FPCFCT20 / 30
FOAM CONTROLLER AND SENSORS

INSTALLATION AND OPERATION MANUAL

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FPCFCT20/30 LIST OF FIGURES

FPCFCT20/30 SPECIFICATIONS

Power Supply:	FPCFCT20 - 110 V ac or 24 V dc. (0.3A) FPCFCT30 - 230 V ac or 24 V dc (0.3 A) (Can be changed by voltage selector switch)
Outputs:	Volt-free change over contacts 240 V a.c. 30 V d.c. 2 A max. 4-20 (0-20) mA
Indicators:	Power indicator – Green : always on Sense indicator – Red : On when foam is initially detected. Activate indicator – Yellow : On when foam is detected after delay time.
Adjustments:	Delay Time 0 - 30 seconds (3 pole d.i.l. switch) Shot Time 0-30 seconds (3 pole d.i. switch) Sensitivity 0.3K - 100K ohms impedance. (4 pole d.i.l switch) Relay function - normally off or on. (d.i.l. switch) Dose overrun Function (d.i.l switch)
Fouling Immunity:	0.2% of sensitivity to Foam
Hysteresis	5% between trigger & reset
Enclosure Data:	IP65 Polystyrene with polycarbonate lid 240 wide x 220 height x 115 depth mm Colour Grey (Ral 7035) Connections: screw terminals
Sensor Cable:	Screened twisted pair cable 0.5 sq. mm - 150 metres max (see fig Q) e.g. Belden 8760

1. INTRODUCTION TO THE FPCFCT20/30

The FPCFCT20 & 30 are advanced purpose designed Foam Controller units intended for use in a permanent installation to sense and/or control foam in a reactor or other containment area and should only be used with a Hycontrol/Charis Foam Sensor to achieve the operation described. The principle parts of a system are as follows:

- Foam Sensor
- Interconnecting Cable
- Controller Unit

There are a variety of sizes and styles of Foam Sensor. They are all designed for hygienic applications and will operate in the presence of high levels of fouling (i.e. surface coating).

The Controller Unit can be used as a transmitter to signal to a process controller or alarm via volt free contacts or 4-20 ma. The controller can also be used to control a pump or valve directly to dose antifoam by means of a 'Delay and Shot' algorithm.

This is one of a series of products designed and manufactured by Hycontrol for the sensing and control of foam.

2. PRINCIPLE OF OPERATION

The Foam Sensor operates by passing a small alternating current through the foam under test, and uses this to measure impedance. The impedance of the material being sensed is used to determine when foam is present.

The Sensor is designed with two electrodes. One is used to sense foam while the other is designed to supply any leakage currents which pass along the body of the Sensor. If the Sensor is covered with a fouling layer deposited on it, then a leakage current must pass through that layer and down to earth. This leakage may be measure as part of the sensing current and consequently cause false readings. In the case of serious fouling this could cause a false alarm and an unnecessary intervention to the process. In this design the guard electrode supplies all the leakage current leaving the sense electrode to sense only foam. The guard electrode effectively isolates the sensor from the interference caused by fouling. This gives the Sensor the ability to continue working reliably even in conditions of extreme fouling.

The controller energizes the sensor and processes the measured data. It discriminates between foam spurious events such as splashing. It also determines when foam is present and signals to a process controller or alarm that foam has been detected. Various output interfaces are available including volt-free contacts (relay), digital output and 4-20 mA.

3. INSTALLATION

3.1 Installing the Sensor

The Sensor should be installed in such a way that the sensing electrode is positioned at the point where foam is required to be detected. The sensing electrode is the lower of the two electrodes at the end of the sensor. Ensure that the Sensor is mounted securely and is not close to any permanent structure such that a "bridge" of foam can get caught. Ideally the sensing electrode should be more than 50 mm from any other metal parts but certainly more than 25 mm.

If the Sensor is in an area where air or gas is extracted, then the best location is near to the gas exit where foam could exit the vessel. However this is not essential.

Ensure that the Sensor cannot be flooded by any liquid contents. For example, if varying liquid heights are likely, ensure that the Sensor is high enough to be always above the liquid surface, unless it is especially in use to detect the liquid level as well as foam.

If the Sensor is installed in a pressurised vessel check that the Sensor fitting is tightened and sealed as appropriate before the pressure is raised.

It is essential that the sensor is connected properly: see 3.4 below.

3.2 Installing the FPCFCT20 or 30 Controller

The FPCFCT20/30 is designed to be surface mounted, inside an existing control cabinet. There are 4 mounting lugs on the corners which can be used for fitting to a panel. Connections should be made by means of the orange terminal block at the end of the unit. The terminal block can be removed from the enclosure by pulling it straight out from the enclosure. Refer to figures E and F for the connections.

Ensure that the unit is powered with the correct supply. The FPCFCT30 is supplied to operate at 230VAC. This can be changed to 115V AC by means of a selector switch. The selector switch may be fitted such that it cannot be set to 115VAC without removing the fuse. This is to protect against inadvertent adjustment. The fuse F1 should be changed to 500ma if the unit is switched to 115VAC. The voltage selector tab should be shortened by snipping off the end with a sharp pair of cutters if it hits the F1 fuse.

It is essential that the unit is connected to earth to provide a return path for the Sensor. Ensure that the correct type of cable is used for the Sensor and that the length does not exceed the maximum stated in the specification. (see 3.3 below for cabling)

The relay output provides change-over volt-free contacts. They can be used to signal to a process controller, alarm or computer. If used for vacuum cooling or degassing applications, use the normally closed contacts to interrupt the supply to the control valve. The relays can be configured to operate powered on or off, see section 5.5

There is also an analog output (4-20ma) which can be used to give an indication of foam height. This is an active output (i.e. it does not require an external supply) but is not isolated.
See section 4 for notes on commissioning and configuration settings. Ensure that appropriate cable is used for the connections.

3.3 Sensor Cabling

It is essential that the sensor is connected with a suitable cable to the controller. For short cable runs (<25 m) an unscreened twisted pair cable can be used as shown in figures D & F. For longer cables use screened cable with the screen connected to the guard as shown in fig. Q. *The screen should never be connected to ground as this increases the capacitance of the cable and can case false readings. Neither should other cores in the same cable be connected to earth for the same reason.* If an earth connection is needed a separate cable should be used. It is essential that the cable is connected correctly. If the sensor wiring is reversed the sensor may appear to function but the results will be unpredictable.

If an industrial Sensor is being used the cable must be wired into the terminal block in the head. Connect the sense wire to the terminal marked "+" and the guard wire to the terminal marked "-". Use an IP66 cable gland to seal the cable into the head and to prevent any moisture access. (An appropriate cable gland is normally supplied with the Sensor). (see Fig. J)

If a laboratory type Sensor is used the cable is connected by means of a Lemo connector. A lead can be supplied by Hycontrol if required. Ensure that the sense and guard are the connected to the correct terminals (see Fig.s D & E)

It is essential that an earth return is provided for the Sensor. This is normally supplied via an earth bond to the vessel or structure in which foam is being sensed. If the vessel is not connected to earth a separate earth wire should be connected between the controller and the vessel. If a non-conducting vessel is used, it is essential that an earth connection is made to the contents. This can be done by another electrode immersed in the liquid and connected to the instrument earth.

