DIFOAM SENSORS & CONTROLLERS

In Hazardous Areas

INSTALLATION AND OPERATION MANUAL

Version: 1.6

Includes: Controllers FDCW2BY, FDCW2CY
Sensors type FD601-, FD602-, FD605- etc.

Hycontrol Limited, Larchwood House, Orchard Street, Redditch, Worcestershire, B98 7DP, U.K.

Tel: +44 (0)1527 406800. Fax: +44 (0)1527 406810 email: sales@hycontrol.com

CONTENTS

FIGURES

SPECIFICATIONS

Power Supply :	230 V ac, / 24Vdc (FDCW2CY) , 0.3A 115 V ac, / 24Vdc (FDCW2BY), 0.3 A
Outputs :	Relay 1 – Dosing Control (volt-free change-over contacts) Relay 2 – Foam Detect (Volt-free change over contacts) 240 V a.c. / 30 V d.c. 2 A max. 4-20 mA continuous o/p
Indicators :	Power indicator - Green Sense indicator - Red On when foam is initially detected. Activate indicator - Yellow On when foam is detected continually for response time.
Adjustments :	Delay Time 0 - 30 seconds Dose Time 0 - 30 seconds Relay Trigger adjustment 20, 40, 60, 80% of range Fail Safe Mode - off or on Sensitivity adjust 16 selectable options
Enclosure:	IP65, Polystyrene with polycarbonate lid 240 wide x 220 height x 115 depth mm Colour Grey (Ral 7035) Connections: screw terminals.
Sensor Cable:	CAT 5e to Belden 1633E (low attenuation)
Zener barriers:	MTL7760ac x1 & MTL7755ac x1
Error Codes:	All leds flashing in sequence – sensor not synchronising.
Zero Reference:	Must be set with sensor in operating position.

1. INTRODUCTION TO THE FDCW2BY & FDCW2CY

The Hycontrol DiFoam Controllers are advanced purpose designed Foam Controller units intended for materials that are non-conducting such as oils, resins and solvents. The controller will only function with a Hycontrol DiFoam Sensor to achieve the operation described. The principle parts of a system are as follows:

- Foam Sensor – DiFoam Type
- Interconnecting Cable
- Controller Unit – DiFoam type

There are a variety of sizes and styles of Foam Sensor. They are all designed for hygienic applications. The Controller can be used as a transmitter to signal to a process controller or alarm via volt free contacts or 4-20ma signal. They can also be used to control a local dosing pump or valve directly using a separate relay output.

Relay 1 is used to control a dosing function via an algorithm called shot and delay. It switches on and off to control a valve or pump etc. Relay 2 is activated when a material is sensed and stays on when the signal is above the trigger level, and can be used to switch an alarm to connect to a process controller or plc. An analogue output can be used to indicate level via a 4-20 mA signal, although this may be difficult to calibrate.

The Y option, at the end of the part no, refers to use in hazardous areas. The controller must only be installed in a safe area, while the sensor can be installed in a hazardous zone provided it is connected correctly with the correct type of zener barriers.

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

Note that the zero level of the system must be set-up as described in section 4.2 for the system to function correctly. The correct zener barriers must be used for hazardous areas.

2. PRINCIPLE OF OPERATION

The DiFoam Sensor operates by measuring the dielectric constant of the material being tested. The dielectric constant of air is 1 by definition and all other materials are higher than 1. The dielectric constant is measured by means of as high frequency signal from the sensor that is generated by an oscillator circuit in the sensor head. The sensor is extremely sensitive and can be used for materials that are normally very difficult to sense.

The controller energizes the sensor and measures the frequency of the signal. The signal from the sensor is used to determine how much foam or other material is present. The data is used to discriminate between foam and 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 (relays x2) and 4-20 mA.

3. INSTALLATION

3.1 Installing The Sensor

The Hycontrol DiFoam Sensor should be installed in such a way that the sensing electrode is positioned at the point where foam is required to be detected. 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 content. For example, if varying liquid heights are likely, ensure that the DiFoam Sensor is high enough to be always above the liquid surface, unless it is required 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 be connected properly: see 3.4 below.

It is essential that the sensor is connected via zener barriers in the proscribed way using an appropriate cable type (see 3.4 below) for the system to be safe.

3.2 Installing the Controller

The FDCW2BY / FDCW2CY controller must be installed in a safe area and connected via zener barriers as shown in figure P below.

The DiFoam Controller is designed to be fastened to a wall or other permanent structure, in a safe area. It can be attached in one of two ways. There are two mounting brackets at the top corners and two mounting holes at the bottom on each side under the terminal cover. If the mounting brackets are inconvenient for any reason they can be removed and the top of the unit can be fixed to the wall at the top by means of a small fixing in the back of the unit in the centre. Refer to Figure I.

To connect cabling, remove any blanking plugs in the glands at the bottom of the enclosure and insert the cables. *Blanking plugs should be fitted to unused cable glands to maintain the IP65 rating and to prevent the ingress of moisture and dust.* Access to the terminals is via the small terminal compartment at the bottom of the unit. Ensure that suitable cable is used to provide the power connection that meets local regulations.

