

B U O Y A N C Y P R O D U C T S



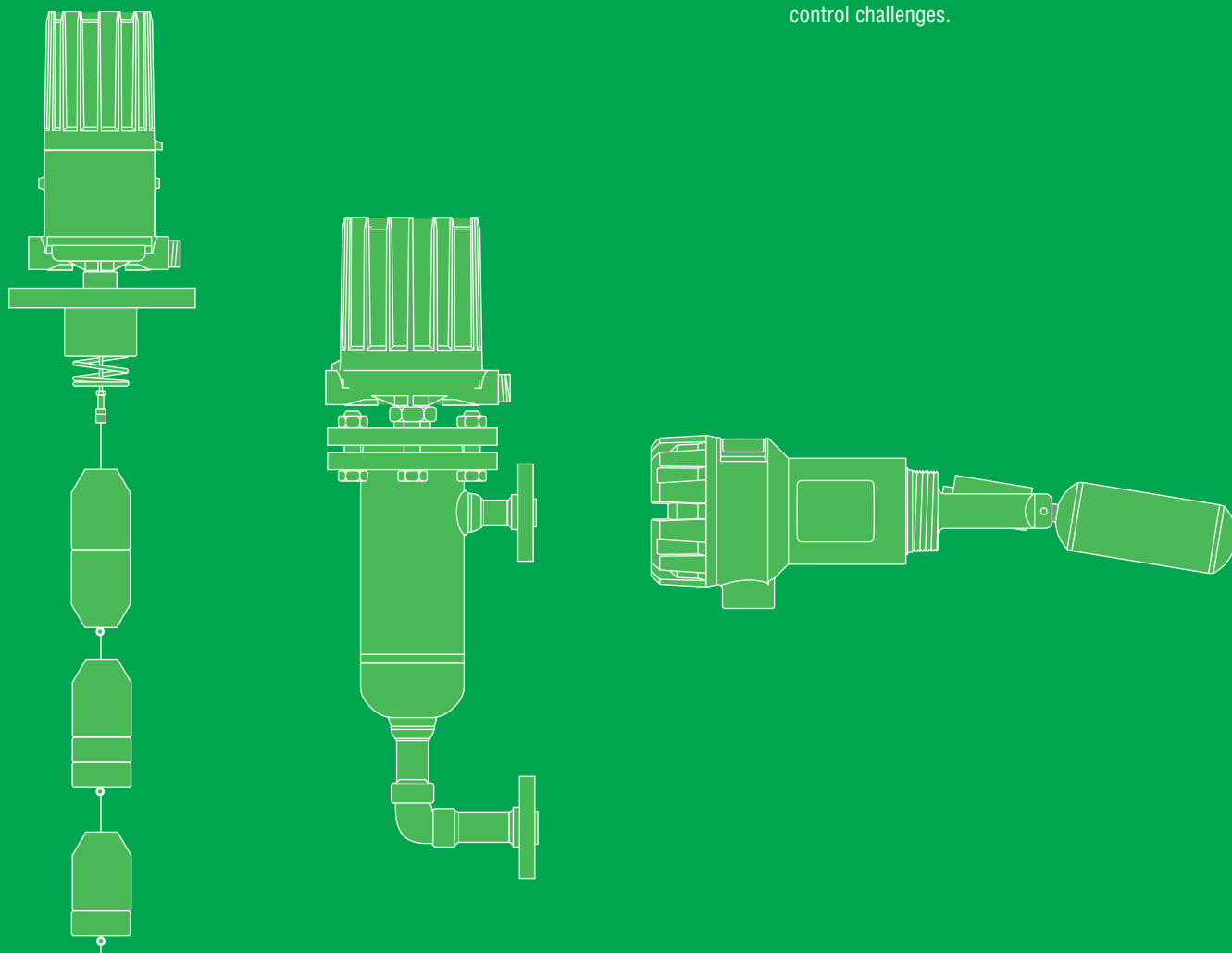
Magnetrol®

Worldwide Level and Flow Solutions™

The Total Spectrum of Solutions ▶

Magnetrol products employ many technologies for the measurement and control of level and flow. Buoyancy technology, with its utilization of float and displacer sensing elements, represents our most time-tested product group.

