

pulsar[™]



PULSAR[™] PULSE BURST RADAR



Magnetrol[®]

Worldwide Level and Flow Solutions[™]

The Total Spectrum of Solutions ▶

Magnetrol's products employ a number of technologies to meet the challenges of level and flow control. Pulsar™ transmitters utilize Pulse Burst Radar for accurate and reliable level control.



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Magnetrol International—a world leader in level and flow measurement technology—designs, manufactures, markets and services level and flow instrumentation worldwide.

Magnetrol's product groups are based upon these technologies:

- Buoyancy
- Contact Ultrasound
- Non-Contact Ultrasound
- Guided Wave Radar
- Pulse Burst Radar
- RF Capacitance
- Thermal Dispersion
- Vibration
- Visual Indication

The industries we serve include:

- Petroleum Production
- Petroleum Refining
- Power Generation
- Petrochemical
- Chemical
- Water & Wastewater
- Pulp & Paper
- Food & Beverage
- Pharmaceutical

Liquid Level Sensing with Pulsar Pulse Burst Radar



EVOLUTION. Practical radar instrumentation, first developed by defense initiatives of WWII, has grown to



include a myriad of sensors and transmitters. Today, radar serves us in applications that range from the commonplace to the cosmic. Radar maps the topology of distant planets and pinpoints

weather fronts on earth (doppler radar); it automatically opens supermarket doors (continuous wave radar); and it cooks our meals with microwaves (cavity magnetron radar). Though radar for level sensing is a newer application, it is presently the fastest growing measurement technology in level control.

But radar's beginnings were less than auspicious. Early level instruments were costly, bulky, over specialized and complicated. The development of simpler, less costly and easier-to-use devices would be made possible by solid state components and by a growing fund of applications knowledge.

TYPES. Radar level sensing devices detect the position of process liquids by measuring the interval between the emission and return of high frequency radio waves. Guided Wave Radar, used by Magnetrol's Eclipse® and Horizon transmitters, is a contact technology that launches its signal along a waveguide which runs directly into the process media. Pulsar's Pulse Burst Radar is a non-contact technology that launches its signal into open air along a trajectory directed toward the process media.

PULSE RADAR. Of the two operational technologies in common use today for radar, Pulsar utilizes a pulse burst approach rather

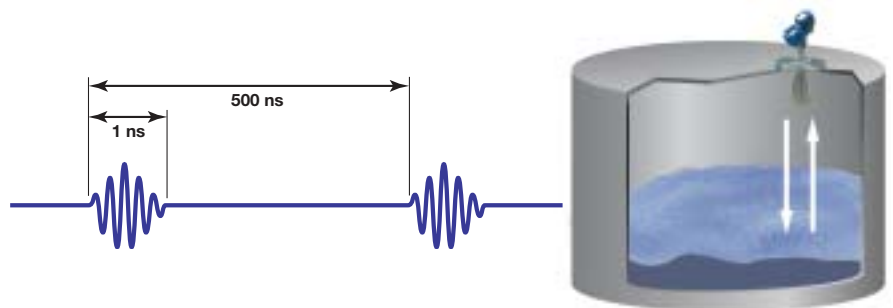
than frequency modulated continuous wave (FMCW). Pulse Burst Radar operates in the time domain and does not require complex and expensive processing required to enable FMCW. Because echoes are discrete and separated in time, Pulse Burst Radar is better able to sort through extraneous echoes and select the one generated by true level. Pulse Burst Radar also has excellent averaging characteristics, important in those applications where a return signal is attenuated by factors described below in *The Three Ds of Radar*.

Unlike true pulse devices that transmit a single, sharp (fast rise-time) waveform of wide-band energy, Pulsar emits short bursts of 5.8 (Europe) or 6.3 GHz (North America) energy and measures the transit time of the signal reflected from the liquid surface. Distance is calculated utilizing the equation

$$\text{Distance} = C \times \frac{\text{Transit time}}{2} \quad (C = \text{speed of light})$$

then developing the Level value by factoring in Tank Height and Sensor Offset information. The exact reference point for distance and level calculations is the Sensor Reference Point—bottom of an NPT thread, top of a BSP thread or face of a flange.

Equivalent Time Sampling or ETS measures the high speed, low power electromagnetic energy (EM). ETS is a critical key in the application of radar to vessel level measurement technology. The highspeed EM energy 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 waveguide to collect thousands of samples. The round trip event on a 65 foot (20 meter) tank takes only 133 nanoseconds in real time. After it is reconstructed in equivalent time it measures 200 milliseconds.

THE THREE Ds. Radar applications are influenced by three basic conditions: (1) the **Dielectric** of the process medium; (2) the **Distance**, or measuring range of the application; and (3) a variety of **Disturbances** that attenuate or distort the radar signal.

