

GDS2010

SERIES

MODULAR GAS ALARM

OPERATING HANDBOOK

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SYSTEM DATA

Manufacture date: -		Works Order No:-	
Sensor type: -	life:	life:	life:
Gas: -			
Range: -			
Low alarm trip: -			
High alarm trip: -			
Details: -			

DESCRIPTION

The GDS 2010 has been designed with features that will provide an effective response to the detection and control of hazards in a wide range of industrial environments from boiler rooms to offshore petrochemical installations.

The system is offered in a wide range of enclosures, from single module din rail mounting to multi-channel interconnected 19" rack based tower systems of unlimited size.

Each alarm module operates independently having alarm status indicators, sounder and three alarm levels with individual relays for the control of remote safety systems. 4~20mA or 1~10v outputs are available for use in proportional control systems such as speed control of extractor fans.

Common alarm relays and indicators are available via an optional facilities module which can be plugged into any available module socket on the system. The facilities module can also be used remotely as a control and status indicator panel, having built-in sounder with sounder accept and alarm reset functions.

The advanced features designed into the GDS 2010 system ensure ease of maintenance and provide the highest integrity rating, with the minimum loss of sensor cover should a fault condition occur.

COMBUSTIBLE GAS CARD

When connected to a suitable power supply and sensor this unit becomes a single channel monitor being fully equipped with:-

- 1 Meter - indication of gas concentration
- 2 Power ON indicator
- 3 Alarm 1, 2 and 3 indicators (Low, High, Overrange) - latched or unlatched, energised or de-energised option.
- 4 Fault indicator
- 5 Alarm relays
- 6 Alarm sounder
- 7 Analogue output signal 4~20mA - optional 1~10v
- 8 Alarm Accept/Reset switch
- 9 Inhibit switch with indicator to disable Alarm relays
- 10 System test switch
- 11 Zero and calibration adjustments

TOXIC GAS CARD

Similar to the Combustible Gas Card but having the input circuit configured to function with a 4~20mA input from a sensor device.

Common facilities card (optional)

Is used in multi-channel systems to provide alarm outputs which are common to all cards within the same enclosure, and may be inserted into any slot within the enclosure.

The facilities card collects alarm information from all the connected cards and provides common alarm functions as follows:

- 1 Low alarm indicator
- 2 Low alarm relay
- 3 High alarm indicator
- 4 High alarm relay
- 5 Overrange alarm indicator
- 6 Overrange alarm relay
- 7 Fault alarm indicator
- 8 Fault alarm relay
- 9 Common alarm sounder
- 10 Common accept/reset switch
- 11 Power ON indicator

TERMINAL MOTHER BOARD

Houses the field terminals for the connection of external equipment i.e. sensor, shut-off valves, mimic panels etc.. Also in multi-channel systems is used to connect the various alarm and facilities cards together.

INSTRUMENT ENCLOSURE

A standard 19" wide rack houses up to 14 cards, various types of enclosure being available to suit the users requirements, from single to multiples of 14.

ALARM INDICATORS

Red L.E.D.'s flashing - steady when accepted.

Three levels Low (Lo), High (Hi) and Overrange (Or) adjustable between 5% and 100% F.S.

FAULT ALARM INDICATOR

Amber L.E.D.

Initiated in the event of a sensor cable fault (short or open circuit), control circuit malfunction.

ALARM RESET

Alarm circuits can only be reset when the hazard has cleared.

SYSTEM ELECTRICAL TEST

The unit may be electrically tested by pressing the test pad for 15 seconds after which the alarm indicators and sounder will activate intermittently, maintaining pressure on the pad for a further 15 seconds will result in constant indicators and activation of alarm relays (full system test).

To ensure that the system responds correctly to the presence of gas, the sensor should be exposed to test gas. It is advisable to carry out this test at six monthly intervals.

ALARM INHIBIT DELAY

From the application of power a period of 60 seconds applies during which alarm relays and indicators are held in the normal operating condition (inhibited). This period is indicated by the green power on indicator flashing and allows for sensor stabilisation.

ALARM RELAY INHIBIT

During servicing alarm relays may be isolated by pressing the reset pad for 15 seconds after which the inhibit indicator will come on indicating inhibit mode, to remove inhibit press the reset pad for 15 seconds the inhibit indicator will turn off.

POWER ON INDICATOR

Green L.E.D. – power on flashing, constant after 60 seconds.

ANALOGUE OUTPUT

4-20mA into 250 ohms max. load.

Optional 1~10V output

Technical specification

All relay contacts used to switch inductive loads (relays etc) should have suppressors fitted, typical device Farnell 772-756

POWER REQUIREMENTS

DC 24v (nominal) operating range 21 to 32v.

AC 110, 230± 6% 50 Hz.

POWER CONSUMPTION

2.5w per module (normal operating condition).

5W per module (full alarm condition).

SENSOR CURRENT

150 to 550mA adjustable constant current drive (no field adjustment required).

SENSOR CABLE

Catalytic - 3 core 1.5mm - screened, M.I.C.C., S.W.A. maximum cable loop resistance 20 ohms

Toxic/Oxygen (4~20mA) - 3 core 0.5mm screened, M.I.C.C., S.W.A. maximum cable loop resistance 200 ohms

TERMINALS

Screw type accepting up to 2.5mm cable.

