

# BULLETIN 824A

## INSTALLATION & OPERATION

### SFD-2 Microwave Solids Flow Detector

Monitor's SFD-2 Microwave Solids Flow Detector is a high quality, industrial grade instrument capable of providing a signal indicating flow/no-flow conditions of solids and powders in pneumatic pipelines, gravity chutes and feeders. This non-contact detector contains no moving parts or probes that can wear out or break off in the material flow, thus ensuring process integrity.

The SFD-2 uses low power microwaves to sense motion within the vessel or channel being monitored. Microwave technology is used in the SFD-2 because the microwaves are virtually unaffected by heat, humidity, ambient light, pressure, vacuum, high or low temperatures, or dust, thus providing maximum effectiveness in industrial applications.

Every SFD-2 assembly consists of a sensor head and a remote power supply/conditioner board. The remote board can be purchased with or without a NEMA 4X fiberglass enclosure. The two separate components are connected via a low-voltage 3-wire system.

#### PRINCIPLE OF OPERATION

The SFD-2 consists of a split architecture design incorporating a sensor head and a separate power supply/conditioner. The SFD-2 sensor head is a microwave transceiver (combination transmitter/receiver) encased in a watertight aluminum housing with a screw-on cover. A process seal (Teflon® or Rytan®) acts as a transparent window through which the microwave signal is



Model SFD-2

- ▼ No maintenance
- ▼ Non-contact operation
- ▼ Non-intrusive flush mounting
- ▼ Immune to environmental conditions
- ▼ Dust-ignition proof design

transmitted and the reflected return signal is received. The transceiver module generates and transmits a microwave signal into the area where the flow is being monitored. The reflected signal is analyzed whereby a frequency shift in the reflected signal caused by material movement is decoded as a flow condition. The resultant output is carried back to the power supply/conditioner PCB where the signal is indicated by an output relay and LEDs. This PCB also provides the power to drive the sensor head and is the location for control settings such as sensitivity, hold-off delay, hold-on delay and fail-safe selection.

#### PRE-INSTALLATION CONSIDERATIONS

**CHOOSING THE SYSTEM LOCATION** (See Figure 1)

**1) Hazardous/Non-hazardous** - The sensor portion of the split architecture is designed for use in Hazardous Locations associated with combustible dusts. The location chosen must comply with the classification listed in the specifications. The power supply/conditioner is to be used in non-hazardous environments unless the user chooses to house the PCB in a customer supplied enclosure which has the appropriate hazardous location classifications.

**2) Temperature Limits** - The operational temperature limits for the sensor and power supply/conditioner must be satisfied.

**3) Accessibility** - Since the sensor head usually does not need adjustment after installation, it can be located at a remote location not as accessible to personnel. The power supply/conditioner should be located where personnel can easily access the



internal controls and where indicators can be clearly seen. The sensor and power supply/conditioner can be separated up to 2500 feet (See Electrical Installation section).

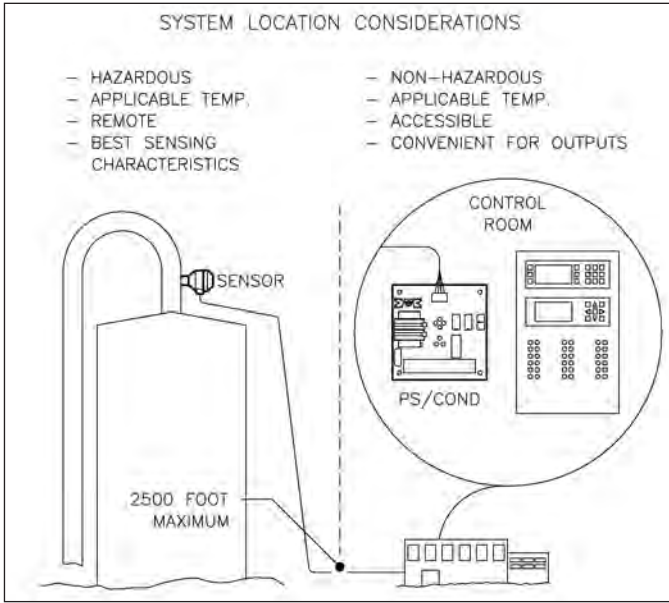


Figure 1

**CHOOSING THE SENSOR LOCATION** (See Figure 2)

**1) Pipe/Chute Material** - Microwave energy is contained and channeled by metallic pipes or chutes. Internal reflections within the line enhance the sensitivity of sensor. As the diameter of the pipe/chute increases, the sensitivity of the sensor decreases. When possible it is desirable to mount the sensor to a metallic line to take advantage of the enhanced sensitivity. For non-metallic pipes such as glass, plastics and concrete, material is not as easily sensed so increased sensitivity must be set on the electronics. However, since microwave energy can propagate through non-metallic material, the sensor can be mounted to be truly non-contact.

**2) Material Flow Tendencies** - Select a mounting location where the process seal will be exposed to the full motion of the process material under normal flow conditions. The SFD-2 has the greatest sensitivity when the material being detected is either coming toward or going away from the process seal. When possible, mount the sensor to take advantage of this phenomena. Many applications will be satisfied without this type of mounting. However, if the application poses sensitivity concerns, mounting the sensor less than 90 degrees to material flow is recommended; refer to the Calibration section which describes sensitivity. Avoid locations where substantial product buildup can occur. In applications where material coating occurs, position the sensor to take advantage of any cleaning action provided by normal flow.

