Installation and Operating Instructions

Series 303-2X
Fly Ash Controls
using 406-6000 Electronics
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1.0 Introduction

The instructions in this manual are for the Drexelbrook point level controls for fly ash or similar materials.

1.1 System Description

The Drexelbrook 303-21 (Section 4.0), 303-22 (Section 5.0), and 303-23 Series (Section 6.0) level controls include a 406-6000 Series electronic package, 303-29 Series sensing element(s), and 380 Series measuring cable(s). See Figure 1-1. The first three numbers in the system model number indicate a point level fly ash system, the center two digits indicate the electronic package series, and the last digit refers to the number of individual electronic units in the package. For example: 303-22-4 is a point level fly ash system in a multiple unit package containing four separate 406-6000 Series electronic units. See Section 1.2, Models Available.

The 406-6000, Series electronic unit is a precision RF (radio frequency), relay output instrument. It provides double-pole double-throw relay contact closure when material (fly ash) reaches a preset point in a hopper. 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 buildup or material coating on the sensing element.

The 303-29 Series 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 available
Introduction

path to ground for the RF current is through the material being measured. See Figure 1-2.

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

Figure 1-2
Three-Terminal
Sensing Element

1.2 Models Available

1.2.1 Control Units

303-21-1

Single unit control consists of one electronic unit.* Can be used to operate either one independent or two parallel sensing elements in a single hopper. See Figure 1-3. See Section 4.0.

303-22-X**

Multiple unit control includes up to six electronic units.* Each unit can be used to operate either one independent or two parallel sensing elements per hopper (up to 12). See Figure 1-4. See Section 5.0.

*Electronic units are available in 120 Vac, 230 Vac or 24 Vdc models.

**X indicates number of electronic units included in a housing (one through six).
Multiple unit, dual-point control includes up to six electronic units* with sensing element selector switches and alarm lights for all units. Each electronic unit can be used to operate either two independent or four (two and two) parallel sensing elements in two separate hoppers (up to 24). See Figure 1-5. See Section 6.0.

**Figure 1-5**
303-23 Series Control

1.2.2 Sensing Elements

See Figures 1-6 & 1-7. The 303-29 Series sensing elements are applicable to all three series of Drexelbrook fly ash controls. They are available in both low temp (450°F max) and high temp (1500°F max) models, with various standard insertion lengths that depend on the mounting nozzle length. See Section 2.2.

---

*Electronic units are available in 120 Vac, 230 Vac or 24 Vdc models.

**X** indicates number of electronic units included in a housing (one through six).
1.2.3 Connecting Cables

The electronic unit and sensing element are connected by a three-conductor coaxial cable. Drexelbrook cables are available in:

General Purpose: 380-XXX-12
High Temperature: 380-XXX-11
(for temps above 160°F)
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. 5-foot increments up to 25 feet are standard, but cut lengths up to 150 feet are available. General-purpose cable can also be purchased in bulk lengths up to 1000 feet. See Figure 1-8. Be sure to use Drexelbrook 389-1-6 Cable End Termination kit and tool for terminating bulk cable. See Section 7.6.

1.3 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.

Important:

Spark protection is included in the box with the sensing element condute(s). This spark protector circuit is to be installed in the condute by the customer. Do Not Throw Away! Spark protection is necessary, as insulating fly ash can accumulate a static charge that can damage the electronic unit. See Sections 4.5, 5.5, and 6.5 "Wiring the Sensing Element". See Figure 1-9.

---

Figure 1-8
General Purpose Three-Terminal Cable

Figure 1-9
Spark Protection
2.0 Specifications

Notice: Drexelbrook equipment is built with great care, and sub-
jected to rigorous quality control. Even so, failures of any equipment
are not uncommon. Sound engineering practice demands that, whenever
equipment failure may result in more than an inconvenience, a com-
pletely independent backup system be employed so that failure of
either the unit or the backup unit will not permit the hazardous con-
dition to occur.

2.1 Electronic Unit

A. Power Requirement

406-60XX Series: 120 ±25 Vac
50/60 Hz, 1 watt

406-61XX Series:
12-30 Vdc, 1 watt

406-63XX Series:
230/120 ±25 Vac 50/60 Hz, 1
watt (field convertible)

B. Operating Temperature

-40° to 140°F (-40° to 60°C)

C. Sensitivity (Max. Differential)

0.1 pF standard

D. Operating Point Range

0-130° pF standard

E. Hazardous Areas

Electronic Unit: 303-21-1
Housing is explosionproof for
Class I, Groups A,B,C, and D
(Div. 1 & 2) and Class II,
Groups E,F, and G (Div. 1 & 2). Housing FM approved.

Sensing Element and Cable (all systems): Intrinsically Safe
for Class I, Groups A,B,C, and
D. (Div. 1 & 2). Suitable for
Class II, Groups E, F, & G
(Div. 1 & 2).