RELAY OUTPUTS

All relay contacts used to switch inductive loads (relays etc) should have suppressors fitted. Typical device Farnell 772-756

ALARM CARD

Alarm – Low	}	Latched or auto-reset	S.P.C.O. N/D or N/E	}	Factory set N/D - latched
Alarm – High			S.P.C.O. N/D or N/E		
Fault Alarm			S.P.C.O. N/D or N/E		

All contacts rated at 5A/230v AC.

FACILITIES CARD

Common Alarm - Low	}	Latched or auto reset	S.P.C.O. N/D or N/E	}	Factory set N/D - latched
Common Alarm – High			S.P.C.O. N/D or N/E		
Overrange Alarm			S.P.C.O. N/D or N/E		
Fault Alarm			S.P.C.O. N/D or N/E		

Analogue Output 4~20 mA into 250 ohms max load. Optional 0~10v

ENVIRONMENTAL

CE Cert. No.	C587
Ambient Operation Temp	0-50 degrees centigrade
Storage temperature	-20 degrees to + 60 degrees centigrade
Humidity range	0-90% RH

DIMENSIONS

Alarm and Facilities Module - 3U high - 6E wide - 160mm deep.

Installation

The GDS 2010 Series control instrumentation is designed for installation in a safe area only. Siting of the instrument should be chosen with regard to the following points:

- (a) Away from sources of local heat and with room for adequate ventilation.
- (b) Within easy reach and audible distance of operating personnel.
- (c) Convenient to a separately fused power supply.
- (d) Incoming sensor cables and outgoing alarm annunciation.
- (e) Sensor cables to be electrically shielded i.e. M.I.C.C., steel wire armoured, screened cable - 3 core 1.5mm.

To prevent any effect from earth currents the cable shielding should be grounded at one end only.

The instrumentation should be subjected to a minimum of vibration and shock.

Ascertain the voltage rating of the power supply to which the instrument will be connected.

SITING THE SENSING HEADS

A key feature of the installation is the correct siting of the sensing head. Several considerations must be taken into account, the most important being the density of the gas.

Density (air = 1)

Acetone	2.0	n-Hexane	3.0
Ammonia	0.6	Hydrogen	0.1
Benzene.....	2.8	Methane	0.6
n-Butane	2.0	n-Octane	3.9
Carbon monoxide	1.0	n-Pentane	2.5
Ethane	1.0	n-Propane	1.6
Ethyl alcohol	1.6	Town gas	0.4-0.7
n-Heptane	3.5	Xylene	3.7

Under still air conditions, a 'lighter than air' gas such as methane leaking from a small orifice at ground level, will rise in a plume the shape of which approximates an inverted cone. As the gas rises, it draws air from the surroundings and creates a turbulence. Resulting from this there occurs rapid dilution and, unless a sensor is positioned within the plume, there will be no initial indication of a leak.

As gas continues to escape, the diluted concentration rises to ceiling level and begins to layer. In time the concentration at ceiling level will increase and this, in turn, will displace air downwards.

Dangerous levels will, therefore, tend to occur at ceiling level and the thickness of this layer will increase with the passage of time.

* When installing apparatus in explosive atmosphere (hazardous areas), you must be aware of the requirements of BSEN60079, BSEN50014, IEC61241.

Ventilation of the room will of course alter the situation significantly but it should be remembered that if the ventilator is not at ceiling level, a dangerous concentration can still occur between the top of the ventilator and the ceiling.

For heavier than air gases such as propane or butane, the formation of dangerous layers occurs at ground level. These gases tend to behave like water and will run down gradients and pool at the lowest point.

The number of heads required in individual rooms is determined by the number of possible hazards in the vicinity.

Gas leakage may occur around valves, flanges and anywhere where gas pipes are jointed. It may be possible to cover several probable gas leaks in one room by the careful siting of a single head. Cable ducts, trenches and manholes are also likely places where a build up of heavy gases may collect.

When siting a head in such places it is most important to ensure that there is no likelihood of flooding by water, or excessive dust which may block the sintered disc and prevent gas reaching the sensor.

When monitoring gases outside, those lighter than air will be quickly dispersed, but gases heavier than air will tend to form in layers and again cause a dangerous hazard. When siting heads outside prevailing winds must be taken into consideration and adequate protection given against wind and rain.

POISONING OF CATALYTIC SENSORS

Catalytic elements used in flammable gas sensors are liable to be rendered inactive due to 'poisoning' by certain groups of compounds.

In general contact with any gaseous compound capable of producing an involatile residue upon heating is to be avoided.

Examples of such substances are:

- a. Silicon containing vapours, as emitted by silicone polishes, greases and oils.
- b. Petroleum vapours containing tetra-ethyl lead or other organo-metallic compounds.
- c. Phosphorus in the form of phosphate esters.

These compounds will permanently affect the detector and if their presence is suspected the response of the detector should be determined by the calibration procedure.

It is also possible that the reaction of the detector to a flammable gas could be inhibited by halogen containing gases such as chloroform, carbon tetra chloride and trichloro-ethylene. this effect is not permanent.

Commissioning

GAS SENSORS

Before applying power to the instrument ensure that all detector heads are connected to the sensor terminals on the printed circuit board (fig 3).

Red	=	flammable
Yellow	=	toxic
Blue	=	oxygen
Green	=	others

Switch on power to the instrument.
Allow ten minutes for the sensors to stabilise.

