Installation and Operating Instructions

For
Drexelbrook Series 408-800 Level Transmitters
Using Cote Shield™ Electronics

FOR FACTORY SERVICE, CALL TOLL FREE: 1-800-527-6297
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1.0 Introduction

The instructions in this manual are for the Drexelbrook MagiCal™ 408-800 Series transmitter for level measurement in liquids, slurries, interfaces and granulars.

These transmitters are available with either fixed-span or selectable-span ranges. No field calibration is needed. The 408-800 transmitters are designed for use with the DE8000™ microprocessor based measuring system or the Tru-View™ material inventory information system. Calibration of the transmitters is done from one central keyboard. (See instruction manual for the DE8000)

1.1 System Description

Each Drexelbrook 508-2X-XX MagiCal™ system consists of a 408-800 Series two-wire electronic unit, a 700 Series sensing element (probe), and a 380 Series connecting cable.

The system model numbers indicate the application where they most often will be used:

508-25-X: For conducting liquids
508-26-X: For liquid/liquid interfaces
508-27-X: For insulating liquids
508-29-X: For granular solids

The final digits in the transmitter model number refer to the type of 700 Series sensing element used. A 508-29-1 transmitter uses a 700-205-78 type sensing element for measuring level in granular solids.

In the two-wire transmitter, the current supplied to the electronic unit from an external power supply is the same current used for the transmitter output signal. See Figure 1-1.

1.2 Models Available

1.2.1 Electronic Chassis

The following is a partial list of the various 408-800 Series chassis models available:

408-800-1 - Basic electronic unit intended for use with insulating materials, interfaces, and semi-conducting granulars. Standard frequency 100 KHz.

408-830-1 - Basic electronic unit modified for use with conductive materials and certain insulating granulars.

408-8X2-1 - Time delay option added.
Introduction

There are two plug-in (401-28 Series) span modules available with the 408-800 Series transmitters. One module has an 8-position span switch for a range of 8 pF to 40,000 pF (Modif. 91-38). The other module is supplied with a fixed span capacitor (Modif. 91-23 to 91-37), factory installed according to sensing element capacitance ratings and application parameters. Both of these modules can be easily changed in the field. See Figures 1-2 and 1-3.

explosionproof housings. A “1” in the last position of instrument number indicates chassis only, no housing. Example, 408-800-1 means chassis only. The standard housing meets the following Nema classifications:

1 General Purpose
2 Drip Tight
3 Weather Resistant
4 Waterproof
5 Dust Tight
12 Industrial use: oil and dust tight

For typical dimensions of the standard housing, see Figure 1-4.

Fig. 1-4
Weatherproof Housing

The explosionproof housing is suitable for Class I Groups C and D, Class II Groups E,F, and G (Div. 1 and 2). For dimensions of the explosionproof case, see Figure 1-5.

Fig. 1-5
Explosionproof Housing

1.2.2 Housings

The 408-800 Series electronic units are available in either standard weatherproof, Nema 4, or

408-800-LM/P. 4
1.2.3 Sensing Elements

The following sensing elements are most often recommended with a 508-12-XX transmitter according to the application requirements. See Section 1.3.2 for detailed specifications. This listing does not include all of the sensing elements available with the 508-2X-XX series transmitters. For identification, the last digits of the sensing element model number are stamped into the mounting gland. If you have additional questions about sensing elements, contact the factory or your local representative.

![Typical Sensing Element Diagram]

**Fig. 1-6**

**Typical Sensing Element**

700-2-57 - Heavy duty, rigid sensing element for most conducting liquid and interface measurements.

700-2-51 - Flexible sensing element for longer insertion lengths in waterlike conducting liquids.

700-2-18 - Flexible sensing element for agitated conducting liquids and for granulars.

700-2-19 - Heavy-duty, flexible sensing element for highly abrasive mineral granulars.

700-202-23 - Rigid 3-terminal sensing element for short range spans in insulating liquids and granulars.

700-205-78 - Flexible sensing element with slack adjuster for insulating liquids and granulars.

1.2.4 Connecting Cables

Typically, the electronic unit and sensing element are connected by a three-terminal coaxial cable. Drexelbrook cables are available in:

General Purpose: 380-XXX-12

High Temperature: 380-XXX-11

Composite: 380-XXX-18 (first 10 feet high temp.)

The XXX in the model number indicates the length of the cable in feet. 25 feet is standard, but cut lengths up to 100 feet are available. Cable can also be purchased in bulk lengths with termination kits. Contact factory for maximum recommended lengths for your application.

