i> value (mA).
7	Units (select)	Select units of measure	Select <b>cm</b> (xxxx), <b>inches</b> (xxx.x), <b>meters</b> (xx.xx) or <b>feet</b> (xx.xx). Allowable decimal position is controlled; four characters is maximum reading. Decimal position is controlled by <i>Units</i> and <i>Tank Height</i> .
8	AntnaTyp (select)	Select the <i>Antenna Type</i> used.	Select first 7 digits of the Model Number (first 4 are significant). Information is located on the nameplate mounted on the side of transmitter housing.
9	AntnaExt (select)	Select the <i>Antenna Extension</i> used.	Select last 3 digits of the Model Number corresponding to the <i>Antenna Extension</i> . This relates to the maximum nozzle length where it can be used: 0** ≤ 1" (25 mm), -1** ≤ 4" (100 mm), -2** ≤ 8" (200 mm), -3** ≤ 12" (300 mm)
10	AntnaMnt (select)	Select the type of <i>Antenna Mounting</i>	Select <b>NPT</b> , <b>BSP</b> , or <b>Flange</b>
11	SnsrOfst xx.x units	Enter the <i>Sensor Offset</i> value.	<i>Sensor Offset</i> is the distance (+ or -) from the <i>Sensor reference point</i> (bottom of NPT thread or flange face, top of BSP thread) to the top of the tank.
12	Tank Top (select)	Select the shape/type of tank top	Select the metallic tank top structure: <b>Flat</b> , <b>Horizontal Cylinder</b> , <b>Dome</b> , <b>Irregular</b> , or <b>Other (non-metallic)</b> .
13	Tank Ht xxx.x units	Enter the <i>Tank Height</i>	<i>Tank Height</i> is measurement from the bottom to the top of tank.
14	Block Dis xxx.x units	Enter the <i>Blocking Distance</i>	<i>Blocking Distance</i> defines an area near the antenna where reflections can not be measured effectively due to antenna ringing. It is measured from the <i>Sensor Reference point</i> . Minimum value is set by choice of <i>Antenna Type</i> and is calculated as antenna length + 2" (50 mm); larger values are encouraged. Output will be held at value corresponding to <i>Blocking Distance</i> . Do not allow liquid on to the antenna.
15	LevlOfst xxx.x units	Enter the <i>Level Offset</i>	<i>Level Offset</i> defines an area at the bottom of the vessel where reflections can not be measured effectively due to angled bottoms, heating coils, reflections from flat metal tank bottom in low dielectric applications, etc. It is the distance from the bottom of the tank to the lowest valid level reading. Level reading will never be lower than <i>Level Offset</i> value.

	Display	Action	Comment
16	Dielctrc (select)	Select the <i>Dielectric</i> range value	Select the Dielectric range of the medium. Choices are: <b>1.7–3.0; 3.0–10.0; 10.0–100.0</b> (typical values: Hydrocarbons 1.9–3, Glycol 32, Water-based 80. See Technical Handbook 41-600 for complete listing)
17	Turbulnc (select)	Select amount of <i>Turbulence</i> of the liquid	<b>None, Light, Medium, Heavy.</b> Increase choice if Quality value is consistently <20. Always set for worst case conditions.
18	RateChng (select)	Select <i>Rate of Change</i> of the liquid	Select the MAXIMUM <i>Rate of Change</i> of the level surface (rising or falling) in inches (cm)/minute; <b>&lt;5 (13), 5-20 (13-50), 20-60 (50-150), &gt;60 (&gt;150)</b>
19	Foam (select)	Select amount of <i>Foam</i>	<b>None, Light, Medium, Heavy</b> Increase choice if Quality value is consistently <20. Always set for worst case conditions.
20	Targets	<p>Press Enter to view all <i>Targets</i></p> 	If vessel is empty, skip this screen and proceed directly to Target Rejection (#21). Review all Targets detected by the transmitter including false targets (targets other than Level). Ensure the proper Level target is available then move to <i>False Target Rejection</i> . If reported LEVEL is close to actual and the Quality number is >20, it is probably correct. Check the <i>Tank Height</i> and <i>Sensor Offset</i> values to ensure accurate LEVEL reading. Liquid level can be viewed by LEVEL or DISTANCE; access under MODE sub-menu. Choose ESCAPE to exit
21	Targ Rej (status)	<p>Select <b>YES</b> to store false target profile for Empty or Partially full tank. (Maximum of 9 False Targets)</p> <p>Unit will show <b>Enabled</b> after running the routine. <i>False Target Rejection</i> can be suspended for troubleshooting purposes by choosing <b>Disable</b>.</p>	<ul style="list-style-type: none"> <li>Do not proceed with this procedure until confirming LEVEL and QUALITY values in TARGETS screen.</li> <li>FALSE TARGET REJECTION should be run with vessel at or near empty when all targets are exposed; re-run this routine with liquid at a lower level if initial calibration is done with significant liquid in vessel.</li> <li>“Level Too High” message indicates liquid is too close to the antenna to run this routine (typically within 30" (750 mm) of end of antenna.</li> <li>The false target profile will be disabled and this routine should be re-run if the following parameters are modified: ANTENNA TYPE, ANTENNA MOUNT, SENSOR OFFSET, TANK HEIGHT, BLOCKING DISTANCE, DIELECTRIC, TURBULENCE, RATE CHANGE, FOAM or when launcher is repositioned.</li> </ul> <p>The NO FALSE TARGET REJECTION message will be displayed if this algorithm is not enabled.</p> <p>The <i>Target Rejection</i> routine detects, stores and cancels false targets to ensure detection of the proper level signal.</p> <ol style="list-style-type: none"> <li>Choose if Tank is <b>Empty</b> or <b>Partial</b> (some liquid present)</li> <li>a If <b>Empty</b> is chosen, press Enter, then select YES to run false target rejection routine for entire tank.</li> <li>b If <b>Partial</b> is chosen, various <i>Level/</i> targets will be offered; choose the Target reflection that represents the actual <i>Level/</i>; all other targets will be cancelled.</li> <li>If correct <i>Level/</i> is not offered, ensure Tank dimensional information is correct; information must be entered correctly to ensure reflections offered show correct <i>Level/</i> values.</li> <li>If Level cannot be found, manually enter correct value. Choose <b>Entr Lvl</b>, then enter the correct level value.</li> </ol>
22	Set 4mA xxx.x units	Enter the value for the 4 mA point	During normal operation, mA value will never read into the area defined by the <i>Level Offset</i> value. Refer to #15.

	Display	Action	Comment
23	Set 20mA xxx.x units	Enter the value for the 20 mA point	During normal operation, mA value will never read into the area defined by the <i>Blocking Distance</i> value. Refer to #14.
24	Damping xx	Enter the <i>Damping</i> factor	A damping factor (0–45) may be added to smooth a noisy display and/or output due to turbulence.
25	SysFault (select)	Select the system <i>Fault</i> value	Select <b>3.6 mA</b> , <b>22 mA</b> or <b>HOLD</b> (last value). See Section 3.3.2 for Fault information.
26	LOEFault (select)	Select the <i>Loss of Echo Fault</i> value	Select <b>3.6 mA</b> , <b>22 mA</b> or <b>HOLD</b> (last value).
27	LOEDelay (xxx sec)	Enter value for Loss of Echo Delay	Select a value 0–255; 30 is default
28	SZ Fault (select)	Select the <i>Safety Zone Fault</i>	<i>Safety Zone</i> is a user-defined area just below the <i>Blocking Distance</i> . See drawing on page 20. Enable Fault if necessary to ensure safe, reliable high-level readings in critical applications. Choices are <b>None</b> , <b>3.6 mA</b> , <b>22 mA</b> , <b>Latch 3.6</b> or <b>Latch 22</b> . If <b>Latch 3.6</b> or <b>Latch 22</b> is chosen, the loop current will remain in alarm until it is manually cleared with the SZ Alarm Reset below (#30)
29	SZHeight (xx.x units)	Enter a <i>Safety Zone Height</i>	Enter a distance value that develops a safety zone just below the <i>Blocking Distance</i> . Here the unit will report a <i>Safety Zone Fault</i> (#28) if the level rises into this area.
30	SZ Alarm Reset	Reset <i>Safety Zone Latch</i>	Clear a latched <i>Safety Zone</i> alarm.
31	Poll Adr (xx)	Enter HART <i>Poll Address</i> number	Enter a HART <i>Poll Address</i> (0–15). Enter 0 for a single transmitter installation; enter 1–15 for multi-drop network (loop will latch at 4 mA).
32	Trim 4	Fine tune the 4 mA point	Attach a mA meter to the output. If the output does not equal 4.00 mA, adjust the value on the display until meter reads 4.00 mA.
33	Trim 20	Fine tune the 20 mA point	Attach a mA meter to the output. If the output does not equal 20.00 mA, adjust the value on the display until meter reads 20.00 mA.
34	Trim Lvl xxx.x units	Fine Tune the <i>Level</i> value	<i>Trim Lvl</i> is an offset value ( $\pm 10"$ or 244mm) to be used to force the transmitter to output the exact Level. This should only be used after all parameters have been entered correctly, <i>Tank Height</i> and <i>Sensor Offset</i> have been confirmed accurate and it has been confirmed that the transmitter is tracking the correct level target.
35	PIPE ID xx.x units	Enter Pipe ID	For mounting in a standpipe/stillwell. Enter a value for inside diameter of the pipe. Range of values is 0", 3" to 20" (0, 40 to 500 mm). <b>Value MUST be left as 0 if no standpipe/stillwell is present.</b>
36	Loop Tst xx.xx mA	Enter a mA Output value	Enter a mA Output of any given value to perform loop test.
37	New Pass xxx	Enter new <i>Password</i>	Use arrows to select desired value between 0 and 255; 0=No Password. During normal operation, an encrypted password is shown.
38	Status	Review <i>Status</i> information	<i>Status</i> information is updated continuously showing only the most recent diagnostic events. See <i>Diagnostic</i> screen in Factory Menu for a cumulative review.
39	Language	Select <i>Language</i>	Select the <i>Language</i> that will be displayed on the transmitter screen. Choices are English (default), Spanish, German and French.
40	ModelRX5 Verxx.xx	Revision information	Processor firmware Rev level Coprocesor firmware Rev level