The FDCW2BY controller can be operated at 110V ac or 24V dc and the FDCW2CY at 230Vac or 24Vdc. The unit is shipped for use at the required voltage and marked accordingly. *Ensure that the unit is powered with the correct supply*. If another supply is required than the one set please contact the supplier. For connections, refer to figures E and F. Ensure that appropriate cable is used for the connections.

3.3 Sensor Cabling

Due to the sensitivity required it is essential that an appropriate cable is used to connect the signal from the sensor. This should be a CAT 5e type cable to Belden 1633E which has a low attenuation of the signal. The same cable carries the energising supply for the sensor.

The connections are shown for the sensor head in figure J.

The sensor must be connected via two zener barriers (see fig P) if it is used in a hazardous area. It is absolutely essential for the zener barrier to be connected to a clean earth / ground to ensure safety of the system. In addition there should be a suitable ground connection between the vessel and the barrier to ensure that there is no potential difference between the ground at the vessel and the ground at the barrier. This is referred to as an "isopotential earth connection"

It is essential that an earth return be 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 to the vessel. If a non-conducting vessel is used, it is important that an earth connection be made to the contents. This can be usually be done via a metal pipe or flange on the vessel. However it may be necessary in some applications to install another electrode immersed in the liquid and connected to the instrument earth.

If the sensor is not connected correctly, the three lights on the controller flash in sequence. This indicates that the sensor signal is not being received correctly.

When the controller is receiving the correct signal from the sensor the green indicator will be continuously on. If the green light is flashing, the controller is in zero-setting mode (see section 4.2 for details). It is necessary to zero the sensor after installation. (see section 4.2)

Note: The terms "ground" and "earth" are used interchangeably in this manual. In the UK the term "earth" is generally used while in the USA the term "ground" refers to the same thing.

3.4 Output Cabling

The available outputs are volt-free change over contacts and a 4-20mA signal. The volt-free contacts can be used to switch a low voltage signal such as 24Vdc or can be used to switch power to an actuator such as a valve or pump. In either case it is necessary to use cable of a suitable rating.

The analogue output is powered from the controller, is not isolated, and is referred to ground potential. Care must be taken to connect this signal only to a passive input which returns to zero volts. If in doubt use a separate galvanic isolator on the output of the DiFoam controller. See figure F for the connections.

4. COMMISSIONING

4.1 Self Test

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 and the controller is synchronised with the sensor correctly. If the self-test fails all the front panel lights will flash indicating that there is a failure. If the sensor is not communicating correctly with the controller, then the three lights will flash in sequence. This may happen initially as the sensor must be zeroed to work correctly. (see 4.2 below). If this still happens after zeroing then check the sensor cabling.

4.2 Setting Up Zero Level

The zero level of the instrument should be set up first but only after the sensor is installed in its normal working position. This must be done in the following way:

1. Allow the conditions of the vessel to settle. If the process operates at a high temperature, then this should be reached before attempting to set the zero level.
2. Switch off the controller and set the DIP switch SW4-8 to ON. See figure H for details of the position of the switch.
3. Switch on the controller. The green light will start to flash; relay 2 will be active (energised or not according to the failsafe setting) and the 4-20mA output will be set at 4mA.
4. After 2 minutes, a reading will be taken to establish the zero level. The green light will go off and the red and yellow light will start flashing alternately. Also, relay 2 will be de-energised (or energised if in failsafe mode) and the 4-20mA output will go to 20mA.
5. Switch off the controller and set the DIP switch SW4-8 back to OFF.
6. Switch on the controller. It will now operate as normal using the new zero level.

4.3 Sensitivity

It will be necessary to adjust the unit for the particular application. To make a simple initial test that the unit is operating correctly make touch the end of the Sensor with your hand or a metal rod. The red "sense" light on the panel should switch on, and after the delay time the yellow light should switch on and stay on. Check that the output connects through to the process controller or other device and that the correct channel has been used. When the connection is removed the red and yellow lights should switch off. It is important that the complete measuring chain is tested back to the process controller if appropriate, 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 that is to be sensed. Ideally, if foam can be generated for a test, then the unit should be tested with foam in the vessel. If the controller does not trigger when foam is present, then increase the sensitivity slightly and try again. See section 5.2 to adjust the sensitivity.

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.

4.4 Delay Time

The delay time is a set period after foam is first detected before the output is activated. This is designed to give some discrimination against splashing and other interference. This is set to 4 seconds by default. However it can be adjusted to suit the application. For example in vacuum process foam can develop very quickly and a shorter delay time may be required. See section 5.3 for details of how to adjust this parameter.

4.5 Shot Time

The shot time is the time for which the output remains activated. It is part of the overall shot/delay algorithm which is designed to trigger an antifoam pump to best effect. The shot time is set to a default value 4 seconds in the factory. If the controller is not switching a pump then the shot/delay function may be best be switched off. This can be done by switching the shot time to zero. Refer to section 5.4 for more details of making adjustments to the shot time.

4.6 Failsafe/Default Modes of Operation

The relays can be set to be powered up or down in the normal state. This provides 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.

a) Default Mode: The instrument assumes a normal condition in which foam is not detected.
i.e. Relay 1 normal, Relay 2 normal.
The relays are powered *down* when foam is *not* present.

b) Failsafe Mode: The instrument assumes an alarm condition in which foam is detected.
i.e. Relay 1 alarm, Relay 2 dose.
The relays are powered *down* when foam *is present*.