408-800-LM/P. 5
1.3 Technical Specifications

1.3.1 Electronic Unit

A. Power requirement: 24 Vdc max. (To be used with Tru-View™ or DE8000™ only).

B. Input range:

| Selectable Span Range Card (Modif. 91-38) | 8pF to 40,000 pF |

Each of the eight steps on the selectable span range card correspond to one of the fixed range cards listed below.

<table>
<thead>
<tr>
<th>Step #</th>
<th>Corresponding Fixed Span</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>(Modif. 91-23)</td>
</tr>
<tr>
<td>2</td>
<td>(Modif. 91-25)</td>
</tr>
<tr>
<td>3</td>
<td>(Modif. 91-27)</td>
</tr>
<tr>
<td>4</td>
<td>(Modif. 91-29)</td>
</tr>
<tr>
<td>5</td>
<td>(Modif. 91-31)</td>
</tr>
<tr>
<td>6</td>
<td>(Modif. 91-33)</td>
</tr>
<tr>
<td>7</td>
<td>(Modif. 91-35)</td>
</tr>
<tr>
<td>8</td>
<td>(Modif. 91-37)</td>
</tr>
</tbody>
</table>

Fixed Span Range Card:

- (Modif. 91-23): 8pF to 17pF
- (Modif. 91-24): 8pF to 26pF
- (Modif. 91-25): 8pF to 40pF
- (Modif. 91-26): 10.4pF to 69pF
- (Modif. 91-27): 18pF to 120pF
- (Modif. 91-28): 30.7pF to 205pF
- (Modif. 91-29): 57pF to 380pF
- (Modif. 91-30): 101pF to 675pF
- (Modif. 91-31): 180pF to 1200pF
- (Modif. 91-32): 315pF to 2100pF
- (Modif. 91-33): 570pF to 3800pF
- (Modif. 91-34): 1080pF to 7200pF
- (Modif. 91-35): 1875 to 12,500pF
- (Modif. 91-36): 3300 to 22,000pF
- (Modif. 91-37): 6000 to 40,000pF

C. Output range: Span of 1.6mA to 16mA within 4-20 mA range.

D. Linearity: ± 0.5%.

E. Load resistance: \( V_s - 13k \Omega \) (i.e. max 550 @ 24VDC) \( .02 \)

*Where \( V_s \) = power supply voltage

F. Temperature effect: ± 0.35% per 30°F or ± 0.15 pF whichever is larger (16mA dc span).

G. Effect of load resistance: 0.2% or less for full resistance range at 24 VDC supply.

H. Response to Step Change: 20 milliseconds std. (To 90% of final value); 0-30 seconds available in time delay units.

I. Fail-Safe: Field adjustable. Low-Level Fail-Safe (LLFS) std. Also called direct acting because current increases as the level increases. High-Level Fail Safe (HLFS). Also called reverse acting because current decreases as level increases.

Note: THERE ARE NO DEVICES THAT ARE ABSOLUTELY "fail-safe". "Fail-safe" means that in the event of the most probable failures, the instruments will fail safely. "Most probable failures" means such things as loss of power and most transistor and component failures. If your application needs absolute fail-safe, a backup instrument should be installed.

J. Ambient temperature: -40° to 140°F (-40° to 60°C).

K. Lowest permitted resistance (sensing element to ground): 100Ω

L. Intrinsic Safety: Sensing element and cable are intrinsically safe for Class I Groups A, B, C and D; Class II Groups E, F and G (Div. 1 and 2).

Electronics and signal wires are intrinsically safe for Class I Groups C and D, Class II Groups E, F and G (Div. 1) when powered by an intrinsically safe power supply. Non-incendive for Class I Groups A, B, C, and D; Class II Groups E, F, and G (Div. 2).
### 1.3.2 Sensing Elements