CALIBRATION

Establish calibration figures with respect to the L.E.L. limit or the T.L.V. limit of the calibration gas being used. See page 13.

The following calibration gases are recommended:

Flammable gases 2.5% methane in air.

Toxic gases - T.L.V.

When using this gas ensure adequate ventilation.

If necessary zero each detector channel in clean air (for ambient oxygen monitoring the meter should be adjusted to read 20.8% using the s-span potentiometer).

Apply the calibration gas to the appropriate head at a flow rate of approximately 1 litre per minute.

When the METER reads a steady value adjust the Calibration Potentiometer to obtain the correct reading for the calibration gas being used.

Shut off the calibration gas.

CALIBRATION WHEN USING CV TRANSMITTER (4~20mA DEVICE)

Where a sensor CV transmitter has been supplied the setting up procedure as described on pages 17 or 18 should be followed.

Alarm level adjustment

The alarm level is factory set at the level stated on the instrument test certificate.

To adjust the gas alarm level.

- 1 For toxic/flammable gases zero the instrument in clean air using the zero potentiometer (for ambient oxygen monitoring the meter should be adjusted to read 20.8 using the calibration potentiometer).
- 2 Press the alarm set switch for approximately 5 seconds the sounder will bleep and the low alarm indicator will come on, the green power indicator will turn off, release the alarm switch.
- 3 Using the zero potentiometer adjust the digital display for the required low trip level reading, press the alarm set switch until the high alarm indicator comes on, release the alarm set switch.
- 4 Adjust the digital display to read the required high trip level reading and again press the alarm set switch, the overrange indicator will come on. Adjust the digital display to read the required overrange trip level. Press the alarm set switch again, all three alarm indicators will come on,
- 5 Zero digital display (toxic/flammable) or 20.8 for oxygen and press alarm set switch, alarm indicators will turn off and the green power indicator will turn on.

OPERATION

On power up the green power indicator will flash for 60 seconds indicating that the sensors are stabilising, during this period all alarms are held in the off condition.

After the stabilisation period any gas detected by the sensor will be indicated on the digital display with any alarm level being exceeded resulting in the sounder and appropriate red L.E.D and relay activating.

Pressing the reset pad will result in the sounder being silenced, alarm indicators and relay may only be reset when the indicated gas level has reduced to below that of the alarm trip points.

SENSOR SUPPLY ADJUSTMENTS (CATALYTIC SENSOR)

The sensor supply is factory set and requires no further adjustment, where adjustment is necessary the following procedure should be carried out. For ease of setting, measurements are taken across a 1 ohm resistor (located on the alarm card) which is connected in series with the supply to the detector head. Current required by each type of sensor is VQ21-300mA/VQ23DCP-335mA therefore measuring mV across the 1ohm resistor at test points TP5 (Ov) and TP7 will provide a mV reading proportional to mA's supplied. Adjustment may be carried out using potentiometer RV6 (sensor supply adjustment).

Alternatively the sensor voltage may be set at the detector head across terminal P and W (VQ21-2v/VQ23DCP-2.5v).

Service – routine attention

The owner or occupier of the premises should place the supervision of the system in the charge of a responsible executive whose duty it should be to ensure the day to day operation of the system and to lay down the procedure for dealing with a gas alarm or fault warning. To ensure reliability an agreement should be negotiated for regular servicing. When a service contract cannot be arranged an employee with suitable experience of electrical equipment should be trained to deal with the basic servicing and instructed not to attempt to exceed the scope of such training.

Liaison should be established with those responsible for maintenance of the building fabric or redecoration etc. to ensure that their work does not cause a fault or otherwise interfere with the operation of the gas alarm installation. Particular attention appertaining to the Detector Head.

The operating instructions should be kept available preferably with the control unit, all faults, service tests and routine attention given should be recorded.

DAILY: A check should be made that any fault condition which may be indicated is in fact being attended to and that all other indicators are normal.

WEEKLY: In plants involving a high risk process or having gases which may cause loss of sensitivity a check on calibration should be carried out.

TWICE YEARLY MAINTENANCE SCHEDULE

1. All zeros at the control unit to be checked, logged and aligned.
2. Each detector to be gas tested and reading logged (sensitivity checked).
3. Field indicators to be tested.
4. All alarm set points checked and re-aligned.
5. Lamp Test.
6. All faulty parts replaced where required.
7. All filter elements checked and replaced as necessary.
8. Power supply - complete functional check.
9. Visual inspection made to confirm that all cabling fitting and equipment is secure, undamaged and adequately protected.

ACTION TO BE TAKEN IF THE APPARATUS ALARM SOUNDS: -

- A Extinguish all naked flames, including all smoking materials.
- B Turn off all gas appliances.
- C Do not switch on or off any electrical lights or appliances.
- D Turn off the gas supply at the gas emergency control and/or (with L.P.G supply) the storage tank.
- E Open doors and windows to increase ventilation

If the alarm continues to operate, even after an alarm re-setting action where appropriate, and the cause of the leak is not apparent and/or cannot be corrected, vacate the premises and immediately notify the gas supplier and/or the gas emergency 24 hour service in order that the installation may be tested and made safe and any necessary repairs carried out.

FAX BACK SHEET SERVICE / MAINTENANCE PLAN 0113 287 8178

GDS Technologies can offer comprehensive maintenance & service cover on all of your gas detection systems. Should you require further details, please complete and fax / return this document for an immediate response.

Company Name

Company Address

Tel No.

