Installation and Operating Manual for Pulsar® Model R86 with HART® output
Software Version 1.x

High Performance 26 GHz Pulse Burst Radar Level Transmitter
Read this Manual Before Installing

This manual provides information on the Pulsar® Model R86 Radar transmitter. It is important that all instructions are read carefully and followed in sequence. The QuickStart Installation instructions are a brief guide to the sequence of steps for experienced technicians to follow when installing the equipment. Detailed instructions are included in the Complete Installation section of this manual.

Conventions Used in this Manual

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

NOTES

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

Cautions

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

WARNINGS

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

Safety Messages

The PULSAR Model R86 system is designed for use in Category II, Pollution Degree 3 installations. Follow all standard industry procedures for servicing electrical and computer equipment when working with or around high voltage. Always shut off the power supply before touching any components. Although high voltage is not present in this system, it may be present in other systems.

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

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

FCC ID: LPN-R86

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

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

Low Voltage Directive

For use in Installations Category II, Pollution Degree 3. If equipment is used in a manner not specified by the manufacturer, protection provided by equipment may be impaired.

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

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

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1.0 QuickStart Installation

The QuickStart Installation procedures provide an overview of the key steps for mounting, wiring, and configuring the PULSAR Model R86 radar level transmitter. These procedures are intended for experienced installers of electronic level measurement instruments.

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

1.1 Getting Started

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

1.1.1 Equipment and Tools

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

- Threaded antenna and process connection. 2 1/8” (54 mm) wrench
- Transmitter/antenna connection. 1 1/2” (38 mm) wrench
- Torque wrench. highly desirable
- Flat-blade screwdriver
- Digital multimeter or volt/ammeter. Optional
- 24 VDC (23 mA) power supply. Optional
1.1.2 Configuration Information

A helpful SETUP WIZARD, which will guide you through the simple configuration (with parameter explanations), is available in the PULSAR Model R86. Located in the local user interface menu under MAIN MENU/WIZARDS/SETUP WIZARD, some key information is required for configuration. The transmitter will prompt confirmation questions at the end of the Setup Wizard to verify operation.

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

NOTE: These configuration steps are not necessary if the transmitter was pre-configured prior to shipment.

<table>
<thead>
<tr>
<th>Display</th>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement</td>
<td>What is the intended measurement type (Level, Volume, or Flow)?</td>
<td></td>
</tr>
<tr>
<td>System Units</td>
<td>What units of measurement will be used?</td>
<td></td>
</tr>
<tr>
<td>Antenna Model</td>
<td>What type of antenna is being used? Select first 3 digits of model number.</td>
<td></td>
</tr>
<tr>
<td>Antenna Extension</td>
<td>What is maximum nozzle length for which the antenna can be used? Select 8th digit of antenna model number.</td>
<td></td>
</tr>
<tr>
<td>Antenna Mount</td>
<td>Is the antenna mounting NPT, BSP, or flanged?</td>
<td></td>
</tr>
<tr>
<td>Heat Extension</td>
<td>Is there a heat extension connected to the antenna?</td>
<td></td>
</tr>
<tr>
<td>Tank Height</td>
<td>What is the tank height?</td>
<td></td>
</tr>
<tr>
<td>Stillwell ID</td>
<td>What is the Inner Diameter (ID). Enter 0 if not applicable.</td>
<td></td>
</tr>
<tr>
<td>Dielectric Range</td>
<td>What is the dielectric of the process medium?</td>
<td></td>
</tr>
<tr>
<td>Turbulence</td>
<td>What amount of turbulence is expected?</td>
<td></td>
</tr>
<tr>
<td>Foam</td>
<td>What amount of foam is expected?</td>
<td></td>
</tr>
<tr>
<td>Rate of Change</td>
<td>What is the expected maximum rate of level change?</td>
<td></td>
</tr>
<tr>
<td>Primary Variable</td>
<td>Select Level, Volume, or Flow</td>
<td></td>
</tr>
<tr>
<td>4 mA Setpoint (LRV)</td>
<td>What is the 0% reference point for the 4.0 mA value?</td>
<td></td>
</tr>
<tr>
<td>20 mA Setpoint (URV)</td>
<td>What is the 100% reference point for the 20.0 mA value?</td>
<td></td>
</tr>
<tr>
<td>PV Alarm Selection</td>
<td>What output current is desired when a failure indicator is present?</td>
<td></td>
</tr>
<tr>
<td>Damping</td>
<td>How much damping (averaging) is required? Default = 1 second</td>
<td></td>
</tr>
</tbody>
</table>
1.2 QuickStart Mounting

NOTE: Confirm the configuration style and process connection (size and type) of the PULSAR Model R86 radar transmitter. Ensure it matches the requirements of the installation before continuing with the QuickStart installation.

① Confirm the model and serial numbers on the nameplates of PULSAR Model R86 electronics and antenna are identical.

1.2.1 Antenna

② Carefully place the antenna into the vessel. Mount in a location equal to 1/2 the radius of tank top. Do not mount in center of vessel nor closer than 45 cm (18”) 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 and inside of the antenna are clean and dry. Clean with isopropyl alcohol and cotton swabs if necessary.

2. Place the transmitter onto the antenna.

3. Rotate the transmitter so that it is in the most convenient position for wiring, configuring, and viewing.

4. While keeping the housing aligned, tighten the large Universal connector Hex nut to 30 ft. lbs (40 N m) of force. A torque wrench is highly desirable.

   DO NOT LEAVE HAND TIGHT.

• Do not place insulating material around any part of the Radar transmitter including the antenna flange.
1.3 QuickStart Wiring

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

NOTE: Ensure that the electrical wiring to the PULSAR Model R86 radar transmitter is complete and in compliance with all regulations and codes.

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

1.4 Setup Wizard – Configuration

If requested, the PULSAR Model R86 transmitter is shipped fully pre-configured for the application and can be installed immediately. Otherwise, the unit is shipped configured with default factory values and can be easily reconfigured in the shop. The minimum configuration instructions follow. Use the information from the operating parameters table before beginning configuration. See Section 1.1.2, **Configuration Information**.

The Setup Wizard offers a very simple step-by-step menu indicating the basic parameters required for a typical application.

1. Apply power to the transmitter.

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

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

2. Remove the cover of the electronics compartment.
3. The push buttons offer multiple forms of functionality for menu navigation and data entry. (See Section 2.6 for complete explanation.)

- UP moves up through the menu or increases a displayed value.
- DOWN moves down through the menu or decreases a displayed value.
- BACK exits a branch of the menu or exits without accepting entered value.
- ENTER enters a branch of the menu or accepts a displayed entry.

**NOTE:** Holding down the ENTER key for two seconds when any menu or parameter is highlighted will show help text in reference to that item.

4. Press any key at the Home Screen to access the Main Menu.

5. Press ENTER with the WIZARDS menu item highlighted.

6. Press ENTER with the SETUP WIZARD menu item highlighted.

   The Setup Wizard shows the basic parameters, along with Help Text to guide the procedure.

   One can now quickly and easily scroll through the Setup Wizard configuration items, changing those parameters as required:
   - Press ENTER at the highlighted parameter.
   - Scroll to the desired option, then press ENTER.
   - Scroll to next parameter or press BACK when finished to exit the WIZARDS menu.

   Section 1.4.1 lists and describes the nine parameters in the SETUP WIZARD menu.

7. After making all of the necessary changes in the WIZARDS menu, press the BACK button three times to return to the Home Screen.

8. The QuickStart configuration is complete. The Model R86 transmitter should be measuring and is ready for service.
### 1.4.1 Setup Wizard Menu Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level Units</strong></td>
<td>Select the Units of measurement for the level output:</td>
</tr>
<tr>
<td></td>
<td>• Inches • Feet • Millimeters • Centimeters • Meters</td>
</tr>
<tr>
<td><strong>Tank Height</strong></td>
<td>Enter tank height (in Level Units selected)</td>
</tr>
<tr>
<td><strong>Antenna Model</strong></td>
<td>• RB1-x — 1 1/2” horn • RB2-x — 2” horn • RB3-x — 3” horn • RB4-x — 4” horn • RBE-x — Encapsulated • RBF-x — Faced Flange</td>
</tr>
<tr>
<td><strong>Antenna Extension</strong></td>
<td>0 No nozzle  1 For nozzle height ≤ 100 mm (4”)  2 For nozzle height ≤ 200 mm (8”)  3 For nozzle height ≤ 300 mm (12”)  4 For nozzle height ≤ 600 mm (24”)  5 For nozzle height ≤ 1200 mm (48”)  6 For nozzle height ≤ 1800 mm (72”)</td>
</tr>
<tr>
<td><strong>Antenna Mount</strong></td>
<td>Select the type of Antenna Mounting to the vessel (refer to antenna nameplate):</td>
</tr>
<tr>
<td></td>
<td>• NPT (National Pipe Thread) • BSP (British Standard Pipe) • Flange (ASME or EN)</td>
</tr>
<tr>
<td><strong>Dielectric Range</strong></td>
<td>Enter the Dielectric Range for the material to be measured.  Below 1.7 (light hydrocarbons like propane and butane; stillwell only)  1.7 to 3.0 (most typical hydrocarbons)  3.0 to 10 (varying dielectric, for example: mixing tanks)  Above 10 (water-based media)</td>
</tr>
<tr>
<td><strong>4 mA Set Point</strong></td>
<td>Enter the level value (0 % -point) for the 4 mA point. Lower Range Value (LRV). Refer to Section 1.4.1.1.</td>
</tr>
<tr>
<td><strong>20 mA Set Point</strong></td>
<td>Enter the level value (100 % -point) for the 20 mA point. Upper Range Value (URV). Refer to Section 1.4.1.1.</td>
</tr>
<tr>
<td><strong>PV Alarm Selection</strong></td>
<td>Enter the desired output state when a Failure Indicator is active.  • High (22 mA)  • Low (3.6 mA)  • Hold (hold last value is not recommended for standard configuration). Consult factory.</td>
</tr>
</tbody>
</table>
1.4.1.1 Setup Wizard Numerical Data Entry

To make numerical entry changes to Tank Height:

- UP moves up to the next highest digit (0,1,2,3,....,9 or the decimal point). If held down the digits scroll until the push button is released.

- DOWN moves up to the next lowest digit (0,1,2,3,....,9 or the decimal point). If held down the digits scroll until the push button is released.

- BACK moves the cursor to the left and deletes a digit. If the cursor is already at the leftmost position, then the screen is exited without changing the previously saved value.

- ENTER Moves the cursor to the right. If the cursor is located at a blank character position, the new value is saved.

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

- BACK returns to the previous menu without changing the original value, which is immediately redisplayed.

- ENTER accepts the displayed value and returns to the previous menu.
2.0 Complete Installation

This section provides detailed procedures for properly installing, wiring, configuring, and, as needed, troubleshooting the PULSAR Model R86 Radar Level Transmitter.

2.1 Unpacking

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

Before proceeding with the installation, do the following:

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

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

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


2.3 Before You Begin

2.3.1 Site Preparation

Each PULSAR Model R86 Radar transmitter/antenna is built to match the physical specifications of the required installation. Ensure that the antenna process connection is correct for the threaded or flanged mounting on the vessel where the transmitter will be placed. See Section 2.4, Mounting.

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

Ensure that the wiring between the power supply and PULSAR Model R86 Radar transmitter is complete and correct for the type of installation. See Section 3.6, Specifications.

2.3.2 Equipment and Tools

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

- Threaded antenna and process connection .............. 2 1/8" (54 mm) wrench
- Transmitter/antenna connection .... 1 1/2" (38 mm) wrench
- Torque wrench .................................. highly desirable
- Flat-blade screwdriver
- Digital multimeter or volt/ammeter .............. Optional
- 24 VDC (23 mA) power supply ................. Optional

2.3.3 Operational Considerations

Radar applications are characterized by three basic conditions;

- Dielectric (process medium)
- Distance (measuring range)
- Disturbances (turbulence, foam, false targets, multiple reflections and rate of change).

The PULSAR Model R86 Radar transmitter is offered with a horn antenna configuration—Horn (1 1/2", 2", 3", 4"). Ideally, if the installation allows, the 4" horn antenna should be used to ensure the best possible performance in all operational conditions.
2.3.3.1 Maximum Distance

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

<table>
<thead>
<tr>
<th>Antenna Type</th>
<th>R86 Maximum Recommended Measuring Range in meters (feet)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Turbulence None or Light</td>
</tr>
<tr>
<td>Dielectric &gt; 1.7 – 3</td>
<td>3 – 10</td>
</tr>
<tr>
<td>1½” Horn</td>
<td>9 (30)</td>
</tr>
<tr>
<td>2” Horn</td>
<td>10 (33)</td>
</tr>
<tr>
<td>3” Horn</td>
<td>15 (50)</td>
</tr>
<tr>
<td>4” Horn</td>
<td>20 (66)</td>
</tr>
</tbody>
</table>

2.3.3.2 Minimum Distance

Liquid should not be allowed closer than:

For Metal Antennas:
50 mm (2”) from the bottom of the antenna or 300 mm (12”) from the sensor reference point (whichever is greater). Refer to illustration at left.

For Encapsulated Horn Antennas:
50 mm (2”) from the bottom of the antenna or 300 mm (12”) from the launch point (whichever is greater). Refer to illustration at left.

2.3.3.3 Problematic Applications; GWR Alternative

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

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

Refer to Eclipse® Model 706 bulletin BE 57-106 for additional information.
The PULSAR Model R86 Radar transmitter can be mounted to a vessel using a variety of process connections. Generally, either a threaded or flanged connection is used. For information about the sizes and types of connections available, see Section 3.8.2, Antenna Model Numbers.

### 2.4 Mounting

#### 2.4.1 Installing the Antenna

Before installing, ensure that:

- Model and Serial numbers on the nameplates of the PULSAR Model R86 transmitter and antenna are identical.
- Process temperature, pressure, dielectric, turbulence and distance are within the antenna specifications for the installation.
- 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 comes in contact with the antenna, noise and media buildup drastically decrease reliable measurement. Liquid should not be allowed closer than 50 mm (2") from the bottom of the antenna or 300 mm (12") from the sensor reference point, whichever is greater.

#### 2.4.1.1 Location

Ideally, the Radar transmitter should be mounted providing an unobstructed signal path to the liquid surface where it should illuminate (with microwave energy) the largest, possible surface area. See Section 2.4.1.2, Beam Angle. Unavoidable obstacles will produce reflections that must be minimized during field configuration. See Section 3.3.3, Echo Rejection. Mount in a location equal to 1/2 the radius of tank top. Do not mount in center of vessel nor closer than 45 cm (18") of tank wall. Contact Magnetrol Technical Support when mounting closer than 45 cm (18") is required.

#### 2.4.1.2 Beam Angle

The various horn antennas exhibit slightly different beam patterns. Ideally, the beam pattern should illuminate with microwave beam the maximum liquid surface with minimum contact with other objects in the vessel including the tank wall. Use the chart at left to determine the optimum installation location.
2.4.1.3 Obstructions

Almost any object that falls within the beam pattern will cause reflections that may be misinterpreted as a false liquid level. Although PULSAR Model R86 has a powerful Echo Rejection routine, all possible precautions should be taken to minimize false target reflections with proper installation and orientation. Refer to Section 4.0, Advanced Configuration/Troubleshooting Techniques for additional information.

2.4.1.4 Nozzles

Improper installation in a nozzle can create “ringing” that will adversely affect measurement. The antenna should always be mounted so the active section of the antenna is a minimum of 13 mm (0.5”) outside the nozzle. Antenna extensions are offered to allow the PULSAR Model R86 transmitter to work reliably in nozzles up to 1.8 m (72”). See Section 3.6.7 for dimensional drawings of all antenna designs including nozzle extensions.

Be sure to include any nozzle distance extending within the vessel.

2.4.1.5 Standpipes and Stillwells

The PULSAR Model R86 can be mounted in a standpipe or stillwell but certain items must be considered:

• Metal stillwells only: inside diameter 45–200 mm (1 3/4”–8”).
• Diameter must be consistent throughout length; no reducers or gaps.
• Stillwell length must cover complete range of measurement (i.e., liquid must be in stillwell).
• Welds should be smooth.
• Vents: holes < 3 mm (0.125”) diameter, slots < 3 mm (0.125”) width.
• If an isolation valve is used, it must be a full port ball valve with an I.D. equal to the pipe diameter.
• Configuration must include a non-zero entry for PIPE I.D parameter.

2.4.2 Installing the Transmitter

• Remove the protective plastic cap from the top of antenna. Store the cap in a safe place in case the transmitter has to be removed later.
• Carefully place the transmitter on the antenna.
• Rotate the transmitter to face the most convenient direction for wiring, configuration and viewing.
NOTE: ALWAYS RUN THE ECHO REJECTION ROUTINE AFTER MAKING CHANGES TO MENU ITEMS (Antenna Model, Antenna Extension, Antenna Mount, Tank Height, Blocking Distance, Dielectric, Turbulence, Rate of Change, Foam).

2.4.2.1 Low Echo Margin

Echo Margin is a parameter that, when used with Echo Strength, can be a very useful troubleshooting tool. It is defined as a numeric value that is related to the strength of the target peak relative to the Level Threshold or competing waveform features, i.e., noise.

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

- Scroll to Display Config Menu under Device Setup. Scroll down to Echo Strength and Echo Margin and change the settings from Hide to View. This will allow you to view these values from the home screen.
- Bring the Level up (or down) to the exact point where the signal is repeatedly lost. Monitor the Echo Margin value as this point is being approached. The Echo Margin value will degrade to a low point before it begins to increase.
- Refer to Section 4.4 for additional information.
2.5 Wiring

Caution: HART versions of the PULSAR Model R86 transmitter operate at voltages of 11–36 VDC. FOUNDATION Fieldbus™ versions operate at 9–17.5 VDC. Higher voltages will damage the transmitter.