<table>
<thead>
<tr>
<th>Model #</th>
<th>Std. Mat. of Construction</th>
<th>OD &amp; Mtg.</th>
<th>Temp. and Pressure Limits</th>
<th>Max Rec. Insertion Length</th>
<th>Sensing Element Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>700-1-22</td>
<td>TFE COVERED ROD</td>
<td>ROD 3/8&quot; OD 3/4&quot; NPT</td>
<td>100°F @ 1000 PSI 300°F @ 500 PSI</td>
<td>20 FT.</td>
<td>2-TERM RIGID</td>
</tr>
<tr>
<td>700-1-24</td>
<td>TFE COVERED ROD W/CS CONCENTRIC SHIELD</td>
<td>CONCENTRIC SHIELD 1.66&quot; OD 1 1/2&quot; NPT</td>
<td>100°F @ 1000 PSI 300°F @ 500 PSI</td>
<td>20 FT.</td>
<td>2-TERM RIGID</td>
</tr>
<tr>
<td>700-1-34</td>
<td>TFE COVERED ROD W/CS CAGE</td>
<td>CAGE 4.026&quot; OD 4&quot; 150# FLANGE</td>
<td>100°F @ 1000 PSI 300°F @ 500 PSI</td>
<td>19 FT.</td>
<td>2-TERM RIGID</td>
</tr>
<tr>
<td>700-2-24</td>
<td>TFE COVERED ROD</td>
<td>Rod 3/4&quot; OD 3/4&quot; NPT</td>
<td>100°F @ 1000 PSI 450°F @ 500 PSI</td>
<td>14 FT.</td>
<td>2-TERM RIGID</td>
</tr>
<tr>
<td>700-2-27</td>
<td>TFE COVERED ROD</td>
<td>ROD .54&quot; OD 3/4&quot; NPT</td>
<td>100°F @ 1000 PSI 300°F @ 500 PSI</td>
<td>12 FT.</td>
<td>2-TERM RIGID</td>
</tr>
<tr>
<td>700-2-37</td>
<td>* X COVERED ROD</td>
<td>ROD .54&quot; OD 3/4&quot; NPT</td>
<td>100°F @ 1000 PSI 250°F @ 500 PSI</td>
<td>13 FT.</td>
<td>2-TERM RIGID</td>
</tr>
<tr>
<td>700-2-57</td>
<td>* X COVERED ROD</td>
<td>ROD .84&quot; OD 1&quot; NPT</td>
<td>100°F @ 1000 PSI 250°F @ 500 PSI</td>
<td>20 FT.</td>
<td>2-TERM RIGID</td>
</tr>
<tr>
<td>700-5-14</td>
<td>TFE COVERED CABLE</td>
<td>CABLE 1/8&quot; OD 3/4&quot; NPT</td>
<td>250°F @ 50 PSI</td>
<td>400 FT.</td>
<td>2-TERM FLEXIBLE</td>
</tr>
<tr>
<td>700-5-18</td>
<td>* X COVERED CABLE</td>
<td>CABLE 5/16&quot; OD 3/4&quot; NPT</td>
<td>100°F @ 1000 PSI 250°F @ 500 PSI</td>
<td>200 FT.</td>
<td>2-TERM FLEXIBLE</td>
</tr>
<tr>
<td>700-5-19</td>
<td>URETHANE COVERED CABLE</td>
<td>CABLE 3/4&quot; OD 2&quot; NPT</td>
<td>150°F @ 50 PSI</td>
<td>200 FT.</td>
<td>2-TERM FLEXIBLE</td>
</tr>
<tr>
<td>700-202-23</td>
<td>BARE 304 SS ROD</td>
<td>ROD 1/2&quot; OD 1 1/2&quot; NPT</td>
<td>100°F @ 1000 PSI 450°F @ 500 PSI</td>
<td>10 FT.</td>
<td>3-TERM RIGID</td>
</tr>
<tr>
<td>700-205-78</td>
<td>* X COVERED CABLE</td>
<td>CABLE 5/16&quot; OD 1&quot; NPT</td>
<td>250°F @ 5 PSI</td>
<td>200 FT.</td>
<td>3-TERM FLEXIBLE</td>
</tr>
</tbody>
</table>

*"X" is a fluorocarbon-type insulation.*
1.3.3 Three-Terminal Cable

A. General Purpose 380-XXX-12: .51" OD at largest point, 160°F temp limit.

B. Composite Cable (first 10 ft. high temp) 380-XXX-18: .62" OD at largest point, 450°F temp limit for first 10 ft. 160°F temp limit for remainder.

C. High Temp. Cable 380-XXX-11: .51" OD at largest point, 450°F temp limit.
2.0 Theory of Operation

2.1 The Electronic Unit

The theory of operation for the Cote-Shield™ electronic unit is similar to the theory of a capacitance electronic unit, but with two very important circuit additions. These additions followed an important discovery about the electrical nature of a conductive coating which will be discussed in the paragraph that follows.

Figure 2-1 shows a block diagram of a three-terminal Cote-Shield™ transmitter with the critical circuits shown in heavy outline.

These are the OSCILLATOR BUFFER and the CHOPPER DRIVE circuits. The need for these circuits is determined by the electrical nature of the signal produced by a sensing element (probe) with a conductive coatings above the level.

Figure 2-2A shows a vessel filled with a highly conductive material. Since the material is conductive, the ground is at the outside surface of the probe insulation in the bulk liquid, and the electronic unit sees a pure capacitance. In this case, either a capacitance or a Cote-Shield (more technically an admittance) transmitter can adequately measure the level.

As the vessel is drained, the picture changes. What was before a pure capacitance circuit now contains a resistive element, because the resistance in the coating is much higher than in the bulk liquid.

