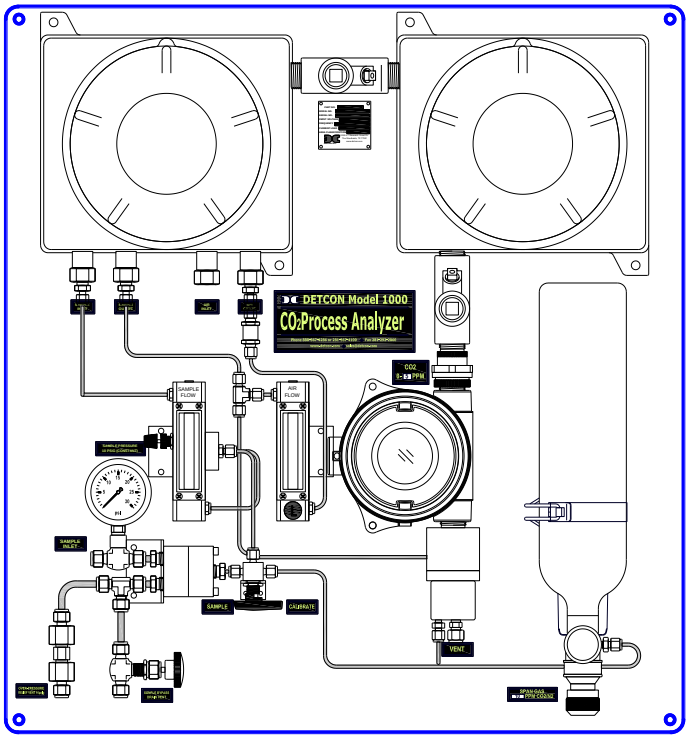
Model 1000

CO_2 Process Analyzer



Operator's Installation and Instruction Manual

Covers units with and without Air Dilution
Detcon Model 1000 CO_2 Analyzer consists of two major assemblies:
1. The Model 1000 Series gas sample-conditioning assembly.
2. The Model IR-640/IR642 CO_2 gas sensors.

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1. Introduction

The Detcon Model 1000 Series CO_2 Process Analyzer is a 110/220VAC or 24VDC powered analyzer that provides a select gas sample mixture to on-board IR-640/IR-642 CO_2 gas sensor assemblies. The ranges of analysis are determined at time of order.

When located outdoors, the CO_2 Process Analyzer package should be appropriately covered from direct weather exposure. The Model 1000 Series CO_2 Process Analyzer can optionally be ordered with a full NEMA 4 enclosure.

The "Power Supply" enclosure on the upper right side of the unit houses a 24 VDC power supply, a 24V DC-DC Converter, and a terminal PCB labeled for all input and output field wiring. The "Pump/Flow" enclosure located on the upper left houses an air dilution pump, an activated carbon scrubber, and optional air flow fault and sample flow fault alarm PCB's.

The analyzer requires a constant, liquid-free, 10±2 psig sample pressure, which is provided by the customer or may be supplied by Detcon as a separate gas sample handling system.

The on-board gas sample conditioning system includes a stainless steel pressure gauge (0-30 psig), and a Genie membrane filter to provide the analyzer with absolute condensate liquid protection. On the bypass port of the Genie membrane filter, a 15 psig over-pressure relief valve and flow control valve are also provided. The flow control valve can be used as a sample bypass and liquid exhaust vent. The IR-640/IR-642 CO_2 gas sensor measures the sample directly, except in units that utilize dilution.. The CO_2 sample flow is maintained by a constant-flow 'Mass Flow controller' and an associated rotameter, while airflow is maintained by a control valve rotameter. A 3-way valve is provided for manually switching between sample monitoring and span calibrations.

1.1 IR-640/IR-642 Description

Figure 1 IR-640

Detcon MicroSafe™ Model IR-640 carbon dioxide gas sensors are non-intrusive "Smart" sensors designed to detect and monitor CO_2 gas in the 0-5% range. Using dilution the IR-640 can be used to measure 15%. The Detcon Model IR-642 is used to measure CO_2 gas in ranges from 0-10% up to 0-100%. In some cases the IR-640 CO2 gas sensor will alternatively be used to measure in ranges from 0-10% and 0-100%. In these cases air dilution is used to reduce the actual gas content hitting the sensor to 0-5%. (Table 2 Dilution Rate.) One of the

primary features of the sensors is its method of automatic calibration, which guides the user through each step via instructions displayed on the backlit LCD. The sensor features field adjustable, fully programmable alarms, and provides relays for two alarms plus fault as standard. The sensor comes with two different outputs: analog 4-20mA, and serial RS-485. These outputs allow for greater flexibility in system integration and installation. The microprocessor-supervised electronics are packaged as a plug-in module that mates to a standard connector board. Both are housed in a condulet that includes a glass lens window, which allows for the display of sensor readings as well as access to the sensor's menu driven features via a hand-held programming magnet.

The sensor technology is a field proven "plug-in replaceable" non-dispersive infrared (NDIR) optical type. NDIR optical sensors show an excellent response to CO_2. The NDIR type sensor is characteristically stable for both span and zero and is capable of providing reliable performance with low maintenance requirements for periods approaching 5 years in most industrial environments.

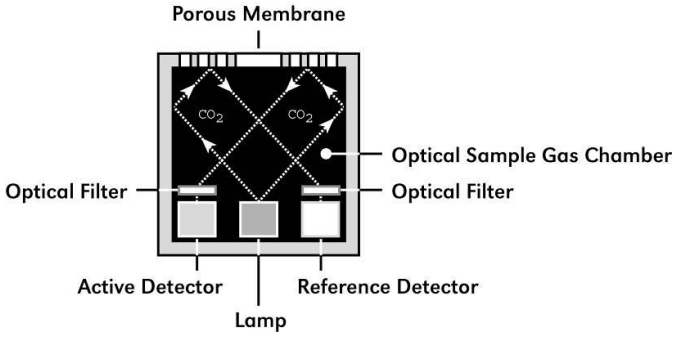

Figure 2 Sensor Diagram

Non-dispersive infrared (NDIR) optical sensor

The Detcon NDIR sensor is designed as a miniature single piece "plug-in replaceable" component, which can easily be changed out in the field. The NDIR sensor consists of an infrared lamp source, two pyroelectric detectors, and an optical gas sample cavity. The lamp source produces infrared radiation, which interacts with CO_2 as it travels through the optical gas sample cavity. The infrared radiation contacts each of two pyroelectric detectors at the completion of the optical path. The "active" pyroelectric detector is cove red by a filter specific to the part of the IR spectrum where CO_2 absorbs light. The "reference" pyroelectric detector is covered by a filter specific to the non-absorbing part of the IR spectrum. When CO_2 is present, it absorbs IR radiation and the signal output from the "active" pyroelectric detector decreases accordingly while the "reference" detector output remains unchanged. The ratio of the "active" and "reference" detector outputs is then used to compute CO_2 concentration.