Fax No

Site Location

(if different from above)

Contact Name

Product Type

(if known)

No. of Sensors

For telephone inquiries your contact is:- Julie Mitchell 0113 286 0166

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Table of lower explosive limits - L.E.L.

The figures quoted below are taken from British Standards Institute publication BS 5354 Part 1: 1976 and show the L.E.L. of some of the more common gases and vapours:

GAS	L.E.L. % VOLUME
Acetone	2.1
Ammonia	15.0
Benzene.....	1.2
n-Butane	1.5
Carbon monoxide.....	12.5
Ethylene	2.7
Heptane	1.1
Hexane	1.2
Hydrogen	4.0
Methane	5.0
Propane	2.0
Pentane.....	1.4
Toluene	1.2
Xylene	1.0

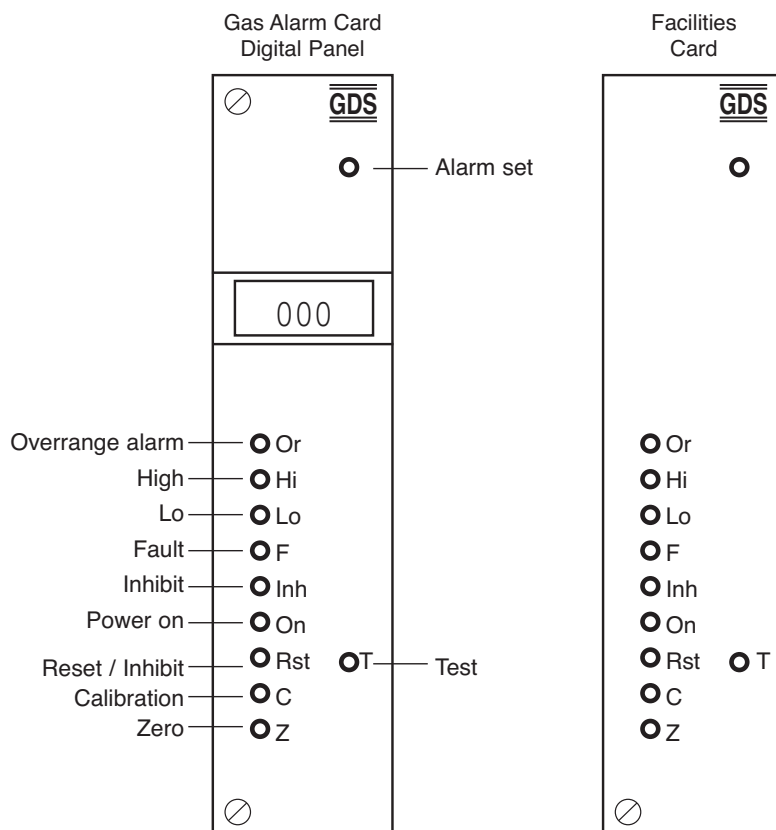
Table of occupational exposure limits - P.P.M.

The figures quoted below are taken from guidance note EH40 from the Health and Safety Executive.

GAS	8 HOUR - T.W.A. - P.P.M.
Hydrogen sulphide	5
Carbon monoxide	30
Sulphur dioxide	2
Nitrogen monoxide	25
Nitrogen dioxide	3
Chlorine	0.5
Ammonia.....	25
Ozone	0.1
Ethylene oxide	5