When resistance enters the sensing element circuit, energy is consumed in the resistance of the coating and draws down the oscillator voltage. This results in output error. To prevent this problem, a buffer amplifier is placed between the oscillator and bridge circuits so that the loss in power does not affect the
The coating must be electrically "long" for this measurement to work perfectly. How long will depend on the thickness of the coating, the capacitance of the sensing element, the sensing element diameter, and the frequency at which the measurement is made. Generally, a coating of several inches to one foot is long enough not to produce an error. Shorter coatings have some error, but only a fraction of the length of the coating. For any one set of parameters, the coating error is in inches, not percent. A set of conditions that produces a coating error of one inch will always produce an error of one inch, regardless of the sensing element length or calibrated span.

By the time this instrument was developed, the three-terminal sensing element bridge circuit had already been in use for several years in the on/off (Cote-Shield) control. By replacing the older balanced bridge with a three-terminal measuring circuit, the two-wire instrument eliminates the need for a compensate cable and generally permits longer distances between the sensing element and the transmitter. A further improvement in the bridge circuit allows spans as high as 40,000 pf, instead of the 4000 pf allowed in the older models. This span increase permits measurements in larger vessels and makes it possible to use...
sensing elements with higher capacitance and improves the instrument's ability to reject the effects of coatings. A great advantage of this unit is that the two-wire transmission can be made intrinsically safe. This often removes conduit and explosionproof requirements, and eliminates safety hazards to the instrument mechanic.

All of the above circuitry is fed from a conventional two-wire 4-20 mA power source where the first 4 mA runs the circuitry and the current from 4-20 mA is the output signal.

2.2 Sensing Elements

The necessary change of input capacitance is provided by a sensing element or "probe", which is mounted in or near the material being measured.

Sensing elements are available in many forms, depending chiefly on the application factors of temperature, pressure, insertion length, and the characteristics of the product being measured; such as viscosity, coating, corrosion, conductivity, and dielectric constant. When these properties are known, the factory will select the correct sensing element for the application.

Sensing elements are of two general types - immersion and proximity.

Immersion type sensing elements can be divided into two general categories, "insulated" and " uninsulated".

Uninsulated or "bare" immersion sensing elements have a bare metal probe to sense the product. These are commonly used when the product being measured is nonconducting and not highly corrosive. See Figure 2-3.

Insulated immersion sensing elements have the probe covered in an insulating material such as teflon or glass. Insulated sensing elements may be used in applications measuring conductive or nonconductive products. See Figure 2-4.

Fig. 2-4
Insulated Sensing Element

Proximity-type sensing elements are used for short spans when it is necessary or desirable that the material being measured does not come in contact with the sensing element. See Figure 2-5.

Fig. 2-5
Proximity-Type Sensing Element

For long insertion lengths or where head clearance is a problem, flexible cable probes are also available in both insulated and bare metal models.

2.3 Connecting Cables

the Drexelbrook 508-2X-XX series transmitters typically use a three-terminal coaxial cable to connect the sensing element to the electronic unit. The center wire of the cable carries the change in capacitance signal from the probe to the electronic unit, while the coaxial shield is driven at guard potential (sometimes called (Cote-ShieldTM). The purpose of the shield is to eliminate any
capacitance from the center wire to ground. As a result, the cable capacitance does not interfere with the capacitance signals from the probe. There is no need for the electronic unit to "zero out" the cable capacitance in order to get a reliable reading. The shield also prevents output errors due to changes in cable capacitance caused by temperature. See Figure 2-6.

Fig. 2-6
Typical Coax Cable
3.0 Installation

3.1 Unpacking

Carefully remove the contents of the carton and check each item against the packing list before destroying any packing material. If there is any shortage or damage, report it immediately to the factory.

3.2 Mounting the Electronics

The 408-800 Series transmitter was designed for field mounting, but it should be mounted in a location as free as possible from vibration, corrosive atmospheres, and any possibility of mechanical damage. For convenience at start-up, mount the instrument in a reasonably accessible location. Ambient temperatures should be between -40°F and 140°F (-40°C and 60°C). See Figure 3-1.

![Figure 3-1](image)

**Fig. 3-1**
Typical Mounting Dimensions

3.3 Mounting the Sensing Element

The mounting location for the sensing element (probe) is often determined by the placement of nozzles or openings in the vessel. The sensing element should not be placed in a fill stream. When there is no suitable location inside a vessel, an external side arm or float cage can be considered.

The following sensing element mounting and installation instructions should be followed so that the equipment will operate properly and accurately:

**A.** In applications requiring an insulated sensing element, use particular care during installation. There is always the danger of puncturing the insulating sheath, especially with the thin-walled, high capacitance probes.