	Display	Action	Comment
41	Disp Fact	<b>Review</b> <i>Factory</i> parameters	Select <b>YES</b> to reveal <i>Factory</i> parameters; <b>NO</b> to hide
42	Diagnost	<b>Review</b> <i>Diagnostic</i> messages	A cumulative review of all diagnostic messages Press ENTER twice to clear
43	TrgRjLvl	Review Target Rejection Level	Shows level where the last Target Rejection routine was run
44	Launcher	None, do not adjust	Diagnostic, factory setting
45	Fact Cal	None, do not adjust	Diagnostic, factory setting
46	Peaks	None, do not adjust	Diagnostic, factory setting
47	Algorithm	None, do not adjust	Diagnostic, factory setting
48	Range	None, do not adjust	Diagnostic, factory setting
49	TVG Type	None, do not adjust	Diagnostic, factory setting
50	TVG Max	None, do not adjust	Diagnostic, factory setting
51	Fid Pos	None, do not adjust	Diagnostic, factory setting
52	Fid Gain	None, do not adjust	Diagnostic, factory setting
53	Sys Gain	None, do not adjust	Diagnostic, factory setting
54	Conversion Factor	None, do not adjust	Diagnostic, factory setting
55	Cef dm/s	None, do not adjust	Diagnostic, factory setting
56	Scale Offset	None, do not adjust	Diagnostic, factory setting
57	Distance Correction	None, do not adjust	Diagnostic, factory setting
58	Echo Amp	None, do not adjust	Diagnostic, factory setting
59	#Run Average	None, do not adjust	Diagnostic, factory setting
60	Adaptive Filter	None, do not adjust	Diagnostic, factory setting
61	#Adap Average	None, do not adjust	Diagnostic, factory setting
62	Scatter High	None, do not adjust	Diagnostic, factory setting
63	Rate High	None, do not adjust	Diagnostic, factory setting
64	Scatter Rate	None, do not adjust	Diagnostic, factory setting
65	Peak Detect Reference	None, do not adjust	Diagnostic, factory setting
66	Peak Detect Threshold	None, do not adjust	Diagnostic, factory setting
67	Minimum Threshold	None, do not adjust	Diagnostic, factory setting
68	ROC/min	None, do not adjust	Diagnostic, factory setting
69	Max Rate	None, do not adjust	Diagnostic, factory setting
70	Max dD	None, do not adjust	Diagnostic, factory setting
71	SZ Hysteresis	None, do not adjust	Diagnostic, factory setting
72	ES Delay	None, do not adjust	Diagnostic, factory setting
73	DataLog	None, do not adjust	Diagnostic, factory setting

Notes:

Clear all Diagnostic messages upon completion of configuration. See Screen 42 above.

It is encouraged that all setup information be recorded for future use. Table on page 45 is offered for this information.



## 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 transmitter. When connected to the control loop, the same system measurement readings shown on the transmitter are shown on the communicator. In addition, the communicator can be used to configure the transmitter.

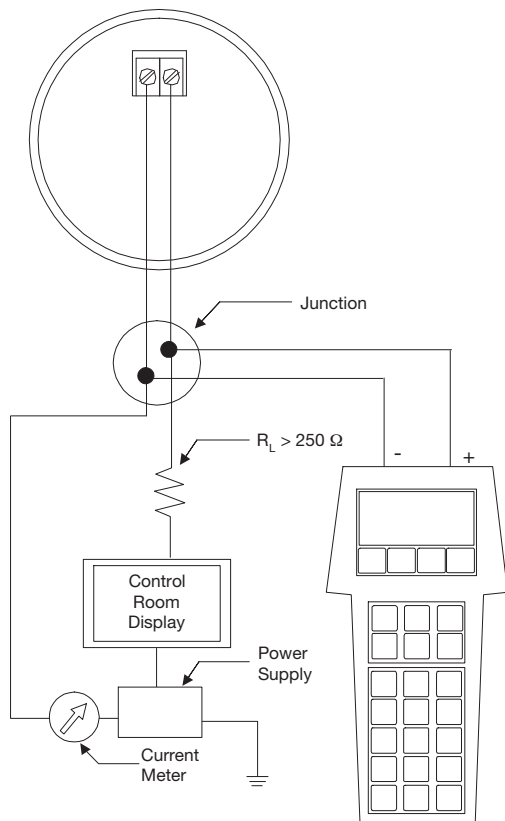
To confirm HART hand-held communications, attach unit per Section 2.7.1. If communicator reads GENERIC on first two lines, the HART hand-held does not contain the current DDs (device description) for the PULSAR Radar transmitter. Contact your local HART Service Center and specify a MAGNETROL PULSAR Model RX5 device descriptor.

See HART Revision Table, Section 2.7.3.

### 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 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 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 RX5) and its tag number or address. Usually the bottom line of each menu is reserved for software-defined function keys (F1–F4). For detailed operating information, refer to the instruction manual provided with the HART communicator.

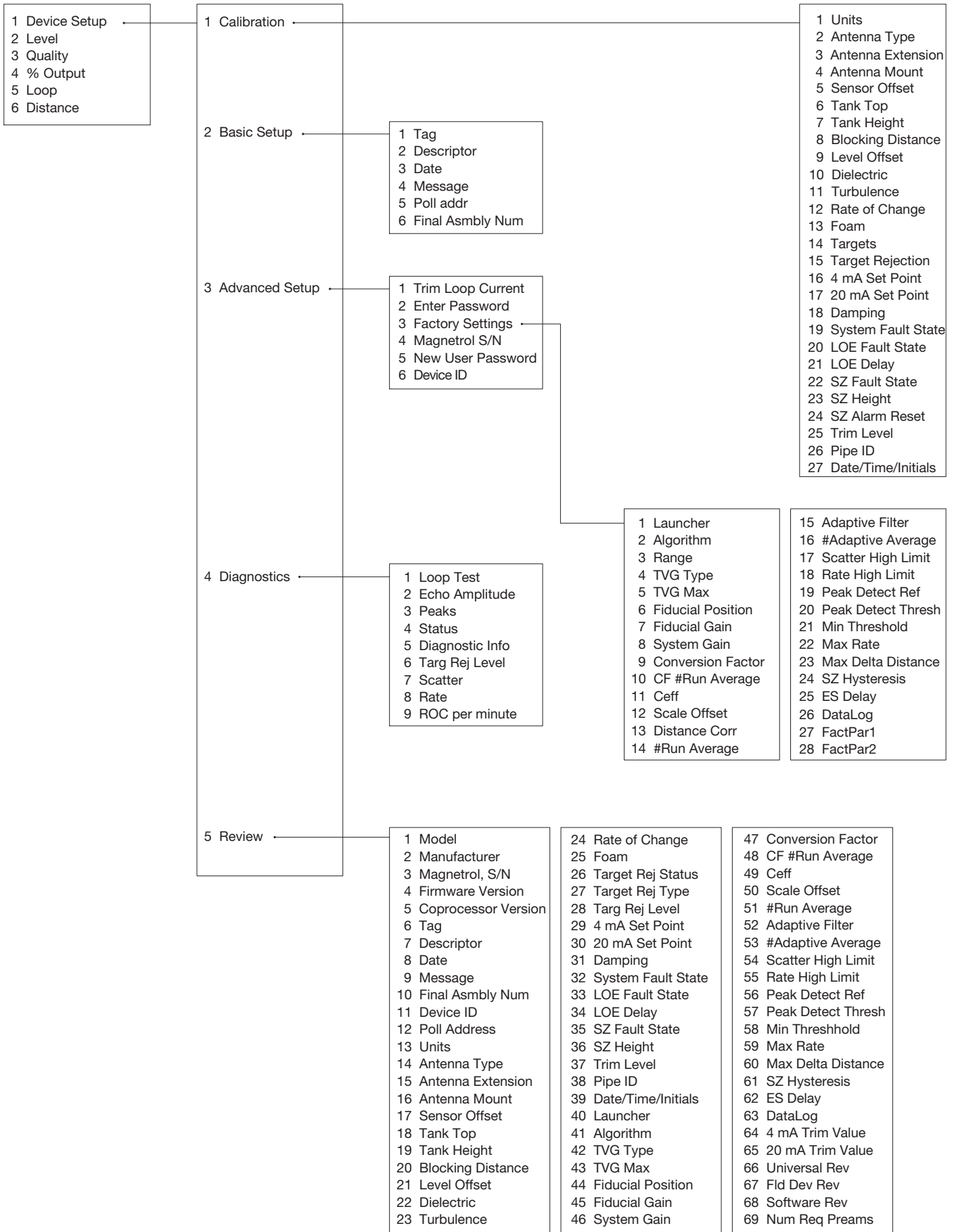
The PULSAR transmitter online menu trees are shown in the following illustration. Open the menu by pressing the alphanumeric key 1, Device Setup, to display the second-level menu.

### 2.7.3 HART Revision Table

#### 2.7.3.1 Model RX5

HART Version	HCF Release Date	Compatible with RX5 Software
Dev V2 DD V1	July 2003	Version 1.1a–1.2e
Dev V4 DD V1	July 2004	Version 2.0a and later

## 2.7.4 HART Menu



## 3.0 Reference Information

This section presents an overview of the operation of the PULSAR 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.