To this day, buoyancy technology provides optimum solutions for many of today's level control challenges.



BUOYANCY PRODUCTS



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

Magnetrol product groups are based upon these technologies:

- Air Sonar
- Buoyancy
- Contact Ultrasound
- Guided Wave Radar
- Pulse Burst Radar
- RF Capacitance
- Thermal Dispersion
- Vibration
- Visual Indicators

The industries we serve include:

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

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Buoyancy Level Controls

A Time-Tested Solution

The application of buoyancy principles to the challenges of liquid level measurement and control is one of the oldest and most reliable solutions available in the process control industry. The key to the success of buoyancy instruments is the means by which the motion of the liquid and, therefore, the float or displacer is converted into the desired level control action. Magnetrol incorporates the optimal features into its level switches while providing repeatable, dependable performance. The result of completely isolating the process environment from the switching mechanism and keeping all magnetic components out of the process environment, is a robust, versatile instrument suitable for a wide variety of control applications.

Buoyancy Technology's Advantages:

- + Service pressures up to 5000 psig (345 bar)
- + Service temperatures to +1200° F (+649° C)
- + No calibration of switches
- + Setup of displacer switches without level change
- + Highly reliable and familiar technology
- + Multiple-stage control available
- + Narrow and/or wide differential displacer switches
- + Transmitters available for continuous output
- + Switches do not require power

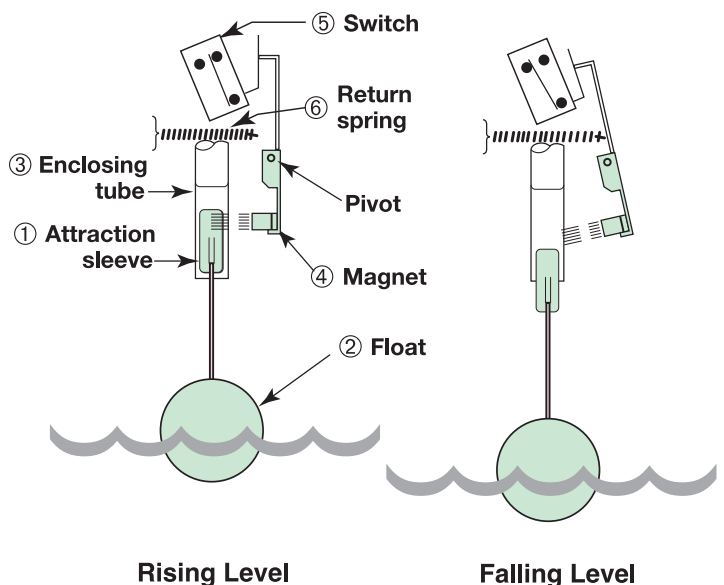
Buoyancy Technology's Limitations:

- Buildup or dirty process may impede performance.
- Switch accuracy limited to ± 0.25 inches (6 mm).
- Not suitable for solids
- Moving parts in process

Vertical Float

The float orientation utilized for top mounted switches and as the primary sensing method for external cage switches is the vertical float. The principle of operation is simple and provides a practical solution to narrow level differential requirements.

A rigid stem and attraction sleeve^① assembly is affixed to the top of a spherical or oblong float.^② The size of the float determines the buoyancy force of the process liquid against the float, stem and sleeve assembly. This buoyancy force must be greater than the weight of the assembly and is increased by enlarging the float. Because the buoyancy force is greater, the float assembly rises directly with the liquid level. As it does so, the attraction sleeve moves within a static pressure boundary, the enclosing tube.^③ A permanent magnet^④ is attached to the switch assembly^⑤ outside of the enclosing tube. When the attraction sleeve enters the field of the switch magnet, the magnet is pulled toward the sleeve, snapping against the enclosing tube and causing the switch to change state. As the liquid level falls, the float/stem/sleeve assembly follows it. When the attraction sleeve moves out of the field of the switch magnet, a return spring^⑥ on the switch mechanism pulls the magnet away from the enclosing tube, returning the switch to its original state.

