

# 440 - 450 vibration switch

INSTALLATION - OPERATION - MAINTENANCE

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READ AND UNDERSTAND THIS MANUAL PRIOR TO OPERATING OR SERVICING THIS PRODUCT.



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## description

### **Introduction**

The single set point model contains one trip limit for shutdown. The optional dual set point model contains two independent trip limits; one for alarm and one for shutdown. Shutdown and Alarm trip is set in velocity. In addition, a 4-20 mA output proportional to vibration level is provided.

The 440 and 450 performance, wiring, and specifications are identical except for the enclosure. The 440 meets NEMA 3, 4 and 12. The 450 meets these and certain explosion proof specifications.

### **Protection of Rotating and Reciprocating Machinery**

A system is required which is responsive to faults which:

1—present themselves as low frequency vibrations such as imbalance, misalignments, defective sleeve bearings, broken tie down bolts, etc.

2—present themselves as higher frequency vibrations such as defective ball or roller bearings, gear mesh, blade pass frequencies, and in the case of reciprocating machinery, detonation and broken parts.

Velocity is the optimum parameter for both high and low frequencies, since it is equally sensitive to both. Acceleration (as with mechanical switches) is over sensitive to the high frequencies and very insensitive to the low frequencies.

On machines operating at very low RPM (100 - 200 RPM), displacement may also be suitable.

Time delay is absolutely essential in any usable vibration monitor. Virtually all machines will exhibit high vibration for several seconds during startup. If time delay is not provided, the operator must turn up the trip point to get thru startup. The resultant setting will be too high to provide protection during normal running. This is one reason there are so many cases where machines with mechanical type vibration switches have not tripped. Time delay is included in the Solid State Model 440.

### **Summary of Capabilities**

Refer to Panel Control

1—Trip is based on vibration severity. The internal sensor (unless the external sensor option has been purchased) is a piezoelectric crystal with built-in microelectronics to reduce noise sensitivity. The output signal is electronically integrated to measure and trip on velocity or displacement. 2—Calibrated set

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## description

point controls permit adjusting set points to known values of vibration level. Shutdown and Alarm set point range is in velocity. Alarm setpoint is calibrated 10% to 90% of shutdown setpoint.

3–4-20 mA output provides continuous monitoring capability on a millimeter or a programmable controller for data logging or alarm. The 4 mA will be present even when there is no vibration, thus demonstrating the unit is functioning. 4mA = No Vibration and 20mA Full Scale.

4–A solid-state relay (triac) is provided with contacts that are optically isolated from the input power. The optional dual set point has two triacs. Each triac is independently settable for open on alarm or close on alarm. Optional analog switches or mechanical relays are available.

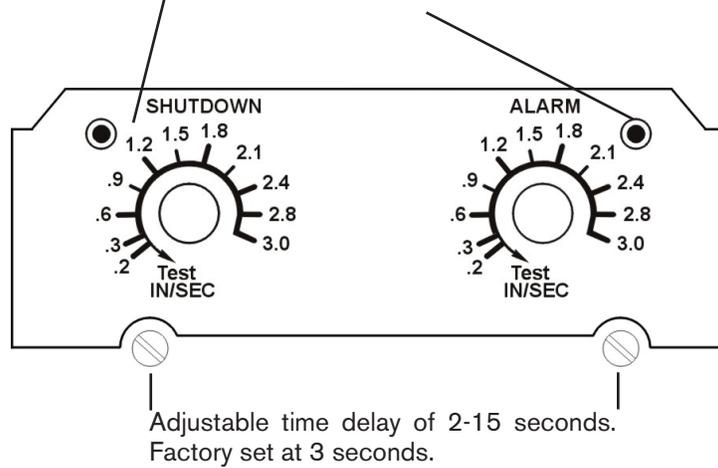
5–Adjustable (2-15 seconds) time delay is standard. This prevents false tripping on high startup vibrations and also from non-repetitive transient events.

6–Self test and calibration.

A light adjacent to the set point control comes on the instant the measured vibration level exceeds the set point. The unit can be periodically calibrated on line, by turning the set point control down until the light comes on. This setting is then compared with the vibration measured with a portable vibration meter, thus providing a calibration check of the unit. If this setting is maintained, trip will occur after the duration of the time delay.