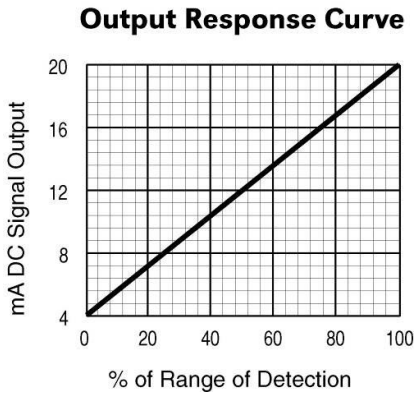

Figure 3 Response Curve

Infrared Sensor Principal of Operation

CO_2 in the sample stream diffuses through a sintered stainless steel flame arrestor and into the volume of the sample gas optical cavity. A lamp source provides a cyclical IR radiation source, which travels through the optical gas sample cavity and terminates at two pyroelectric detectors. The "active" and "reference" pyroelectric detectors each give an output, which measures the intensity of the radiation contacting their surface. The "active" pyroelectric detector is covered by an optical filter specific to the part of the IR spectrum where CO_2 absorbs light. The "reference" pyroelectric detector is covered by a filter specific to the non-absorbing part of the IR spectrum. When present, CO_2 absorbs a fraction of the IR radiation and the signal output from the "active" pyroelectric detector decreases accordingly. The signal output of the "reference" detector remains unchanged in the presence of CO_2. The ratio of the "active" and "reference" detector signal outputs is then used to compute CO_2 concentration. By using the ratio of the active/reference signal outputs, measurement drift caused by changes in the intensity of the lamp source and changes in the optical path are negated.

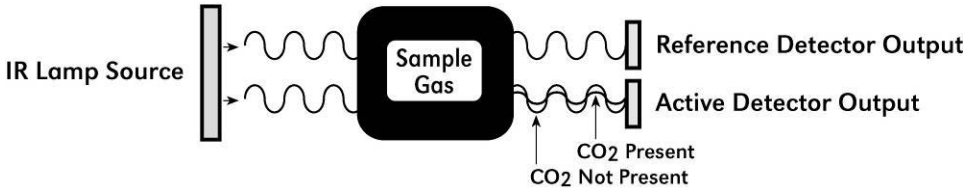

Figure 4 Principle of operation

Characteristics

The NDIR optical sensor element maintains strong sensitivity to CO_2, as shown in the Figure 4. Typical zero calibration intervals would be quarterly and typical span calibration intervals would be quarterly to bi-annual. However, actual field experience is always the best determination of appropriate calibration intervals.

The NDIR optical sensor readings can be adversely affected by dust, dirt and oil mist accumulation as well as severe corrosion. These deposits may reduce the optical reflectivity inside the sensor, and although accurate readings are continually maintained, excessive loss in useable signal eventually gives way to noise and unstable readings. The optical sensor may, over a long period of time (3-7 years), lose its IR lamp source filament, and in this case, an optical sensor modular replacement is required. The IR-640/IR-642 has an extensive list of Fault Diagnostics to alert and pinpoint operational problems. See section 13 Troubleshooting,

Microprocessor Control Circuit

The control circuit is microprocessor based and packaged as a plug-in field replaceable module, facilitating easy replacement and minimum down time. Circuit functions include a basic sensor pre-amplifier, sensor temperature measurement, on-board power supplies, microprocessor, back lit alpha numeric display, alarm status LED indicators, magnetic programming switches, an RS-485 communication port, and a linear 4-20mA DC output.

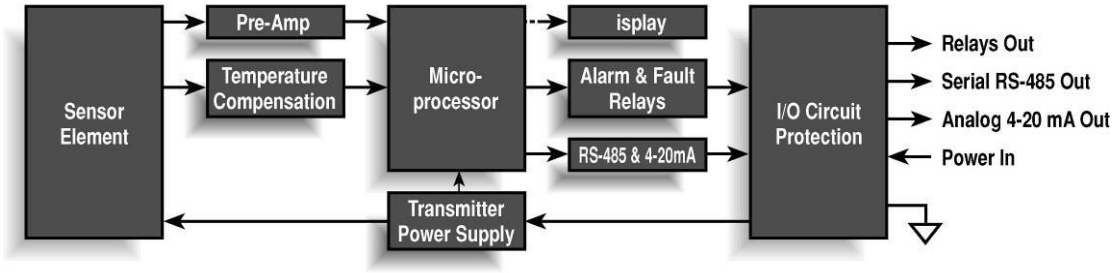

Figure 5 Functional Block Diagram

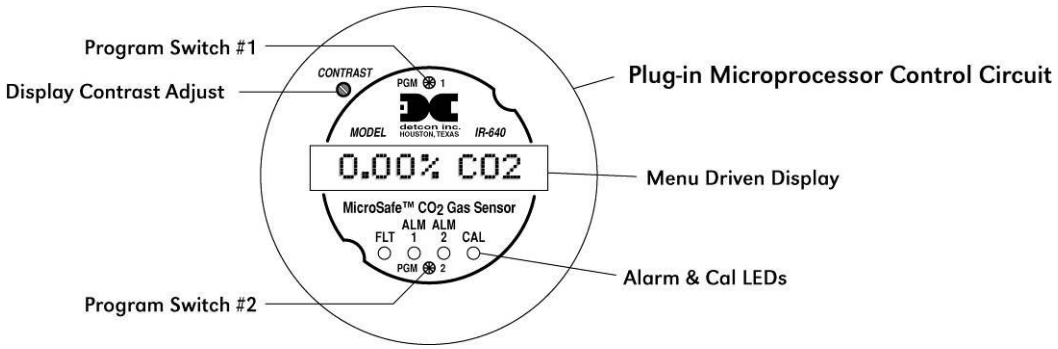

Figure 6 Control Circuit

Base Connector Board

The base connector board is mounted in the enclosure and includes: the mating connector for the control circuit, reverse input and secondary transient suppression, input filter, alarm relays, lug less terminals for all field wiring, and a terminal strip for storing unused programming jumper tabs. The alarm relays are contact rated 5Amps @ 250 VAC, 5Amps @ 30 VDC and coil rated at 24VDC. Gold plated program jumpers are used to select either the normally open or normally closed relay contacts.

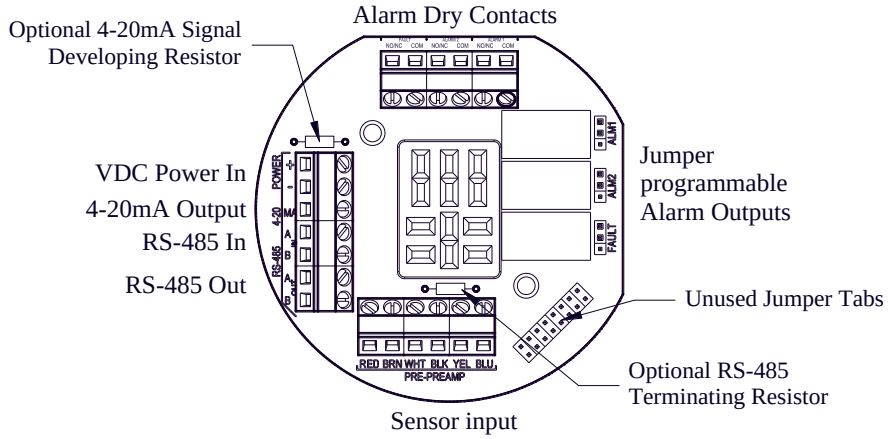

Figure 7 Connector Board Terminals

1.2 Enclosures

The sensors are packaged in cast metal enclosures. The enclosures are fitted with a threaded cover with glass lens window. Magnetic program switches located behind the transmitter module faceplate are activated through the lens window via a hand-held magnetic programming tool allowing non-intrusive operator interface with the sensor. All calibration and alarm level adjustments can be accomplished without removing the cover.