**3) System Movements** - The electronic circuitry has been designed to be relatively insensitive to slow movements commonly associated with augers/conveyors. However, for best operation, position sensor away from such mechanical movements. When sensing through non-metallic materials, the energy can travel through the pipe/chute to the backside of the installation. The sensor must be positioned to avoid having motion of nearby equipment or personnel interpreted as a flow condition. Backing the non-metallic pipe/chute with a metallic shield will greatly reduce the possibility of false signals.

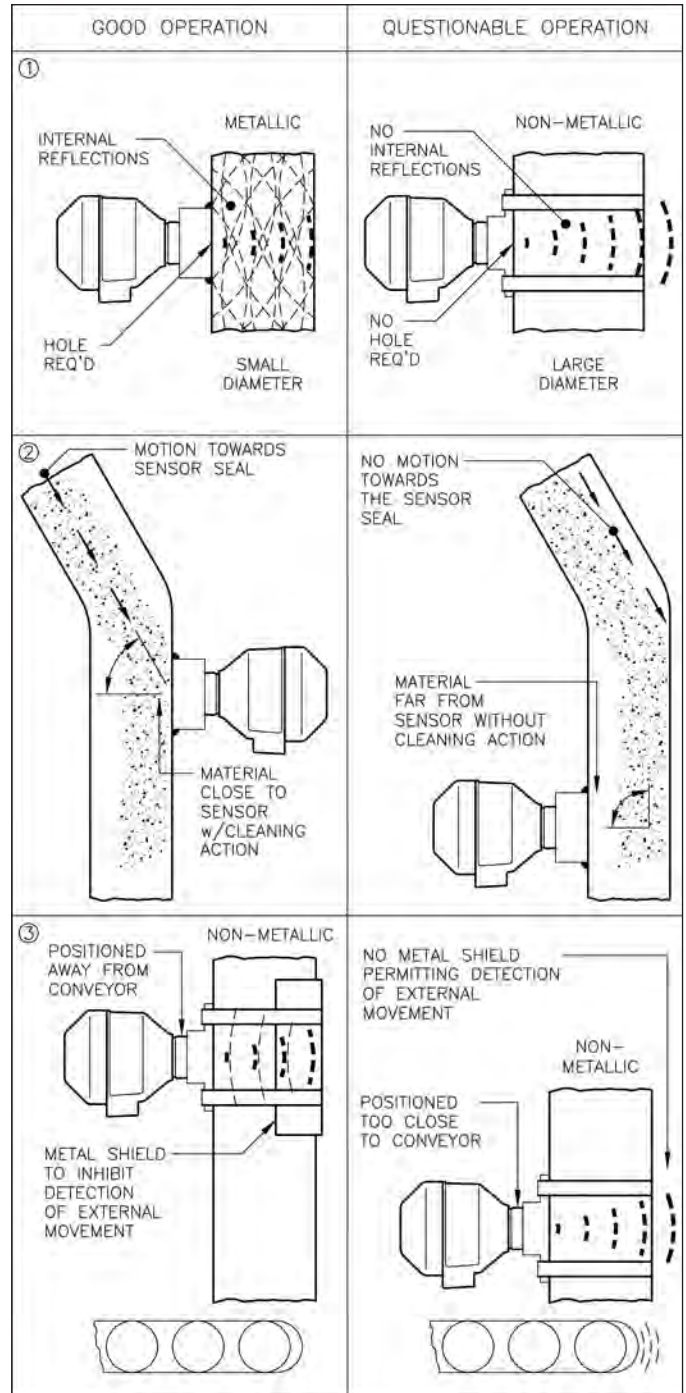


Figure 2

**MECHANICAL INSTALLATION**

**SENSOR MOUNTING**

**Coupling Mount** - (See Figure 3) The SFD-2 sensor housing incorporates an aluminum 1 1/4" NPT connection. The connection is specially machined to provide flush mount installation when installed into a standard 1 1/4" half coupling. After selecting the appropriate location, cut a 1 1/2" diameter hole with in the pipe/chute. Position/center a 1 1/4" half coupling over the hole and weld into place. Prior to sensor installation, prepare the mounting threads with Teflon® tape or pipe dope to insure sealing. Tighten the sensor into place insuring the conduit connection is facing downward.

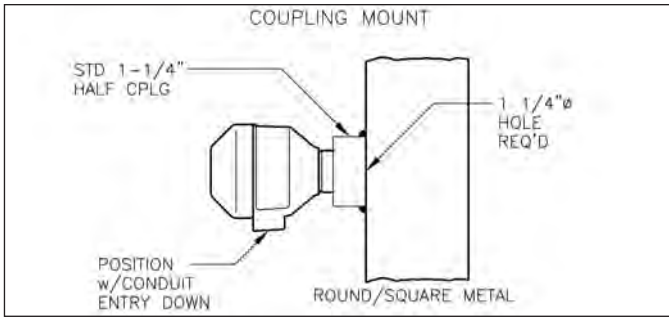


Figure 3

**Saddle Coupling** - (See Figure 4) In cases where the SFD-2 sensor is to be installed on small pipes/chutes, Monitor's saddle coupling can be used to overcome the difficulty of welding to the curvature of the material handling line. The aluminum saddle coupling is threaded to permit engagement of the 1 1/4" NPT connection on the SFD-2. Using the supplied gasket, acceptable mounting can be achieved for diameters ranging from 4" to 10". After selecting the appropriate location, cut a 1 1/2" diameter hole in the pipe/chute. Position/center the saddle coupling over the hole while placing the gasket in between. Fasten the saddle coupling to the pipe/chute using industrial grade hose clamps. Prior to sensor installation, prepare the mounting threads with Teflon<sup>®</sup> tape or pipe dope to insure sealing. Tighten the sensor into the saddle coupling insuring the conduit connection is facing downward. The saddle coupling can also be fastened to a pipe/chute with standard screw/nut fasteners by simply creating mounting holes in the saddle coupling's "ears" and fastening to the pipe/chute. It is also feasible to flatten the profile of the saddle coupling (via belt sander, mill, etc.) and use it as a standard half coupling.