**B.** Sensing elements should be mounted so they are not in the direct stream of a filling nozzle or chute. If this is not possible, a deflecting baffle should be installed between the probe and the fill.

**C.** Do not take a sensing element apart or loosen the packing glands.

**D.** Tighten the sensing element with the wrench flats nearest the mounting threads.

**E.** If waves caused by agitation make the output unsteady, consult the factory for the correct solution to the problem.

3.4 Wiring the Electronic Unit

See Figure 3-2 for wiring connections to the adjustable span module. See Figure 3-3 for wiring connections to the fixed span module. In both cases, the orange wire goes to the shield (SH) terminal and the white wire goes to the center wire (CW) terminal.

![Figure 3-2](image)

**Fig. 3-2**
Wiring Connections to the Adjustable Span Module
Installation

The signal connections are made to the terminal strip(s) on the chassis. Due to the low power consumption of the instrument, the wiring need only be light gauge. See Figure 3-4 for proper connections.

Caution: Before using Intrinsic Safety Barriers, read the manufacturer's instructions for barrier operation. Barriers supplied by Drexelbrook Engineering Company, and prewired to the power supply, have already been tested for proper operation. See Figure 3-6.

Only coaxial cables supplied by Drexelbrook Engineering Company should be used to connect the cable from the sensing element to the transmitter and the sensing element.

Fig. 3-3
Wiring Connections to the Fixed Span Module

Fig. 3-4
Power/Signal Connections

Fig. 3-5
Cable Connections to Transmitter

Fig. 3-6
Typical Intrinsic Safety Barrier
The 408-800 has a built-in current limiter which holds the signal current to a maximum of 35 mA. Check to make sure that the barriers being used will limit current to less than 35 mA. Make sure that the voltage applied will not exceed the barrier voltage rating.

3.5 Sensing Element Connections

The cable connections to the sensing element are shown in Figures 3-7A and 3-7B. Do not connect the cable to the sensing element until after the sensor has been installed in the vessel and the conduit housing has been screwed on securely. Two-terminal probes do not have a shield connection. Be sure to clip and/or tape the shield wire at the probe end of the cable. See Figure 3-7A.

If spark protection is supplied, use the following instructions for installing the spark protector in the sensing element conduit. See Figure 3-8.

A. Attach the mounting link on the spark protector to the probe center connection screw.

B. Connect the green wire from the spark protector to the ground screw.

C. Feed the cable into the conduit.

D. Connect the cable center wire (CW) to the spark protector and the ground wire (gnd) to the ground screw as shown.

E. For two terminal sensing elements, clip and tape the shield wire as shown in Figure 3-7A.
4.0 Calibration

4.1 Span and Adjustments

The 408-800 Series transmitters are factory-set to maintain a zero reading close to 4mA regardless of the span capacitance. However, zero will not necessarily be 4mA and 100% will not necessarily be 20mA.

Once the transmitter has been set for a coarse span, with either the 8-position switch or a fixed capacitor, the MagiCal software is used to calibrate the instrument. (See the instruction manual for either the DE8000 or Tru-View). Given any two level points, the MagiCal software will calculate the current to level ratio from which the 0% to 100% level output is determined.

If the calculated 0% level has a current output of less than 3.5mA, or the 100% level has a current output greater than 22mA, an error message will be displayed and the calibration input data will be rejected. An output of less than 3.5mA may mean transmitter malfunction. Consult the factory Service Department. An output greater than 22 mA means the span should be readjusted to the next higher step.

**Note:** Fixed span capacitors are specified according to the calibration characteristics of a specific application. In the event of a transmitter failure, be sure that the same fixed-span capacitor stays with the appropriate channel. It can be used with a replacement electronic unit.

On the transmitter with the adjustable-span control, each step position increases the range by a factor of approximately 3X. See Section 1.3.1. Usually, the higher the pF per foot of the sensing element in air, the higher the position on the span control that should be used. For best temperature stability, choose the step span position (or span capacitor) that produces an output closest to, but not above, 20 mA for the 100% level.

On units with the time delay option (adjustable damping), calibrate the channel with the time delay off. Then set it after the calibration.

4.2 Time Delay Control

Time delay or adjustable damping is available on most Drexelbrook level transmitters. See Figure 4-1. It is a RC time constant circuit that is switchable from 0 to 30 seconds. For most applications requiring damping, five or ten seconds is usually sufficient. Calibration of the transmitter is done with the time delay turned off.

![Time Delay Unit](image)

See Figure 4-1. After calibration is complete, the time delay can be added, without affecting the calibration, by turning the control knob clockwise. Occasionally, when the time delay is first turned on, there is a temporary upset in the transmitter output until the circuit settles out.