Fig 1

Module Detail



Rack Detail

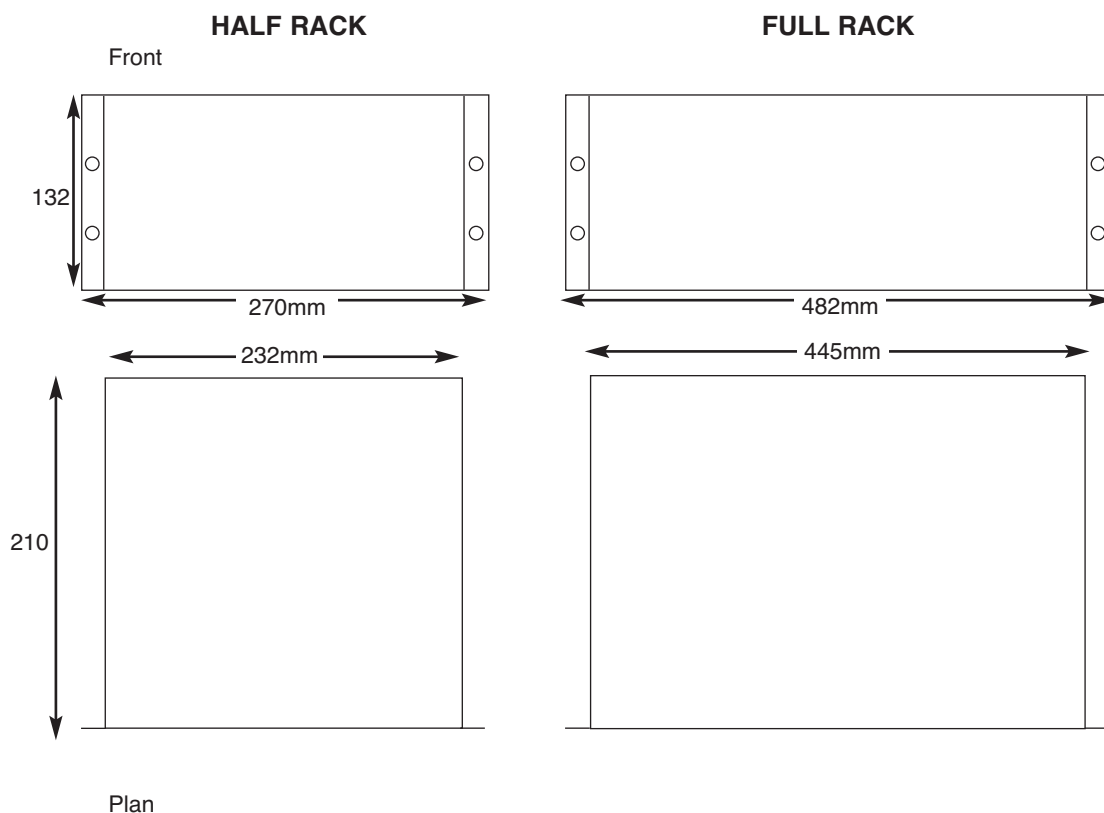
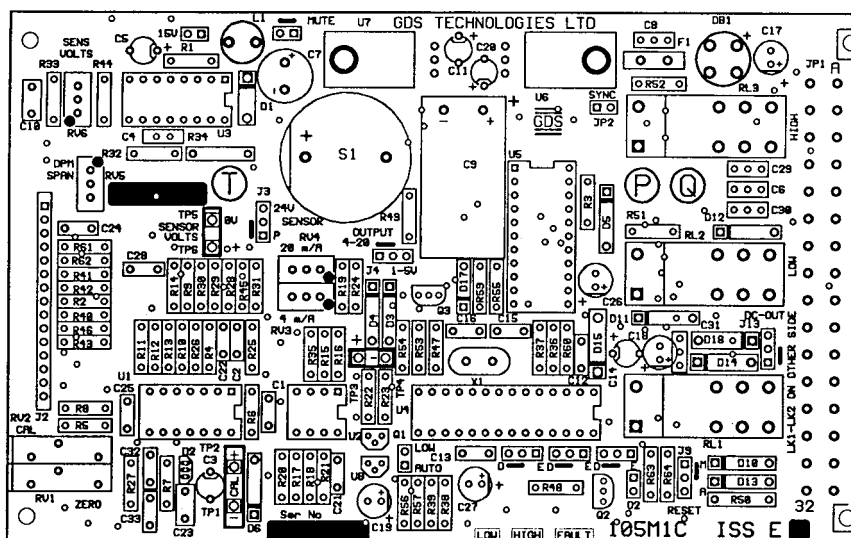


Fig 2

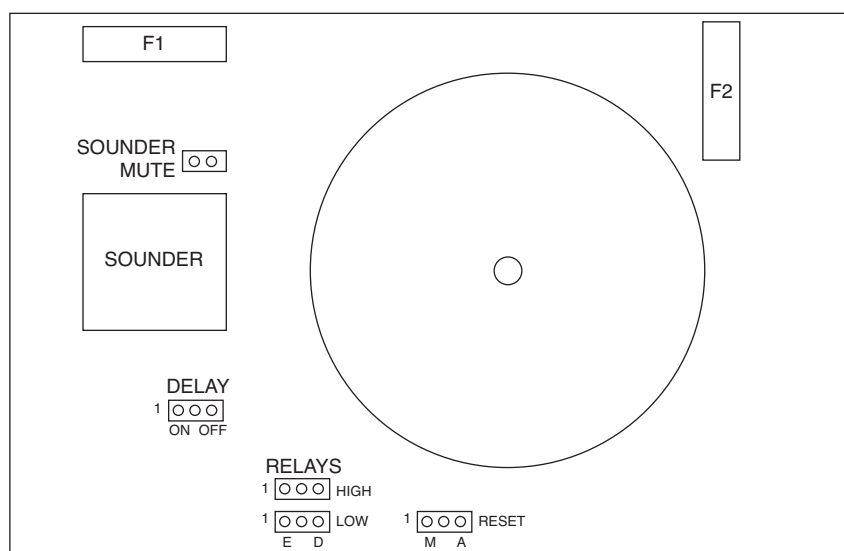
Alarm Card - Component Detail



Jumper Terminals

J9	M - Manual alarm relay reset A - Auto alarm relay reset	Low Auto - Auto reset low alarm Mute - Sounder O2 - Oxygen Monitor
J3	24V DC sensor supply - 4~20mA transmitters P - Adjustable sensor supply – pellistor only	OR LO (D) De-energised/ (E) Energised HI F
J4	V - Voltage output I - 4~20mA output	

Facilities Card - Component Detail



Jumper Terminals

E - High common relay normally energised – link 1&2 D - High common relay normally de-energised – link 2&3	Factory set normally de-energised
E - Low common relay normally energised – link 1&2 D - Low common relay normally energised – link 2&3	Factory set normally de-energised
M - Manual alarm relays reset – link 1&2 A - Auto alarm relays reset – link 2&3	Factory set manual reset
ON OFF High common relay delay – 2 minute delay of relay action following an alarm	Factory set off