F. RFI Protection (Built-In)

Less than 2 pF shift in oper-
at ing point for unit in stan-
dard housing from 5W field @27
MHz, 150 MHz, or 450 MHz at a
distance of 5 ft from exposed
sensing element, cable, or
power line.

G. Temperature Effect

Operating Point:

.15pF/30°F

Sensitivity:

.05pF/30°F

H. Output - DPDT Relay Contact

Rating-

Standard:

120 Vac: 5A non-inductive
3A inductive

230 Vac: 5A non-inductive
2A inductive

24 Vdc: 5A non-inductive
1A for inductive
loads up to 300mH

Optional Hermetically Sealed
Relay (Modif. 91-11):

120 Vac: 3A non-inductive
2A inductive

230 Vac: 3A non-inductive
2A inductive

24 Vdc: 1A for inductive
loads up to 30mH

I. Fail-Safe

Field-switchable to either Low-
Level Fail-Safe (LLFS) or High-
Level Fail-Safe (HLFS).
Specifications

J. Housings

303-21 Series: Meets Nema classifications 1-5 and 12. Also explosionproof for Class I, Groups A,B,C,D, (Div. 1 and 2) and Class II, Groups E,F,G, (Div. 1 and 2).

303-22 and 303-23 Series: 14" X 16" weatherproof enclosures meet Nema classifications 1-3, 5 and 12.
2.2 Sensing Element

A. Low-Temp Sensing Element

<table>
<thead>
<tr>
<th>MODEL NUMBER</th>
<th>TEMP. &amp; PRESS. MOUNTING</th>
<th>ROD OD &amp; MATL.</th>
<th>HOPPER INSULATION THICKNESS</th>
<th>MAXIMUM NOZZLE LENGTH</th>
<th>INSERTION LENGTH</th>
<th>INSTALL CLEARANCE REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>303-29-1</td>
<td>450°F@ 20 3/4&quot; NPT</td>
<td>3/8&quot; OD Bare SS w/TFE Insulators</td>
<td>0&quot; 0&quot;</td>
<td>19&quot;</td>
<td>24&quot;</td>
<td></td>
</tr>
<tr>
<td>303-29-2</td>
<td>450°F@ 20 3/4&quot; NPT</td>
<td>3/8&quot; OD Bare SS w/TFE Insulators</td>
<td>0-5&quot; 8&quot;</td>
<td>26&quot;</td>
<td>40&quot;</td>
<td></td>
</tr>
<tr>
<td>303-29-3</td>
<td>450°F@ 20 3/4&quot; NPT</td>
<td>3/8&quot; OD Bare SS w/TFE Insulators</td>
<td>0-10&quot; 16&quot;</td>
<td>34&quot;</td>
<td>56&quot;</td>
<td></td>
</tr>
<tr>
<td>303-29-4</td>
<td>450°F@ 20 3/4&quot; NPT</td>
<td>3/8&quot; OD Bare SS w/TFE Insulators</td>
<td>0-13&quot; 20.5&quot;</td>
<td>38.5</td>
<td>65&quot;</td>
<td></td>
</tr>
<tr>
<td>303-29-5</td>
<td>450°F@ 20 3/4&quot; NPT</td>
<td>3/8&quot; OD Bare SS w/TFE Insulators</td>
<td>0-16&quot; 25&quot;</td>
<td>43&quot;</td>
<td>74&quot;</td>
<td></td>
</tr>
</tbody>
</table>

*All 303-29 sensing elements can be used with any Drexelbrook Fly Ash Control System. The sensing element is specified according to hopper insulation thickness and temperature requirements.
### B. High-Temp Sensing Element

<table>
<thead>
<tr>
<th>MODEL NUMBER</th>
<th>TEMP. &amp; PRESS. °F AT PSI</th>
<th>MOUNTING 304 SS</th>
<th>ROD OD &amp; MATL.</th>
<th>HOPPER INSULATION THICKNESS</th>
<th>RECOMMENDED NOZZLE LENGTH</th>
<th>INSERTION LENGTH</th>
<th>INSTALL CLEARANCE REQUIRED</th>
</tr>
</thead>
<tbody>
<tr>
<td>303-29-102</td>
<td>1500 ° @ 2 NPT</td>
<td>1 1/4&quot;</td>
<td>1/2&quot; OD Bare SS w/Ceramic Insulators</td>
<td>0&quot;</td>
<td>0&quot;</td>
<td>19&quot;</td>
<td>31.5&quot;</td>
</tr>
<tr>
<td>303-29-103</td>
<td>1500 ° @ 2 NPT</td>
<td>1 1/4&quot;</td>
<td>1/2&quot; OD Bare SS w/Ceramic Insulators</td>
<td>0-6&quot;</td>
<td>9.5&quot;</td>
<td>27.5&quot;</td>
<td>50.5&quot;</td>
</tr>
<tr>
<td>303-29-104</td>
<td>1500 ° @ 2 NPT</td>
<td>1 1/4&quot;</td>
<td>1/2&quot; OD Bare SS w/Ceramic Insulators</td>
<td>0-12&quot;</td>
<td>19&quot;</td>
<td>37&quot;</td>
<td>69.5&quot;</td>
</tr>
<tr>
<td>303-29-105</td>
<td>1500 ° @ 2 NPT</td>
<td>1 1/4&quot;</td>
<td>1/2&quot; OD Bare SS w/Ceramic Insulators</td>
<td>0-14&quot;</td>
<td>22&quot;</td>
<td>40&quot;</td>
<td>75.5&quot;</td>
</tr>
<tr>
<td>303-29-106</td>
<td>1500 ° @ 2 NPT</td>
<td>1 1/4&quot;</td>
<td>1/2&quot; OD Bare SS w/Ceramic Insulators</td>
<td>0-16&quot;</td>
<td>25&quot;</td>
<td>43&quot;</td>
<td>81.5&quot;</td>
</tr>
</tbody>
</table>

