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Installation and Operating Instructions

Series 506-6000 LCS™ Point Level Control using 406-6000, 406-6100, or 406-6300 Electronics

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EDO #6-02-241
506-6000-LM

Series 506-6000 LCS™ Point Level Control using 406-6000, 406-6100, or 406-6300 Electronics

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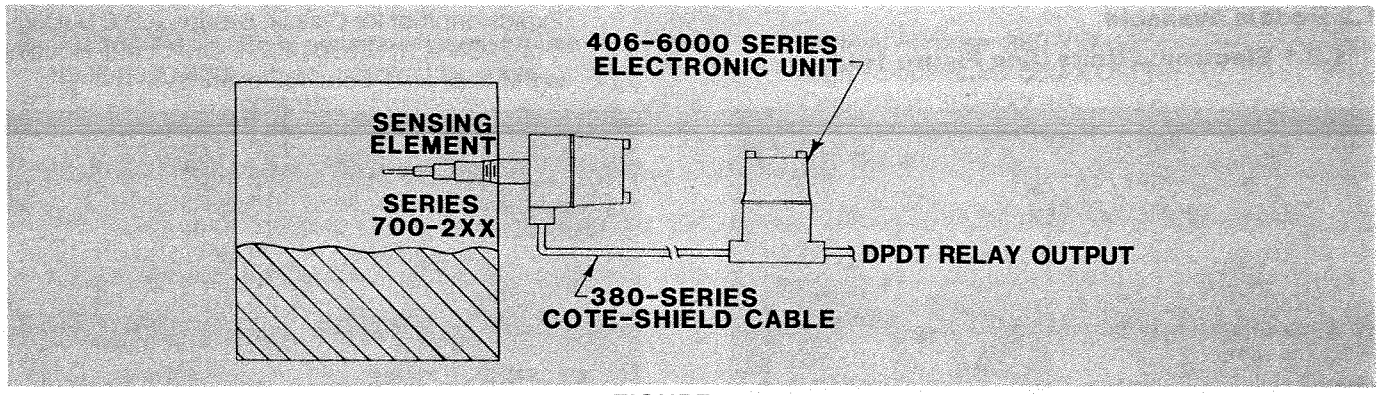


FIGURE 1-1
Typical System

1.0 INTRODUCTION

The instructions in this manual pertain to the Drexelbrook LCS™ 506-6000 Series Cote-Shield™ Point Level Control System.

1.1 System Description

The Drexelbrook 506-6000 Series point level control includes a 406-6000, 406-6100, or 406-6300 Series relay output electronic unit and a 700 Series sensing element (either integrally or separately mounted). If the sensing element is mounted separately, a 380 Series connecting cable is included. See Figure 1-1. The center four digits in the system model number refer to the electronic unit series, and the last digits indicate the sensing element model. 506-6000-8 indicates a standard electronic unit with a 700-221-2 sensing element.

The 406-6000, 406-6100, or 406-6300 Series instrument is a precision RF (radio frequency), relay operated electronic unit. It provides double-pole double-throw relay contact closure when material reaches a preset point in a vessel .The relay contacts may be used to operate alarms, solenoid valves, or other low power devices.

Cote-Shield action is designed into each system and enables the instrument to ignore the effect of build-up or material coating on the sensing element.

The sensing element is mounted in or near the material being measured and provides a change in RF admittance indicating presence or absence of material. It consists of three sections (center measuring section, ground, and Cote-Shield) which compliment the Cote-Shield electronics. The Cote-Shield element guards against the transmission of RF current through any coating on the sensing element, from the center measuring element to ground. The only path to ground available for the RF current is through the material being measured. See Figure 1-2A.

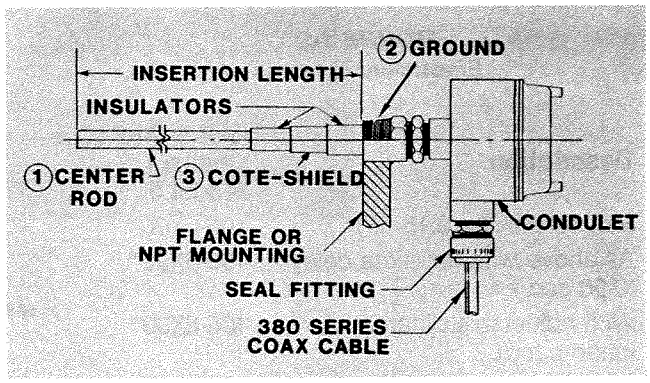


FIGURE 1-2A
Three-Terminal
Sensing Element

The change in admittance indicated by the sensing element is transmitted to the electronic unit through a Drexelbrook 380 Series Cote-Shield cable.

Two-terminal type sensors (ground and insulated center measuring element) are used with the adjustable differential systems, or when metallic contact with the process material is undesirable. See Figure 1-2B.

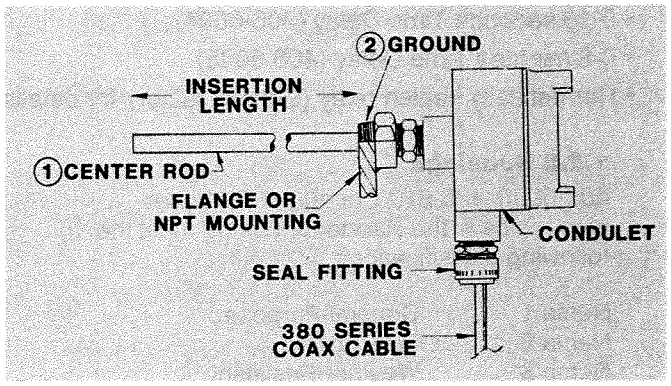


FIGURE 1-2B
Two-Terminal
Sensing Element

1.2 Models Available

1.2.1 Electronic Units (See Figure 1-3.)

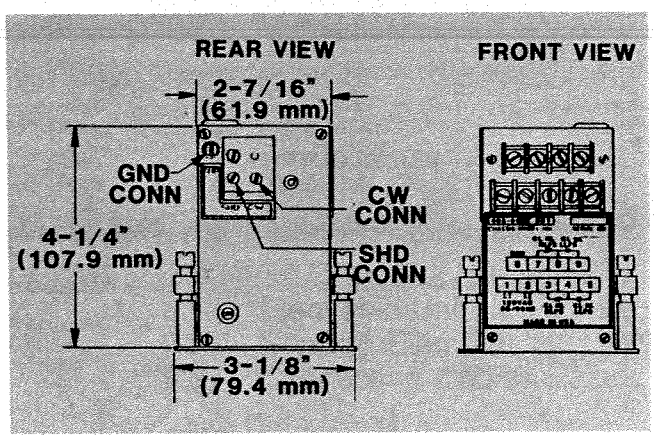


FIGURE 1-3
Electronic Chassis

Description	Electronic Chassis Model #
Std. sensitivity (0.15 pF)	*406-6X00**
As above with adj. time delay (0-90 sec.)	*406-6X02**
With adjustable differential (dead band)	*406-6X03**
High sensitivity unit (0.015 pF)	*406-6X20**
As above with time delay	*406-6X22**

*X = power requirement

X = 0: 120 Vac Unit
X = 1: 12-30 Vdc Unit
X = 3: 230/120 Vac Unit

NOTE: Units are not available with time delay and adjustable differential options on the same model.

Additional Options:

- 0-16 seconds Time Delay (406-6004)
- 0-8 minutes Time Delay (406-6005)
- Hermetically sealed relay (Consult factory for details)

1.2.2 Housings

406-6000, 406-6100, or 406-6300 Series electronics in the standard housing meet the following classifications:

Nema 1	General-Purpose
Nema 2	Drip-Tight
Nema 3	Weather-Resistant
Nema 4	Waterproof
Nema 5	Dust-Tight
Nema 12	Industrial Use

Explosionproof for Class I, Groups A,B,C,D (Div. 1 or 2) Class II, Groups E,F,G (Div 1 or 2). Housing is FM approved. See Figure 1-4.

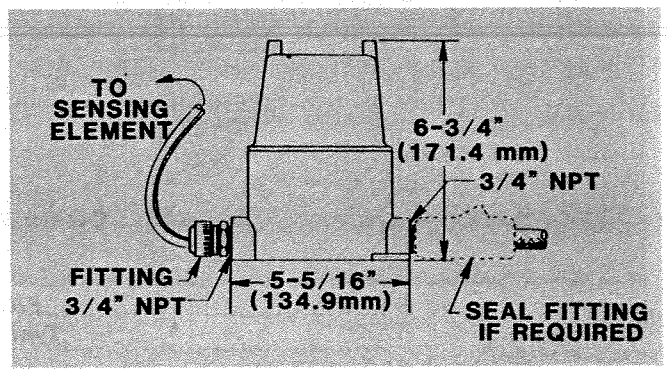


FIGURE 1-4
Typical Housing

1.2.3 Sensing Elements (See Figures 1-2A and 1-2B.)

The following sensing elements are most often recommended for 506-6000 Series controls, according to the application requirements. For identification, the last two digits of the sensing element model number are stamped on the mounting gland or flange. This list does not include all of the sensing elements available with the 506-6000 Series controls. If you have additional questions about sensing elements, contact the factory or your local representative. See Section 2.2.

700-201-5 *(506-6000-5)	Rigid sensing element for liquids and light slurries
700-202-2 *(506-6000-2)	Rigid sensing element for liquids, light slurries and granulars
700-202-19 (506-6000-15)	Rigid sensing element for liquids, light granulars, or foam
700-202-23 *(506-6000-6)	Rigid sensing element for liquids, slurries, and granulars
700-204-38 *(506-6000-16)	Rigid sensing element for liquids, slurries, and light granulars at higher temperatures
700-205-15 *(506-6000-35)	Flexible sensing element for liquids and granulars
700-207-1 *(506-6000-20)	Flush sensing element for granular materials in chutes and bins
700-221-2 *(506-6000-8)	Heavy-duty rigid sensing element for heavy granulars and highly agitated slurries

*System Number

700-1-4 Rigid sensing element for use
*(506-6000-400) with adjustable differential controls

700-2-57 Heavy-duty rigid sensing
*(506-6000-401) element for use with adjustable differential controls

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 ft. high temp)
See Section 2.3.

The XXX in the model number indicates the length of the cable. Five foot increments up to 25 feet are standard, but cut lengths up to 150 feet are available. Cable can also be purchased in bulk lengths up to 1000 feet. See Figure 1-5.

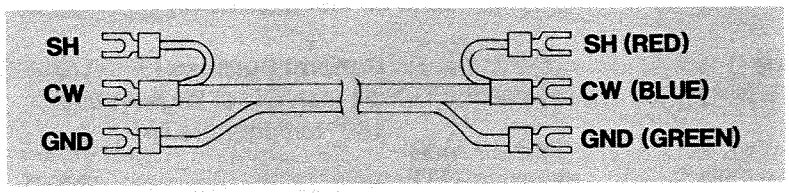


FIGURE 1-5
General Purpose
Three-Terminal Cable

2.0 Specifications

2.1 Electronic Unit

a. Power Requirement

406-60XX Series: 120±25 Vac
50/60Hz, 1 watt.
406-61XX Series: 12-30Vdc, 1 watt.

406-63XX Series: 230/120±25 Vac
50/60 Hz, 1 watt.
(Field convertible. See *8.0 Appendix A.*)

b. Operating Temperature

-40° to 140°F (-40° to 60°C)

c. Sensitivity (Max. Differential)

0.1 pF (406-6X0X)
0-8 pF (406-6X2X)

d. Operating Point Range

0-100 pF (406-6X0X)
0-8 pF (406-6X2X)

e. Hazardous Areas

Electronic Unit: Housing is explosionproof for Class I, Groups A,B,C, and D (Div. 1 and 2), and Class II, Groups E and G (Div. 1 and 2).
Housing: FM Approved.
Sensing Element and Cable: Intrinsically safe for Class I, Groups A,B,C, and D, (Div. 1 and 2). Suitable for Class II, Groups E and G (Div. 1 and 2).

f. RFI Protection (Built-in)

Less than 2 pF shift in operating point for unit in standard housing from 5W field @27 MHz, 150 MHz, or 450 MHz at a distance of 5 feet from exposed sensing element, cable, or power line.

g. Temperature Effect

	406-6X0X	406-6X2X
Operating Point:	.15pF/30°F	.05pF/30°F
Sensitivity:	.05pF/30°F	.005pF/30°F

h. Output - DPDT Relay Contact Rating

Standard Relay:
120 Vac: 5A non-inductive. 3A inductive.
230 Vac: 3A non-inductive. 2A inductive.
24 Vdc: 5A non-inductive.1A for inductance up to 300 mH.

Optional Sealed Relay: (Modification 91-19)
120 Vac: 3A non-inductive. 2A inductive.
230 Vac: 3A non-inductive. 2A inductive.
24 Vdc: 1A for inductance up to 300 mH.

i. Adjustable Differential Range (406-6XX3 Units)

	Differential Range	Low Point Range
406-6003	30-1000pF	0-1,000pF
406-6006	3-100pF	0-100pF
406-6007	300-10,000pF	0-10,000pF

j. Fail-safe

Field switchable to either low level fail-safe (LLFS) or high level fail-safe (HLFS).