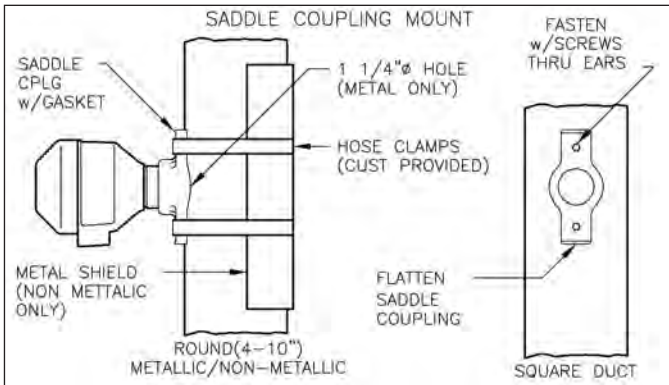


Figure 4

**Stainless Steel Adapter** - (See Figure 5) In some cases, the standard aluminum 1 1/4" NPT threads are not suitable for the application primarily due to poor abrasion or corrosion resistance. A stainless steel adapter with 1 1/2" NPT process connection threads can be installed to the standard sensor. Using a suitable mating 1 1/2" NPT half coupling will achieve flush mounting to the pipe/chute. Teflon<sup>®</sup> or Ryton<sup>®</sup> process seals can be used with this adapter.

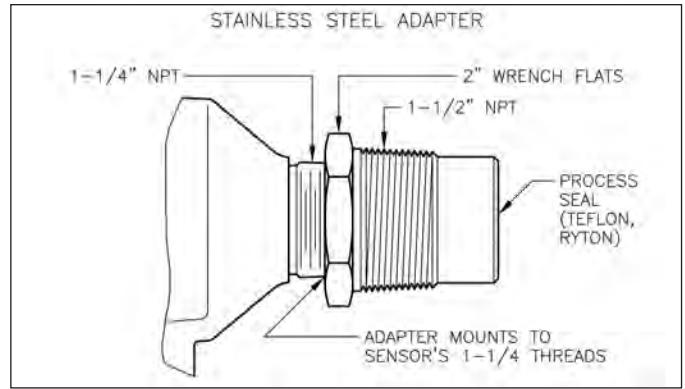


Figure 5

**Food Grade Adapter** - (See Figure 6) In applications where mounting threads are not permitted, a food grade adapter with an 2" industry standard TRI-CLOVER<sup>®</sup> or Cherry Burrell type connection can be installed to the standard sensor. A 2" mating ferrule must be used for mounting to the line.

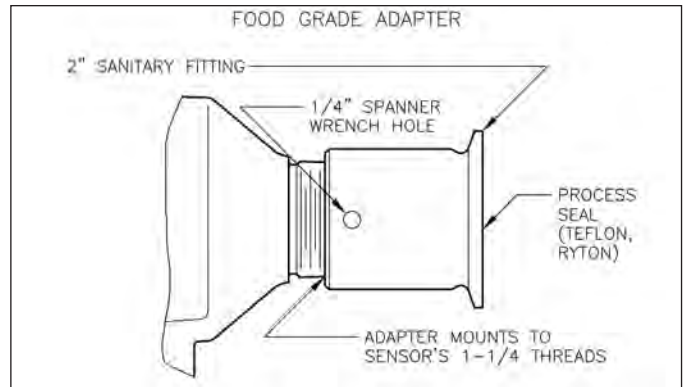


Figure 6

**Locknut** - (See Figure 7) A chrome-plated 1 1/4" NPSM locknut is available in cases where particular positioning of the sensor in the mounting apparatus is desired. Some mounting couplings (straight thread types) may require a locknut to achieve flush mounting. Using the locknut with other mounting couplings (tapered thread types) may prohibit flush mounting. Therefore, careful consideration should be made to insure the mounting technique does not create a void where material could accumulate in front of the sensor's process seal.

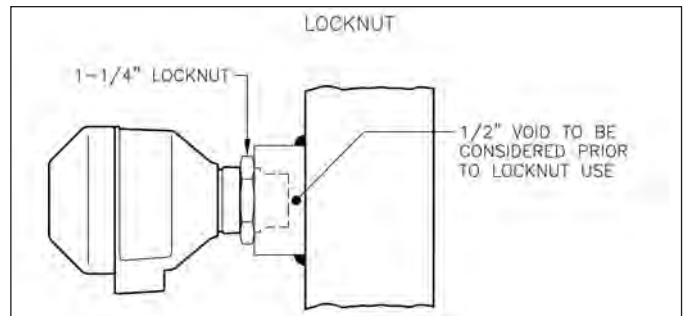


Figure 7

## POWER SUPPLY/CONDITIONER MOUNTING

**PCB Only** - (See Figure 8) Carefully handle the PCB so as not to damage components or to create an electrostatic discharge (ESD). Leave PCB in shielded bag until ready to install. Mount the PCB in an enclosure suitable for the particular application (i.e. water-tight, dust-tight, non-hazardous location). Select a location free from heavy electrical switching caused by heavy motors, actuators, etc. Position PCB so all connectors and control adjustments can be accessed. Use the four corner holes to mount the PCB. Hardware (standoffs, nuts, screws, washers) is provided for installation convenience.