Calibrated setpoint controls enable operator to set specific velocity trip points.

Light comes on immediately when vibration exceeds setpoint (alarm or shutdown will trip after 3 second time delay).

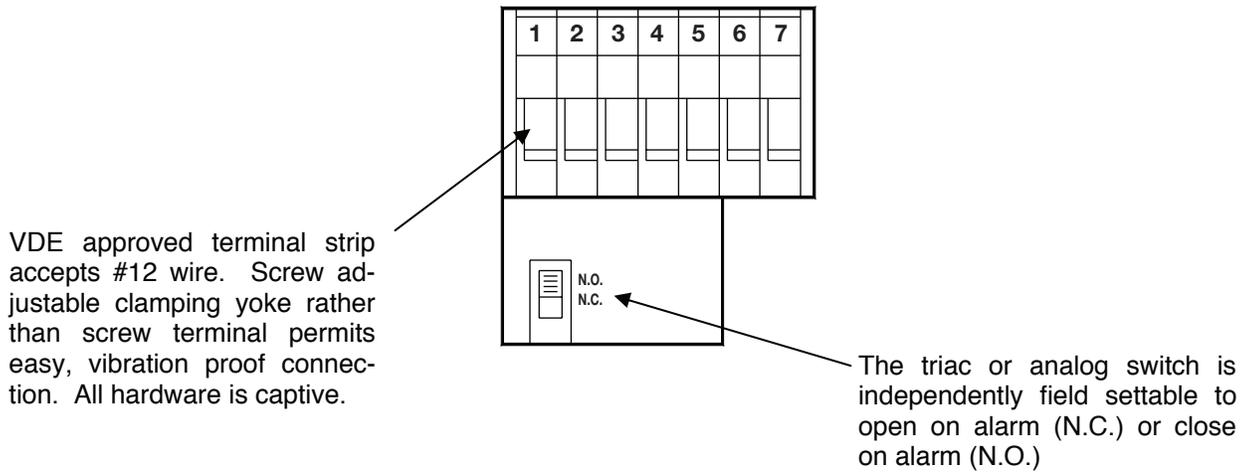


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## description

### Panel Control

Test position sets in minimum set point so that any vibration will cause trip condition. Light will come on immediately, and trip will occur after duration of the time delay, proving that the complete system is operational. If test position is maintained for less than the duration of the time delay, trip will not occur, thus permitting system test without shutdown.



### Specifications

**No. of Trips**—440DR: TWO: One for alarm and one for shutdown. Shutdown set in in/sec (velocity model).

**Analog Output for Trending and Remote Indication**—440SR & 440DR:  $\pm 10\%$  accuracy over 4-20 mA DC range.

**Absolute Option**—4 mA = 0 vibration; 20 mA = Full scale range of switch. Termination load resistance, less than 450 ohms.

**Velocity Set Point**—0.1 to 1.5 in in/sec or 0.2 to 3 in/sec peak. Metric ranges: 3 to 40 mm/sec or 6 to 80 mm/sec peak.

**Frequency Range**—2 to 1000 Hz

**Time Delay**—Field adjustable 2-15 sec. Factory set for 3 sec unless specified otherwise.

**Alarm or Shutdown Output(s)**—Solid state relay (triac). Two in 440DR. Isolated (dry) contact. Each triac field settable for close on alarm (N.O.) or open on alarm (N.C.). 5A continuous, 100A for 10 msec. Max. off-state leakage current: 1 Ma Min holding current: 50 mA typical Max. voltage across SS relay: 140VAC (280VAC on 230V input units).

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### Note

***If the relay output is connecting to a PLC or DCS, DO NOT use 5A Triac.***

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## description

**Remote Reset**—Connection between terminals 5 and 6 latches triac output in alarm state after set point is exceeded. Opening the connection will reset the output to non-alarm state.

**Set Point Accuracy**—  $\pm 10\%$  of setting with repeatability of  $\pm 2\%$ . Circuitry utilizes RMS detector.

**Vibration Sensitive Axis**—Perpendicular to base. Unit can be mounted in any orientation without affecting setting.

**Temperature Limits**—  $-20^{\circ}\text{F}$  to  $+140^{\circ}\text{F}$  ( $-30^{\circ}\text{C}$  to  $+60^{\circ}\text{C}$ ) including internal transducer.  $-65^{\circ}\text{F}$  to  $+190^{\circ}\text{F}$  ( $-55^{\circ}\text{C}$  to  $+88^{\circ}\text{C}$ ) for optional external transducer.