(Please note that all the diagrams are drawn to show the default mode with no foam present.)

This function is set by SW2 : 8 as follows:

SW2 : 8	Off :	Default mode
	On :	Failsafe mode

See Figure H for location of switch.

4.7 Analogue Output

The analogue output can be used to indicate the level of foam or liquid or other material under test. The output is in the range 4-20 mA. If a voltage output is required, this can be achieved by connecting a suitable resistor across the output terminals. The instrument is an active device and does not need an external power supply for the current output.

To set the output scaling, see section 5.5 Range Setting below.

5. OPERATION OF THE DIELECTRIC CONTROLLERS

5.1 Making Adjustments

The following adjustments are provided for the operator:

Delay time	- 3 internal DIL switches
Shot time	- 3 internal DIL switches
4-20mA Range	- 2 internal DIL switches
Sensitivity	- 4 internal DIL switches
Zero setting Switch	- 1 internal DIL switch
Failsafe mode	- 1 internal DIL switch

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 FDiCR/Z remove it from the rack. The location of the switches is shown in figure G.

In the case of the FDiCW/Z open the front cover by pushing in the latch on the left side, then remove the four screws securing the front panel. Then carefully remove the front panel from the enclosure and put to one side in a safe place. This gives access to the control board. The location of adjustment switches is shown in figure H. After adjustment replace the front panel being careful to ease the LEDs into the window recesses behind the panel. *Take care not to put pressure onto the LEDs if the panel is not located properly as this may cause damage.* 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 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. The sensitivity is set by means of 4 small switches on the detector board. The settings are shown in figure B. The location of the switches is shown in figures G and H. 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. The range setting changes the level at which the unit triggers the dosing and the alarm state. It also affects the 4-20 mA output.

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 dielectric constant.

5.3 Delay Time (Response Time)

The delay time switch is used to set the response 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 detector 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. The switch is located near the top edge of the board and is shown in Figures G and H. 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. This does not affect the 4-20 mA output.

5.4 Shot Time (Dose Time)

The shot time is part of the dosing function, which is used as part of a feedback loop to control a process. This can be used for example to control level or to add a chemical such as an antifoam or defoamer. The shot time is the time for which relay 1 is activated. The settings for this are shown in Figure A.

5.5 Analogue output - 4-20mA Range Setting

The range is set principally by the sensitivity setting described in section 5.2 above. This sets the point at which foam is recognized as being present. The 4-20mA output will change if the sensitivity is adjusted. The 4-20mA is moved around the trigger point by the range setting shown in Figure C below. This moves the 4-20mA range above or below the trigger setting, at which the volt-free contacts operate. This can be a bit confusing at first.

The options are as follows:

Trigger Levels: 20%, 40% (default), 60%, 80% of range.

The default value at which the unit switches to indicate foam is 40%. Most applications use the continuous 4-20 mA output or the relay output so usually the trigger level can be left at 40% and the sensitivity adjusted to suit the application. However if the output is switching ok but the analogue output is not large enough then move then increase the Trigger Level % setting. Alternatively if the analogue output reaches 20mA and the foam is still rising the Trigger Level % can be decreased. (See figure C)

FIGURE A - DETECTOR DELAY AND SHOT TIME SETTINGS

	DELAY (Secs)	SWITCH 1	SWITCH 2	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 >	0	OFF	OFF	OFF

	SHOT (Secs)	SWITCH 5	SWITCH 6	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 SW4 DIL SWITCH ON THE BOARD, FOR LOCATION SEE FIGURE H.
SWITCHES ARE ONLY READ AT POWER UP - SWITCH POWER OFF TO CHANGE SETTINGS

FIGURE B –RANGE SETTINGS

	RANGE	SWITCH SW2: 1	SWITCH SW2: 2	SWITCH SW2: 3	SWITCH SW2: 4
Most Sensitive >	16	ON	ON	ON	ON
	15	OFF	ON	ON	ON
	14	ON	OFF	ON	ON
	13	OFF	OFF	ON	ON
Default >	12	ON	ON	OFF	ON
	11	OFF	ON	OFF	ON
	10	ON	OFF	OFF	ON
	9	OFF	OFF	OFF	ON
	8	ON	ON	ON	OFF
	7	OFF	ON	ON	OFF
	6	ON	OFF	ON	OFF
	5	OFF	OFF	ON	OFF
	4	ON	ON	OFF	OFF
	3	OFF	ON	OFF	OFF
	2	ON	OFF	OFF	OFF
Least Sensitive >	1	OFF	OFF	OFF	OFF

Adjust by means of SW2: 1-4 for location see Figures G and H

To make the controller more sensitive to material set the range to a larger number.

To reduce the risk of false triggers do not set the sensitivity higher than required for the application. Power up after adjusting switches.