Wiring connections between the power supply and the PULSAR Model R86 Radar Transmitter should be made using 0.5–1 mm² (18–22 AWG) shielded twisted pair instrument cable. Connections are made to the terminal strip and the ground connections within the top enclosure compartment. Wiring connections are to be torqued to a minimum of 0.79 N·m (7 in. lbs.) and shall not exceed 1.13 N·m (10 in. lbs.).

The instructions for wiring the PULSAR Model R86 transmitter depend on the application:

• General Purpose or Division 2
• Intrinsically Safe
• Explosion Proof

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

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

2.5.1 General Purpose or Division 2

A general purpose installation does not have flammable media present.

Areas rated Division 2 have flammable media present only under abnormal conditions.

24 VDC electrical connections are required.

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

To install General Purpose or Division 2 wiring:

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

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

See Agency Drawing – Intrinsically Safe Installation, Section 3.5.1.

To install Intrinsically Safe wiring:
1. Ensure that the IS barrier is properly installed in the safe area (refer to local plant or facility procedures). Complete the wiring from the power supply to the barrier and from the barrier to the PULSAR Model R86 transmitter.
2. Remove the cover from the wiring compartment of the transmitter. Install the conduit plug in the unused opening and use PTFE tape/sealant to ensure a liquid-tight connection.
3. Install a conduit fitting and pull the supply wires.
4. Connect shield to an earth ground at power supply.
5. Connect an earth ground wire to the nearest green ground screw (not shown in illustration).
6. Connect the positive supply wire to the (+) terminal and the negative supply wire to the (-) terminal.
7. Replace and tighten the cover to the wiring compartment of the transmitter before applying power.

2.5.3 Explosion Proof

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

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

- Due to the specialized design of the PULSAR Model R86 transmitter, no Explosion Proof conduit fitting (EY seal) is required within 45 cm (18”) of the transmitter.
- An Explosion Proof conduit fitting (EY seal) is required between the hazardous and safe areas. See Section 3.5, Agency Specifications.
To install an Explosion Proof transmitter:

1. Install Explosion Proof conduit from the safe area to the conduit connection of the PULSAR Model R86 transmitter (refer to local plant or facility procedures).
2. Remove the cover from the wiring compartment of the transmitter.
3. Connect shield to an earth ground at the power supply.
4. Connect an Earth ground wire to the nearest green ground screw per local electrical code (not shown in illustration).
5. Connect the positive supply wire to the (+) terminal and the negative supply wire to the (-) terminal.
6. Replace and tighten the cover to the wiring compartment of the transmitter before applying power.

### 2.6 Configuring the Transmitter

Although the PULSAR Model R86 transmitter can be delivered pre-configured from the factory, it can also be easily reconfigured in the shop or at the installation using the local LCD/Keypad or PACTware/DTM. Bench configuration provides a convenient and efficient way to set up the transmitter before going to the tank site to complete the installation.

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

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

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

Refer to I/O manual BE 58-641 for information on FOUNDATION Fieldbus™ output.

#### 2.6.1 Bench Configuration

The PULSAR Model R86 transmitter can be easily configured at a test bench by connecting a standard 24 VDC power supply directly to the transmitter terminals as shown in the accompanying diagram. An optional digital multimeter is shown in the event that mA current measurements are desired.

**NOTE:** Current measurements taken at these test points are an approximate value. Accurate current readings should be taken with the digital multimeter directly in series with the loop.
NOTE: When using a HART communicator for configuration, a minimum 250-ohm line load resistance is required. Refer to your HART communicator manual for additional information.

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

2.6.2 Menu Traversal and Data Entry

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

The PULSAR Model R86 user interface is hierarchical in nature, best described as a tree structure. Each level in the tree contains one or more items. Items are either menu labels or parameter names.

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

2.6.2.1 Navigating the Menu

- UP moves to the previous item in the menu branch.
- DOWN moves to the next item in the menu branch.
- BACK moves back one level to the previous (higher) branch item.
- ENTER enters into the lower level branch or switches to the entry mode. Holding the ENTER down on any highlighted menu name or parameter will show help text for that item.

2.6.2.2 Data Selection

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

- UP and DOWN to navigate the menu and highlight the item of interest
- ENTER allows modification of that selection
- UP and DOWN to choose new data selection
- ENTER to confirm selection

Use BACK (Escape) key at any time to abort the procedure and escape to previous branch item.
2.6.2.3 Entering Numeric Data Using Digit Entry

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

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

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

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

2.6.2.4 Entering Numeric Data Using Increment/Decrement

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

<table>
<thead>
<tr>
<th>Push button</th>
<th>Keystroke Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up</td>
<td>Increments the displayed value. If held down the digits scroll until the push button is released. Depending on which screen is being revised, the increment amount may increase by a factor of 10 after the value has been incremented 10 times.</td>
</tr>
<tr>
<td>Down</td>
<td>Decrements the displayed value. If held down the digits scroll until the push button is released. Depending on which screen is being revised, the decrement amount may increase by a factor of 10 after the value has been decremented 10 times.</td>
</tr>
<tr>
<td>Back</td>
<td>Returns to the previous menu without changing the original value, which is immediately redisplayed.</td>
</tr>
<tr>
<td>Enter</td>
<td>Accepts the displayed value and returns to the previous menu.</td>
</tr>
</tbody>
</table>
2.6.2.5 Entering Character Data

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

General Menu Notes:

<table>
<thead>
<tr>
<th>Push button</th>
<th>Keystroke Action</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Up" /> Up</td>
<td>Moves to the previous character (Z...Y...X...W). If held down, the characters scroll until the push button is released.</td>
</tr>
<tr>
<td><img src="image" alt="Down" /> Down</td>
<td>Moves to the next item character (A...B...C...D). If held down, the characters scroll until the push button is released.</td>
</tr>
<tr>
<td><img src="image" alt="Back" /> Back</td>
<td>Moves the cursor back to the left. If the cursor is already at the leftmost position, then the screen is exited without changing the original tag characters.</td>
</tr>
<tr>
<td><img src="image" alt="Enter" /> Enter</td>
<td>Moves the cursor forward to the right. If the cursor is at the rightmost position, then the new tag is saved.</td>
</tr>
</tbody>
</table>

2.6.3 Password Protection

The PULSAR Model R86 transmitter has three levels of password protection to restrict access to certain portions of the menu structure that affect the operation of the system.

User Password

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

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

The user password can be changed to any numerical value up to 59999. When the transmitter is programmed for password protection, a password is required whenever configuration values are changed.

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

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

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

Factory Password

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

2.6.4 Model R86 Menu: Step-By-Step Procedure

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

The tables in Section 2.6.5 provide a complete explanation of the software menus displayed by the PULSAR Model R86 transmitter. The menu layout is similar between the local Keypad/LCD interface, the DD, and the DTM.

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

• Level Only
• Volume & Level
• Flow

HOME SCREEN

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

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

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

At left is an example of a Home Screen for a Model R86 configured for a Level Only application.
MAIN MENU

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

- DEVICE SETUP
- DIAGNOSTICS
- MEASURED VALUES
- WIZARDS

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

<table>
<thead>
<tr>
<th>Push button</th>
<th>Keystroke Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>❌</td>
<td>Up No action as the cursor is already at the first item in the MAIN MENU</td>
</tr>
<tr>
<td>❌</td>
<td>Down Moves the cursor to DIAGNOSTICS</td>
</tr>
<tr>
<td>←</td>
<td>Back Moves back to HOME SCREEN, the level above MAIN MENU</td>
</tr>
<tr>
<td>→</td>
<td>Enter Presents the selected item, DEVICE SETUP</td>
</tr>
</tbody>
</table>

NOTES: 1. Items and parameters that are shown in lower level menus will depend on the Measurement Type chosen. Those parameters not applicable to the present Measurement Type will be hidden.

2. Holding down the Enter key when the cursor is highlighted over a parameter or menu will provide additional information about that item.
**DEVICE SETUP**
Choosing DEVICE SETUP from the MAIN MENU will result in an LCD presentation as shown at left.

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

Section 2.6.5 shows the entire tree menu for the Model R86 DEVICE SETUP Menu.

**DIAGNOSTICS**
Refer to Section 3.4

**MEASURED VALUES**
Allows the user to scroll through all of the available measured values for the measurement type chosen.
2.6.5 Model R86 Configuration Menu — Device Setup

NOTE: Context-sensitive HELP is available for all menu items. With the menu item highlighted, hold down the \( \rightarrow \) ENTER key for two seconds. Use \( \uparrow \) UP and \( \downarrow \) DOWN for navigation.

**Model (read only)**
- Magnetrol S/N (read only)
- Hardware Rev. (read only)
- Firmware Rev. (read only)
- Long Tag

**Measurement Type:**
- Level Only
- Volume and Level
- Flow

**System Units:**
- Inches
- Feet
- Millimeters
- Centimeters
- Meters

**Antenna Model:**
- RB1-x 1.5" Horn
- RB2-x 2" Horn
- RB3-x 3" Horn
- RB4-x 4" Horn
- RBE-x – Encapsulated
- RBF-x – Faced Flange

**Antenna Extension:**
- 0" No nozzle
- 1" Nozzle ≤ 4"
- 2" Nozzle ≤ 8"
- 3" Nozzle ≤ 12"
- 4" Nozzle ≤ 24"
- 5" Nozzle ≤ 48"
- 6" Nozzle ≤ 72"

**Antenna Mount:**
- NPT
- BSP
- Flange

**Heat Extension:**
- Yes
- No

**Tank Height**
- 50 cm to 40 m
  (20 inches to 130 feet)

**Stillwell I.D.**
- 40 to 500 mm
  1.6 to 19.7 inches

**Dielectric Range:**
- 1.7 to 3.0
- 3.0 to 10
- Above 10

**Turbulance:**
- None
- Light
- Medium
- Heavy

**Foam:**
- None
- Light
- Medium
- Heavy

**Rate of Change:**
- < 5 in/min
- 5-20 in/min
- 20-60 in/min
- > 60 in/min

**ECHO REJECTION:**
- View Echo Curve
- View Reject Curve
- Echo Rejection Type
  - Standard
  - Custom
- Echo List Mode
  - Level
  - Distance
- Live Echo List
- Rejected Echo List
- Reject Curve End
- Echo Reject State
  - Off
  - Disabled
  - Enabled

**NEW REJECT CURVE**
- Select Target Echo
- New Rej Curve End
- Save Reject Curve
2.6.5 Model R86 Configuration Menu — Device Setup

**Identity**
- Basic Config
- Volume Config
- I/O Config
- Display Config
- Advanced Config
- Factory Config

**Measurement Type:**
- Level Only
- Volume and Level
- Flow

**SYSTEM UNITS**
- Level Units:
  - Inches
  - Feet
  - Millimeters
  - Centimeters
  - Meters

- Volume Units:
  - Cubic Feet
  - Cubic Inches
  - Cubic Meters
  - Gallons
  - Barrels
  - Milliliters
  - Liters

**Antenna Model:**
- RB1-x 1.5" Horn
- RB2-x 2" Horn
- RB3-x 3" Horn
- RB4-x 4" Horn
- RBE-x Encapsulated
- RBF-x Faced Flange

**Level Units:**
- Inches
- Feet
- Millimeters
- Centimeters
- Meters

**Volume Units:**
- Cubic Feet
- Cubic Inches
- Cubic Meters
- Gallons
- Barrels
- Milliliters
- Liters

**Antenna Extension:**
- -0" No nozzle
- -1" Nozzle ≤ 4"
- -2" Nozzle ≤ 8"
- -3" Nozzle ≤ 12"
- -4" Nozzle ≤ 24"
- -5" Nozzle ≤ 48"
- -6" Nozzle ≤ 72"

**Antenna Mount:**
- NPT
- BSP
- Flange

**Heat Extension:**
- Yes
- No

**Tank Height:**
- 50 cm to 40 m
  (20 inches to 130 feet)

**Stillwell I.D.:**
- 40 to 500 mm
- 1.6 to 19.7 inches

**Dielectric Range:**
- 1.7 to 3.0
- 3.0 to 10
- Above 10

**Turbulence:**
- None
- Light
- Medium
- Heavy

**Foam:**
- None
- Light
- Medium
- Heavy

**Rate of Change:**
- < 5 in/min
- 5-20 in/min
- 20-60 in/min
- > 60 in/min

**ECHO REJECTION:**
- View Echo Curve
- View Reject Curve
- Echo Rejection Type
- Echo List Mode
- Level
- Distance

**NEW REJECT CURVE**
- Select Target Echo
- New Rej Curve End
- Save Reject Curve

**CUSTOM TABLE SETUP:**
- Custom Table Type:
  - Linear
  - Spline
- Level Input Source:
  - Keypad
  - Sensor

**CUSTOM TABLE VALUES:**
- VESSEL DIMENSIONS:
  - (not used with Custom Table)
  - Radius
  - Ellipse Depth
  - Conical Height
  - Width
  - Length
  - Sensor Offset
2.6.5 Model R86 Configuration Menu — Device Setup

**Primary Variable (PV)**
- 4 mA Set Pt (LRV):
  - 0 to 40 meters
  - (0 to 130 feet)
  - 0 to 9999999 gals (Volume)
- 20 mA Set Pt (URV):
  - 0 to 30 meters
  - (0 to 130 feet)
  - 0 to 9999999 cf (Volume)

**PV Alarm Selection:**
- High
- Low
- Hold (Last Output Value)

**Damping:**
- 0 to 10 seconds

**Language:**
- English
- French
- German
- Spanish
- Russian
- Portuguese
- Polish

**Status Symbol:**
- Hide
- View

**Long Tag:**
- Hide
- View

**PV Bar Graph:**
- Hide
- View

**Level:**
- Hide
- View

**Volume:**
- (Volume and Level mode only)
  - Hide
  - View

**Flow:**
- Hide
- View

**Head:**
- Hide
- View

**NR Totalizer:**
- (Flow setup only)
  - Hide
  - View

**R Totalizer:**
- (Flow setup only)
  - Hide
  - View

**Distance:**
- Hide
- View

**PV% Range:**
- Hide
- View

**Analog Output:**
- Hide
- View

**Echo Strength:**
- Hide
- View

**Echo Margin:**
- Hide
- View

**Elec Temp:**
- Hide
- View
2.6.5 Model R86 Configuration Menu — Device Setup

- **Sensitivity:** 50 to 200
- **Top Blocking Distance:** 30 cm to 3 meters (12 to 120 inches)
- **Bottom Blocking Distance:** 0 to 3 meters (0 to 120 inches)

**SAFETY ZONE SETTINGS**
- **Safety Zone Alarm:**
  - None
  - 3.6 mA
  - 22 mA
  - Latched 3.6 mA
  - Latched 22 mA
- **Safety Zone Height:**
  (not used when Safety Alarm is None)
  - 5 cm to 6 meters (2 inches to 20 feet)
- **Reset SZ Alarm**
  (used when Safety Alarm is Latch 3.6 mA or Latch 22 mA)

**ECHO LOSS SETTINGS**
- **Echo Loss Alarm:**
  - High
  - Low
  - Hold (Last Value Output)
- **Echo Loss Delay:** 1 to 1000 seconds

**THRESHOLD SETTINGS**
- **Target Selection:**
  - First Echo
  - Largest Echo
- **Target Thresh Mode:**
  - Automatic
  - Fixed Value
- **Target Thresh Value:** 0–99
- **Base Threshold:** 0–99 ESU

**TIME VARIABLE GAIN**
- **TVG Start Value**
- **TVG Start Location**
- **TVG End Value**
- **TVG End Location**
- **# Run Average**
- **Max Surface Velocity**
- **Max Level Jump**
- **Empty State Delay**
- **Compound Peak Logic**
  - Disabled
  - Enabled

**ANALOG OUTPUT**
- **HART Poll Address:** 0 to 63
- **Loop Current Mode:**
  - Disabled (Fixed)
  - Enabled (PV)
  - [Fixed Current Value] 4 to 20 mA

**CONFIG CHANGED**
- **Indicator Mode:**
  - Disabled
  - Enabled
- **Reset Config Chngd:**
  - Reset?
    - No
    - Yes
- **Reset Parameters:**
  - No
  - Yes

**LEVEL TABLE SETUP**
- **Level Table Mode:**
  - Disabled
  - Enabled

**FACTORY CALIBRATION**
- **Elec Temp Offset**
- **Conversion Factor**
- **Scale Offset**
- **Window**
- **Fiducial Gain:** 0-255 (read only)
- **Fiducial Strength**
- **Initial Gain**
- **TVG Divisor**
2.7 Configuration Using HART®

A HART (Highway Addressable Remote Transducer) remote unit, such as a HART communicator, can be used to provide a communication link to the PULSAR Model R86 transmitter. When connected to the control loop, the same system measurement readings shown on the transmitter are also shown on the communicator. The communicator can also be used to configure the transmitter.

The HART communicator may need to be updated to include the PULSAR Model R86 software (Device Descriptions). Refer to your HART Communicator Manual for update instructions.

One can also access configuration parameters using PACTware and the Model R86 DTM, or using the AMS with EDDL.

2.7.1 Connections

A HART communicator can be operated from a remote location by connecting it to a remote junction or by connecting it directly to the terminal block in the electronics housing of the PULSAR Model R86 transmitter.

HART uses the Bell 202 frequency shift key technique of high-frequency digital signals. It operates on the 4–20 mA loop and requires 250 Ω load resistance. A typical connection between a communicator and the PULSAR Model R86 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 R86) and its tag number or address. For detailed operating information, refer to the instruction manual provided with the HART communicator.

The PULSAR Model R86 transmitter online menu trees are shown in the following illustration. Open the menu by pressing the alphanumeric key 4, Device Setup, to display the second-level menu.