3.4 Interface Cabling

There are various interfaces available to connect the controller to control devices or to a process control computer. These are listed below:

Relay 1 : Volt-free contacts - change-over type with 2 sets of changeover –contacts.
Operates as the controller output with delay & shot function.
The relay can be connected to a low voltage to switch to a computer or may be connected to a high voltage to operate a pump etc.

Relay 2 : volt-free contacts used as a “detector” function. Relay operates when foam is detected
but only after the delay time. This is not affected by the shot time. The relay resets when foam is dispersed.
The relay can be connected to a low voltage to switch to a computer or may be connected to a high voltage to operate a pump etc. This may also be used in some cases as an alarm function.

Analogue: 4-20 mA output (can be set to 0-20ma see 5.9 below).
Output The negative side is connected to the instrument ground and is not isolated.

Please note that it is essential that the cabling used is suitable for the voltage connected in all cases. If in doubt please consult Hycontrol, or your supplier.

4. COMMISSIONING

When power is first applied a self test in performed and as this happens all the front panels lights should momentarily switch on and then go out. After this the green power light should be on and the other indicators should be off. This indicates that power is applied and that the internal processor is operating correctly. If the self test fails all the front panel lights will flash on and off together indicating that there is a major failure. In this case contact your supplier for advice.

The FPCFCT20/30 is set up in the factory to the default settings. This will be suitable for a wide range of applications. However it may be necessary to adjust the unit for a particular application. To make a simple initial test that the unit is operating correctly make a temporary connection between the end of the Sensor and the vessel wall with a piece of cable. If this is impractical, make a temporary connection between the sense terminal at the Sensor head and earth. The red "sense" light on the panel should switch on, and after a delay time of 4 seconds the yellow light should switch on and stay on for two seconds. This will be repeated continually. Ensure that the information has passed correctly to the process controller or other device and that the correct channel has been used. Ensure that the temporary connection is removed and that the red and yellow lights then switch off. It is important that the complete measuring chain is tested together with any control feedback.

The Sensor should have been mounted in such a position that it will readily come into contact with the foam which is to be sensed. Ideally, if foam can be generated for a test then the unit should be tested with foam before use. If the Controller does not trigger when foam is present, then increase the sensitivity slightly and try again. (See section 5.5). *Do not set the sensitivity higher than necessary as this could decrease the immunity to fouling.* In most applications the sensitivity required is below 20K. The sensitivity settings are shown in Figure B. The adjustment switches location are shown on figure F. To increase the sensitivity set a larger value as shown in the sensitivity column.

In many cases it is impossible or undesirable to create foam for a test. In these situations the operation of the equipment should be monitored to ensure that it is operating as required by visual inspection.

If a sample of foam is required to be tested, ensure that it is a fresh sample and test in a metal container with a connection to earth. Some types of foam can drain quickly which will substantially change its characteristics which makes this rather difficult to do well and it is therefore not recommended. *Do not use a plastic container for testing.*

The delay time (or response time) gives discrimination against splashing. This acts as a response time before any action is taken. In most applications a few seconds is adequate to differentiate between occasional splashing and the presence of foam. (See section 5.3). The default setting is 4 seconds but this can be adjusted if necessary. The delay may not be apparent when testing initially but should be borne in mind to allow enough time for the unit to trigger.

5. OPERATION

5.1 Making Adjustments

The following adjustments are provided for the operator:

Delay time	- internal d.i.l switch - 3 pole
Shot Time	- internal d.i.l switch - 3 pole
Sensitivity	- internal d.i.l switch - 4 pole
Manual Switch	- if fitted externally

These are described below; please refer to the relevant figures for settings. *Ensure that the power is switched off before adjustments are made, as there are high voltages present on this board.*

To make adjustments to the FPCFCT20 or 30 remove the cover. The location of the switches is shown in figure F.

Replace the four retaining screws and then ensure that the front cover is closed securely.

The switches are only read by the system when power is applied. When making changes to the switch settings ensure that the unit is turned off and then on again.

5.2 Manual Switch

Connections are provided for the use of an external momentary action switch. This switch may be used to override the action of the controller or test the connection to a process controller. Pressing the switch will trigger the controller outputs.

5.3 Delay Time (Response Time)

The delay time switch is used to set the delay time. This is the time for which foam is continuously sensed before the output is activated. It is used to discriminate between the presence of foam and the intermittent splashing of liquid. It is set by means of a dual in-line switch on the controller board. The default time of 4 seconds is suitable for many applications but this can be adjusted if required. To change the setting, adjust the switches with a small screwdriver or similar tool. The settings are shown in Figure A. (Sw2:5-7) The switch is located near the top edge of the board and is shown in Figure F. In some cases no response time is required at all and in this case the time may be set to zero. However in most applications some short delay time is beneficial.

5.4 Shot Time

The shot time is the time for which the switch is active. The shot and delay system is designed primarily to dose antifoam or defoamer into a process. Antifoam often requires a finite time to take effect so in can be added as a dose or 'shot' and then time allowed for the chemical to be effective. This minimizes the amount of antifoam added. The delay time between shots is the same as the initial delay time. The shot time is set by internal dil switches as shown in figure A.(sw4:1-3) It is set independently to the delay time.

If the shot and delay algorithm is not required it can be disabled by setting the shot time to zero. In this case the controller acts like a transmitter. The output relay will switch on after the initial delay time and stay on until the foam subsides. This can be used to signal to a process controller or Scada system.

5.5 Sensitivity

The sensitivity of the unit to foam can be adjusted if necessary. The default value, which is set in the factory, is suitable for most applications but there are times when this may need to be adjusted. *Please note that the value should not be set at a higher value than is required for the application, in order to optimize the fouling immunity.* The sensitivity of the Probe to fouling is a small percentage of its sensitivity to foam. This means that if the gain is too high for the application, the fouling rejection is reduced.

The sensitivity is set by means of 4 small switches on the controller board. (SW2:1-4) The settings are shown in figure B. The location of the switches is shown in figure F. Set the combination of the four switches to give the desired sensitivity as shown in figure B. The switches are marked "on" at one side and the combination of on/off sets the sensitivity.

To increase the sensitivity the value should be set to a higher number. To detect very low density foam a higher sensitivity will be needed. Low density foam is characterized by a low liquid content, large bubble size or low conductivity.

5.6 Hysteresis

Hysteresis is a means of improving the switching point and to avoid rapid cycling when the foam is only slowly changing in height. The hysteresis is a small difference between the sensitivity at which the unit triggers and the sensitivity at which it resets. This is set to 5% hysteresis to provides very clean and noise free switching. Once the unit has detected foam the switching level is changed by 5% so the foam has to fall further down to reset the unit.

5.7 Failsafe Operation

The relays can be set to be powered up or down in the normal state. This gives the option to set the relay for the required condition in the event of a power failure or other serious fault. In the default mode when the power is off the condition indicated is the same as when no foam is detected.