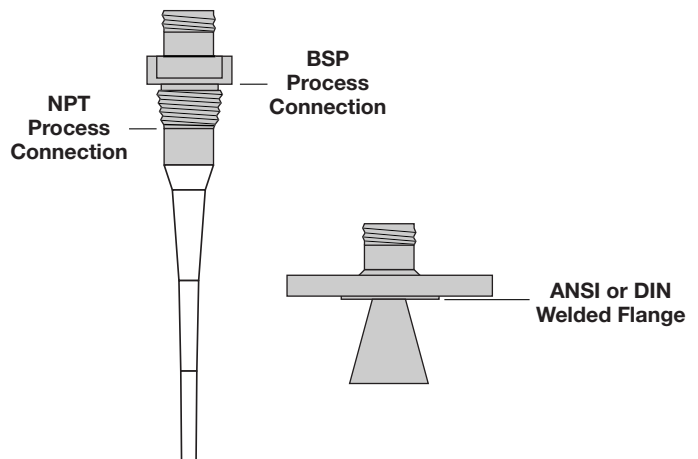
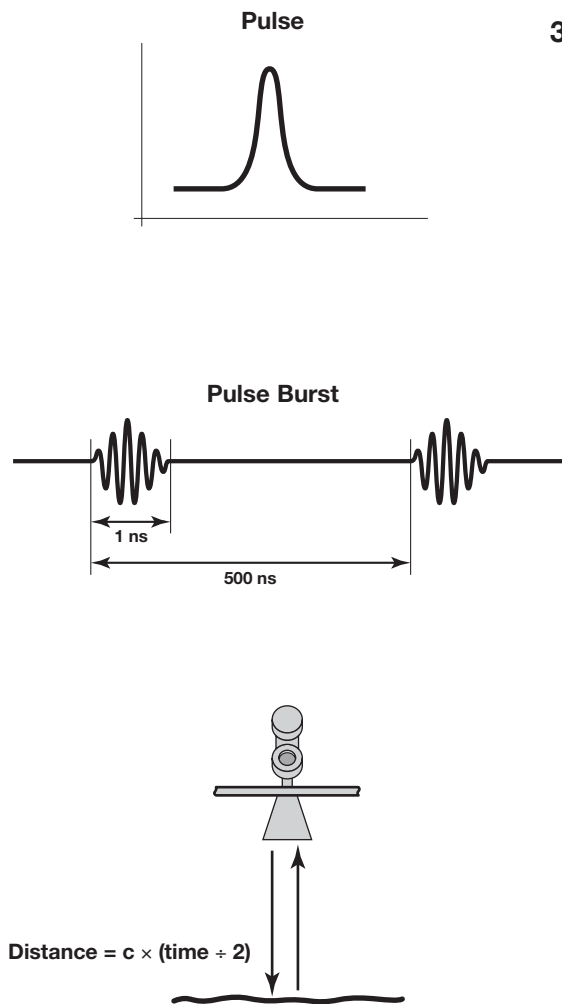
## 3.1 Description

PULSAR 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 an explosion-proof and watertight feed-through.

## 3.2 Theory of Operation

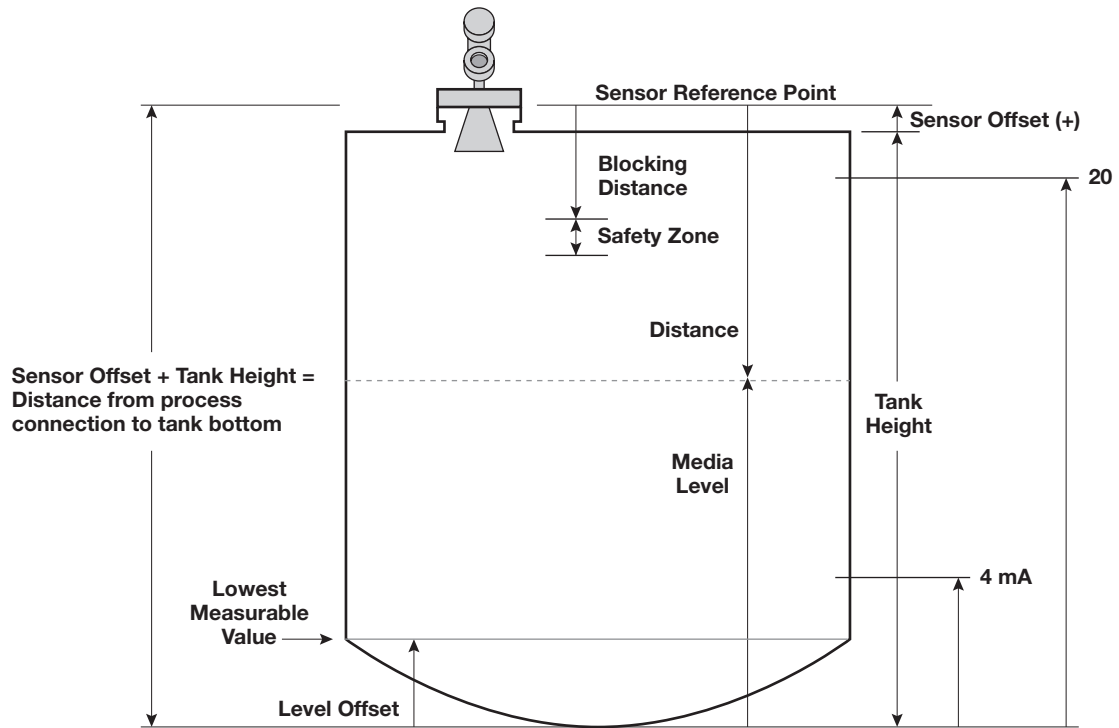
### 3.2.1 Pulse Burst Radar

PULSAR is a top-mounted, downward-looking pulse burst radar operating at 5.8 GHz (Europe) or 6.3 GHz (North America). Unlike true pulse devices that transmit a single, sharp (fast rise-time) waveform of wide-band energy, PULSAR emits short bursts of 5.8 or 6.3 GHz energy and measures the transit time of the signal reflected off the liquid surface. Distance is calculated utilizing the equation  $\text{Distance} = C \times \text{Transit time} / 2$ , then developing the Level value by factoring in Tank Height and Sensor Offset information. 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 circuitry is extremely energy efficient so no duty cycling is necessary to accomplish effective measurement. For this reason, PULSAR can track high rates of change that were heretofore impossible with existing loop-powered radar transmitters.



### 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/ $\mu$ s) 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. The round-trip event on a 65 foot (20m) tank takes only 133 nanoseconds in real time. After it is reconstructed in equivalent time it measures 200 milliseconds.

### 3.3 Troubleshooting

The PULSAR transmitter is designed and engineered for trouble-free operation over a wide range of operating conditions. Common transmitter problems are discussed in terms of their symptoms and recommended corrective actions.

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

Use of the included PACTware™ PC program is highly recommended and invaluable for troubleshooting and advanced calibration. A HART RS232 or USB modem (purchased separately) is required. See MAGNETROL PACTware™ bulletin 59-101.

#### 3.3.1 Troubleshooting System Problems

Symptom	Problem	Solution
Level reading drops out at a repeatable position in the vessel	Multipath is cancelling good level signal	Orient launcher to reduce multipath; turn launcher 20–30 degrees at a time until multipath at this point disappears. Refer to Section 2.4.2.3
Level reading locked onto a value that is not correct Level	Measurement engine finding a reflection it believes is level signal	<ol style="list-style-type: none"> <li>1. Is high dielectric (<math>\epsilon &gt; 20</math>) foam present</li> <li>2. Run False Target Rejection routine with Level below this point (or with Empty tank) to eliminate false echoes</li> </ol>
LEVEL, % Output and LOOP values are all inaccurate	Basic configuration data questionable	<ol style="list-style-type: none"> <li>1. Check validity of all configuration data</li> <li>2. Check DISTANCE value of device against manually measured distance</li> </ol>
LEVEL readings are repeatable but consistently high (or low) from actual by a fixed amount	Configuration data does not accurately match tank dimensions	<ol style="list-style-type: none"> <li>1. Ensure proper values for Tank Height and Sensor Offset</li> <li>2. Check vessel for present liquid level. Trim Level can be used to ensure exact measurement</li> <li>3. Reconfigure LOOP values if necessary</li> </ol>
LEVEL reading on Display is correct but LOOP is stuck at 4 mA	HART Poll Address set a value of 1-15	Set HART Poll Address to 0
LEVEL reading on Display stuck at value related to Blocking Distance	Device believes antenna is flooded (level very near or on antenna)	Check actual level. If antenna is not flooded, power down, then power up transmitter with the level well below the antenna.

---

### 3.3.2 Error Messages

The PULSAR Radar transmitter utilizes a 3-section hierarchy for reporting diagnostic conditions: FAULTS, WARNINGS, and INFORMATION. This information can be reviewed at the STATUS screen in the user menu. This screen captures only current conditions. Historical information can be viewed at the DIAGNOSTIC screen in the Factory menu.

**FAULT:** The highest level in the hierarchy of diagnostics annunciating a defect or failure in circuitry or software that precludes reliable measurement. The current (mA) value unit defaults to 3.6, 22, or HOLD and a message is displayed on the rotating screen. Further error information can be obtained by viewing the Status or Diagnostic (Factory Menu) screens.

**WARNING (MESSAGE):** The second level in the hierarchy of Diagnostics annunciating conditions that are not fatal but may affect measurement. A message will occur on the main (rotating) screen when a Warning is detected but will not affect output current. Further error information can be obtained by viewing the Status or Diagnostic screens.

**INFORMATION (MESSAGE):** The lowest level in the hierarchy of diagnostic conditions providing operational factors that are not critical to measurement. Further error information can be obtained by viewing the Status or Diagnostic (Factory Menu) screens.

