Installation and Operating Instructions

Series 508-41 and 508-42 Two-Wire Tru-Level™ Systems using 408-7200 Electronics
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Two-Wire Tru-Level™ Systems
using 408-7200 Electronics
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1.0 Introduction

The instructions in this manual are for the Drexelbrook 508-4X-XXX Series two-wire Tru-Level(TM) systems for level measurement and control. For applications where insulating material composition, temperature or density may change, the Tru-Level system can electronically compensate for those changes, and automatically recalibrate itself to give readings of consistently higher accuracy and repeatability.

1.1 System Description

The Drexelbrook 508-4X-XXX Series system consists of a 408-7200 Series two-wire Tru-Level transmitter, 700 Series signal sensing element(s), and 380-Series connecting cable(s). In a two-wire transmitter, the current supplied to the transmitter from an external power supply is the same current used for the output signal. See Figure 1-1.

The system model number indicates a 408-7200 Series transmitter together with the number and type of sensors used.

The 508-41-XXX System model numbers represent a 408-7200 series transmitter, a five-terminal cable, and a single element sensor, that includes both the level and reference sensor in a single structure.

The 508-42-XXX System model numbers are used to indicate a 408-7200 Series transmitter, two separate rf cables, and two separate sensor structures; a long sensor for the level channel information and a short sensor for the reference channel information.

The final digits of the system model number refer to the type of 700 series sensing element(s) used.

1.2 Available Models

1.2.1 Transmitter

The standard 408-7200 transmitter is used in all typical two-wire Tru-Level systems. Adjustable damping or time delay is available as an option (Model number 408-7200-20X).

1.2.2 Housing Options

The 408-7200 Series transmitter comes with a number of package options. These options are indicated by a modification number that is added to the system number. Figure 1-2 illustrates a typical case option package in a Nema 4 housing.

![Diagram of Typical Two-Wire Tru-Level System](image-url)
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Figure 1-2. Typical Transmitter Housing Option (Nema 4)

1. Modif. 9110-1
   Vertical meter visible through cover, housed with the transmitter.

2. Modif. 9110-2
   120 Vac power supply, and vertical meter visible through cover, housed with the transmitter.

3. Modif. 9110-3
   Setcon™ current activated switch, 120 Vac power supply, and vertical meter visible through cover, housed with the transmitter.

4. Modif. 9110-4
   3 1/2" digit loop powered meter visible through cover, housed with the transmitter.

1.2.3 General Options

408-9110-20  RFI Filters (3) for two-wire loop powered system.
408-9110-22  RFI Filters (3) for ac powered system.
408-9110-23  RFI Filters (4) for ac powered system with 4-20 output.
408-9110-24  115 Vac power supply.
408-9110-29  115 Vac power supply with on/off switch and fuse.

1.2.4 Sensing Elements

The final digits of the system model number indicate the type of sensing element(s) used.

The special dual signal sensors available are:

700-8-124 -- Dual signal sensor with concentric shield ground element (508-41-101 system).
For low viscosity liquids and mild agitation. See Figure 1-3.

Figure 1-3. Concentric Shield Tru-Level Sensor

700-8-134 -- Dual signal sensor with cage ground element (508-41-102 system). For medium viscosity liquids and mild agitation. See Figure 1-4.

Figure 1-4. Cage Shield Tru-Level Sensor

408-7200/Page 2
700-8-242 -- Dual signal sensor with insulated ground rod elements (508-41-105 system). For heavier viscosity liquids and no agitation. See Figure 1-5.

Figure 1-5. Ground Rod Shield Tru-Level Sensor

1.3 Specifications

1.3.1 Transmitter

A. Output: 4-20 mA, two-wire signal.

B. Max Load Resistance: 
   \[ *V_s \geq 0.02 \] or 535 Ω when used with a 24 Vdc loop power supply. 
   \[ *V_s = \text{Voltage supply} \]

C. Power requirement: 2-wire hook up, 13.3-100 Vdc at transmitter. Optional 120 Vac, 50-60 Hz or 230 Vac, 5-60 Hz, 1.5 watts max.

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

E. Ambient temp. error: ± 2.5%/100°F

F. Accuracy: ± .25" or ± .5% of span, whichever is greater.

G. Step response: Less than 1 sec. to 90% of final output. Optional 0-20 second adjustable damping (time delay).

H. Linearity: ± .35% of span.

I. Resolution: ± .1% span.

J. Hysteresis: .1% span.

K. Load regulation: 0 to .1% maximum.

L. Regulation for Power Supply Voltage: ± .2%/10 Vdc.

M. Compensation for dielectric: ± 1% (for dielectric constant of 2+).

N. Long-term drift: ± .25%/3 months.

O. Vibration: 3 G’s 25-250 Hz.

P. Shock: 5 G’s at 2 msec.

Q. Lightning protection: 15,000 amp surge on signal terminals.

R. Measurement range: Depends on maximum applicable insertion length. First 5 1/2" at the tip of dual-signal sensor are inactive.

S. Applicability: Any homogeneous liquid with dielectric constant greater than 1.8.

T. Intrinsic safety: Manufacturer rated 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 Housing Options

A. NEMA 4X Fiberglass Weatherproof Housing
   10 x 12 x 6 inches
   12 lbs., incl. transmitter
   Meter visible through cover.

