

**MAGNE-SONIC**  
**300 SERIES**  
**4-20mA LEVEL TRANSMITTERS**

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# PART ONE - INTRODUCTION

## SECTION 1 - GENERAL INFORMATION

### 1.1 Description

The Series 310 RF electronic level transmitter is designed for continuous level measurement of conductive and non-conductive liquids, granular materials, slurries and interface applications. It can be used with any Magne-Sonics bare or insulated level sensing probe.

### Anti-Coating

The instrument contains special "anti-coat" circuitry to compensate for the effect of conductive coating which may build up on the level sensing probe surface.

### Output Flexibility

The transmitter provides a 4-20mA isolated output with adjustable damping. The unit may be field selected for direct or reverse acting output modes.

### 1.2 Product Identification

The serial number of your instrument is located on the electronic chassis next to the power input terminals. Write the serial number in the space provided below for convenient identification should technical assistance be required.

**Serial #** \_\_\_\_\_

## SECTION 2 - SPECIFICATIONS

### 2.1 Operational

Display None

Ambient Conditions..... -40 to 160°F (-40 to 71°C), 0 to 95% relative humidity, non-condensing

#### Power Requirements:

AC Line Powered..... 115 or 230 VAC, 50/60 Hz.

DC Powered..... 18 to 35 VDC

#### Level Probe to

Transmitter Distance..... 150 feet maximum (when Series 310 is remote mounted)

Analog Output..... Isolated 4-20mA, field selectable direct or reverse acting

#### Output Load:

AC Line Powered..... 600 ohms max. load

DC Powered..... 550 ohms max. load @ 24 VDC; for higher loads R=50 (V-13)

Output Damping..... Adjustable, 0.1 to 10 seconds

Anti-Coat Circuitry..... Phase shift type; compensates automatically for conductive coatings

Protection..... RFI, EMI and static charge

### 2.1 Performance

Zero Adj. Range..... 0 to 500 pF

Span Adj. Range..... 10 to 10,000 pF

Zero/Span Ratio..... 10:1 maximum

Linearity..... 0.5% of full scale

Temp. Stability..... Greater of 0.01 pF per °F or 0.01%  
of span per °F

### **2.3 Mechanical**

Enclosure

Standard..... Cast aluminum finish w/urethane  
finish - NEMA 4, 7 BCD and 9 EFG  
(weatherproof, hoseproof, dust and  
vapor explosion proof)

Optional..... PVC - NEMA 4X for corrosive areas

Net Weight..... 3.6 lbs. (1.63 kg)

## PART TWO - INSTALLATION

After unpacking, open the transmitter enclosure and inspect the electronic chassis for shipping damage. If there is evidence of damage, notify the carrier immediately. Save the small plastic screwdriver and banana plug for later use.

### SECTION 2 - MECHANICAL REQUIREMENTS

#### 2.1 Location

Mounting positions for the level probe should be carefully considered. The probe must be installed vertically and its length must be sufficiently long to handle the entire measuring range. Do not locate the level probe in a position where the inflow of measured material could contact it. Also, locations should be well clear of obstructions and agitators. Figure 2-1 illustrates typical mounting locations.

***Note!:** When measuring the level of a non-conductive material in an irregularly shaped vessel, the output will be non-linear due to the varying distance between the level probe and the vessel wall. In this case, mount the probe in a grounded metal standpipe or use a concentric shield level probe to linearize the output. This is not necessary if the measured material is conductive and grounded.*

*Figure 2-1 Typical Level Probe/Transmitter Locations*

Level probes used in granular materials should be located halfway between the vessel wall and the apex of the material pile created by the incoming material. The output will then be representative of the average level.

For applications involving a vessel with non-conductive walls, a ground reference plate or grounded reference level element is required. However, if the measured material is conductive and grounded, this is not necessary.

The Series 310 may be installed directly onto the level probe (integral mounting) or in a remote location up to 150 feet from the level probe.

***Note!:** Remote mounting is necessary when the temperature at the Series 310 exceeds its rated specification (-40 to 160°F) or if severe vibration exists. Triaxial interconnect cable must be used for remote mounting.*

The DC powered Series 310 is housed in a cast aluminum weatherproof and explosion proof enclosure allowing it to be located in Class I or II, Division 1 hazardous areas.

## **2.2 Integral Mounting**

The Series 310 has 1/2 inch NPT hole on the bottom center of the enclosure for direct mounting onto the installed level probe.

To install the level probe and the Series 310:

1. Install level probe into vessel opening without the Series 310 mounted on it. Use a wrench on the larger lower hex nut portion only of the two piece fitting to tighten level probe into vessel.

**CAUTION!:** Do not tighten or loosen the smaller upper hex nut portion of the two piece fitting. This is a compression seal that could be destroyed if the upper portion is turned.