2.2 Three-Terminal Coaxial Cables

Cables up to 150 feet long can be used, depending on the application. (High sensitivity units, 406-6X2X, normally use only the shorter cable lengths, typically up to 25 feet maximum.)

a. General Purpose (380-XXX-12):

.51 inch OD at largest point.
160° temperature limit.

b. Composite (380-XXX-18):

First ten feet high temperature.
.62 inch OD at largest point.
450° temperature limit for remainder of cable.

c. High Temperatue (380-XXX-11):

.51 inch OD at largest point.
450°F temperature limit.

2.3 Sensing Elements

The following table lists specifications for sensing elements used in a 506-6000 LCS system.

SPECIFICATIONS

System Number 506-	Typical Application	Sensing Element Model Number	Standard Material of Construction	OD and Standard Mounting	Temperature & Pressure Limits
6000-X55	Liquids, slurries, granulars	700-1202-1	Bare SS with T1 insulators	3/8" OD 3/4" NPT	450°F @ 200 PSI
6000-X56	Liquids, slurries, granulars	700-1202-14	Bare SS with T1 insulators	3/8" OD 3/4" NPT with cable attachment and 316SS bottom weight	450°F @ 200 PSI
6000-X67	Liquids, slurries, granulars	700-1202-12	Bare SS with T1 insulators	3/8" OD 3/4" NPT with cable attachment and brass bottom weight	450°F @ 200 PSI
6000-X02	Liquids, light slurries, or granulars	700-202-2	Bare SS with TFE insulators	3/8" OD 3/4" NPT	300°F @ 50 PSI 450°F @ 20 PSI
6000-X05	Liquids, light slurries	700-201-5	Bare SS with TFE insulators	1/4" OD 3/4" NPT	100°F @ 1000 PSI 450°F @ 200 PSI
6000-08	Heavy duty Higher temperatures	700-221-2	Bare SS with TFE insulators	7/8" OD 2"NPT	300°F @ 50 PSI 450°F @ 20 PSI
6000-16	High temperature High pressure	700-204-38	Bare SS with ceramic insulators	1/2" OD 1 1/4" NPT	200°F @ 2000 PSI 500°F @ 1000 PSI
6000-X22	Liquids, light slurries, or granulars	700-202-43	316 SS	1/2" OD 1" NPT	100°F @ 1000 PSI 450°F @ 200 PSI
6000-X36	Liquids, light slurries, or granulars	700-202-36	Bare SS with TFE insulators	3/8" OD 1 1/2" Clamp	300°F @ 50 PSI 450°F @ 20 PSI
6000-20	Flush control	700-207-1	Special poly-urethane and 304 SS	12" x 12"	180° @ 1PSI
6000-21	Flush control	700-207-2	TFE and 304 SS	12" x 12"	300° @ 1PSI
6000-23	Flush control	700-207-3	Rubber and 304 SS	12" x 12"	180° @ 1PSI
6000-26	Flush control	700-207-6	Special poly-urethane and 304 SS	8" x 8"	180° @ 1PSI
6000-X400	Non-coating liquid or solid	700-1-22	Bare SS with TFE insulators	3/8"OD 3/4" NPT	100° @1000 PSI 300° @ 500 PSI
6000-X401	Non-coating liquid or solid Heavy duty	700-2-57	Bare SS with X insulators	.84"OD 1" NPT	100° @1000 PSI 250° @ 500 PSI
6000-X402	Insulating liquid or solid	700-2-23	316 SS	1/2"OD 3/4" NPT	100° @1000 PSI 300° @ 500 PSI

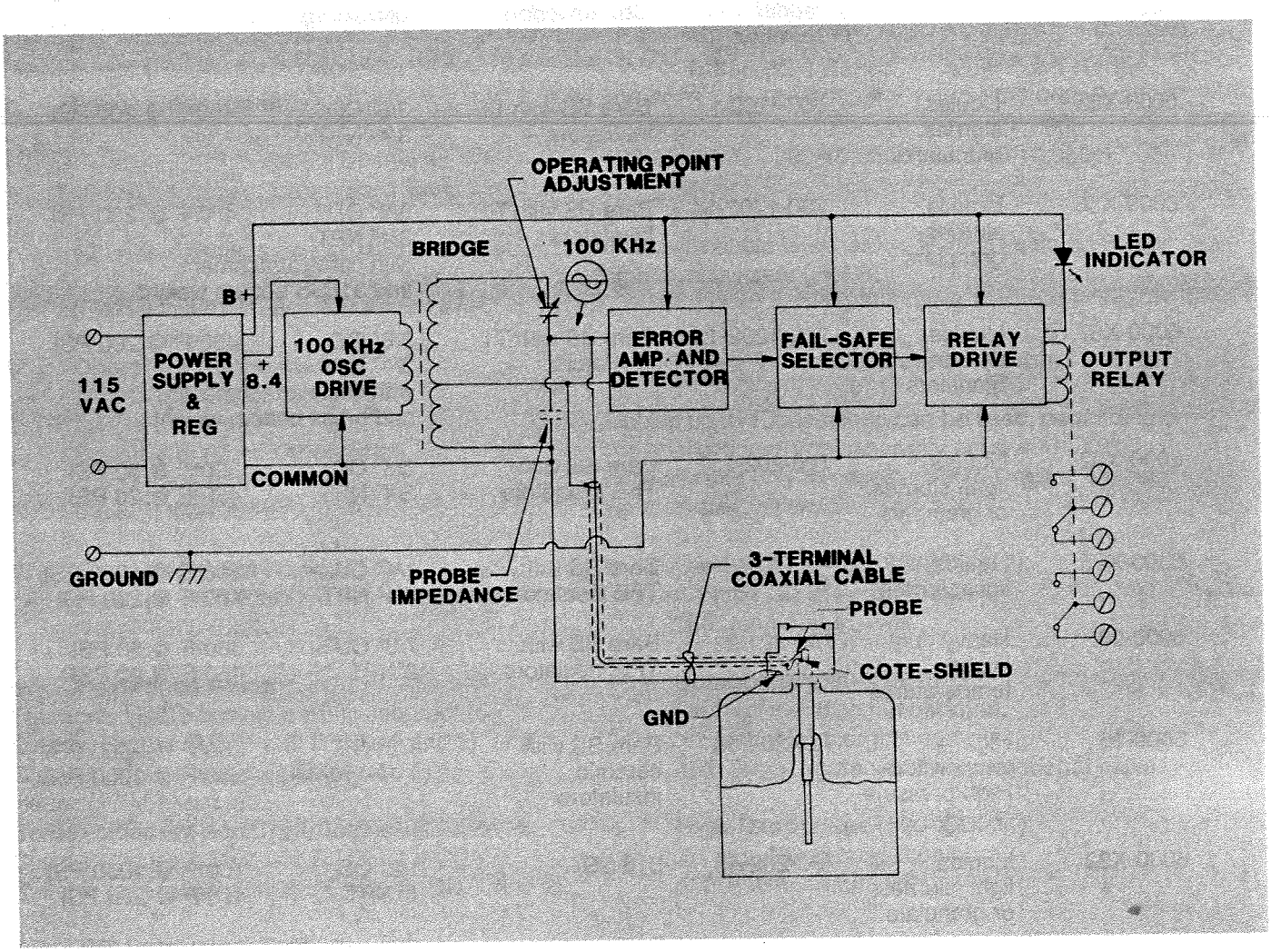


FIGURE 3-1
Block Diagram of
506-6000 Series
Point Level Control

3.0 Theory of Operation

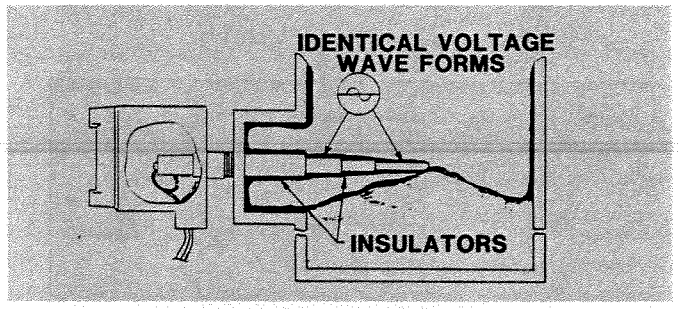
3.1 Electronic Unit

The 406-6000, 406-6100, or 406-6300 Series electronic unit is designed for use with Drexelbrook Cote-Shield, three-terminal sensing elements and three-terminal coaxial cables.

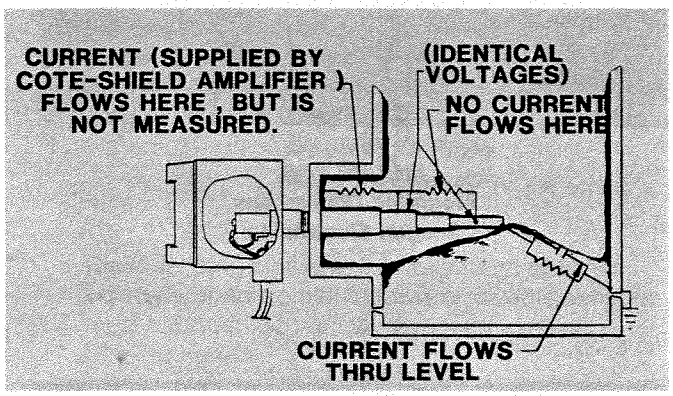
The electronic unit accepts 120 Vac (optional 230 Vac, 12-30 Vdc) and the internal power supply circuit provides a suitable voltage to operate the rest of the circuitry. See Figure 3-1.

The bridge circuit converts the sensing element admittance (determined by material level) into an ac error signal. The bridge is energized by a 100 KHz RF voltage from the oscillator. The transformer side of the bridge contains a tap which serves as the bridge reference and also drives the Cote-Shield electrode of the sensing element. Both the Cote-Shield and center measuring element of the sensing element are driven at virtually the same voltage.

The capacitance side of the bridge circuit contains both the RF admittance information measured at the sensing element, and the operating point adjustment capacitor. The adjustment capacitor is set by the user so that the electronic unit switches states at a preset admittance level, determined by material between the sensing element and ground.



3-2A



3-2B

FIGURE 3-2
Conductive Coating on
a Three-Terminal
Sensing Element

Figure 3-2A shows an exaggerated view of how a coating may look on a level control sensor. Figure 3-2B shows an electrical equivalent circuit of the coating left on the sensing element. The center wire of the coax is connected to the center measuring rod of the sensing element, and the shield of the coax is connected to the middle element, called the Cote-Shield. The ground wire of the cable is connected to the condulet and, therefore, to the vessel body. Since there is no difference in voltage between the center element and the Cote-Shield element, there can be no current flow through any resistance (due to the coating) that may exist on the insulator. The electronic instrument measures only the current that travels from the sensing element center wire to ground. Because of the Cote-Shield element, this can only occur through the actual material being controlled. There will be a current flowing from the Cote-Shield element to the vessel wall because of the potential difference that exists there. However, this current is not measured, and will not cause the instrument to indicate high level. When the level in the vessel does rise and touch the center rod of the sensing element, it causes a current to flow that is demodulated, amplified, and causes the relay to change state.

3.2 Sensing Element

The change in admittance measured by the electronic unit is provided by the sensing element. Wherever the material being measured is conducting and leaves a coating, three-terminal Cote-Shield sensing elements should always be used. In such applications, the sensing element is mounted either horizontally at the desired level, or vertically with the insertion length stopping at the desired level.
In conducting materials, the operating point will be the lowest point on the active (center portion) sensing element.

For insulating materials, a vertically mounted three-terminal sensing element may have the operating point adjusted over the entire active length (between the Cote-Shield and the tip) of the rod. See Figure 3-3.

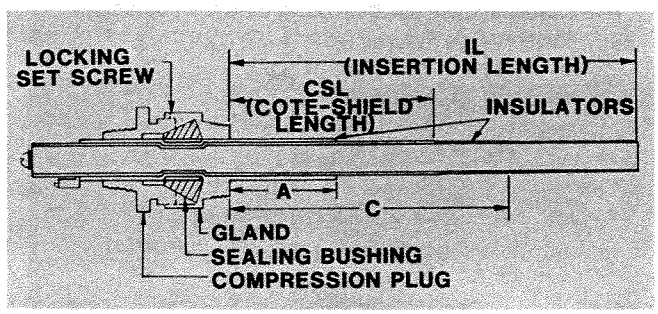


FIGURE 3-3
Cross-Section of a
Typical Three-Terminal
Sensing Element

A horizontally mounted sensing element has the advantage of much greater capacitance change per inch, and will operate within a fraction of an inch of its lowest active point.

3.3 Connecting Cables

The Drexelbrook 506-6000 Series point level controls use three-terminal coaxial cables to connect the sensing element to the electronic unit. The center wire of the cable carries the admittance information from the probe to the electronic unit, while the coaxial shield (Cote-Shield) is driven at the same potential. This prevents any current from flowing through the insulation of the cable. Because there is no current flow through the cable insulation, any change in capacitance due to temperature or change of length in the cable will not change the original calibration.

4.0 Installation

4.1 Unpacking

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

4.2 Mounting the Electronic Unit

The electronic unit is designed for field mounting, but it should be mounted in a location that is as free as possible from vibration, corrosive atmospheres, and any possibility of mechanical damage. Ambient temperatures should be between—40°F and 140°F. For convenience at start-up, it is best to install the instrument in a reasonably accessible location. It may be mounted in any position. See Figures 4-1A, 4-1B, and 4-1C.