B. NEMA 4 Housing
   10 x 12 x 6 inches
   20 lbs., incl. transmitter
   Meter visible through cover.

C. Explosionproof
   13 x 11 x 6 inches
   59 lbs.
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<tbody>
<tr>
<td>700-8-124</td>
<td>1000 PSI @ 100°F 500 PSI @ 300°F</td>
<td>20 ft.</td>
<td>TFE and 304, 316, or carbon steel 1.75&quot; O.D.</td>
<td>1 1/2&quot; NPT or 2&quot; RF flange</td>
</tr>
<tr>
<td>700-8-134</td>
<td>1000 PSI @ 100°F 500 PSI @ 300°F</td>
<td>20 ft.</td>
<td>TFE and 304, 316, or carbon steel 3 1/8&quot; Clearance O.D.</td>
<td>4&quot; RF flange</td>
</tr>
<tr>
<td>700-8-242</td>
<td>1000 PSI @ 100°F 500 PSI @ 300°F</td>
<td>20 ft.</td>
<td>All TFE 3.00&quot; O.D.</td>
<td>3&quot; RF flange</td>
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*If temperature exceeds 300°F, consult factory for alternate systems.

**Other flange styles and larger flange sizes available.

1.3.3 Dual Signal Sensing Elements

A. Single nozzle, single rod sensor.
B. Intrinsically safe for Classes I and II, all groups, Div. 1 and 2.
C. Vibration: 25 G's, 25-250 Hz.
D. Shock: 50 G's at 2 msec.
E. Spark protection: 100 amp maximum.
2.0 Theory of Operation

In a level control application where the material's conductivity is below 20 μmho/cm and the dielectric constant is changing, a Drexelbrook Tru-Level continuous transmitter provides a consistent calibration, regardless of gross changes in electrical character. In addition to the level measuring channel and sensor, the Tru-Level instrument includes a second reference sensor and a corresponding reference measuring channel. The output of the level measuring channel varies with both the liquid level and the liquid composition. The output of the reference channel varies only with the liquid composition. The level channel and reference channel are connected to an arithmetic divider circuit, as shown in Figure 2-1. The divider circuit divides out the effect of material changes and produces a 4-20 mA signal that is proportional solely to the liquid level.

\[
\frac{L_A}{A} = \text{Tru-Level} \quad \text{Measurement}
\]

Successful Tru-Level measurement requires that the material being measured be homogeneous in composition from bottom to top, so that both sensors “see” the same electrical properties. When there is a tendency for material to settle or interface, there must be appropriate agitation to mix the material into a homogeneous state.

Tru-Level sensing elements have a ground reference built into the sensor assembly to provide a controlled geometry and optimize the measurement. The three types of ground references used in Drexelbrook Tru-Level sensing elements are described in paragraph 1.2.4.

Figure 2-1. Tru-Level Transmitter, Block Diagram
3.0 Installation

3.1 Unpacking

Carefully remove the contents of the shipping 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 Transmitter

The 408-7200 Series transmitter is designed for field mounting but should be as free as possible from vibration, corrosive atmospheres, and any possibility of mechanical damage. See Figure 3-1.

![Figure 3-1. Mounting Dimensions of Typical Transmitter Housing](image)

For convenience at start-up, place the instrument in an accessible location.

3.3 Mounting the Sensing Element

The location and method for mounting the sensing element are often determined by the placement of nozzles or openings in the vessel. The following mounting and installation suggestions ensure that the equipment operates properly and accurately.

**Caution:** When using a dual-signal sensor, rotation of the condulet can cause permanent sensor damage. See Section 3.5

A. Use particular care during installation not to puncture or tear the insulation. Be sure to keep the inside of sensing element condulet free from moisture and corrosive fumes.

B. Sensing elements should not be mounted in the direct stream of a filling nozzle or chute.

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

D. When using two separate sensors for Tru-Level detection, be sure to mount the reference sensing element in a position so that it will always be covered with material, as shown in Figure 3-2A. In a single true-level sensor, the reference portion is the first 5 1/2 inches from the tip of the sensor, as shown in Figure 3-2B.

E. The sensor cable and condulet interior must be kept dry. Do not use pulling lubricant when sensor cable is installed in conduit.

![Figure 3-2A. Reference Sensor, Mounting Position in Two-Sensing Element System](image)
3.4 Wiring the Transmitter

3.4.1 Signal Loops

The signal current loop carries both the transmitter signal and the transmitter power. See Figure 3-3. The maximum current in this loop should not exceed 30 mA, so light gauge signal wire can be used for these connections. The transmitter requires a minimum of 13.3 volts at its signal terminals (maximum current condition).

The loop power supply is typically 24 volts dc. However, any supply voltage up to 100 volts dc is suitable. Notify the factory if the output of the power supply exceeds 30 volts.

The signal loop connects to transmitter terminals (+) and (-). The transmitter can operate with either voltage polarity between these two terminals. If the polarity of the voltage connections should be reversed, the operation of the transmitter is not affected.

When the transmitter is supplied without a local meter in its housing, then a terminal jumper is provided to connect terminals (-) and (M).