FIGURE C – 4-20mA RANGE

Trigger Level %	SWITCH SW2: 5	SWITCH SW2: 6
20	OFF	OFF
40 Default	ON	OFF
60	OFF	ON
80	ON	ON

The trigger is the percentage of the output range at which the relays trigger to the alarm state. For example at the default 40% setting the relays trigger to foam at 40% of the analogue output range i.e. at 10.4 mA on the 4-20 mA range. This does not affect the sensitivity and the level at which the relays trigger: it only sets the 4-20mA output. See section 5.5 for description.

Adjust by means of SW2: 5 & 6. See figures H for location of switches.

To increase the 4-20mA output for a given sensitivity setting, increase the Trigger Level % shown above.

FIGURE E - CONNECTIONS TO DiFOAM CONTROLLERS

TERMINAL	DESCRIPTION
1	Line Supply – LIVE (115/230 V a.c.)
2	Line Return – NEUTRAL
3	Supply Ground / EARTH
4	D.C. Supply 24 V +ve
5	D.C. Supply 0 V
6	Return
7	No Connection
8	No Connection
9	No Connection
10	Relay 1/A Common.
11	Relay 1/A Normally Open
12	Relay 1/A Normally Closed
13	Relay 1/B Common
14	Relay 1/B Normally Open
15	Relay 1/B Normally Closed
16	Relay 2 Common. (optional)
17	Relay 2 Normally Open (optional)
18	Relay 2 Normally Closed (optional)
19	4-20 mA +ve
20	4-20 mA –ve (0 V d.c.)
21	Manual Switch
22	Manual Switch.
23	Spare
24	Screen
25	Supply return (Orange/White wire)
26	Sensor supply (Orange wire)
27	Sensor O/P (Brown wire)
28	Sensor Return (Brown/white wire)