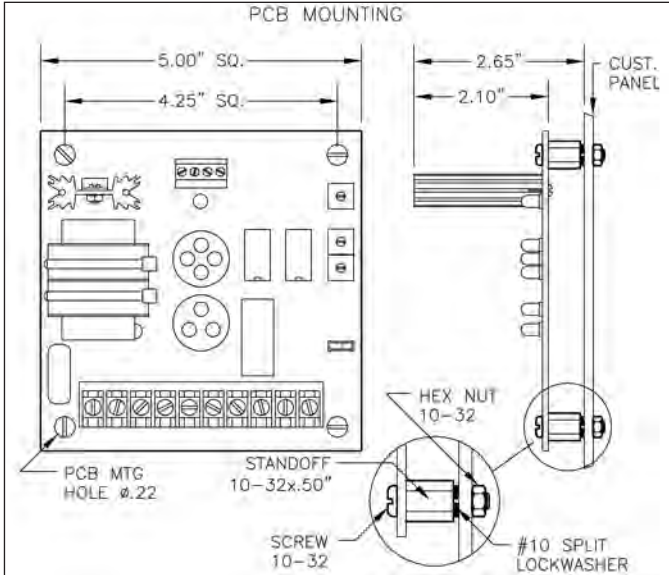


Figure 8

**Enclosure** - (See Figure 9) Locate the SFD-2 power supply/conditioner where the controls are accessible and the indicators can be seen. Position the enclosure for convenient conduit/cord connector access. Use the four mounting ears to mount the enclosure. Before altering the enclosure in any way, remove the internal PCB by removing the four corner screws. Carefully handle the PCB so not to damage components or to create an electrostatic discharge (ESD). Cut the necessary conduit/cord connector holes in enclosure wall with punch or hole saw. Use proper fittings to preserve the NEMA 4X integrity of the enclosure.

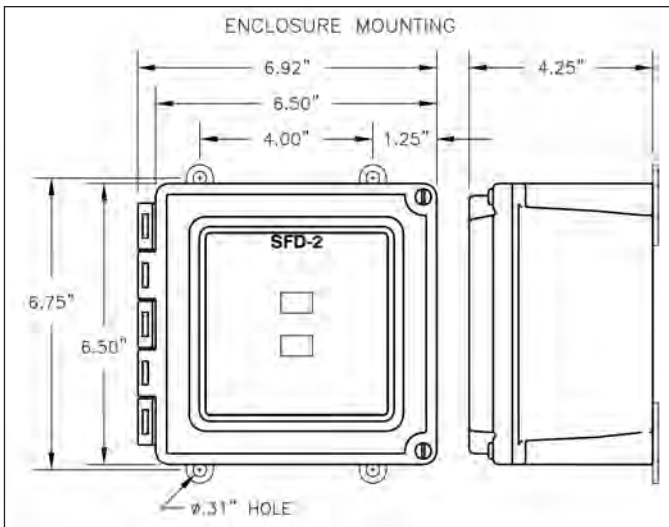


Figure 9

## ELECTRICAL INSTALLATION

**1) Sensor to Power Supply/Conditioner** - (See Figure 10) Insure the sensor and power supply/conditioner are positioned closer than 2500 feet from each other. Interconnect the sensor to the power supply/conditioner via a 3-conductor cable. A shielded cable should be used when the cable is in close proximity to high voltage or heavy current switching wires. Recommended cable types are as follows:

- Shielded, 22 AWG, 3-conductor, (Belden 8771 or similar)
- Unshielded, 22 AWG, 3-conductor, (Belden 8443 or similar)

On the sensor route the wires through the 1/2" NPT entrance. Match up the terminal block designations "+, -, SIG" found on both the sensor and power supply/conditioner. Improper interconnection may result in circuit damage. If a shielded cable is used, connect the shield to the power supply/conditioner at the terminal designated "SHLD". (Note: The "SHLD" terminal is connected to the "EGND" terminal on the power supply/conditioner as explained below. The shield will perform its function only if the "EGND" terminal is connected properly.) The earth ground post should be used in hazardous location applications as directed by the National Electrical Code.

**2) Line Power** - The SFD-2 power supply/conditioner is designed to accept either 115 or 230VAC line voltages. Distinct terminals are provided for wiring each voltage. Improper wiring of the power input will prevent operation and may damage the unit. The "EGND" terminal should be used for safety and "SHLD" drain purposes.

**3) Power Supply/Conditioner Outputs** - The power supply/conditioner provides DPDT (two Form C) dry contacts for customer connection. They are capable of switching high voltage/high current loads as listed in the specifications. The terminal block designations represent the condition of the relay contacts as if all power was off (See Figure 13).