4.3 Below-Chassis Adjustments

There are two adjustments below the chassis that are set by the factory and normally do not need to be changed. However, if necessary, they may be reset by field personnel. They are the fail-safe selector and a modification procedure for changing the 408-800 to a 408-830.
4.3.1 Fail-Safe Selector

The fail-safe selector determines whether increasing or decreasing level will cause the output current to increase. It is a movable link located on a P.C. board on the right side of the chassis. See Figure 4-2.

![Fail-Safe Link](image)

**Fig. 4-2**
Fail-Safe Link

The instrument is supplied as low-level fail-safe unless otherwise specified. However, it may be changed in the field, after which it must be recalibrated.

To change the fail-safe of the instrument, take the chassis out of the housing by removing the four holddown screws and lifting up. See Figure 4-3. To change the fail-safe link, loosen the fail-safe screw that the link is attached to and swing the link to the other fail-safe screw. When the link is in place, tighten down both screws. Do not force. See Figure 4-2.

Low-Level Fail-Safe is also called DIRECT ACTING. This is the most commonly used fail-safe position FOR CONTINUOUS INSTRUMENTS. Output CURRENT INCREASES as the LEVEL INCREASES. In the event of most probable failures, the output current will drop and indicate LOW LEVEL.

![Electronic Unit in Typical Housing](image)

**Fig. 4-3**
Electronic Unit in Typical Housing

High-Level Fail-Safe is called REVERSE ACTING. Output CURRENT INCREASES as the LEVEL DECREASES. In the event of most probable failures, output current will drop indicating HIGH LEVEL.

4.3.2 408-830 Modification Procedure

The following procedure can be used to modify a basic 408-800 electronic unit to a 408-830 electronic unit. See Figure 4-4. It should only be used when the application makes it necessary. Consult factory.

![Modification Procedure for 408-830](image)

**Fig. 4-4**
Modification Procedure for 408-830
Calibration

a. Locate the jumper on the Oscillator P.C. Board toward the middle of the board.

b. Unsolder the end of this jumper which is presently on the land connected to C7.

c. Solder the free end of the jumper to the land joining R12.

d. To convert 408-830 unit to a 408-800 unit, follow the preceding instructions in reverse.

4.4 Start-Up

Before applying power to the instrument, be sure that the input power will be from 13 to 100 VDC. Check all wiring connections, observing polarity of the output loop.

Caution: Explosionproof Units in Hazardous Areas: Before the explosionproof housing cover is removed to calibrate the instrument, the area must be checked and known to be nonhazardous. When calibration is complete, the housing cover must be replaced. Each lead from the explosionproof case must be equipped with an approved seal fitting.

4.5 Calibration

For transmitters to be used with DE8000 systems, see Instruction Manual 602-8000-LM. For Tru-View systems, see Instruction Manual 601-1000-LM. Also see Section 4.1.

Note: If entering the low point first, it is a good idea to record the current for each step span position that falls below 20 mA.
5.0 Troubleshooting

5.1 Introduction

The 408-800 Series instruments are designed to give years of unattended service. No periodic or scheduled maintenance is required.

A spare chassis is recommended for every 10 units so that, in case of a failed unit, a critical application will not be held up while the unit is returned to the factory for repair.

If a difficulty occurs when operating your measurement system, divide the system into its component parts and test each part individually for proper operation.

These troubleshooting procedures should be followed in checking out your system. If attempts to locate the difficulty fail, notify your local factory representative or call the factory direct and ask for the service department.

5.2 Testing the 408-800 Series Electronic Unit

5.2.1 Operation Check

A. Remove the sensing element and signal wires from the transmitter.

B. Be sure Fail-Safe link is in low-level fail-safe position. See Figure 5-1.

C. Observing polarities, connect a DC milliammeter and DC power supply (13 to 100 volts) in series, and complete the loop by connecting Terminals 1 and 2. See Figure 5-2.

D. Select a capacitor that is 50% of the maximum span range of the span module used. Connect this capacitor across probe to ground inputs (Terminals 7 and 9). A capacitance standard adjusted to 50% can also be used. Signal loop current should be at or near 12 mA. If so, the instrument is probably working correctly.

E. If the difficulty has not been located at this point, proceed to the next checkout procedure.
5.2.2 Drift Check

If the output of a transmitter seems to be drifting, it is important to determine whether the drift is in the transmitter or in the probe. (A properly connected cable never drifts.)

A. Remove the sensing element cable from the transmitter.

B. Connect a capacitance standard or an NPO capacitor* across the probe to ground input. Adjust the capacitance standard or select a capacitor value that will bring the unit on scale.

*The capacitor should remain stable with changes in temperature.