**EFFECTS OF EACH DIAGNOSTIC MESSAGE**

	<b>mA Loop</b>	<b>Display Message</b>	<b>Diagnostic (history)</b>
<b>Fault</b>	3.6/22/HOLD	Yes	Yes
<b>Warning</b>	No Effect	Yes	Yes
<b>Information</b>	No Effect	No	Yes

**ERROR MESSAGES**

	<b>Symptom</b>	<b>Problem</b>	<b>Solution</b>
<b>Faults</b>	Echo Lost	Target peak cannot be found	<ul style="list-style-type: none"> <li>• Increase Turbulence setting</li> <li>• Decrease Dielectric setting</li> <li>• Increase ROC setting</li> <li>• Increase LOE delay</li> <li>• Confirm valid False Target Rejection; re-run if necessary</li> <li>• Possible multipath if lost repeatedly at same point in tank (See Section 2.4.2.3)</li> </ul>
	No Fiducial	Can not find valid fiducial signal	Ensure transmitter/antenna Universal connector is tight; Consult Factory if this problem persists
	Safety ZoneAlrm	Level within Safety Zone and SZ Alarm parameters enabled	Normal operation; modify SZ Alarm parameter screens if not operating to expectations
	Default Paramtrs	Configuration parameters have been corrupted and reset to the factory defaults	Modifying one parameter clears this condition; check validity of all parameters
	Sfwr Err Inv Arg	Software algorithms corrupted	Consult Factory
	EE Write failure	EEPROM Write failure	Consult Factory
	EE Read failure	EEPROM Read failure	Consult Factory
	CPU failure	Microprocessor failure	Consult Factory
<b>Warnings</b>	NoTrgRej	False Target Rejection has not been run or manually disabled	Re-run False Target Rejection routine or manually enable
	Level Too High	Indicates liquid is too close to antenna to run this routine	Lower liquid and re-run False Target Rejection routine
	CorptTgR	Invalid False Target Rejection data	Re-run False Target Rejection routine; Consult Factory if problem persists
	FidUnclr	Fiducial signal quality questionable	Ensure transmitter/antenna connection is tight; Consult Factory
	Factory Cal Reqd	Invalid Calibration Data	Transmitter requires re-calibration of Factory parameters; the instrument will continue to operate with reduced performance; Consult Factory
<b>Information</b> <small>(available only in Status or Diagnostic screens)</small>	<b>Co-processor Communications</b>		
	IPC bus	Internal communication error	Consult Factory
	IPC chks	Internal communication error	Consult Factory
	IPC leng	Internal communication error	Consult Factory
	IPC ack	Internal communication error	Consult Factory
	<b>Signal</b>		
	DC Noise	Excessive noise on A/D channel	Consult Factory
	Signal Too High	Level signal amplitude excessive	Choose higher Dielectric range, reduce Turbulence or Foam settings; Consult Factory if problem persists
	Signal Too Low	Level signal amplitude insufficient	Choose lower Dielectric range, increase Turbulence or Foam settings; Consult Factory if problem persists
	<b>Quality</b>		
	IncTrgRj	Incomplete Target Rejection False target only partially captured	Re-run False Target Routine with level lower in vessel
	ScattTgt	Return signals scattered due to turbulence	
	UncerTgt	Target is missing but not determined to be lost	Device is holding last valid value while confirming the target position; will continue based upon setting in LOE Delay screen; Consult Factory if problem persists
	TankInv	Tank dimensions exceed maximum range of the transmitter	Reduce Tank Height and/or Sensor Offset values

### 3.4 Agency Approvals

AGENCY	MODEL	PROTECTION METHOD	AREA CLASSIFICATION
<b>FM</b>  APPROVED	RX5-5X0A-1X0	Intrinsically Safe	Class I, Div. 1; Groups A, B, C, & D Class II, Div. 1; Groups E, F, & G Class III, NEMA 4X, T4 @80°C Entity
	RX5-5X0A-3X0	Explosion Proof	Class I, Div. 1; Groups B, C & D Class II, Div. 1; Groups E, F, & G Class III, NEMA 4X, T5 @80°C
	RX5-5X0A-XX0	Non-Incendive ①	Class I, Div. 2; Groups A, B, C, & D Class II, Div. 2; Groups F & G Class III, NEMA 4X
<b>CSA</b> 	RX5-5X0A-1X0	Intrinsically Safe ②	Class I, Div. 1; Groups A, B, C, & D Class II, Div. 1; Groups E, F & G Class III, Type 4X, T4 @80°C Entity
	RX5-5X0A-3X0	Explosion Proof ②	Class I, Div. 1; Groups B, C & D Class II, Div. 1; Groups E, F, & G Class III, Type 4X, T5 @80°C
	RX5-5X0A-XX0	Non-Incendive ①②	Class I, Div. 2; Groups A, B, C, & D Class II, Div. 2; Groups E, F, & G Class III, Type 4X, T4 @80°C
<b>ATEX</b> 	R05-5X0A-AX0	Intrinsically Safe ③	ATEX II 1G EEx ia IIC T4 @70°C IEC Ex ia IIC T4@70°C
	R05-5X0A-CX0	Explosion Proof ④	ATEX II 1/2G EEx d IIC T6 @70°C

① Measured media inside vessel must be non-flammable only.

② The antenna complies with Canadian Electrical Code requirements of ANSI/ISA 12.27.01-2003 as a single seal device.

Special conditions for safe use:

③ Ex ia

When an insulated probe is used in a potentially explosive atmosphere caused by gas, damp or a non-conducting liquid, precautions must be taken to avoid ignition due to hazardous electrostatic charges.

④ Ex d

When the transmitter enclosure that is made of aluminum alloy is installed in a potentially explosive atmosphere, requiring the use of apparatus of equipment category 1G, it shall be installed so that in the event of rare incidents, an ignition source due to impact or friction between the enclosure and iron/steel is excluded.

The transmitter's antenna shall be installed so that electrostatic discharges are prevented.



These units have been tested to EN 61326: 1997+A1+A2 and are in compliance with the EMC Directive 2004/108/EC.

#### ATEX/IEC Entity Parameters

Vi	28.4VDC
Ii	120mA
Pi	0.84w
Ci	2.2nF
Li	430µH

#### COMMUNICATIONS APPROVALS

Region	Agency	Frequency
US	FCC	6.3 GHz
Canada	IC	6.3 GHz
Europe	RTTE	5.8 GHz

#### SIL

PULSAR	Model RX5	
SIL	1 as 1001	
Instrument Type	B	
SFF	73.7%	
PFDavg	9.72E-04	
	FITS	Annual
Fail Dangerous Undetected	222	1.94E-03
Fail Dangerous Detected	308	2.70E-03
Safe	314	2.75E-03



### 3.4.1 Agency (FM/CSA) Drawing and Entity Parameters

SYM	DESCRIPTION	BY & DATE	CHANGE NO
A.	RELEASED	RC 10-03-02	5175-004

**HAZARDOUS LOCATION**  
MODEL R95 RADAR LEVEL TRANSMITTER  
INTRINSICALLY SAFE FOR  
CLASS I, DIV. 1 GROUPS A, B, C & D  
CLASS II, DIV. 1 GROUPS E, F & G (G ONLY FOR CSA)  
CLASS III

**ENTITY**  
 $V_{max} = 28.6\text{ V}$   
 $I_{max} = 140\text{ mA}$   
 $P_{max} = 1\text{ W (FM ONLY)}$   
 $C_i = 5.6\text{ nF}$   
 $L_i = 440\text{ }\mu\text{H}$

**NON-HAZARDOUS LOCATION**  
**LIMITING VALUES**  
 $V_{oc} =$  to or less than 28.6V.  $C_a =$  to or greater than 5.6 nF  
 $I_{sc} =$  to or less than 140 mA.  $L_a =$  to or greater than 440  $\mu\text{H}$   
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 ( $V_{oc}$  OR  $V_A$ ) AND THE MAXIMUM SHORT CIRCUIT CURRENT ( $I_{sc}$  OR  $I_E$ ) WHICH CAN BE RECEIVED BY THE TRANSMITTER. THE MAXIMUM CAPACITANCE ( $C_a$ ) AND INDUCTANCE ( $L_a$ ) OF THE LOAD AND THE CAPACITANCE AND INDUCTANCE OF THE INTERCONNECTING WIRING MUST BE EQUAL TO LESS THAN THE CAPACITANCE ( $C_a$ ) OR THE INDUCTANCE ( $L_a$ ), WHICH CAN BE DRIVEN BY THE SOURCE DEVICE.

**NOTES:**

- MANUFACTURER'S INSTALLATION INSTRUCTIONS SUPPLIED WITH THE PROTECTIVE BARRIER AND THE CEC (FOR CSA) OR THE NEC AND ANSISA RP 12.06.01 (FOR FM) MUST BE FOLLOWED WHEN INSTALLING THIS EQUIPMENT. BARRIER MUST BE CSA CERTIFIED FOR CANADIAN INSTALLATIONS & FM APPROVED FOR U.S. INSTALLATION.
- CONTROL EQUIPMENT CONNECTED TO PROTECTIVE BARRIERS MUST NOT USE OR GENERATE MORE THAN THE CURRENT RATING OF THE BARRIER.
- NRTL LISTED DUST-TIGHT SEALS MUST BE USED WHEN TRANSMITTER IS INSTALLED IN CLASS II & III ENVIRONMENTS.
- NO REVISIONS TO THIS DRAWING WITHOUT CSA AND FM APPROVAL.
- FOR CSA: EXAM INTRINSICALLY SAFE SECURE INTRINSIQUE.
- FOR FM: EXAM INTRINSICALLY SAFE SECURE INTRINSIQUE.
- FOR SUPPLY CONNECTIONS, USE WIRE SUITABLE FOR THE OPERATING TEMPERATURE. FOR 71°C AMBIENT, USE WIRE WITH A MINIMUM TEMPERATURE RATING OF 75°C.
- THE TRANSMITTER CAN ALSO BE INSTALLED IN:  
CLASS I, DIVISION 2, GROUPS E, F & G (G ONLY FOR FM)  
CLASS II, DIVISION 2, GROUPS E, F & G (G ONLY FOR FM)  
PROTECTIVE BARRIER WHEN INSTALLED PER THE CEC (FOR CSA) OR THE NEC (FOR FM) AND WHEN CONNECTED TO A POWER SOURCE NOT EXCEEDING 30 VDC.
- FOR CSA CERTIFICATION: CSA CERTIFIED BARRIERS WITH LINEAR OUTPUT CHARACTERISTICS MUST BE USED. REFER TO THE TABLE FOR PROPER BARRIER SELECTION.

TYPICAL LINEAR TYPE BARRIER OUTPUT			
BARRIER OUTPUT CURRENT (ISC)	VDC	$C_b$	$L_b$ MINIMUM
800mA	30 V	013F	4.0 nH
1000mA	28 V	013F	3.0 nH
1200mA	26 V	017F	2.3 nH
1400mA	24 V	021F	1.7 nH

NONLINEAR BARRIERS **MUST NOT BE USED**. THEIR  $V_{oc}$  &  $L_a$  VALUES ARE TYPICALLY MUCH LESS THAN VALUES GIVEN IN THE ABOVE TABLE.