However in the failsafe mode when the power is off the relay state is the same as when foam is indicated. This allows a power failure to indicate an alarm.
Default mode: the relays are powered down when foam is not present and when foam is detected the relays are powered up and switch over.

Failsafe mode: the relays are powered up when foam is not present and when foam is detected the relays are powered down and switch off.

This function is set by SW4 : 8 as follows:

SW4 : 8	Off :	Relay normally off (default mode)
	On :	Relay normally on. (failsafe mode)

The diagrams in the manual show the relays with the default option in the normally off state, when foam is not present. See Fig. F for location of switch.

5.8 Overun Function

This function is designed to allow more action to be taken once the foam has subsided. It can be enabled or disabled using the internal switches (sw4:4). The effect of the overrun is to give one extra shot after the foam has subsided. This is sometimes useful to ensure the foam is controlled enough. However it is probably best to disable the overrun if the intention is to use the absolute minimum of chemical additives.

If the shot time is set to zero and the controller is operated as a detector/transmitter then the effect is to increase the on time of the relay by one delay time. This can be useful in vacuum cooling applications where a vacuum valve is being controlled to prevent 'hunting' of the valve. In other word it adds an extra delay to prevent rapid switching of an actuator.

5.9 Analogue Output (4-20 ma)

The FPCFCT has a current output which can be used as an analogue output to sense the level of foam. This will not give a precise level measurement, as foam is not an homogeneous material, however it will give a good indication if the foam is rising or falling which can be a useful indicator. It could also be used to input a PID controller if required.

The current output can be set to 0-20 ma or 4-20 ma by means of an internal switch (SW4:7) The default setting is 4-20. The scale factor of the current output is linked to the sensitivity adjustment. When the sensitivity is changed th
e ma scale changes accordingly. However the switch point on the current range can be altered by changing the ma range factor. The current range is effectively stretched or compressed to set the switch point at 20,40,60 or 80% of the 4-20 ma range. The default setting is 40%. so that the relay switches at 40% of the current range which is 10.4 ma (4-20) or 8 ma (0-20). By changing the range factor the ma range is adjusted around the relay trigger point.

See Figure P for switch settings.

5.10 Summary of switch operations

Switch	No	Function
SW2	1	Sensitivity settings – see figure B
	2	
	3	
	4	
	5	Delay Time settings – see figure A
	6	
	7	
	8	Reserved for future use
SW4	1	Shot time settings – see figure A
	2	
	3	
	4	Overun function – on to enable, off to disable
	5	mA o/p range factor – (0,20,40,60,80%) – see figure P
	6	
	7	4-20/0-20 ma (off for 4-20ma)
	8	Failsafe mode (on for failsafe, off for normal mode)

FIGURE A – TIME SETTINGS

CONTROLLER DELAY TIME SETTINGS

	TIME (Secs)	SW2 SWITCH 5	SW2 SWITCH 6	SW2 SWITCH 7
MAX >	30	ON	ON	ON
	20	OFF	ON	ON
	12	ON	OFF	ON
	8	OFF	OFF	ON
DEFAULT >	4	ON	ON	OFF
	2	OFF	ON	OFF
	1	ON	OFF	OFF
MIN >	0 *	OFF	OFF	OFF

ADJUST BY MEANS OF SW2: 5-7 DIL SWITCH ON THE BOARD.
(* If set to 0 relay response immediately with the red led.)

CONTROLLER SHOT TIME SETTINGS

	TIME (Secs)	SW4 SWITCH 1	SW4 SWITCH 2	SW4 SWITCH 3
MAX >	30	ON	ON	ON
	20	OFF	ON	ON
	12	ON	OFF	ON
	8	OFF	OFF	ON
DEFAULT >	4	ON	ON	OFF
	2	OFF	ON	OFF
	1	ON	OFF	OFF
MIN >	OFF **	OFF	OFF	OFF

ADJUST BY MEANS OF SW4: 1-7 DIL SWITCH ON THE BOARD.
(** if set to off the shot/delay function is disabled)

FOR LOCATION OF SWITCH SEE FIGURES G & H.
SWITCHES ARE ONLY READ AT POWER UP
(SWITCH POWER OFF AND ON AFTER SWITCHES ARE CHANGED)

FIGURE B – SENSITIVITY SETTINGS

	SENSITIVITY	SWITCH 1	SWITCH 2	SWITCH 3	SWITCH 4
MIN >	0.35K	ON	ON	ON	ON
	0.5K	OFF	ON	ON	ON
	0.7K	ON	OFF	ON	ON
	1K	OFF	OFF	ON	ON
	2K	ON	ON	OFF	ON
	5K	OFF	ON	OFF	ON
	7.5K	ON	OFF	OFF	ON
DEFAULT >	10K	OFF	OFF	OFF	ON
	12K	ON	ON	ON	OFF
	15K	OFF	ON	ON	OFF
	20K	ON	OFF	ON	OFF
	25K	OFF	OFF	ON	OFF
	35K	ON	ON	OFF	OFF
	50K	OFF	ON	OFF	OFF
	75K	ON	OFF	OFF	OFF
MAX >	100K	OFF	OFF	OFF	OFF

Adjust by means of SW2: 1-4 for location see Fig. F

Sensitivity required is in the range 5K –20K for most applications. For less dense or lighter foam increase the sensitivity to a higher value.