If the field wiring is to be in hazardous areas, suitable safety barriers are required between the control room and the field to provide for intrinsically safe field wiring.

3.4.2 Current Meter

Many of the case options used with the two-wire Tru-Level transmitter include a local loop meter that is housed with the transmitter. In this case, the positive and negative meter leads are connected to terminals (M) and (-) respectively, in place of the terminal jumper. See Figure 3-3. There are then two terminal lugs on terminal (-) (one lug from the negative meter lead and one from the negative signal loop lead).

Figure 3-3. Wiring the Transmitter
3.4.3 Cable Connections Between Transmitter and Sensing Element(s)

Remove the cable cover on the transmitter to show the sensing element center wire terminals for the Level and Reference channels (Figure 3-3). When two separate sensors are used, they are connected to the transmitter by two separate coaxial cables. When a dual-signal sensor is used, it is connected to the transmitter by a special five-terminal cable. Be sure that the center wires of the Level and Reference channels are connected to the corresponding terminals at the transmitter (the terminals are labeled). On the five-terminal cable, the center wire with the blue band goes to the Reference channel and the center wire with the black band goes to the Level channel.

Once the two center wires (CW) have been connected, the cable cover shield on the transmitter must be replaced. After the cover is in place, connect the two shield wires (SH) to the two panhead screws used to hold down the cover. Slip the spade lug for each of the shield wires (SH) under the appropriate screw head before tightening the screws to fasten the cable cover.

The cable(s) from the sensor(s) has either one or two ground wires (gnd). Connect these to the ground terminals on the transmitter terminal strip.

3.5 Wiring the Sensing Element

The transmitter and sensor are typically connected by a special five-terminal low capacity (380-XX-135) cable. See Figure 3-4.

The XX in the cable model number indicates the length of the cable in feet. Five-foot increments up to 50 feet are standard, but special lengths are available. Contact the factory for maximum recommended cable lengths per specific application.

When installing the sensor cable, do not use a pulling lubricant. Cable should be kept dry at all times. For wet environments, consult factory for special waterproof cable.

The cable connections to the sensing element are made after it has been installed in the vessel, with the conduit attached, as shown in Figure 3-5.

![Figure 3-5. Wiring a Tru-Level, Dual-Signal Sensor](image)

Warning: When using a dual-signal sensor, rotation of the conduit can cause permanent sensor damage.

Remove the cover plate before attaching cable terminals. Be sure to replace cover plate after cable has been installed, as the sensor will not function correctly without it.

When using two single-signal sensing elements, the Reference sensor will always be a three-terminal (CW, SH, and GND) sensor, but the level sensor may only be a two-terminal (CW and GND) design. When connecting to a two-terminal single-signal level sensor, clip and tape the shield wire (SH) at the conduit end to avoid a short in the wiring. See Figure 3-6.

![Figure 3-4. Five-Terminal Connecting Cable](image)
Figure 3-6. Wiring Two Sensors for Tru-Level

3.6 RFI Filters

Radio Frequency Interference (RFI) filters (Figure 3-7) are designed to protect Drexelbrook RF level transmitters from the interference of outside radio transmissions. Without this protection, those interfering transmissions can cause an error in the output of the transmitter. For protection up to 460 MHz, all electrical lines to and from the transmitter housing must be filtered. Each filter should be close-coupled to the housing, and the housing should be earth-grounded.

Figure 3-7. RFI Filters
4.0 Calibration/Operation

4.1 Introduction

The 408-7200 Series Universal, Tru-Level Transmitters are designed for trouble-free field operation. Optimum performance depends on careful first time calibration of the instrument. Correct calibration ensures that the instrument gives reliable level measurements for a long time. To get the best possible performance from the transmitter, its 4-20 mA output signal should be calibrated with a milliammeter that is accurate to within ±.1% (such as typical 3-1/2 digit multimeters). Do not confuse zero offset variations between meters with transmitter drift.

There are no control adjustments required during normal operation of this instrument. All of the field calibration controls are located on the top surface of the instrument chassis for convenient calibration of the instrument while mounted in its field housing. The MODE switch must be in its OPERATE position for the level measurement to work properly.

For proper operation of a Tru-Level System, the Reference Channel sensor must be fully covered by the material (except when the Reference Channel is being calibrated for ZERO). When a dual signal single element Tru-Level sensor is used, it should be uncovered only down to its zero level point. The bottom few inches (typically 5 1/2 inches) containing the Reference sensor must remain covered by material. See Figure 3-2B. When the Reference Sensor is uncovered, the instrument output indicates zero level (0% or 4 mA).

The Tru-Level measuring system provides automatic compensation for variations in the material being measured. Thus, changes in material dielectric constant, conductivity, or viscosity do not degrade the level measurement. However, the measurement process is based on the assumption of material homogeneity. Any change in dielectric constant between the material surrounding the Reference Sensor and the material surrounding the Level Sensor will produce a measurement error. When material separations within the vessel are expected, they should be broken up by thorough mixing.