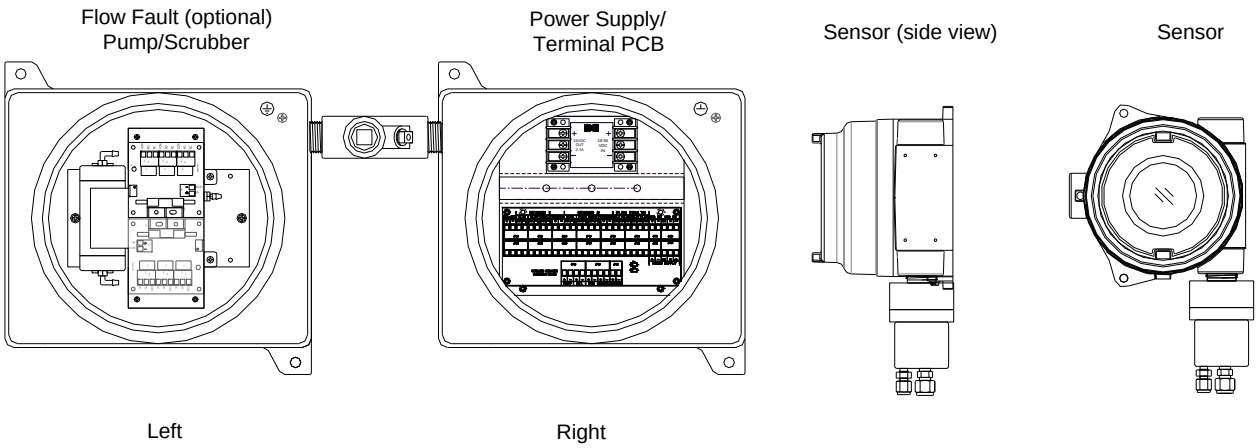

Figure 8 Enclosures

A 24 VDC power supply and termination PCB for the power, relay contacts, 4-20mA output, and or RS485 signal, are located in the enclosure located in the upper right of the unit. The pump, activated carbon scrubber and optional low flow fault assembly are located in the enclosure located in the upper right of the unit.

2. Specifications

Sensor Type
Non-Dispersive Infrared (IR-640/IR-642 CO_2 Sensor)
Measurement Range
0.3% up to 5% (IR-640 CO_2 Sensor)
10% up to 100% (IR-642 CO_2 Sensor)
10% up to 100% (IR-640 CO_2 Sensor with air dilution)
Accuracy/Repeatability
± 5% Full Scale (IR-640/IR-642/IR642 CO_2 Sensor)
Response/Clearing Time
T50<30 seconds, T80<60 seconds (IR-640/IR-642 CO_2 Sensor)
Operating Temperature
-40°C to +50°C
Operating Pressure:
Inlet: 10±2psig
Outlet: Ambient±1psig
Outputs
Linear 4-20mA DC; RS-485 Modbus™; 3 relays (alarm 1, alarm 2, and fault), Contacts rated 5 amps
Sensor Life/Warranty
Sensor: 5-year conditional warranty. Transmitter: 2-year warranty (IR-640/IR-642 CO_2 Sensor)
Input Voltage
117/220VAC; 18-36VDC
Power Consumption
925mA max (22.2Watts), 300 mA nominal (7.2 Watts) @ 24VDC
Electrical Classification
Non Hazardous Area
Analyzer Weight
75 lbs.
Dimensions
29”H X 29”W X 8”D

3. Installation

3.1 Mounting

Securely mount the Model 1000 analyzer panel or NEMA 4 enclosure (optional) in accordance with Figure 9.

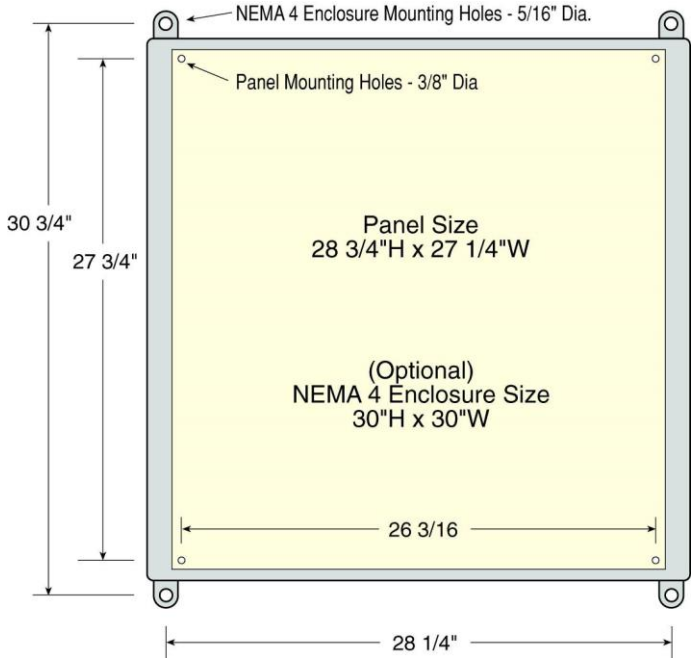

Figure 9 Unit Dimensions

3.2 Gas Connections and Sampling System

1. Install a length of tubing from the desired sample point to the sample inlet port as shown in Figure 10. Sample draw tubing should be 316 stainless steel of 1/4" O.D.

   NOTE: A constant pressure of 10-±2 psig should be provided to the analyzer for proper operation. In applications where line pressure varies significantly, two-stage pressure regulation is recommended to hold the constant pressure. Ideally, the pressure drop from the source to 10 psig for analyzer should be taken as close to the pipeline as possible. This speeds up response time to actual gas concentration changes. An insertion probe membrane device is advisable to use for pipeline sources with high levels of condensates, mist, and contamination.