2.7.3 HART Revision Table

<table>
<thead>
<tr>
<th>HART Version</th>
<th>HCF Release Date</th>
<th>Compatible with R86 Software</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dev V1 DD1</td>
<td>April 2017</td>
<td>Version 1.0a and later</td>
</tr>
</tbody>
</table>
### 2.7.4 HART Menu

#### 1 Identity
1. Enter Password
2. Measurement Type
3. System Units
4. Antenna Model
5. Antenna Mount
6. Basic Config Diagram
7. Tank Height
8. Stillwell I.D.
9. Dielectric Range
10. Turbulance
11. Foam
12. Rate of Change
13. Echo Rejection

#### 2 Basic Config
1. Enter Password
2. Measurement Type
3. System Units
4. Antenna Model
5. Antenna Mount
6. Basic Config Diagram
7. Tank Height
8. Stillwell I.D.
9. Dielectric Range
10. Turbulance
11. Foam
12. Rate of Change

#### 3 Volume Config
1. Enter Password
2. Vessel Type
3. Length
4. Width
5. Radius
6. Ellipse Depth
7. Conical Height
8. Sensor Offset
9. Table Type
10. Level Source
11. Sensor Input
12. Vessel Diams
13. Table Length
14. Custom Table

#### 4 I/O Config
1. Enter Password
2. PV is
3. PV LRV
4. PV URV
5. PV AO Alarm Type
6. Damping
7. I/O Config Diagram
8. Variable Selection

#### Factory Identity
1. Manufacturer
2. Model
3. Magnetrol S/N
4. Hardware Rev.
5. Firmware Rev.
6. Cfg chng count
7. Dev id
8. Universal Rev
9. Fid Dev Rev
10. Software Rev
11. Num Req Preams
3.0 Reference Information

This section presents an overview of the operation of the PULSAR Model R86 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

The PULSAR Model R86 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 20-degree angle for ease of wiring and calibration. These two compartments connect via a watertight feed-through.

3.2 Theory of Operation

3.2.1 Pulse Burst Radar

PULSAR Model R86 is a top-mounted, downward-looking pulse burst radar operating at 26 GHz. Unlike true pulse devices (GWR, for example) that transmit a single, sharp (fast rise-time) waveform of wide-band energy, PULSAR Model R86 emits short bursts of 26 GHz energy and measures the transit time of the signal reflected off the liquid surface. Distance is calculated utilizing the equation: Distance = \( \frac{c \times \text{time}}{2} \), then developing the Level value by factoring in application-specific configuration. The exact reference point for distance and level calculations is the Sensor Reference Point—bottom of an NPT thread, top of a BSP thread or face of a flange.
The exact level measurement is extracted from false target reflections and other background noise via the use of sophisticated signal processing. The new PULSAR Model R86 circuitry is extremely energy efficient so no duty cycling is necessary to accomplish effective measurement.

3.2.2 Equivalent Time Sampling

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

ETS is accomplished by scanning the tank to collect thousands of samples. Approximately three scans are taken per second; each scan gathers more than 14,000 samples.

3.3 Configuration Information

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

3.3.1 Bottom Blocking Distance Description

The parameter referred to as Bottom Blocking Distance in the PULSAR Model R86 DEVICE SETUP/ADVANCED CONFIG menu is defined as the distance from the bottom of the tank to the lowest valid level reading.

NOTE: The level reading will never be lower than the Bottom Blocking Distance or higher than the Top Blocking Distance.

The PULSAR Model R86 transmitter is shipped from the factory with Bottom Blocking Distance set to 0. With this configuration, level measurements are referenced from the bottom of the tank. See Example 1.

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

Application calls for a Model RB2 antenna in an 200 cm tank with a flanged process connection. The process medium is water.

The user wants the 4 mA Set Point (LRV) at 60 cm and the 20 mA Set Point (URV) at 150 cm as referenced from the bottom of the tank.
Example 2 (Bottom Blocking Distance = 25 cm):

Application calls for a Model RB4 antenna in an 200 cm tank with a flanged process connection.

The user wants the 4 mA Set Point (LRV) at 60 cm and the 20 mA Set Point (URV) at 150 cm as referenced from the bottom of the tank.

When the PULSAR Model R86 transmitter is mounted in a stillwell, it is usually desirable to configure the unit with the 4 mA Set Point (LRV) at the lower process connection and the 20 mA Set Point (URV) at the upper process connection. The measuring range then becomes the center-to-center dimension.

Example 3:

Application calls for a Model RB3 flanged antenna measuring water in a chamber with ID = 8 cm. The user wants the 4 mA point at the bottom process connection and the 20 mA point at the top process connection.

3.3.2 Reset Function

A parameter labeled "Reset Parameters" is located at the end of the DEVICE SETUP/ADVANCED CONFIG menu. In the event a user gets confused during configuration or advanced troubleshooting, this parameter gives the user the ability to reset the Model R86 transmitter configuration.

Unique to the Model R86 transmitter is the ability for MAGNETROL to fully “pre-configure” devices to customer requests. For that reason, the Reset function will return the device back to the state at which it left the factory.

It is recommended that MAGNETROL Technical Support be contacted as the Advanced User password will be required for this reset.
3.3.3 Echo Rejection

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

The Model R86 transmitter Echo Rejection feature is located in the DEVICE SETUP/BASIC CONFIG menu, and requires the User Password to activate. It is highly recommended that this feature be used with the waveform capture capability of the Model R86 DTM and PACTware™.

Refer to Section 4.0, Advanced Configuration/ Troubleshooting Techniques or contact MAGNETROL Technical Support for additional instructions.

3.3.4 Volumetric Capability

Selecting Measurement Type = Volume and Level allows the Model R86 transmitter to measure volume as the Primary Measured Value.

3.3.4.1 Configuration using built-in Vessel Types

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

<table>
<thead>
<tr>
<th>Configuration Parameter</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>System Units</td>
<td>A selection of Gallons, Barrels, Milliliters, Liters, Cubic Feet, or Cubic Inches, is provided. (Factory default is Cubic Feet)</td>
</tr>
<tr>
<td>Vessel Type</td>
<td>Select either Vertical/Flat (factory default Vessel Type), Vertical/Elliptical, Vertical/Spherical, Vertical/Conical, Rectangular, Horizontal/Flat, Horizontal/Elliptical, Horizontal/Spherical, Spherical, or Custom Table. Note: Vessel Dims is the next screen only if a specific Vessel Type was selected. If Custom Table was selected. Refer to page 44 to select the Cust Table Type and Cust Table Vals.</td>
</tr>
<tr>
<td>Vessel Dims</td>
<td>See the vessel drawings on the following page for relevant measuring areas.</td>
</tr>
<tr>
<td>Radius</td>
<td>Used for all Vessel Types with the exception of Rectangular.</td>
</tr>
<tr>
<td>Ellipse Depth</td>
<td>Used for Horizontal and Vertical/Elliptical vessels.</td>
</tr>
<tr>
<td>Conical Height</td>
<td>Used for Vertical/Conical vessels.</td>
</tr>
<tr>
<td>Width</td>
<td>Used for Rectangular vessels.</td>
</tr>
<tr>
<td>Length</td>
<td>Used for Rectangular and Horizontal vessels.</td>
</tr>
</tbody>
</table>
Vessel Types

HORIZONTAL/SPHERICAL

SPHERICAL

HORIZONTAL/ELLIPICAL

VERTICAL/ELLIPICAL

VERTICAL/SPHERICAL

RECTANGULAR

VERTICAL/FLAT

VERTICAL/CONICAL

HORIZONTAL/FLAT
3.3.4.2 Configuration using Custom Table

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

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

**LINEAR**

Use where walls are not perpendicular to base.
Concentrate at least two points at beginning (P1) and end (P9); and three points at either side of transition points.

**SPLINE**
3.3.5 Open Channel Flow Capability

Selecting Measurement Type = Flow allows the PULSAR Model R86 transmitter to measure flow as the Primary Measured Value.

Open channel flow is performed by using the Model R86 to measure the Head in a hydraulic structure. The hydraulic structure is the primary measuring element, of which the two most common types are weirs and flumes.

Since the primary element has a defined shape and dimensions, the rate of flow through the flume or over the weir is related to the Head at a specified measurement location.

The Model R86 is the secondary measuring device, which measures the Head of the liquid in the flume or weir. Open channel flow equations stored in the transmitter firmware convert the measured Head into units of flow (volume/time).

NOTE: Proper positioning of the Model R86 should be per the recommendation of the flume or weir manufacturer.
### 3.3.5.1 Configuration using Flume/Weir Equations

The following table provides an explanation of each of the System Configuration parameters required for open channel flow applications using one of the Flow Elements that are stored in the firmware.

<table>
<thead>
<tr>
<th>Configuration Parameter</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flow Units</strong></td>
<td>A selection of Gallons/Minute (factory default Flow Unit), Gallons/Hour, Mil Gallons/Day, Liters/Second, Liters/Minute, Liters/Hour, Cubic Meter/Hour, Cubic Ft/Second, Cubic Ft/Minute, and Cubic Ft/Hour are provided.</td>
</tr>
<tr>
<td><strong>Flow Element</strong></td>
<td>Select one of the following primary Flow Elements that are stored in the firmware: Parshall flume sizes of 1&quot;, 2&quot;, 3&quot;, 6&quot;, 9&quot;, 12&quot;, 18&quot;, 24&quot;, 36&quot;, 48&quot;, 60&quot;, 72&quot;, 96&quot;, 120&quot; and 144&quot;. Palmer-Bwls (Palmer-Bowlus) flume sizes of 4&quot;, 6&quot;, 8&quot;, 10&quot;, 12&quot;, 15&quot;, 18&quot;, 21&quot;, 24&quot;, 27&quot; and 30&quot;. V-notch weir sizes of 22.5°, 30°, 45°, 60°, 90° and 120°. Rect with Ends (Rectangular Weir with End Contractions), Rect w/o Ends (Rectangular Weir without End Contractions), and Cipoletti weir. Custom Table (see page 44 can be selected if none of the stored Flow Elements can be used. The table can be built with a maximum of 30 points. The Model R86 also has the capability of using a Generic Equation (see page 42) for flow calculation.</td>
</tr>
<tr>
<td><strong>Weir Crest Length</strong></td>
<td>The Weir Crest Length screen only appears when the chosen Flow Element is Cipoletti or one of the Rectangular weirs. Input this length in the user-selected level units.</td>
</tr>
<tr>
<td><strong>Flume Channel Width</strong></td>
<td>Allows for entry of the width of the Palmer-Bowlus flume.</td>
</tr>
<tr>
<td><strong>V-Notch Weir Angle</strong></td>
<td>Only appears when flow element is V-Notch weir. It allows for the entry of angle of the V-Notch weir.</td>
</tr>
<tr>
<td><strong>Reference Dist</strong></td>
<td>The Reference Distance is measured from the sensor reference point to the point of zero flow in the weir or flume. This must be measured very accurately in the user-selected level units.</td>
</tr>
<tr>
<td><strong>Maximum Head</strong></td>
<td>Maximum Head is the highest liquid level (Head) value in the flume or weir before the flow equation is no longer valid. The Maximum Head is expressed in the user-selected Level Units. The Model R86 will default to the largest Maximum Head value that is allowed for any given flume or weir. The Maximum Head value can be revised depending on the value of the Reference Distance, or for end user preference.</td>
</tr>
<tr>
<td><strong>Maximum Flow</strong></td>
<td>Maximum Flow is a read-only value that represents the flow value corresponding to the Maximum Head value for the flume or weir.</td>
</tr>
<tr>
<td><strong>Low Flow Cutoff</strong></td>
<td>The Low Flow Cutoff (in user-selected level units) will force the calculated flow value to zero whenever the Head is below this point. This parameter will have a default and minimum value of zero.</td>
</tr>
</tbody>
</table>
### 3.3.5.2 Configuration using Generic Equation

The following table provides an explanation of each of the System Configuration parameters for Open channel flow applications using the Generic Equation.

<table>
<thead>
<tr>
<th>Configuration Parameter</th>
<th>Explanation (Open Channel Flow — using the Generic Equation)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flow Units</strong></td>
<td>A selection of Gallons/Minute (factory default Flow Unit), Gallons/Hour, Mil Gallons/Day, Liters/Second, Liters/Minute, Liters/Hour, Cubic Meter/Second, Cubic Ft/Second, and Cubic Ft/Hour are provided.</td>
</tr>
<tr>
<td><strong>Flow Element</strong></td>
<td>Select one of the following primary Flow Elements that are stored in the firmware: Parshall flume sizes of 1&quot;, 2&quot;, 3&quot;, 6&quot;, 9&quot;, 12&quot;, 18&quot;, 24&quot;, 36&quot;, 48&quot;, 60&quot;, 72&quot;, 96&quot;, 120&quot; and 144&quot;. Palmer-Bowlus flume sizes of 4&quot;, 6&quot;, 8&quot;, 10&quot;, 12&quot;, 15&quot;, 18&quot;, 21&quot;, 24&quot;, 27&quot; and 30&quot;. V-notch weir sizes of 22.5°, 30°, 45°, 60°, 90° and 120°. Rect with Ends (Rectangular Weir with End Contractions), Rect w/o Ends (Rectangular Weir without End Contractions), and Cipoletti weir. Custom Table (see page 43) can be selected if none of the stored Flow Elements can be used. The table can be built with a maximum of 30 points. The Model R86 also has the capability of using a Generic Equation (see below) for flow calculation.</td>
</tr>
<tr>
<td><strong>Generic Eqn Factors</strong></td>
<td><strong>Generic Equation</strong> is a discharge flow equation in the form of ( Q = K(L-CH)H^n ), where ( Q ) = flow (Cu Ft/Second), ( H ) = Head (Feet), ( K ) = a constant, and ( L, C ) and ( n ) are user input factors that depend on which Flow Element is being used. Make sure the flow equation is in the form of ( Q = K(L-CH)H^n ), and proceed to enter the values of ( K, L, C, H ) and ( n ). See example below. <strong>NOTE:</strong> The Generic Equation parameters <strong>must be entered in Cu Ft/Second units</strong>. The resultant flow is converted by the Model R86 into whatever Flow Units are selected above. See example below.</td>
</tr>
<tr>
<td><strong>Reference Dist</strong></td>
<td>The Reference Distance is measured from the sensor reference point to the point of zero flow in the weir or flume. This must be measured very accurately in the user-selected level units.</td>
</tr>
<tr>
<td><strong>Maximum Head</strong></td>
<td>Maximum Head is the highest liquid level (Head) value in the flume or weir before the flow equation is no longer valid. The Maximum Head is expressed in the user-selected level units. The Model R86 will default to the largest Maximum Head value that is allowed for any given flume or weir. The Maximum Head value can be revised depending on the value of the Reference Distance, or for end user preference.</td>
</tr>
<tr>
<td><strong>Maximum Flow</strong></td>
<td>Maximum Flow is a read-only value that represents the flow value corresponding to the Maximum Head value for the flume or weir.</td>
</tr>
<tr>
<td><strong>Low Flow Cutoff</strong></td>
<td>The Low Flow Cutoff (in user-selected level units) will force the calculated flow value to zero whenever the Head is below this point. This parameter will have a default and minimum value of zero.</td>
</tr>
</tbody>
</table>

### Generic Equation Example (using equation for an 8' rectangular weir w/ end contractions)

<table>
<thead>
<tr>
<th>( Q ) (Cubic Ft/Second)</th>
<th>( L ) = 8' (weir crest length in feet)</th>
<th>( H ) = Head value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( K ) = 3.33</td>
<td>C = 0.2 (constant)</td>
<td>( n ) = 1.5 as an exponent</td>
</tr>
</tbody>
</table>

Using the factors above the equation becomes:

\[
Q = 3.33 \ (8-0.2H) \ H^{1.5}
\]

The discharge flow value for a Head value of three feet becomes 128.04 Cubic Ft/Second. If GPM was selected for the Flow Units, the Model R86 Measured Values screen would display this value converted to 57,490 GPM.
### Configuration using Custom Table

The following table provides an explanation of each of the System Configuration parameters for open channel flow applications using the Custom Table.

<table>
<thead>
<tr>
<th>Configuration Parameter</th>
<th>Explanation (Open Channel Flow — Custom Table)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow Units</td>
<td>A selection of Gallons/Minute (factory default Flow Unit), Gallons/Hour, Mil Gallons/Day, Liters/Second, Liters/Minute, Liters/Hour, Cubic Meters/Hour, Cubic Ft/Second, Cubic Ft/Minute, and Cubic Ft/Hour are provided.</td>
</tr>
<tr>
<td>Flow Element</td>
<td>Select one of the following primary Flow Elements that are stored in the firmware: Parshall flume sizes of 1&quot;, 2&quot;, 3&quot;, 6&quot;, 9&quot;, 12&quot;, 18&quot;, 24&quot;, 36&quot;, 48&quot;, 60&quot;, 72&quot;, 96&quot;, 120&quot; and 144&quot;. Palmer-Bowlus flume sizes of 4&quot;, 6&quot;, 8&quot;, 10&quot;, 12&quot;, 15&quot;, 18&quot;, 21&quot;, 24&quot;, 27&quot; and 30&quot;. V-notch weir sizes of 22.5°, 30°, 45°, 60°, 90° and 120°. Rect with Ends (Rectangular Weir with End Contractions), Rect w/o Ends (Rectangular Weir without End Contractions), and Cipoletti weir. Custom Table (see below) can be selected if none of the stored Flow Elements can be used. The table can be built with a maximum of 30 points. The Model R86 also has the capability of using a Generic Equation (see page 42) for flow calculation.</td>
</tr>
<tr>
<td>Custom Table</td>
<td>The Custom Table points can be a Linear (straight line between adjacent points) or Spline (can be a curved line between points) relationship. Refer to the drawing above for more information.</td>
</tr>
<tr>
<td>Cust Table Vals</td>
<td>A maximum of 30 points can be used in building the Custom Table. Each pair of values will have a Head (height) in the units chosen in the Level Units screen, and the associated flow for that Head value. The values must be monotonic, i.e., each pair of values must be greater than the previous Head/flow pair. The last pair of values should have the highest Head value (usually the Maximum Head value) and the flow associated with that Head value.</td>
</tr>
<tr>
<td>Reference Dist</td>
<td>The Reference Distance is measured from the sensor reference point to the point of zero flow in the weir or flume. This must be measured very accurately in the user-selected level units.</td>
</tr>
<tr>
<td>Maximum Head</td>
<td>Maximum Head is the highest liquid level (Head) value in the flume or weir before the flow equation is no longer valid. The Maximum Head is expressed in the user-selected Level Units. The Model R86 will default to the largest Maximum Head value that is allowed for any given flume or weir. The Maximum Head value can be revised depending on the value of the Reference Distance, or for end user preference.</td>
</tr>
<tr>
<td>Maximum Flow</td>
<td>Maximum Flow is a read-only value that represents the flow value corresponding to the Maximum Head value for the flume or weir.</td>
</tr>
<tr>
<td>Low Flow Cutoff</td>
<td>The Low Flow Cutoff (in user-selected level units) will force the calculated flow value to zero whenever the Head is below this point. This parameter will have a default and minimum value of zero.</td>
</tr>
</tbody>
</table>

**Concentrate points as follows:**
A. At least two points at beginning (P1 and P2);
B. At least two points at end (P9 and P10);
C. Three points at approximate average flow rate (for example, P3, P4, P5); and at transition point (P7) and points on either side (P6,P8)
3.4 Troubleshooting and Diagnostics

The PULSAR Model R86 transmitter is designed and engineered for trouble-free operation over a wide range of operating conditions. The transmitter continuously runs a series of internal self-tests and displays helpful messages on the large graphic liquid crystal display (LCD) when attention is required.