4.2 Controls

The calibration controls are divided into three groups, shown in Figure 4-1. The controls are separated on the face panel by boundary line markings between the functional groups. The upper group of controls select the Functional Modes of the instrument. Also included in this group is the Fine Span level control. The middle group of controls adjust the instrument Zero. The lower group of controls adjust the instrument Span. Because the instrument uses two distinct pieces of information in calculating the Tru-Level measurement, zero and span calibration must be done on both of the instrument channels.

4.2.1 MODE Section (See Figure 4-2)

A. MODE Rotary Switch

The MODE switch is a six-position rotary switch which has five calibration positions and an operate position. In each of the calibrate positions (listed below), specific instrument subsections are connected to the output to make individual calibrations.

1) BASE 4 mA - adjust zero level output
2) ZERO REF - adjust reference channel zero
3) ZERO LEV - adjust level channel zero
4) SPAN REF - adjust reference channel span
5) SPAN LEV - adjust level channel span

Upon completion of the calibration sequence, the MODE switch must be placed in the OPERATE position for normal operation.
Figure 4-2. Calibration MODE Controls

B. BASE ADJUST

The BASE ADJUST control is located in the upper left corner of the MODE control area. It is a multi-turn screwdriver adjustment that sets the bias level on the transmitter output amplifier, in order to give a zero level output current of 4.00 mA.

C. FINE (Span Lev)

The FINE level span control is a black, ten-turn screwdriver control located in the right side of the MODE control area. This control provides very fine adjustment of the instrument output (level) signal. It is used as the final trim of the instrument calibration.

4.2.2 ZERO Section (See Figure 4-3)

A. REF STEP (ZERO) Rotary Switch (Red)

The REF STEP (ZERO) rotary switch is located on the right side of the Zero Section. It is the inside, smaller red knob. This control provides a coarse step zero adjustment of the Reference Channel. Turning the small red zero knob clockwise (toward zero) increases the Reference Channel zero current. Note that the small red and large blue knobs in the ZERO control group provide different and independent functions.

B. LEV STEP (ZERO) Rotary Switch (Blue)

The LEV STEP (ZERO) switch is located on the right side of the ZERO Section. It is the larger blue knob. This control provides a coarse step zero adjustment of the Level Channel. Turning the large, blue knob clockwise (toward zero) increases the Level Channel zero current. Note that the small red and large blue knobs in the ZERO control group provide different and independent functions.

C. REF FINE (ZERO)

The REF FINE (ZERO) control is located at the lower left of the Zero Section. It is adjusted by a screwdriver through a black grommet. The control is used with the REF STEP ZERO switch to provide a continuous adjustment of the Reference Channel zero balance.

D. LEV FINE (ZERO)

The LEV FINE (ZERO) control is located at the upper left of the Zero Section. It is adjusted by a screwdriver through a black grommet. This control is used with the LEV STEP (ZERO) switch to provide continuous adjustment of the Level Channel zero balance.
4.2.3 SPAN Section (See Figure 4-4)

A. REF COARSE/REF FINE (SPAN) Rotary Switch
The span adjustment for the reference channel is made with the dual rotary switch control located in the upper right of the Span Section.

![Figure 4-4. SPAN Adjustment Controls](image)

The two control knobs work together to set the Reference Channel span. On this switch, the large outside knob provides a coarse step setting, and the smaller inside knob provides finer step adjustments. It is not necessary to have an exact setting for the span of the Reference Channel, so there is no provision for a continuous adjustment. Note that both sections of this switch relate to the one span function. This is different than the step zero functions. Maximum clockwise rotation (to the setting 0-0) produces maximum Reference Channel sensitivity and results in maximum output current for the Reference Channel span calibration.

B. LEV STEP (SPAN) Thumbwheel Switches
The LEV STEP (SPAN) thumbwheel switches are located at the bottom of the Span Section. They provide step adjustments for the Level Channel Span. The dial on the left has a range of 0-9 and provides coarse steps. The dial on the right provides relatively fine adjustment steps and has a range of 0-15. Minimum level channel sensitivity is given by the switch setting of 0-15. Maximum channel sensitivity, corresponding to maximum signal current, is provided by a switch setting of 0-0.

4.3 Before Starting Calibration

For results that are the most accurate, power should be applied to the transmitter for 20 minutes before starting calibration adjustments. The 408-7200 Series units are high sensitivity instruments operating on very low power. Small bridge unbalances, which can occur during initial calibration, are likely to cause the instrument to saturate at either maximum or minimum current. It may take the instrument as long as 30 seconds to return to normal operation after a saturating condition is removed. These effects are minimized by pre-setting the controls prior to initial calibration.

The Reference and Level Channels are both zeroed before the spans are adjusted. The zeros are set with the vessel empty. Then, when the vessel is filled, both channels can be spanned. The Reference Channel is always set before the Level Channel is calibrated because the Level Channel output depends on the Reference Channel.

The calibration procedure is presented in dual format - a simplified 'quick reference' description on the left-hand side of the page and a detailed procedure on the right-hand side. Users who are already familiar with the 408-7200 may wish to use the quick reference notes only. Those less familiar with this calibration procedure are urged to read both sides of each page for greater clarification or whenever encountering difficulties.
4.4 408-7200 Transmitter Calibration Procedure

The following quick reference section provides a convenient step-by-step pictorial guide for calibrating the 408-7200 transmitter.