DO NOT SET SENSITIVITY HIGHER THEN REQUIRED FOR THE APPLICATION

Power up after adjusting switches

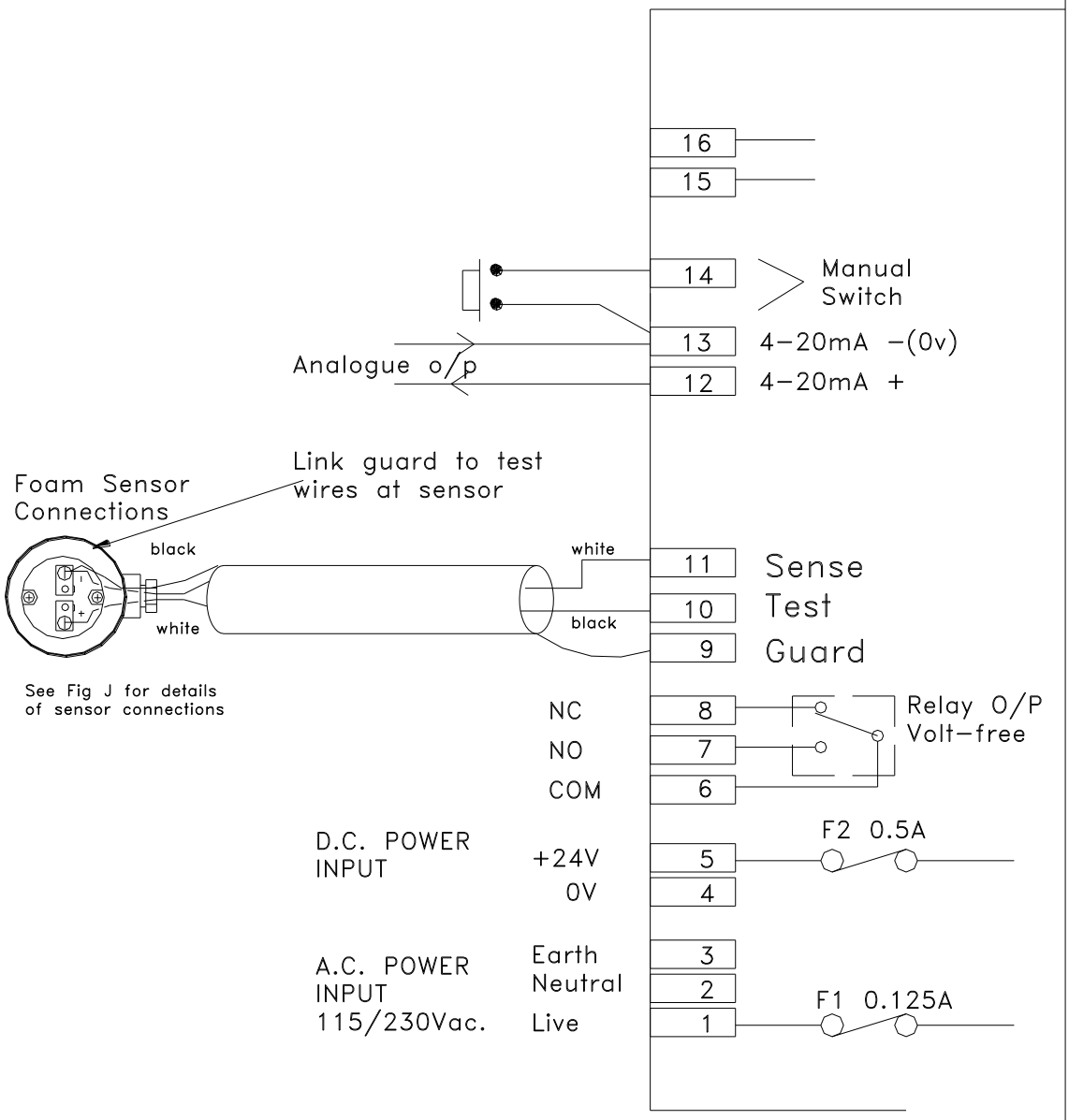
FIGURE C - CONNECTIONS

TERMINAL	DESCRIPTION
1	Line Supply – LIVE (115/230 V a.c.)
2	Line Return – NEUTRAL
3	Supply Ground / EARTH
4	D.C. Supply 0 V dc
5	D.C. Supply +24 V dc
6	Relay RL1 common
7	Relay RL1 Normally open
8	Relay RL1 normally closed
9	Sensor : Guard
10	Sensor: Test (must be linked to guard)
11	Sensor: Sense
12	4-20 mA +
13	4-20mA - / manual switch return
14	Manual Switch
15	RL2 common
16	RL2 normally open

Terminals are numbered left to right when lid is uppermost.

Note: Relay connections refer to the normally off condition with no foam present. If the failsafe mode is set to normally on, then the relay normally open contacts will be closed when foam is not present.

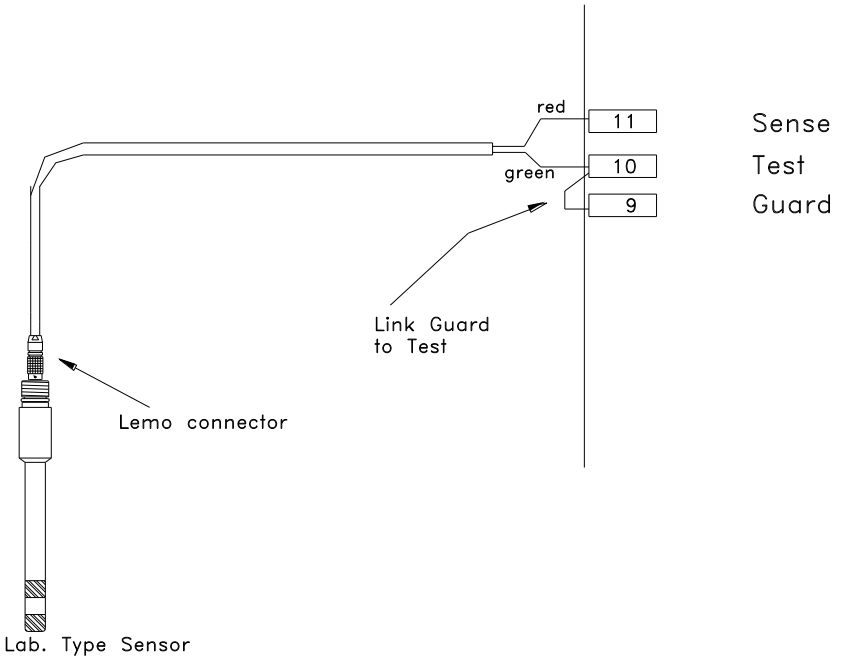
Figure D Cabling for Industrial Sensor FPCFCT20 & 30



use SCREENED twisted pair cable for sensor
see figure J & Q for more details
see figure M for more details on supply connections.

Relay Contacts: 240 Va.c. / 30 Vd.c. 2 amps Rating

Figure E
Connecting a Laboratory Sensor



Use unscreened twisted pair cable, length must not exceed 20m
Hycontrol part no for lead – CH–F1158–FL1–length