*All 303-29 Series sensing elements can be used with any Drexelbrook Fly Ash Control System. The sensing element is specified according to hopper insulation thickness and temperature requirements.*
2.3 Connecting Cables

Cables up to 150 feet long can be used, depending on the application.

A. General Purpose (380-XXX-12): .51" O.D. at largest point. 160°F temp limit.

B. Composite, first 10 ft. high temp (380-XXX-18): .62" O.D. at largest point. 450°F temp limit for first 10 feet. 160°F temp limit for remainder of cable length.

3.0 Theory of Operation

3.1 Electronic Unit

The 406-6000 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.

Figure 3-2A shows an exaggerated view of how a coating may lock 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
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. Whenever the material being measured is conducting and leaves a coating, three-terminal Cote-Shield sensing elements should always be used. In fly ash applications, the sensing element is mounted horizontally at a downward angle at the desired control level. The operating point is adjustable over the full length of the active (center portion) sensing element. An exception is the rare case that the fly ash is conductive. Then the operating point will be the first place the fly ash touches the active portion of the sensing element.

3.3 Connecting Cables

The Drexelbrook 303-2X 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 capacitance, any change in capacitance due to temperature or change of cable length will not affect the original calibration.
4.0 303-21 Series

4.1 Model Descriptions

The 303-21 Series single unit control includes one electronic unit and can be used to operate one independent or two parallel sensing elements.

Mode 1A uses two single unit controls to provide individual alarm circuits for both sides of a divided hopper. See Figure 4-1. Two sensing elements are used for divided hoppers, one on either side of the divider. Each sensing element is connected to an electronic unit. When the fly ash level reaches either sensing element, the corresponding electronic unit will energize its alarm circuit to tell which side of the hopper is full.

Mode 1B uses one single unit control to provide one alarm circuit for an undivided hopper, or one side of a divided hopper. See Figure 4-2. One sensing element is mounted in the side of the hopper where the fly ash level is known to reach high level first and is connected to a single electronic unit. When the fly ash level reaches the sensing element, the electronic unit will energize its alarm circuit.

Mode 1C uses one single control unit to provide an alarm circuit for both sides of a divided hopper. See Figure 4-3. Two sensing elements are connected in parallel and mounted in both sides of a divided hopper. They are both connected to a single electronic unit. When the fly ash level reaches either sensing element, the electronic unit will energize its alarm circuit.
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 and calibration, it is best to install the instrument in a easily accessible location. See Figure 4-4.

4.3 Mounting the Sensing Element

The mounting position of the sensing element depends on the location of nozzles into the hopper.

Note: Do not mount a Cote-Shield sensing element through a nozzle which exceeds the length of the first insulator. The Cote-Shield element should extend into the vessel at least 2 inches beyond the maximum expected wall build-up. See Figure 4-5.

4.4 Wiring the Electronic Unit

All power and relay connections are made to the terminal strips on the electronic chassis. See Figure 4-6. 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. For low voltage 12-30 Vdc models, terminal 1 is (-) and terminal 2 is (+).
Sensing element cable connections to the electronic chassis are made to the individual terminals on the side opposite the power and relay terminal strips. See Figure 4-8.

Figure 4-8
Sensing Element Cable Connections to the Electronic Unit

Only coaxial cables supplied by DREXELBROOK ENGINEERING COMPANY should be used to connect the control unit to the sensing element. For cable lengths greater than 150 feet between sensing element and electronic unit, consult factory for proper installation. No padding of the instrument is required to compensate for cable length.

NEVER splice cables. Do not shorten or reterminate cables without using a Drexelbrook termination kit. See Section 7.6.

4.5 Wiring the Sensing Element

Important:

Spark protection is included in the packing box with the sensing element condulet(s). It is to be installed in the condulet by the customer. Do Not Throw Away!
The sensing element cable connections are made to the sensing element after it has been installed in the vessel, with the conduit and spark protection attached.

Applications involving fly ash require extra spark protection against the discharge of static sparks, that can damage the electronic unit.