**Humidity**— $1\%$  to  $100\%$  (non-condensing).

**Input Power**— $100\text{-}130\text{ VAC}$   $50/60\text{ Hz}$  standard.  $200\text{-}260\text{ VAC}$   $50/60\text{ Hz}$  optional. DC input power optional.

**Enclosure**—Rugged, water-tight, dust-tight, cast aluminum. Meets NEMA, 3, 4 and 12 standards. Optional CSA mark for Class I, Div 2, Grps B-D, Or explosion proof Model 450. 440 - NEMA 4X.

**Weight**—440 -  $1.6\text{ kg}$  ( $3.5\text{ lb}$ ); 450 -  $2.72\text{ kg}$  ( $6\text{ lb}$ )

**Mounting**— $\frac{1}{4}$ " hardware, 3 mounting bosses

**Terminals**—All terminals will accept #12 AWG wire in clamping type yoke without need for termination hardware. All hardware is captive.

**Self Test**—Test position on set point control and light emitting diode provide functional test of trip circuitry, time delay and triac closure. Also permits on-line calibration of switch.

**Circuitry**—Proprietary hybrid circuitry throughout for minimum size and maximum reliability in vibration environment.

**Remote Transducer Option**—The standard 440 includes a built-in transducer. A separate transducer can be specified. Please request separate transducer when placing order. The SA6200A accelerometer ( $100\text{ mV/g}$ ) is recommended.

**Analog Switch Option**—Recommended in place of triac for DC operation or light loads such as computer or PLCs:

AC/DC Solid-State

Contacts are optically isolated from input power.

Field settable N.O. or N.C.

$170\text{ mA}$  continuous

Maximum off state leakage,  $10\text{ micro amps}$

No holding current required

Maximum voltage:  $250\text{V}$

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## description

### **Mechanical Relay Option—**

SPDT Version - 8 amp at 250 VAC or 24 VDC

DPDT Version - 1. DPDT, 2 amp each half at 250 VAC or 24 VDC

2. SPDT, 8 amp each half at 250 VAC or 24 VDC.

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### **Note**

***The N.O./N.C. slide switch is not available on the mechanical relay versions.***

Additional Environment Specifications—

Operating Altitude: up to 2000 meters

Main voltage fluctuation: up to  $\pm 10\%$

Approvals: CSA General Safety

CSA Class I Hazardous Environments

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### **⚠ Warning**

#### ***Shock Hazard 230/110 Volts***

***The terminal block inside the 440 is connected to AC power (110 VAC or 230 VAC depending on model) except DC input power models.***

***If adjustments to the device are being made with power applied, exercise caution to avoid contact with the terminal block screws by any part of the body or electrically conductive tool.***

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### **⚠ Caution**

***If the 440 vibration switch is used in a manner not specified by the manufacturer, the protection provided by the unit may be impaired.***

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# installation

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## **Mechanical Installation**

### **Orientation**

The sensitive vibration “measuring” axis is perpendicular to the base of the unit (vibration switch or transducer). Always mount the unit such that the desired vibration of the equipment being monitored will occur along this axis.

### **Mounting Surface**

Choose or fabricate a solid (rigid) surface (on the equipment being monitored) to mount the vibration switch or transducer. This will ensure transfer of the vibration to the vibration transducer, while not introducing spurious vibrations. In addition, the surface presented to the base of the unit should be flat. Fasten using sturdy hardware at all places provided.

### **Temperature Considerations**

The switch is designed to dissipate internal heat by conduction through its base. Hence, it is important to keep the mounting surface below the switch max temperature limit of 140°F. If the equipment being monitored is going to exceed this limit, consideration should be given to either using one of the remote transducers, or thermally isolating the switch.

To ensure accurate switch performance, a warm-up time of 5 minutes is recommended.

### **Cable/Wiring**

The method chosen to electrically connect to the switch or transducer should be mechanically flexible, to eliminate the measurement of vibration of material not of interest (piping, etc.), and provide a moisture barrier as well.