**MATERIAL**

RAW MATERIAL PART NO.	
HEAT FINISH	
FINISH	

UNLESS OTHERWISE SPECIFIED, DIMENSIONS ARE IN INCHES. [1 OR mm DIMENSIONS ARE IN MILLIMETERS]

REMOVE ALL BURRS AND SHARP EDGES

MAX. ALLOWED .02 (0.51) OR BETTER

INSIDE FINISH .02 (0.51) OR BETTER

ALL FINISHES: 12.5 (0.5) OR BETTER

TOLERANCES: ±.015 IN. (0.4mm) OR BETTER

2 PL. DECIMAL ±.005 IN. (0.125mm)

ANGULAR: ±.1°

**TITLE**

SYSTEM DRAWING  
MODEL R95 RADAR TRANSMITTER

DRAWN: R.CAMPBELL	DATE: 10-03-02
CHECKED: T.HORICHTER	DATE: 10-03-02
APPROVED: P.SNIDER	DATE: 10-03-02
PROJECT NO: 5175-004	SHEET NO: 1 OF 1

**Magnetrol®**  
5300 BELMONT ROAD, DOWNERS GROVE  
ILLINOIS 60615, AREA CODE 630/689-4000

AGENCY LISTED DRAWING  
ALL REVISIONS TO THIS DRAWING REQUIRE QA APPROVAL

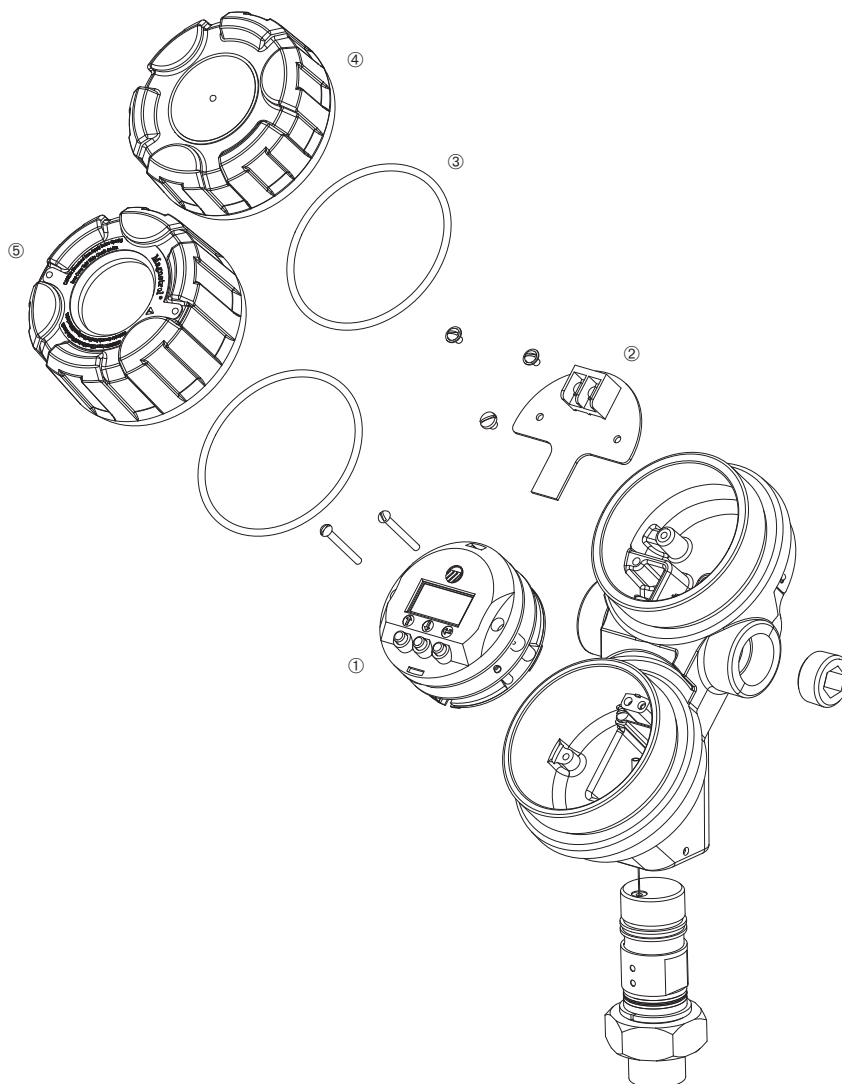
## 3.5 Parts

### 3.5.1 Replacement Parts

Item	Description		Part Number	
①	Electronic Module	6.3 GHz	Z31-2827-001	w/HART
		5.8 GHz	Z31-2827-003	w/HART
②	Terminal Board	General Purpose Intrinsically Safe Explosion Proof	Z30-9143-001	
③	O-ring: Viton		012-2201-237	
④	Housing cover without glass		004-9193-002	
⑤	Housing cover with glass	GP/IS	Z36-4410-001	
		XP	-005	
		Ex d	-003	

### 3.5.2 Recommended Spare Parts

Description		Part Number	
Electronic Module	6.3 GHz	Z31-2827-001	w/HART
	5.8 GHz	Z31-2827-003	w/HART



## 3.6 Specifications

### 3.6.1 Functional – Transmitter

#### System Design

Measurement Principle Pulse burst radar @ 5.8 GHz (Europe), 6.3 GHz (U.S.) ①

#### Input

Measured Variable Level, determined by the time-of-flight of a radar pulse from transmitter to product surface and back

Span 0.5 to 65 feet (0.2 m to 20 m)

#### Output

Type Analog 4 to 20 mA with optional HART digital signal

Range Analog 3.8 to 20.5 mA useable

Digital 0 to 999" (0 to 9999 cm)

Resolution Analog 0.01 mA

Digital 0.1"

Loop Resistance GP/IS/XP - 400  $\Omega$  @ 24 VDC/20 mA, 350  $\Omega$  @ 24 VDC/22 mA

Diagnostic Alarm Adjustable 3.6 mA, 22 mA, HOLD

Damping Adjustable 0-45

#### User Interface

Keypad 3-button menu-driven data entry and system security

Indication 2-line  $\times$  8-character display

Digital Communication ① HART Version 5 compatible

#### Power (Measured at instrument terminals)

General Purpose 16 to 36 VDC

Intrinsically Safe 16 to 28.6 VDC

Explosion Proof 16 to 36 VDC

#### Housing

Material Cast aluminum A356T6 (<0.2% copper), cast 316 SS (optional)

Cable Entry  $\frac{3}{4}$ " NPT, M20

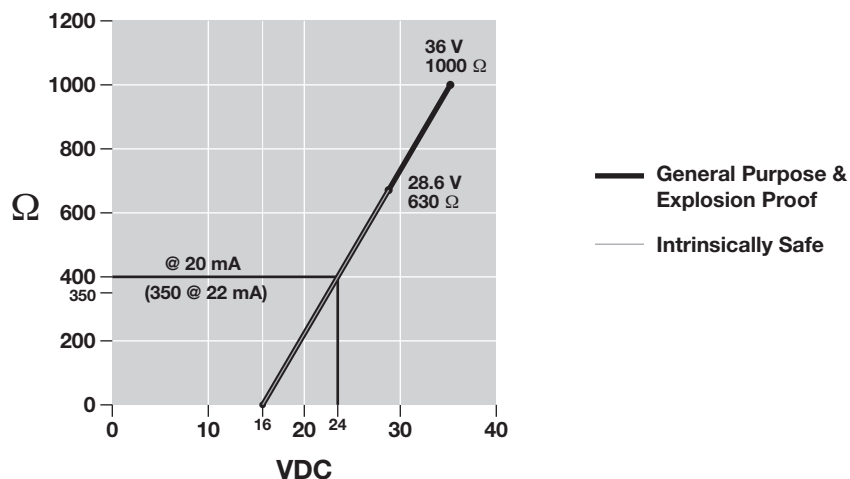
Ingress Protection Type 4X (IP66)

Net/Gross Weight Aluminum 6 lbs (2.36 kg) / 7 lbs (2.76 kg)

316 Stainless steel 13.5 lbs (5.3 kg) / 14 lbs (5.7 kg)

Overall Dimensions H 10.21" (259 mm)  $\times$  W 4.38" (111 mm)  $\times$  D 7.40" (188 mm)

① RTTE: European approval, FCC & IC: North American approval



## Environment

Operating Temperature	-40 to +175° F (-40 to +80° C)
LCD Operating Temperature Range	-5 to +160° F (-20 to +70° C)
Storage Temperature	-50 to +175° F (-46 to +80° C)
Humidity	0-99%, non-condensing
Electromagnetic Compatibility	Meets CE Requirements: EN 50081-2, EN 50082-2
Surge Protection	Meets CE Requirements: EN 61326 (1000 volts)
Shock Class	ANSI/ISA-S71.03 Class SA1
Vibration Class	ANSI/ISA-S71.03 Class VC2

## 3.6.2 Performance

Reference Conditions	Reflection from ideal reflector at +70° F (+20° C)
Linearity	±0.4 inch (10 mm) or 0.1% of tank height (whichever is greater)
Measured Error	±0.4 inch (10 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 (2.5 mm)
Repeatability	< 0.2 inch (5 mm) or 0.05% of tank height
Response Time	< 1 second
Warm-up Time	30 seconds
Operating Temp. Range	-40° to +175° F (-40° to +80° C) (ATEX EEx d: -40 to +160° F (-40 to +70° C))
LCD Temp. Range	-5° to +160° F (-20° to +70° C)
Ambient Temp. Effect	0.05% per 10° C
Process Dielectric Effect	< 0.3 inch within selected range
Maximum Rate of Change	180 inches (450 cm)/minute