Use the following instructions for installing the spark protector and cable to the sensing element. See Figure 4-9.

A. Attach the mounting link on the spark protector to the sensing element center connection screw. See Figure 4-9A.

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

C. Feed the cable into the conduit.

D. Connect the cable center wire (Blue) to the spark protector and the cable ground wire (Green) to the ground screw as shown in Figure 4-9.

E. Connect the shield wire (SH) to the Cote-Shield terminal.

Note:

See Figure 4-10 for wiring of parallel sensing elements (Mode C)
4.6 Start-Up

Before applying power to the instrument, be sure that the input power will be 120 Vac 50/60 Hz for 406-60XX Series electronic chassis, 230 Vac 50/60 Hz for 406-63XX Series electronic chassis, or 12-30 Vdc for 406-61XX Series electronic chassis. 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.

4.7 Controls

4.7.1 Setpoint Control

There is a single adjustment located on top of the electronic unit that controls the point at which the relay operates. A lighted LED indicates that the relay is energized. The LED light goes out when the relay is in the alarm condition. Each revolution of the control will change the operating point approximately 4 to 5 pF. Turning the adjustment clockwise will raise the level at which the relay operates, and turning it counterclockwise will lower the level at which the relay operates. Refer to Figure 4-11.

Figure 4-11
Setpoint Control

4.7.2 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, also indicating high level upon loss of power. Low-Level Fail-Safe (LLFS) means the relay will de-energize under low level conditions, also 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 4-12.

Figure 4-12
Fail-Safe Selector
4.8 303-21 Series Calibration

Be sure to use the red insulated tool provided with the electronic unit. See Figure 4-13. For proper operation, this tool must be used. Do not turn any adjustment past its mechanical stops. Damage to the unit may occur. Note: The LED light on indicates relay energized or normal condition (not alarm).

A. The hopper must be empty. If the precipitator has been operating before calibration, it is necessary to completely empty the hopper. Be sure there is no material bridging to within one foot of the sensing element(s).

B. With the setpoint adjustment in the full counterclockwise (CCW) position, use the red insulated tool to slowly turn the adjustment clockwise (CW) until the relay just operates. (LED comes on). See Figure 4-13. If you go past the operate point, back the adjustment off one turn and repeat.

C. Note the position of the pointer on the calibration tool, then preload the unit by turning the adjustment one half turn further clockwise (CW). Do not turn CCW! This is the normal amount of preload needed for fly ash. Due to variations in the ash and/or the mounting position of the sensing element, the unit may need more or less preload.

D. If you are having difficulties or need assistance in calibrating your control unit, contact the factory service department.

Calibration Complete.

LED Indicator

![Figure 4-13 Calibration Adjustment Tool]
5.0 303-22 Series

5.1 Model Description

The 303-22 Series multiple unit control includes up to six electronic units. Each unit can be used to operate either one independent or two parallel sensing elements per hopper (up to 12).

**Mode 2A** uses a multiple unit control to provide individual alarm circuits for both sides of divided hoppers (up to three hoppers). See Figure 5-1. Two sensing elements are mounted in each hopper, one on either side of the divider. Each sensing element is connected to an individual electronic unit. When the fly ash level reaches either sensing element, the corresponding electronic unit will energize its alarm circuit to tell which side of the hopper is high.

![Figure 5-1](image1)

**Figure 5-1**
303-22 Series
Mode 2A Control

**Mode 2B** uses a multiple unit control to provide one alarm circuit for an undivided hopper (up to six hoppers). See Figure 5-2. One sensing element is mounted in the side of the hopper where the fly ash level is known to pile the highest, and is connected to a single electronic unit. When the fly ash level reaches the sensing element, the electronic unit will energize its alarm circuit.

![Figure 5-2](image2)

**Figure 5-2**
303-22 Series
Mode 2B Control

**Mode 2C** uses a multiple unit control to provide one alarm circuit for both sides of a divided hopper (up to six hoppers). See Figure 5-3. Two sensing elements are connected in parallel and

![Figure 5-3](image3)

**Figure 5-3**
303-22 Series
Mode 2C Control
mounted in both sides of a divided hopper. They are both connected to a single electronic unit. When the fly ash level reaches either sensing element, the electronic unit will energize its alarm circuit.

5.2 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 and calibration, it is best to install the instrument in a reasonably accessible location. See Figure 5-4.

5.3 Mounting the Sensing Element

The mounting position of the sensing element depends on the location of nozzles into the hopper.

Note: Do not mount a Cote-Shield sensing element through a nozzle which exceeds the length of the first insulator. The Cote-Shield element should extend at least 2 inches beyond the maximum expected wall buildup. See Figure 5-5.

5.4 Wiring the Electronic Unit

The power and relay connections are made to the terminal strips located in the lower position of the 303-22 Series package; the units have been prewired to the terminal strips. See Figure 5-6. Due to the low power consumption of the instrument (1 watt), the wiring need only follow local electrical codes.
These power connections are made to terminals Gnd, Com and Hot. See Figure 5-7. For low voltage 12-30 Vdc models, the terminals are (-) and (+).