ALARM/FACILITIES/STAND-BY BATTERY CHARGER - FIELD TERMINAL CONNECTIONS

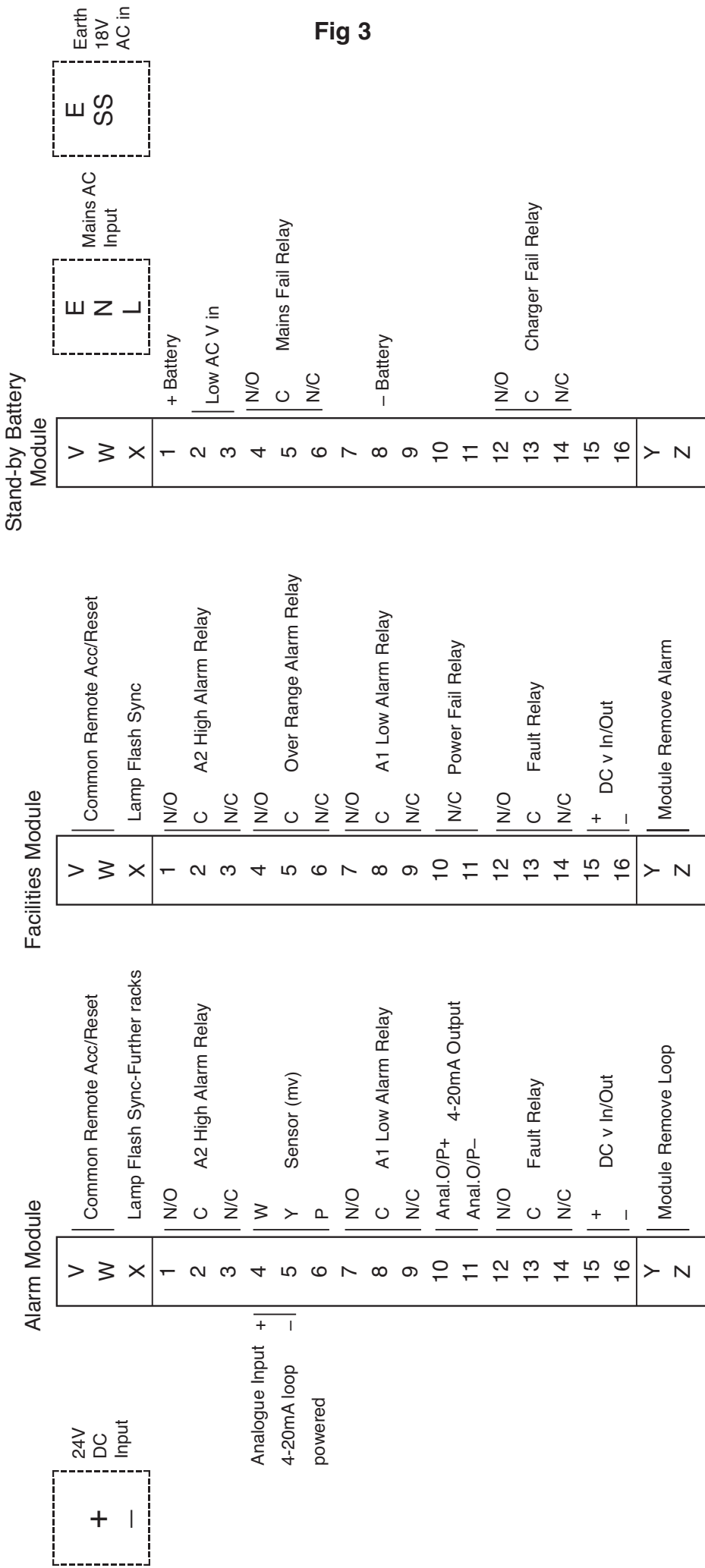
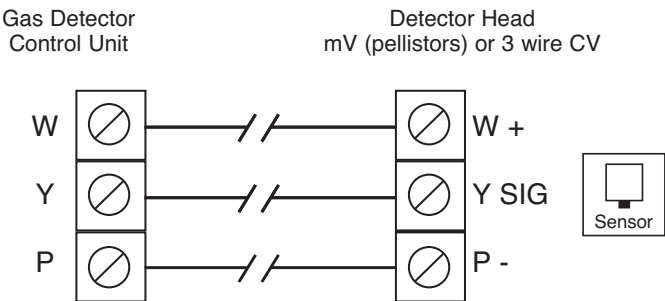


Fig 3

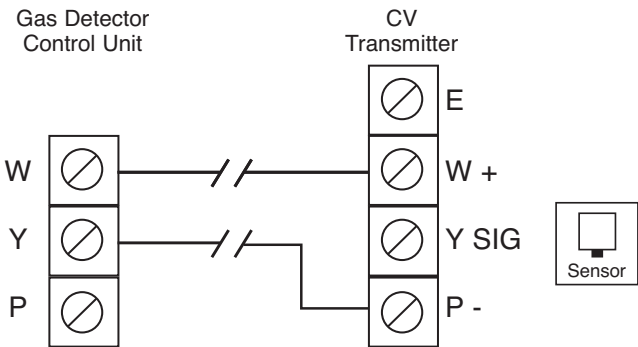
Contacts draw in powered up none alarm state.