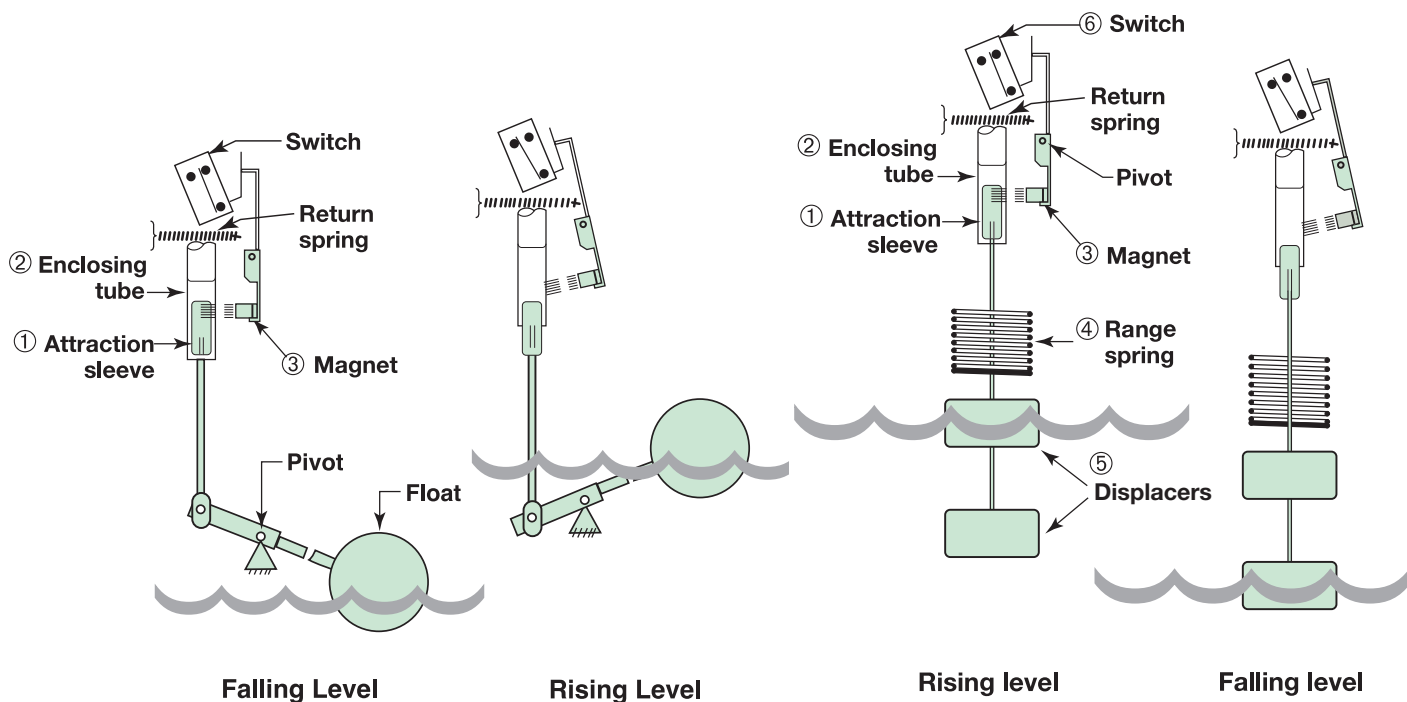


Horizontal Float

A horizontal float switch, often called a side mounted unit, operates much like a vertical float. It utilizes the same components, float, stem, sleeve,^① enclosing tube,^② switch magnet^③ and mechanism, but functions in a slightly different manner. The lower float stem pivots on a fulcrum. This means that as the float rises, the attraction sleeve is pulled down out of the field of the switch magnet causing the magnet to be pulled away from the enclosing tube. Conversely, as the float falls, the sleeve moves upward causing the switch magnet to pull in. Side mounted controls may be used for wide level differential. By lengthening the float stem, the liquid level and float must move through a greater distance in order to change the state of the switch. Side mounted units offer the option of mounting toward the bottom of a vessel for use in low level service, something that may not be done with a top mounted vertical float.