Sensing element cable connections on the electronic chassis are made to the individual terminals on the side opposite the power and relay terminal strips. See Figure 5-9.

The relays used in these units have double-pole, double-throw contacts. All relay connections are made to the terminal as shown in Fig. 5-7. Each relay serves as a low power switch and will not provide sufficient current to activate motors or heavy equipment. Refer to Figures 5-7 and 5-8.

Only coaxial cables supplied by DREXELBROOK ENGINEERING COMPANY should be used to connect the control unit to the sensing element. For cable lengths greater than 150 feet between the sensing element and electronic unit, consult factory for proper installation. No padding of the instrument is required to compensate for cable length.

NEVER splice cables. Do not shorten or reterminate cables without using a Drexelbrook termination kit. See Section 7.6.
5.5 Wiring the Sensing Element

Important:

Spark protection is included in the box with the sensing element conduit. It is to be installed in the conduit by the customer. Do not throw away!

The sensing element cable connections are made to the sensing element after it has been installed in the vessel, with the conduit and spark protection attached.

Applications involving fly ash require extra spark protection against the discharge of static sparks, that can damage the electronic unit.

Use the following instructions for installing the spark protector and cable to the sensing element. See Figure 5-10.

A. Attach the mounting link on the spark protector to the sensing element center connection screw. See Figure 5-10A.

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

C. Feed the cable into the conduit.

D. Connect the cable center wire (Blue) to the spark protector and the cable ground wire (Green) to the ground screw as shown in Figure 5-10.

E. Connect the shield wire (SH) to the Cote-Shield terminal.

Note:

See Figure 5-11 for wiring of parallel sensing elements (Mode C).
5.6 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 electronic chassis, 230 Vac 50/60 Hz for 406-6300 Series electronic chassis, or 12-30 Vdc for 406-6100 Series electronic chassis. Check all the wiring connections. See Sections 5.5 and 5.6.

5.7 Controls

5.7.1 Setpoint Control

There is a single adjustment located on top of the electronic unit 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. Turning the adjustment clockwise will raise the level at which the relay operates, and turning it counterclockwise will lower the level at which the relay operates. Refer to Figure 5-12.

5.7.2 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, also indicating high level upon loss of power. Low-Level Fail-Safe (LLFS) means the relay will de-energize under low level conditions, also 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 5-13.

Figure 5-13
Fail-Safe Selector

Figure 5-14
Calibration Adjustment Tool
5.8 303-22 Series Calibration

Use the following procedure for each of the individual control units in the 303-22 Series package.

Be sure to use the red insulated tool provided with the electronic unit. See Figure 5-14. For proper operation, this tool must be used. Do not turn any adjustment past its mechanical stops. Damage to the unit may occur. Note: The LED light on indicates relay energized or normal condition (not alarm).

A. The hopper must be empty. If the precipitator has been operating before calibration, it is necessary to completely empty the hopper. Be sure there is no material bridging to within one foot of the sensing element(s).

B. With the setpoint adjustment in the full counterclockwise (CCW) position, use the red insulated tool to slowly turn the adjustment clockwise (CW) until the relay just operates. (LED comes on). See Figure 5-14. If you go past the operate point, back the adjustment off one turn and repeat.

C. Note the position of the pointer on the calibration tool, then turn the adjustment one half turn further clockwise (CW). Do not turn CCW! This is the normal amount of preload needed for fly ash. Due to variations in the ash and/or the mounting position of the sensing element, the unit may need more or less preload.

D. If you are having difficulties or need assistance in calibrating your control unit, contact the factory service department.

Calibration Complete.
6.0 303-23 Series

6.1 Model Descriptions

The 303-23 Series multiple unit, dual-point control includes up to six electronic units with sensing element selector switches and alarm lights for each unit. Each electronic unit can be used to operate either two independent or four (two sets of parallel) sensing elements (up to 24).

Mode 3A uses a multiple unit, dual-point control to provide a single alarm circuit for two sides of a divided hopper, with a switch to tell which side is full (up to six hoppers). See Figure 6-1. Two sensing elements are mounted in each hopper, one on either side of the divider. Both are connected to a single electronic unit. When the fly ash level reaches either sensing element, the applicable electronic unit will energize its alarm circuit and the corresponding light on the housing cover will come on. The two-position spring-loaded switch can be used to tell which side of the hopper is in alarm condition. Example: if the alarm light is on with the switch in position "A", but off with the switch in position "B", only sensing element "A" is in high level condition.