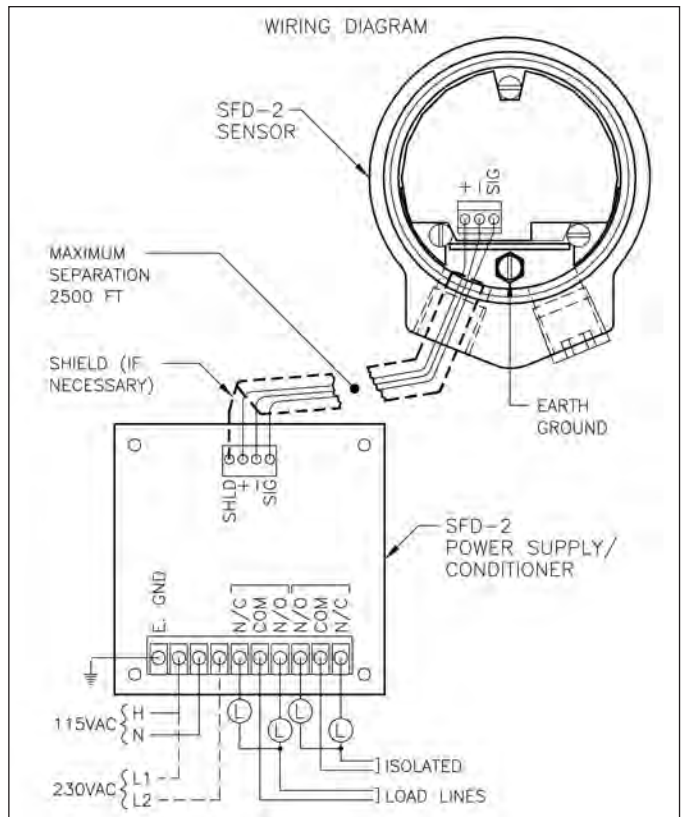


Figure 10

## CALIBRATION

**SENSOR** (See Figure 11)

**Coarse Sensitivity** - The coarse sensitivity is a slide switch which permits selection of "HI" or "LO" settings. This selection operates in tandem with the main sensitivity adjustment found in the power supply/conditioner. The sensor is provided with the coarse sensitivity switch placed in the "LO" setting which will satisfy most applications. The status of the coarse sensitivity can be changed to "HI" if the adjustability range found on the power supply/conditioner is inadequate. (See Calibration of Power Supply/Conditioner.)

### SENSOR INDICATORS

**1) Green LED** - Illumination of the Green LED indicates that power is properly connected to the sensor. Lack of illumination could be from lack of supplied power or reversing the polarity of the input connections.

**2) Yellow LED** - Any illumination of the Yellow LED indicates that the "SIG" connection loop is correctly installed. Lack of illumination could be from improper connection between the sensor and power supply/conditioner. Detected motion will cause the Yellow LED to more intensely illuminate.

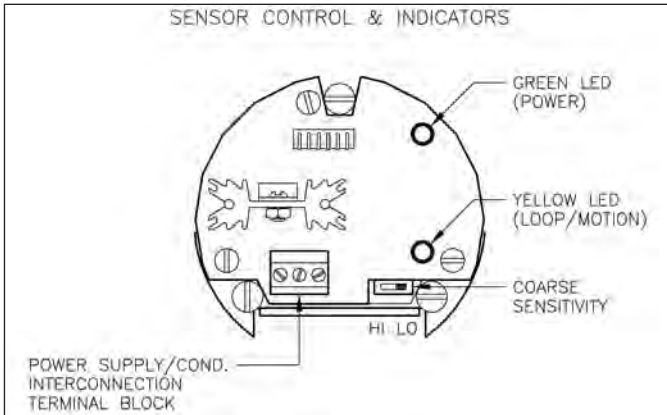


Figure 11

**POWER SUPPLY/CONDITIONER** (See Figure 12)

**Sensitivity** - A single-turn potentiometer is used to adjust how sensitive the SFD-2 will be to objects in motion. The potentiometer permits adjustment between the 7 o'clock and 5 o'clock positions (300 degrees of rotation). Physical stops exist at both extremes of the adjustment. A fully counter-clockwise adjustment (7 o'clock) creates a very insensitive setting where nearly all motion is ignored. A fully clockwise adjustment (5 o'clock) creates the greatest sensitivity. In addition, this setting forces the power supply/conditioner into the "sense" condition regardless of motion presence. Ideal adjustment can be achieved via a simple "2-Step Calibration" procedure. The setting and the ability of the SFD-2 to sense material is influenced by the mechanical mounting (See Pre-Installation Considerations) as well as material characteristics such as velocity, flow density, dielectric constant, and particle size.

**1) Material velocity** - Electronic signal conditioning enables the sensor to see faster moving material easier than slow moving material. This is particularly important when distinguishing between typical material movement and extraneous influences such as augers, conveyors, etc. Generally, the slower the material movement, the greater the sensitivity setting must be.

**2) Material Density in the Pipe/Chute** - As more product is placed in motion, the amount of disturbance which is analyzed as motion also increases. Thus, applications which have significant material flow can tolerate a lower sensitivity setting than those applications with minimal material flow.

**3) Material Dielectric Constant** - Microwave propagation is affected by the dielectric constant of the material being sensed. Typically, low dielectric materials tend to absorb/pass the energy while high dielectrics tend to reflect the energy. The SFD-2 will sense material better when energy is reflected. Therefore, low dielectric materials (i.e. plastics, soap, cement) will require a greater sensitivity setting than high dielectric materials (i.e. grains, feed, ores)

**4) Material Particle Size** - Microwaves have a particular wavelength and therefore are more easily reflected when hitting larger particle sizes. Thus, applications with small particle sizes (i.e. powders) will require a greater sensitivity setting than large particle sizes (i.e. granulars).

**5) Mounting Environment** - When microwave energy is entrapped within metal containers, internal reflections are produced therefore creating a increased probability to see material motion. Thus applications utilizing metallic pipes/chutes require a lower sensitivity setting than applications utilizing non-metallic pipes/chutes. Also, since microwave energy losses its power density with respect to traveled distance, applications utilizing small diameter pipes/chutes require a lower sensitivity setting than applications utilizing large diameter pipes/chutes.

### 2-STEP CALIBRATION

1) While the system is operating (conveyors, augers, etc.) but no material is flowing, rotate the sensitivity adjustment clockwise until the "sense" (Yellow) LED illuminates. Note the adjustment position. (On most applications, this will occur near the 4 o'clock position).

2) With the material flowing, rotate the adjustment counter-clockwise until the "sense" (Yellow) LED turns off. Note the adjustment position. Reposition the sensitivity adjustment at the halfway point between the LED "on" and LED "off" settings. (NOTE: If the difference between the two conditions is very small, thereby making final calibration difficult, reposition the sensor's coarse sensitivity setting to the "HI" position and repeat the 2-Step Calibration procedure. (See Calibration of the Sensor.) In general, applications which are difficult to sense will require a greater clockwise setting.