Displacer Switches

While taking advantage of the same buoyancy and magnetic coupling principles as float switches, displacer level switches utilize a precision range spring^④ to convert the change in buoyancy force to movement of an attraction sleeve.^① Because the displacer^⑤ is weighted, it hangs into the liquid rather than floating on top. As the liquid level moves changing the volume of liquid displaced by the displacers, the buoyancy force on the displacers changes. This causes elongation or compression of the range spring which, in turn, moves the attraction sleeve into or out of the field of the switch magnet, changing the state of the switch.^⑥

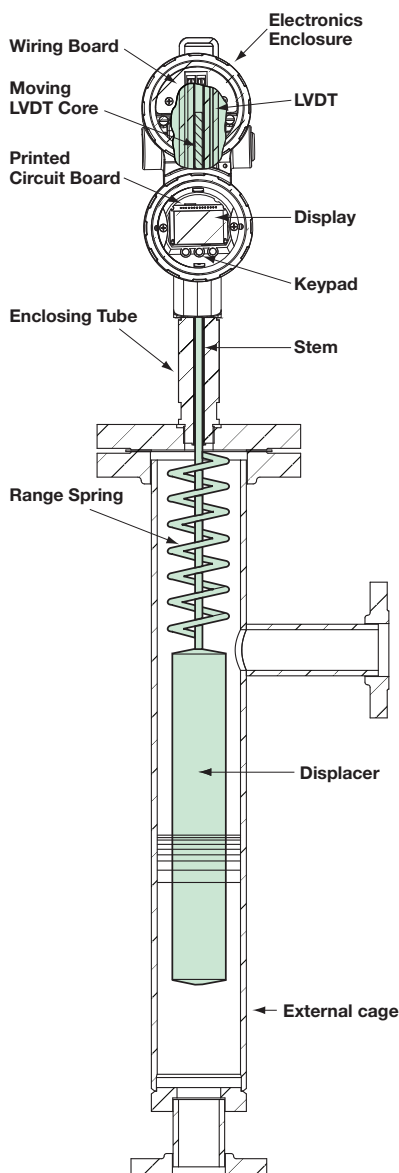


Buoyancy Level Controls (continued)

Displacer Transmitters

As with displacer switches, the change in buoyancy force on a range spring is converted to motion in a displacer transmitter. This motion is used to produce an output proportional to the change in liquid level. The pneumatic Modulevel has a sleeve that attracts a follower magnet, changing the position of a nozzle lever and the output from the controller head. The E3 Modulevel employs a linear variable differential transformer (LVDT) to produce the proportional output. The core of the LVDT is fixed to the top of the displacer stem. As the

spring compresses or elongates, the core moves within the LVDT windings, inducing currents in the secondary windings. This information is processed and output as a 4–20 mA proportional signal. In addition, the E3 superimposes a HART® compatible signal on the 4–20 mA allowing communications via the HART protocol or is available with FOUNDATION fieldbus™ protocol.