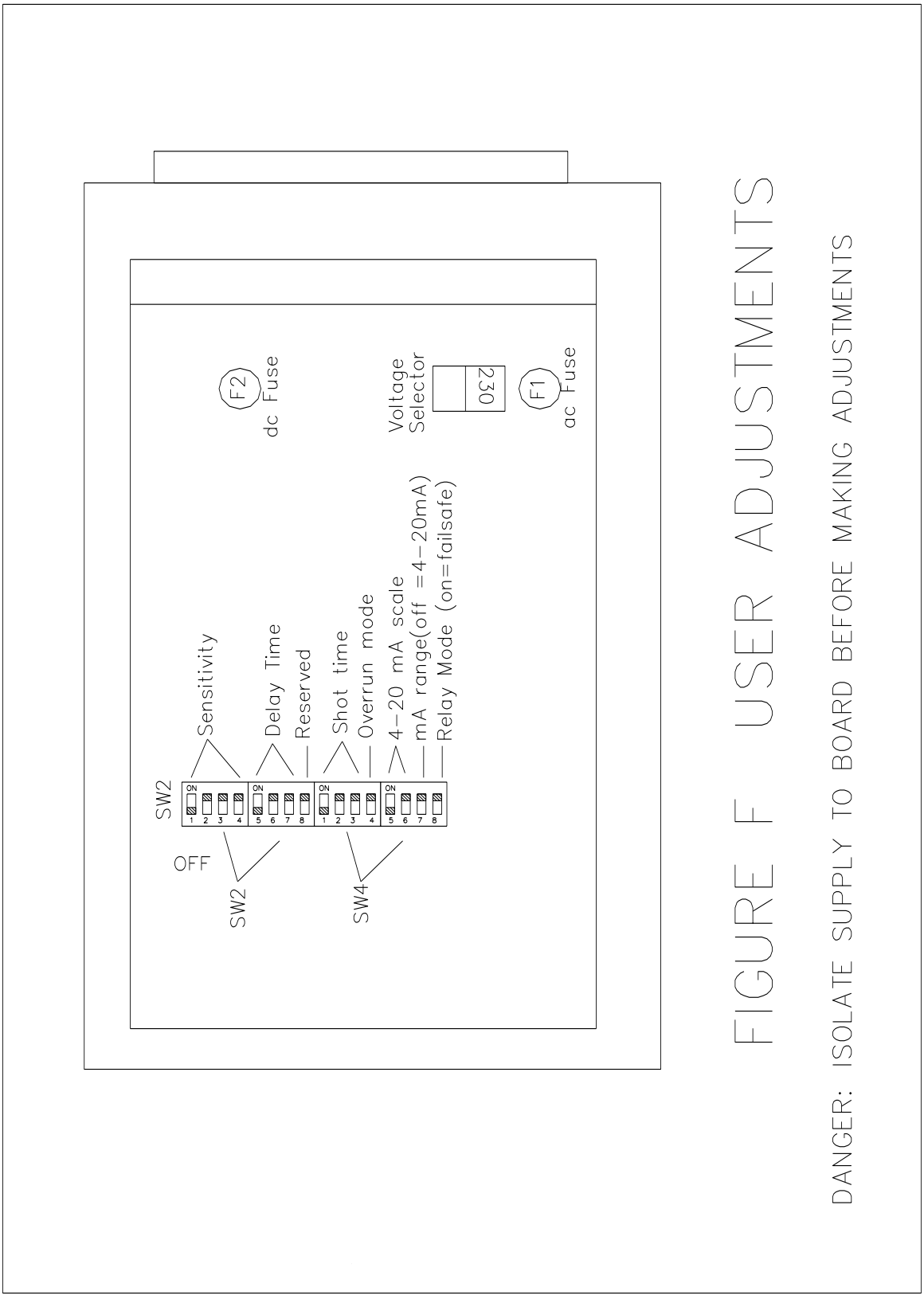
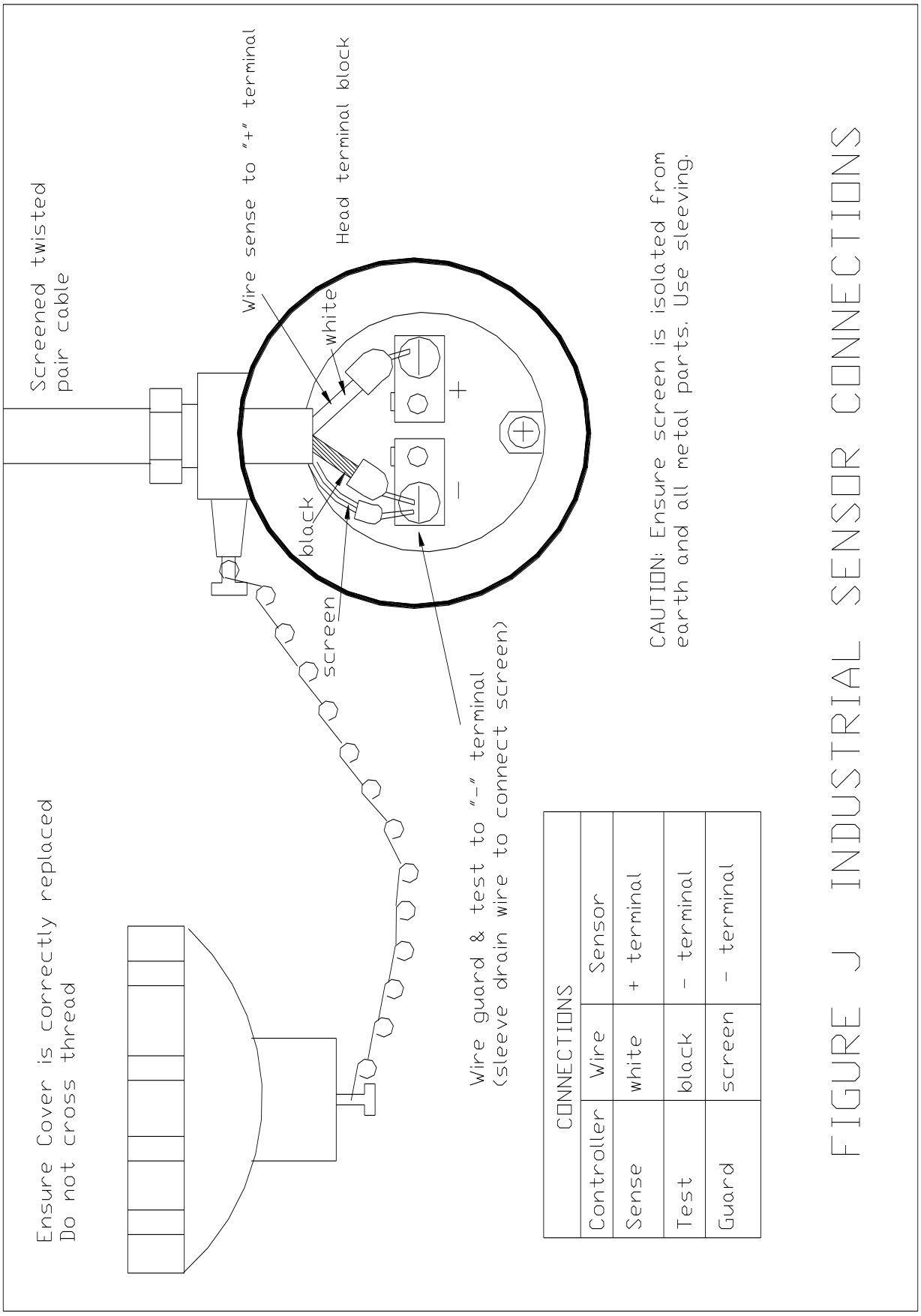