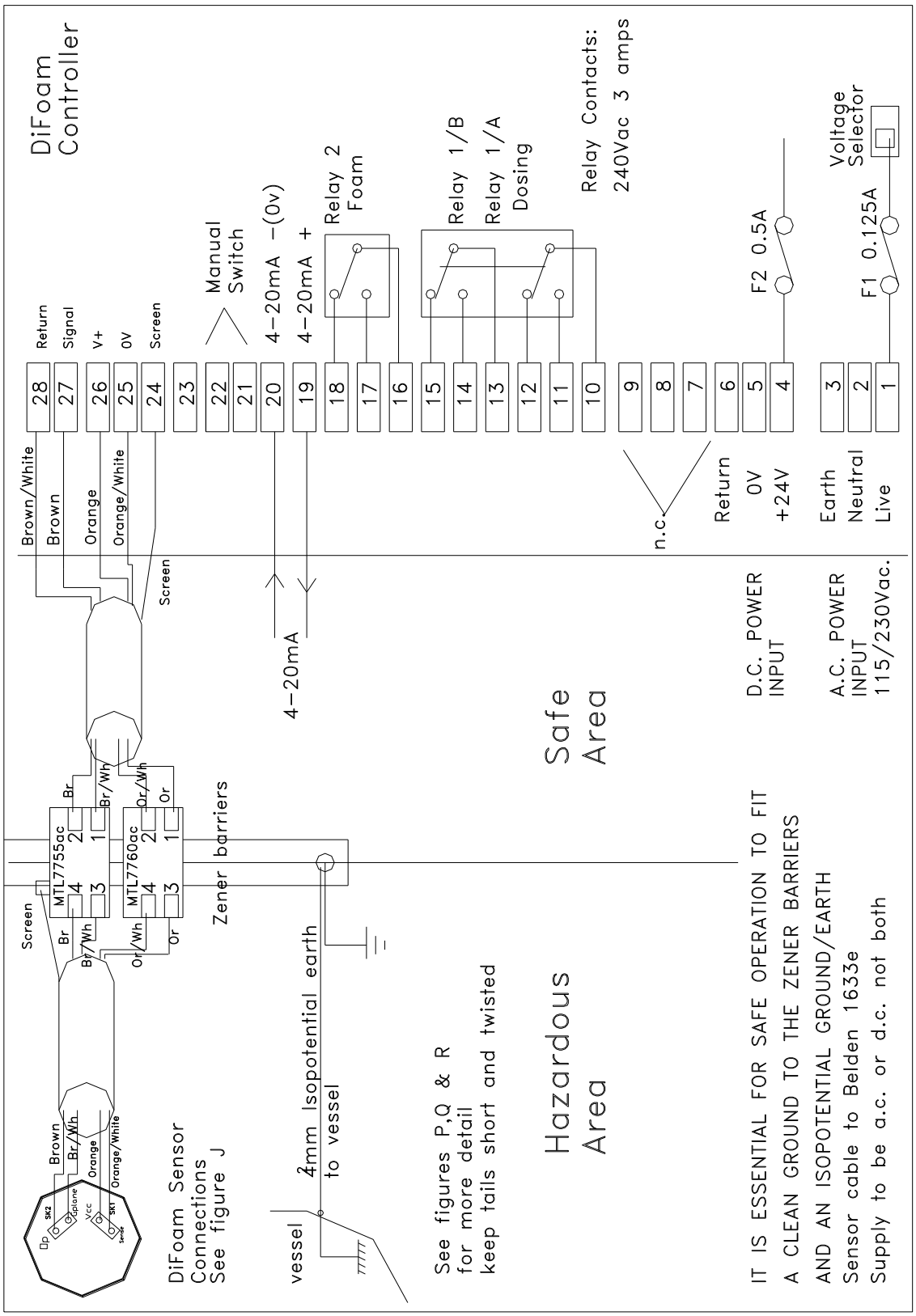


Figure F Cabling DIFOAM CONTROLLERS FOR HAZARDOUS AREA USE

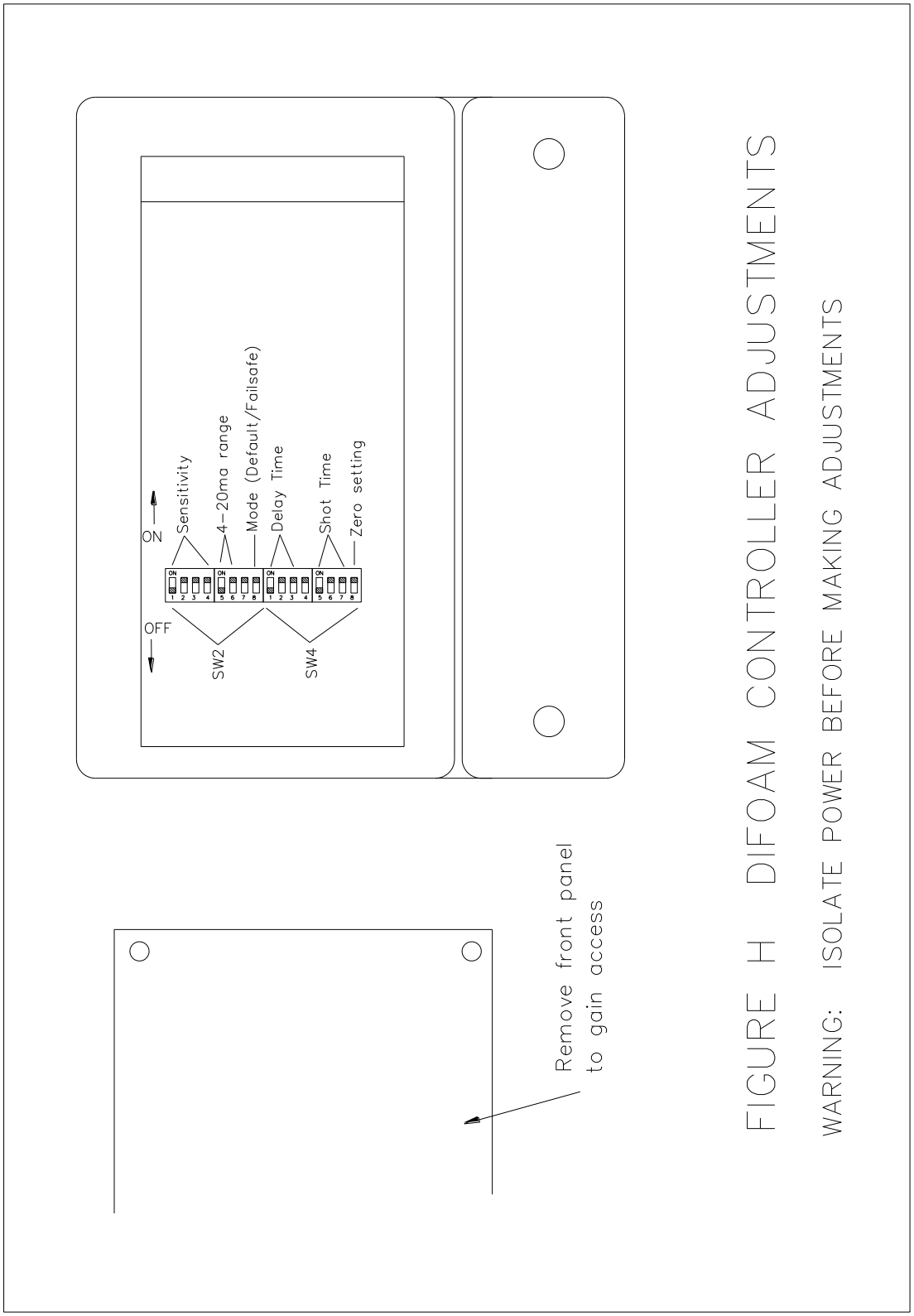


FIGURE H DIFOAM CONTROLLER ADJUSTMENTS
WARNING: ISOLATE POWER BEFORE MAKING ADJUSTMENTS
Remove front panel to gain access
ON
OFF
Sensitivity
4-20ma range
Mode (Default/Failsafe)
Delay Time
Shot Time
Zero setting
SW2
SW4