Advantages (+) and Limitations (-)

Vertical Float :

- + Highly reliable and repeatable
- + Broad product offering
- + High temperature capability
- + Many modifications and options available
- Low S.G. means a low pressure rating
- Only narrow differential standard
- External cage units are expensive when large floats (and therefore cages) are required

Horizontal Float:

- + Highly reliable and repeatable
- + Wide or narrow differentials
- + Low S.G. rating on counterweighted units
- Invasive mounting; can't be isolated without additional chamber
- Use only on very clean liquids due to pivots in the process

Displacer Switches:

- + Highly reliable and repeatable
- + Wide and narrow differentials or combinations
- + High pressure capability with low S.G.
- + Not affected by turbulence
- Temperature limited by range spring

Displacer Transmitters:

- + High pressure/temperature capabilities
- + Stable signal in turbulent applications
- + No flexure of pressure boundary parts
- + HART or FOUNDATION fieldbus compatible
- Affected by shifting S.G.

At-A-Glance: Magnetrol Buoyancy Products

The chart below summarizes the principle features of the leading Magnetrol buoyancy products. A green dot (●) indicates a standard feature; a red triangle (▲) indicates an optional feature.



		External Digital E3	External Pneumatic	Series 3 Switches	Top Mount Displacer Switches	Top Mount Displacer Switches	Side Mount Float Switches	Top Mount Float Switches	Tuffy II Switches	TK1 Switches	Flow Switches	Boiler Switches	Aurora Level Gauge	
	Page Number	8	9	10	11	11	12	13	14	15	16	17	18	19
Sensor Type ▶	Float			●	●			●	●	●	●		●	●
	Displacer	●	●	●		●	●							
Control Action/Output ▶	Single Switch			●	●	●	●	●	●	●	●	●	●	▲
	Multiple Switch		▲	●	●		●	●	●				●	▲
	Controller		●											
	Transmitter	●	●											▲
	Narrow Switch Differential		▲	●	●	●	●	●	●	●	●	●	●	▲
	Wide Switch Differential						●		●	●				
	Indicator	●	●											●
	HART	●												●
	FOUNDATION fieldbus	▲												▲
	External Cage	●	●	●	●	●	▲				▲		●	●
Configurations ▶	Top Mount	●	●				●	●				●		▲
	Side Mount		▲						●	●	●	●		
	Integral Mount	●	●	●	●	●	●	●	●	●	●	●	●	●
	Remote Mount	▲	▲											▲
	NACE Construction	▲	▲	●			▲	▲	▲	▲		▲		▲
Construction to Code ▶	ASME B31.1	▲	▲	●	▲									▲
	ASME B31.3	▲	▲	●	▲		▲	▲	▲	▲				▲

SERIES 3 Liquid Level Switches

ASME B31.1 and B31.3 Conformance-Certified Switches

Description: Magnetrol Series 3 float- displacer-actuated external cage level switches are designed, constructed, tested and certified to ASME B31.1, Power Piping Code or ASME B31.3, Process Piping Code.

Measurement Principle: Vertical float- or displacer-actuated level switch.

Features:

- Construction to NACE MR0175 and MR0103 optional
- Sealed and flanged top external chambers
- Broad selection of switch types
- Single or multiple switch points
- Exotic materials of construction available
- Can be modified for interface service
- Available with many sizes, types and configurations of process connections, including optional weld neck, RTJ or DIN flanges.
- All switch enclosures rotate through 360° for ease of conduit entry positioning

Model Selection: For model numbers, options and specification information on Series 3 refer to Magnetrol Bulletin 46-127.



Series 3 Flanged Cage Design

SPECIFICATIONS



Process Temp Range: -20° to +1000° F (-29° to +538° C) with carbon steel chamber
Lower temperatures possible with stainless steel chambers

Process Pressure: Up to 1680 psig (116 bar) for ASME B31.1
Up to 2240 psig (154 bar) for ASME B31.3

Specific Gravity: Down to 0.41 for ASME B31.1
Down to 0.33 for ASME B31.3

Chamber Material: Standard is carbon steel
Options include 304/304L SS, 316/316L SS, Monel, Hastelloy C, duplex SS, etc.

Trim Parts: 300 and 400 series stainless steels

Quality Assurance: Full penetration welds done by qualified welders per ASME Section IX procedures. Certificate of Conformance on all pressure boundary materials, certified ten minute hydrostatic test, post-weld heat treatment (NACE units only) and 5% radiographic examination (ASME B31.3 only).