Although seal tight and other flexible conduit have been used successfully, in areas of extreme humidity or moisture it is recommended that an “SO” type cable together with a suitable rain-tight CGB fitting be used.

No stress should be possible on the wiring to the terminal block. If such protection is not provided by the conduit system, some form of stress relief must be installed where the wiring exits the 440.

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## installation

To assure compatibility with EMC standards, any signal level wiring such as transducer, reset, lockout, or 4-20 mA wiring should utilize shielded cable in EMI proof conduit, separate from any power wiring. The signal conduit and power-wiring conduit can be connected at the 440-cable entry via a “T” fitting.

### Sealing

In 440 installations where temperature and humidity conditions vary around the dew point, it is important that the cover plate be evenly and firmly fastened down with the four screws provided.

Although the switch enclosures meet NEMA standards for water tightness, it will do no good if proper sealing of both cover and wiring entrances are not followed. Please remember that a hollow pipe through which wires may enter a switch may conduct moisture as well.

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## Electrical Wiring

### *Wiring to the Vibration Switch*

The following sections refer to the wiring diagrams at the end of this section.

#### **For 440/450 Models Using Triac or Analog Switch**

7	Lockout (Optional)	Not Used	8
6	Remote Reset	Not Used	9
5	Common	Input Signal (Optional)	10
4	Shutdown	Common	11
3	Circuit	4-20mA Analog Output	12
2	AC Input	Alarm	13
1	Power	Circuit	14



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## installation

### For 440/450 Models Using Mechanical Relay

7	Remote Reset	4-20mA Analog Output	8
6	Common	Not Used	9
5	Shutdown N.C.	Not Used	10
4	Shutdown Common	Input Signal (Optional)	11
3	Shutdown N.O.	Alarm N.C.	12
2	AC Input	Alarm Common	13
1	Power	Alarm N.O.	14

#### ***Alarm circuit is not used for SR versions.***

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#### **Note**

**AC Power**—Connect a grounding wire to the grounding screw provided in the switch. This is important for safety as well as noise. Power only with the AC voltage level indicated on the inner cover label. Orientation of AC power to terminals 1 and 2 is not important.

**Shutdown Circuit**—The internal shutdown switch circuit is designed to be wired in series with the external shutdown circuit i.e.; motor starter, relay, contactor, etc.

**Remote Reset**—Shielded wire is required. To avoid creating ground loops, the N.C. remote switch contacts should be electrically isolated from other circuits or grounds.

#### ***Remote reset is disabled if push-button reset option is selected.***

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#### **Note**

**Lockout (Optional)**—Terminal 7 will be labeled “Lockout”. Shielded wire is recommended. To avoid the possibility of ground loops, the remote N.O. lockout switch contacts should be electrically isolated from other external circuitry or grounds.

**4-20 mA Analog Output**—To avoid the possibility of ground loops, the 4-20 mA remote meter terminals should be electrically isolated from external grounds. Shielded wire is recommended to protect against damage due to long wire runs and the possibility of high induced voltage spikes from storms, etc. The 4-20 mA output is self-powered and therefore requires no external power source.

**Alarm Circuits**—The internal single pole solid state switch between terminals 13 and 14 is designed to be wired in series with the external alarm circuit e.g.; annunciator, lamp, relay, etc.

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# installation

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## Functional Description and Installation Considerations

**Alarm or Shutdown**—Units with Triacs (identified by Model No. 440DR-2X01-XXXX).

Maximum ratings for the solid state relays used for alarm and shutdown are as follows:

Continuous Current Surge and Overload (Duty Cycle Less Than 1%)	5 A
1 Second	25 A
16 Millisecond	50 A
1 Millisecond	125 A
Maximum Voltage	140 VAC (115V Model)
	280 VAC (230V Model)
Maximum Off State Leakage	1 mA
Isolation	2500 VAC min
Required Holding Current	50 mA

As you can see from the above specs, these are medium power rated devices and are quite useful in controlling relays, contactors and most motor starters directly. Maximum noise immunity is obtained when used in the open on alarm (N.C.) mode.