**Step 1: Initialization**

Set MODE switch to BASE ADJUST. Verify that zero & span controls are set per precalibration label on inside of housing door - otherwise, set controls as shown above.

- **Detailed Procedure** -

A. Ensure that all installation and wiring is complete. Also check that the level of the product is below the tip of the sensing element. In the case of a two-sensing element system (508-42-XXX), both must be in air only.

B. Apply power to the unit and sweep the MODE switch back and forth between the BASE 4 mA and OPERATE positions 8 times to remove any minute amounts of contact oxidation. Next, set the MODE switch to BASE 4 mA.

C. If the transmitter was factory precalibrated, verify that the STEP ZERO and STEP SPAN switches are set per the precalibration label on the inside of the housing door and do not make any adjustments to the screwdriver settings.

Otherwise, set the controls as shown:

- REF STEP ZERO (red knob) to ... 0
- LEV STEP ZERO (blue knob) to ... 0
- REF COARSE STEP SPAN (outer black knob) to ... 4
- REF FINE STEP SPAN (inner black knob) to ... 1
- LEV COARSE STEP THUMBWHEEL SWITCH (left side) to ... 4
- LEV FINE STEP THUMBWHEEL SWITCH (right side) to ... 8
- BASE ADJUST - as factory set
- SPAN LEV FINE - 3 1/4 turns clockwise from stop
- REF FINE ZERO - 6 turns clockwise from stop
- LEV FINE ZERO - 6 turns clockwise from stop.

D. Allow transmitter to warm up for 20 minutes.
- Detailed Procedure -

Output current should be 4.0 mA or 0%. If necessary, slowly adjust the 10-turn BASE ADJUST control with a small screwdriver to reach the desired output (4 mA or 0%). Clockwise rotation decreases the output. If the specified output cannot be reached, call the factory service department at 1-800-527-6297.

Step 2: Base 4mA Adjust

Adjust base to 4.00 mA.
Clockwise decreases base.
- Detailed Procedure -

A. Ensure that the material level is below the REFERENCE sensing element (see Figures 3-2A and 3-2B).

B. Set the MODE switch to ZERO REF.

C. If the transmitter was factory precalibrated, skip to step D.

Otherwise ADJUST THE REF STEP ZERO (red inner knob) until the output is as near to 4.00 mA as possible without going below 4.00 mA. Clockwise rotation of this control increases output current.

Note: If the transmitter appears to have run out of control zeroing range (setting II is insufficient) before lowering the output current to 4.00 mA, refer to step “3a and 4a” at the end of this section.

D. With a screwdriver, slowly adjust the 10-turn REF FINE ZERO control to get an output of precisely 4.00 mA.

E. Turn the COARSE REF STEP SPAN (black outer knob) to 0 and the FINE REF STEP SPAN (black inner knob) to 1 and again, adjust the REF FINE ZERO control to get an output of precisely 4.00 mA.

F. If the transmitter was factory precalibrated, return the COARSE and FINE REF STEP SPAN controls to the settings indicated on the precalibration label on the inside of the housing door.

Otherwise, return the COARSE and FINE REF STEP SPAN controls to settings of 4 and 1, respectively.

Step 3: Empty Tank Adjustment (Zero Reference)

A. Adjust red knob to approximately 4 mA.

B. Adjust REF FINE to 4.00 mA.
- Detailed Procedure -

A. Ensure that the material level is below the LEVEL sensing element (see figures 3-2A and 3-2B).

B. Set the MODE switch to ZERO LEV. Note whether the output current is less than 4.00 mA (0%) or greater than 4.00 mA.

C. If the transmitter was factory precalibrated, skip to step D.

Otherwise, wait 30 seconds! Then, perform the following adjustment. Before beginning, please understand that once the output current drops below 4.00 mA, it will not respond immediately to any control changes. To avoid confusion, when the output current is below 4.00 mA, wait 30 seconds between each single step change of the blue LEV STEP ZERO control before proceeding.

If the output current is less than 4.00 mA (0%), it is most likely "noisy" and varies between 3.2 mA and 3.6 mA (-5.0% and -2.5%). Turn the blue LEV STEP ZERO control ONE position clockwise and WAIT 30 seconds. If the output current remains less than 4.00 mA, turn the blue REF STEP ZERO control one more single step clockwise and again wait 30 seconds. Proceed in this manner until the output first rises above 4.00 mA, and then go to Step D.

If the output current is greater than 4.00 mA (0%), slowly turn the blue LEV STEP ZERO control counter-clockwise until the output first drops below 4.00 mA. Stop! Go to Step D.

Note: If the transmitter appears to have run out of control zeroing range (setting II is insufficient) before lowering the output current to 4.00 mA, refer to step "3a and 4a" at the end of this section.

D. If the output current is less than 4.00 mA (0%), it is most likely "noisy" and varies between 3.2 mA and 3.6 mA (-5.0% and -2.5%). Slowly turn the 10-

Step 4: Empty Tank Adjustment (Zero Level)

A. Adjust blue knob to approximately 4 mA. Response may be slow. (up to 30 seconds)

B. Adjust LEV FINE to 4.00 mA.

C. Optional: Set MODE knob to OPERATE. Reading should still be approximately 4.00 mA (3.9 to 4.1). If not, call 1-800-527-6297.