Mode 3B uses a multiple unit, dual-point control to provide individual alarm circuits for two undivided hoppers, with a switch to tell which of the two hoppers is in alarm condition (up to twelve hoppers). See Figure 6-2. Each sensing element is mounted at a point in the hopper where the fly ash level is known to pile the highest. Two sensing elements are connected to a single electronic unit. When the fly ash level reaches either

Figure 6-1
303-23 Series
Mode 3A Control

Figure 6-2
303-23 Series Mode 3B Control
sensing element, the electronic unit will energize its alarm circuit and, the corresponding light on the housing cover will come on. The two-position spring-loaded switch can be used to tell which hopper is in high level condition. Example: if the alarm light is on with the switch in position "B", but off with the switch in position "A", hopper "B" is in high level condition.

Mode 3C uses a multiple unit, dual-point control to provide a single alarm circuit for both sides of two divided hoppers, with a switch to tell which of the two hoppers is in alarm condition (up to twelve hoppers). See Figure 6-3. Two sensing elements each are connected in parallel and mounted in both sides of the divided hoppers. Four sensing elements (two and two) are connected to each electronic unit. When the fly ash level reaches any of the four sensing elements, that electronic unit will energize its alarm circuit, and the corresponding light on the housing cover will come on. The two-position spring-loaded switch can be used to tell which hopper is in the alarm condition. Example: if the alarm light is on with the switch in position "A" but off with the switch in position "B", hopper "A" is in the high level condition.

6.2 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 and calibration, it is best to install the instrument in a reasonably accessible location. See Figure 6-4.
6.3 Mounting the Sensing Element

The mounting position of the sensing element depends on the location of the nozzles into the hopper.

Note: Do not mount a Cote-Shield sensing element through a nozzle which exceeds the length of the first insulator. The Cote-Shield element should extend at least 2 inches beyond the maximum expected wall buildup. See Figure 6-5.

6.4 Wiring the Electronic Unit

The power and relay connections are made to the terminal strips in the lower portion of the 303-23 Series package; the units have all been prewired to these terminal strips. See Figure 6-6. Due to the low power consumption of the instrument (1 watt), the wiring need only follow local electrical codes.

These power connections are made to terminals Gnd, Com and Hot. See Figure 6-7. For low voltage 12-30 Vdc models, the terminals are (-) and (+).

Figure 6-5
Mounting the Sensing Element

Figure 6-6
303-23 Series Package with Terminal Strips for Power and Relay Wiring

Figure 6-7
Power and Relay Connections to the 303-23 Series Control

The relays used in these units have double-pole, double-throw contacts. All relay connections are made to the terminal strips as shown in Fig. 6-7. Each relay serves as a low power switch and will not provide sufficient current to activate motors or heavy equipment. Refer to Figures 6-7 and 6-8.
Sensing element cable connections to the electronics unit are made to the individual terminal boards across the top of the electronic package. See Figure 6-9.

Only coaxial cables supplied by DREXELBROOK ENGINEERING COMPANY should be used to connect the control unit to the sensing element. For cable lengths greater than 150 feet between the sensing element and electronic unit, consult factory for proper installation. No padding of the instrument is required to compensate for cable length.

NEVER splice cables. Do not shorten or reterminate cables without using a Drexelbrook termination kit. See Section 7.6.

6.5 Wiring the Sensing Element

Important:

Spark protection is included in the box with the sensing element conduit. It is to be installed in the conduit by the customer. Do not throw away!

The sensing element cable connections are made to the sensing element after it has been installed in the vessel, with the conduit and spark protection attached.
Applications involving fly ash require extra spark protection against the discharge of static sparks, that can damage the electronic unit.

Use the following instructions for installing the spark protector and cable to the sensing element. See Figure 6-10.

A. Attach the mounting link on the spark protector to the sensing element center connection screw. See Figure 6-10A.

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

C. Feed the cable into the conduit.

D. Connect the cable center wire (Blue) to the spark protector and the cable ground wire (Green) to the ground screw as shown in Figure 6-10.

E. Connect the shield wire (Red) to the Cote-Shield terminal.

Note:
See Figure 6-11 for wiring of parallel sensing elements (Mode 3C).
6.6 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 electronic chassis, 230 Vac 50/60 Hz for 406-6300 Series electronic chassis, or 12-30 Vdc for 406-6100 Series electronic chassis. Check all the wiring connections. See Section 6.4 and 6.5.

6.7 Controls

6.7.1 Setpoint Control

There is a single adjustment located on top of the electronic unit 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. Turning the adjustment clockwise will raise the level at which the relay operates, and turning it counterclockwise will lower the level at which the relay operates. Refer to Figure 6-12.

6.7.2 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, also indicating high level upon loss of power. Low-Level Fail-Safe (LLFS) means the relay will de-energize under low-level conditions, also 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 6-13.

Figure 6-12
Setpoint Control

Figure 6-13
Fail-Safe Selector
6.7.3 Sensing Element Selector Switches

For each of the control units in the 303-23 Series packages, there is a sensing element selector switch located on the outside of the housing, adjacent to its corresponding unit. See Figure 6-14. This spring-loaded switch is held in either position "A" or "B" when balancing the unit for each of its two sensing element inputs. See Section 6.8.