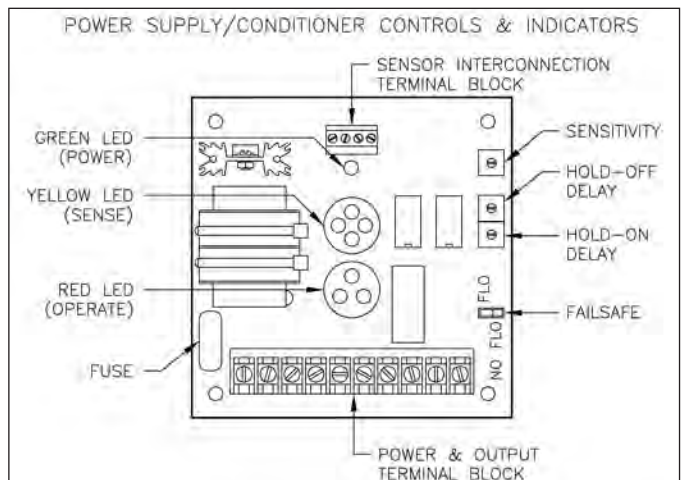


Figure 12

**Hold-off Time Delay** - The single-turn adjustment controls the amount of time that motion must be sensed before the SFD-2 will change from its “no-motion/no-flow” condition to its “motion/flow” condition. Clockwise rotation of the potentiometer will increase the time required for such activity from .25 to 15 seconds. The delay permits the user to adjust the sensor to ignore unwanted sensing caused by equipment vibration or short durations of material flow.

**Hold-on Time Delay** - The single-turn adjustment controls the amount of time that no-motion must be seen before the SFD-2 will change from its “motion/flow” condition to its “no-motion/ no-flow” condition. Clockwise rotation of the potentiometer will increase the time required for such activity from .25 to 15 seconds. The delay permits the user to adjust the sensor to ignore momentary material stoppages induced by shifting or settling of material.

**Fail-safe** (See Figure 13) Selection of the fail-safe mode will permit the output contacts to be signaled in a manner which assures proper control of loads in the event of SFD-2 sensor/power failure. Depending on which condition is most critical to signal (flow or no-flow), the selection can be made by positioning the slide switch to the desired state.

**FLOW** - When no-motion/no-flow is sensed, the relay will be energized. The relay will de-energize when motion/flow occurs, or if sensor/power failure occurs.

**NO-FLOW** - When motion/flow is sensed, the relay will be energized. The relay will de-energize when no-motion/no-flow occurs, or if sensor/power failure occurs.

All SFD-2 units are set to the NO-FLOW fail-safe configuration prior to shipping. The terminal block designations represent the condition of the relay contacts as if all power was off.

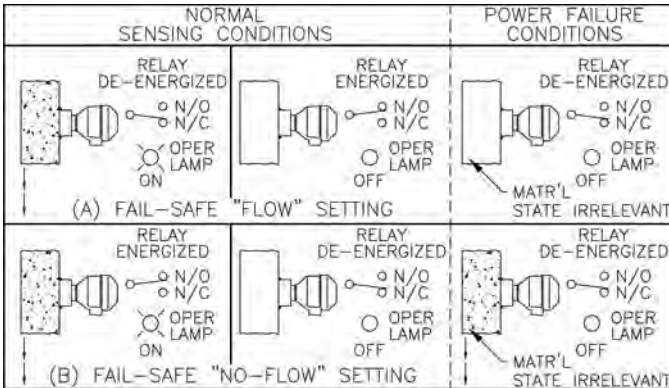


Figure 13

**POWER SUPPLY/CONDITIONER INDICATORS**

**1) Green LED** - Illumination of the Green LED indicates power is properly connected to the power supply/conditioner PCB. Failure to illuminate indicates that the input AC voltage is improperly connected, the fuse is blown, or that the power supply/conditioner is damaged.

**2) Yellow LED (and external indicator)** - The Yellow LED indicates whether the motion detected by the sensor is above the threshold established by the sensitivity adjustment. Illumination of the Yellow LED indicates the threshold has been reached. Its state is not affected by the time delay settings.

**3) Red LED (and external indicator)** - The Red LED indicates the condition of the output relay. Illumination of the red LED indicates the output status of the relay is in the “motion/flow” condition. Its state is influenced by the time delay settings.

**TROUBLESHOOTING**

**PROBLEM: The SFD-2 does not provide relay activation upon material flow.**

**CAUSE/SOLUTION:**

- 1) Verify electrical power is connected to proper terminations and that the sensor is properly interconnected to the power supply conditioner.
- 2) Verify sensitivity settings and increase if necessary.
- 3) Verify hold-off delay setting and decrease if necessary.
- 4) Verify material flow at sensor face. Eliminate any conductive buildup. Reevaluate sensor position and move if increased disturbance can be detected elsewhere.

**PROBLEM: The SFD-2 provides relay activation without material flow.**

**CAUSE/SOLUTION:**

- 1) Verify interconnection between sensor and power supply/conditioner.
- 2) Verify sensitivity settings and decrease if necessary.
- 3) Verify hold-on delay and decrease if necessary.
- 4) Verify movement at sensor face. Reevaluate sensor position if motion from augers, conveyors or other material movement causes sensing.

**MAINTENANCE**

**WARNING:** The SFD-2 is a maintenance free product and shall be serviced by Monitor Technologies LLC only. Changes or modifications to the SFD-2 not expressly approved by Monitor Technologies LLC could void the user’s authority to operate the product.