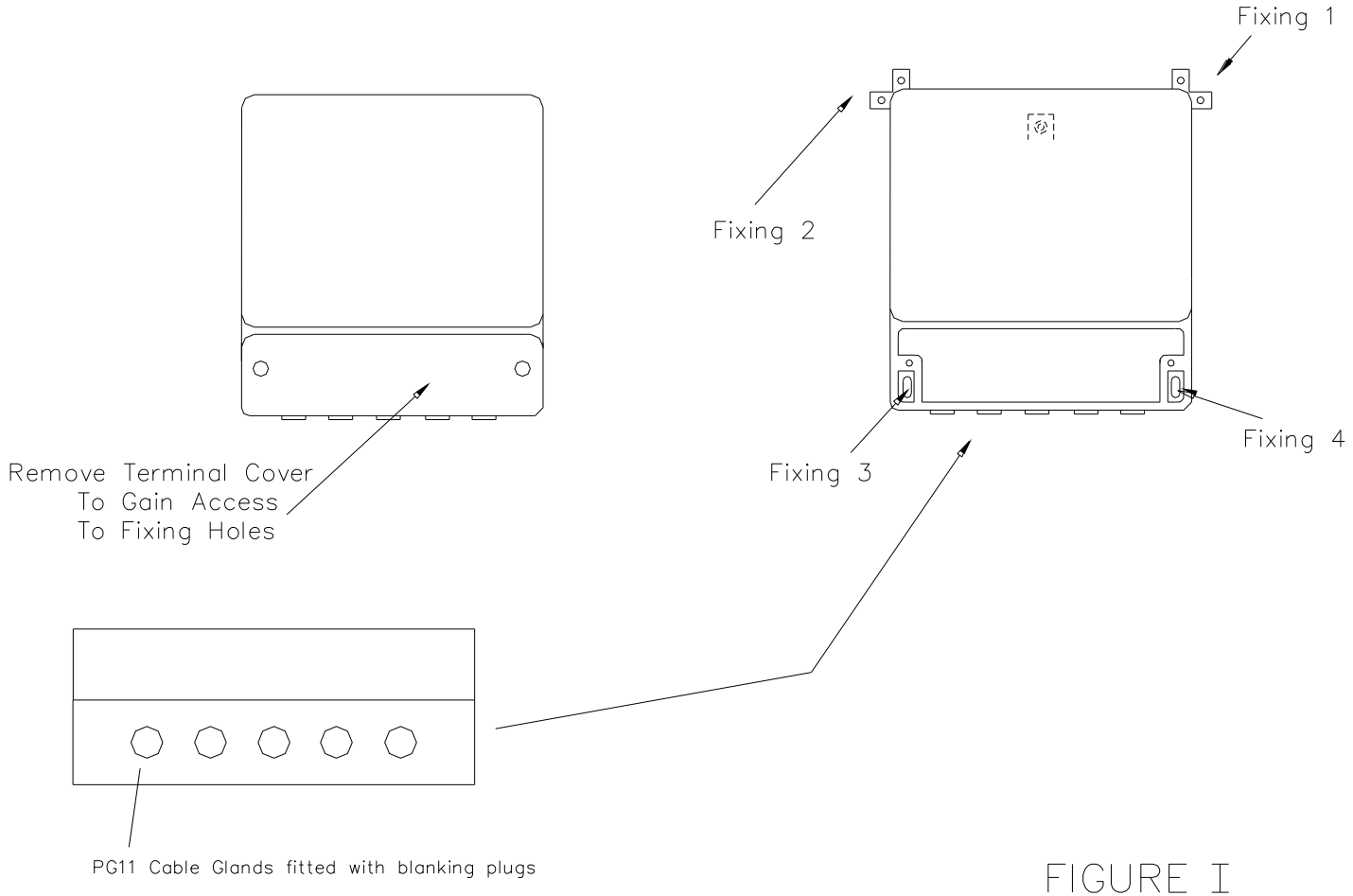


FIGURE I

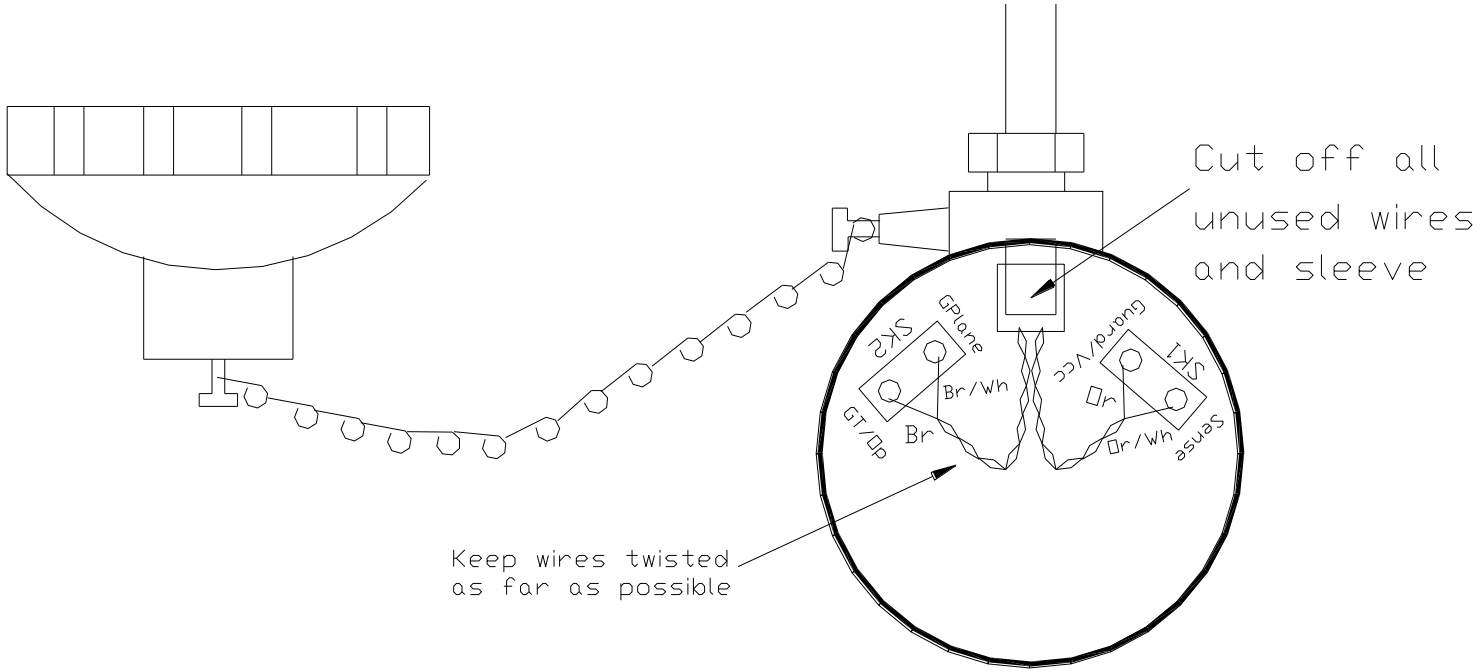
FITTING OF WALL MOUNT UNITS

Remove blanking plugs from cable glands where required.

Finally ensure terminal cover is replaced securely.

Terminal	Function	Wire Colour
Op	Sensor o/p	Brown
GPlane	Signal gnd	Brown/White
Vcc	Sensor Supply	Orange
Sense	Supply Return	Orange/White