6.8 303-23 Series Calibration

Use the following procedure for each of the individual control units in the 303-23 Series package.

Be sure to use the red insulated tool provided with the electronic unit. See Figure 6-15. For proper operation, this tool must be used. Do not turn any adjustment past its mechanical stops. Damage to the unit may occur. Note: The LED light on indicates relay energized or normal condition (not alarm).

Figure 6-14
Sensing Element Selector Switches on 303-23 Series Housing

Figure 6-15
Calibration Adjustment Tool

Figure 6-16
Sensing Element Selector Switch and Balancing Adjustments
A. The hopper must be empty. If the precipitator has been operating before calibration, it is necessary to completely empty the hopper. Be sure there is no material bridging to within one foot of the sensing element.

B. With both sensing elements connected, make sure the selector switch, on the control unit being calibrated, is in the center position. See Figure 6-16.

C. With the setpoint adjustment on the electronic unit in the full counterclockwise (CCW) position, use the insulated tool to turn the adjustment slowly clockwise (CW) until the relay just operates. (LED comes on). See Figure 6-15. If you go past the operate point, back the adjustment off one turn and repeat. Leave the calibration tool in place.

D. Turn the selector switch to the position for sensing element "A" and hold in place. See Figure 6-16.

E. Locate the mounting bar for the control unit selector switch just inside the housing. See Figure 6-16. On either side of the switch are two piston capacitors (sensing element balancing adjustments). With the capacitor for sensing element "A" in the full counterclockwise (CCW) position (do not force), use a small screwdriver and slowly turn clockwise (CW) until the relay just operates and the corresponding alarm light on the housing door goes out. There should be an audible click if background noise is not too loud.

F. Turn the selector switch to the position for sensing element "B". Again, with the piston capacitor "B" in the full counterclockwise (CCW) position, use the small screwdriver and slowly turn clockwise (CW) until the relay just operates ("clicks"). As before, the alarm light on the cover door should just go out.

G. Return the selector switch to the central position.

H. Note the position of the pointer on the control unit calibration tool and turn it one half turn further clockwise (CW). Do not turn CCW. This is the normal amount of preload needed for fly ash. Due to variations in the ash and/or the mounting position of the sensing element(s), the unit may need more or less preload.

I. Repeat Steps A-H for each control unit in the 303-23 Series package.

J. If you are having difficulties or need assistance in calibrating your control unit, contact the factory service department.

Calibration Complete.
7.0 Troubleshooting

7.1 Introduction

The 303-2X 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.

7.2 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 7-1.

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 the 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 1/8 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.
7.3 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 sets of contacts will be open with high or low level, and two sets will be closed with high or low level. See Figure 7-2.

B. Adjust the instrument as described in the electronics checkout Section 7.2.

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 7-3 to determine if the relay contacts are switching.

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 7-2. Be sure to use the diagram for the fail-safe in which the instrument is set.
7.4 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 7-4.

![Figure 7-4 Testing the Sensing Element](image)

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 conduit, 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 - 1000Ω
- center wire to shield - 600Ω
- shield to ground - 300Ω

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

* A digital ohmmeter may give erroneous readings.
Troubleshooting

7.5 Cable Checkout

See Figure 7-5.

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 cable checkout procedure.

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

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

3. Short probe and cote-shield terminals together at one end.

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

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

6. Short cote-shield and ground terminals at one end.

7. Repeat step 4 for cote-shield and ground terminals.

Figure 7-5
Testing the Cable
7.6 Cote-Shield(TM) Cable Termination

For terminating Drexelbrook Cote-Shield cables, be sure to use the Drexelbrook cable end termination kit, #389-1-6. See Figure 7-6. Use the following procedure.

A. Cut the cable to the desired length, plus 2 inches.

B. Strip the ground lead away from the coax cable for a length of 2 inches.

C. Trim one inch off the outer insulation of the center wire, cutting down to, but not into the metallic braided sheath.

D. Trim the metallic braid back 3/4 inch.

E. Slip a ferrule (389-1-3) over the end of the cable so that the metallic braid slides between the inner and outer parts of the ferrule. The outside part of the ferrule should be over the end of the outer sheath of cable about 1/32 inch.

F. Insert the bare end of the terminal wire (920-3000-6) inside the back of the ferrule.

G. Open the cable termination tool (290-1-3) and insert the ferrule into the center hole of the tool so that the slots are at right angle to the tool seam.

H. Tighten the tool completely. Open and rotate the ferrule 90°, then tighten the tool again to flatten any extruded "ears".
Troubleshooting

I. Trim the inner plastic sheath to 3/16 inch from the head of the ferrule.

```
3/16 IN.
```

J. Slip a termination lug (353-3-3) over the bare center wire so that the insulation bottoms out on the center plastic sheath, and the tip of the wire shows at the lug end. Crimp the lug.

```

K. Slip blue plastic sleeve (388-1-1) over the cable end so that one end is about 1/16 inch from the end of the lug insulation, and the other end extends about 1/4 inch past the end of the ferrule.