Fig 4

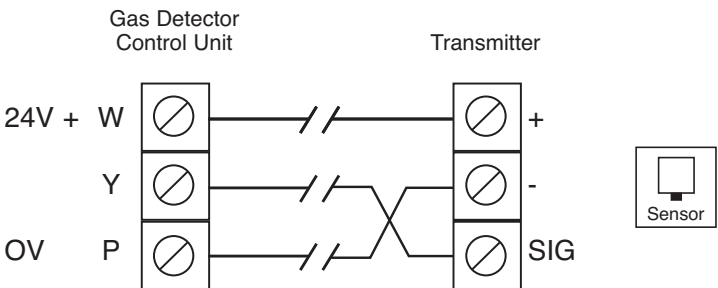
SENSOR – 3 WIRE



SENSOR – 2 WIRE



INFRA RED SENSOR – 3 WIRE



- RED ident – (R) = flammable
- YELLOW ident – (Y) = toxic
- BLUE ident – (B) = oxygen
- GREEN ident – (G) = others

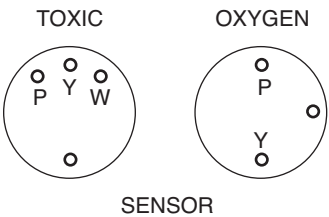


Fig 5

C323 CV TRANSMITTER - FLAMMABLE

TECHNICAL

Input Voltage

12-30v DC - 24v nominal

Current

Nominal 160ma

Output Standard

Analogue 4- 20 ma (250 ohms max) - 3 wire (source mode – standard)

Option 1 - 5v output – solder C

Sensor Cable

3 core 1.5mm screened, maximum cable loop resistance 20-ohms

Alarm Relay Board

Relay contacts S.P.C.O. rated 1A/24vDC 0.5A/120vAC option 5A/230vAC

Options

Trip Indicator LED - trip point selectable 10% to full scale

(safe area board only)

Fire Alarm panel signalling - Remove LK1

Logic output - JP1 position L and end of line link JP2 – normally set at A (analogue)

Full Board Options

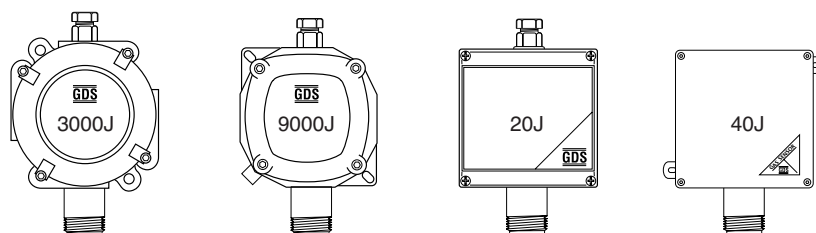
On board sounder

(safe area board only)

Auxiliary output DC volts - standard - as input volts 24vDC

(selection by fixed voltage regulator U5 - 5,12, 15 volts)

DPM - gas readout display - (DPMZ and DPMS potentiometers used only for DPM setting)



INSTALLATION

Siting of the equipment should be chosen with regard to the following points:

- Away from sources of heat and with room for adequate air circulation.
- Within easy reach for operating and maintenance personnel.
- Connecting cables to be electrically shielded, i.e. M.I.C.C., steel wire armoured, screened cable or steel conduit.

Note: Sensor cables should not be run in the same ducting as power cables.

SET UP

- Having powered up allow 5 minutes for the sensor to stabilise.
- SAFE AREA SENSOR BOARD** – the sensor current/voltage should be set by connecting a voltmeter (mV range) across TP3/TP4 and adjusting the sensor voltage potentiometer (10 turn) until the required voltage reading is obtained (mV meter reading = mA sensor current) CAUTION – DO NOT EXCEED 360mV (mA).

EEExd SENSOR BOARD – measuring across sensor terminals W and P adjust the sensor voltage potentiometer for required voltage.

- Zero the card in clean air by adjustment of the potentiometer marked zero until the GREEN ON/Z LED just turns from GREEN/RED to GREEN. (At this point the output will = 4ma). If you require to check this, connect a digital meter (mV range) to the test pins marked TP1 and TP2, if adjustment is required adjust the 4ma potentiometer (4mV = 4mA).

CALIBRATION

With the digital meter connected to the test pins TP1 and TP2 and a reading of (4mV clean air) apply test gas and wait until a maximum reading is obtained, if necessary adjust the 20mA potentiometer for the required mV reading for the calibration gas being used.

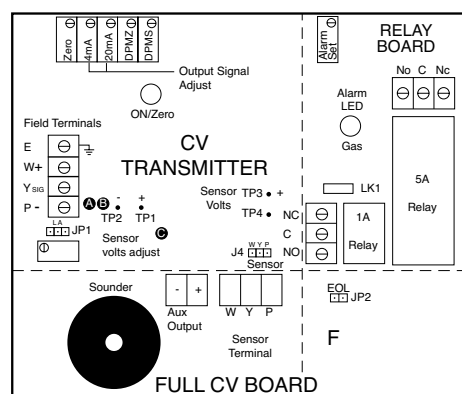
Where 4 to 20mA span = 0 - 100% L.E.L. (Lower explosive level) and the sensor is to be calibrated for Methane which has an L.E.L. of 5% vol, when using 1% Methane in air test gas (20% L.E.L.) a reading of 7.2mv (7.2mA) would be required.

Where a digital panel meter is fitted, readings should be taken directly from the readout and if necessary adjusted using the 4 and 20mA potentiometers.