FIGURE F USER ADJUSTMENTS

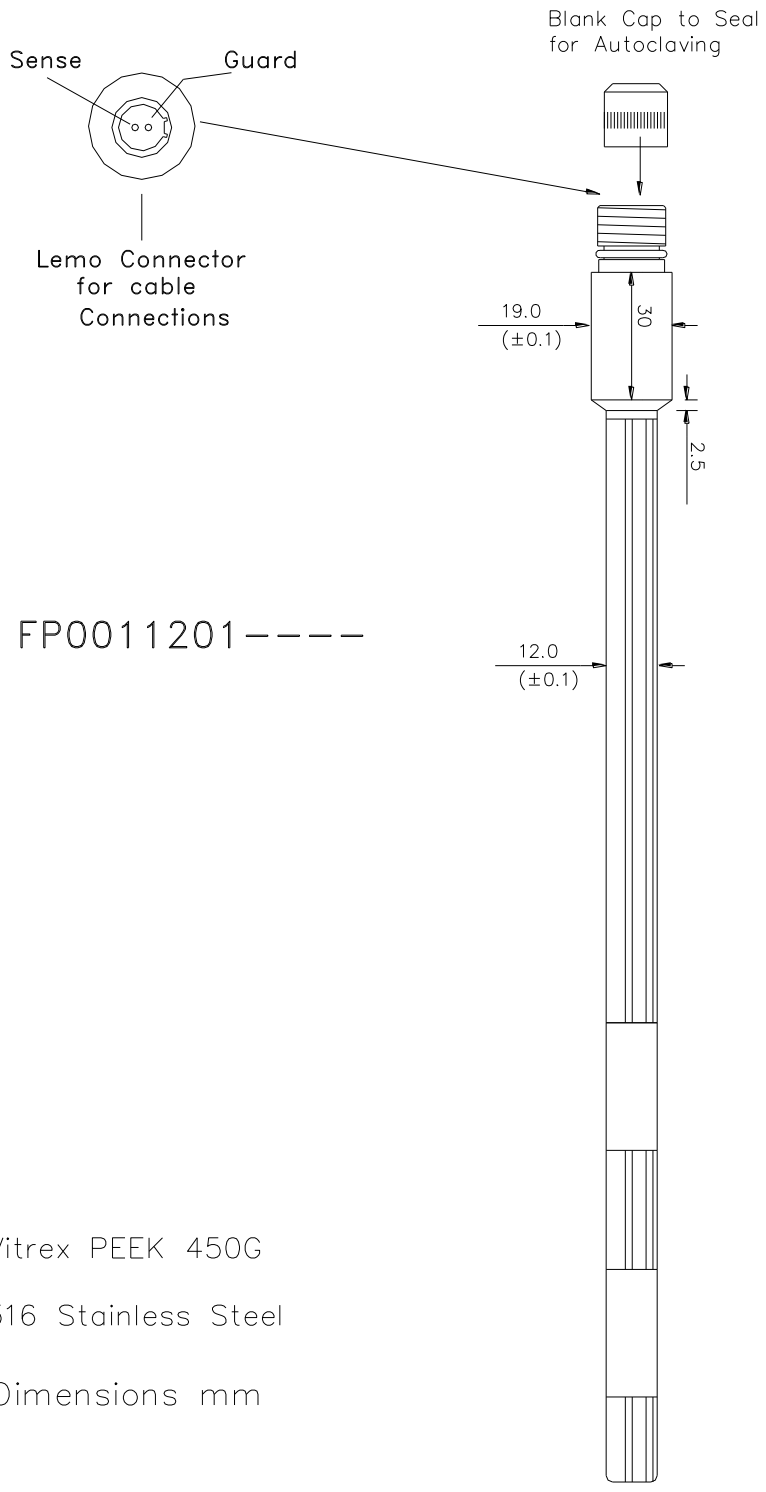
DANGER: ISOLATE SUPPLY TO BOARD BEFORE MAKING ADJUSTMENTS



CONNECTIONS		
Controller	Wire	Sensor
Sense	white	+ terminal
Test	black	- terminal
Guard	screen	- terminal