**Alarm or Shutdown**—Units with Analog Switch in place of Triac (identified by Model NO. 440DR 2X22-XXXX).

For light loads such as computers or PLCs, the analog switch is easier to interface since it has virtually no leakage current. The analog switch does not require the 50 mA holding current and operates equally well with AC or DC. Maximum ratings for units with Analog Switch in place of Triac are as follows:

Continuous Current	170 mA
Maximum Voltage	250V
Maximum Off State Leakage	10 Micro amp
Required Holding Current	None
Isolation	2500 V



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## installation

**Open / Close on Alarm**—The alarm and shutdown triacs (or analog switches) are independently field settable for N.O. (close on alarm) or N.C. (open on alarm). The switches are accessible with a non-conductive screwdriver via the inner side panels.

Open on alarm is recommended in installations where triac lines are likely to be noisy, e.g.: large transient voltage spikes due to unsuppressed relay, solenoid, or other inductive loads.

**Auto Reset Mode**—In this mode, alarm and shutdown switches are automatically reset to the non-alarm condition when the vibration level falls below the set point.

**Latch Mode**—In this mode, alarm and shutdown switches remain “latched” in alarm (shutdown) condition when the vibration level exceeds the set point for the duration of the time delay. The unit is in this condition when the reset terminal is connected to common.

**Remote Reset Mode**—When wired in this mode, the alarm and shutdown switches latch in “trip”, but can be reset to the “non-alarm” mode by momentarily interrupting the connection from terminal Reset to Common. This can be accomplished with a normally closed momentary switch. The switch contacts should be isolated from other circuits, potentials or grounds.

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### Note

***Remote reset is disabled if push-button reset option is selected.***

**20 Second Lockout** (optional)—With this option, the shutdown and/or alarm triacs will not be permitted to actuate for 20 seconds after Lock out is connected to Common.

**4-20 mA Output**—This “self-powered” loop provides a 4-20 mA output current proportional to vibration. For absolute option, 4mA = 0 vibration, 20mA = full scale of the switches vibration range.

### Special Considerations

**Light Loads**—The solid state triacs used in the standard 440 series are a special high transient immunity, medium power type. Off state leakage is 1 mA max and should not create any problems, even when interfaced with a load as light as a programmable controller.

Minimum load required to keep the triac on is 20 mA typical and 50 mA max due to the “holding current” specifications. If the load is less than this, a resistor may have to be placed in parallel with the load, i.e.; for 115 VAC light load

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## installation

(50 mA or less) a 2K-ohm 10 watt power resistor is recommended.

**D.C. Loads with Triacs**—Although most applications use AC input power and AC on the triac outputs (alarm and shutdown), these triacs may be used in DC applications providing minimum loading requirements are met. When DC is used, a triac will automatically latch in the “on” condition after trip, thus only “close on alarm” (N.O.) can be used. To reset an external reset switch, the rest switch must be wired in series with the load.

To avoid large voltage drops during DC operation, the triac should be connected as follows:

Shutdown:	Term 4 POS	Alarm:	Term 14 POS
	Term 3 NEG		Term 13 NEG

**120 mA Analog Switch Option**—The special requirements of the above two sections (Light Loads and D.C. Loads with Triacs) do not apply. However, maximum current is limited to 170 mA

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## Control Settings

### Setting Trip Points

The Model 440DR provides two trips: one for alarm and one for shutdown. The first trip (alarm) is set at a vibration alarm level to provide early warning that the condition of the machine is deteriorating. If the machine condition continues to deteriorate, the shutdown trip provides protection against catastrophic failure. The shutdown and alarm is set directly in inches/seconds or mm/sec.

### Setting of Time Delay

An important feature of PMC/BETA switches is the built-in time delay. This prevents triggering of the alarm or shutdown functions from transient increases in vibration levels. It also avoids shutdown due to transitory vibrations occurring during start-up.

The time delay is adjustable. It will have been set at the factory for three (3) seconds unless your order specified otherwise.



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## installation

The time a vibration must be above set point before trip occurs is individually adjustable for shutdown and alarm from 2 to 15 seconds. To readjust the time delay, turn the shutdown set point (or alarm set point for alarm time delay) knob CCW until the LED illuminates. The time from this point to relay actuation is the time delay. Change the time delay via a nylon non-conductive screwdriver. Set CW to increase time delay (one complete turn is approximately 0.5 seconds). Then recheck and readjust until the desired time delay is achieved.