**NOTE:** This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential and industrial installations. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference in radio communications.

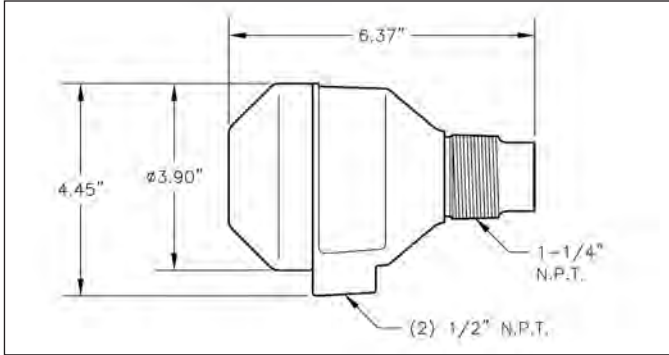
However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between SFD-2 and receiver.
- Connect the SFD-2 to a different circuit different from which the receiver is connected.
- Consult the dealer or a radio/TV technician for help.

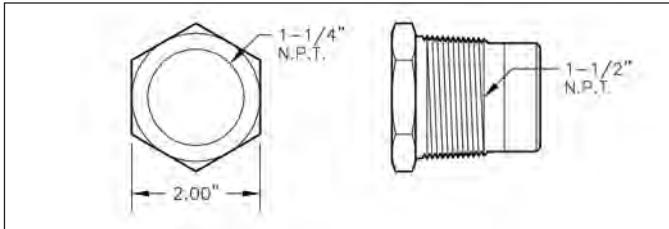
This device complies with RSS-210 of Industry Canada. Operation is subject to the following two conditions:

- This device may not cause interference.
- This device must accept any interference, including interference that may cause undesired operation of the device.