Low dielectric media can weaken radar's return signal and thus shorten a device's effective measurement range. Pulsar can provide accurate measurement even for low dielectrics; but in instances where the dielectric is extremely low, as is the case with liquid gas, fuels and solvents, Guided Wave Radar may be the better choice in radar technology.

The Distance, or measurement range, of Pulsar is a function of the type of antenna selected, the dielectric constant of the media, and the presence of signal interference. Disturbances caused by turbulence, foam, false targets (interior tank obstructions causing false echoes), multiple reflections (reflections from off the tank roof), or a high rate of level change, can weaken, scatter or multiply radar signals. Very high and very low liquid levels can also be problematic.

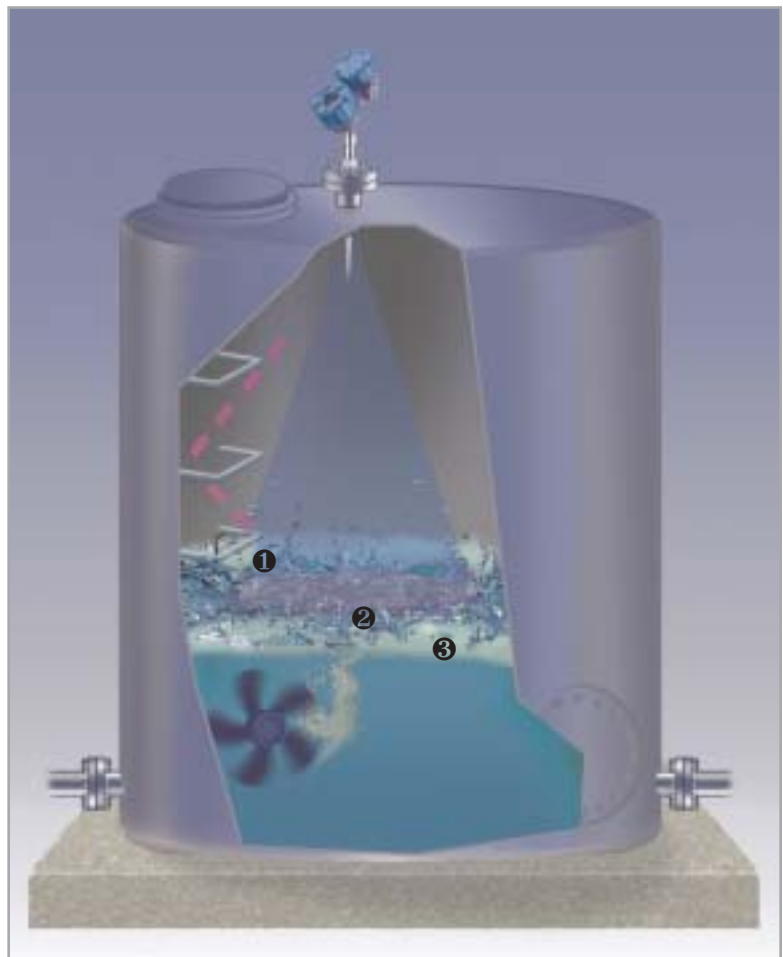
SIGNAL PROCESSING.

The signal processing function of Radar is critically important because radar exhibits interference effects similar to those that affect light. It is the quality of a device's signal processing, in fact, that separates today's leading-edge radar transmitters from the others.

Most disturbances mentioned above can be readily managed by Pulsar's signal processing. Pulsar extracts true level from false targets and

other background noise through its sophisticated signal processing capabilities. Pulsar circuitry is extremely energy efficient, so no duty cycling is necessary to accomplish effective measurement. For this reason, Pulsar can also track high rates of change that have been impossible with other loop-powered radar transmitters. Although Pulsar has a powerful False Target Recognition and Rejection routine, minimizing false target reflections is significantly affected by proper installation and orientation.

ANTENNAS. The transmitter's antenna transmits and receives the radar signal. Pulsar offers four antenna types: TFE and polypropylene dielectric rods, a 4" (100 mm) horn, and a 6" (150 mm) horn. Maximum measuring range of each antenna is chiefly dependent upon dielectric constants and the degree of turbulence.



Pulse Burst Radar technology and advanced signal processing help Pulsar manage common disturbances: (1) false echoes caused by obstructions, or multi-path reflections caused by waves hitting a sidewall; (2) turbulence generated by agitators or aggressive chemical reactions; and (3) a layer of light to medium density foam.