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

All of this information can be obtained directly from the transmitter on the LCD, or remotely by using a HART communicator or PACTware and the PULSAR Model R86 DTM.

PACTware™ PC Program

The PULSAR Model R86 offers the ability to perform more advanced diagnostics such as Trending and Echo Curve analysis using a DTM with PACTware. This is a powerful troubleshooting tool that can aid in the resolution of any diagnostic indicators that may appear.

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

3.4.1 Diagnostics (Namur NE 107)

The PULSAR Model R86 transmitter includes an exhaustive list of Diagnostic Indicators which follow the NAMUR NE 107 guidelines.

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

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

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

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

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

From an external Model R86 transmitter perspective, diagnostic information includes measurement of process conditions, in addition to detection of internal device or system anomalies.

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

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

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

Users will not have the ability to unassign certain indicators from the Failure signal category as the Model R86 user interfaces will prohibit or reject such re-assignment entries. This is to ensure that current loop alarms are asserted in situations where the device is not able to provide measurements due to critical failures. (For example, if the alarm selection has not been set to Hold or a fixed current mode is in effect.)

A default mapping of all diagnostic indicators will be applied initially, and can be re-applied through use of a reset function.
Refer to the Diagnostic Indicator tables in this section for a complete listing of the Model R86 diagnostic indicators, along with their explanations, default categories, and recommended remedies.

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

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

3.4.2 Diagnostic Indication Simulation

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

3.4.3 Diagnostic Help

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

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

If the explanation and remedy text (and additional name-explanation pairs) exceeds the available space, a ➔ appears in the rightmost column of the last line indicating more text below. In this situation, the DN key scrolls text up one line at a time. Similarly, while text exists above the upper line of the text field, a ➔ appears in the rightmost column of the top (text) line. In this situation, the UP key scrolls the text down one line at a time. Otherwise the DN and UP keys are inoperative. In all cases the ENT or DEL key reverts to the previous screen.
When the transmitter is operating normally and the highlight cursor is positioned on Present Status, the bottom LCD line displays “OK” because no diagnostic indicators are active.

**EVENT HISTORY** – This menu displays the last twenty events related to configuration and diagnostic event logging.

**ADVANCED DIAGNOSTICS** – This menu displays parameters related to some of the advanced diagnostics available within the Model R86.

**INTERNAL VALUES** – Displays read-only internal parameters.

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

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

**ECHO CURVES** – This menu allows the user to display the live Echo Curve, Echo Reference Curve, Echo History Curves or Echo Rejection Curve on the LCD.
Shown below and at right is a listing of the Model R86 diagnostic indicators, showing their priority, explanations and recommended remedies. (Priority 1 is highest priority.)

<table>
<thead>
<tr>
<th>Priority</th>
<th>Indicator Name</th>
<th>Default Category</th>
<th>Explanation</th>
<th>Remedy (Context Sensitive Help)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Software Error</td>
<td>Failure</td>
<td>Unrecoverable error occurred in stored program.</td>
<td>Contact MAGNETROL Technical Support.</td>
</tr>
<tr>
<td>2</td>
<td>RAM Error</td>
<td>Failure</td>
<td>RAM (read/write) memory failing.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>ADC Error</td>
<td>Failure</td>
<td>Analog-to-digital converter failure.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>EEPROM Error</td>
<td>Failure</td>
<td>Non-volatile parameter storage failing.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Analog Board Error</td>
<td>Failure</td>
<td>Unrecoverable hardware failure.</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Analog Output Error</td>
<td>Failure</td>
<td>Actual loop current deviates from commanded value.</td>
<td>Perform Adjust Analog Output maintenance procedure.</td>
</tr>
<tr>
<td>7</td>
<td>Spare Indicator 1</td>
<td>OK</td>
<td>Reserved for future use.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Default Parameters</td>
<td>OK</td>
<td>Saved parameters are set to default values.</td>
<td>Perform complete Device Configuration.</td>
</tr>
<tr>
<td>9</td>
<td>Spare Indicator 2</td>
<td>OK</td>
<td>Reserved for future use.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Sweep Time Error</td>
<td>Failure</td>
<td>Analog board sweep time error</td>
<td>Contact MAGNETROL Technical Support.</td>
</tr>
<tr>
<td>11</td>
<td>Spare Indicator 3</td>
<td>OK</td>
<td>Reserved for future use.</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Too Many Echoes</td>
<td>Failure</td>
<td>Excessive number of possible echoes detected</td>
<td>Check Settings: Dielectric, Sensitivity. Check Polarization.</td>
</tr>
<tr>
<td>13</td>
<td>Safety Zone Alarm</td>
<td>Failure</td>
<td>Risk of echo loss if liquid rises above Blocking Distance.</td>
<td>Ensure that liquid cannot reach Blocking Distance.</td>
</tr>
<tr>
<td>15</td>
<td>Spare Indicator 4</td>
<td>OK</td>
<td>Reserved for future use.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Config Conflict</td>
<td>Failure</td>
<td>Measurement type and primary variable selection parameters are inconsistent.</td>
<td>Confirm proper configuration. Check Measurement Type.</td>
</tr>
<tr>
<td>17</td>
<td>High Volume Alarm</td>
<td>Failure</td>
<td>Volume calculated from Level reading exceeds capacity of vessel or custom table.</td>
<td>Check settings: Vessel Dimensions, Custom Table entries</td>
</tr>
<tr>
<td>18</td>
<td>High Flow Alarm</td>
<td>Failure</td>
<td>Calculated flow exceeds maximum for flume or custom table.</td>
<td>Check settings: Vessel Dimensions, Custom Table entries</td>
</tr>
<tr>
<td>19</td>
<td>Spare Indicator 5</td>
<td>OK</td>
<td>Reserved for future use.</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Initializing</td>
<td>Function Check</td>
<td>Distance measurement is inaccurate while internal filters are settling.</td>
<td>Standard start-up message. Wait for up to 10 seconds.</td>
</tr>
<tr>
<td>Priority</td>
<td>Indicator Name</td>
<td>Default Category</td>
<td>Explanation</td>
<td>Remedy</td>
</tr>
<tr>
<td>---------</td>
<td>-----------------------------</td>
<td>------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>-------------------------------------------------------------------------</td>
</tr>
<tr>
<td>21</td>
<td>Config Changed</td>
<td>Function Check</td>
<td>A parameter has been modified from the User Interface.</td>
<td>If desired, reset Config Changed indicator in ADVANCED CONFIG menu.</td>
</tr>
<tr>
<td>22</td>
<td>Spare Indicator 6</td>
<td>OK</td>
<td>Reserved for future use.</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>High Elec Temp</td>
<td>Out of Spec</td>
<td>Electronics too hot. May compromise level measurement or damage instrument.</td>
<td>Shield transmitter from heat source or increase air circulation. Locate transmitter remotely in a cooler area.</td>
</tr>
<tr>
<td>24</td>
<td>Low Elec Temp</td>
<td>Out of Spec</td>
<td>Electronics too cold. May compromise level measurement or damage instrument.</td>
<td>Insulate transmitter. Locate transmitter remotely in a warmer area.</td>
</tr>
<tr>
<td>25</td>
<td>Calibration Req’d</td>
<td>Out of Spec</td>
<td>Factory calibration has been lost. Measurement accuracy may be diminished.</td>
<td>Return transmitter to factory for recalibration.</td>
</tr>
<tr>
<td>26</td>
<td>Echo Reject Invalid</td>
<td>Out of Spec</td>
<td>Echo Rejection inoperative. May report erroneous Level readings. Upr Echo may be lost.</td>
<td>Save a fresh Echo Rejection Curve.</td>
</tr>
<tr>
<td>27</td>
<td>Spare Indicator 7</td>
<td>OK</td>
<td>Reserved for future use.</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Inferred Level</td>
<td>Out of Spec</td>
<td>Level inferred to have entered Blocking Region if echo lost within Max Distance Jump of Top or Bottom Blocking Region.</td>
<td>Verify level reading; if incorrect, check configuration.</td>
</tr>
<tr>
<td>29</td>
<td>Adjust Analog Out</td>
<td>Out of Spec</td>
<td>Loop current is inaccurate.</td>
<td>Perform Adjust Analog Output maintenance procedure.</td>
</tr>
<tr>
<td>30</td>
<td>Totalizer Data Lost</td>
<td></td>
<td>Totalizer data has been lost; restarted from zero.</td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>Low Supply Voltage</td>
<td>Out of Spec</td>
<td>Loop current may be incorrect at higher values. Analog output is inaccurate.</td>
<td>Verify loop resistance. Replace loop power supply.</td>
</tr>
<tr>
<td>32</td>
<td>Spare Indicator 8</td>
<td>OK</td>
<td>Reserved for future use.</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Max Jump Exceeded</td>
<td>Maintenance Required</td>
<td>Transmitter has jumped to an echo at location that exceeds “Max Level Jump” from previous echo location.</td>
<td>Check settings: Dielectric Range Sensitivity View Echo Curve.</td>
</tr>
<tr>
<td>34</td>
<td>Low Echo Margin</td>
<td>Maintenance Required</td>
<td>Signal Margin is less than allowable minimum.</td>
<td>Check settings: Dielectric Range Sensitivity View Echo Curve.</td>
</tr>
<tr>
<td>35</td>
<td>High Surface Velocity</td>
<td>Maintenance Required</td>
<td>Measured Surface Velocity greater than Max Surface Velocity derived from configured Rate of Change.</td>
<td>Confirm actual rate of change. Adjust rate of change setting, if needed.</td>
</tr>
<tr>
<td>36</td>
<td>Spare Indicator 9</td>
<td>OK</td>
<td>Reserved for future use.</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Sequence Record</td>
<td>OK</td>
<td>A Sequence Record number has been stored in Event Log.</td>
<td>If desired, report Sequence Record number to factory.</td>
</tr>
</tbody>
</table>
3.4.5 Additional Diagnostic/Trouble Shooting Capabilities

3.4.5.1 Echo History Setup

The Model R86 contains the unique and powerful feature that allows waveforms to be automatically captured based on Diagnostic Events, Time or both. This menu contains those parameters that configure that feature.

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

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

3.4.5.2 Event History

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

3.4.5.3 Context-sensitive Help

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

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

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

3.4.5.4 Trend Data

Another feature of the Model R86 is the ability to log several measured values (selectable from any of the primary, secondary, or supplemental measured values) at a configurable rate (for example, once every five minutes) for a period ranging from several hours to a number of days (depending on the configured sample rate and number of values to be recorded). The data will be stored in non-volatile memory in the transmitter with date and time information for subsequent retrieval and visualization using the associated Model R86 DTM.

TREND DATA — A 15-minute trend of the PV can be displayed on the LCD.
3.5 Agency Approvals

These devices are in compliance with the RED-directive 2014/53/EU, the PED-directive 2014/68/EU, the ATEX directive 2014/34/EU and RoHS directive 2011/65/EU.

**Explosion Proof**

**US/Canada:**
- FM17US0108X / FM17CA0055X
- Class I, Div 1, Group B, C, D, T4...T1
- Class I, Zone 0/1 AEx/Ex ia/IIB + H2 T4...T1 Ga/Gb
- Class I, Zone 1 AEx/Ex db ia/IIB + H2 T4...T3 Ga
  - Ta = -40 °C to +70 °C
  - Type 4X, IP67

**Flame Proof**

**ATEX – FM17ATEX0027X:**
- II 1/2 G Ex ia/db IIB + H2 T4...T1 Ga/Gb
- II 2 G Ex db ia/IIB + H2 T4...T3 Ga
  - Ta = -40 °C to +70 °C
  - IP67

**IEC – IECEx FMG 17.0012X:**
- Ex ia/db IIB + H2 T4...T1 Ga/Gb
- Ex db IIB + H2 T4...T3 Ga
  - Ta = -40 °C to +70 °C
  - IP67

**Intrinsically Safe**

**US/Canada:**
- FM17US0108X / FM17CA0055X
- Class I, II, III, Div 1, Group A, B, C, D, E, F, G, T4...T1
- Class I, Zone 0 AEx ia/IIC T4...T1
- Class I, Zone 0 Ex ia IIC T4...T1 Ga
  - Ta = -40 °C to +70 °C
  - Type 4X, IP67

**ATEX – FM17ATEX0027X:**
- II 1 G Ex ia IIC T4...T1 Ga
  - Ta = -40 °C to +70 °C
  - IP67

**IEC – IECEx FMG 17.0012X:**
- Ex ia IIC T4...T1 Ga
  - Ta = -40 °C to +70 °C
  - IP67

**Non-Incendive**

**US/Canada:**
- FM17US0108X / FM17CA0055X
- Class I, II, III, Div 2, Group A, B, C, D, E, F, G, T4...T1
- Class I, Zone 2 AEx na IIC T4...T1
- Class I, Zone 2 Ex na IIC T4...T1
  - Ta = -15 °C to +70 °C
  - Type 4X, IP67

**ATEX – FM17ATEX0028X:**
- II 3 G Ex na IIC Gc T4...T1
  - Ta = -15 °C to +70 °C
  - IP67

**IEC – IECEx FMG 17.0012X:**
- Ex na IIC Gc T4...T1
  - Ta = -15 °C to +70 °C
  - IP67

**Dust Ignition Proof**

**US/Canada:**
- FM17US0108X / FM17CA0055X
- Class II, III, Div 1, Group E, F and G, T4...T1
- Ta = -15 °C to +70 °C
- Type 4X, IP67

**ATEX – FM17ATEX0027X:**
- II 2 D Ex ia tb IIIC T100 °C Db
  - Ta = -15 °C to +70 °C
  - IP67

**IEC – IECEx FMG 17.0012X:**
- Ex ia tb IIIC T100 °C Db
  - Ta = -15 °C to +70 °C
  - IP67

**Telecommunications Approvals**

<table>
<thead>
<tr>
<th>Agency</th>
<th>In-Tank</th>
<th>Out of Tank</th>
</tr>
</thead>
<tbody>
<tr>
<td>ISED</td>
<td>RSS-211</td>
<td>RSS-211</td>
</tr>
<tr>
<td>ETSI</td>
<td>EN 302 372 V2.1.1 (2016-12)</td>
<td>EN 302 729 V2.1.1 (2016-12)</td>
</tr>
</tbody>
</table>

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

1. The enclosure contains aluminum and is considered to present a potential risk of ignition by impact or friction. Care must be taken during installation and use to prevent impact or friction.

2. Provisions shall be made to provide transient overvoltage protection to a level not to exceed 119 VDC.

3. To maintain the T4 temperature code, care shall be taken to ensure the ‘enclosure temperature’ does not exceed 70 °C.

4. For installation with ambient temperature of 60 °C, refer to manufacturer’s instructions for guidance on proper selection of conductors.

5. The risk of electrostatic discharge shall be minimized at installation, following the direction given in this instruction manual.

6. The Pulsar R86 includes flamepath joints. Consult Magnatrol if repair of flamepath joints is necessary.

7. Temperature class for the process temperature ranges is defined by the following table when digit 10 (seal option) is "N".

<table>
<thead>
<tr>
<th>Process Temperature Range</th>
<th>Temperature Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 0 °C to 130 °C</td>
<td>T4</td>
</tr>
<tr>
<td>From 130 °C to 195 °C</td>
<td>T3</td>
</tr>
<tr>
<td>From 195 °C to 295 °C</td>
<td>T2</td>
</tr>
<tr>
<td>From 295 °C to 400 °C</td>
<td>T1</td>
</tr>
</tbody>
</table>

8. Temperature class for the process temperature ranges is defined by the following table when digit 10 (seal option) is "0".

<table>
<thead>
<tr>
<th>Process Temperature Range</th>
<th>Temperature Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 0 °C to 130 °C</td>
<td>T4</td>
</tr>
<tr>
<td>From 130 °C to 180 °C</td>
<td>T3</td>
</tr>
</tbody>
</table>

Process temperature ranges for seal options is defined by the following table

<table>
<thead>
<tr>
<th>Seal option</th>
<th>Process Temperature Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>10th digit = 0</td>
<td>-40 °C to +180 °C</td>
</tr>
<tr>
<td>10th digit = N</td>
<td>-40 °C to +400 °C</td>
</tr>
</tbody>
</table>

9. Temperature class for the process temperature ranges is defined by the following table when digit 10 (seal option) is "2", "8" or "A".

<table>
<thead>
<tr>
<th>Process Temperature Range</th>
<th>Temperature Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>From 0 to 130 °C</td>
<td>T4</td>
</tr>
<tr>
<td>From 130 to 195 °C</td>
<td>T3</td>
</tr>
<tr>
<td>From 195 to 295 °C</td>
<td>T2</td>
</tr>
</tbody>
</table>

The seal for option "2", "8" or "A" is limited for use where process temperature range is from -7 °C to +200 °C.