Switch Enclosures: NEMA 4X/7/9 aluminum for Class I, Div. 1, Groups B, C & D areas and IEC Ex Ex d IIC T6, IP66 areas. Aluminum ATEX enclosures for Ex II 2 G EEx d IIC T6.

Switch Mechanisms: Dry contact, hermetically sealed, and pneumatic.



Series 3 Sealed Cage Design

EXTERNAL CAGE Liquid Level Switches

Reliability in Sealed or Flanged Top External Chambers

Description:

The Magnetrol external cage float- and displacer-actuated level switches have been industry standards for decades. With 28 basic models from which to choose, these self-contained instruments provide time-proven solutions to a wide range of level control applications.

Measurement Principle:

Vertical float- or displacer-actuated level switch.

Features:

- Sealed and flanged top external chambers
- Broad selection of switch types
- Single or multiple switch points
- Exotic materials of construction available
- Can be engineered for interface service
- Available with many sizes, types and configurations of process connections, including optional weld neck, RTJ or DIN flanges.
- All switch enclosures rotate through 360° for ease of conduit entry positioning.

Model Selection:

Refer to Magnetrol bulletins 46-115, 46-116 and 46-121 for model numbers, options and complete specification information.



SPECIFICATIONS



Process Temp Range:

-50° to +1000° F (-29° to +538° C)

Process Pressure:

Float controls up to 2240 psig (154 bar)
Displacer controls up to 5000 psig (345 bar)

Specific Gravity:

Down to 0.32

Chamber Material:

Standard is carbon steel. Sealed cage models available in stainless steel. Options include 304/304L SS, 316/316L SS, Monel, Hastelloy C, duplex SS, etc.

Float and Trim Parts:

300 and 400 series SS or all 316/316L SS

Switch Enclosures:

Polymer power coat finished aluminum NEMA 4X/7/9 for Class I, Div. 1, Group B or Groups C & D areas, IEC Ex Ex d IIC T6, IP66 areas and ATEX Ex II 2 G EEx d IIC T6.

Switch Mechanisms:

Dry contact, hermetically sealed, and pneumatic

Options:

Interface service, high and low temperature modifications, customized installation dimensions, vents and drains, customized actuation levels, special finishes, etc.



SPECIAL PURPOSE Liquid Level Switches

Model B40 LIQUID LEVEL SWITCH

Description:	The B40 is a float-actuated liquid level switch designed for high pressure and temperature service. The sealed external cage houses a horizontally oriented float assembly for use in single-stage applications.
Measurement Principle:	Horizontal float-actuated level switch.
Features:	<ul style="list-style-type: none">• Chambers in carbon steel, 316 SS, 304 SS and chrome moly• Optional construction to ASME B31.1 for use in power plants
Process Temp Range:	−50° to +1200° F (−29° to +649° C)
Pressure Pressure:	Up to 3700 psig (255 bar)
Model Selection:	Refer to Magnetrol Bulletin 46-120 for model numbers, options and complete specification information.



Models F10 and F50 FLOW SWITCHES

Description:	The F10 and F50 are mechanical flow switches designed for use in horizontal flow lines. The F10 is a vane-actuated flow switch for use in lines 2" and greater in diameter. The F50 is a disc-actuated flow switch for use in lines 2" and smaller in diameter.
Measurement Principle:	Vane- and disc-actuated flow switches.
Features:	<ul style="list-style-type: none">• F10 mounting available threaded or flanged, carbon steel, 304 SS or 316 SS• F50 body available in bronze or 316 SS• F10 actuation flow rate is field-adjustable• F50 requires no calibration
Process Temp Range:	−50° to +450° F (−29° to +232° C) for F10 −50° to +750° F (−29° to +399° C) for F50
Process Pressure:	Up to 1000 psig (69 bar) for F10 Up to 1150 psig (79 bar) for F50
Model Selection:	Refer to Magnetrol Bulletin 47-116 for model numbers, options and complete specification information.