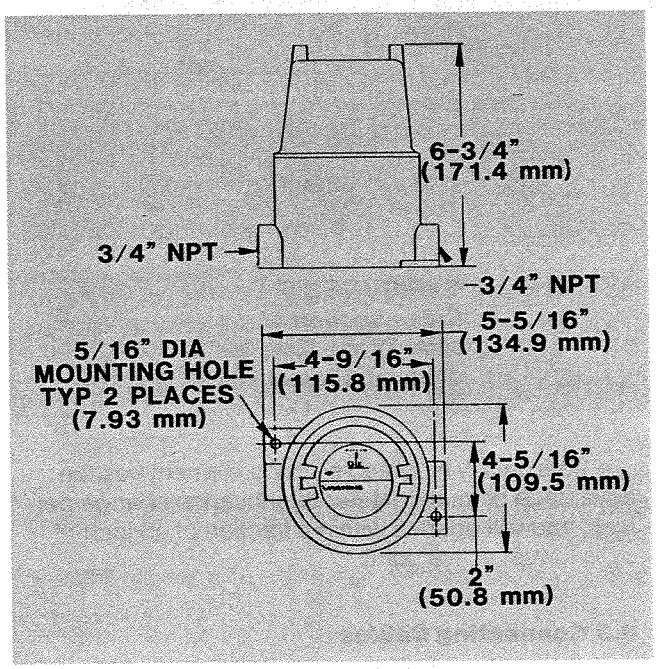


FIGURE 4-1A
Mounting Dimensions
Separate Electronics

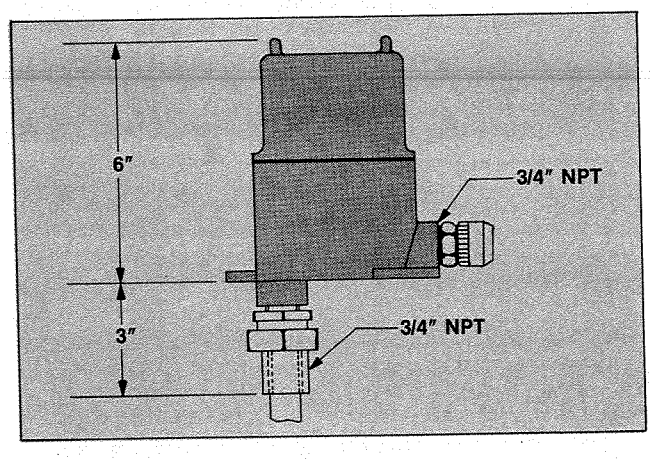


FIGURE 4-1B
Mounting Dimensions
Integral Electronics

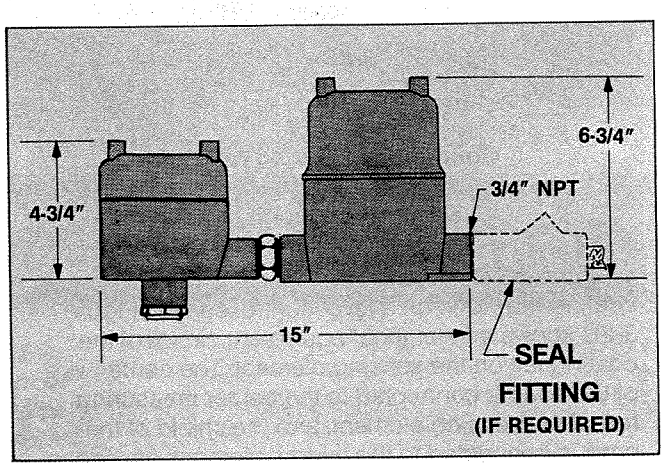


FIGURE 4-1C
Mounting Dimensions
Close-Coupled Electronics

4.3 Mounting the Sensing Element

The mounting location of the sensing element, whether remotely mounted, integrally mounted, or close-coupled to the electronic unit, often depends on the placement of nozzles or openings into the vessel. *Note:* Do not mount a Cote-Shield sensing element through a nozzle which exceeds the length of the first insulator. See Figure 4-2. In all cases, it is necessary to protect the insulation on the sensing element against cuts and scrapes during installation.

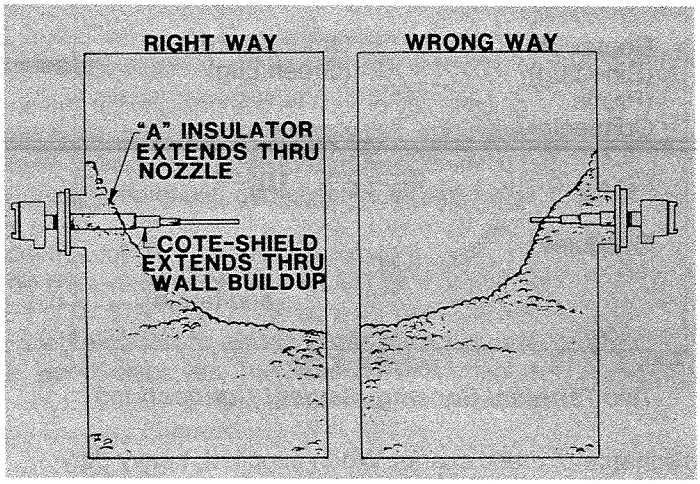


FIGURE 4-2
Mounting a Rigid Sensing Element

Rigid sensing elements can be mounted either vertically or horizontally. However, flexible sensors must be mounted from the top of the vessel. See Figure 4-3.

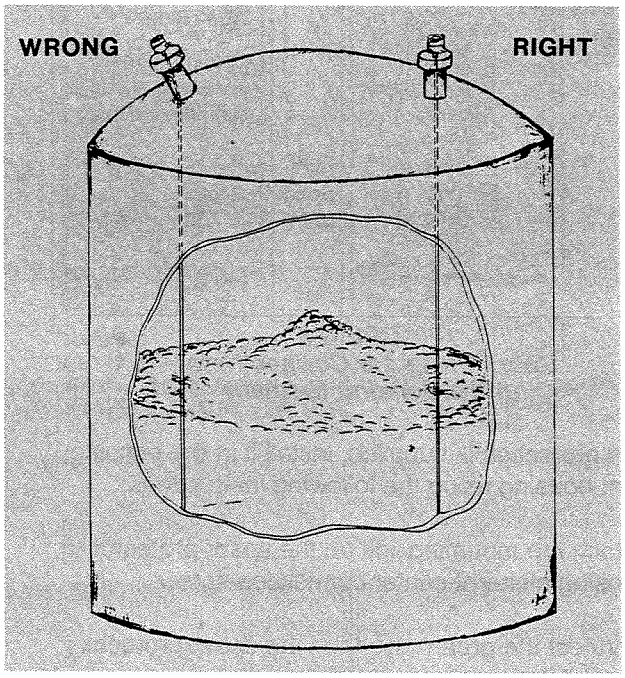


FIGURE 4-3
Mounting a Flexible Sensing Element

4.4 Wiring the Electronic Unit

All power and relay connections are made to the terminal strips on the electronic chassis. Due to the low power consumption of the instrument (1 watt), the wiring need only follow local electrical codes.

The power connections are made to terminals 1,2 and 6. See Figure 4-4. For low voltage 12-30 Vdc models, terminal 1 is (–) and terminal 2 is (+).

The relays used in these units have double-pole, double-throw contacts. All relay connections must also be made to the terminal strips. The relay serves as a low power switch and will not provide sufficient current to activate motors or heavy equipment. Refer to Figures 4-4 and 4-5.

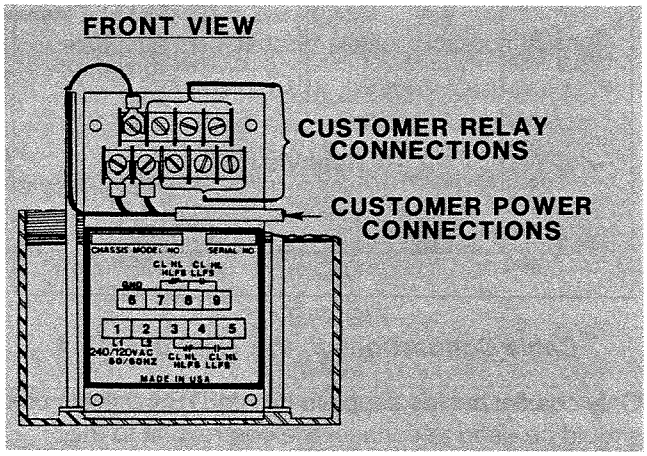


FIGURE 4-4
Power and Relay Connections

All sensing element connections at the electronic unit are made to the individual terminals on the side opposite the terminal strips. See Figure 4-6. It is important to separate the sensing element connections from the power connections to maintain the intrinsically safe character of the cable and sensing element.

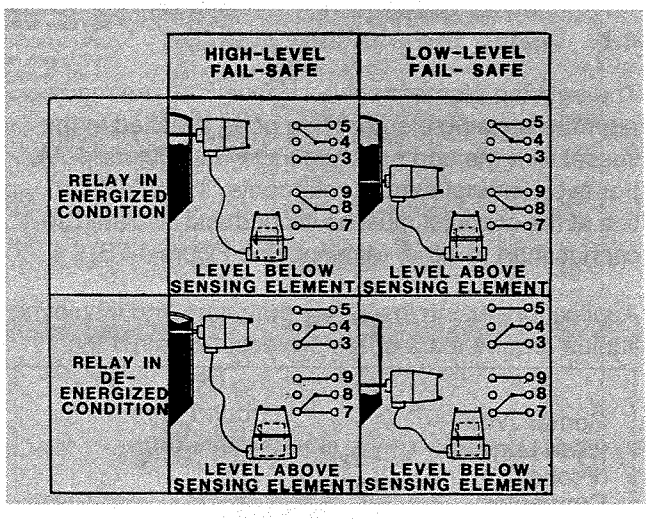


FIGURE 4-5
Relay Contact Chart

4.4 Wiring the Electronic Unit (cont.)

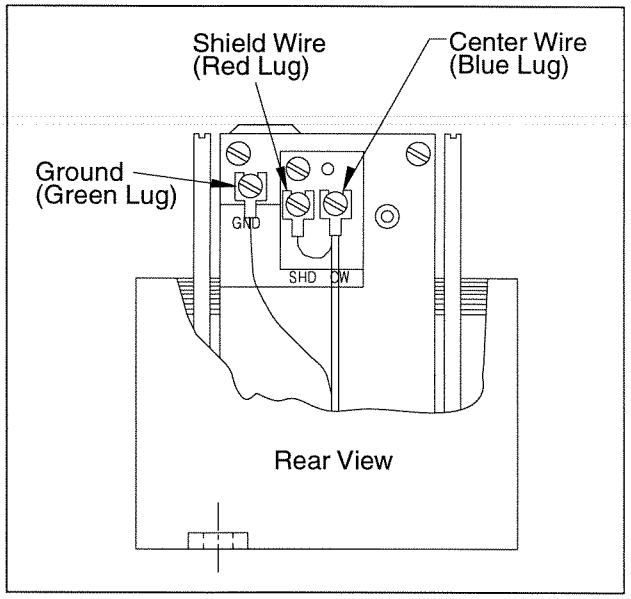


FIGURE 4-6
Cable Connections to the Electronic Unit

Only coaxial cables supplied by AMETEK Drexelbrook should be used to connect the control unit to the remote sensing element. For cable lengths greater than 150 feet, consult factory for installation. Models that are integral or close-coupled to electronic unit are wired at the factory prior to shipment. No padding of the instrument is required to compensate for cable length. Do not splice cables. Do not shorten or reterminate cables without using a Drexelbrook termination kit.

4.5 Wiring the Sensing Element

The sensing element cable connections are made after the sensing element has been installed in the vessel with the condulet attached. See Figure 4-7A. For two-terminal sensing elements, the shield connection at the condulet must be clipped and insulated so it cannot short to either terminal. See Figure 4-7B.

Applications using insulating granulars and insulating liquids require extra spark protection against the discharge of static sparks. When supplied, heavy duty spark protection is normally mounted in the sensing element condulet by the customer. See Figure 4-8.