FIGURE J INDUSTRIAL SENSOR CONNECTIONS

FIGURE K Laboratory Probe Connections



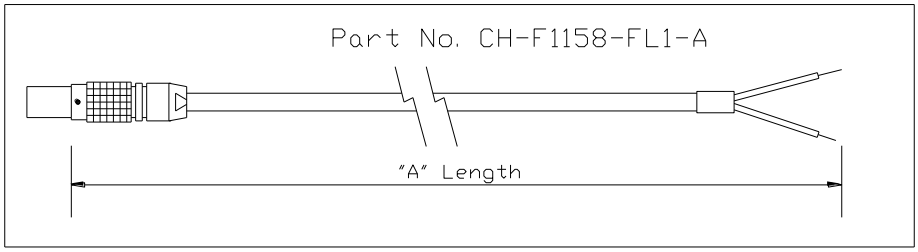
Type: FP0011201----

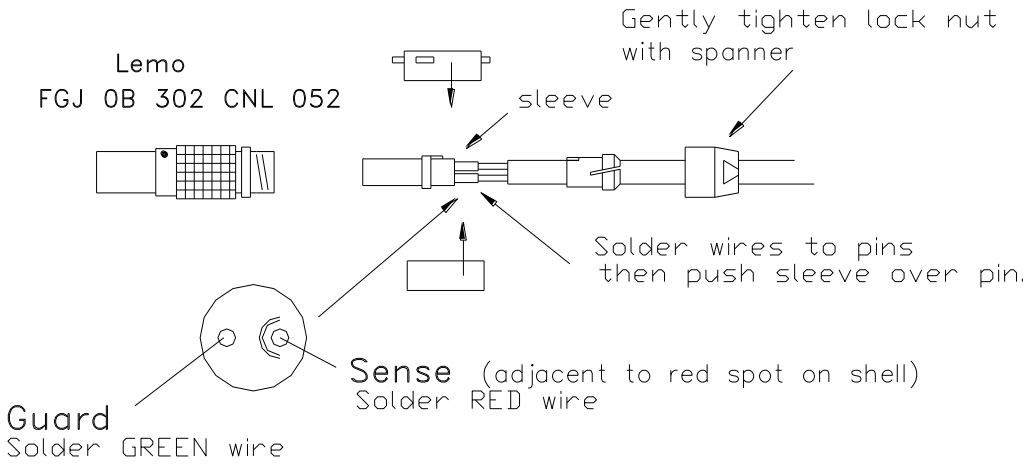
Vitrex PEEK 450G

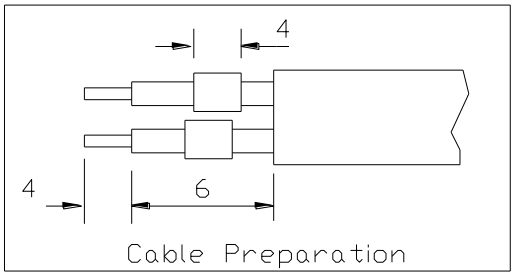
316 Stainless Steel

Dimensions mm

FIGURE L Laboratory Probe Lead Assembly



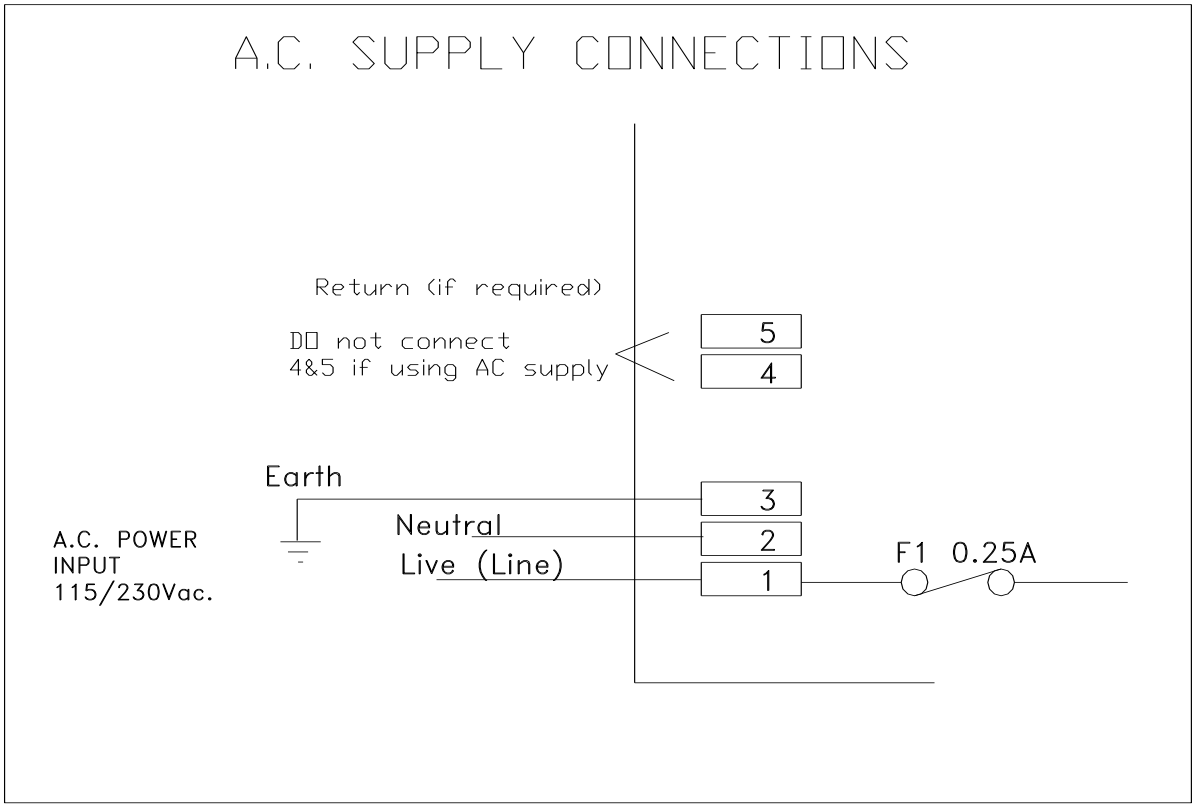


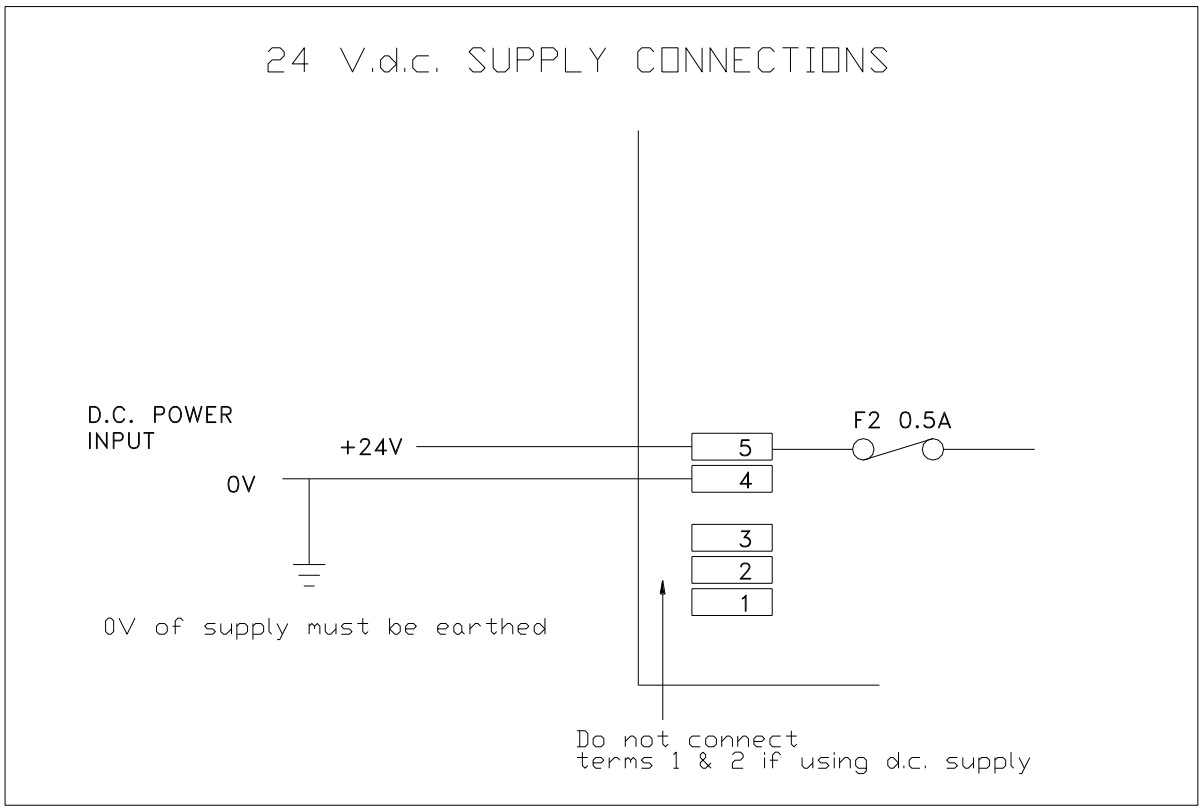


After assembly check: continuity & insulation.

CABLE TO PROBE MUST BE SPECIFIED TYPE
I.E. UNSCREENED TWISTED PAIR E.G. BELDEN 8795.

FIGURE M: POWER SUPPLY CONNECTION OPTIONS





The return terminal can be used to connect to the vessel if it is not earthed, to provide a return signal. It most installations it is not required. See section 3.4 for details.

FIGURE P

ANALOGUE OUTPUT SETTINGS (4-20 mA)