BOILER Level Switches

Providing Reliable Boiler Controls Since 1932

Description: Magnetrol boiler level switches are the first choice of the largest boiler manufacturers. Single-stage units provide reliable low water cut-off while multiple-stage water column style units provide boiler water level control.

Measurement Principle: Vertical float-actuated level switch.

Features:

- Reliable operation
- Single or multiple switch points
- Both fabricated and cast chambers available
- Water columns with try-cock and gauge glass connections
- Left hand and right hand water column mountings
- Pressures up to 600 pounds working steam pressure
- Available with a variety of electric and pneumatic switch mechanisms

Model Selection: Refer to Magnetrol Bulletin 46-118 for model numbers, options and complete specification information.



SPECIFICATIONS



Process Temp Range: -20° to +750° F (-29° to +399° C)

Process Pressure: Up to 900 psig (62 bar)

Specific Gravity: Down to 0.75

Chamber Material: Cast iron or fabricated carbon steel chambers

Float and Trim Parts: Brass chamber liners
Trim in 300 and 400 series SS or all 316/316L SS

Actuation Levels: One to three narrow differential set points

Switch Enclosures: Polymer power coat finished aluminum NEMA 4X/7/9 for Class I, Div. 1, Group B or Groups C & D areas, IEC Ex Ex d IIC T6, IP66 areas and ATEX Ex II 2 G EEx d IIC T6.

Switch Mechanisms: Dry contact, hermetically sealed, and pneumatic



Aurora Magnetic Level Indicator with Guided Wave Radar Transmitter

Achieve True Redundancy with this State-of-the-Art MLI

Description:

The Orion Instruments, a Magnetrol company, unique marriage of magnetic level indication with guided wave radar has resulted in a truly redundant level control instrument. Clamp-on reed, dry contact and pneumatic switches are also available to augment the transmitter output.

Measurement Principle:

Float and magnetic coupling and Eclipse Guided Wave Radar

Features:

- Large selection of materials of construction
- Unique "flux ring" within the float produces a strong, consistent magnetic field for reliable magnetic coupling
- Shuttle-type or flag indicators
- Broad range of process connection types and sizes
- Optional ASME B31.1, B31.3 or NACE construction
- Choice of scale units of measure
- High temperature and cryogenic insulation available

Model Selection:

Refer to Orion Instruments® Bulletin ORI-138 for model numbers, options and complete specification information.

SPECIFICATIONS

Process Temp Range:

-320° to +106° F (-196° to +538° C)

Process Pressure:

Full vacuum to 4500 psig (310 bar)

Specific Gravity:

Down to 0.35

Dielectric:

Down to 1.4

Chamber Material:

MLI materials of construction include 304/304L SS, 316/316L SS, Monel®, Hastelloy® C, titanium, Hastelloy B, 321 SS, Alloy 20, Inconel 625, Inconel 825, 347 SS, 904L SS and other non-magnetic alloys

Measuring Range:

12 to 600 inches (0.3 to 15.2 meters)

Transmitter:

24 VDC supply, 4-20 mA output, HART, FOUNDATION fieldbus™ or LCD optional

Indicators:

Shuttle-type follower or flags, visible from 100 feet

Scale:

Available in units of height (inches, centimeters), volume (gallons, liters), percentage of span or other custom units

Options:

Clamp-on Jupiter magnetostrictive transmitter and switches. Remote-mounted electronics, additional materials of construction, custom span, process connections, etc.



ORION
INSTRUMENTS
A Magnetrol Company

Aurora



Featuring

ECLIPSE
GUIDED WAVE RADAR

Atlas Gemini JUPITER



Additional Orion products available include Atlas and Gemini MLIs and the Jupiter magnetostrictive transmitter



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Worldwide Level and Flow Solutions™

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