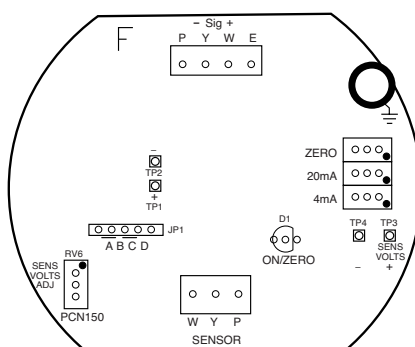
ADDITIONAL RELAY BOARD ALARM TRIP POINT ADJUSTMENT

This level will normally be set at 20% of the range reading i.e. 7.2mA.

- Connect the DVM as above, using the zero potentiometer adjust for the required trip level (mv)
 - Adjust the alarm level potentiometer until the relay just changes state.
 - Using the zero potentiometer re-adjust the DVM to 4mV.
- The above adjustment may be carried out in house by connecting the CV transmitter directly to a DC power supply.



SAFE AREA SENSOR BOARD



EEExd SENSOR BOARD

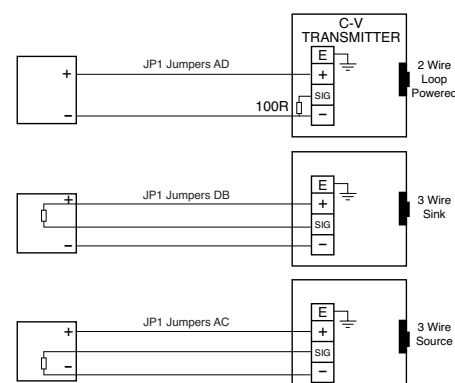
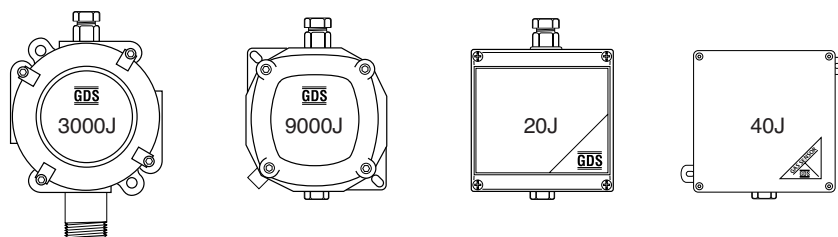


Fig 6

C284 CV TRANSMITTER - TOXIC/OXYGEN

TECHNICAL

Input voltage	12-30v DC – 24v nominal
Output Standard	Analogue 4~20 ma (250 ohms max) – source Option 1–5v output – solder G
Alarm relay board options (safe area board only)	3 wire system only (2 wire if the 4~20mA signal is not used) Signal relay contacts S.P.C.O. rated 1A/24v (Logic and fire panel signal only) Mains relay S.P.C.O. 5A/230v AC Trip Indicator LED – trip point selectable 10% to full scale Fire Alarm panel signalling – cut F Logic output - JP3 position L and end of line link JP4
Full board (safe area board only)	On board sounder Auxiliary output DC volts – standard-as input volts 24v (selection by fixed voltage regulator U5 - 5.12,15v) DPM – gas readout display – (zero and span potentiometers used only for DPM setting)



INSTALLATION

Siting of the equipment should be chosen with regard to the following points:

- Away from sources of heat and with room for adequate air circulation.
- Within easy reach for operating and maintenance personnel.
- Connecting cables to be electrically shielded, i.e. M.I.C.C., steel wire armoured, screened cable or steel conduit.

Note: Sensor cables should not be run in the same ducting as power cables.

CALIBRATION

- Connect a digital voltmeter (millivolt range) to the + and – test terminals (2 wire system) or X and Y test terminals (3 wire system)
For 3 wire systems the CV is preset in the current source mode.
- In clean air check that the DVM reads 4mV, if not adjust the 4mA potentiometer on the CV transmitter board.
- Apply test gas and wait until a maximum DVM reading is obtained, if necessary adjust the 20mA potentiometer for the required mV reading for the calibration gas used (see range/reading on test certificate or printed on the CV circuit board).
- For oxygen level monitoring remove the sensor terminal connector from the PCB J4 and adjust the 4mA potentiometer for 4mA (4mv).

Reconnect the cell and allow reading to stabilise adjust the DVM reading for 17.3mA (20.8% Vol. ambient oxygen) using the 20mA potentiometer.

Where a Digital panel meter is fitted readings should be taken directly from the readout and if required adjusted using the 4-20mA potentiometers.

ADDITIONAL RELAY BOARD ALARM TRIP POINT ADJUSTMENT

This level will normally be set at 20% of the range reading i.e. 7.2mA.

- Connect the DVM as above, using the 4mA potentiometer adjust for the required trip level.
- Adjust the alarm level potentiometer until the alarm LED just comes on.
- Using the 4mA potentiometer re-adjust the DVM to 4mV.
The above adjustment may be carried out in house by connecting the CV transmitter directly to a DC power supply.
Should a full board be required to operate on a 2 wire loop then the relay must be disabled - remove JP2

Gas Type Programming – Works/preset.

CO, H₂S, SO₂, H₂ remove R4, R6, R15, R28, R29, R10
HCN remove R4, R6, R8, R15, R28, R29, R10
NO₂, CL₂, O₃, remove R4, R7, R11, R28, R29, R10
NO, HCL, C₂H₄O Remove R3, R4, R6, R12, R15, R28, R29, R10
O₂ Remove R3, R8, R6, R15, R42, R43, IC-U2
NH₃ Remove R3, R4, R6, R12, R15, R28, R29, R10, R8.