### *Figure 2-2 Integral Mounting*

If level probe is welded into a mounting flange, simply bolt flange to the mating flange on the vessel.

2. Install banana plug onto back end of level probe extension by screwing it into the threaded hole.

**CAUTION!:** Do not tighten plug with excessive force it can be easily twisted off.

as

3. Carefully screw the Series 310 enclosure onto threaded upper portion of fitting on back end of level probe. The banana plug makes the necessary electrical connection to the electronic chassis. Screw until tight, but without excessive force to avoid stripping the aluminum threads.

*Note!:* It may be necessary to rotate enclosure to orient wiring entrances to a desired position. Use a wrench to hold the upper smaller hex nut stationary while turning the enclosure.

### **2.3 Remote Mounting**

An explosion proof junction box, which mounts onto the level probe, and triaxial interconnect cable are required to remote mount the Series 310. An optional remote-mount threaded adapter is also required to remote mount the Series 310.

1. Install level probe into vessel opening or flange mounting as previously described in Section 2.2, step 1.
2. Screw explosion proof junction box onto threaded upper portion of fitting on back end of level probe. The same "CAUTION" regarding the compression seal that's described in Section 2.2 - step 1 applies here when tightening and orienting junction box onto top of level probe.
3. Remote mount the Series 310 in as clean and dry a location as possible where minimal mechanical vibration exists. Avoid locations where corrosive fluids may fall on the instrument or where ambient temperature limits (-40 to 160°F, -40 to 71°C) may be exceeded.

#### A. Blind Style Model

1. Install remote mount threaded adapter into 1/2 inch NPT hole in bottom of enclosure casting.

*Note!:* The adapter must be solid fitting to preserve the explosion proof rating of the enclosure. (Should adapter become lost, do not use a pipe nipple in explosion proof applications. Also, use only approved explosion proof wiring seal fittings - not provided - in conduit entrance holes).

2. Surface mount the Series 310 with the remote mount threaded adapter within 150 feet of the installed level probe.

*Figure 2-3 Remote Mounting*

## SECTION 3 - ELECTRICAL CONNECTIONS

### 3.1 AC Line Powered

#### Level Probe

#### Integral Mounted Probe

Connect level probe to Series 310 via the banana plug installed onto back end of probe. The plug must be securely fastened and not damaged.

#### Remote Mounted Probe

Use only triaxial interconnect cable (P/N 1000-3073 for up to 160°F; P/N 1000-3074 for up to 392°F) to connect junction box terminals to Series 310. Any other type causes incorrect instrument operation. Refer to Figure 2-4 and connect triaxial cable, matching wires to terminals as follows:

#### Triaxial Cable Wires

#### Terminal Designations

Center wire

PROBE

Blue wire (inner shield)

SHIELD

Green wire (outer shield)

Ground symbol

*Figure 2-4 Level Probe Hook-up*

## Line Power

Line power requirements may be 115 VAC or 230 VAC depending on the model selected. Check which voltage is correct for the unit being installed. Refer to Figure 2-5 and connect line power to terminals designated "L1/HOT" and "GND" which are fuse protected. Use wiring practices which conform to local codes (National Electrical Code Handbook in the U.S.A.). This includes:

Using wire sizes recommended by the local code for primary power wiring.

Using only the standard three wire connection for AC wiring. The ground terminal grounds the instrument which is mandatory for safe operation.

*Figure 2-5 AC Line Power Hook-up*

## 3.2 DC Powered

### Level Probe

Integral Mounted Probe - Refer to same category in Section 3.1

Remote Mounted Probe - Refer to same category in Section 3.1

## DC Power and Output

### When Using Non-Indicating Power Supply

1. Refer to Figure 2-6 and connect non-indicating DC voltage power supply to terminals designated "18-35 VDC", matching polarity as shown.
2. Connect indicating device to terminals designated "4-20mA OUTPUT", matching polarity as shown. This isolated output can drive a load up to 550 ohms @ 24 VDC.

*Figure 2-6 DC Power and Output Hookup - Blind Style*

## DC Power (24VDC Two Wire)

### When Using Non-Indicating Power Supply

1. Refer to Figure 2-7 and connect non-indicating DC voltage power supply to terminals designated "18-35 VDC", matching polarity as shown.

*Figure 2-7 24VDC Two Wire (Loop Powered)*

# PART THREE - OPERATION

## SECTION 1 - OPERATING CONTROLS

All controls used for setup and operation are described in this section. Familiarize yourself with each item before operating the instrument. Use the small plastic screwdriver provided to make control adjustments. Do not force any adjustment past its stops to avoid breakage.

### 1.1 Calibration

#### 1. **ZERO COARSE** switch

Positions 0 through 9 progressively add 50 pF to the **ZERO FINE** control (item 2) adjustment. This switch is used in combination with the **ZERO FINE** control to establish the output signal.