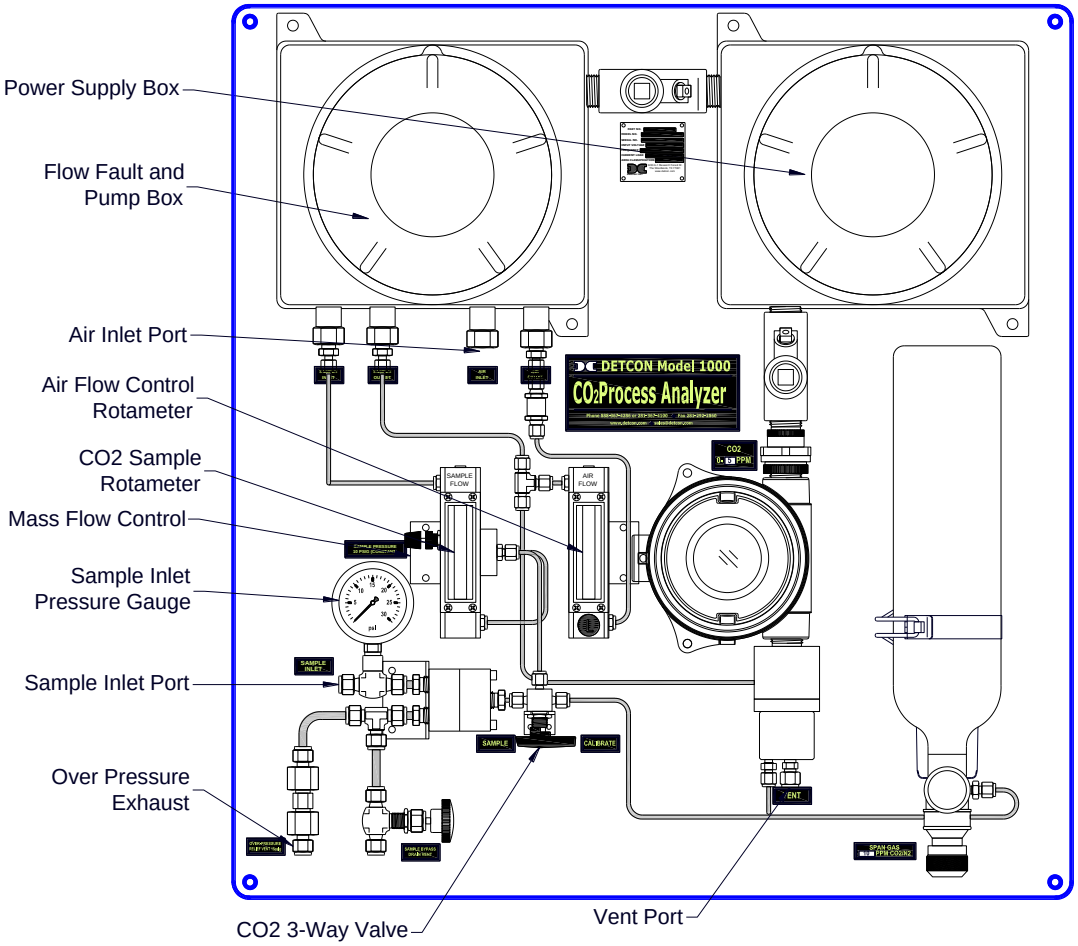

Figure 10 Unit Overview (Ir-640 0-15% with Air Dilution shown)

2. Whenever possible, the Sample Bypass flow control valve of the Genie membrane filter should be used to minimize the sample lag time between the sample tap and the analyzer location. It can also be used as a means to exhaust condensed liquids in the sample line away from the Genie filter and prevent a "loss of flow" condition. Set a flow of 100-200cc/min. and vent to a safe area using ¼ O.D. tubing.

3. Connect to the Over-pressure Relief valve and vent to a safe area. The pressure relief valve is set at Detcon to open at 15-20psig. *For convenience sake, the sample bypass and over-pressure relief can be vented together.*

4. Install a length of 1/4" OD stainless steel tubing from the vent port to an area deemed safe for venting as shown below. *The sensor vent ports can be tied together, but should be separately vented from the over-pressure relief vent and the sample by-pass vent.*

5. The Air Inlet Port should remain open and un-obstructed. In the case of Air Dilution this Air Inlet Port is used to supply the dilution coefficient. In some cases, the user may opt to operate on instrument air instead of ambient air provided by the pump. In this case, the instrument air must be regulated to a constant pressure of 5psig. The instrument air (because it is extremely dry) must be passed through a humidifying tube. (See Detcon for details.)

3.3 Electrical Connections

1. For AC powered unit connect 117/220VAC to the terminal connector labeled “VAC IN” (JP8A) inside the enclosure on the right. If applicable, connect 24VDC to the Terminal Connector Board labeled “VDC IN” (JP7A) (Figure 11).

2. The 4-20mA and/or RS-485 signal outputs should be wired from the terminal PCB and then out the right side of the “Power Supply” enclosure (Figure 11).

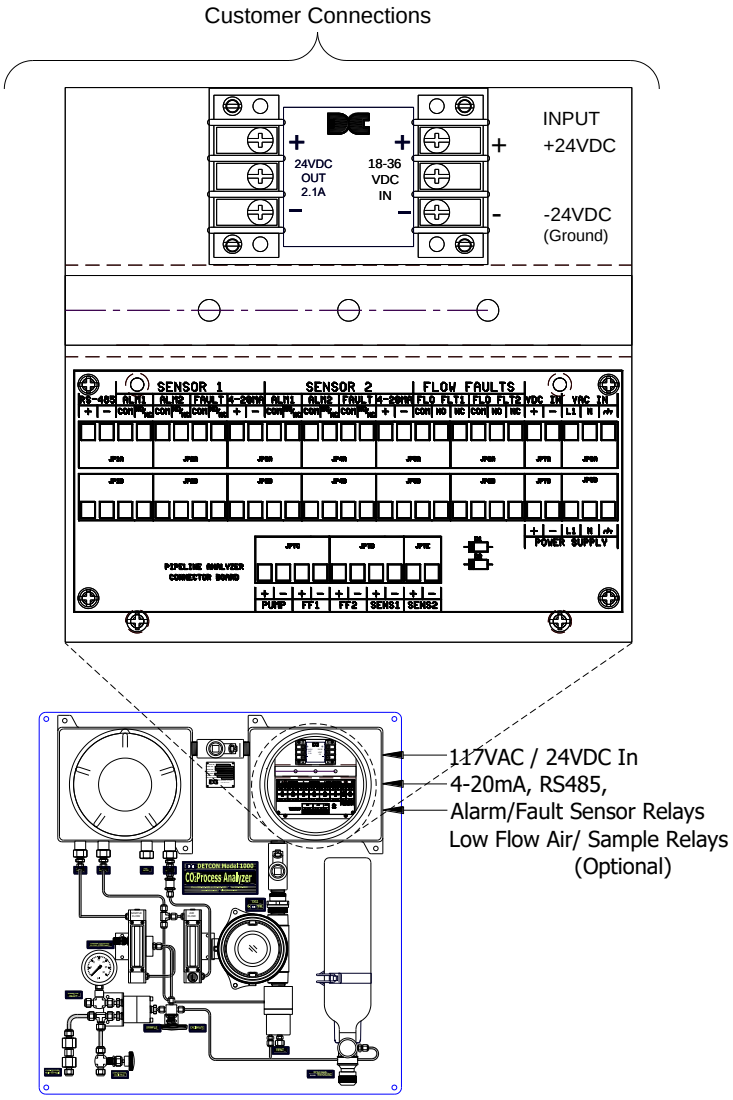

Figure 11 Installation Wiring Connections

3. Discrete alarm relay contacts are provided for three alarms: Fault, Low and High. The contacts consist of common and choice of normally open or normally closed. Contact output selections are jumper programmable on the sensor connector board. See IR-640/IR-642 wiring diagram for details. These connections also should be wired out of the right side of the “Power Supply” enclosure. See wiring diagram for detail. Sensor #1 termination corresponds to IR-640/IR-642 CO_2 Sensor.

4. Optional Low Flow Fault alarms for Sample gas and Air are available. They provide a form "C" relay contact (common, normally open and normally closed) rated 1 amp at 30 VDC/0.24 amp at 125 VAC. Relay contacts are pre-wired to the I/O connector PCB located in the "Power Supply" enclosure.

3.4 Relays and RS-485 Setup

Program the alarms via the gold plated jumper tab positions located on the CPU board (Figure 12). Alarm 1 and Alarm 2 have three jumper programmable functions: latching/non-latching relays, normally energized/normally de-energized relays, and ascending/descending alarm set points. The fault alarm has two jumper programmable functions: latching/non-latching relay, and normally energized/normally de-energized relay. The default settings of the alarms (jumpers removed) are normally de-energized relays, non-latching relays, and alarm points that activate during descending gas conditions.

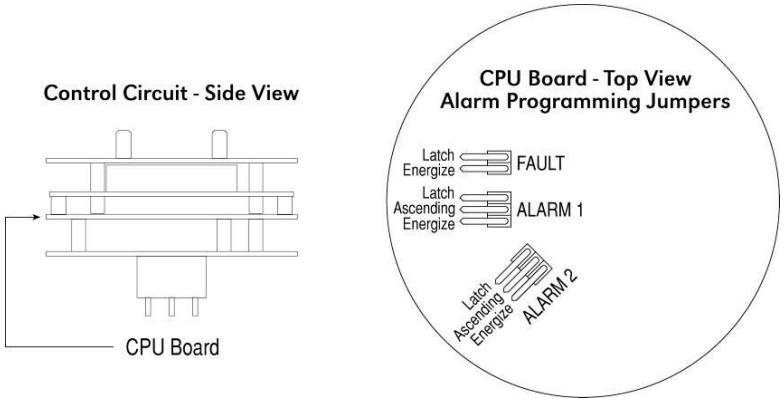

Figure 12 Alarm Jumpers

If a jumper tab is installed in the latch position, then that alarm relay will be in the latching mode. The latching mode will latch the alarm after alarm conditions have cleared until the alarm reset function is activated. The non-latching mode (jumper removed) will allow alarms to de-activate automatically once alarm conditions have cleared.