Horn antenna configuration



Dielectric rod antenna

Both types tolerate maximum process temperatures of +400° F (+204° C) and pressures of 750 psi (51.7 bar). Horn antennas will measure dielectric media as low as 1.7, while the minimum dielectric for rod types is 2.0. A dielectric rod's polypropylene or TFE construction will tolerate very aggressive media. Both TFE and polypropylene dielectric rod antennas are offered with a Kynar mounting nut for use in non-metallic vessels where metallic surfaces are prohibited.

INSTALLATION.

Pulsar's QuickStart installation procedures provide the key steps for mounting, wiring and configuring the Pulsar radar level transmitter. Though the transmitter comes configured from the factory, it can be reconfigured in the shop. Bench con-

figuration provides a convenient and efficient way to set up the transmitter before going to the tank site to complete the installation. The transmitter is password protected to protect configuration values.

A HART® remote unit, such as a HART communicator, can be used to provide a communication link to the Pulsar transmitter. When connected to the control loop, the measurement readings shown on the transmitter will be shown on the communicator. The communicator can also be used to configure and trouble shoot the transmitter.

BENEFITS. Pulsar radar accurately and reliably measures a wide range of media in a broad range of process conditions, from calm product surfaces and water-based media to turbulent surfaces and aggressive hydrocarbon media. As a non-contact device, Pulsar is not susceptible to the complications that arise whenever a probe contacts the process media, such as coating by viscous media or corrosive attack due to aggressive chemicals. The greater the measuring range, the more does radar prove itself to be the economical solution, given the cost of extended probe lengths.

Radar is virtually unaffected by temperatures, pressures, the presence of vapors, or air movement within a vessel's free space. Changes in specific gravity, conductivity and dielectric constants also have no effect on Pulsar's measurement accuracy. As a 100% electronic instrument, the absence of moving parts translates into low maintenance costs. As a two-wire, loop-powered device, power requirements and installation for Pulsar are vastly simplified.

Welcome to Pulsar Pulse Burst Radar! Its accuracy, reliability, and simplicity make it *the* non-contact level measurement technology for the 21st Century. ■



Pulsar transmitter with a 6" horn antenna



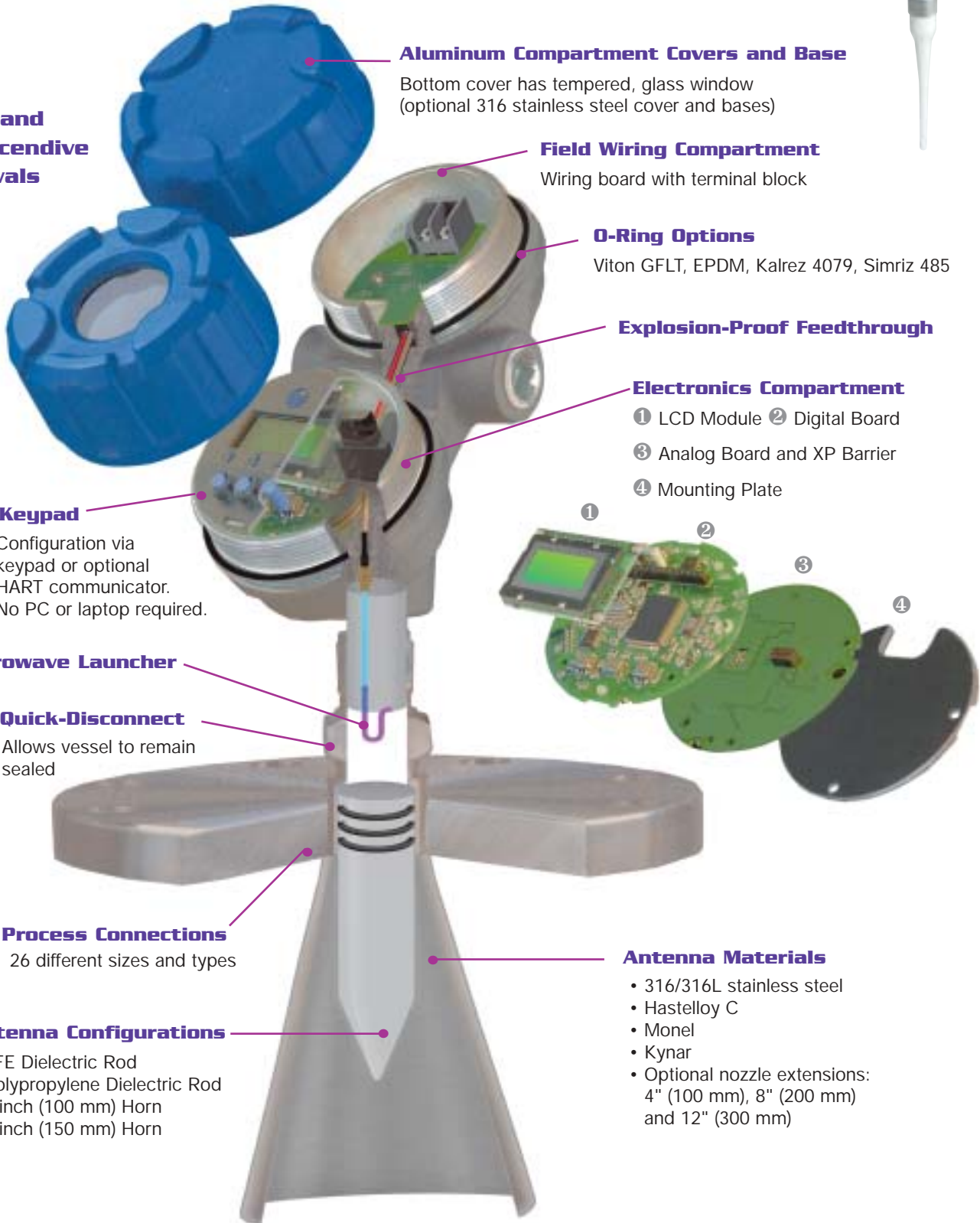
The Anatomy of a Pulsar Transmitter and Sensor