C. Observe the reading over a 24-hour period to see if it is stable.

D. If the reading is stable, the sensing element or the application must be the source of the drift. If the reading drifted, return the instrument for repair. Be sure to mark on the tag that the problem is drift. (List the capacitor size and mA deviation.)

5.3 Checking the Two-Wire System Loop. See Figure 5-3

A. With the probe disconnected, disconnect the power from Terminals 1 and 2 and measure the open circuit voltage from the power supply. Voltage should be between 24 and 100 VDC.

B. By using a capacitance substitution box, or selecting the proper capacitor and connecting it across the probe and ground terminals, bring the signal loop to 20 mA.

C. Measure the voltage between Terminals 1 and 2. Voltage should be between 13 and 100 VDC. If there is less than the minimum 13 volts required, the loop has too much resistance or not enough power supply voltage.

D. If, in Step C above, the voltage is less than 13 VDC, disconnect the power supply and signal wires to the unit. Short the wires that were removed from the power supply (+) and (-) terminals.

E. Measure the resistance between the two wires that were just removed from Terminals 1 and 2 of the electronic unit. See Figure 5-4. The graph below will tell you when the resistance is too large.

Fig. 5-3
Loop Check

408-800-LM/P. 20
5.4 Checking the Sensing Element

A. With an analog ohmmeter*, check the resistance of the probe-to-ground with level below the probe. See Figure 5-5.

Resistance should be infinite. Resistance less than 1 megohm indicates excessive leakage, probably due to product or condensation in the condulet, around the gland/packing nut area. (Consult factory.)

*A digital ohmmeter may produce erroneous readings.

B. Check the resistance of the probe-to-ground with level above the probe. See Figure 5-6. Resistance readings less than 1 megohm indicate either defects in the probe insulation or, if a bare probe, that the process material is conductive and an insulated probe may be required. (Consult factory.)

C. Coating error is characterized by high output with falling level, and a sharp drop to 0% when the material goes below the tip of the probe. To verify a coating problem, wipe the coating off the probe and recheck instrument operation. If the instrument reads correctly after cleaning, consult the factory for the best solution to the problem.
5.5 Checking the Sensing Element Cable.