If a jumper tab is installed in the energize position, that alarm relay will be in the energized mode. The energized mode will energize or activate the alarm relay when there is no alarm condition and de-energize or de-activate the alarm relay when there is an alarm condition. The de-energized mode (jumper removed) will energize or activate the alarm relay during an alarm condition and de-energize or de-activate the alarm relay when there is no alarm condition.

If a jumper tab is installed in the ascending position, then that alarm relay will be in the ascending mode. The ascending mode will cause an alarm to fire when the gas concentration detected is greater than or equal to the alarm set point. The descending mode (jumper removed) will cause an alarm to fire when the gas concentration detected is lesser than or equal to the alarm set point. Except in special applications, H_2S and CO_2 monitoring will require alarms to fire in "ASCENDING" gas conditions.

Any unused jumper tabs should be stored on the connector board on the terminal strip labeled "Unused Jumpers".

If applicable, set the RS-485 ID number via the two rotary dip switches located on the preamp board (see below). There are 256 different ID numbers available, which are based on the hexadecimal numbering system. If RS-485 communications are used, each sensor must have its own unique ID number. Use a jeweler's screwdriver to set the rotary dipswitches according to the hexadecimal table listed below. If RS-485 communications are not used, leave the dipswitches in the default position, which is zero/zero (0)-(0).

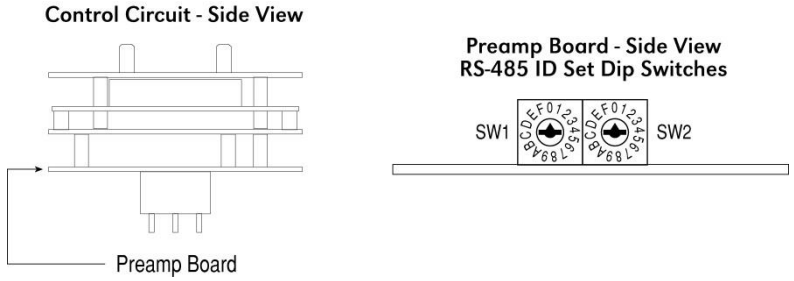

Figure 13 RS-485 Dip Switches

Replace the plug-in control circuit and replace the junction box cover.

Hexadecimal Table 1

ID#	SW1	SW2	ID#	SW1	SW2	ID#	SW1	SW2	ID#	SW1	SW2	ID#	SW1	SW2	ID#	SW1	SW2
none	0	0	43	2	B	86	5	6	129	8	1	172	A	C	215	D	7
1	0	1	44	2	C	87	5	7	130	8	2	173	A	D	216	D	8
2	0	2	45	2	D	88	5	8	131	8	3	174	A	E	217	D	9
3	0	3	46	2	E	89	5	9	132	8	4	175	A	F	218	D	A
4	0	4	47	2	F	90	5	A	133	8	5	176	B	0	219	D	B
5	0	5	48	3	0	91	5	B	134	8	6	177	B	1	220	D	C
6	0	6	49	3	1	92	5	C	135	8	7	178	B	2	221	D	D
7	0	7	50	3	2	93	5	D	136	8	8	179	B	3	222	D	E
8	0	8	51	3	3	94	5	E	137	8	9	180	B	4	223	E	F
9	0	9	52	3	4	95	5	F	138	8	A	181	B	5	224	E	0
10	0	A	53	3	5	96	6	0	139	8	B	182	B	6	225	E	1
11	0	B	54	3	6	97	6	1	140	8	C	183	B	7	226	E	2
12	0	C	55	3	7	98	6	2	141	8	D	184	B	8	227	E	3
13	0	D	56	3	8	99	6	3	142	8	E	185	B	9	228	E	4
14	0	E	57	3	9	100	6	4	143	8	F	186	B	A	229	E	5
15	0	F	58	3	A	101	6	5	144	9	0	187	B	B	230	E	6
16	1	0	59	3	B	102	6	6	145	9	1	188	B	C	231	E	7
17	1	1	60	3	C	103	6	7	146	9	2	189	B	D	232	E	8
18	1	2	61	3	D	104	6	8	147	9	3	190	B	E	233	E	9
19	1	3	62	3	E	105	6	9	148	9	4	191	B	F	234	E	A
20	1	4	63	3	F	106	6	A	149	9	5	192	C	0	235	E	B
21	1	5	64	4	0	107	6	B	150	9	6	193	C	1	236	E	C
22	1	6	65	4	1	108	6	C	151	9	7	194	C	2	237	E	D
23	1	7	66	4	2	109	6	D	152	9	8	195	C	3	238	E	E
24	1	8	67	4	3	110	6	E	153	9	9	196	C	4	239	F	F
25	1	9	68	4	4	111	6	F	154	9	A	197	C	5	240	F	0
26	1	A	69	4	5	112	7	0	155	9	B	198	C	6	241	F	1
27	1	B	70	4	6	113	7	1	156	9	C	199	C	7	242	F	2
28	1	C	71	4	7	114	7	2	157	9	D	200	C	8	243	F	3
29	1	D	72	4	8	115	7	3	158	9	E	201	C	9	244	F	4
30	1	E	73	4	9	116	7	4	159	9	F	202	C	A	245	F	5
31	1	F	74	4	A	117	7	5	160	A	0	203	C	B	246	F	6
32	2	0	75	4	B	118	7	6	161	A	1	204	C	C	247	F	7
33	2	1	76	4	C	119	7	7	162	A	2	205	C	D	248	F	8
34	2	2	77	4	D	120	7	8	163	A	3	206	C	E	249	F	9
35	2	3	78	4	E	121	7	9	164	A	4	207	C	F	250	F	A
36	2	4	79	4	F	122	7	A	165	A	5	208	D	0	251	F	B
37	2	5	80	5	0	123	7	B	166	A	6	209	D	1	252	F	C
38	2	6	81	5	1	124	7	C	167	A	7	210	D	2	253	F	D
39	2	7	82	5	2	125	7	D	168	A	8	211	D	3	254	F	E
40	2	8	83	5	3	126	7	E	169	A	9	212	D	4	255	F	F
41	2	9	84	5	4	127	7	F	170	A	A	213	D	5			
42	2	A	85	5	5	128	8	0	171	A	B	214	D	6			

4. Start Up

Upon completion of all tubing connections and field wiring the Model 1000 Series Process Analyzer is ready for startup. Note that after power is applied, varying readings may occur during sensor warm-up. Allow at least 1 hour to stabilize (24 hours is best). With sample gas and airflows properly set, apply system power and observe the following normal conditions:

a) IR-640/IR-642 "Fault" LED is off
b) A reading close to the anticipated CO_2 level should be indicated upon conclusion of a 1-minute "warming up" cycle.

NOTE: All alarms will be disabled for 1 minute after power up. In the event of power failure, the alarm disable period will begin again once power has been restored.

NOTE: Sample flow rates are actual Rotameter set-point flow rates, after accounting for Rotameter gas.