C OPTIONAL - MOVE MODE SWITCH TO "OPERATE" TO SEE IF STILL APPX. 4.00 mA (3.9 TO 4.1 mA) IF NOT CONSULT FACTORY
turn LEV FINE (ZERO) control clockwise with a screwdriver.

Note: The output may not respond immediately to this adjustment. It may take several seconds for a response, if it responds at all. The usual situation is that no effect will be observed (even after several seconds of waiting) for several turns of the control, and then the output will begin increasing rapidly with additional clockwise turning.

Also, as the control is rotated clockwise to increase the output, the output may begin "bouncing" between approximately 3.6 and 4.0 mA (-2.5% and 0%). If this "bouncing" occurs, continue turning the control slowly clockwise and the output will eventually "settle down" and increase smoothly toward 4.00 mA. If the adjustment runs out before reaching 4.00 mA, turn the blue LEV STEP (ZERO) control one position clockwise and wait 30 seconds. The output should now be above 4.00 mA (0%) and counterclockwise rotation of the LEV FINE (ZERO) adjusts the output back down to 4.00 mA (0%).

OR

If the output current is greater than 4.00 mA (0%), slowly turn the 10-turn LEV FINE (ZERO) control counterclockwise until the output drops to 4.00 mA (0%). If you run out of adjustment before reaching 4.00 mA, turn the blue "LEV STEP (ZERO)" control one position counterclockwise. The output should drop below 4.00 mA and become "noisy", varying between approximately 3.2 mA and 3.6 mA (-5.0% and -2.5%). Slowly begin turning the LEV FINE (ZERO) control back clockwise.

Note: Once below 4.0 mA (0%), the output may not respond immediately to this adjustment - it may take several seconds for the output to respond, if it responds at all. The usual situation is that no effect will be observed (even after several seconds of waiting) for several turns of the control, and then the output will begin increasing rapidly with additional clockwise turning.
Step 5: Full Vessel Adjustment (Span Reference)
(Full vessel is 100% or highest possible level)

Calibrated at Factory:
Verify that output is between 8 and 24 mA (25% and 125%).

Not Precalibrated at Factory:
If material is conductive, adjust for closest setting to 20 mA or "100%".

If material is insulating, adjust for closest setting to 12 mA or "50%".

Detailed Procedure -

A. Fill the vessel as full as possible. The higher the % level at which the span calibration is done, the more accurate the result (refer to Figures 3-2A and 3-2B).

In a dual-signal sensor application, (508-41-XXX) the product should cover the bottom 5 1/2" reference section, and 10% or more of the level section (above the first 5 1/2"). In the case of a two-sensing element system (508-42-XXX), the reference element is separate and below the tip of the level element. For this system, cover at least the bottom 10% of the level element.

B. Set the MODE switch to SPAN REF.

C. If the transmitter was factory precalibrated, merely verify that the output current is between 8 and 24 mA (25% and 125%) and go to step #6. If the output current is not in this range, consult the factory service department (1-800-257-6297) before continuing.

Otherwise, adjust the COARSE REF STEP SPAN (black outer knob) and the FINE REF STEP SPAN (black inner knob) according to the following "rule of thumb":

If material is conductive (e.g. water, acid) - closest setting to 20 mA or "100%"

If material is insulating (e.g. hydrocarbons) - closest setting to 12 mA or "50%"

Clockwise rotation of the controls increases the output current.

Note: If the output current is too high even with the REF FINE (SPAN) knob in the 0-0 position, adjust the SPAN LEV FINE control (in the MODE Section) to get an output current of 19 ± 1/2 mA.
**Step 6:** Full Vessel Adjustment (Span Level)  
(Full vessel is 100% or highest possible level)

A. Adjust coarse and fine STEP SPAN thumbwheel switches for closest value to actual level.

B. Adjust FINE LEV SPAN knob to actual level.

Actual % = \( \frac{\text{actual mA} - 4 \text{ mA}}{16 \text{ mA}} \times 100\% \)

Actual mA = 4 mA + actual % \times 16 mA

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**- Detailed Procedure -**

A. Fill the vessel as full as possible. The higher the % level at which the span calibration is done, the more accurate the result. By some independent means, (stick, sight-glass, horizontal pipe, etc.) determine the precise level as a percent of the level sensor's length (refer to Figures 3-2A and 3-2B).

In a dual-signal sensor application, (508-41-XXX) the product should cover the bottom 5 1/2" reference section, and 10% or more of the level section (above the first 5 1/2"). In the case of a two-sensing element system, (508-42-XXX), the reference element is separate and below the tip of the level element. For this system, cover at least the bottom 10% of the level element.

B. Set the MODE switch to SPAN LEV.

C. Adjust the COARSE and FINE LEV STEP SPAN thumbwheel switches for an output close to the actual percent level. Adjustment of the thumbwheel switches to lower numbers increases the output current.