## 3.6.3 O-ring (seal) Selection Chart

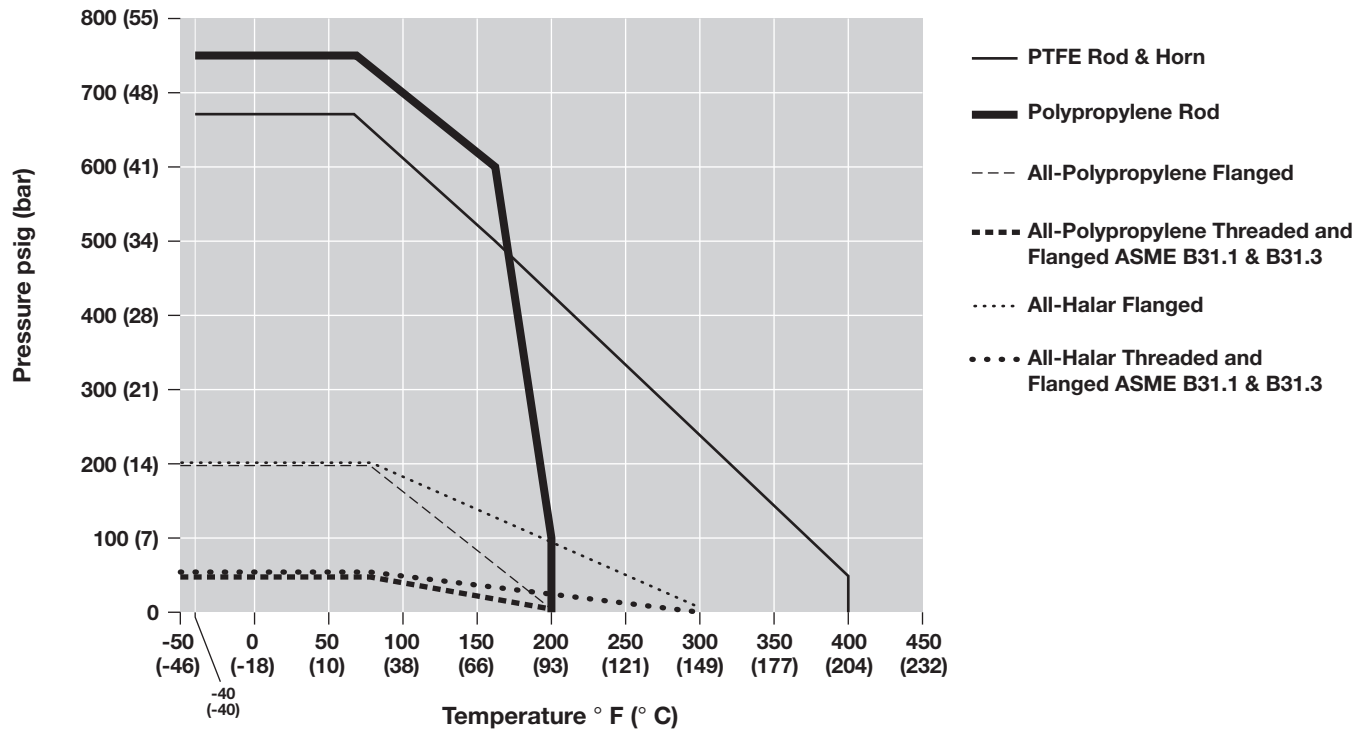
Material	Code	Maximum Temperature	Maximum Pressure	Min. Temp.	Recommended For Use In	Not Recommended For Use In
Viton® GFLT	0	+400° F @ 232 psig (+200° C @ 16 bar)	750 psig @ +70° F (50 bar @ +20° C)	-40° F (-40° C)	General purpose, steam, ethylene	Ketones (MEK, acetone), skydrol fluids, amines, anhydrous 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

### 3.6.4 Functional – Dielectric Rod / Horn

Model	Dielectric Rod TFE	Dielectric Rod <sup>①</sup> Polypropylene	Dielectric Rod All-Halar <sup>®</sup> Antenna	3", 4", and 6" Horn
Materials	316 SS (Hastelloy <sup>®</sup> C, Monel <sup>®</sup> and Kynar <sup>®</sup> opt.), TFE, Viton <sup>®</sup> O-rings	316 SS, Polypropylene, Viton <sup>®</sup> O-rings	All-Halar, Viton O-rings	316 SS (Hastelloy C and Monel opt.), TFE, Viton <sup>®</sup> O-rings
Process Connection	1½" NPT and BSP, ANSI or DIN flanges	1½" NPT and BSP, ANSI or DIN flanges	1½" NPT, BSP, ANSI, or DIN Flanges	6" ANSI or DIN flanges
Maximum Process Temperature	+400° F @ 50 psig (+204° C @ 3.5 bar)	+200° F @ 50 psig (+93° C @ 3.5 bar)	+300° F @ atmos (+150° C @ atmos)	+400° F @ 50 psig (+204° C @ 3.5 bar)
Maximum Process Pressure	675 psig @ +70° F (46.5 bar @ +20° C)	750 psig @ +70° F (51.7 bar @ +20° C)	50 psig @ +70° F (3.5 bar @ +20° C)	675 psig @ +70° F (46.5 bar @ +20° C)
Minimum Dielectric (application dependent)	2.0	2.0	2.0	1.7

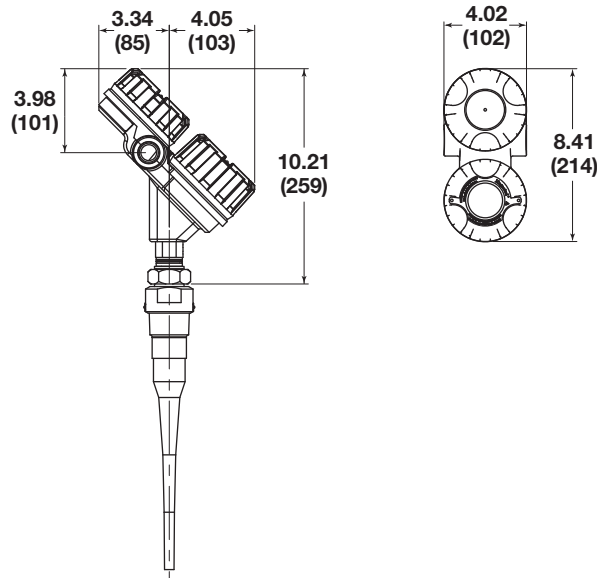
① All-polypropylene construction optional (see chart below for ratings)

### 3.6.5 PULSAR Antenna Pressure / Temperature Ratings

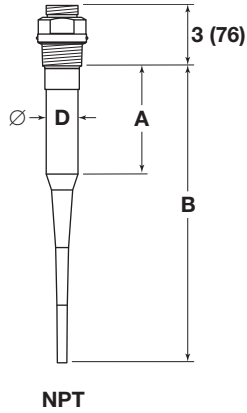


### 3.6.6 Physical – Inches (mm)

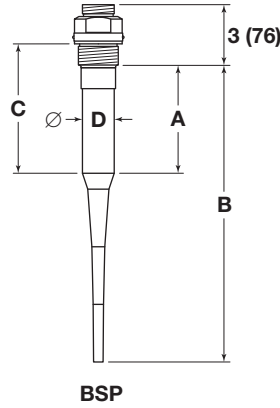
**Transmitter**



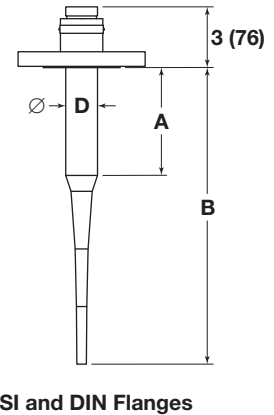
**Dielectric Rod**



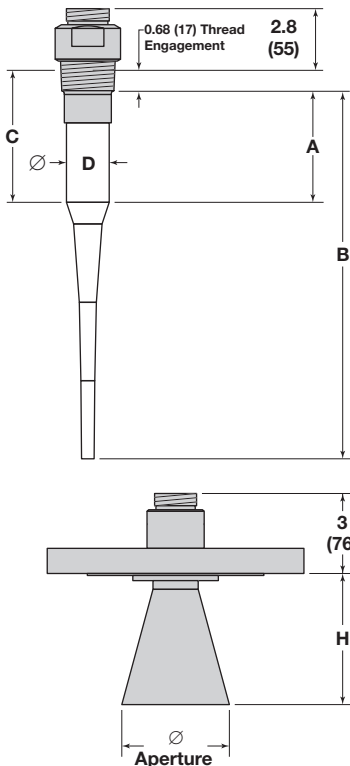
**NPT**



**BSP**



**ANSI and DIN Flanges**



#### DIELECTRIC RODS

Model #	Antenna Extension (maximum "L" dimension)	All	All	BSP
8th Digit		Dim A	Dim B	Dim C
0	1" (25 mm)	2.3 (58)	11.1 (282)	3.0 (76)
1	4" (100 mm)	5.1 (130)	14.0 (356)	5.9 (150)
2	8" (200 mm)	9.1 (231)	18.0 (457)	9.9 (251)
3	12" (300 mm)	13.1 (333)	22.0 (559)	13.9 (353)

Antenna Extension O.D. Dimension D	
TFE Rod	∅ 1.625 (41)
PP Rod	∅ 1.50 (38)
All-Plastic Rod	∅ 1.625 (41)

#### HORNS

Model #	Antenna Extension (maximum "L" dimension)	3" Horn	4" Horn	6" Horn	
8th Digit		Dim H	Dim H	Dim H	
0	1" (25 mm)	2.7 (51)	↓	↓	
1	4" (100 mm)	N/A	4.6 (117)	↓	
2	8" (200 mm)		8.4 (213)		8.3 (211)
3	12" (300 mm)		12.4 (315)		12.4 (315)
<b>Aperture</b>		2.95" (75 mm)	3.75" (95 mm)	5.75" (146 mm)	

## 3.7 Model Numbers

### 3.7.1 PULSAR Radar Transmitter

#### BASIC MODEL NUMBER AND OPERATING FREQUENCY

R95	Through-Air Radar Level Transmitter- 6.3 GHz Pulse Radar (North America)
R05	Through-Air Radar Level Transmitter- 5.8 GHz Pulse Radar (Europe)



#### POWER

5	24 VDC, Two-wire
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#### SIGNAL OUTPUT

1	4-20 mA with HART
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#### ACCESSORIES

A	Digital Display and Keypad
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#### MOUNTING/CLASSIFICATION

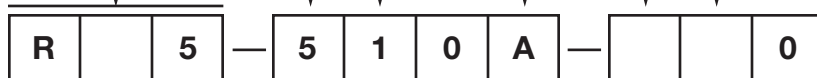
1	Integral, General Purpose & Intrinsically Safe (FM & CSA), Non-incendive (CL1, Div II) ①
3	Integral, Explosion-Proof (FM & CSA Class I Div. 1, Groups B, C & D)
A	Integral, General Purpose & Intrinsically Safe (ATEX II 1G EEx ia IIC T4 IEC Ex ia IIC T4)
C	Integral, Explosion-Proof (ATEX II 1/2G EEx d ia IIC T6)

① Measured media inside vessel must be non-flammable only.