#### 2. **ZERO FINE** control

Sets the exact zero level to 4 mA output. The range of adjustments is 60 pF in 40 turns.

**Caution!:** Do not force this 40 turn control past its adjustment stops to avoid breakage.

#### 3. **SPAN COARSE** switch

Positions 1 through 6 progressively changes the total span from a minimum of 0-10 pF to a maximum of 0-10,000 pF. This switch is used in combination with the **SPAN FINE** control (item 4) to establish the total span.

#### 4. **SPAN FINE** control

Sets the exact 100% level to 20 mA output. The range of adjustment is 30 turns.

### 1.2 Output Mode

#### 5. **REV/DIR** switch

Selects output to be direct (**DIR**) or inverted (**REV**):

**DIR** - Output increases from 4 mA to 20 mA as measured level rises.

**REV** - Output decreases from 20 mA to 4 mA as measured level rises.

### **1.3 Output Damping**

#### **6. RESP control**

Dampens output signal via an RC time constant circuit from 0.1 to 10 seconds by turning clockwise (270° rotation).

*Figure 3-1 Control Panel Layout - Blind Style*

## SECTION 2 - CALIBRATION

### 2.1 With Output in Direct Acting Mode

#### Setting Zero Level Output

With material at the desired low level (0% full) on the level sensing element:

1. Connect a milliamp meter to the Series 310 to monitor the 4-20mA loop current:
  - A. Connect milliamp meter with test leads to "TEST" jacks located on control panel, matching polarity as indicated.
  - B. Connect a load across - or short together - the "4-20mA OUTPUT" terminals. See Part One, Section 2 specifications for maximum allowable load resistance.

***Note!:** If the milliamp meter resistance is more than 25 ohms, disregard steps 1 and 2. Instead, connect the milliamp meter in series with a load across the "4-20mA OUTPUT" terminals. Do not exceed maximum allowable resistance.*

2. Place the following controls and switches to these settings:

<u>Control</u>	<u>Setting</u>
<b>ZERO COARSE</b> switch.....	<b>0</b>
<b>ZERO FINE</b> control.....	Fully counterclockwise
<b>SPAN COARSE</b> switch.....	<b>1</b>
<b>SPAN FINE</b> control.....	Fully counterclockwise
<b>REV/DIR</b> switch.....	<b>DIR</b>
<b>RESP</b> control.....	Fully counterclockwise

**Caution!:** The **ZERO FINE** control is a glass component. To avoid breakage, do not force it past its 40 turn adjustment stops.



***Note!:** The **SPAN FINE** control does not have adjustment stops. To set it to the end of its travel, slowly turn counterclockwise (left) until a "soft clicking" sound is heard while turning.*

3. Apply power to the instrument. The milliamp meter reading should be 20 mA or higher.
4. Increase **ZERO COARSE** switch setting in clockwise steps until the milliamp meter reads 4 mA or lower. Then turn switch back (counterclockwise) one position step. The output should increase to 20 mA or higher again. Leave **ZERO COARSE** switch at this setting. If switch is at position **9** and output is not yet at 4 mA or lower, leave at setting **9**.
5. Turn **ZERO FINE** control slowly clockwise (right) until the milliamp meter reads exactly 4 mA. This is the output at 0% full level. Leave **ZERO FINE** control at this setting. If output cannot be adjusted to 4 mA, the zero adjustment range has been exceeded. Consult factory for assistance.

#### Setting The Full Level Output

1. Change **SPAN COARSE** switch setting from **1** to **6** and **SPAN FINE** control setting from fully counterclockwise to fully clockwise (approximately 30 turns).
2. Manually raise the measured material level up to the desired "full level" position on the level sensing element. The milliamp meter reading should be less than 20 mA. If the reading is higher than 20 mA, the measuring element has produced a capacitance change greater than the maximum span of the instrument. This is unlikely, except in cases where the measuring element is very long and submerged in conductive material.

***Note!:** If the material level cannot be raised up to the desired full level position, refer to the "special case" box on the next page for instructions.*

3. Decrease **SPAN COARSE** switch setting in counterclockwise steps until the milliamp meter reads higher than 20 mA. Then turn switch forward (clockwise) one position step. The output should decrease below 20 mA again. Leave **SPAN COARSE** switch at this setting. If

switch is at position **1** and output is still below 20 mA, leave at setting **1** and proceed with step **4**.

4. Turn **SPAN FINE** control slowly counterclockwise (left) until the milliamp meter reads exactly 20 mA. This is the output at 100% full level. Leave **SPAN FINE** control at this setting. If output cannot be adjusted to 20 mA, the capacitance change produced by the level element is less than the minimum measurement span. Consult factory for assistance.

The instrument is now calibrated.