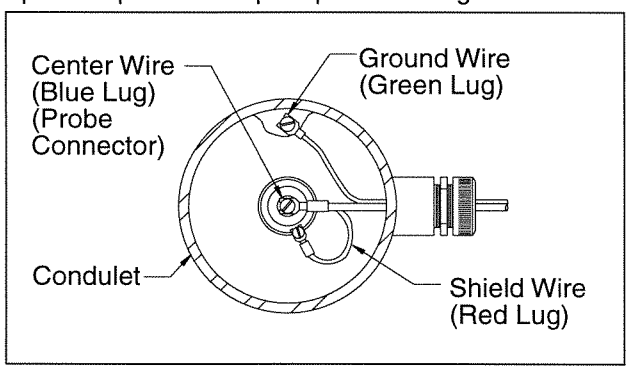


FIGURE 4-7A
Three Terminal Sensing Element Connections

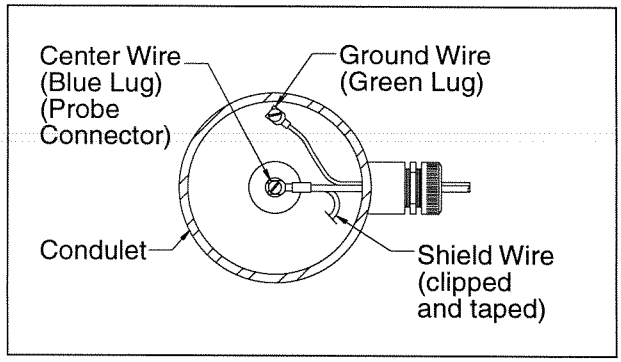


FIGURE 4-7B
Two Terminal Sensing Element Connections

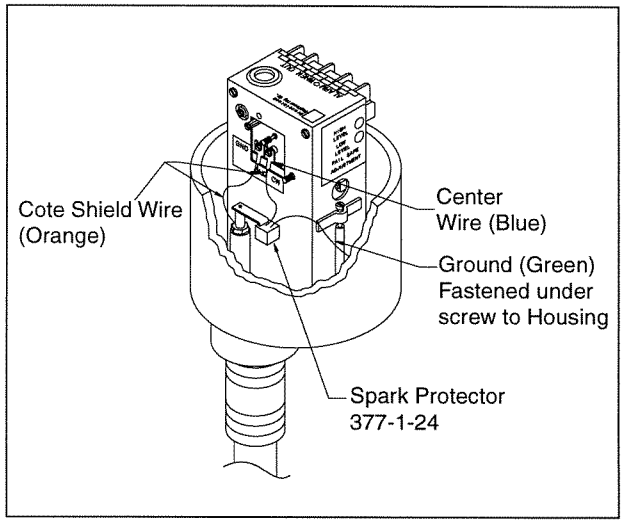


FIGURE 4-8
Spark Protector Connections at the Sensing Element

If spark protection is supplied, install it in the sensing element housing using the following instructions.

a. Attach the mounting link on the spark protector to the sensing element center connection screw.

b. Connect the green wire from the spark protector to the condulet green screw.

c. Feed the cable into the condulet.

d. Connect the cable center wire (CW) to the spark protector and the cable ground wire (GND) to the ground screw.

e. Connect the shield wire (SH) to the Cote-Shield terminal. For sensing elements without a shield connection, the shield wire must be clipped and taped.

4.6 Installation of Flush-Mounted Sensing Elements

These instructions apply to all flush on/off sensing elements. Models 700-207-1, 700-207-4, 700-207-6.

These systems will sense presence of material (no flow or plugged chute) and absence of material (flow or empty chute) at the sensing element. It will ignore free falling material. See Figure 4-9.

The flush sensing element should be mounted IN THE FLOW STREAM. These sensing elements are designed and built to withstand the impact of coal, rock, wood, chips, etc. This location is important to prevent EXCESSIVE build up of material on the face of the Sensing Element.

Excessive build up, typically consisting of wet and/or sticky fines, can occur if the sensing element is protected from falling material.

For recommended sensing element location at the top of a chute, see Figure 4-10.

For recommended sensing element location at the bottom of a chute, see Figure 4-11. Low Level sensors typically see enough flowing material that location is not as critical. Low-level sensor can be used to detect a plug or to insure that a seal is present (chute is full at this point).

For recommended sensing element location in an angle chute, see Figure 4-12.

NUMBER 355

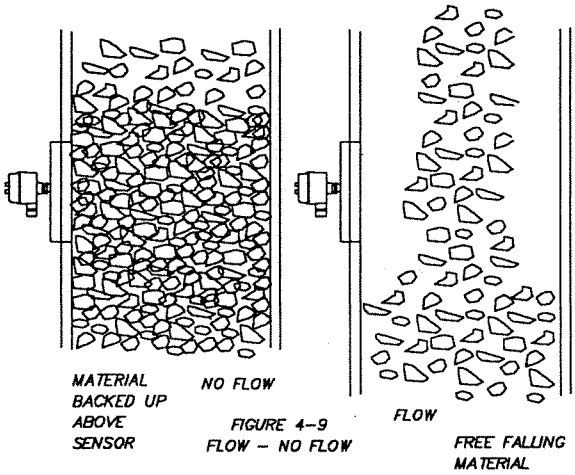


FIGURE 4-9
FLOW – NO FLOW

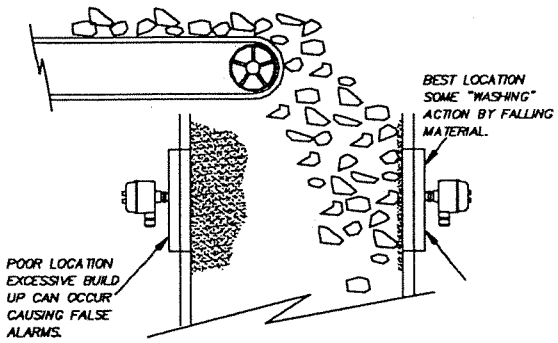


FIGURE 4-10 VERTICAL CHUTE
HIGH LEVEL SENSING ELEMENT LOCATION

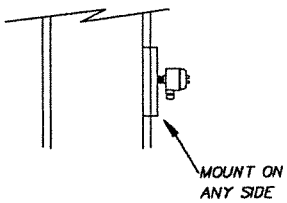


FIGURE 4-11 VERTICAL CHUTE LOW LEVEL
SENSING ELEMENT LOCATION

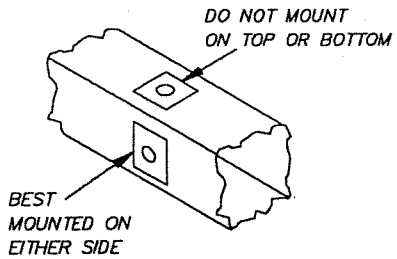


FIGURE 4-12 CHUTE ON ANGLE

5.0 Calibration

This section contains the calibration and operating information for point level controls using the 406-6000, 406-6100, or 406-6300 Series electronic units.

5.1 Start Up

Before applying power to the instrument, be sure that the input power will be 120 Vac 50/60 Hz for 406-6000 Series, 230 Vac 50/60 Hz for 406-6300 Series, or 12-30 Vdc for 406-6100 Series. Check all the wiring connections. See Sections 4.4 and 4.5

WARNING – UNITS IN HAZARDOUS AREAS
Before the explosionproof housing cover is removed to calibrate the unit, the area must be checked and known to be non-hazardous.

When calibration is complete, the cover must be replaced.

Each conduit from the explosion proof case must be equipped with an approved seal fitting.

5.2 Controls

5.2.1 Setpoint Control

There is a single adjustment located on top of the instrument that controls the point at which the relay operates. A lighted LED indicates that the relay is energized. Each revolution of the control will change the operating point approximately 4 or 5 pF. (For high sensitivity models, each revolution will change the operating point approximately .4 pF.) Turning the adjustment clockwise will tend to raise the level at which the relay operates, and turning it counterclockwise will tend to lower the level at which the relay operates. Refer to Figure 5-1 and Section 5.3.

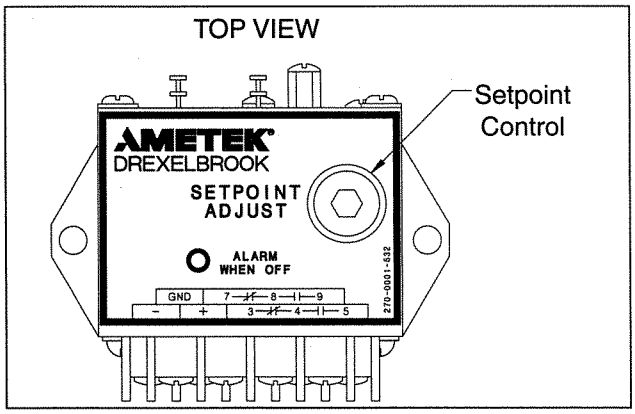


FIGURE 5-1
Setpoint Control

5.2.2 Time Delay Adjustment (Optional)

The optional time delay adjustment is located on top of the instrument, across from the setpoint adjustment. See Figure 5-2. It is used to help stop an oscillating relay output due to agitation or frothing in the vessel. The standard time delay is 0-90 seconds and is represented by a number 2 in the seventh digit from the left in the model number. Example: 406-6002-XX.

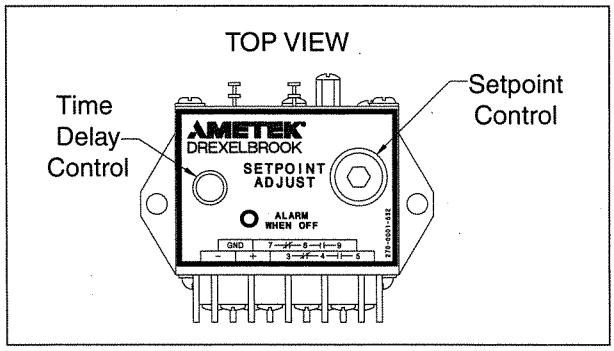


FIGURE 5-2
Time Delay Control

The delay applies only to recovery from the alarm condition. On a High-Level Fail-Safe unit, the delay will be effective only on falling level. The output will indicate high level as long as waves continue to touch the sensing element. The unit will stop indicating high level only after the delay time has passed, with no further contact between the sensing element and the material being measured.

When calibrating instruments with a time delay option, see Section 5.3.5

5.2.3 Adjustable Differential Controls (Optional)

Differential is the hysteresis (dead band) or change in level necessary to switch the electronic unit from one state to another. The 506-6000 Series level control with adjustable differential allows the user to determine the amount of capacitance change (hence level) between the control point and the recovery point. The user can select two separate points on a vertical sensing element where the relay contacts will open at one point and close at the other.

An adjustable differential option is represented by the number 3 in the seventh digit from the left in the model number. Example: 406-6003-XX.

See Section 2.1 for specific ranges on adjustable differential units.

The lo point range is that range of capacitance over which the lower switching point may be adjusted.

The differential range corresponds to the differential in level on the sensing element, and depends on the capacitance of the sensing element and the properties of the material being measured. See Figure 5-3 for location of the adjustments. For calibration of adjustable differential units, see Section 5.3.6

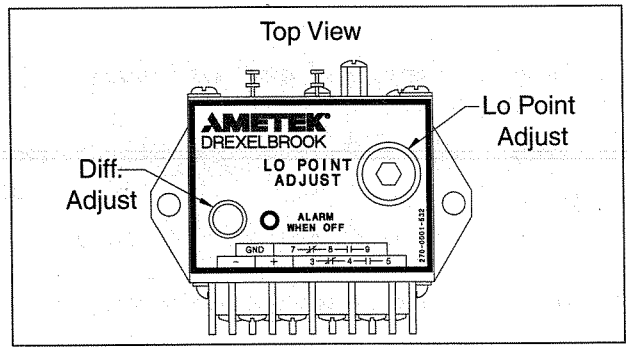


FIGURE 5-3
Adjustable Differential Controls

5.2.4 Fail-Safe Selector

Fail-safe describes the level condition which causes the output relay to de-energize.

High-Level Fail-Safe (HLFS) means the relay will de-energize under high-level conditions, indicating high level upon loss of power. Low-Level Fail-Safe (LLFS) means the relay will de-energize under low-level conditions, indicating low level upon loss of power. The instrument is supplied in the fail-safe requested when the order is placed. (HLFS, if not specified).

The fail-safe may be field selected by a slide switch, accessible through a hole in the side of the chassis. See Figure 5-4.

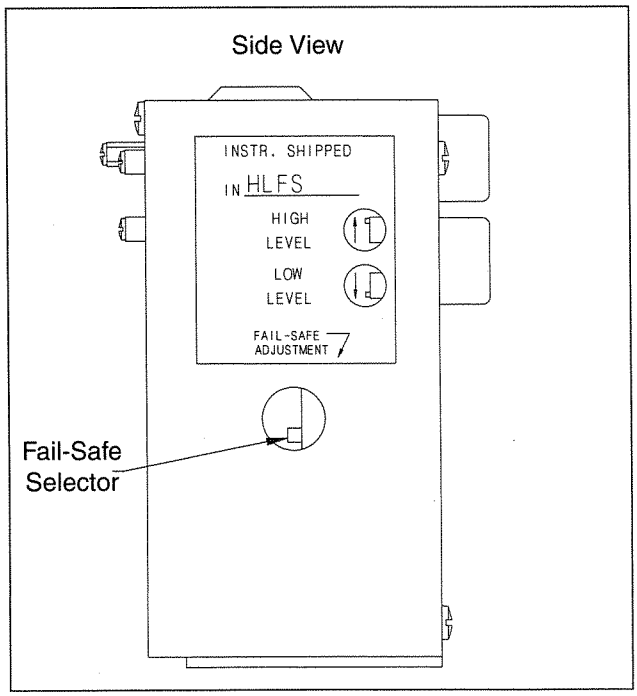


FIGURE 5-4
Fail-Safe Adjustment

5.3 Calibration Procedures

All 506-6000 Series controls with bare metal sensing elements are factory set to switch in all water-based conducting materials. No calibration adjustment is needed.

If the material is not known to be conducting, or the calibration adjustment has been tampered with, use one of the following procedures.