#### HOUSING/CONDUIT CONNECTION

1	Cast Aluminum, Dual Compartment, 45° / ¼" NPT (IP66)
2	Cast Aluminum, Dual Compartment, 45° / M20 (IP66)
3	Cast 316 SS, Dual Compartment, 45° / ¼" NPT (IP66) ②
4	Cast 316 SS, Dual Compartment, 45° / M20 (IP66) ②

② Consult factory for delivery.



### 3.7.2 Radar Antennas – Dielectric Rod

#### TECHNOLOGY / OPERATING FREQUENCY

R A	PULSAR radar antennas / 5.8/6.3 GHz
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#### CONFIGURATION / STYLE

A	TFE (Material of Construction codes A, B, C, and K only)
B	Polypropylene (Material of Construction codes A, G, K, and L only)
C	Halar® (Material of Construction codes G and L only)

#### MATERIAL OF CONSTRUCTION

A	316/316L stainless steel
B	Hastelloy® C
C	Monel®
G	All-Plastic wetted surfaces including flanges (Configuration/Style codes B and C only)
K	316/316L SS; ASME B31.1 and B31.3 (meets CRN specifications)
L	All-Plastic wetted surfaces; ASME B31.1, B31.3 (meets CRN specifications; Configuration/Style codes B and C only)

#### PROCESS CONNECTION - SIZE/TYPE ①

31	1½" NPT thread	32	1½" BSP (G 1½) thread
43	2" 150# ANSI raised face flange	DA	DN 50, PN 16 DIN 2527 Form B
44	2" 300# ANSI raised face flange	DB	DN 50, PN 25/40 DIN 2527 Form B
45	2" 600# ANSI raised face flange	DD	DN 50, PN 64 DIN 2527 Form E
53	3" 150# ANSI raised face flange	EA	DN 80, PN 16 DIN 2527 Form B
54	3" 300# ANSI raised face flange	EB	DN 80, PN 25/40 DIN 2527 Form B
55	3" 600# ANSI raised face flange	ED	DN 80, PN 64 DIN 2527 Form E
63	4" 150# ANSI raised face flange	FA	DN 100, PN 16 DIN 2527 Form B
64	4" 300# ANSI raised face flange	FB	DN 100, PN 25/40 DIN 2527 Form B
65	4" 600# ANSI raised face flange	FD	DN 100, PN 64 DIN 2527 Form E
73	6" 150# ANSI raised face flange	GA	DN 150, PN 16 DIN 2527 Form B
74	6" 300# ANSI raised face flange	GB	DN 150, PN 25/40 DIN 2527 Form B
75	6" 600# ANSI raised face flange	GD	DN 150, PN 64 DIN 2527 Form E

#### HYGIENIC PROCESS CONNECTIONS

4P	2" Triclover® type, 16 AMP	6P	4" Triclover type, 16 AMP
5P	3" Triclover type, 16 AMP	7P	6" Triclover type, 16 AMP

① Metal flanges welded to antenna; Plastic flanges and metal flanges with threaded antenna connection ordered separately. Refer to Optional Flanges chart on page 41.

#### O-RINGS ②

0	Viton® GFLT
1	EPDM
2	Kalrez 4079
8	Aegis PF128

② All-Polypropylene and All-Halar antennas (Materials of Construction Codes G and L) use Viton® GFLT O-rings

#### 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) (ESP designation for TFE rod only)
3	For nozzle height ≤ 12" (300 mm)





### 3.7.3 Radar Antennas – Horn

#### TECHNOLOGY / OPERATING FREQUENCY

R A	PULSAR radar antennas / 5.8/6.3 GHz
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#### CONFIGURATION / STYLE

3	3" horn (for Standpipe/Stillwell use only; Materials of Construction codes A & K only)
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

53	3" 150# ANSI raised face flange
54	3" 300# ANSI raised face flange
55	3" 600# ANSI raised face flange
63	4" 150# ANSI raised face flange
64	4" 300# ANSI raised face flange
65	4" 600# ANSI raised face flange
73	6" 150# ANSI raised face flange
74	6" 300# ANSI raised face flange
75	6" 600# ANSI raised face flange
FA	DN 100, PN 16      DIN 2527 Form B
FB	DN 100, PN 25/40    DIN 2527 Form B
FD	DN 100, PN 64      DIN 2527 Form E
GA	DN 150, PN 16      DIN 2527 Form B
GB	DN 150, PN 25/40    DIN 2527 Form B
GD	DN 150, PN 64      DIN 2527 Form E

#### HYGIENIC PROCESS CONNECTIONS

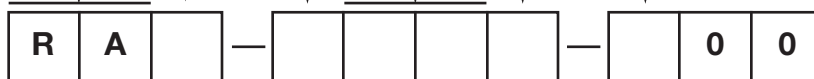
6P	4" Tri-Clover type, 16 AMP Hygienic Flange
7P	6" Tri-Clover type, 16 AMP Hygienic Flange

#### O-RINGS

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

#### ANTENNA EXTENSION

0	For 3" Horn in standpipes/stillwells only
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)



#### OPTIONAL FLANGES (for use with Antenna Extension Codes 1–3 only)

Part Number:	2"		3"		4"		6"	
04-6852	150#	300#	150#	300#	150#	300#	150#	300#
316L Stainless Steel	-001	-005	-002	-006	-003	-007	-004	-008
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

Part Number:	2"		3"		4"		6"	
04-6852	150#	300#	150#	300#	150#	300#	150#	300#
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

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## Glossary

**Accuracy** The closeness of agreement between the result of measurement and the true value of the measure (inaccuracy equals the maximum positive and negative % deviation over the total span).

**ANSI** American National Standards Institute.

**Antenna** A mechanical component that serves as an impedance match between the transmission of a signal in a cable (or waveguide) and air.

**AntnaMnt** *Antenna Mount* The type of process mounting (NPT, BSP or Flange) utilized in the installation. This aids in establishing an exact Sensor Reference Point for Radar propagation and measurement.

**AntnaTyp** *Antenna Type* A particular antenna configuration or design. Each antenna design has a set of unique performance characteristics.

**ATEX** *ATmosphere EXplosive* European regulations governing the use in hazardous areas.

**BlockDist** *Blocking Distance* The area near the antenna where reflections cannot be measured effectively due to antenna ringing and noise.

**CE** *Conformité Européene* Standards and performance criteria for the new European Union.

**CENELEC** *Comité Européen de Normalisation Electrotechnique* European organization that sets standards for electrical equipment.

**CSA** *Canadian Standards Association* Canadian, third party agency that qualifies the safety of electrical equipment.

**Damping** Factor applied to smooth output variations due to turbulence.

**Default Screen** The main position of the menu structure that displays the primary measurement values of LEVEL, Quality, % OUTPUT, and LOOP. The transmitter returns to this position after 5 minutes of inactivity (except Screens 2-6).

**Diagnostics** Three levels of error messages; Fault, Warning and Information.

**Dielectric Constant** ( $\epsilon$ ) The electrical permittivity of a material. The units are farad/meter. Typical values: Hydrocarbons 1.9–3, Glycol 32, Water-based media 80. See Technical Handbook 41-600 for complete listing.

**Dielectric Rod antenna** A non-metallic (TFE and polypropylene typical) transition between the microwave waveguide and air.

**Distance** The present reading measured from the transmitter's Sensor Reference Point to the material in a vessel; compliment of Level.

**DVM/DMM** Digital Volt Meter/Digital Multimeter.

**Electromagnetic Energy** The radiation that travels through space as electric and magnetic fields varying with position and time. Examples in increasing frequency: radio waves, microwave, infrared light, visible light, ultraviolet light, x-rays, gamma waves, and cosmic waves.

**EM** See Electromagnetic Energy.

**EMI** *Electromagnetic Interference* Electrical noise caused by electromagnetic fields that may affect electrical circuits, particularly low-power electronic devices.

**EN** *European Normal* Committee guidelines in EC countries that take precedence over local, country guidelines.

**ENV** Preliminary EN guidelines, or pre-standards.

**Ergonomic** A mechanism that considers human capability in its design or function.

**ETS** *Equivalent Time Sampling* Process that captures high speed electromagnetic events in real time (nanoseconds) and reconstructs them into an equivalent time (milliseconds).

**Explosion Proof Enclosure** An enclosure designed to withstand an explosion of gas or vapor within it and prevent the explosion from spreading outside the enclosure.

**Factory Sealed** A third-party-approved Explosion Proof seal installed in the unit during manufacturing. This alleviates the end user from installing an external XP seal adjacent (within 18") to the device.

**Fault** The highest level in the hierarchy of diagnostics annunciating a defect or failure in circuitry or software that preclude reliable measurement. The current (mA) value unit defaults to 3.6, 22, or Hold and a message is displayed on the rotating screen. Further information can be obtained by viewing the Status or Diagnostic (Factory Menu) screens.

**Feedthrough** A small, connecting cavity between the main housing compartments, carrying the cable that supplies the operating energy to the measurement circuitry and returns the output value proportional to level. This cavity is potted to maintain the environmental isolation between the two compartments.

**Fiducial** A reference signal (baseline) to which all measurements are referenced.

**FM** *Factory Mutual* American, third party agency that qualifies the safety of electrical equipment.

**Foam** The entraining of air in a liquid. The effect of foam on radar measurement is based on four factors; 1.) dielectric of the liquid from which the foam has developed, 2.) density of the foam (bubble size), 3.) amount of foam above the liquid and, to a lesser extent, 4.) wall thickness of the bubbles.