Ensure Cover is correctly replaced
Do not cross thread



Use only low attenuation CAT5 cable e.g. Belden 1633e

FIGURE J DFOAM SENSOR CONNECTIONS

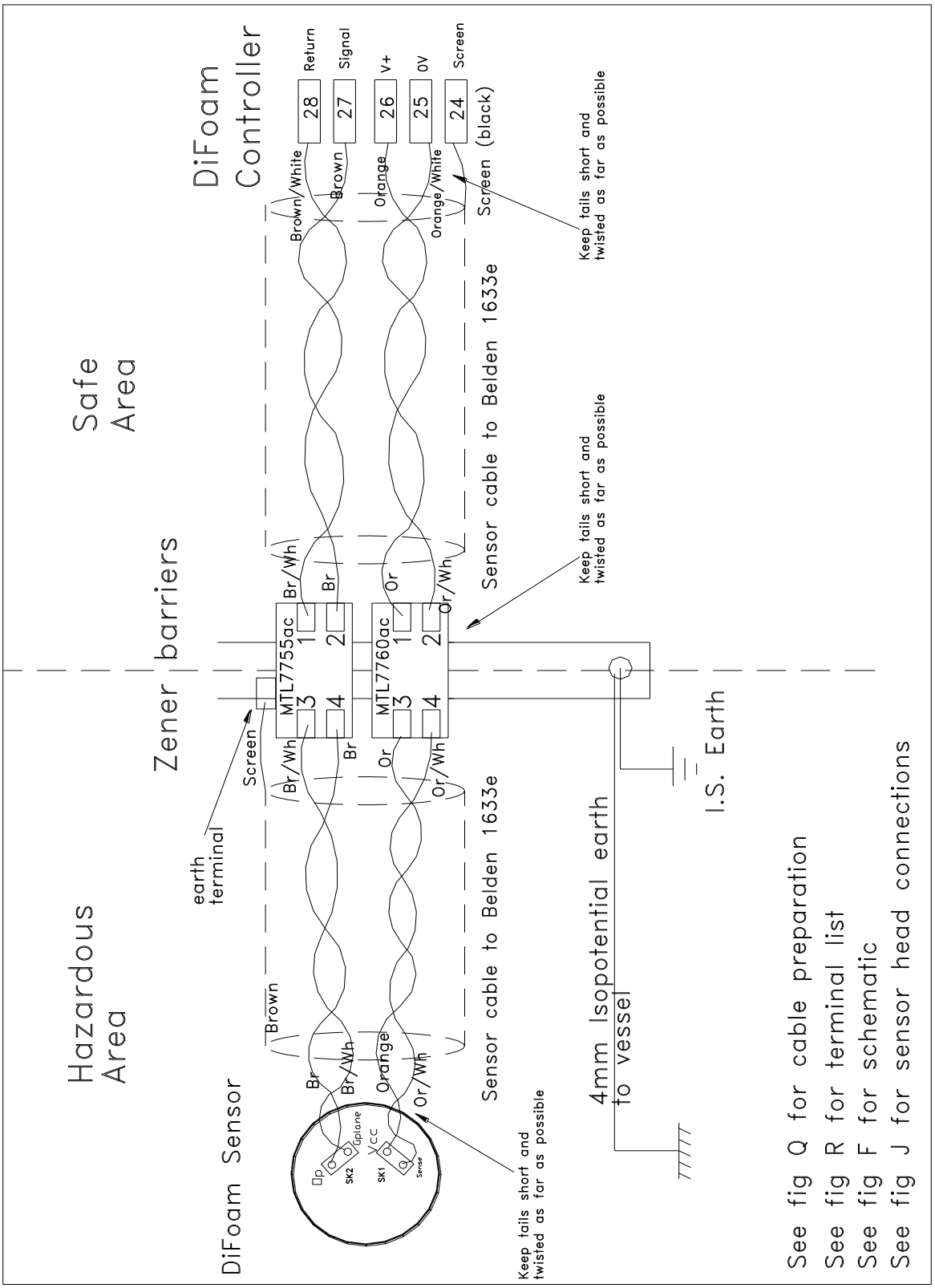


Figure P Sensor Cabling Connections

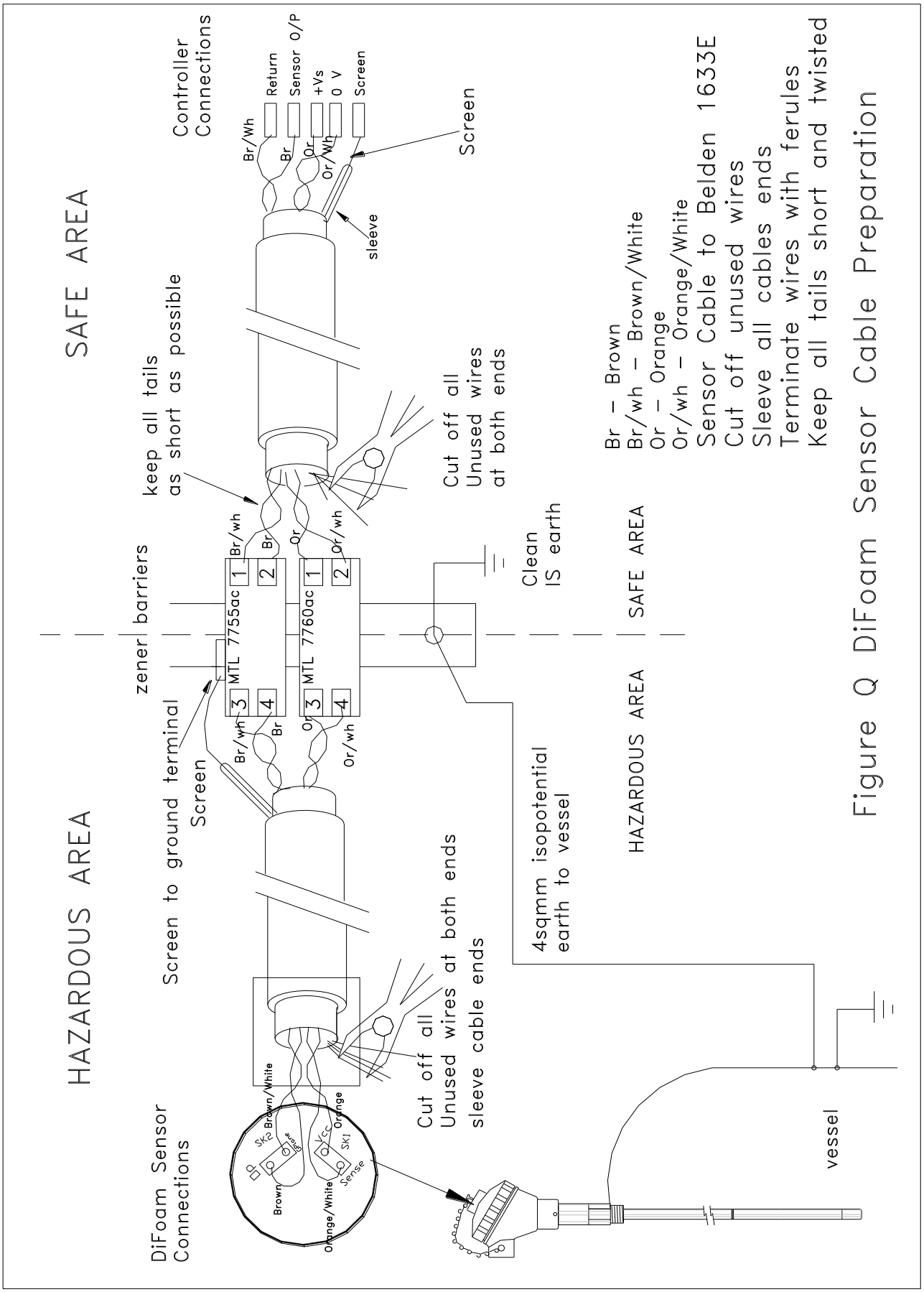


Figure Q DiFoam Sensor Cable Preparation

Figure R - Connections

Sensor Terminal	Barrier Haz Area Terminal	Barrier Safe Area Terminal	Controller Terminal	Wire Colour
Op	MTL7755ac Term 4	MTL7755ac Term 2	Aux In Sensor o/p	Brown
GPlane	MTL7755ac Term 3	MTL7755ac Term 1	Aux Return Sensor ret	Brown/White
Vcc	MTL7760ac Term 3	MTL7760ac Term 1	Sensor Supply V+	Orange
Sense	MTL7760ac Term 4	MTL7760ac Term 2	Sensor Supply Return Ov	Orange/White