NOTE: If the low range IR-640 is used for high range CO2 measurements (10% - 100%) the sample flow and air flow rate must be set per the Table 2 Dilution Rate. Note that the 'Arrow' marks on the Rotometers show the correct set points for the dilution rate.

Table 2 Dilution Rate for sample and calibration modes

Full Scale Range	Sample Flow Rotameter	Span Cal Flow	Air Flow Rotameter
10%	200ccm (per 'S' mark)	250ccm (per 'C' mark)	250ccm
25%	200ccm (per 'S' mark)	250ccm (per 'C' mark)	1000ccm
50%	75ccm (per 'S' mark)	100ccm (per 'C' mark)	900ccm
100%	75ccm (per 'S' mark)	100ccm (per 'C' mark)	1900ccm

5. Operating Software

5.1 Programming Magnet Operating Instructions

Operator interface to MicroSafe™ gas detection products is via magnetic switches located behind the transmitter faceplate. ***DO NOT*** remove the glass lens cover to calibrate or change programming parameters. Two switches labeled "PGM 1" and "PGM 2" allow for complete calibration and alarm level programming without removing the enclosure cover, thereby eliminating the need for area de-classification or the use of hot permits.

Figure 14 Programming Magnet

A magnetic programming tool (Figure 14) is used to operate the switches. Switch action is defined as momentary contact, 3-second hold, and 30-second hold. In momentary contact use, the programming magnet is waved over a switch location. In 3-second hold, the programming magnet is held in place over a switch location for 3 or more seconds. In 30-second hold, the programming magnet is held in place over a switch location for 30 or more seconds. Three and 30-second hold is used to enter or exit calibration and program menus while momentary contact is used to make adjustments. The location of "PGM 1" and "PGM 2" are shown in section 1.3.

NOTE: If, after entering the calibration or program menus, there is no interaction with the menu items for more than 30 seconds, the sensor will return to its normal operating condition.

5.2 Operating Software

Operating software is menu listed with operator interface via the two magnetic program switches located under the faceplate. The two switches are referred to as "PGM 1" and "PGM 2". The menu list consists of 3 items which include submenus as indicated below. (Note: see Figure 15 for a complete software flow chart.)

01. Normal Operation
    a) Current Status
02. Calibration Mode
    a) Zero
    b) Span
03. Program Menu
    a) Program Status
    b) Alarm 1 Level
    c) Alarm 2 Level
    d) Calibration Level

5.2.1 Normal Operation

In normal operation, the display tracks the current status of the sensor and gas concentration and appears as: "**##.# % CO2**". The milliamp current output corresponds to the monitoring level and range of the sensor, where Zero is 4mA and Full Scale is 20mA.

5.2.2 Calibration Mode

Calibration mode allows for sensor zero and span adjustments. "**1-ZERO 2-SPAN**"

Zero Adjustment

Zero is set with zero gas applied to the sensor. "**AUTO ZERO**"

Span Adjustment

Unless otherwise specified, span adjustment is typically performed at 50% of full-scale range of CO_2. "**AUTO SPAN**"

5.2.3 Program Mode

Program Mode provides a program status menu (View Program Status) to check operational parameters. Program Mode also allows for the adjustment of alarm set point levels, and the calibration gas level setting. Refer to Section 6 Calibration and Section 7.1 Alarm Levels .

Program Status

View Program Status is a listing that allows the operator to view the gas, range, and software version number of the program, as well as the current alarm settings, calibration gas level setting, RS-485 ID number, and estimated remaining sensor life.

a) Enter the programming menu by holding the programming magnet stationary over "PGM 2" for 15 seconds. When the display changes to "**VIEW PROG STATUS**", withdraw the magnet. Scroll through the programming menu by momentarily waving the programming magnet over either "PGM 1" or "PGM 2". The menu options are: View Program Status, Set Alarm 1 Level, Set Alarm 2 Level, and set Cal Level.

b) Scroll to the "**VIEW PROG STATUS**" listing and hold the programming magnet over "PGM 1" for 3 seconds. The display will automatically scroll, at five-second intervals, through the following information before returning to the "**VIEW PROG STATUS**" listing.

- Software version number. The menu item appears as: "**106-######-###**"
- Alarm set point level of alarm 1. The menu item appears as: "**ALM1 SET @ ##%**"
- Alarm firing direction of alarm 1. The menu item appears as: "**ALM1 ASCENDING**" or descending.
- Alarm relay latch mode of alarm 1. The menu item appears as: "**ALM1 NONLATCHING**" or latching.
- Alarm relay energize state of alarm 1. The menu item appears as: "**ALM1 DE-ENERGIZED**" or energized.
- Alarm set point level of alarm 2. The menu item appears as: "**ALM2 SET @ ##%**"
- Alarm firing direction of alarm 2. The menu item appears as: "**ALM2 ASCENDING**" or descending.
- Alarm relay latch mode of alarm 2. The menu item appears as: "**ALM2 LATCHING**" or non-latching.
- Alarm relay energize state of alarm 2. The menu item appears as: "**ALM2 DE-ENERGIZED**" or energized.
- Alarm relay latch mode of the fault alarm. The menu item appears as: "**FLT NONLATCHING**" or latching.
- Alarm relay energize state of the fault alarm. The menu item appears as: "**FLT ENERGIZED**" or de-energized.
- Calibration gas level setting. The menu item appears as: "**CALLEVEL @ #.##%**"
- Identification of the RS-485 ID number setting. The menu item appears as: "**485 ID SET @ ##**"
- Sensor temperature in °C appears as: "**TEMPERATURE ## °C**"
- Estimated remaining sensor life. The menu item appears as: "**OPTICS AT 100%**"

c) Exit back to normal operations by holding the programming magnet over "PGM 2" for 3 seconds, or automatically return to normal operation in 30 seconds.

Alarm 1 Level Adjustment

The alarm 1 level is adjustable over the range 10 to 90% of full-scale range. For CO_2 gas sensors, the level is factory set at 20% of full-scale range. The menu item appears as: "**SET ALM1 @ #.##%**"

Alarm 2 Level Adjustment

The alarm 2 level is also adjustable over the range 10 to 90% of full-scale range. For CO_2 gas sensors, the level is factory set at 60% of full-scale range. The menu item appears as: "**SET ALM2 @ #.##%**"

Calibration Level Adjustment

The Calibration level is adjustable from 10% to 90% of full-scale range. The menu item appears as: "**CAL LEVEL @ #.##%**"