1. Disconnect cable at both ends. Be sure all terminals are standing clear.

2. Measure resistance from center wire to cote-shield. Resistance should be infinity (open circuit).

3. Short probe & ground terminals together at one end.

4. Measure resistance from probe to ground terminals at other end. Resistance should be near zero ohms (short circuit).

5. Repeat step 2 for cote-shield and ground terminals.
### Troubleshooting

#### 5.6 List of Some Possible Problems and Causes

<table>
<thead>
<tr>
<th>PROBLEM</th>
<th>POSSIBLE CAUSE</th>
<th>CHECKOUT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Transmitter reads 20 mA or greater even when vessel is not full.</td>
<td>a. Transmitter malfunction</td>
<td>a. Sec. 5.2.1</td>
</tr>
<tr>
<td></td>
<td>b. Water in probe conduit</td>
<td>b. Sec. 5.4</td>
</tr>
<tr>
<td></td>
<td>c. Short in cable</td>
<td>c. Sec. 5.5</td>
</tr>
<tr>
<td></td>
<td>d. Cut in probe insulation</td>
<td>d. Sec. 5.4</td>
</tr>
<tr>
<td></td>
<td>e. Calibration is wrong</td>
<td>e. Sec. 4.1 &amp; 4.5</td>
</tr>
<tr>
<td>2. Transmitter never reaches 20 mA even though the vessel is full, or the output reading is non-linear at the upper end of the scale.</td>
<td>a. Load resistance too high</td>
<td>a. Sec. 5.3</td>
</tr>
<tr>
<td></td>
<td>b. Calibration is wrong</td>
<td>b. Sec. 4.1 &amp; 4.5</td>
</tr>
<tr>
<td></td>
<td>c. Transmitter malfunction</td>
<td>c. Sec. 5.2.1</td>
</tr>
<tr>
<td>3. Transmitter is drifting.</td>
<td>a. Moisture in probe gland</td>
<td>a. Sec. 5.4</td>
</tr>
<tr>
<td></td>
<td>b. Water in probe conduit</td>
<td>b. Sec. 5.4</td>
</tr>
<tr>
<td></td>
<td>c. Transmitter malfunction</td>
<td>c. Sec. 5.2.2</td>
</tr>
<tr>
<td></td>
<td>d. Water in cable</td>
<td>d. Sec. 5.5</td>
</tr>
<tr>
<td></td>
<td>e. Cut in probe insulation</td>
<td>e. Sec. 5.4</td>
</tr>
<tr>
<td></td>
<td>f. Calibration is wrong</td>
<td>f. Sec. 4.1 &amp; 4.5</td>
</tr>
<tr>
<td>4. Transmitter is erratic. Output reading jumps anywhere from 10% to 100%.</td>
<td>a. Radio frequency interference</td>
<td>a. Need RFI filters. Consult factory</td>
</tr>
<tr>
<td></td>
<td>b. Cut in probe insulation</td>
<td>b. Sec. 5.4</td>
</tr>
<tr>
<td></td>
<td>c. Waves in liquid</td>
<td>c. Sec. 4.2</td>
</tr>
<tr>
<td>5. Transmitter was shipped precalibrated, but is not reading correct level.</td>
<td>a. Wrong precalibration information was supplied to factory</td>
<td>a. Verify precal. info</td>
</tr>
<tr>
<td></td>
<td>b. Nozzle or pipe around probe is 6&quot; or less in diameter</td>
<td>b. Need to include info on nozzle</td>
</tr>
<tr>
<td></td>
<td>c. Accuracy being checked by measuring outage as a % of full tank</td>
<td>c. Note: The zero point is at end of probe; not bottom of tank</td>
</tr>
<tr>
<td>6. Probe installed in stilling well, and readings are incorrect.</td>
<td>a. Probe touching stilling well</td>
<td>a. Adjust mounting</td>
</tr>
<tr>
<td></td>
<td>b. Reading lower than actual level: Air trapped in stilling well</td>
<td>b. Put holes in stilling well to allow air to escape</td>
</tr>
<tr>
<td></td>
<td>c. Calibration is wrong</td>
<td>c. Sec. 4.1 &amp; 4.5</td>
</tr>
<tr>
<td>7. As level increases, output reading decreases</td>
<td>a. Fail-safe in HLFS position</td>
<td>a. Sec. 4.3.1</td>
</tr>
<tr>
<td></td>
<td>b. Transmitter malfunction</td>
<td>b. Sec. 5.2.1</td>
</tr>
<tr>
<td>PROBLEM</td>
<td>POSSIBLE CAUSE</td>
<td>CHECKOUT</td>
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<tr>
<td>----------------------------------------------</td>
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</tbody>
</table>
| 8. Transmitter reading 5% to 10% or greater in error. | a. Conductive buildup on probe  
     b. Calibration is wrong | a. Sec. 5.4  
     b. Sec. 4.1 & 4.5 |
| 10. Output current reading less than 2mA.    | a. Wiring short form shield-to-ground, probably in probe head | a. Sec. 3.5    |
5.7 Factory and Field Service Assistance

5.7.1 Telephone Assistance

If you are having difficulty with your Drexelbrook equipment, and attempts to locate the problems have failed, notify your local Drexelbrook representative, or call the factory direct and ask for the service department. Drexelbrook Engineering Company is located at 205 Keith Valley Road, Horsham, Pa. 19044. The telephone number is 1-800-527-6297. To help us solve your problem quickly, please have as much of the following information as possible when you call:

Instrument Model# __________________________
Probe Model# __________________________
P.O. # __________________________
Date __________________________
Cable Length __________________________
Application __________________________

Material being measured __________________________
Temperature __________________________
Pressure __________________________
Agitation __________________________
Brief description of the problem __________________________

Checkout procedures that failed __________________________

5.7.2 Equipment Return

Do not return equipment without first contacting the factory for a return authorization number. Any equipment being returned must include the following information in addition to the above:

Reason for return __________________________
Return Authorization# __________________________

Original P.O. # __________________________
Drexelbrook order# __________________________
Your company contact __________________________
"Ship To" address __________________________

To keep the paperwork in order, please include a purchase order with returned equipment even though it may be coming back for warranty repair. You will not be charged if covered under warranty. Please return your equipment with freight charges prepaid. We regret that we cannot accept collect shipments.

Drexelbrook usually has a stock of reconditioned exchange units available for faster turnaround of a repair order. If you prefer your own unit repaired rather than exchanged, please mark clearly on the return unit, "Do Not Exchange".

Spare instruments are generally in factory stock. If the application is critical, a spare chassis should be kept on hand.

5.7.3 Field Service

Trained field servicemen are available on a time-plus-expense basis to assist in start-ups, diagnosing difficult application problems, or in-plant training of personnel. Contact the service department for further details.

5.7.4 Customer Training

Periodically, Drexelbrook instrument training seminars for customers are held at the factory. These sessions are guided by Drexelbrook engineers and specialists, and provide detailed information on all aspects of level measurement including theory and instrument operation. For more information about these valuable workshops, write to Drexelbrook Engineering, Attention: Communications/Training Group; or call direct (215) 674-1234.