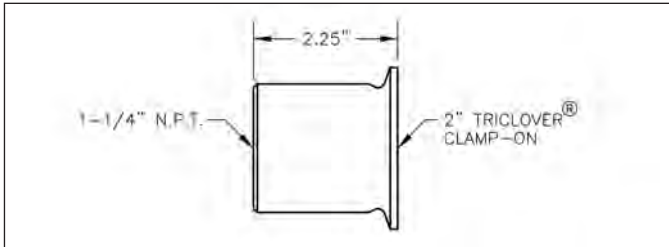
## MECHANICALS



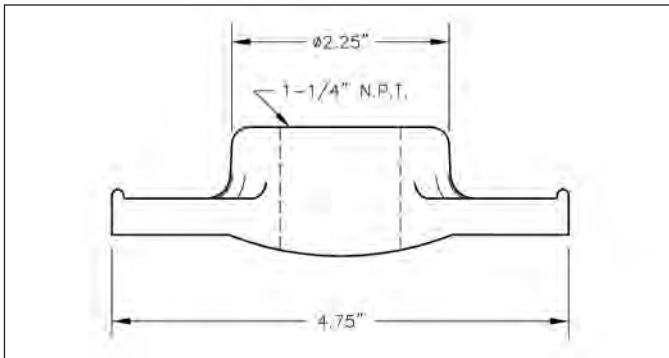
Sensor



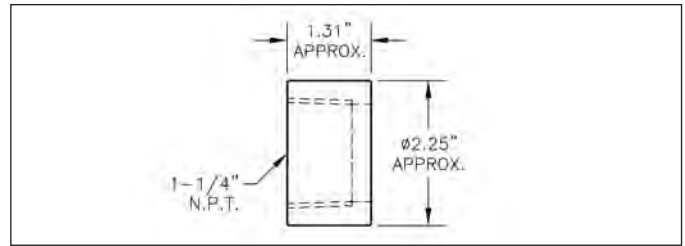
Stainless Steel Adapter



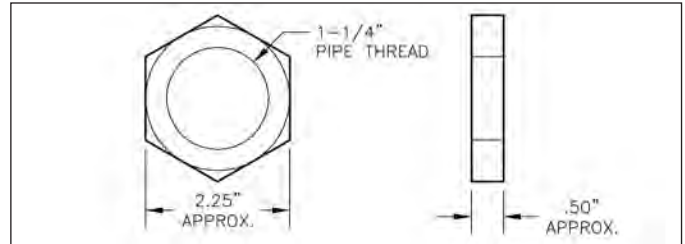
Food Grade Adapter



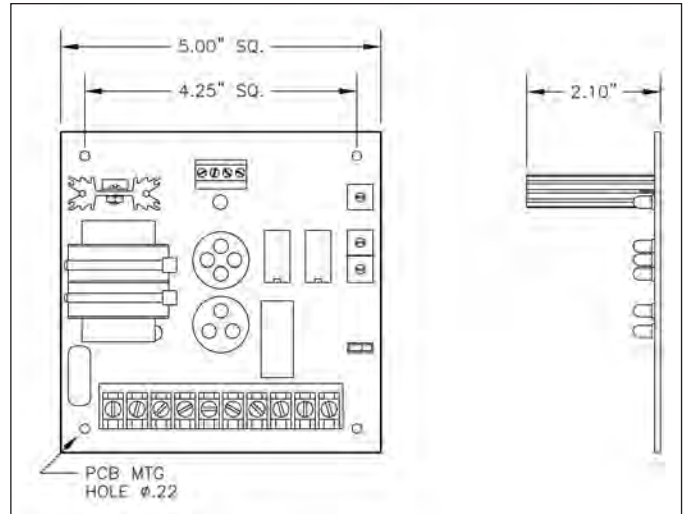
Saddle Coupling



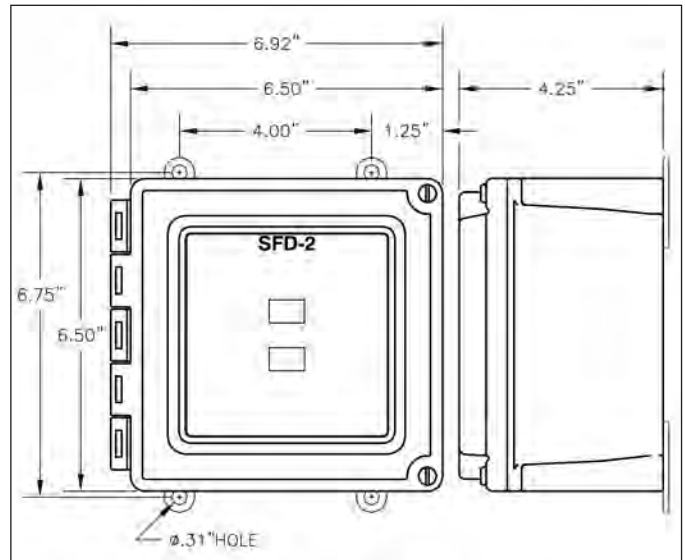
Half Coupling



Locknut



Power Supply/Conditioner PC Board



Enclosure

# BULLETIN 824

## SAFETY

### Electrical Shock Caution:

The SFD-2 power supply/conditioner is powered with HIGH VOLTAGE. Care shall be taken whenever the main terminal block connections are exposed. To avoid electrical shock, do not contact any exposed electrical connections.

### Hazardous Location Caution:

The SFD-2 sensor is "approved" for use in certain Hazardous Locations (see specifications). The products shall only be used in applications covered by these ratings or those considered non-hazardous. Failure to comply could result in catastrophe damage to personnel and property. The following must be maintained to assure safe operation:

- 1) **Housing integrity** - the dimensions of the housing, cover or process seal shall not be altered.
- 2) **Maintenance** - Removal of the sensor cover to conduct maintenance while power is yet supplied does not meet hazardous location requirements. If done, it is at the risk of the customer only.

### Radiated Energy

OSHA has adopted regulations designed to prevent possible harmful effects in human being from exposure to electromagnetic fields in the frequency range of 300 KHz to 100 GHz. The SFD-2 generates energy within this band. OSHA permits human exposure to power densities up to 10mW/cm<sup>2</sup> for 1/10 hour or greater continuous duration. The SFD-2 produces a power density less than 1mW/cm<sup>2</sup> at the sensor face and therefore poses no health danger to operators or the general public.

## WARRANTY

Monitor Technologies LLC warrants each SFD-2 it manufactures to be free from defects in material and workmanship under normal use and service within two (2) years from the date of purchase within North America, and within one (1) year from date of purchase outside of North America. The purchaser must give notice of any defect to Monitor Technologies LLC within the warranty period, return the product intact and prepay transportation charges. The obligation of Monitor Technologies LLC under this warranty is limited to repair or replacement at its factory. This warranty shall not apply to any product which is repaired or altered outside of the Monitor Technologies LLC factory, or which has been subject to misuse, negligence, accident, incorrect wiring by others or improper installation. Monitor Technologies LLC reserves the right to change the design and/or specifications without prior notice.

## SPECIFICATIONS

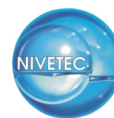
### SENSOR

Enclosure	cast aluminum, polyester coated (orange)
Enclosure protection	NEMA 4, IP66
Operational temp. range	-40~+185 degrees F (-40~+85 degrees C)
Process temp. max	+250 degrees F (+121 C) if ambient air temp. below +150 degrees F (+65 C)
Process seals	TFE Teflon®, Ryton®
Pressure ratings	TFE Teflon® (75 PSI intm), Ryton® (300 PSI)
Process connection	1 1/4" NPT (flush mount with half coupling)
Conduit connection	(2) 1/2" NPT
Detection range	0 to 10' free air, environment and target dependent
Sensitivity	switch selectable HI/LOW
Power requirement	provided by power supply/conditioner PCB
Output	none, signal delivered to and processed by power supply/conditioner
Indicators	Green LED- power Yellow LED- loop, intensifies with motion
Emission	24.125 GHz, FCC and IC certified, less than 1mW/cm <sup>2</sup> (OSHA limit at 10mW/cm <sup>2</sup> )
Approvals	Class II, Div. 1, Groups E, F & G (CSA/FM)

### POWER SUPPLY/CONDITIONER (PS/COND)

Enclosure (if applicable)	fiberglass, JIC 6" x 6" x 4"
Enclosure protection	NEMA 4X, IP66
Operational temp. range	-40~+158 degrees F (-40~+70 degrees C)
Interconnection distance	2500ft max (minimum wire size 22 AWG)
Power	115/230 VAC (+/- 15%) 50/60 HZ
Power consumption	9 VA max
Output	DPDT dry contact, 5A @ 240VAC or 24VDC max 1/8 HP @ 120/240VAC
	External lights (if applicable)- solid state LED clusters Yellow- material sense, Red-output operate
Sensitivity adjustment	single-turn adjustment 0~100% of sensor range
Time delay	hold-off, single-turn adjustment, .25~15 seconds hold-on, single-turn adjustment, .25~15 seconds
Fail-safe	switch selectable, (FLOW/NO-FLOW)
Indicators	Green LED- power, Yellow LED- sense, Red LED-output
Approvals	ordinary locations, industrial control equipment (CSA/FM)

Ryton® - Trademark of Phillips Chemical Co.  
Teflon® - Trademark of Dupont Chemical Co.  
TRI-CLOVER® - Trademark of Tri-Clover Inc.



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