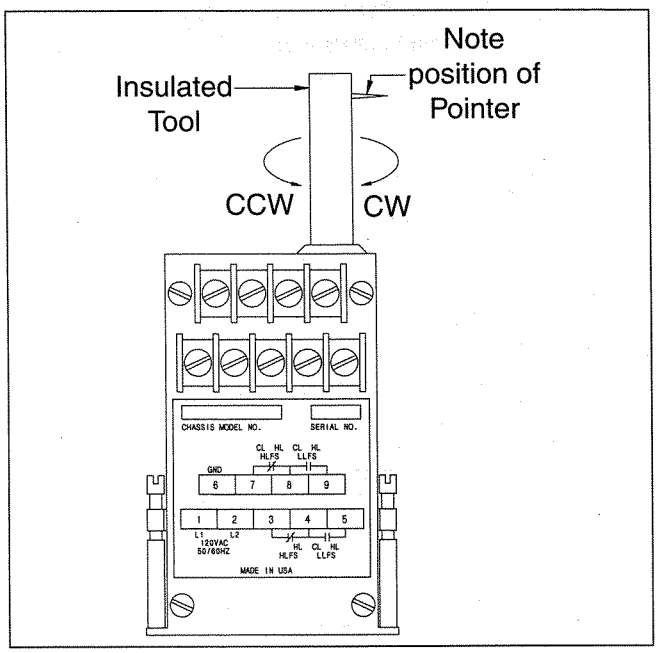


FIGURE 5-5
Insulated Tool for Setpoint Adjustments

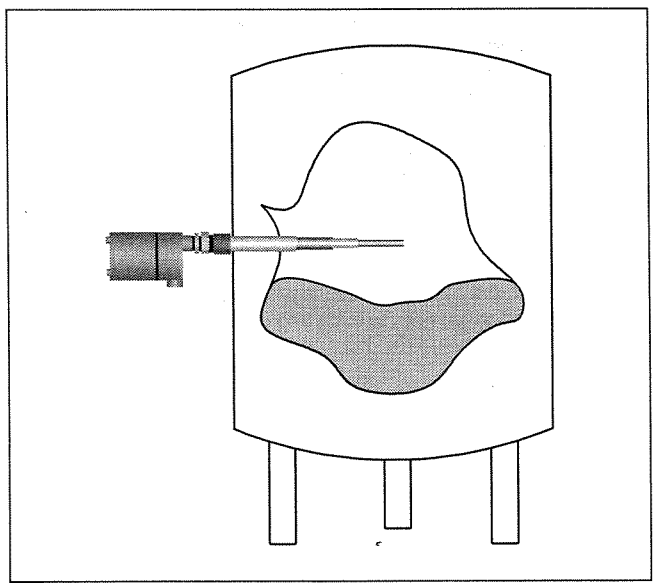


FIGURE 5-6
Material Level Below the Sensing Element

5.3.1 Quick Calibration

NOTE: The quick calibration method is only recommended for horizontally mounted, bare metal, Cote-Shield™ sensing elements. In all cases, it is necessary to have the material level below the probe (sensing element in air).

Be sure to use the insulated calibration tool. See Figure 5-5. Do not turn any adjustment past its mechanical stops. Damage to the unit could occur. LED on indicates that the relay is energized, or in the normal condition (not alarm).

A. For either HLFS or LLFS, begin with the sensing element in air. See Figure 5-6.

B. With the calibration adjustment in the full counterclockwise (CCW) position, turn slowly clockwise until the relay *just* operates. (LED will light in HLFS, and turn off in LLFS.)

C. Note the position of the adjustment tool pointer and turn the adjustment further CW the number of turns indicated in the Quick Calibration Table below.

Calibration is complete.

Calibration Chart

Material Being Measured	Number of Adjustment Turns Clockwise (CW) From Operate Position	
	406-6XOX Unit (Std. Sensitivity)	**406-6X2X Unit (High Sensitivity**
Conducting Materials— (Water Based) (See Note 1)	15 Turns (Note 2)	20 Turns (Note 2)
Insulating Liquids— Organics, Oil, Plastics	1/2 Turn (180°)	3 Turns
Granular Above 50#/Ft³	1/2 Turn (180°)	3 Turns
Granular 30-60#/Ft³	1/3 Turn (120°)	2 Turns
Granular 25-50#/Ft³	1/4 Turn (90°)	1 1/2 Turns
Granular 20-40#/Ft³	1/6 Turn (60°)	1 Turn (360°)
Granular 10-20#/Ft³	High Sensitivity Recommended	3/4 Turn (270°)
Granular 5-15#/Ft³	High Sensitivity Recommended	1/2 Turn (180°)

Notes:

1. Most materials that are water-based can be considered to be conducting. This includes water, acids, bases, salt solutions, water based slurries and very wet granular materials. Carbon black and powered metals will be conducting even without any water.
2. In the case of conducting materials, if heavy build up is anticipated, the calibration adjustment can be turned to its clockwise limit, using care not to force and damage the adjustment.

5.3.2 Calibration of all horizontal insulated sensing elements, or horizontal sensing elements in insulating materials.

Note: Be sure to use the insulated calibration tool. See Figure 5-5. Do not turn any adjustment past its mechanical stops; damage to the unit may occur. LED on indicates that the relay is energized or normal condition (not alarm).

A. Be sure that the level is well below the end of the sensing element. See Figure 5-7.

B. Using the *insulated tool* supplied with the instrument, turn the set point adjustment to the full counterclockwise (CCW) position. See Figure 5-5.

C. Turn the adjustment slowly clockwise (CW) until the relay just operates. (LED changes states).

D. Mentally note the position of the adjustment tool pointer.

E. Increase the material level until it is well above the sensing element. See Figure 5-8. (LED changes states).

F. Counting the number of turns, turn the adjustment slowly clockwise (CW) until the relay once again just operates or you come to the end of the adjustment travel.

G. Turn the adjustment back counterclockwise (CCW) *half* the number of turns that were counted.

H. For recalibration purposes, record half the number of turns that were counted as "Preload". See Section 5.3.4

Calibration is now complete.

Note: If less than ¼ turn of the adjustment was observed between the points where the sensing element was covered and uncovered, please consult the factory.

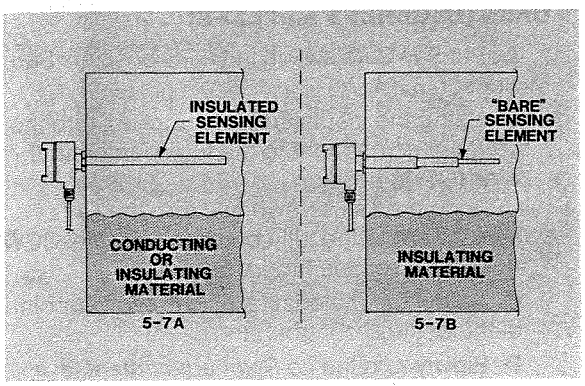


FIGURE 5-7
Material Level Below the Sensing Element

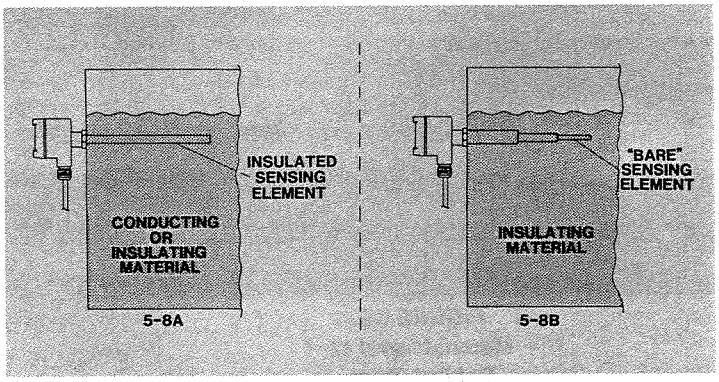


FIGURE 5-8
Material Level Above the Sensing Element

5.3.3 Calibration of all vertical insulated sensing elements, or vertical sensing elements in insulating materials.

Note: Be sure to use the insulated calibration tool. See Figure 5-5. Do not turn any adjustment past its mechanical stops; damage to the unit may occur. LED on indicates that the relay is energized or normal condition (not alarm).

A. Set the level to a point on the sensing element where control is desired. See Figure 5-9.

B. With the insulated tool supplied, start from the full counterclockwise (CCW) position and counting the number of turns, turn the setpoint adjustment clockwise (CW) until the relay just operates. Record the number of turns from full CCW position for recalibration.

Calibration is now complete.

**A minimum of 3 inches of covering on the sensor is required.

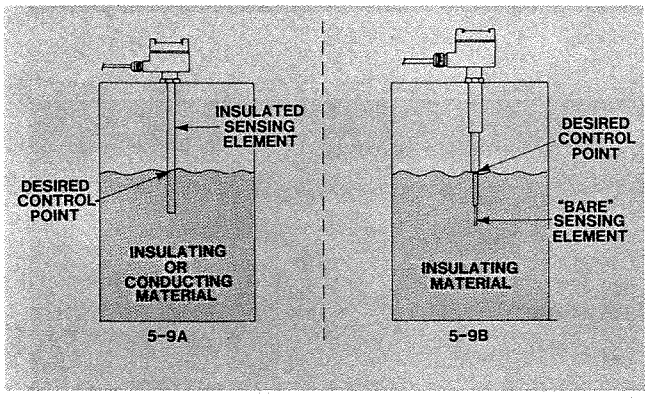


FIGURE 5-9
Material Level at Control Point

5.3.4 Recalibration

If the amount of preloading was recorded at the time of initial calibration, it is possible to replace the instrument without experimentally determining the proper amount of preload.

A. For recalibration using the procedure in Section 5.3.2., follow steps A, B, and C, then turn the adjustment further clockwise (CW) the amount of preload.

B. For recalibration using the procedure in Section 5.3.3., turn the adjustment clockwise (CW), from the full CCW position, the amount of the preload.

C. When recalibrating for bare sensing elements in conductive materials (factory set), use the insulated tool to turn the tuning adjustment to the full clockwise (CW) position. No other adjustment is necessary.

5.3.5 Calibration of Time Delay Units

0-90 seconds is the standard time delay. See Section 5.2.2.

A. Turn the time delay adjustment to the extreme counterclockwise position (i.e. minimum time delay). See Figure 5-2.

B. Proceed with the appropriate calibration procedure.

C. After the instrument is adjusted to the desired operating point, turn the time delay adjustment clockwise until the required delay is achieved. Standard time delay instruments are adjustable over the range of approximately 0-90 seconds delay. If the instrument is in High-Level Fail-Safe, the delay will occur with decreasing level. If the instrument is in Low-Level Fail-Safe, the delay will be with increasing level.

With the material level well below the sensing element, you can observe the operation of the time delay by touching the center wire connection (blue) at the electronic unit.

5.3.6 Calibration of Adjustable Differential Units (Both HLFS and LLFS)

A. Put Fail-Safe switch in HLFS position. See Section 5.2.4.

B. Using the insulated tool supplied, turn the *Lo Point adjustment* to the full counterclockwise (CCW) position.

Using a small screwdriver turn the *Diff adjustment* to the full counterclockwise (CCW) position also. See Figure 5-3.

C. Adjust the material level to the lower point of the desired control band.

D. Slowly turn the *Lo Point adjustment* clockwise (CW) until the instrument just operates (LED comes on). Be sure to use the insulated tool provided.

E. Turn the *Diff adjustment* to the full clockwise (CW) position (max differential).

F. Raise the material level to the upper point of the desired control band.

G. Slowly turn the *Diff adjustment* counterclockwise (CCW) until the LED goes out.

H. Select the desired Fail-Safe position.

Calibration is now complete.

5.3.7 High Level Fail Safe Blind Calibration of Control with Flush Sensing Element

(Alarm when chute is full at sensor). See Figure 5-10A.

A. Start with the sensing element uncovered (no material at sensing element) and the tuning adjustment full counter clockwise. At this point the LED will be out. Turn the adjustment clockwise until the LED just turns on.

B. Test the unit by turning the adjustment slowly counter clockwise, then clockwise to determine the differential of the electronics. If the turn-on and turn-off of the LED is greater than 1/4 turn, the unit is not operating correctly. Please consult the factory service department for assistance. This is a simple function test of the electronics.

C. If the above operation is satisfactory, then continue turning the tuning adjustment:

(1) Clockwise (1) one turn for granulars containing moisture.

(2) Clockwise (1/2) one half turn for dry insulating powders.

Calibration is now complete.

5.3.8 Low Level Fail Safe Blind Calibration of Control with Flush Sensing Element

(Alarm when chute is empty at sensor). See Figure 5-10B.

A. Start with the sensing element uncovered (no material at sensing element) and the tuning adjustment full counter clockwise. At this point the LED will be on. Turn the tuning adjustment clockwise until the LED just goes off.

B. Test the unit by turning the tuning adjustment slowly counter clockwise then clockwise to determine the differential of the electronics. If the turn-on and turn-off of the LED is greater than 1/4 turn, the unit is not operating correctly. Please consult the factory service department for assistance. This is a simple function test of the electronics.

C. If the above operation is satisfactory, then continue turning the tuning adjustment:

(1) Clockwise (1) one turn for granulars containing moisture.

(2) Clockwise (1/2) one half turn for dry insulating powders.

Calibration is now complete.