FCC (ID# LPN-R86) Compliance Statement:

§15.209    The 1 1/2" and 2" horns can only be used for installations directly into tanks.

§15.105   Information to the user.

(b) For a Class B digital device or peripheral, the instructions furnished the user shall include the following or similar statement, placed in a prominent location in the text of the manual:

Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

—Reorient or relocate the receiving antenna.
—Increase the separation between the equipment and receiver.
—Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
—Consult the dealer or an experienced radio/TV technician for help.

(i) The installation of the LPR/TLPR device shall be done by trained installers, in strict compliance with the manufacturer’s instructions.

(ii) The use of this device is on a “no-interference, no-protection” basis. That is, the user shall accept operations of high-powered radar in the same frequency band which may interfere with or damage this device. However, devices found to interfere with primary licensing operations will be required to be removed at the user’s expense.

ISED Certification Number 2331A–R86 Statement:

This device shall be installed and operated in a completely enclosed container to prevent RF emissions, which can otherwise interfere with aeronautical navigation.

This device complies with Industry Canada’s licence-exempt RSSs. Operation is subject to the following two conditions:

(1) This device may not cause interference; and
(2) This device must accept any interference, including interference that may cause undesired operation of the device.
### 3.5.1 Agency Drawing and Entity Parameters

**HAZARDOUS LOCATION**

**PULSAR R86 LEVEL TRANSMITTER**

**INTRINSICALLY SAFE FOR:**
- **Cl, III** DIV 1, GRP A, B, C, D, E, F, G
- **Cl, I, Zone 0, AEx ia IIC**
- **Cl, I, Zone 0, Ex ia IIC**
- **II G, Ex ia IIC**
- **Ex ia IIC**

**ENTITY**

- **UH** (Vmax) = 28.6 V
- **Ii** (Imax) = 140 mA
- **Pi** = 1 W
- **Ci** = 4.44 µF
- **Li** = 2.7 µH

**SEE NOTE 1**

**TRANSmitter INSTRUMENT**

**NON-HAZARDOUS LOCATION**

**LIMITING VALUES**

- **Voc** = 28.6 V
- **Isc** = 140 mA
- **La** = 2.7 µH
- **Ca** = 4.44 µF

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

**SPECIAL CONDITIONS OF USE:**

1. THE ENCLOSURE CONTAINS ALUMINUM AND IS CONSIDERED TO PRESENT A POTENTIAL RISK OF IGNITION BY IMPACT OR FRICTION. CARE MUST BE TAKEN DURING INSTALLATION AND USE TO PREVENT IMPACT OR FRICTION.
2. PROVISIONS SHALL BE MADE TO PROVIDE TRANSIENT OVERVOLTAGE PROTECTION TO A LEVEL NOT TO EXCEED 119 VDC.
3. TO MAINTAIN THE T4 TEMPERATURE CODE CARE SHALL BE TAKEN TO ENSURE THE "ENCLOSURE TEMPERATURE" DOES NOT EXCEED 70°C.
4. FOR INSTALLATION WITH AMBIENT TEMPERATURE OF 60°C, REFER TO THE MANUFACTURER'S INSTRUCTIONS FOR GUIDANCE ON PROPER SELECTION OF CONDUCTORS.
5. THE RISK OF ELECTROSTATIC DISCHARGE SHALL BE MINIMIZED AT INSTALLATION, FOLLOWING THE DIRECTION GIVEN IN THE INSTRUCTION MANUAL.
6. THE PULSAR R86 INCLUDES FLAMPATH JOINTS, CONSULT MAGNETROL IF REPAIR OF FLAMPATH JOINTS IS NECESSARY.
7. TEMPERATURE CLASS FOR THE PROCESS TEMPERATURE RANGES IS DEFINED BY THE FOLLOWING TABLE.

### PROCESS TEMPERATURE RANGE | TEMPERATURE CODE
--- | ---
From 0°C TO 130°C | T4
From 130°C TO 190°C | T3
From 195°C TO 295°C | T2
From 295°C TO 400°C | T1

**NOTES:**

1. FOR EXPLOSION PROOF INSTALLATIONS THE I.S. GROUND TERMINAL SHALL BE CONNECTED TO APPROPRIATE INTRINSICALLY SAFE GROUND IN ACCORDANCE WITH THE CANADIAN ELECTRICAL CODE (CEC) OR THE NATIONAL ELECTRICAL CODE (NEC). FOR INTRINSICALLY SAFE INSTALLATIONS THE I.S. GROUND TERMINAL DOES NOT REQUIRE GROUNDING.
2. MANUFACTURER'S INSTALLATION INSTRUCTIONS SUPPLIED WITH THE PROTECTIVE BARRIER AND THE IEC OR THE NEC MUST BE FOLLOWED WHEN INSTALLING THIS EQUIPMENT. BARRIER MUST BE CERTIFIED FOR CANADIAN & U.S. INSTALLATION.
3. CONTROL EQUIPMENT CONNECTED TO PROTECTIVE BARRIERS MUST NOT USE OR GENERATE MORE THAN 250 VDC OR VRMS.
4. AGENCY APPROVED DUST TIGHT SEALS MUST BE USED WHEN TRANSMITTER IS INSTALLED IN CLASS II & III ENVIRONMENTS.
5. FOR SUPPLY CONNECTIONS, USE WIRE SUITABLE FOR THE OPERATING TEMPERATURE.
6. FM APPROVED BARRIERS WITH LINEAR OUTPUT CHARACTERISTICS MUST BE USED.
3.5.1 Agency Drawing and Entity Parameters

SPECIAL CONDITIONS OF USE:

1. THE ENCLOSURE CONTAINS ALUMINUM AND IS CONSIDERED TO PRESENT A POTENTIAL RISK OF IGNITION BY IMPACT OR FRICTION. CARE MUST BE TAKEN DURING INSTALLATION AND USE TO PREVENT IMPACT OR FRICTION.

2. PROVISIONS SHALL BE MADE TO PROVIDE TRANSIENT OVERVOLTAGE PROTECTION TO A LEVEL NOT TO EXCEED 115VAC.

3. TO MAINTAIN THE TA TEMPERATURE CODE, CARE SHALL BE TAKEN TO ENSURE THE ENCLOSURE TEMPERATURE DOES NOT EXCEED 70°C.

4. FOR INSTALLATION WITH AMBIENT TEMPERATURE OF 60°C, REFER TO THE MANUFACTURER’S INSTRUCTIONS FOR GUIDANCE ON PROPER SELECTION OF CONDUCTORS.

5. THE RISK OF ELECTROSTATIC DISCHARGE SHALL BE MINIMIZED AT INSTALLATION, FOLLOWING THE DIRECTION GIVEN IN THE INSTRUCTION MANUAL.

6. THE PULSAR RB INCLUDES FLAMEPATH JOINTS, CONSULT MAGNETROL IF REPAIR OF FLAMEPATH JOINTS IS NECESSARY.

7. TEMPERATURE CLASS FOR THE PROCESS TEMPERATURE RANGES IS DEFINED BY THE FOLLOWING TABLE WHEN SEAL OPTION IS "K":

<table>
<thead>
<tr>
<th>PROCESS TEMPERATURE RANGE</th>
<th>TEMPERATURE CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM 0°C TO 130°C</td>
<td>T4</td>
</tr>
<tr>
<td>FROM 130°C TO 150°C</td>
<td>T3</td>
</tr>
<tr>
<td>FROM 150°C TO 250°C</td>
<td>T2</td>
</tr>
<tr>
<td>FROM 250°C TO 450°C</td>
<td>T1</td>
</tr>
</tbody>
</table>

8. TEMPERATURE CLASS FOR THE PROCESS TEMPERATURE RANGE IS DEFINED BY THE FOLLOWING TABLE WHEN SEAL OPTION IS "D":

<table>
<thead>
<tr>
<th>PROCESS TEMPERATURE RANGE</th>
<th>TEMPERATURE CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM 0°C TO 130°C</td>
<td>T4</td>
</tr>
<tr>
<td>FROM 130°C TO 150°C</td>
<td>T3</td>
</tr>
<tr>
<td>FROM 150°C TO 250°C</td>
<td>T2</td>
</tr>
</tbody>
</table>

9. TEMPERATURE CLASS FOR THE PROCESS TEMPERATURE RANGE IS DEFINED BY THE FOLLOWING TABLE WHEN SEAL OPTION IS "H":

<table>
<thead>
<tr>
<th>PROCESS TEMPERATURE RANGE</th>
<th>TEMPERATURE CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM 0°C TO 130°C</td>
<td>T4</td>
</tr>
<tr>
<td>FROM 130°C TO 150°C</td>
<td>T3</td>
</tr>
<tr>
<td>FROM 150°C TO 250°C</td>
<td>T2</td>
</tr>
</tbody>
</table>

10. PROCESS TEMPERATURE RANGE FOR THE SEAL OPTIONS IS DEFINED BY THE FOLLOWING TABLE (DO NOT HIGHLIGHT THE TABLE):

<table>
<thead>
<tr>
<th>SEAL OPTION</th>
<th>PROCESS TEMPERATURE RANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>B</td>
<td>-40°C TO -86°C</td>
</tr>
<tr>
<td>N</td>
<td>-40°C TO 450°C</td>
</tr>
<tr>
<td>H</td>
<td>-1°C TO 206°C</td>
</tr>
</tbody>
</table>

NOTES:

11. AGENCY APPROVED DURANT SET SEALS MUST BE USED WHEN TRANSMITTER IS INSTALLED IN CLASS I & II ENVIRONMENTS.

12. FOR SUPPLY CONNECTIONS, USE WIRE SUITABLE FOR THE OPERATING TEMPERATURE.

13. TOP WIRING COMPARTMENT HAS EXPLOSION PROOF APPROVAL. BOTTOM COMPARTMENT IS INTRINSICALLY SAFE ONLY.

14. POWER SUPPLY CONTROL EQUIPMENT CONNECTED TO THE PULSAR RB MUST NOT USE OR GENERATE MORE THAN 36VAC.
3.5.1 Agency Drawing and Entity Parameters

HAZARDOUS LOCATION
PULSAR R86-LEVEL TRANSMITTER
EXPLOSION PROOF FOR:
DI. 3G1 C6 P2R 5, C3, C4
G1, ZONE 1 A1/51
ZONE 1A1 R1 B1
ZONE 3

ENTITY
Un = 35V/3E

SPECIAL CONDITIONS OF USE:
1. THE ENCLOSURE CONTAINS ALUMINUM AND IS CONSIDERED TO PRESENT A POTENTIAL RISK OF IGNITION BY IMPACT OR FRICTION. CARE MUST BE TAKEN DURING INSTALLATION AND USE TO PREVENT IMPACT OR FRICTION.
2. PROVISIONS SHALL BE MADE TO PROVIDE TRANSIENT OVERVOLTAGE PROTECTION TO A LEVEL NOT TO EXCEED 115VDC.
3. TO MAINTAIN THE T4 TEMPERATURE CODE CARE SHALL BE TAKEN TO ENSURE THE "ENCLOSURE TEMPERATURE" DOES NOT EXCEED 70°C.
4. FOR INSTALLATION WITH AMBIENT TEMPERATURE OF 40°C, REFER TO THE MANUFACTURER'S INSTRUCTIONS FOR GUIDANCE ON PROPER SELECTION OF CONDUCTORS.
5. THE RISK OF ELECTROSTATIC DISCHARGE SHALL BE MINIMIZED AT INSTALLATION. FOLLOWING THE DIRECTION GIVEN IN THE INSTRUCTION MANUAL.
6. THE PULSAR R86 INCLUDES FLAMEPATH JOINTS, CONSULT MANUFACTURER IF REPAIR OF FLAMEPATH JOINTS IS NECESSARY.
7. TEMPERATURE CLASS FOR THE PROCESS TEMPERATURE RANGES IS DEFINED BY THE FOLLOWING TABLE.

<table>
<thead>
<tr>
<th>PROCESS TEMPERATURE RANGE</th>
<th>TEMPERATURE CODE</th>
</tr>
</thead>
<tbody>
<tr>
<td>FROM 0°C TO 130°C</td>
<td>T4</td>
</tr>
<tr>
<td>FROM 130°C TO 180°C</td>
<td>T3</td>
</tr>
</tbody>
</table>

8. THE SEAL ZONE LIMITS USE WHERE PROCESS TEMPERATURE IS -7 TO +250°C.

NOTES:
9. AGENCY APPROVED DUST TIGHT SEALS MUST BE USED WHEN TRANSMITTER IS INSTALLED IN CLASS I & II ENVIRONMENTS.
10. FOR SUPPLY CONNECTIONS, USE WIRE SUITABLE FOR THE OPERATING TEMPERATURE.
11. TOP WINDING COMPARTMENT HAS EXPLOSION-PROOF APPROVAL. BOTTOM COMPARTMENT IS INTRINSICALLY SAFE ONLY.
12. POWER SUPPLY/CONTROL EQUIPMENT CONNECTED TO THE PULSAR R86 MUST NOT USE OR GENERATE MORE THAN 36VDC.

AGENCY LISTED DRAWING
ALL REVIEWS TO THIS DRAWING REQUIRE QA APPROVAL

099-5077-001-G

SHEET 5 OF 7

AGENCY LISTED DRAWING
ALL REVIEWS TO THIS DRAWING REQUIRE QA APPROVAL

099-5077-001-G

SHEET 6 OF 7
3.5.1 Agency Drawing and Entity Parameters

HAZARDOUS (CLASSIFIED) LOCATION
CI 1 DIV 1 GRP B, C, D
CI 1 ZONE 0/1 AEx ia/id ib+H2
CI 1 ZONE 0/1 Ex ia/id ib+H2
II 11, 11 DIV 1 GRP E, F, G
II 1/2 G Ex ia/id ib+H2
II 2 D Ex ia ib III
Ex ia/id ib+H2
Ex ia tb III/C

UNCLASSIFIED LOCATION

Pulsar Level Transmitter
Pulsar R86-52XX-1XX FISCO FIELD DEVICE

Ui (Vmax) = 17.5V
Ii (Imax) = 380 mA
Pi = 5.52 W
C = 440pF
Li = 2.7μH
Leakage current < 50μA

Pulsar Level Transmitter
Pulsar R86-52XX-1XX FISCO FIELD DEVICE

Ui (Vmax) = 17.5V
Ii (Imax) = 380 mA
Pi = 5.52 W
C = 440pF
Li = 2.7μH
Leakage current < 50μA

Any FM/CSA Approved
Intrinsically Safe
Associated Apparatus with
Parameters suitable for the
FISCO Concept.

APPROVED TERMINATOR

Ui (Vmax) = 24V
Ii (Imax) = 20mA
Pi = 1.93W

or

Any approved termination on with
R = 90...100Ω
C = 0...2.2μF

The Pulsar Level Transmitter;
Pulsar R86-52XX-1XX is suitable for use in a FISCO system

FISCO Concept:
The FISCO concept allows interconnection of intrinsically safe apparatus to associated apparatus not specifically examined in such combination. The criteria for the interconnection is that the voltage (Ui or Vmax), the current (Ii or Imax) and the power (Pi) which intrinsically safe apparatus can receive and remain intrinsically safe, considering faults, must be equal or greater than the voltage (Lo or Voc or Vi), the current (Io or Iac or Ii) and the power (Po or Pi) levels which can be delivered by the associated apparatus, considering faults and applicable factors. In addition, the maximum unprotected capacitance (Ci) and (Li) of each apparatus (other than the termination) connected to the fieldbus must be less than or equal to 5nF and 10μH respectively.

In each segment only one active device, normally the associated apparatus, is allowed to provide the necessary energy for the fieldbus system. The voltage (Lo or Voc or Vi), of the associated apparatus has to be limited to the range of 14V to 24V d.c. All other equipment connected to the bus cable has to be passive, meaning that they are not allowed to provide energy to the system, except to a leakage current of 50μA for each connected device. Separately powered equipment needs a galvanic isolation to assure that the intrinsically safe fieldbus circuit remains passive.

The cable used to interconnect the devices needs to have the parameters in the following range:

- Loop resistance R′:
  15...150Ω/km
- Inductance per unit length L′:
  0.4...1μH/km
- Capacitance per unit length C′:
  80...200nF/km

C = C′ line/line + 0.5 C′ line/screen, if both lines are floating or
C = C′ line/line + C′ line/screen, if screen is connected to one line.
- Length of splice < 1m (T-box must only contain terminal connections with no energy storage capability)
- Length of spur cable: < 30m
- Length of trunk cable: < 1km

At each end of the trunk cable an approved infallible termination with the following parameters is suitable:
- R = 90...100Ω and C = 0...2.2μF

The number of passive devices connected to the bus segment is not limited for I.S. reasons. If the above rules are followed, up to a total length of 1000m (sum of the length of the trunk cable and all spur cables), the insulation and capacitance of the cable will not impair the intrinsic safety of the installation.