5.2.4 Software Flow Chart

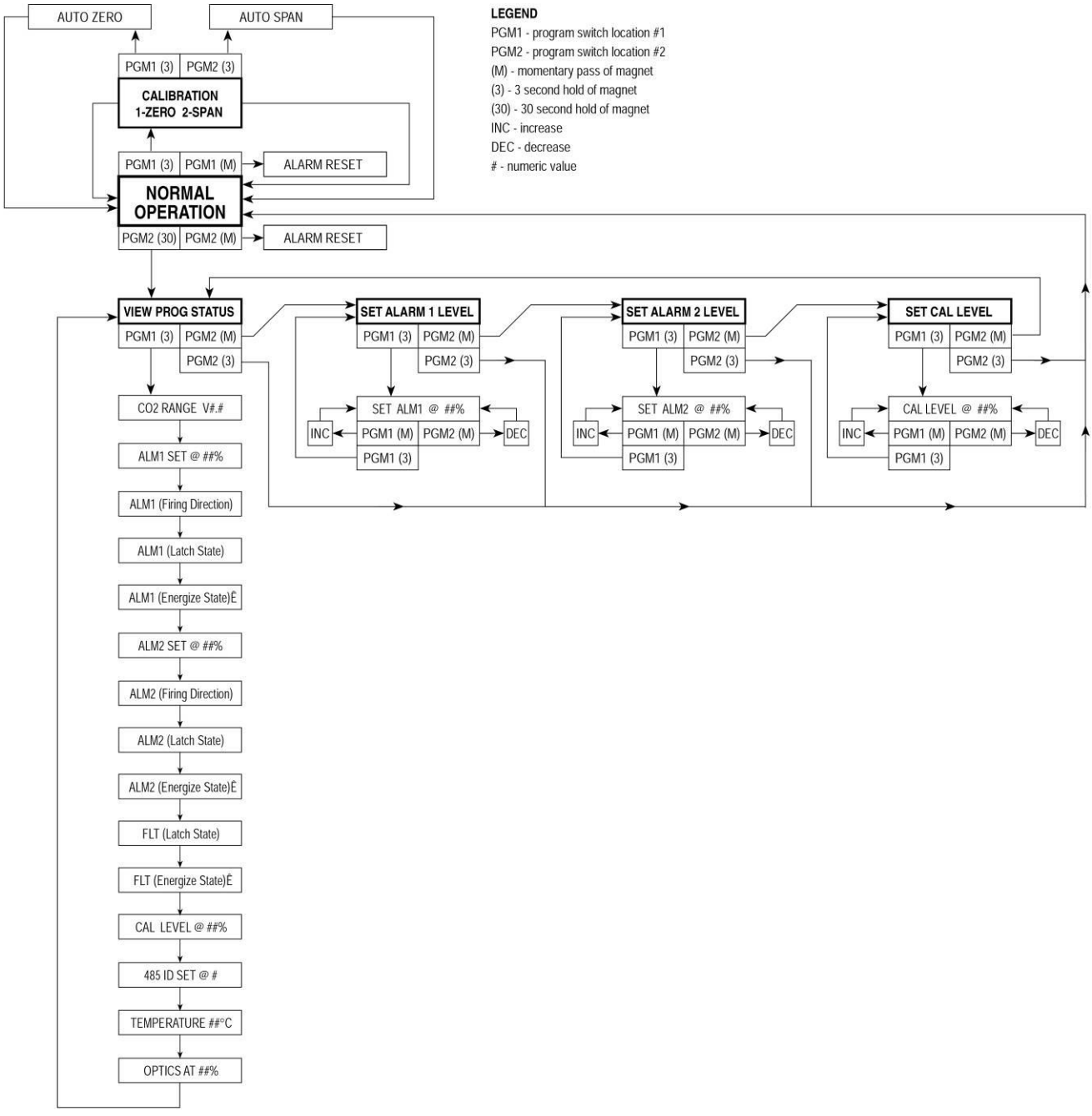

Figure 15 IR-640/IR/642 Software Flow Chart

6. Calibration

Model 1000 Series H_2S/CO_2 Process Analyzers are factory calibrated prior to shipment. Only minimal adjustment should be required at time of commissioning.

Material Requirements

- ✓ Detcon Part Number 327-000000-000 MicroSafe™ Programming Magnet
- ✓ Span Gas containing the applicable CO_2 concentration in air. Span gas concentration is recommended at 50% of full-scale range (which is the factory default). Other concentrations can be used as long as they fall within 10% to 90% of range.
- ✓ Zero gas containing no CO_2. Room air or N_2 may be used as a zero gas.

Zero Calibration

Zero Calibration should be performed quarterly in the field. If the ambient air is known to contain no CO_2 gas content, it can be used to calibrate zero. If a zero air or N2 gas cal cylinder is used, attach the gas to the CO_2 Calibration Port. When zero calibrating, turn the three-way valve to "Calibrate" and apply 250cc/min of zero gas. Allow the unit 5 minutes to stabilize. Before executing AutoZero.

1) Enter the calibration menu by holding the programming magnet stationary over "PGM 1" (see above) for 3 seconds until the display reads "**1-ZERO 2-SPAN**", and remove the magnet. Note that the "CAL" LED comes on.
2) Enter the zero menu by holding the magnet stationary over "PGM 1" for 3 seconds until the display reads: "**ZERO 0%**", and remove the magnet. The sensor has now entered the auto zero mode. When complete the sensor will display "**ZERO COMPLETE**" for 5 seconds and then return to the normal operation menu, "**0.00 %CO2**".
3) Turn the 3-way valve back to sample and re-establish the target sample flow rate per the arrow indicator on the CO_2 sample Rotameter.

Span Calibration

Span gas cylinder containing CO_2 gas in background air as per the following range table. For units utilizing the IR-640 sensor with dilution use span gas cylinder containing CO_2 gas in background per Table 2 CO_2 Dilution Rate. Background gas may also be nitrogen.

> **CAUTION:** Verification of the correct calibration gas level setting and calibration span gas concentration is required before "span" calibration can be completed. These two numbers must be equal.

Calibration consists of entering the calibration function and following the menu-displayed instructions. The display will ask for the application of span gas in a specific concentration. This concentration is equal to the calibration gas level setting. The factory default setting for span gas concentration is 50% of full-scale range. In this instance, a span gas containing a concentration equal to 50% of full-scale range is required. If a span gas containing 50% of range is not available, other concentrations may be used as long as they fall within 10% to 90% of range. However, any alternate span gas concentration value must be programmed via the calibration gas level menu before proceeding with span calibration. Follow the instructions below for span calibration.

1) Verify that the current calibration gas level is equal to the calibration span gas concentration. (Refer to Section 5.2.3 Program Mode, "**VIEW SENSOR STATUS**". The item appears as "**CAL LEVEL @ ### %**".)
2) If the calibration gas level setting is equal to the calibration span gas concentration, proceed to item "3)". If the calibration gas level setting is not equal to the calibration span gas concentration, adjust the calibration gas level setting so that it is equal to the calibration span gas concentration.

a) Enter the programming menu by holding the programming magnet stationary over "PGM 2" for 30 seconds until the display reads "**VIEW PROG STATUS**", and then withdraw the magnet. Scroll through the programming menu by momentarily waving the programming magnet over "PGM 1" or "PGM 2". The menu options are: View Program Status, Set Alarm 1 Level, Set Alarm 2 Level, and Set Cal Level.
b) From the programming menu scroll to the calibration level listing. The menu item appears as: "**SET CAL LEVEL**". Enter the menu by holding the programming magnet stationary over "PGM 1" for 3 seconds until the display reads "**CALLEVEL @ ##%**", then withdraw the magnet. Use the programming magnet to increase (PGM 1) or decrease (PGM 2) the display reading until the reading is equal to the desired calibration span gas concentration.
c) Exit to the programming menu by holding the programming magnet over "PGM1" for 3 seconds.
d) Exit back to normal operation by holding the programming magnet over "PGM 2" for 3 seconds, or, the sensor will automatically return to normal operation in 30 seconds.

3) Enter the calibration menu by holding the programming magnet stationary over "PGM 1" for 3 seconds. The display will read "**1-ZERO 2-SPAN**". Hold programming magnet stationary over "PGM 2" for 3 seconds, the display will change to "**APPLY #.##% CO2**", withdraw the programming magnet. The #.## indicates the gas concentration requested.
4) Turn the 3-way valve (CO_2) so that the arrow is pointing toward the cal gas source. The sample is now being drawn from the Calibration Port (CO_2).
5) Turn the fixed flow regulator on the Cal Gas Bottle to the "ON" position, and set the sample Rotameter flow valve so the flow is 250cc/min. On units with dilution adjust the sample Rotameter and the air flow Rotameter per Table 2.