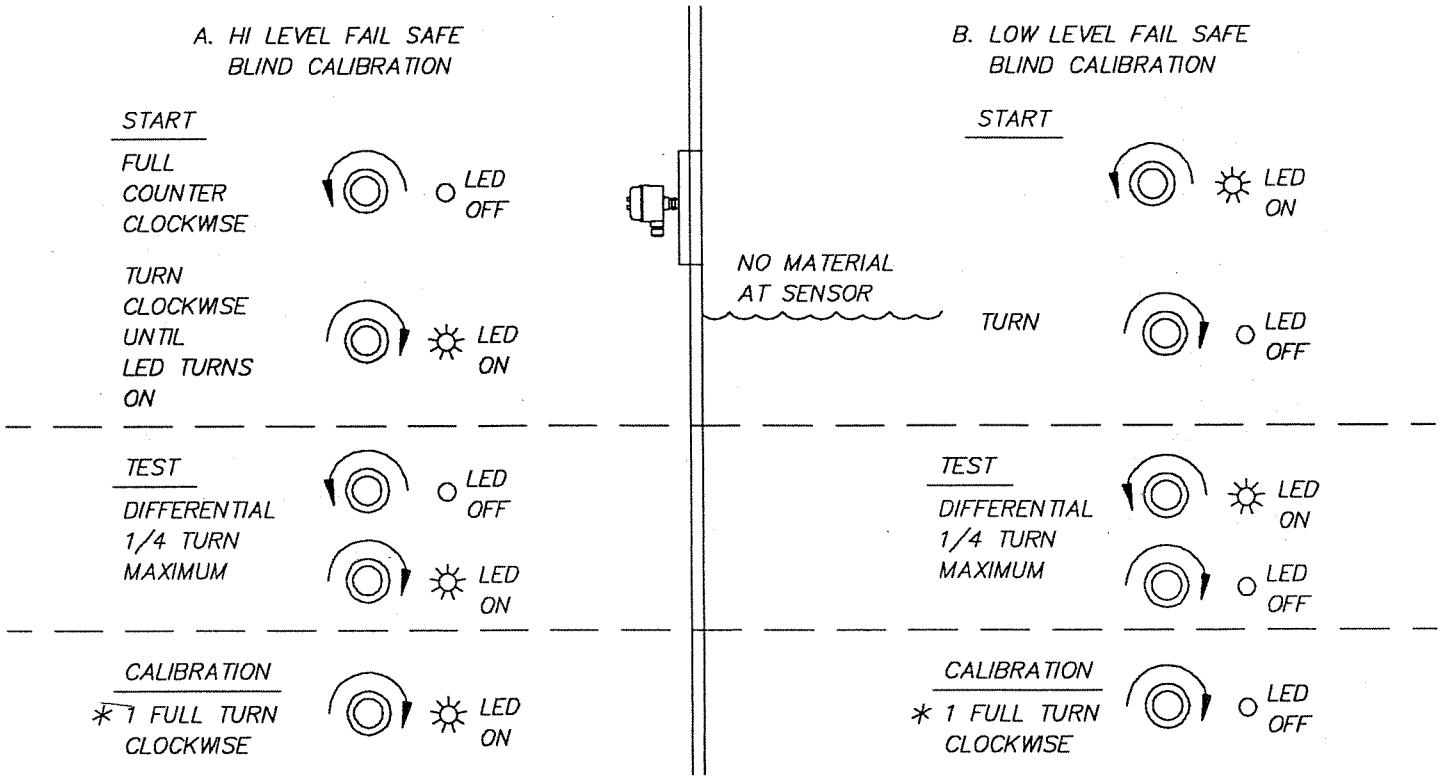


FIG 5–10 CALIBRATION OF FLUSH SENSING ELEMENT

Notes:

1. When excessive build up on the sensor occurs, turning the adjustment clockwise will generally eliminate a false high-level signal. But build up may continue to form or it may drop off. In the latter case, when material reaches the sensing element it may not respond. Hence this should be discussed with factory service.
2. Any questions or problems, contact Drexelbrook Factory Servcie at 1-800-527-6297.

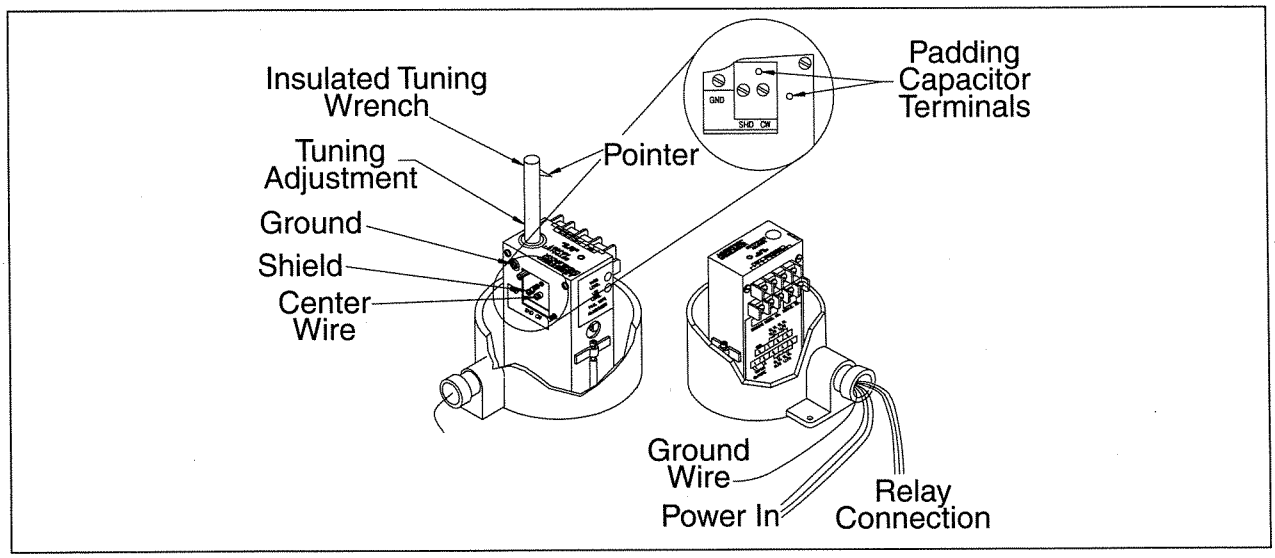


FIGURE 6-1
Electronic Unit Checkout

6.0 Troubleshooting

6.1 Introduction

The 506-6000 Series instruments are designed to give years of unattended service. No periodic or scheduled maintenance is required.

There are no specific spare parts that we would recommend be stocked by the user. However, if the application is critical, it is best to have a spare electronic unit available in the event of a component failure. The chassis should be returned to the factory for repair.

If difficulty should occur when operating your level control, divide the system into its component parts and test each part individually for proper operation.

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

6.2 Electronic Unit Checkout

A. Disconnect the cable from the center wire (CW), Cote-Shield (SH), and ground (gnd) terminals at the instrument. Leave the power connected. See Figure 6-1.
Note: If the instrument has the time delay option, turn the time delay control to the full counterclockwise (CCW) position.
See Figure 5-2.

B. Starting with the setpoint adjustment in the extreme counterclockwise (CCW) position, turn the insulated tuning wrench clockwise (CW) until the relay operates. (Adjust only with the insulated tool supplied).
Note: Do not turn the adjustment past its stops. This can damage this unit.

C. Rotate the adjustment back and forth about this point, observing the travel of the pointer between relay pull-in and relay drop-out. The pointer should travel less than ⅛ turn to operate the relay. If so, the instrument is working properly.

Note: For adjustable differential models, use a small screwdriver and turn the Diff adjustment to the full counterclockwise (CCW) position (min differential). Rotate the Lo Point adjustment back and forth around its operate point, observing the travel of the pointer between relay pull-in and relay drop-out. The pointer should travel no more than one full turn to operate the relay. If so, the instrument is working properly.

D. If the instrument does not function properly, consult the factory for assistance.

6.3 Relay Circuit Checkout

A. The relay circuit consists of double-pole double-throw relay contacts brought out to a terminal strip. When the relays are operating properly, two pair of contacts will be open with high or low level, and two pair closed with high or low level. See Figure 6-2.

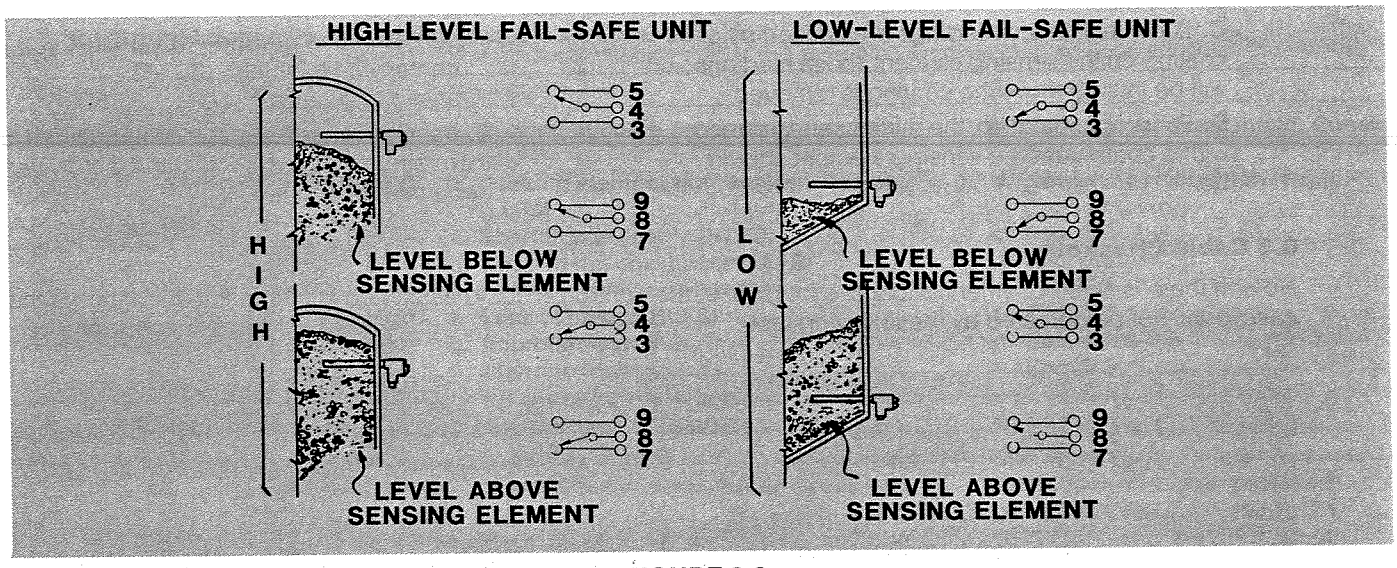


FIGURE 6-2
Relay Contact Chart

B. Adjust the instrument as described in the electronics checkout Section 6.2.

C. Relay operation may generally be heard as an audible click when the background noise is not too high. Use one of the methods shown in Figure 6-3 to determine if the relay contacts are switching.

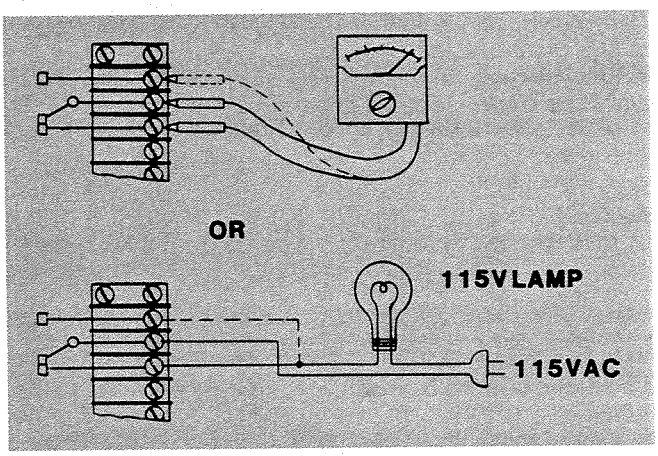


FIGURE 6-3
Relay Checkout

D. Difficulty in calibration can often be traced to improper wiring of the relay terminals to an annunciator or other panel device. Check the wiring against the relay chart in Figure 6-2. *Be sure to use the diagram for the fail-safe in which the instrument is set.*

6.4 Sensing Element Checkout

A. With the material level below the sensing element, use an analog (non-digital) ohmmeter* to measure the resistance between the sensing element terminals, and record the values. See Figure 6-4.

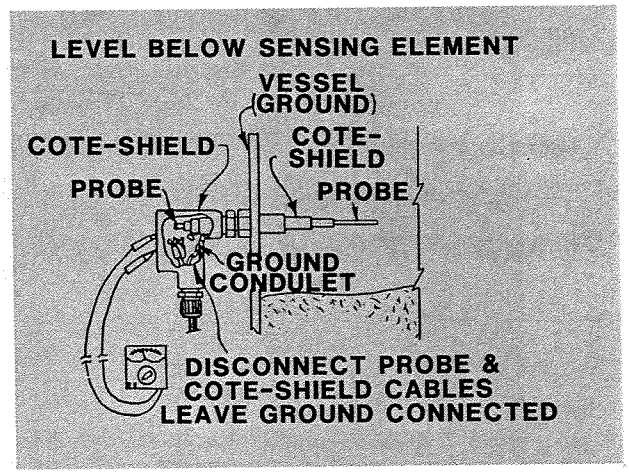


FIGURE 6-4
Sensing Element Checkout

a. Resistance, center wire to shield _____

b. Resistance, shield to ground _____

c. Resistance, center wire to ground _____

* A digital ohmmeter may give erroneous readings.