Actual mA = 4 mA + actual % \times 16 mA

D. Adjust the LEV FINE SPAN control until the output precisely equals the actual percent level.
Step 7: Operate Mode

Set MODE knob to OPERATE

Calibration is now complete.
-Detailed Procedure-

External ZERO Padding Capacitors are used in circumstances where either LEVEL or REFERENCE sensing elements are unusually long, etc., and exhibit air capacities beyond the range of the transmitter's internal ZERO controls. ZERO Padding capacitors add their own value of capacitance to whatever is selected on the transmitter internal ZERO control (LEV or REF).

In order not to destabilize the measurement, such capacitors should be:

1. COG (NPO) and
2. Shielded from ground per the illustration on the left.

Users who are not familiar with ZERO padding Drexelbrook 408-7200 transmitters, are urged to consult the factory at 1-800-527-6297 before proceeding further.

Step 3a and 4a:

Zero Pad
(If required)

ZERO Padding Ratio 1:1
REF ZERO Range approximately 0-10 pF
LEV ZERO Range approximately .5-150 pF
4.5 Secondary Calibration Methods

In some applications, it is difficult or even impossible to fill or empty a vessel for calibration purposes. In such a case, it is possible to use capacitance substitution instruments in place of the variable vessel conditions.

Drexelbrook makes two types of capacitance standards for input calibration; the fixed calibration set (including a 401-6-6 standard for the Level Channel and a 401-6-9 standard for the Reference Channel) is factory set, while the 401-6-81 is a variable capacitance reference. In either case, two capacitance standards (C-Boxes) must be used to calibrate the Tru-Level system because the input conditions for both the Reference and Level Channels must be provided at the same time.

4.5.1 Factory Pre-Calibration With Fixed Calibration Standards

During factory precalibration, the Tru-Level system is set to operate over a maximum range of conditions, within dielectric constants and conductivities specified by the customer. This calibration covers materials from oils to acids. The zero calibration is made in air, and the 100% calibration is set according to user specifications (e.g. 8.5 feet on a 10-foot insertion length probe, as shown in Figures 3-2A and 3-2B).

Once the system has been zeroed and spanned, as an option, fixed reference standards (401-6-6 and 401-6-9) are set to simulate the zero (0%) and span (100%) conditions for the transmitter. These reference standards, each with a two-way toggle switch for zero and span, provide a simple means of recalibrating the Tru-Level system, independent of vessel conditions.

4.5.2 Recalibration with Fixed 401-6-6 and 401-6-9 Reference Standards

A. Disconnect the sensing element cables from the transmitter.

B. Connect the 401-6-6 standard to the Level Channel terminals of the transmitter, and the 401-6-9 standard to the Reference Channel terminals of the transmitter. See Figure 4-11.

Figure 4-11. Tru-Level Connections to Secondary Calibration Standards

C. Calibrate the system using the procedure in Section 4.4 and switching the standards to simulate zero and span conditions as required.

4.5.3 Calibration with Variable Calibration (C-Box) Standards

When a user has several capacitance based measuring loops to recalibrate, it may be cost effective to use a single pair of variable C-Boxes for all required input simulation. The Drexelbrook 401-6-8 Series C-Boxes (401-6-8, 401-6-81, and 401-18-20 including a 401-6-8) allow the user to input the desired capacitance either by adjusting for effect or by direct dial entry.

Before recalibration can be done using variable C-Boxes, the user must have recorded the original calibration data in order to input the correct capacitance values for both zero and span on each of the Level and Reference Channels. The calibration data can be obtained either from the factory precalibration data located on the inside door of the transmitter housing or by direct substitution measurement when the Tru-Level system is initially calibrated in the vessel.
4.5.4 Recording the Calibration Data Using Drexelbrook 401-6-8 Series C-Boxes

A. Disconnect the sensing element cables from the calibrated True-Level transmitter.

B. Connect two 401-6-8 Series C-Boxes to the transmitter. See Figure 4-12. One C-Box connects directly to the Level Channel terminals, and the second C-Box connects to the Reference Channel through the plug-in 401-18-5 C-Box attenuator. The attenuator shifts the range of the C-Box to provide capacitance readings between .5 and 25 pF that are needed for the Reference Channel.

C. Set the MODE switch to its BASE 4 mA position and check the output current. Adjust the BASE control to produce an output current of 4.00 mA.

D. In order to preserve the calibration, do not change any other control setting on the True-Level transmitter.

E. Set the MODE switch to the ZERO REF position. Adjust the C-Box on the Reference Channel until the instrument produces a minimum output current of 4.00 mA. Record the setting on this C-Box under Reference Channel zero capacitance.

F. Set the MODE switch to the ZERO LEV position. Adjust the C-Box on the Level Channel until the minimum output current is 4.00 mA. Record the setting on this C-Box as the Level Channel Zero capacitance.

G. Set the MODE switch to the SPAN REF position. Adjust the C-Box on the Reference Channel to produce a maximum output current of 19.95 mA. Record the setting on the Reference Channel C-Box as the Reference Channel Span Capacitance.

H. Set the MODE switch to the SPAN LEV position. Adjust the C-Box on the Level Channel to produce a maximum output current of 19.95 mA. Record the setting on the Level Channel C-Box as the Level Channel Span capacitance.

I. Disconnect both C-Boxes from the instrument terminals and reconnect the sensing element cable(s). Note: The black banded cable connects to the Level Channel terminals, and the blue banded cable connects to the Reference Channel terminals.