RANGE FACTOR

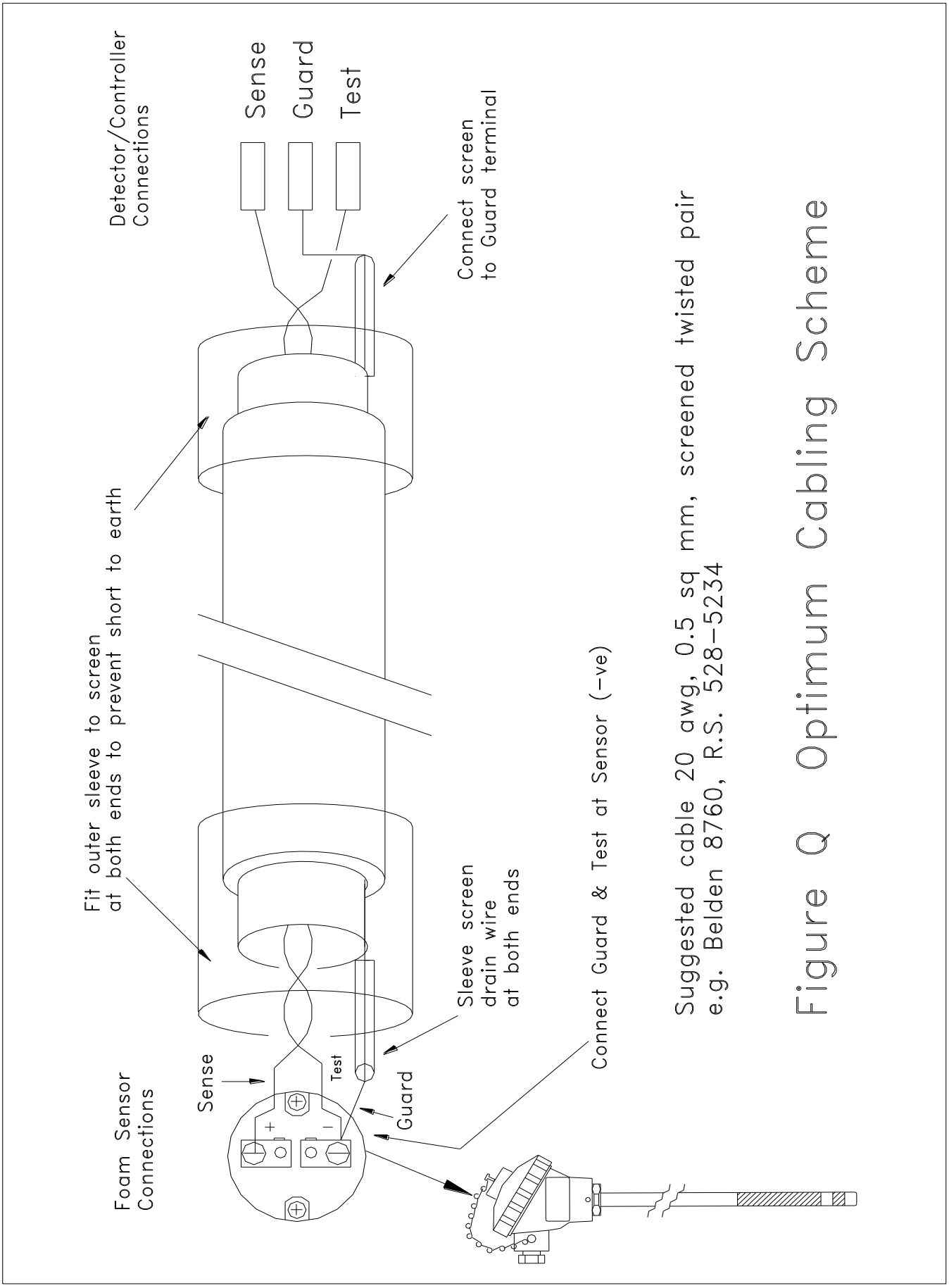
	TRIGGER %	TRIGGER POINT ON 4-20 mA	TRIGGER POINT ON 0-20 mA	SW4 SWITCH 5	SW4 SWITCH 6
	80	16.8	16.0	ON	ON
	60	13.6	12.0	OFF	ON
DEFAULT >	40	10.4	8.0	ON	OFF
	20	7.2	4.0	OFF	OFF

LOWER CURRENT LIMIT

Current Range	SW4 SWITCH 7
4-20 mA	OFF
0-20 mA	ON

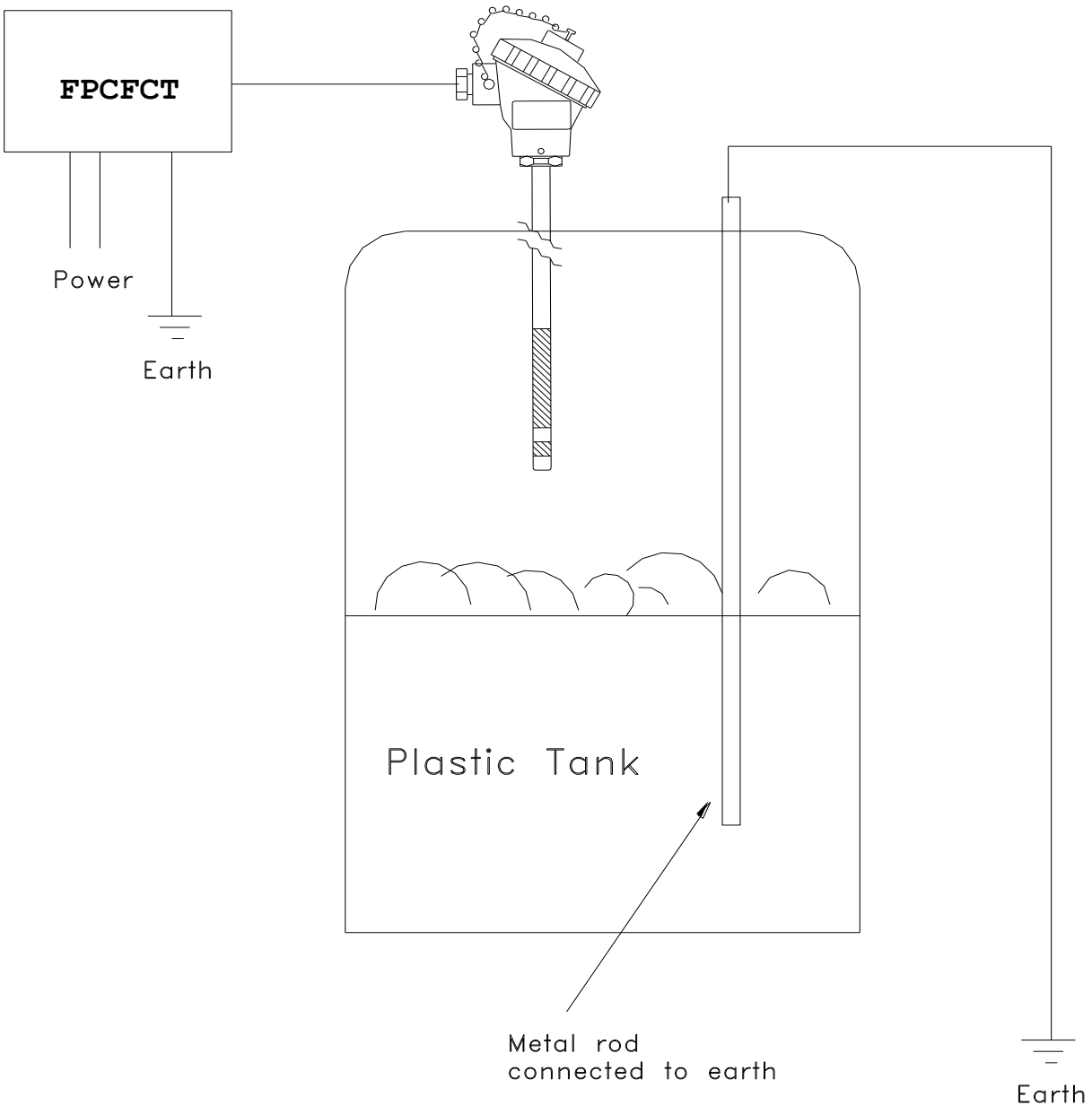
FOR LOCATION OF SWITCH SEE FIGURE F.

SWITCHES ARE ONLY READ AT POWER UP
(SWITCH POWER OFF AND ON AFTER SWITCHES ARE CHANGED)



Suggested cable 20 awg, 0.5 sq mm, screened twisted pair
e.g. Belden 8760, R.S. 528-5234

Figure Q Optimum Cabling Scheme



When using a plastic tank it is necessary to use a metal electrode or pipe connected to eartth (ground) to supply a siganl return path.

Figure R Connections in Plastic Tank