B. With the sensing element in air and no coating, the resistance measured should be infinite in all three cases. Resistance less than one megohm indicates leakage, probably due to product or condensation in the condulet, around the gland/packing nut area. (Consult factory.)

C. If low resistance readings are caused by a coating on the sensing element, those readings will be infinite when the coating is removed.

D. For proper function, the minimum resistance with a coating on the sensing element should be:

center wire to ground – 1000 Ω
center wire to shield – 600 Ω
shield to ground – 300 Ω

E. If the measured resistance figures are lower than recommended, contact the factory service department.

6.5 Cable Checkout

Note: If there is water or other conductive material in the conduit, it could cause the instrument to fail. If this is the case, it will not be detected by the following test.

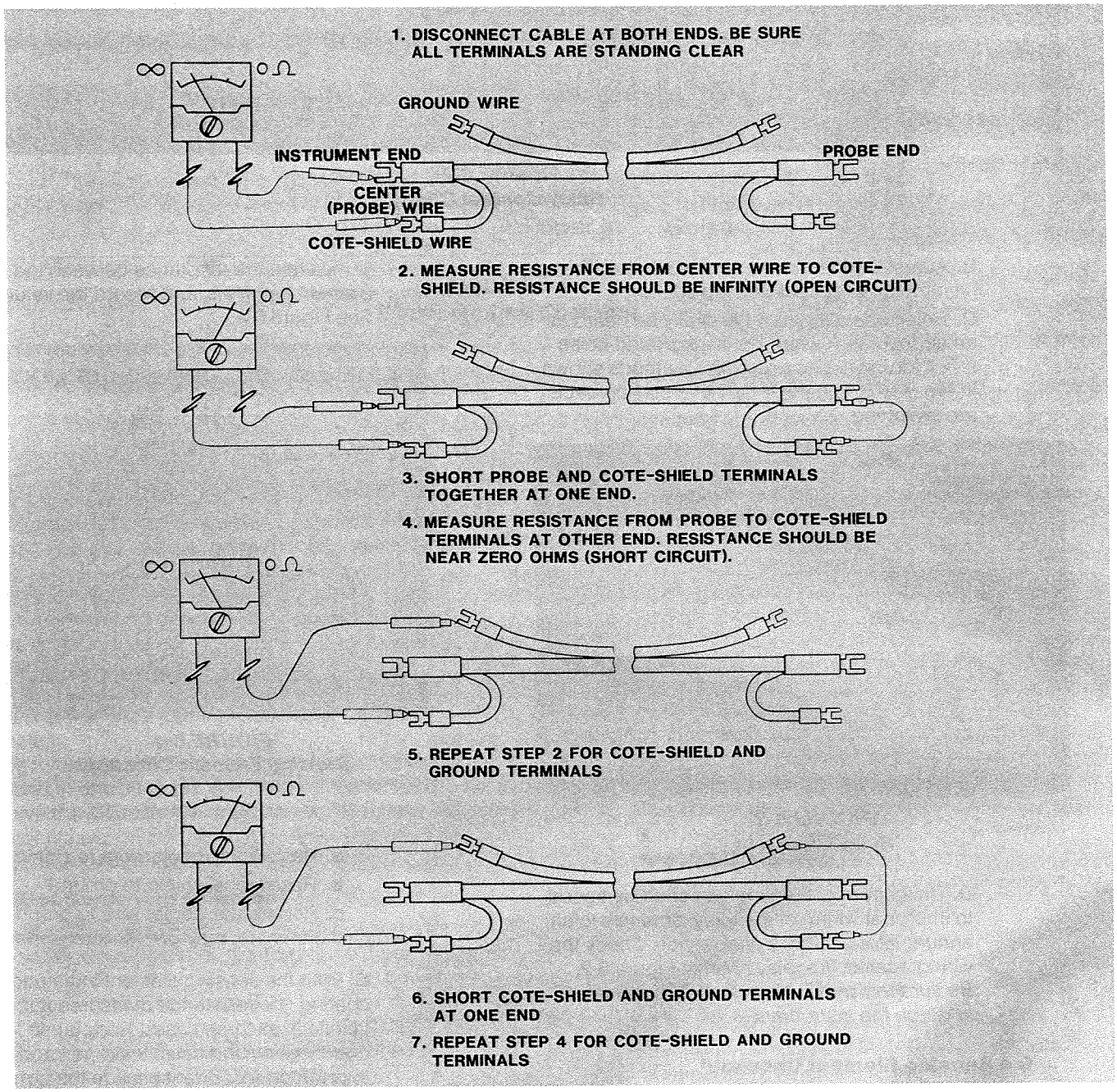


FIGURE 6-5
Cable Checkout

6.6 List of Some Possible Problems and Causes

Problem	Possible Cause	Solution
1. Instrument indicates alarm at all times	a. Coating build-up on sensing element (HLFS)	a. Need longer Cote-Shield. Consult factory.
	b. Sensing element not "seeing" material (LLFS)	b. Need longer insertion length. Consult factory.
	c. Short in coax cable (HLFS)	c. Sec. 6.5
	d. Open in the coax cable (LLFS)	d. Sec. 6.5
	e. Defect in sensing element	e. Sec. 6.4
	f. Loss of power (HLFS)	f. Sec. 4.4
	g. Improper wiring	g. Sec. 4.4 & 4.5
	h. Improper calibration	h. Sec. 5.3
	i. Electronic malfunction	i. Sec. 6.2
	j. Moisture in condulet	j. Sec. 6.1
	k. Moisture in cable conduit	k. Sec. 6.4
2. Instrument never indicates alarm	a. Coating build-up on sensing element (LLFS)	a. Need longer Cote-Shield. Consult factory.
	b. Sensing element not "seeing" material (HLFS)	b. Need longer insertion length. Consult factory.
	c. Open in coax cable (HLFS)	c. Sec. 6.5
	d. Short in coax cable (LLFS)	d. Sec. 6.5
	e. Loss of power (LLFS)	e. Sec. 4.4
	f. Improper wiring	f. Sec. 4.4 & 4.5
	g. Improper calibration	g. Sec. 5.3
	h. Electronic malfunction	h. Sec. 6.2
	i. Moisture in condulet	i. Sec. 6.4
	j. Moisture in cable conduit	j. Sec. 6.5
	k. Static sparks causing electronic damage.	k. Need spark protection circuit. Consult factory.
3. Instrument calibration is not stable	a. Open in coax cable	a. Sec. 6.5
	b. Improper wiring	b. Sec. 4.4 & 4.5
	c. Insufficient signal from sensing element	c. Need longer insertion length. Consult factory.
	d. Setpoint is beyond the tuning range of the electronics	d. Consult factory.
	e. Electronic malfunction	e. Sec. 6.2
	f. Moisture in condulet	f. Sec. 6.4
	g. Moisture in cable conduit	g. Sec. 6.5
4. Instrument gives false alarm	a. Improper calibration	a. Sec. 5.3
	b. Loose wiring	b. Sec. 4.4 & 4.5
	c. Electronic malfunction	c. Sec. 6.2
	d. Static sparks causing electronic damage.	d. Need spark protection circuit. Consult factory.
5. Instrument operates intermittently	a. Improper calibration	a. Sec. 5.3
	b. Loose wiring	b. Sec. 4.4 & 4.5
	c. Electronic malfunction	c. Sec. 6.2
	d. Static sparks causing electronic damage.	d. Need spark protection circuit. Consult factory.

7.0 Factory and Field Service Assistance

7.1 Telephone Assistance

If thereare questions about your Drexelbrook equipment:
•contact your local AMETEK Drexelbrook representative,
•call the Service department toll-free at 1-800-527-6297 (in US and Canada) or 1-215-674-1234 (outside North America),
•fax the following information to the Service department at 1-215-443-5117.

To expedite assistance, please provide the following information:
Instrument Model Number_____

Sensing Element Model Number and Length_____
_____

Coax Cable Length (remote systems)_____

Original Purchase Order Number_____

Material being measured_____

Temperature_____

Pressure_____

Agitation_____

Brief description of the problem_____
_____

Checkout procedures that have failed_____
_____

7.2 Equipment Return

Any equipment being returned for repair or credit must be pre-approved and have a return number issued by the factory.

In many applications, sensing elements are exposed to hazardous materials.
•OSHA mandates that our employees be informed and protected from hazardous chemicals.
•Material Safety Data Sheets (MSDS) listing the hazardous materials that the transducer has been exposed to **must** accompany any repair.
•It is your responsibility to fully disclose all chemicals and decontaminate the sensing element.

To obtain a return authorization number (RA#), contact the Service department at 1-800-527-6297 (US and Canada) or 1-215-674-1234 (outside North America). Please provide the following information:

Model Number of Return Equipment_____

Serial Number_____

Original Purchase Order Number_____

Process Materials that equipment has been exposed to_____

MSDS sheets for any hazardous materials_____

Billing Address_____
_____

Shipping Address_____
_____

Purchase Order Number for Repairs_____

Please include a purchase order even if the repair is under warranty. If repair is covered under warranty, you will not be charged.

Ship equipment freight prepaid to:
AMETEK Drexelbrook
205 Keith Valley Road
Horsham, PA 19044
COD shipments will not be accepted.

7.3 Field Service

Trained field service personnel are available on a time-plus-expense basis to assist in start-ups, diagnosing difficult application problems, or in-plant training of personnel. Preventative Maintenance and Calibration Certification service contracts are also available to maintain plant efficiency. Contact the Service department for further information.

7.4 Customer Training

Instrument Training Seminars for customers are conducted at the factory. These sessions, guided by Drexelbrook engineers and specialists, provide detailed information on all aspects of level measurement, including theory and practice of instrument operation. Contact the Training Department for further information.

8.0 APPENDIX A
406-6300 Supply Voltage Conversion (240/120 Vac)

The 406-6300 Series units are designed to operate with 120 Vac or 240 Vac line power. They are normally wired for 240 Vac operation, unless 120 Vac to 240 Vac is specifically requested. When converting from 240 Vac to 120 Vac operation, you will need a screwdriver, soldering iron, solder wick, solder bulb, 60/40 or 63/37 solder with resin or "no clean" core, and two inches of 20 AWG buss or stranded insulated wire.

WARNING

When changing the operating voltage of the unit, clearly relabel the unit with the new operating voltage. Damage to equipment could occur when operating the unit at the wrong supply voltage. Also, a 406-6300 (240 Vac) instrument converted to a 406-6000 (120 Vac) instrument is not agency-approved.

Step 1 - Disassemble Instrument

Refer to Figure 8-1 for the location of the five assembly screws on the sensing element connection side of the unit. Remove the five screws from the cover and gently open the cover to expose the electronics. Pull insulating plastic away from green ground screw on left side and move right side insulating plastic out of the way. Pivot top circuit board to the right to expose the power board. Use care not to damage ribbon cable.

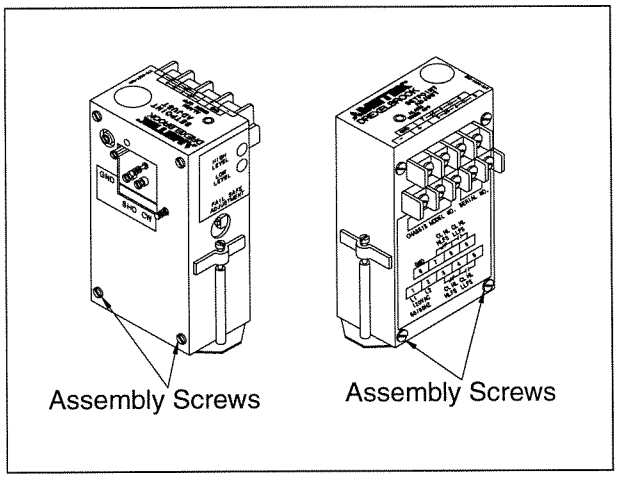


FIGURE 8-1
Electronic Chassis

Step 2 - Remove Power Board From Chassis

Remove four screws securing power board to aluminum chassis. Lightly pull the ends of the chassis out and then slide out the power circuit board. Use care not to damage the LED located at the top of the unit. The plastic insulating sheet should be kept with the chassis.

Step 3 - Unit Conversion

240 Vac to 120 Vac:

After the power circuit board has been removed, locate the four voltage selection holes. When 120 Vac operation is desired, the 240 Vac jumper must be removed and replaced with two new 20 AWG jumpers made of buss or stranded insulated wire. See Figure 8-2. Trim the excess wire from the jumpers on the terminal strip side of the circuit board. The instrument is now ready for 120 Vac operation.