J. Return the transmitter MODE switch to the OPERATE position.

4.5.5 Recalibration Using Variable C-Box Standards

To recalibrate a True-Level instrument using 401-6-8 Series C-Boxes, follow the procedure steps in Section 4.4, but first set the C-Boxes to their previously recorded values (zero and span) and then adjust the instrument controls to the required output currents (while substituting the C-box inputs for the sensor inputs to the transmitter).
5.0 Troubleshooting

5.1 Introduction

The 508-4X-XXX Series Tru-Level Systems are designed to give years of unattended service. No periodic or scheduled maintenance is required. There are no specifically recommended spare parts. However, if the application is critical, it is best to have a spare transmitter chassis on hand in case of a component failure. The damaged chassis should be returned to the factory for repair.

The following troubleshooting procedures are useful in checking out the Tru-Level system. If attempts to solve the difficulty fail, notify your local Drexelbrook representative or call the factory at 1-800-527-6297.

5.2 Checking the Transmitter

A. Make sure the transmitter is in the OPERATE mode.

B. Rotate the MODE switch to BASE 4 mA. The output current should be 4.00 mA. See Figure 5-1.

C. Disconnect the sensing element cables and use two capacitor simulation inputs -- either two 401-6-8 "C" Boxes with a 401-18-5 attenuator for the Reference Channel (Figure 4-12), or one each 401-6-6 (Level Channel) and 401-6-9 (Reference Channel) permanent reference elements (Figure 4-11).

D. Set the simulated inputs for the Zero conditions. Set the MODE switch to the appropriate positions and check the ZERO calibration of the Reference and Level Channels.

E. Be sure that the input conditions represent the ZERO calibration of the Reference and Level Channels. The input conditions should represent the ZERO conditions as recorded during initial calibration. Check and adjust the Reference Channel Zero before checking the Level Channel Zero. If the zero condition, 4.00 mA output current cannot be set for both channels, the transmitter is probably at fault. Consult factory.

If the output current is less than 2.5 mA, check the voltage between terminals (+) and (M). If this voltage is less than 13.3 volts, the difficulty is probably in the connecting loop. Check power supply and loop voltage drops.

If the output current is above 3.6 mA and it cannot be adjusted to 4.00 mA, the transmitter is probably at fault. Consult the factory.

If the output current is above 4.00 mA and it cannot be adjusted down to 4.00 mA, disconnect the sensing element cables. If this reduces the current so that it can now be adjusted to 4.00 mA, the trouble is probably due to a loading fault in the cables or in the sensor itself. See Section 5.3.

Figure 5-1. Troubleshooting the Transmitter
F. Set the MODE Switch to SPAN LEV to check the level span calibration. If the Level Channel cannot be spanned to produce the output current as recorded during initial calibration, there may not be enough voltage at the transmitter terminals. Be sure there is at least 13.3 volts dc between terminals (+) and (M). If there is adequate voltage, the transmitter is probably at fault. Consult the factory.

5.3 Checking the Sensing Element and Cable

A. Disconnect the sensing element cable from the transmitter, but leave it connected to the sensing element.

B. With an analog ohmmeter, measure the resistance between the Reference Channel center wire (CW) and the shield. It should exceed 20 megohms. If it does not, there is a short in either the cable or the sensing element.

C. Measure the resistance between the Reference Channel CW and ground. If the value measured does not exceed 20 megohms, there is a fault in either the cable or the sensing element.

D. Measure the resistance between the Reference Channel shield (SH) and ground. If it does not exceed 20 megohms, there is a fault in either the cable or the sensing element.

E. Measure the resistance between the Level Channel center wire (CW) and shield (SH). It should exceed 20 megohms. If it does not, there is a short in either the cable or the sensing element.

F. Measure the resistance between the Level Channel CW and ground. If the value measured does not exceed 20 megohms, there is a short in either the cable or the sensing element.

G. Measure the resistance between the Level Channel CW and the Reference Channel CW. If the value measured does not exceed 20 megohms, there is probably a short in the sensing element.
6.0 Factory and Field Service Assistance

6.1 Telephone Assistance

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

Transmitter Model # ____________________________
Sensing Element Model # __________________________
P.O. # ____________________________
& Date ____________________________
Cable Length ____________________________
Application ____________________________
Material being measured ____________________________
Temperature Range ____________________________
Pressure Range ____________________________
Agitation ____________________________
Brief description of the problem ____________________________
Checkout procedures that failed ____________________________

6.2 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 that above.

Reason for return ____________________________
Return Authorization # ____________________________
Person to contact at your company ____________________________

“Ship To” address ____________________________

If available, please also include the original P.O. # and the original Drexelbrook #.

To keep the paperwork in order, you must include a purchase order with returned equipment, even though it may be coming back for warranty repair. You will not be charged if the equipment is 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 for quicker turn around of repair orders. If you prefer your own unit repaired rather than an exchange unit, please mark clearly on the returned unit, “DO NOT EXCHANGE”.

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

6.3 Field Service

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

6.4 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 details information on all aspects of level measurement, including theory and practice of instrument operation. For more information about these valuable workshops, write to Drexelbrook Engineering, attention: Communications/Training Group, or call direct (215) 674-1234.