**Four Wire** An electronic instrument design that uses one set of wires to supply power (120/240 VAC, 24 VDC) and another set to carry the process measurement signal (4–20 mA). Also called Line Powered.

**FSK** *Frequency Shift Keying* See HART.

**Gain** Amplification adjustment to attain optimum performance in various product dielectric ranges. (Factory setting).

**Ground** An electrical connection to the Earth's potential that is used as a reference for the system and electrical safety.

**Grounded** A state where no electrical potential exists between the ground (green) connection on the transmitter and the Earth or system ground.

**Guided Wave Radar** See TDR.

**HART** *Highway Addressable Remote Transducer* Protocol that uses the Bell 202 frequency shift keying (FSK) method to superimpose low level frequencies (1200/2000 Hz) on top of the standard 4–20 mA loop to provide digital communication.

**HART ID** See Poll Address.

**Hazardous Area** An area where flammable gases or vapors are or may be present in the air in quantities sufficient to produce explosive or ignitable mixtures.

**Horn Antenna** A metallic, cone transition between the microwave waveguide and air.

**IEC** *International Electrotechnical Commission* Organization that sets international standards for electrical devices.

**Increased Safety** Designs and procedures that minimize sparks, arcs, and excessive temperatures in hazardous areas. Defined by the IEC as Zone 1 environments (Ex e).

**Information (message)** The lowest level in the hierarchy of diagnostic conditions providing operational factors that are not critical to measurement. Further information can be obtained by viewing the Status or Diagnostic (Factory Menu) screens.

**Intrinsically Safe Ground** A very low resistance connecting to a ground, in accordance with the National Electrical Code (NEC, ANSI/NFPA 70 for FMRC), the Canadian Electrical Code (CEC for CSA), or the local inspector.

**Intrinsic Safety** A design or installation approach that limits the amount of energy that enters a hazardous area to eliminate the potential of creating an ignition source.

**Level** The present reading of the height of material in a vessel; compliment of Distance.

**Level Offset** *Level Offset* The distance above the tank bottom where radar level measurement is impossible due to heating coils, baffles, angled or curved tank bottoms, etc. The mA output will never read lower than the Level Offset value.

**Linearity** The worst case error calculated as a deviation from a perfect straight line drawn between two calibration points.

**Line Powered** See Four Wire.

**LOE** *Loss of Echo* Condition where a level measurement is impossible due to the absence of valid reflections from the liquid surface.

**LOE Delay** *Loss of Echo Delay* The amount of time the transmitter spends looking for a valid Level signal before going into Loss of Echo Fault. The last valid Level reading is held during this search.

**LOE Fault** *Loss of Echo Fault* The mA value to which the output is driven after the Loss of Echo Delay times out; choices are 3.6mA, 22mA and HOLD.

**Loop** The present reading of the 4–20 mA current output.

**Loop Powered** See Two Wire.

**Loop Tst** *Loop Test* Built-in system capability to test/calibrate a loop (or separate loop device) by driving the transmitter output to a particular value.

**Low Voltage Directive** A European Community requirement for electrical safety and related issues of devices using 50-1000 VDC or 75–1500 VAC.

**Measured Value** The typical level measurement values used to track the level of a process: Level, % Output, and Loop.

**Media** The liquid material being measured by the level transmitter.

**Multidrop** The ability to install, wire, or communicate with multiple devices over one cable. Each device is given a unique address and ID.

**Non-hazardous Area** An area where no volatile mixtures of vapors/gas and oxygen will be found at any time. Also called General Purpose Area.

**Non-Incendive** A circuit in which any arc or thermal effect produced, under intended operating conditions of the equipment or due to opening, shorting, or grounding of field wiring, is incapable, under specific test conditions, of igniting the flammable gas, vapor, or dust-air mixture.

**Password** A numerical value between 0 and 255 that protects stored configuration data from unauthorized manipulation.

**Percent (%) Output** The present reading as a fraction of the 16 mA scale (4–20 mA).

**Poll Address (HART ID)** A number between 1 and 15 which sets an address or location of a device in a multi-drop loop. Poll address for single device configuration is 0.

**Qual** *Quality* A relative value (0–99) that shows the strength and usefulness for a given reflected signal.

**QuickStart** The essential information needed for the PULSAR radar transmitter and antenna to be installed, wired, and calibrated.

**Radar (Radio Detection And Ranging)** Uses EM energy and high speed timing circuits to determine distance. Original Radar devices used energy in the radio frequency range (MHz), many current devices use much higher frequencies (GHz).

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**Range** The distance over which the transmitter scans for valid return signals.

**RateChng** *Rate of Change* The maximum velocity of vertical movement of a liquid's surface.

**Relative Dielectric** ( $\epsilon_r$ ) A unitless number that indicates the relative permittivity of a material.

**Repeatability** The maximum error between two or more output readings of the same process condition.

**RFI** *Radio Frequency Interference* Electrical noise that can have an adverse affect on electrical circuits, particularly low-power devices.

**Safety Zone** A user-defined area just below the Blocking Distance where level measurement still has a high degree of reliability. Radar can develop ambiguous readings when the level reaches the region of the antenna. An alarm can be annunciated in this area for critical applications where reliable measurement is a necessity for safety reasons.

**Safety Zone Height** The height of the region below the Blocking Distance where an alarm will be annunciated upon detection of liquid.

**Safety Zone Fault** An optional condition added, when necessary, to ensure safe, reliable high-level readings in critical applications. Choices are 3.6 mA, 22 mA, Latch 3.6 or Latch 22. If Latch 3.6 or Latch 22 are chosen, the loop current will remain in alarm until it is cleared in SZ Latch menu screen.

**Safety Zone Alarm Reset** Use screen for clearing a Latched Alarm set in **Safety Zone Fault** (above)

**SnsrOfst** *Sensor Offset* The distance (+ or -) between the customer's 100% reference point (tank top) and the Sensor reference point (bottom of NPT thread, top of BSP thread or face of flange).

**Span** The difference between the upper and lower limits of the range.

**Specific Gravity (SG)** The ratio of the density of a material to the density of water at the same conditions.

**Sensitivity** The amount of amplification applied to the Level signal; a higher value aids in measuring low dielectric media; a lower number assists in ignoring nearby objects.

**Status** The current state of the transmitter's diagnostics; screen updates every 10 seconds.

**Targets** Objects in the vessel that create reflections of the radar signal (microwave energy).

**Targ Rej** *Target Rejection* The ability to ignore reflections from objects in the vessel that are not the liquid level, i.e., false targets (e.g. pipes, ladders, baffles).

**Tank Ht** *Tank Height* The tank measurement between the 0% (tank bottom) and 100% (tank top).

**Tank Top** The 100% point in a vessel. Also considered for the type of tank top; e.g. flat, dome, etc., which affects the development of multiple echoes during high level conditions. Multiple echoes can appear as an invalid Level signal.

**TDR (Time Domain Reflectometry)** Uses a waveguide to carry EM energy to and from the surface of the media to measure distance; similar to conventional through-air Radar but much more efficient. Also called Guided Wave Radar.

**Trim 4/Trim 20** Built-in system capability to fine tune the 4 mA and 20 mA points so the transmitter output corresponds exactly to user's meter, DCS input, etc.

**Trim Lvl** *Trim Level* An offset parameter used to account for various deviations in measurement. It is an offset value that can force the transmitter to read the exact level reading.

**Turbulnc** *Turbulence* Agitation, or disturbance, of the liquid level surface; greater the agitation, greater the scattering of the radar signal (microwave energy).

**Two Wire** An electrical instrument design that uses one set of wires to provide both the supply power and process measurement signal. The process measurement is achieved by varying the current of the loop. Also called Loop Powered.

**Units** The engineering units used to measure level in the system. The choices are in (inches) and cm (centimeters).

**Warning (message)** The second level in the hierarchy of Diagnostics annunciating conditions that are not fatal but may affect measurement. A message will occur on the main (rotating) screen when a Warning is detected but will not affect output current. Further information can be obtained by viewing the Status or Diagnostic screens.



# RX5 Radar Transmitter

## Configuration Data Sheet

Copy blank page and store calibration data for future reference and troubleshooting.

Item	Value	Value	Item (factory defaults)	Value	Value
Vessel Name			Display Factory		
Vessel #			Diagnostics		
Media & Dielectric			Target Rejection Level		
Tag #			Launcher		
Electronics Serial #			Factory Cal		
Antenna Serial #			Peaks	#0	
Level				#1	
Distance				#2	
Quality				#3	
Units				#4	
Antenna Type			Algorithm		
Antenna Extension			Range		
Antenna Mounting			TVG Type		
Sensor Offset			TVG Maximum		
Tank Top			Fiducial Position		
Tank Height			Fiducial Gain		
Blocking Distance			System Gain		
Level Offset			Conversion Factor		
Dielectric			Cef dm/s		
Turbulence			Scale Offset		
Rate of Change			Distance Correction		
Amount of Foam			Echo Amplitude		
Targets	#1	Q ___ - _____	# Run Average		
	#2	Q ___ - _____	Adaptive Filter		
	#3	Q ___ - _____	#Adap Average		
	#4	Q ___ - _____	Scatter High		
	#5	Q ___ - _____	Rate High		
Target Rejection			Scat Rate		
4 mA point			Peak Detect Reference		
20 mA point			Peak Detect Threshold		
Damping Factor			Minimum Threshold		
Sys Fault			ROC/min		
LOE Fault			Maximum Rate		
LOE Delay			Maximum dD		
SZ Fault			Safety Zone Hysteresis		
SZ Height			ES Delay		
SZ Alarm Reset			Data Log		
HART Poll Address					
Trim 4 mA					
Trim 20 mA					
Trim Level			<b>Name</b>		
Pipe ID			<b>Date</b>		
Loop Test			<b>Time</b>		
New Password			<b>NOTES:</b>		
Status					
Language					
Model RX5					
VerX.XXX					

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## Notes

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## Notes

### Service Policy

Owners of MAGNETROL 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. MAGNETROL 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 a MAGNETROL 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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