Note:
FOR PROPER INSTALLATION REFERENCE ALL APPLICABLE NOTES FROM PAGE 2 - 099-5077-001

AGENCY LISTED DRAWING
ALL REVISIONS TO THIS DRAWING REQUIRE QA APPROVAL

099-5077-001-G

SHEET 7 OF 7
## 3.6 Specifications

### 3.6.1 Functional – Transmitter

<table>
<thead>
<tr>
<th><strong>System Design</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Measurement Principle</td>
<td>Pulse burst radar 26 GHz</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Input</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured Variable</td>
<td>Level, determined by the time-of-flight of radar pulse reflections</td>
</tr>
</tbody>
</table>
| Span | 0.2 to 40 m (0.5’ to 130’)

<table>
<thead>
<tr>
<th><strong>Output</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>4 to 20 mA with HART: 3.8 mA to 20.5 mA useable (per NAMUR NE43)</td>
</tr>
<tr>
<td>Resolution</td>
<td>Analog: .003 mA, Digital Display: 1 mm</td>
</tr>
<tr>
<td>Loop Resistance</td>
<td>GP/IS: 591 ohms @ 24 VDC and 22 mA, XP/Flameproof: 500 ohms @ 24 VDC and 22 mA</td>
</tr>
<tr>
<td>Diagnostic Alarm</td>
<td>Selectable: 3.6 mA, 22 mA (meets requirements of NAMUR NE 43), or HOLD last output</td>
</tr>
<tr>
<td>Diagnostic Indication</td>
<td>Meets requirements of NAMUR NE107</td>
</tr>
<tr>
<td>Damping</td>
<td>Adjustable 0-10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>User Interface</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Keypad</td>
<td>4-button menu-driven data entry</td>
</tr>
<tr>
<td>Display</td>
<td>Graphic Liquid Crystal Display</td>
</tr>
<tr>
<td>Digital Communication</td>
<td>HART Version 7—with Field Communicator, FOUNDATION Fieldbus™ AMS, or FDT DTM (PACTware™), EDDL</td>
</tr>
<tr>
<td>Menu Languages</td>
<td>Transmitter LCD: English, French, German, Spanish, Russian, Portuguese, Polish, HART DD: English, French, German, Spanish, Russian, Chinese, Portuguese, Polish</td>
</tr>
<tr>
<td>FOUNDATION Fieldbus™ Host System</td>
<td>English</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Voltage (Measured at instrument terminals)</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>HART: General Purpose (Weather proof)/Intrinsically Safe/Explosion-proof: 11 VDC minimum at terminals under certain conditions</td>
<td></td>
</tr>
<tr>
<td>FOUNDATION Fieldbus™ and PROFIBUS PA: 9 to 17.5 VDC</td>
<td></td>
</tr>
<tr>
<td>FISCO, FNICO, General Purpose (Weatherproof)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Housing</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Material</td>
<td>IP67/die-cast aluminum A413 (&lt;0.6% copper); optional stainless steel</td>
</tr>
<tr>
<td>Net/Gross Weight</td>
<td>Aluminum: 2.0 kg (4.5 lbs.), Stainless Steel: 4.5 kg (10.0 lbs.)</td>
</tr>
<tr>
<td>Overall Dimensions</td>
<td>See section 3.6.7</td>
</tr>
<tr>
<td>Cable Entry</td>
<td>1/2” NPT or M20</td>
</tr>
<tr>
<td>SIL 2 Hardware (Safety Integrity Level)</td>
<td>Safe Failure Fraction = 93.2 % (HART only)</td>
</tr>
<tr>
<td></td>
<td>Functional Safety to SIL 2 as 1oo1 in accordance with IEC 61508</td>
</tr>
<tr>
<td></td>
<td>(Full FMEDA report available upon request)</td>
</tr>
</tbody>
</table>
### 3.6 Specifications

#### 3.6.2 Functional – Environment

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating Temperature</td>
<td>General purpose: -40 °C to +80 °C (-40 °F to +175 °F); Agency approved: -40 °C to +70 °C (-40 °F to +160 °F); LCD viewable -20 °C to +70 °C (-5 °F to +160 °F)</td>
</tr>
<tr>
<td>Storage Temperature</td>
<td>-45 °C to +85 °C (-50 °F to +185 °F)</td>
</tr>
<tr>
<td>Humidity</td>
<td>0–99 %, non-condensing</td>
</tr>
<tr>
<td>Electromagnetic Compatibility</td>
<td>Meets CE requirement (EN 61326) and NAMUR NE 21</td>
</tr>
<tr>
<td>Surge Protection</td>
<td>Meets CE EN 61326 (1000V)</td>
</tr>
<tr>
<td>Shock/Vibration</td>
<td>ANSI/ISA-S71.03 Class SA1 (Shock); ANSI/ISA-S71.03 Class VC2 (Vibration)</td>
</tr>
<tr>
<td>Reference Conditions</td>
<td>Reflection from ideal reflector at +20 °C (+70 °F)</td>
</tr>
<tr>
<td>Linearity</td>
<td>±3 mm (0.1&quot;) or 0.1 % of tank height (whichever is greater)</td>
</tr>
<tr>
<td>Measured Error</td>
<td>±3 mm (0.1&quot;) or 0.1 % of tank height (whichever is greater) (Performance will degrade slightly within 1.5 m (60&quot;) of antenna)</td>
</tr>
<tr>
<td>Resolution</td>
<td>1 mm or 0.1&quot;</td>
</tr>
<tr>
<td>Repeatability</td>
<td>±3 mm (0.1&quot;) or 0.05 % of tank height (whichever is greater)</td>
</tr>
<tr>
<td>Response Time</td>
<td>&lt;2 seconds (configuration dependent)</td>
</tr>
<tr>
<td>Initialization Time</td>
<td>&lt; 30 seconds (configuration dependent)</td>
</tr>
<tr>
<td>Ambient Temperature Effect</td>
<td>Digital Average 3 mm (0.12&quot;) / 10 K, max of ±10 mm (0.4&quot;) over the entire temperature range -40 °C to +80 °C (-40 °F to +175 °F)</td>
</tr>
<tr>
<td></td>
<td>Analog Current Output (additional error with reference to 16 mA span)</td>
</tr>
<tr>
<td></td>
<td>Average 0.03 % / 10 K, max 0.45 % over entire temperature range -40 °C to +80 °C (-40 °F to +175 °F)</td>
</tr>
<tr>
<td>Maximum Rate of Change</td>
<td>450 cm (180&quot;)/minute</td>
</tr>
</tbody>
</table>

**FOUNDATION Fieldbus™:**

- **ITK Version:** 6.2.0
- **H1 Device Class:** Link Master (LAS)—selectable ON/OFF
- **H1 Profile Class:** 31PS, 32L
- **Function Blocks:** (8) AI, (3) Transducer, (1) Resource, (2) PID (1) Arithmetic, (1) Signal Characterizer, (1) Input Selector, (1) Integrator
- **Quiescent Current:** 17 mA
- **Execution Time:** 10 ms (15 ms PID Block)
- **Device Revision:** 01
- **DD Version:** 0x01

#### 3.6.2.1 Safe Operating Areas

![Digital Solar Mode](image1)

- **IS Safe Operating Area**
- **Typical HART 4-20 mA Operating Area**
- **R_{Loop}:** 591 Ω
- **V_{supply}:** 0 – 11 V, 16.25 V, 24 V, 36 V

![XP Safe Operating Area](image2)

- **XP Safe Operating Area**
- **Typical HART 4-20 mA Operating Area**
- **R_{Loop}:** 409 Ω
- **V_{supply}:** 0 – 15 V, 18.5 V, 24 V, 36 V
### Transmitter Terminal Voltage

<table>
<thead>
<tr>
<th>Operational Mode</th>
<th>Current Consumption</th>
<th>Vmin</th>
<th>Vmax</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HART</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Purpose</td>
<td>4mA 20mA</td>
<td>16.25V</td>
<td>36V</td>
</tr>
<tr>
<td>Intrinsically Safe</td>
<td>4mA 20mA</td>
<td>16.25V</td>
<td>28.6V</td>
</tr>
<tr>
<td>Explosion Proof</td>
<td>4mA 20mA</td>
<td>18.5V</td>
<td>36V</td>
</tr>
<tr>
<td><strong>Fixed Current-Solar Power Operation (PV transmitter via HART)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>General Purpose</td>
<td>10mA</td>
<td>11V</td>
<td>36V</td>
</tr>
<tr>
<td>Intrinsically Safe</td>
<td>10mA</td>
<td>11V</td>
<td>28.6V</td>
</tr>
<tr>
<td><strong>HART Multi-Drop Mode (Fixed Current)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td>4mA</td>
<td>16.25V</td>
<td>36V</td>
</tr>
<tr>
<td>Intrinsically Safe</td>
<td>4mA</td>
<td>16.25V</td>
<td>28.6V</td>
</tr>
<tr>
<td><strong>FOUNDATION Fieldbus™</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply Voltage</td>
<td>9V to 17.5V</td>
<td>9V to 17.5V</td>
<td>9V to 17.5V</td>
</tr>
</tbody>
</table>

① Start-up current 12 mA minimum

### O-ring (seal) Selection Chart

<table>
<thead>
<tr>
<th>Material</th>
<th>Code</th>
<th>Maximum Temperature</th>
<th>Maximum Pressure</th>
<th>Min. Temp.</th>
<th>Recommended For Use In</th>
<th>Not Recommended For Use In</th>
</tr>
</thead>
<tbody>
<tr>
<td>Viton® VX065</td>
<td>0</td>
<td>+200 °C @ 16 bar (+400 °F @ 232 psi)</td>
<td>51.7 bar @ +20 °C (750 psi @ +70 °F)</td>
<td>-40 °C</td>
<td>General purpose, ethylene</td>
<td>Ketones (MEK, acetone), skydrol fluids, amines, anhydrous ammonia, low molecular weight esters and ethers, hot hydrofluoric or chlorosulfuric acids, sour HCs</td>
</tr>
<tr>
<td>Kalrez® 4079</td>
<td>2</td>
<td>+200 °C @ 16 bar (+400 °F @ 232 psi)</td>
<td>51.7 bar @ +20 °C (750 psi @ +70 °F)</td>
<td>-40 °C</td>
<td>Inorganic and organic acids (including HF and nitric), aldehydes, ethylene, glycols, organic oils, silicone oils, vinegar, sour HCs</td>
<td>Black liquor, hot water/steam, hot aliphatic amines, ethylene oxide, propylene oxide, molten sodium, molten potassium</td>
</tr>
<tr>
<td>Simriz SZ485 (formerly Aegis PF128)</td>
<td>8</td>
<td>+200 °C @ 16 bar (+400 °F @ 232 psi)</td>
<td>51.7 bar @ +20 °C (750 psi @ +70 °F)</td>
<td>-20 °C</td>
<td>Inorganic and organic acids (including HF and nitric), aldehydes, ethylene, glycols, organic oils, silicone oils, vinegar, sour HCs, steam, amines, ethylene oxide, propylene oxide, NACE applications</td>
<td>Black liquor, Freon 43, Freon 75, Galden, KEL-F liquid, molten sodium, molten potassium</td>
</tr>
<tr>
<td>Kalrez® 6375</td>
<td>A</td>
<td>+200 °C @ 16 bar (+400 °F @ 232 psi)</td>
<td>51.7 bar @ +20 °C (750 psi @ +70 °F)</td>
<td>-40 °C</td>
<td>Inorganic and organic acids (including hydro fluids and nitric), aldehydes, ethylene, organic oils, glycols, silicone oils, vinegar, sour HCs</td>
<td>Hot water/steam, hot aliphatic amines, ethylene oxide, propylene oxide</td>
</tr>
<tr>
<td>Quartz</td>
<td>N</td>
<td>+400 °C @ 94.8 bar (+750 °F @ 1375 psi)</td>
<td>160 bar @ +20 °C (2320 psi @ +70 °F)</td>
<td>-70 °C</td>
<td>General high temperature/high pressure applications, hydrocarbons, full vacuum (hermetic), ammonia, chlorine</td>
<td>Hot alkaline solutions HF acid, media with pH&lt;12, direct exposure to saturated steam</td>
</tr>
</tbody>
</table>

② +180 °C (+350 °F) for options with hazardous locations approvals.
③ Maximum +150 °C (+300 °F) for use on steam.
3.6.4 Functional – Antenna

Antenna Material 316 SS, Hastelloy C, Polypropylene or PTFE
Process Seal Material PEEK, PTFE with O-rings or Alumina
Maximum Process Temperature +400 °C @ 94.8 bar (+750 °F @ 1375 psi)
Maximum Process Pressure -1.0 to 160 bar @ +20 °C (-14.7 to 2320 psi @ +70 °F)
Vacuum Service Hermeticity to <5 x 10^-7 cc/sec helium
Minimum Dielectric (application dependent) 1.7 (1.4 with stillwells)

3.6.5 Antenna Pressure / Temperature Ratings

<table>
<thead>
<tr>
<th>Model R86 T-codes</th>
<th>No Temperature Extension</th>
<th>With Temperature Extension Part No. 032-6922-001</th>
</tr>
</thead>
<tbody>
<tr>
<td>+70 °C</td>
<td>+70 °C</td>
<td>T4</td>
</tr>
<tr>
<td>+135 °C</td>
<td>+42 °C</td>
<td>—</td>
</tr>
<tr>
<td>+70 °C</td>
<td>+70 °C</td>
<td>—</td>
</tr>
<tr>
<td>+135 °C</td>
<td>+42 °C</td>
<td>—</td>
</tr>
</tbody>
</table>

3.6.6 Operating Temperature Range

Safe Operating Regions
A: Standard PTFE Seal  C: HTHP Alumina Seal
B: Standard PTFE Seal with Extension (P/N 032-6922-001)  D: HTHP Alumina Seal with Extension (P/N 032-6922-001)
3.6.7 Physical – mm (inches)

**TRANSMITTER**

**POLYPROPYLENE AND PTFE FACED-FLANGE ANTENNA**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>Process Connection</th>
<th>Horn Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>3th Digit</td>
<td>1 1/2”</td>
<td>2”</td>
</tr>
<tr>
<td><strong>Dim. A</strong></td>
<td>Encapsulated Polypropylene Horn</td>
<td></td>
</tr>
<tr>
<td>1 1/2” NPT</td>
<td>—</td>
<td>100 (3.94)</td>
</tr>
<tr>
<td>2” 150#</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>3” 150#</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>4” 150#</td>
<td>—</td>
<td>—</td>
</tr>
</tbody>
</table>

| **Dim. A**   | Faced Flange PTFE Horn |
| 2” 150#      | — | 100 (3.94) | — |
| 3” 150#      | — | — | 119 (4.69) |

**HORN ANTENNA**

<table>
<thead>
<tr>
<th>Model Number</th>
<th>3rd Digit (Horn Size)</th>
</tr>
</thead>
<tbody>
<tr>
<td>11th Digit (Extension)</td>
<td>1 (1 1/2”)</td>
</tr>
<tr>
<td><strong>Dim. H</strong></td>
<td>0 (None)</td>
</tr>
<tr>
<td>1 (4”)</td>
<td>152 (6)</td>
</tr>
<tr>
<td>2 (8”)</td>
<td>203 (8)</td>
</tr>
<tr>
<td>3 (12”)</td>
<td>305 (12)</td>
</tr>
<tr>
<td>4 (24”)</td>
<td>610 (24)</td>
</tr>
<tr>
<td>5 (48”)</td>
<td>1219 (48)</td>
</tr>
<tr>
<td>6 (72”)</td>
<td>1829 (72)</td>
</tr>
<tr>
<td><strong>Dim. L</strong></td>
<td>40 (1.56)</td>
</tr>
<tr>
<td><strong>Dim. D</strong></td>
<td>—</td>
</tr>
</tbody>
</table>
### 3.7 Parts

#### 3.7.1 Replacement Parts

All replacement parts are for standard models only. Consult factory for replacement parts on modified units (model number preceded by an X).

**EXPEDITE SHIP PLAN (ESP)**

Several parts are available for quick shipment, within max. 1 week after factory receipt of purchase order, through the Expedite Ship Plan (ESP). Parts covered by ESP service are conveniently grey coded in the selection tables.

Consult factory to obtain the correct replacement part numbers for items not listed in the tables below.

#### Table 1: (1) Electronic module

<table>
<thead>
<tr>
<th>Digit 5</th>
<th>Digit 6</th>
<th>Replacement part</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1, B</td>
<td>Z31-2864-001</td>
</tr>
<tr>
<td>2</td>
<td>0, A</td>
<td>Z31-2864-002</td>
</tr>
<tr>
<td>3</td>
<td>0, A</td>
<td>Z31-2873-001</td>
</tr>
</tbody>
</table>

#### Table 2: (2) Display module

<table>
<thead>
<tr>
<th>Digit 7</th>
<th>Replacement part</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>not applicable</td>
</tr>
<tr>
<td>A</td>
<td>Z31-2850-001</td>
</tr>
</tbody>
</table>

#### Table 3: (3) Display “O”-ring

<table>
<thead>
<tr>
<th>Digit 7</th>
<th>Replacement part</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>not applicable</td>
</tr>
<tr>
<td>A</td>
<td>012-2016-001</td>
</tr>
</tbody>
</table>

#### Table 4: (4) Wiring PC board

<table>
<thead>
<tr>
<th>Digit 5</th>
<th>Digit 6</th>
<th>Digit 8</th>
<th>Replacement part</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1, B</td>
<td>0, 1, A, D</td>
<td>Z30-9180-001</td>
</tr>
<tr>
<td>2</td>
<td>0, 1, A, D</td>
<td>Z31-2865-001</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>C</td>
<td>Z30-9180-002</td>
<td></td>
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</tbody>
</table>

#### Table 5: (7) Housing cover

<table>
<thead>
<tr>
<th>Digit 7</th>
<th>Digit 9</th>
<th>Replacement part</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>004-9225-002</td>
</tr>
<tr>
<td>2</td>
<td>004-9225-003</td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>036-4413-013</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>036-4413-016</td>
<td></td>
</tr>
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</table>

#### Table 6: (8) Temperature extension

<table>
<thead>
<tr>
<th>Digit 9</th>
<th>Replacement part</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>004-9225-002</td>
</tr>
<tr>
<td>2</td>
<td>004-9225-003</td>
</tr>
</tbody>
</table>

Digit in partn*: \[1\ 2\ 3\ 4\ 5\ 6\ 7\ 8\ 9\ 10\]

Electronics:

<table>
<thead>
<tr>
<th>Partn*:</th>
<th>Digit 5</th>
<th>Digit 6</th>
<th>Digit 7</th>
<th>Digit 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>R6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Serial n°:

See nameplate, always provide complete part number and serial number when ordering spares.
## 3.8 Model Numbers