```
1/16 IN.  1/4 IN.
```

L. Heat* the plastic sleeve until the sleeve shrinks and tightly grips the cable and lug insulation.

M. Strip the insulation from the ground lead to about 5/16 inch from the end. Attach a spade lug (353-3-3), making sure 1/32 inch of the wire is visible through the crimp. Cover the red insulation on the spade lug with a green plastic sleeve (388-1-32). Heat shrink* to make permanent.

```

*Use a dry heat source of 200°-250°F. A match, candle or heated air stream can be used.
### 7.7 Possible Problems and Probable Causes

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Instrument indicates alarm at all times</td>
<td>a. Coating build-up on sensing element (HLFS)</td>
<td>a. Need longer Cote-Shield.</td>
</tr>
<tr>
<td></td>
<td>b. Sensing element not &quot;seeing&quot; material (LLFS)</td>
<td>b. Need longer Consult factory.</td>
</tr>
<tr>
<td></td>
<td>c. Short in coax cable (HLFS) insertion</td>
<td>c. Sec. 6.5</td>
</tr>
<tr>
<td></td>
<td>d. Open in the coax cable (LLFS)</td>
<td>d. Sec. 6.5</td>
</tr>
<tr>
<td></td>
<td>e. Defect in sensing element</td>
<td>e. Sec. 6.4</td>
</tr>
<tr>
<td></td>
<td>f. Loss of power (HLFS)</td>
<td>f. Sec. 4.4</td>
</tr>
<tr>
<td></td>
<td>g. Improper wiring</td>
<td>g. Sec. 4.4 &amp; 4.5</td>
</tr>
<tr>
<td></td>
<td>h. Improper calibration</td>
<td>h. Sec. 5.3</td>
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<tr>
<td></td>
<td>i. Electronic malfunction</td>
<td>i. Sec. 6.2</td>
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<tr>
<td></td>
<td>j. Moisture in conduit</td>
<td>j. Sec. 6.4</td>
</tr>
<tr>
<td></td>
<td>k. Moisture in cable conduit</td>
<td>k. Sec. 6.5</td>
</tr>
</tbody>
</table>

| | b. Sensing element not "seeing" material (HLFS) | b. Need longer Consult factory. |
| | c. Open in coax cable (HLFS) insertion | 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 conduit | i. Sec. 6.4 |
| | j. Moisture in cable conduit | j. Sec. 6.5 |
| | k. Static sparks causing damage to unit. | k. Need spark protection. Consult factory. |

| 3. Instrument cannot be calibrated | 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 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 conduit | f. Sec. 6.4 |
| | g. Moisture in cable conduit | g. Sec. 6.5 |
### Troubleshooting

<table>
<thead>
<tr>
<th>Problem</th>
<th>Possible Cause</th>
<th>Solution</th>
</tr>
</thead>
</table>
| 4. Instrument gives false alarm | a. Improper calibration  
b. Loose wiring  
c. Electronic malfunction  
d. Static sparks causing damage to unit. | a. Sec. 5.3  
b. Sec. 4.4 & 4.5  
c. Sec. 6.2  
d. Need spark protection. Consult factory. |
| 5. Instrument operates intermittently | a. Improper calibration  
b. Loose wiring  
c. Electronic malfunction  
d. Static sparks causing damage to unit. | a. Sec. 5.3  
b. Sec. 4.4 & 4.5  
c. Sec. 6.2  
d. Need spark protection. Consult factory. |
8.0 Factory and Field Service Assistance

8.1 Telephone Assistance

If you are having difficulty with your Drexelbrook equipment, and attempts to solve the problem have failed, notify your local Drexelbrook representative, or call the factory direct and ask for the service department. Drexelbrook Engineering Company is located at 205 Keith Valley Road, Horsham, Pa. 19044. The telephone number is (215) 674-1234. To help us solve your problem quickly, please have as much of the following information as possible when you call:

Instrument Model #____________________
Probe Model #____________________
P.O. #____________________
& Date________
Cable Length________
Application____________________
Material being measured____________________
Temperature____________________
Pressure____________________
Agitation____________________
Brief description of the problem________________________________________

Checkout procedures that failed____________________

8.2 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 include the original P.O.# and the original Drexelbrook order # also.

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 available for faster turnaround of a repair. If you prefer your own unit repaired rather than exchanged, please mark clearly on the return unit "Do Not Exchange".

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

8.3 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. Contact the service department for further details.

8.4 Customer Training

Periodically, Drexelbrook instrument training seminars for customers are held at the factory. These sessions are guided by Drexelbrook engineers and specialists, and provide detailed information on all aspects of
Service

level measurement, including theory and practice of instrument operation. For more information about these valuable workshops, write to Drexelbrook Engineering, attn: Communications/Training group, or call direct (215) 674-1234.
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