#### SPECIAL CASE FOR SETTING FULL LEVEL OUTPUT

It may not be possible to raise the material level up to the desired "full level" position due to lack of sufficient material. In this case:

- A. Bring as much material into the vessel as possible. Then calculate the standing level as a percentage of the total level span and convert this value to mA on a 4-20 mA scale.
- B. Perform steps 3 and 4 exactly as previously described except using the appropriate calculated mA value instead of 20 mA (12 mA for this example).

**Note!:** *Calibration using less than a 25% full span level change is not recommended. It may be necessary to recalibrate the full level at a later time when the vessel is full*

#### Adjusting Output Signal Damping

Output damping is provided to damp a constantly changing output signal caused by turbulent material level. Turning the **RESP** control clockwise (right) increases the damping from 0.1 to 10 seconds. Turn this control slowly clockwise until any output ripple is no longer evident.

#### 2.2 With Output in

## **Reverse Mode**

The switch and control settings described in Section 2.1 are exactly the same except set the **REV/DIR** switch to the **REV** position.

The calibration procedure is exactly the same as in the direct acting mode except that 20 mA is substituted for 4 mA and 4 mA is substituted for 20 mA wherever referenced.

See Figure 4-1 for a simplified schematic diagram pertaining to these descriptions:

1. The power supply section (not shown) converts line power to appropriate voltages for circuit operation.
2. The OSCILLATOR section produces the triangle wave signal used to measure the probe impedance and several square wave signals used to synchronize other parts of the circuit.

A voltage controlled square wave oscillator operates at a frequency four times that of the measuring signal. Two "flip-flops" divide the oscillator frequency and produce four square waves with a 90° phase difference between each successive signal. One of these square waves is applied through a resistor to a capacitor. The result, a low voltage triangle wave with low distortion, becomes the SHIELD signal.

*Figure 4-1 Instrument Operations Schematic Diagram*

The SHIELD signal is gated with analog switches controlled by two of the square wave signals to a differential amplifier which produces an output voltage proportional to the peak-to-peak voltage of the SHIELD signal. This voltage is compared to a reference voltage by

another differential amplifier which produces an output voltage that is used to adjust the frequency of the voltage controlled oscillator. If the SHIELD voltage is too low, the amplifier output increases. This increases the period of the signal which allows the capacitor to charge to a higher voltage. The reverse occurs if the voltage is too high. This feedback circuit maintains a constant SHIELD signal voltage and compensates for any circuit drift and for any capacitance at the SHIELD terminal from any cable connected there.

3. In the DETECTOR section, the SHIELD signal voltage is amplified and applied to an adjustable ZERO capacitor which is connected to the PROBE terminal. The probe forms a variable capacitor to ground. A large adjustable SPAN capacitor is connected between the PROBE and SHIELD terminals. Since the impedance of the SPAN capacitor is much lower than that of the ZERO or PROBE capacitors, the voltage on the PROBE terminal is approximately equal to the voltage on the SHIELD terminal. When the ZERO and PROBE capacitors are equal, no current flows through the SPAN capacitor. As the PROBE capacitance increases due to increasing level in the vessel, current through the SPAN capacitor increases. This current produces a very small voltage across the capacitor which is transformer coupled to the input of a high gain amplifier.

The output of the amplifier is gated by analog switches to a differential amplifier which produces a voltage proportional to the capacitance difference. The harmonic content of the triangle wave signal and the operation of the analog switches allow the circuit to ignore the effect of probe buildup. The differential amplifier includes a FINE SPAN adjustment which controls its gain.

4. The OUTPUT section includes an adjustment to vary the unit's response time to allow it to produce a steady output signal level even when there is turbulence in the vessel. A switch controls whether or not the resulting signal is inverted before being converted to an output current. If the signal is not inverted, the output is direct acting and will

increase with rising level. If inverted, the output is reverse acting, (decreases with rising level).

## PART SIX - SPARE PARTS & ACCESSORIES

	<b>Description</b>	<b>Part Number</b>
Accessories for Remote Mounting	Threaded Adapter (blind style).....	1000-3071
	Explosion Proof J-Box (with jack and terminal strip).....	1000-3072
	Triaxial Interconnect Cable* (for temperatures up to 160°F).....	1000-3073
	Triaxial Interconnect Cable* (for temperatures up to 450°F).....	1000-3074
	*Cable has stripped and tinned wires at each end. It connects the Series 310 to level probe j-box. Specify length up to 150 feet.	
Electronic Chassis Assemblies	Blind Style DC Powered (18-35 VDC).....	690-7005-101
	Blind Style 115 VAC (four wire).....	690-7005-201
	Blind Style 230 VAC (four wire).....	690-7005-401
Fuse	1/4 Amp Slo-blow Fuse.....	99X1F1036