### 3.8.1 PULSAR Model R86 Radar Transmitter

<table>
<thead>
<tr>
<th>1–3</th>
<th>MEASUREMENT SYSTEM</th>
</tr>
</thead>
<tbody>
<tr>
<td>R 8 6</td>
<td>Through-Air Radar Level Transmitter - 26 GHz Pulse Burst Radar</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>4</th>
<th>POWER</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>24 VDC, Two Wire</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5</th>
<th>SIGNAL OUTPUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4-20 mA with HART</td>
</tr>
<tr>
<td>2</td>
<td>FOUNDATION Fieldbus™ H1 (not available with 8th digit 3 or B)</td>
</tr>
<tr>
<td>3</td>
<td>PROFIBUS PA (not available with 8th digit 3 or B)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>6</th>
<th>SAFETY OPTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>None (FOUNDATION Fieldbus™ and PROFIBUS only, 5th digit = 2 or 3)</td>
</tr>
<tr>
<td>1</td>
<td>SIL 2 Hardware - HART only (5th digit = 1)</td>
</tr>
<tr>
<td>A</td>
<td>None (FOUNDATION Fieldbus™ and PROFIBUS only, 5th digit = 2 or 3) – ETSI ➀</td>
</tr>
<tr>
<td>B</td>
<td>SIL 2 Hardware - HART only (5th digit = 1) – ETSI ➀</td>
</tr>
</tbody>
</table>

➀ Must be used with 3-inch or 4-inch horn

<table>
<thead>
<tr>
<th>7</th>
<th>ACCESSORIES/MOUNTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Digital Display and Keypad - Integral</td>
</tr>
<tr>
<td>A</td>
<td>Digital Display and Keypad - Integral</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>8</th>
<th>CLASSIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>General Purpose, Weatherproof (IP 67)</td>
</tr>
<tr>
<td>1</td>
<td>Intrinsically Safe (FM &amp; CSA)</td>
</tr>
<tr>
<td>3</td>
<td>Explosion-proof (FM &amp; CSA)</td>
</tr>
<tr>
<td>A</td>
<td>Intrinsically Safe (ATEX/IEC)</td>
</tr>
<tr>
<td>B</td>
<td>Flame-proof (ATEX/IEC)</td>
</tr>
<tr>
<td>C</td>
<td>Non-sparking (ATEX)</td>
</tr>
<tr>
<td>D</td>
<td>Dust Ex (ATEX)</td>
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<table>
<thead>
<tr>
<th>9</th>
<th>HOUSING</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>Die-cast Aluminum, Dual Compartment, 20-degree</td>
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<tr>
<td>2</td>
<td>Investment Cast, 316ss, Dual Compartment, 20-degree</td>
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<table>
<thead>
<tr>
<th>10</th>
<th>CONDUIT CONNECTION</th>
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<tbody>
<tr>
<td>0</td>
<td>1/2&quot; NPT</td>
</tr>
<tr>
<td>1</td>
<td>M20</td>
</tr>
<tr>
<td>2</td>
<td>1/2&quot; NPT with sunshade</td>
</tr>
<tr>
<td>3</td>
<td>M20 with sunshade</td>
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</table>
### 3.8.2 PULSAR Model R86 Radar Antenna

#### TECHNOLOGY

<table>
<thead>
<tr>
<th>R B</th>
<th>PULSAR Radar Antennas - 26 GHz</th>
</tr>
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#### 3. CONFIGURATION/STYLE

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>1 1/2&quot; Horn</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2&quot; Horn</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3&quot; Horn</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4&quot; Horn</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>Encapsulated – Polypropylene (available only when 4th and 5th digits = 31, 43, 53, 63, 73, DA, EA, FA, GA)</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Faced Flange – PTFE Coated Wetted Surfaces (available only when 4th and 5th digits = 43, 53, DA, EA)</td>
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#### 4-5. PROCESS CONNECTION - SIZE/TYPE

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>31</td>
<td>1 1/2&quot; NPT thread</td>
<td>41</td>
</tr>
<tr>
<td>32</td>
<td>1 1/2&quot; BSP (G 1 1/2&quot;) thread</td>
<td>42</td>
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<table>
<thead>
<tr>
<th>ASME Flanges</th>
<th>EN Flanges</th>
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<tbody>
<tr>
<td>43</td>
<td>2&quot; 150# ASME raised face flange</td>
</tr>
<tr>
<td>44</td>
<td>2&quot; 300# ASME raised face flange</td>
</tr>
<tr>
<td>45</td>
<td>2&quot; 600# ASME raised face flange</td>
</tr>
<tr>
<td>53</td>
<td>3&quot; 150# ASME raised face flange</td>
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<tr>
<td>54</td>
<td>3&quot; 300# ASME raised face flange</td>
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<td>55</td>
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<tr>
<td>63</td>
<td>4&quot; 150# ASME raised face flange</td>
</tr>
<tr>
<td>64</td>
<td>4&quot; 300# ASME raised face flange</td>
</tr>
<tr>
<td>65</td>
<td>4&quot; 600# ASME raised face flange</td>
</tr>
<tr>
<td>73</td>
<td>6&quot; 150# ASME raised face flange</td>
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<td>74</td>
<td>6&quot; 300# ASME raised face flange</td>
</tr>
<tr>
<td>75</td>
<td>6&quot; 600# ASME raised face flange</td>
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#### 6. CONSTRUCTION CODES

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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>0</td>
<td>Industrial</td>
<td></td>
</tr>
<tr>
<td>K</td>
<td>ASME B31.1</td>
<td></td>
</tr>
<tr>
<td>L</td>
<td>ASME B31.3</td>
<td></td>
</tr>
<tr>
<td>M</td>
<td>ASME B31.3 &amp; NACE MR0175 / MR0103</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>NACE MR0175 / MR0103</td>
<td></td>
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#### 7. FLANGE OPTIONS

<p>| | | |</p>
<table>
<thead>
<tr>
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</tr>
</thead>
<tbody>
<tr>
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<td>None</td>
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BE 58-603 Pulsar® Model R86 Radar Transmitter
### 3.8.2 PULSAR Model R86 Radar Antenna

#### 8 MATERIAL OF CONSTRUCTION

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>316SS/316L SS</td>
</tr>
<tr>
<td>B</td>
<td>Hastelloy C</td>
</tr>
<tr>
<td>R</td>
<td>316SS/316L SS with Carbon Steel Flange</td>
</tr>
<tr>
<td>S</td>
<td>Hastelloy C with Carbon Steel Flange</td>
</tr>
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</table>

#### 9 FUTURE

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<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
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#### 10 O-RING MATERIALS/SEAL OPTIONS

<p>| | |</p>
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<thead>
<tr>
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<tbody>
<tr>
<td>0</td>
<td>Viton VX065</td>
</tr>
<tr>
<td>2</td>
<td>Kalrez 4079 (not suitable for ATEX/IEC flameproof Zone 0)</td>
</tr>
<tr>
<td>8</td>
<td>Simriz SZ485 (formerly Aegis PF128) — NACE</td>
</tr>
<tr>
<td>A</td>
<td>Kalrez 6375 (not suitable for ATEX/IEC flameproof Zone 0)</td>
</tr>
<tr>
<td>N</td>
<td>None - Alumina seal</td>
</tr>
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</table>

(1) Refer to pages 5 and 6 for temperature extension information

#### 11 ANTENNA EXTENSIONS

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<table>
<thead>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>1</td>
<td>For nozzle height ≤ 100 mm (4&quot;) - available only with antenna 3rd digit = 1</td>
</tr>
<tr>
<td>2</td>
<td>For nozzle height ≤ 200 mm (8&quot;) - not available with antenna 3rd digit = 3 or 4</td>
</tr>
<tr>
<td>3</td>
<td>For nozzle height ≤ 300 mm (12&quot;)</td>
</tr>
<tr>
<td>4</td>
<td>For nozzle height ≤ 600 mm (24&quot;)</td>
</tr>
<tr>
<td>5</td>
<td>For nozzle height ≤ 1200 mm (48&quot;)</td>
</tr>
<tr>
<td>6</td>
<td>For nozzle height ≤ 1800 mm (72&quot;)</td>
</tr>
</tbody>
</table>

#### 12 SPECIAL OPTIONS

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>0</td>
<td>None</td>
</tr>
<tr>
<td>1</td>
<td>1/8&quot; NPT Flushing Connection</td>
</tr>
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</table>

#### 13-15 FUTURE

<p>| | |</p>
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<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>000</td>
<td>None</td>
</tr>
</tbody>
</table>
4.0 Advanced Configuration/Troubleshooting Techniques

This section contains information regarding some of the advanced configuration and troubleshooting capability contained within the Model R86 transmitter. Some of these diagnostic options are best suited for use with PACTware and the Model R86 DTM, and should be implemented only after contacting Magnetrol Technical Support.

4.1 Echo Rejection

After choosing a proper mounting location, another way to ignore unwanted signals within the measuring range is by utilizing the Echo Rejection feature.

Setup using DTM/PACTware™
Select the Diagnostics tab and then the Echo Curve tab. After refreshing the waveform, click on the New Rejection Curve button.

![False Level vs Actual Level](image)

Press to Initiate Function
Click on NEXT at the loop warning message.

A password window will then appear. Click OK. The system calculates the curve, and then saves it. Click OK to confirm.
On the next screen, enter the actual location of the level to be measured. Press ENTER and then click on NEXT.

Press NEXT to confirm.
The Live Curve and Rejection Curve will then be displayed as shown in the screenshot below.

A warning screen is shown that the loop can be returned to automatic control.
4.2 Custom Echo Rejection

INTRODUCTION

The Pulsar Model R86 has a very unique feature that allows for a user to modify a Standard Echo Rejection curve.

Custom Echo Rejection is a feature intended to allow a user to manually adjust the curve to account for undesirable waveform features (noise, disturbances, etc.) that may not have been captured by the initial Standard Echo Rejection curve.

For example, undesirable signals may occur if the original echo rejection curve was taken at a time when mixing blades were stopped in a particular location. If the blades then later stop in a different location, a false echo from the blade could then appear in the live echo curve. Custom Echo Rejection can then be used to modify the Standard Echo Rejection curve in order to ensure that all “false echoes” are cancelled out of the waveform.

The Custom Echo Rejection curve is offered in addition to the Standard Echo Rejection curve. Once a Custom Echo Rejection curve has been created, either curve is available for use by the user to reject unwanted echo echoes. The user has the ability to select which curve (or no curve) will be used for echo rejection.

Since the local display does not have the ability to concurrently display the live and rejection echo curves, the manipulation of the echo rejection curve will be done in the DD and DTM only. The ability to view the two curves graphed together is essential in determining how the rejection curve should be modified to provide the desired outcome.

When the Custom Echo Rejection curve is selected for use, the “New Rejection Curve” button will change to “Modify Rejection Curve”. Clicking on this button will guide a user through:

• modifying an existing echo in the custom curve
• copying an echo from the live curve to the custom rejection curve
• resetting a Custom Echo Rejection curve back to the original form from which it was taken (Standard Echo Rejection curve).

OPERATION

BEFORE STARTING: Note that changes to certain parameters cause the Echo Rejection profile to become invalid. Those parameter changes will invalidate both the Standard and the Custom rejection curves simultaneously, regardless of which echo rejection curve option is selected at the time. For example, making any changes to Gain parameters (Dielectric, Turbulence, Foam and Sensitivity) or Tank Height parameter will invalidate all Echo Rejection Curves whether Standard or Custom.
The Custom Echo Rejection curve can be modified in three ways:

1. Modify existing Echo

Changing the amplitude or width of an existing echo in the Custom Rejection Curve is the most typical use of this method. For example, it can be used to account for the variations in mixing blade operation. If mixing blades are stopped when the initial curve was created, the next time the blades stop they may be in a slightly different position. The new blade position can result in a slightly different position of its echo. Echoes from the blade will appear in the echo curve as slightly shifted to the left or right compared to the echo in the original curve. The amplitude may also be somewhat different. In that case, expanding the width of the existing echo, or changing its amplitude would create an echo rejection curve that encompasses both the original echo and the new echo locations.

2. Add an Echo

This is used to copy an echo from the live curve to the Custom Rejection Curve. This would be done in the event that a new echo was found in the live curve after the initial echo rejection curve had been saved.

NOTE: In the case where the level at the time was higher in the tank, saving a new entire echo rejection curve would result in a lower portion of the rejection curve being lost. Therefore, it is beneficial in that circumstance to be able to add the echo to the existing custom curve so that the lower portion of the curve is retained.

3. Reset Custom Curve

If the need arises to eliminate changes made during any of the previous modification procedures, Reset Custom Curve is used to reset the Custom Rejection Curve back to its original values.

**PROCEDURES**

**Changing the widths and amplitude of an existing echo:**

Modifying an existing echo in the custom rejection echo curve consists of the user identifying the desired echo and defining the changes to be made to that echo. The user begins the Customize Rejection Curve method in the DTM at Diagnostics/Echo Curve.

1. Ensure a Standard Echo Rejection has been captured before continuing (Standard Echo Rejection will appear as red curve on graph)

   ![Image](image-url)

   - Change “Echo Rejection Type” from “Standard” to “Custom”
   - The “New Rejection Curve” button changes to “Modify Rejection Curve”; press button
Click on NEXT at the loop warning message.

A password window will then appear. Click OK.
Click OK.

Upon presentation of the Rejection echo list (including the echo amplitudes), along with a display of the present level, select the desired false echo to be modified. (The distance to the echo must be smaller than the distance to the level echo).
Revise left location and press ENTER. (Right location and/or strength can also be revised.)

Click OK.

New Rejected Area
4.3 Tank Profile

Introduction

Non-Contact radar transmitters are typically configured and commissioned with a static liquid level. Ideally, the installer will generate some level change after commissioning to verify proper operation, but rarely can one witness a complete fill and empty cycle of the vessel. Therefore, the transmitter configuration may not initially be optimized for the entire range of operation.

Although previous versions of Magnetrol transmitters contain troubleshooting options for recording and saving diagnostic information such as Data Log, Event History, and Echo History, none contains a way for the device to automatically capture pertinent information for an entire fill and empty cycle. As this complete cycle could take hours, days or even weeks to complete, having this information will confirm proper operation for a given configuration or can provide precious information about the transmitter performance at troublesome levels in the tank.

The information is stored in the transmitter, retrieved at a later time and evaluated by a qualified individual who will decide the next steps to take.

A few items to note:
1. The Tank Profile feature must be manually initiated. It is not an automatic feature.
2. The Tank Profile feature may be manually stopped at any time.
3. Before the feature starts capturing information, the transmitter configuration should be manually saved. This is not necessary for the operation of the feature but provides useful data for determining what configuration change may be warranted.
4. Although the ability to set up and run this feature will be available in all user interfaces (HART and FFLUI, DD and DTM), the results can only be graphically viewed in the corresponding DTM. For DD-based hosts, there is a DD method that will sequentially display the readings one level at a time.
5. The feature can be set to cover a smaller range than the entire tank. For example, some processes may only operate in a smaller range.
6. The increments can be set as a percentage of the Start/Stop range (Increment by %) or in Level/Distance units (Increment by Unit).
7. The information captured at each increment will be:
   a. Time
   b. Level
   c. Distance
d. Echo Strength
e. Echo Margin
f. Loop Current (HART only)
g. Target Threshold
h. Level Ticks
i. BCSM state
8. The saved minimum and maximum Echo Strength and Echo Margin readings can be viewed in a graph in the Tank Profile menu.
**SETUP**

The Tank Profile can be initiated in the DTM in the following manner:

1. Use SET CLOCK button to ensure transmitter clock is set properly
2. Choose LIMIT UNITS of “Level” or “% Range”
3. Choose INTERVAL, LIMITS and TIMES applicable to your needs.
4. TANK PROFILE STATUS will display “Off”, “Running” or “Completed”
5. Once computer is used to configure transmitter it does not have to stay connected.
6. Connect computer at later date to download captured data for analysis.

From the DTM, Tank Profile is accessed from the Diagnostics/Tank Profile tabs

Hit Refresh to begin  Set clock, if desired

Limit Units = PV % Range........Record Interval and Tank Profile units switch to “%”
**4.4 Echo Margin**

Echo Margin is a unique parameter that, when used along with Echo Strength can be a very useful troubleshooting tool. Echo Strength is taken from the standard Signal-to-Noise calculation and is simply defined as:

“The amplitude of the Level echo in Echo Strength units (0-100)”

Echo Margin is defined as:

“A numeric value that is related to the strength of the target peak relative to the Level Threshold or competing waveform features, i.e. "noise."

The Echo Margin value (for the typical First Echo mode) is calculated as the difference of the False target-to-Threshold OR the Level target-to-Threshold whichever is SMALLER.
By reporting the SMALLER value, Echo Margin does a better job of reporting which issue is most likely to become a problem:

- False Target- if this echo becomes large enough to rise above the Threshold it will be mistakenly reported as the Level.
- Level Echo- if this echo becomes small enough to fall below the Threshold the transmitter will report Loss of Echo.

Always examine both Echo Strength and Echo Margin values. Increasing a Gain parameter (Dielectric, Turbulence, Foam or Sensitivity) will increase the amplitude of all echoes in the radar scene. If, after increasing a Gain parameter, the Echo Strength increases but the Echo Margin decreases a False Target is reaching closer to the Threshold (see drawing above). If the False Target reaches above the Threshold it will be detected as a valid Level echo and will be incorrectly reported as Level. In this case running Echo Rejection will eliminate the False Target and increase the Echo Margin value. Echo Margin values >20 are a good goal.

### 4.5 Automated Echo Capture

#### Unattended Echo Capture

One of the ways the Model R86 simplifies an often complex technology like Radar, is to improve the speed at which a user can turn around a problem and get the device back online. Minimizing down time is the ultimate goal of any device.

One of the most important tools used to troubleshoot a Radar application or optimize a transmitter configuration is the echo curve. This graphical representation of a Radar echo speaks volumes to those trained to interpret them. It is like a snapshot in time of the health of the transmitter. It is actually like seeing inside of the tank. However, the challenge with echo curves is acquiring them in a timely fashion. Unfortunately, most problems develop when there is a skeleton crew and no one watching this particular vessel. By the time an instrument technician can investigate, the alarm has cleared and no one understands why it occurred or, more importantly, when it will happen again. Since an echo curve is so important in troubleshooting the device, it is critical to capture the curve at the instant a problem occurs. Too often this means connecting a laptop and gathering information AFTER the first signs of the problem, which is obviously not ideal.