### **Test Mode**

The test position of both shutdown and alarm knobs is used to test the switch functions without the need for vibration. When the shutdown knob is turned to test, the shutdown LED should immediately illuminate, the 4-20 mA should exceed 20 mA, followed after the delay time by actuation of the shutdown relay. Alarm is similar, but has no effect on the 4-20 mA out.

If the shutdown or alarm knob is returned to a normal setting before the duration of the time delay has been exceeded, the LED will come on without energizing the triac.

### **Alarm and Shutdown Light Emitting Diodes**

Since the LEDs activate instantaneously (before time delay), they can be used to check the machines actual vibration level, i.e.; slowly decrease shutdown set point by turning the set point knob counter-clockwise until the shutdown LED illuminates. Note this setting and return the knob to a higher setting (before time delay runs out). This is the actual vibration level present.

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## **System Block Diagram**

An internal transducer module consisting of a crystal assembly and integral charge amplifier senses vibration. Thus, the electrical output of the transducer is a well buffered (low impedance) signal directly proportional to acceleration (G) of the switch.

The signal goes to a custom hybrid circuit to yield an A.C. signal now proportional to velocity. This signal in turn is routed through an amplifier, the gain of which is controlled by the shutdown setpoint.

Next, the signal is processed through a true RMS to DC stage and compared against a preset internal voltage reference. If the signal level is higher than

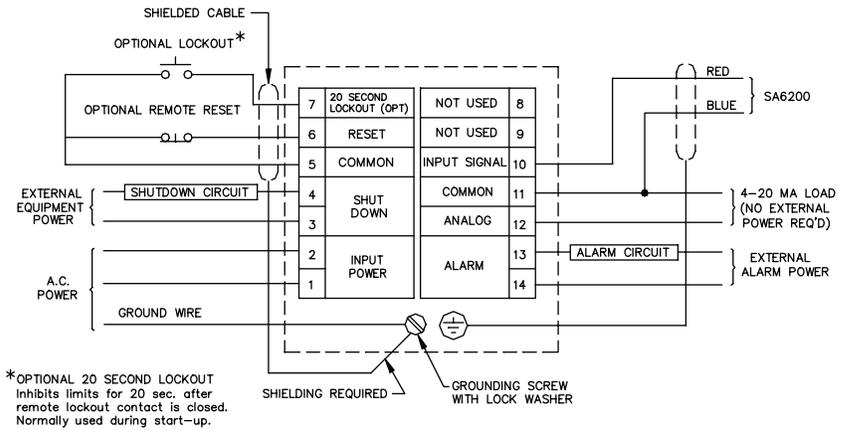
# installation

reference, the shutdown LED is illuminated.

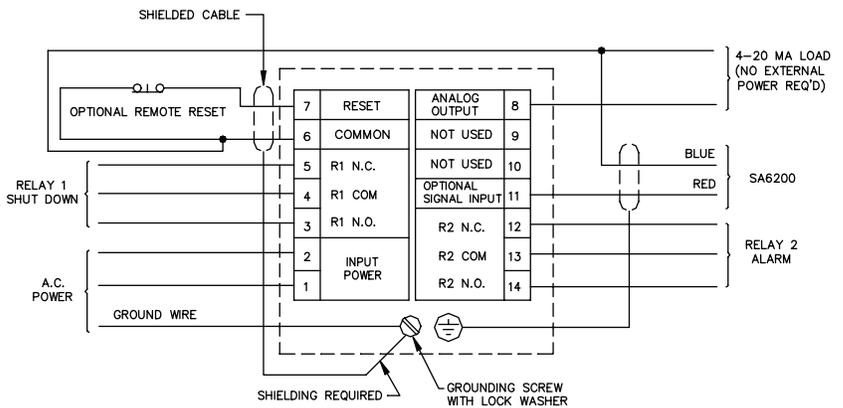
If the voltage level stays above the reference for the duration of the time delay, an output trip occurs and the shutdown solid-state relay will trip.

Alarm trip is derived in much the same manner, branching from the output of the RMS to DC stage. Likewise the DC output is directed to the voltage to current hybrid.

## Wiring Diagram (Fully Configured)



Note: Alarm terminals are used only for DR Models.



# 440 - 450 vibration switch

USER MANUAL

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