Pulsar's dual enclosures orient wiring and electronics on the same plane for convenient wiring, configuration and

display. The display features a two-line, eight-character LCD. A three-button keypad provides the user interface.



IS, XP and Non-Incendive Approvals





PULSAR
 Engineered for
 Multi-Industry
 Solutions



SYSTEM DESIGN	
Measurement Principle	Pulse Burst Radar @ 5.8 GHz (Europe), 6.3 GHz (U.S.)
INPUT	
Measured Variable	Level, determined by the time-of-flight of a radar pulse from the transmitter to the product surface and back
Zero and Span	0.5 to 65 feet (0.2 to 20 meters)
OUTPUT	
Type	Analog: 4-20 mA or 4-20 mA with optional HART digital signal
Range	Analog: 3.8 to 20.5 mA useable; Digital: 0 to 999" (0 to 999 cm)
Resolution	Analog: 0.01 mA; Digital: 0.1"
Loop Resistance	GP/IS/XP 350 Ω @ 24 VDC/22 mA; 400 Ω @ 24 VDC/20 mA
Diagnostic Alarm	Adjustable 3.6 mA, 22mA, HOLD
Damping	Adjustable 0-45
USER INTERFACE	
Keypad	Three-button, menu-driven data entry and system security
Indication	Two-line × eight-character display
Digital Communication	HART version 5 compatible (communicator sold separately)
POWER (Measured at instrument terminals)	
	GP: 16 to 36 VDC; IS: 16 to 28.6 VDC; XP: 16 to 36 VDC
HOUSING	
Material	Aluminum A356T6 (< 0.25% copper), 316 stainless steel (optional)
Cable Entry	¾" NPT, M20
ANTENNAS	
Type	TFE or polypropylene dielectric rod / 4" or 6" horn
Materials (wetted parts)	Dielectric rod: TFE or polypropylene Mounting nut: 316 stainless steel (Hastelloy C, Monel, or Kynar optional) Viton O-rings (standard) Horn: 316 stainless steel (Hastelloy C or Monel optional) Insert: TFE Viton O-rings (standard)
Process Connections	Dielectric rods: 1½" NPT and BSP; ANSI or DIN flanges Horns: 4" or 6" ANSI or DIN flanges
Maximum Process Temperature	+400° F (+204° C)
Maximum Process Pressure	750 psi (51.7 bar)
Minimum Dielectric	2.0 dielectric rods / 1.7 horns
ENVIRONMENT	
Operating Temperature Range	-40° to +175° F (-40° to +80° C)
LCD Operating Temp. Range	-5° to +160° F (-20° to +70° C)
Storage Temperature	-50° to +175° F (-46° to +80° C)
Humidity	0-99%, non-condensing
Electromagnetic Compatibility	Meets CE requirements EN 50081-2, EN 50082-2
PERFORMANCE (Reference Conditions: Reflection from ideal reflector at +70° F / +20° C)	
Linearity	±0.4" or 0.1% of tank height
Measured Error	±0.4" or 0.1% of tank height
Resolution	0.1"
Repeatability	±0.2" or 0.05% of tank height
Warm-up Time	30 seconds
Ambient Temperature Effect	Temperature effect 0.05% per 10° C
Process Dielectric Effect	< 0.3 inch within selected range
Maximum Rate of Change	15 feet (4.5 meters) / minute



Magnetrol®

Worldwide Level and Flow Solutions™

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