The advanced Pulsar Model R86 design is very effective at addressing this issue. This advanced design allows the transmitter to automatically capture an Echo Curve based on an Event (such as Loss of Echo) or Time (using the on-board clock).

It is shipped from the factory so an echo curve is automatically captured based on key Events. The transmitter has the ability to store a number of echo curves in its on-board memory. These echo curves can then be downloaded to a laptop running software such as PACTware and reviewed in Diagnostics/Echo History tab. If necessary, the user can email this information to the factory for expert assistance in troubleshooting. This enables the problem to be resolved much more quickly, minimizing possible down time.
A number of points should be made in this example:

- Curve 1 is showing the current Live echo
- Curve 2 is showing “History 9” — the 9th echo stored in memory which was automatically captured at 5:40 p.m. on 4/5/2017
  - This echo capture was triggered by the “Low Echo Margin” diagnostic

**SETUP**

**NOTE:** The transmitter is shipped from the factory configured to automatically capture Echo Curves based on “Events” with ALL Events being enabled.

Automated Echo Capture is configured in the DTM in the following manner:

Open DTM to Diagnostics/Echo History

![DTM Screenshot](image)

### 4.6 Event History

Although Event History has been included (and found to be very useful) in other Magnetol devices, it has been improved in the Model R86.

Event History becomes the main repository of all key Diagnostic and Configuration data. It now displays a history of the 20 most recent diagnostic indicators and configuration changes. For each event, the time when the event occurred and the duration of the event are shown. The table of history indicators displays the most recent indicator at the top with preceding indicators in descending order.

**NOTE:** A “+” suffix denotes the event remains active

**Key Features:**

- 20 lines of Event information
- All Diagnostic and Configuration info
- Now 7 columns of data
- Event name
- Date
- Item #
- Duration
- Value1
- Value2
Value1 and Value2 entries have various meanings depending on the Event. (A comprehensive explanation of these entries is included in this section.) It is highly recommended to Set Clock (in transmitter) if actual Dates and Times are not shown.

(Although Event History can be viewed via the Local User Interface, the DTM offers a more complete view of the information.)

Press “Refresh Event History” upon opening the screen.

<table>
<thead>
<tr>
<th>#</th>
<th>Event</th>
<th>Date</th>
<th>Time</th>
<th>Duration</th>
<th>Value1</th>
<th>Value2</th>
</tr>
</thead>
<tbody>
<tr>
<td>20</td>
<td>BC Level</td>
<td>2017-01-18</td>
<td>13:05:21</td>
<td>022:34:12+</td>
<td>12</td>
<td>18.0</td>
</tr>
<tr>
<td>19</td>
<td>Echo Reject State</td>
<td>2017-01-15</td>
<td>11:14:01</td>
<td>000:00:00</td>
<td>0</td>
<td>2.0</td>
</tr>
<tr>
<td>18</td>
<td>Std. Echo Rejection</td>
<td>2017-01-15</td>
<td>11:10:59</td>
<td>000:00:00</td>
<td>0</td>
<td>24.1</td>
</tr>
<tr>
<td>17</td>
<td>Foam</td>
<td>2017-01-15</td>
<td>11:08:39</td>
<td>000:00:00</td>
<td>1</td>
<td>35.0</td>
</tr>
<tr>
<td>16</td>
<td>Echo Curve</td>
<td>2017-01-15</td>
<td>09:41:45</td>
<td>000:00:00</td>
<td>2</td>
<td>83.2</td>
</tr>
<tr>
<td>15</td>
<td>Echo Lost</td>
<td>2017-01-15</td>
<td>09:41:15</td>
<td>000:87:45</td>
<td>0</td>
<td>83.2</td>
</tr>
<tr>
<td>14</td>
<td>Foam</td>
<td>2017-01-15</td>
<td>09:40:13</td>
<td>000:00:00</td>
<td>0</td>
<td>9.0</td>
</tr>
<tr>
<td>13</td>
<td>Max. Jump Exceeded</td>
<td>2017-01-12</td>
<td>01:26:41</td>
<td>000:00:49</td>
<td>32</td>
<td>118.5</td>
</tr>
<tr>
<td>12</td>
<td>Echo Reject State</td>
<td>2017-01-12</td>
<td>01:25:23</td>
<td>070:02:13</td>
<td>20</td>
<td>27.4</td>
</tr>
<tr>
<td>11</td>
<td>Foam</td>
<td>2017-01-12</td>
<td>01:25:23</td>
<td>000:00:00</td>
<td>2</td>
<td>88.0</td>
</tr>
<tr>
<td>10</td>
<td>BC Level</td>
<td>2017-01-08</td>
<td>15:51:20</td>
<td>000:17:49</td>
<td>1</td>
<td>33.1</td>
</tr>
<tr>
<td>9</td>
<td>Echo Reject State</td>
<td>2017-01-08</td>
<td>15:51:05</td>
<td>000:00:00</td>
<td>0</td>
<td>2.0</td>
</tr>
<tr>
<td>8</td>
<td>Echo Curve</td>
<td>2017-01-08</td>
<td>15:32:46</td>
<td>000:00:00</td>
<td>7</td>
<td>29.5</td>
</tr>
<tr>
<td>7</td>
<td>Low Echo Margin</td>
<td>2017-01-08</td>
<td>15:32:16</td>
<td>000:00:00</td>
<td>5</td>
<td>29.5</td>
</tr>
<tr>
<td>6</td>
<td>BC Level</td>
<td>2017-01-08</td>
<td>15:31:10</td>
<td>028:35:45</td>
<td>01</td>
<td>42.1</td>
</tr>
</tbody>
</table>

**7 LOW ECHO MARGIN**

Value 1 - EM value when captured
Value 2 - Level value when captured
## Event History – Value1/Value2 Look-up Table

<table>
<thead>
<tr>
<th>Event</th>
<th>Value1</th>
<th>Value2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALL DIAGNOSTIC INDICATORS</td>
<td>0 = No value (unused)</td>
<td>Level value when captured</td>
</tr>
<tr>
<td>(unless otherwise noted below)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Analog Board Error</td>
<td>Error Code</td>
<td>0 = No value (unused)</td>
</tr>
<tr>
<td>Analog Output Error</td>
<td>Measured current</td>
<td>Expected current</td>
</tr>
<tr>
<td>Boundary Condition State (BCS)</td>
<td>XX- 2-digit value</td>
<td>Level value when captured</td>
</tr>
<tr>
<td>changes,</td>
<td>1st digit = Beginning state</td>
<td></td>
</tr>
<tr>
<td>Echo Lost and Inferred Level</td>
<td>2nd digit = Ending state</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Based on following codes:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0 = Initialization</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1 = Level (normal)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 = Empty</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 = Full</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4 = Echo Missing</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5 = Echo Lost</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6 = No Fiducial</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7 = Restart</td>
<td></td>
</tr>
<tr>
<td>Echo Curve (automated capture)</td>
<td>Capture based on:</td>
<td>Level value when captured</td>
</tr>
<tr>
<td></td>
<td>12 - Too Many Echoes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>14 - Echo Lost</td>
<td></td>
</tr>
<tr>
<td></td>
<td>17 - High Volume Alarm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>18 - High Flow Alarm</td>
<td></td>
</tr>
<tr>
<td></td>
<td>28 - Inferred Level</td>
<td></td>
</tr>
<tr>
<td></td>
<td>33 - Max Jump Exceeded</td>
<td></td>
</tr>
<tr>
<td></td>
<td>34 - Low Echo Margin</td>
<td></td>
</tr>
<tr>
<td>Echo Lost</td>
<td>See BCS changes</td>
<td></td>
</tr>
<tr>
<td>High Electrical Temp</td>
<td>0 = No value (unused)</td>
<td>Temp when activated</td>
</tr>
<tr>
<td>High Surface Velocity</td>
<td>Value when activated</td>
<td>Level value when captured</td>
</tr>
<tr>
<td>Inferred Level</td>
<td>See BCS changes</td>
<td></td>
</tr>
<tr>
<td>Low Echo Margin</td>
<td>Value when activated</td>
<td>Level value when captured</td>
</tr>
<tr>
<td>Low Electrical Temp</td>
<td>0 = No value (unused)</td>
<td>Temp when activated</td>
</tr>
<tr>
<td>Low Supply Voltage</td>
<td>Extrapolated terminal</td>
<td>Extrapolated terminal</td>
</tr>
<tr>
<td></td>
<td>Lower voltage</td>
<td>Upper voltage</td>
</tr>
<tr>
<td>Max. Jump Exceeded</td>
<td>Beginning Level value</td>
<td>Ending Level value</td>
</tr>
<tr>
<td>Reject Curve Invalid</td>
<td>0 = No value (unused)</td>
<td>0 = No value (unused)</td>
</tr>
<tr>
<td>Reset Max/Min Temperatures</td>
<td>Max Temp before reset</td>
<td>Min Temp before reset</td>
</tr>
<tr>
<td>Sweep Time Error</td>
<td>DAC setting</td>
<td>Sweep width</td>
</tr>
<tr>
<td>Too Many Echoes</td>
<td>Number of Echoes found</td>
<td>Level value when captured</td>
</tr>
</tbody>
</table>

## Configuration Parameters

<table>
<thead>
<tr>
<th>Event</th>
<th>Value1</th>
<th>Value2</th>
</tr>
</thead>
<tbody>
<tr>
<td># Run Average</td>
<td>Old value</td>
<td>New Value</td>
</tr>
<tr>
<td>4mA (LRV)</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>20mA (URV)</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Base Threshold</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Bottom Blocking Distance</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Custom Echo Rejection</td>
<td>0 = No value (unused)</td>
<td>Level value when captured</td>
</tr>
<tr>
<td>Dielectric</td>
<td>0 = 1.4–1.7</td>
<td>Corresponding Echo Strength</td>
</tr>
<tr>
<td></td>
<td>1 = 1.7–3.0</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 = 3.0–10</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3 = &gt;10</td>
<td></td>
</tr>
<tr>
<td>Event</td>
<td>Value1</td>
<td>Value2</td>
</tr>
<tr>
<td>--------------------------------</td>
<td>-----------------------------</td>
<td>---------------------------------</td>
</tr>
<tr>
<td>Echo Rejection Type</td>
<td>Old value</td>
<td>New Value</td>
</tr>
<tr>
<td>2 = Standard Echo Rejection</td>
<td>3 = Custom Echo Rejection</td>
<td></td>
</tr>
<tr>
<td>Echo Reject State</td>
<td>Old Value</td>
<td>New Value</td>
</tr>
<tr>
<td>0 = Off</td>
<td>1 = Disabled</td>
<td></td>
</tr>
<tr>
<td>2 = Enabled</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FME Distance Threshold</td>
<td>Old value</td>
<td>New Value</td>
</tr>
<tr>
<td>Foam</td>
<td>0 = None</td>
<td>Corresponding Echo Strength</td>
</tr>
<tr>
<td>1 = Light</td>
<td>2 = Medium</td>
<td></td>
</tr>
<tr>
<td>3 = Heavy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HART Poll address</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Level Trim</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Max Level Jump</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Max Surface Velocity</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Passwords (Date/Time only)</td>
<td>0 = No value (unused)</td>
<td>0 = No value (unused)</td>
</tr>
<tr>
<td>Rate of Change</td>
<td>Old value</td>
<td>New Value</td>
</tr>
<tr>
<td>0 = &lt;5 in/min (&lt;130mm/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 = 5–20 in/min (130–500mm/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 = 20–60 in/min (500–1500mm/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 = &gt;60 in/min (&gt;1500mm/min)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sensitivity</td>
<td>Value</td>
<td>Corresponding Echo Strength</td>
</tr>
<tr>
<td>Standard Echo Rejection</td>
<td>0 = No value (unused)</td>
<td>Level value when captured</td>
</tr>
<tr>
<td>Stillwell ID</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Tank Height</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Target Selection</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>1 = First Echo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 = Largest Echo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 = First Moving Echo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target Threshold Mode</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>1 = Automatic</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2= Fixed</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Target Threshold Value</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Automatic = % of Peak Max</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed = Value in Eng. Units</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Top Blocking Distance</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Turbulence</td>
<td>0 = None</td>
<td>Corresponding Echo Strength</td>
</tr>
<tr>
<td>1 = Light</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 = Medium</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 = Heavy</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TVG End Location</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>TVG End Value</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>TVG Start Location</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>TVG Start Value</td>
<td>Old value</td>
<td>New value</td>
</tr>
<tr>
<td>Error Code</td>
<td>Diagnostic</td>
<td>Explanation</td>
</tr>
<tr>
<td>------------</td>
<td>-----------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td>0</td>
<td>OK</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Software Error</td>
<td>Instruction execution traversed an incorrect path</td>
</tr>
<tr>
<td>2</td>
<td>RAM Error</td>
<td>Run-time volatile memory test failed</td>
</tr>
<tr>
<td>3</td>
<td>ADC Error</td>
<td>Run-time analog-to-digital converter test failed</td>
</tr>
<tr>
<td>4</td>
<td>EEPROM Error</td>
<td>Unrecoverable checksum error in non-volatile memory</td>
</tr>
<tr>
<td>5</td>
<td>Analog Board Error</td>
<td>Delay-locked loop malfunction</td>
</tr>
<tr>
<td>6</td>
<td>Analog Output Error</td>
<td>Measured loop current differs from commanded value</td>
</tr>
<tr>
<td>7</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Default Params</td>
<td>All parameters reset to default values</td>
</tr>
<tr>
<td>9</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Sweep Time Error</td>
<td>Analog Board sweep time error</td>
</tr>
<tr>
<td>11</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>Too Many Echoes</td>
<td>Excessive number of waveform features are possible echoes</td>
</tr>
<tr>
<td>13</td>
<td>Safe Zone Alarm</td>
<td>Level is above Safe Zone end</td>
</tr>
<tr>
<td>14</td>
<td>No Echoes</td>
<td>Echo from upper surface missing for longer than Echo Loss Delay</td>
</tr>
<tr>
<td>15</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Config Conflict</td>
<td>Configuration conflict caused by incompatible parameter selections</td>
</tr>
<tr>
<td>17</td>
<td>High Volume Error</td>
<td>Calculated Volume exceeds maximum for vessel or custom table</td>
</tr>
<tr>
<td>18</td>
<td>High Flow Error</td>
<td>Calculated Flow exceeds maximum for flume or custom table</td>
</tr>
<tr>
<td>19</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>Initializing</td>
<td>System warming up, distance measurement not yet valid</td>
</tr>
<tr>
<td>21</td>
<td>Config Changed</td>
<td>A parameter(s) has recently been modified from the User Interface</td>
</tr>
<tr>
<td>22</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>High Electrical Temp</td>
<td>Present electronics temperature above maximum</td>
</tr>
<tr>
<td>24</td>
<td>Low Electric Temp</td>
<td>Present electronics temperature below minimum</td>
</tr>
<tr>
<td>25</td>
<td>Calibration Required</td>
<td>Distance calibration parameters are at default values</td>
</tr>
<tr>
<td>26</td>
<td>Echo Rejection Invalid</td>
<td>Previously stored Echo Rejection Curve invalidated by parameter change</td>
</tr>
<tr>
<td>27</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Inferred Level</td>
<td>Typically this is caused when the Level target has been lost or has entered either the Top or Bottom Blocking Distance zones. If in the Top or Bottom Blocking Distance zones the transmitter will read Full (Top) or Empty (Bottom). The Level reading (and mA value) will never be higher than the value related to the Top Blocking Distance or lower than the value related to the Bottom Blocking Distance.</td>
</tr>
<tr>
<td>29</td>
<td>Adjust Analog Output</td>
<td>Loop trim parameters are at default values</td>
</tr>
<tr>
<td>30</td>
<td>Totalizer Data Lost</td>
<td>Totalizer data has been lost, restarted from zero</td>
</tr>
<tr>
<td>31</td>
<td>Low Supply Voltage</td>
<td>Power supply voltage inadequate to prevent brownout or reset</td>
</tr>
<tr>
<td>32</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>33</td>
<td>Max Jump Exceeded</td>
<td>Transmitter has jumped to an echo that exceeds the Max Distance Jump value from the previous echo.</td>
</tr>
<tr>
<td>34</td>
<td>Marginal Echo</td>
<td>Signal Margin is less than allowable minimum</td>
</tr>
<tr>
<td>35</td>
<td>High Surface Velocity</td>
<td>The measured Surface Velocity is greater than the Max Surface Velocity value derived from the Rate of Change parameter.</td>
</tr>
<tr>
<td>36</td>
<td>Spare</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Seq Record</td>
<td>Instruction execution traversed a correct but unexpected path (formerly System Warning)</td>
</tr>
</tbody>
</table>
IMPORTANT

The Model R86 transmitter is not serviceable in the field. Return to the factory for repair or replacement.

SERVICE POLICY

Owners of Magnetrol products 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. Magnetrol International will repair or replace the control, at no cost to the purchaser, (or owner) other than transportation cost if:

a. Returned within the warranty period; and,
b. The factory inspection finds the cause of the malfunction to be defective material or workmanship.

If the trouble is the result of conditions beyond our control; or, is NOT covered by the warranty, there will be charges for labour 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, labour, direct or consequential damage will be allowed.

RETURNED MATERIAL PROCEDURE

So that we may efficiently process any materials that are returned, it is essential that a “Return Material Authorisation” (RMA) form will be obtained from the factory. It is mandatory that this form will be attached to each material returned. This form is available through Magnetrol's local representative or by contacting the factory. Please supply the following information:

1. Purchaser Name
2. Description of Material
3. Serial Number and Ref Number
4. Desired Action
5. Reason for Return
6. Process details

Any unit that was used in a process must be properly cleaned in accordance with the proper health and safety standards applicable by the owner, before it is returned to the factory.

A material Safety Data Sheet (MSDS) must be attached at the outside of the transport crate or box.

All shipments returned to the factory must be by prepaid transportation. Magnetrol will not accept collect shipments.

All replacements will be shipped Ex Works.