POWER BOARD FOR 120 VAC OPERATION

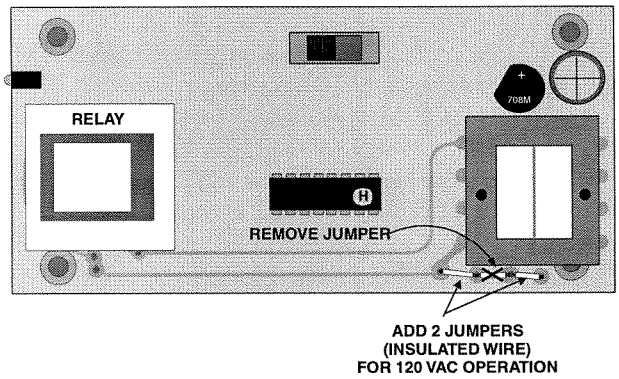


FIGURE 8-2
Unit Conversion 240 Vac to 120 Vac

Step 4 - Unit Reassembly

To reassemble the unit, slide the power circuit board back inside the cover, placing the plastic insulator sheet between the chassis and the board. Be sure that the LED can be seen through the hole on top of the unit. Attach the top circuit board. Slide the plastic insulator sheet over the green ground screw. Reassemble the top cover and replace all the screws. The conversion is now complete.

9.0 APPENDIX 9
Shortening or Lengthening the Sensing Element and FM Installation Drawing

9.1 Introduction
Sometimes your application calls for probe lengths other than the standard 18-inch or longer insertion lengths supplied. Shortening the sensing element is quite simple and can be done in the field. However, lengthening the sensing element is more difficult because the metal rod (typically 304 or 316SS must be welded.

NOTE

The insulation length of either flush or insulated sensing elements cannot be changed. Cable sensing elements can only be shortened and instructions are included with each unit.

Before making any adjustments:
a) read the following instructions thoroughly.
b) disconnect the electronics.

9.2 Shortening
The bare metal rod of the sensing element can be shortened with a hacksaw, being careful not to cut either of the two insulators. See Figure 9-1.

A. In applications using conductive or water-based materials, shortening is not a problem. Leave a minimum bare metal rod length of 2 inches.

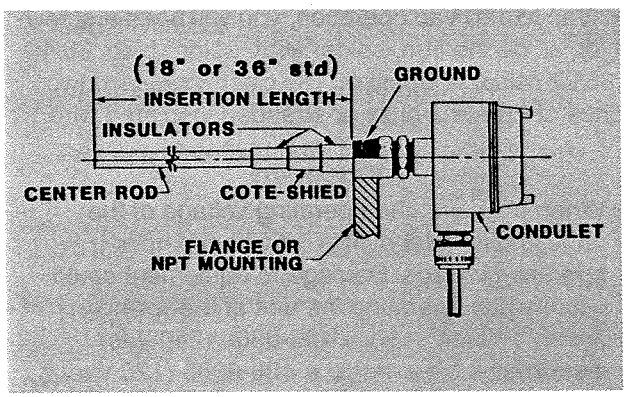
B. For dry granular materials (such as powder, sand, corn, clinker, etc.) you must leave a minimum bare metal rod length of 8 inches. Consult the factory before shortening beyond this point.

NOTES

1. Under **no** circumstances should the Cote-Shield element be modified.

2. Any changes made to the probe length after the instrument has been calibrated, requires re-calibration to insure proper operation.

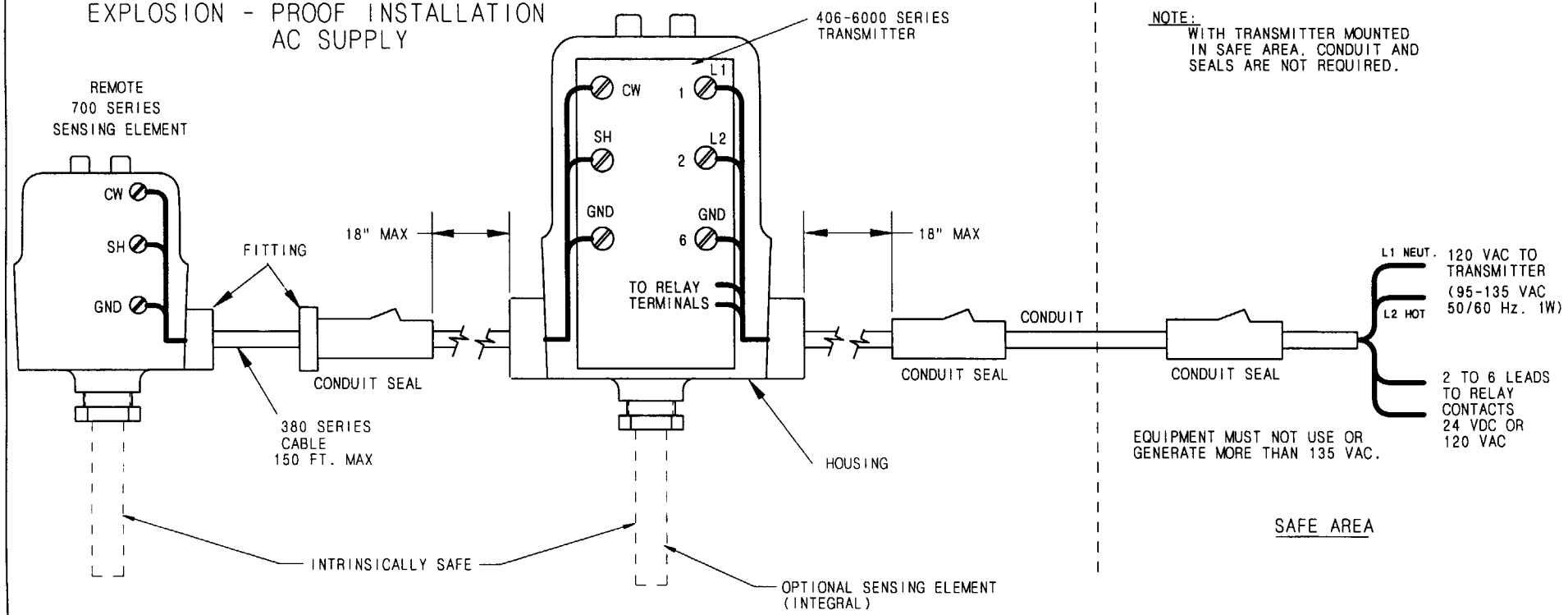
FIGURE 9-1
Shortening or Lengthening the Sensing Element



9.3 Lengthening
A. To lengthen the sensing element, an extension rod can be welded onto the end of the bare metal (center) rod. Make sure that the extension rod is the same metal as the sensing element.

B. An alternate option is to add a pipe coupling and a section of metal pipe after threading the tip of the sensing element. In this case, the metal of the pipe need not be identical to the metal of the sensing element.

EXPLOSION - PROOF INSTALLATION
AC SUPPLY



DIVISION 1 CLASS I GROUPS A-D, CLASS II GROUPS E-G, CLASS III
(SENSING ELEMENTS ARE INTRINSICALLY SAFE FOR ABOVE CLASSIFICATIONS. SEE NOTE 4 ON SHEET 2 FOR MODEL NUMBERS.)

NOTES:

1. MODEL NUMBERS OF 406-6000 SERIES TRANSMITTERS
   406-6abc-F0d-0e

a	= SUPPLY VOLTAGE	0,1
b	= SENSITIVITY	0,2
c	= TIME DELAY	0,2,4,5
F	= FM APPROVED	
d	= HOUSING	4,6,8,9,D,E,G,H,J
e	= FAILSAFE	0,1

2. MODEL NUMBER OF 380 SERIES CABLE
   380-abc-1d
   abc = LENGTH IN FEET, 1 - 150
   d = TEMPERATURE RATING 1,2,8

3. OPTIONAL VERIFY™ SWITCH 401-0010-009 MAY BE CONNECTED TO SENSING ELEMENT PER DRAWING # 401-0010-009-CD

ISS.	EDO/DSR NO.	APP'D	DATE
7	5-01-206	SCF	6-4-01
6	4-00-201	THP	4-6-00
5	2-96-203	THP	2-29-96
4	11-95-206	EJC	12-13-95
3	6-95-205	THP	7-27-95

CERTIFIED by _____
PO # _____
ENG _____
USER _____
DE # _____

SCALE NONE
UNLESS OTHERWISE STATED
ALL DIMENSIONS IN INCHES (MM)

DR. JJS 5-29-01
CK. CW

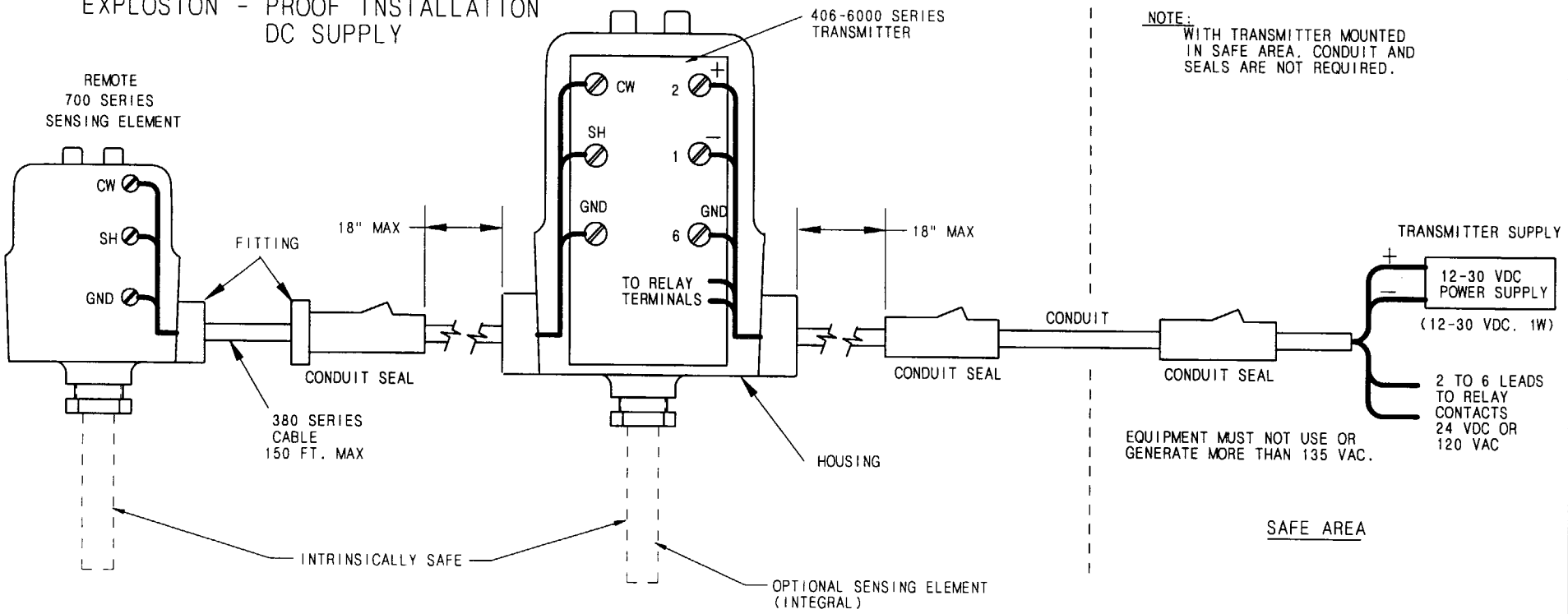
AMETEK®
DREXELBROOK
205 KEITH VALLEY RD
HORSHAM, PA 19044-9986
215-674-1234
FAX 215-674-2731

FM CONTROL DRAWING FOR
406-6000 SERIES

420-0001-596-CD SHT. 1 OF 2 ISS. 7

NO. 420-0001-596-CD SHT 1 OF 2

EXPLOSION - PROOF INSTALLATION
DC SUPPLY



DIVISION 1 CLASS I GROUPS A-D, CLASS II GROUPS E-G, CLASS III
(SENSING ELEMENTS ARE INTRINSICALLY SAFE FOR ABOVE CLASSIFICATIONS.)

NOTES:

4. MODEL NUMBERS OF APPROVED SENSING ELEMENTS SHOWN ON SHEETS 1 & 2 AS INTRINSICALLY SAFE:

701-mnop-qrs-t LEVEL PROBE

l = FAMILY NO. 0, 4
m = FAMILY NO. 0 THROUGH 9, BLANK
n = FAMILY NO. 0 THROUGH 9, BLANK
o = 0 THROUGH 9, BLANK
p = 0 THROUGH 9
q = FAMILY NO. 0 THROUGH 9, BLANK
r = FAMILY NO. 0 THROUGH 9, BLANK
s = FAMILY NO. 0 THROUGH 9
t = 14 CHARACTER EXPANDED NUMBERING SYSTEM. DOES NOT AFFECT SAFETY.

ISS.	EDO/DSR NO.	APP'D	DATE
7	5-01-206	[illegible]	6-4-01
6	4-00-201	THP	4-6-00
5	2-96-203	THP	2-29-96
4	11-95-206	EJC	12-13-95
3	6-95-205	THP	7-27-95

CERTIFIED by _____
PO # _____
ENG _____
USER _____
DE # _____

SCALE NONE
UNLESS OTHERWISE STATED
ALL DIMENSIONS IN INCHES (MM)

DR. JJS 5-29-01
CK. [illegible]

AMETEK®
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FM CONTROL DRAWING FOR
406-6000 SERIES

420-0001-596-CD SHT. 2 OF 2 ISS. 7

NO. 420-0001-596-CD

SHT 2 OF 2

AMETEK®

DREXELBROOK

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