   NOTE: If the analyzer is set up as high range using the IR640 gas sensor with dilution, **the sample flow and air flow must be set per Table 2 during 'Span Calibration'**, and the returned to normal operation after completion of 'Span Calibration'**.**

6) As the sensor signal changes, the display will change to **"SPAN #.##%".** Where "#.##" indicates the actual gas reading. The reading will increase/decrease until the sensor stabilizes. When the sensor signal is stable, it will auto span to the requested concentration and the display will change to **"SPAN COMPLETE"** for two seconds and then **"REMOVE GAS"**.
7) Turn the fixed flow regulator on the Cal Gas Bottle to the "OFF" position and remove the gas.

   NOTE: If the circuitry is unable to adjust the span to the proper setting the sensor will enter into the calibration fault mode which will cause the display to alternate between the sensor's current status reading and the calibration fault screen which appears as: "**CAL FAULT**"

8) Return the 3-way (CO_2) valve so that the arrow is pointing toward the sample source, and re-establish the target sample gas flow through the sample Rotameter to the "S→" reading per Table 2.
9) Span calibration is complete. The total time for span calibration is approximately 5 minutes. The analyzer will then return to normal operation after the reading falls below the Alarm 1 and Alarm 2 set point levels.

Additional Notes

a) Upon entering the calibration menu, the 4-20mA signal drops to 2mA and is held at this level until the sensor returns to normal operation.
b) If during calibration the sensor circuitry is unable to attain the proper adjustment for zero or span, the sensor will enter into the calibration fault mode, which will activate fault alarm functions and cause the display to alternate between the sensor's current status reading and the calibration fault screen which appears as: "**CAL FAULT**". If this occurs, attempt to recalibrate by entering the calibration menu. If the sensor fails again, refer to Section 13, Troubleshooting.

7. Programming Alarms

7.1 Alarm Levels

Both alarm 1 and alarm 2 levels are factory set prior to shipment. Alarm 1 is set at 20% of full-scale range; alarm 2 at 60% of full-scale range. Both alarms can be set in 0.01% increments from 10 to 90% of full-scale range. The following procedure is used to change alarm set points:

a) First, enter the programming menu by holding the programming magnet stationary over "PGM 2" for 30 seconds until the display reads "**VIEW PROG STATUS**", and withdraw the magnet. Scroll through the programming menu by momentarily waving the programming magnet over "PGM 1" or "PGM 2". The menu options are: View Program Status, Set Alarm 1 Level, Set Alarm 2 Level, and Set Cal Level.
b) ALARM 1 LEVEL: From the programming menu scroll to the alarm 1 level listing. The menu item appears as: "**SET ALARM 1 LEVEL**". Enter the menu by holding the programming magnet stationary over "PGM 1" for 3 seconds until the display reads "**SET ALM1 @ #.##%**", and withdraw the magnet. Use the programming magnet to adjust the display reading using "PGM 1" to increase or "PGM 2" to decrease the reading until the desired alarm set point is reached. Exit to the programming menu by holding the programming magnet over "PGM1" for 3 seconds, or automatically return to the programming menu in 30 seconds.
c) ALARM 2 LEVEL: From the programming menu scroll to the alarm 2 level listing. The menu item appears as: "**SET ALARM 2 LEVEL**". Enter the menu by holding the programming magnet stationary over "PGM 1" for 3 seconds until the display reads "**SET ALM2 @ #.##%**", then withdraw the magnet. Use the programming magnet to adjust the display reading using "PGM 1" to increase or "PGM 2" to decrease the reading until the desired alarm set point is reached. Exit to the programming menu by holding the programming magnet over "PGM1" for 3 seconds, or automatically return to the programming menu in 30 seconds.
d) Exit back to normal operations by holding the programming magnet over "PGM 2" for 3 seconds, or, the sensor will automatically return to normal operation in 30 seconds.

7.2 Alarm Reset

An alarm condition will cause the applicable alarm to activate its corresponding relay and LED. If alarm 1, alarm 2, or fault alarms have been programmed for latching relays, an alarm-reset function must be activated to reset the alarms after an alarm condition has cleared. To reset the alarms, simply wave the programming magnet over either "PGM 1" or "PGM 2", momentarily, while in normal operations mode and note that the corresponding alarm LED(s) turn off.

7.3 Other Alarm Functions

Alarms are factory programmed to be non-latching, de-energized; and to fire under ascending gas conditions. The fault alarm relay is programmed as normally energized, which is useful for detecting a 24VDC power source failure. All alarm functions are programmable via jumper tabs. Changing alarm functions requires the sensor housing to be opened, thus declassification of the area is required.

8. Display Contrast Adjustment

Detcon MicroSafe™ sensors feature a 16-character backlit liquid crystal display. Like most LCD's, character contrast can be affected by viewing angle and temperature. Temperature compensation circuitry included in the MicroSafe™ design will compensate for this characteristic; however temperature extremes may still cause a

shift in the contrast. Display contrast can be adjusted by the user if necessary. However, changing the contrast requires that the sensor housing be opened, thus, declassification of the area is required.

To adjust the display contrast, remove the enclosure cover and use a jeweler's screwdriver to turn the contrast adjust screw located beneath the metallic faceplate. The adjustment location is marked "CONTRAST".

9. Program Features

Detcon sensors incorporate a comprehensive program to accommodate easy operator interface and fail-safe operation. Program features are detailed in this section. Each sensor is factory tested, programmed, and calibrated prior to shipment.

Model IR-640/IR-642 MicroSafe™ Sensors incorporate a comprehensive program to accommodate easy operator inter face and fail-safe operation. Program features are detailed in this section. Each sensor is factory tested, programmed, and calibrated prior to shipment.

Over Range

When the sensor detects gas greater than 100% of the full-scale range, it will cause the display to flash "**OVER-RANGE**" on and off.

Optics Life

The Optics Life feature is a reference based on the signal output from the optical sensor. When an optical sensor life of 25% or less remains the optical sensor should be replaced within a reasonable maintenance schedule.

Calibration Fault

If during calibration the sensor circuitry is unable to attain the proper adjustment for zero or span, the sensor will enter into the calibration fault mode and cause the display to alternate between the sensor's current status reading and the calibration fault screen which appears as: "**CAL FAULT.2**".

The following conditions will cause a calibration fault:
1 - Zero calibration cannot converge.
2 - Auto span cannot converge (too noisy or too unstable).
3 - Span gas is not applied before 1 minute elapses.

Fail-Safe/Fault Supervision

Model IR-640/IR-642 MicroSafe™ sensors are programmed for fail-safe operation. All of the fault conditions listed below will activate the fault relay, illuminate the fault LED, cause the mA output to drop to zero (0) mA, and cause the display to read its corresponding fault condition.

Memory Error

If the processor can't save values to memory, the display will indicate: "**MEMORY ERROR**".

Zero Fault

If the sensor should drift below -10% of range, the display will indicate: "**ZERO FAULT**".

Lamp Fault

If the lamp signal is lost, the display will indicate: "**LAMP FAULT.2**".

Reference Peak High Fault

If the reference peak signal is too high (>3600), the display will indicate: "**SIGNAL FAULT.31**".

Active Peak High Fault

If the active peak signal is too high (>3600), the display will indicate: "**SIGNAL FAULT.32**".

Reference Peak Low Fault

If the reference peak signal is too low (<500), the display will indicate: "**SIGNAL FAULT.41**".

Active Peak Low Fault

If the active peak signal is too low (<500), the display will indicate: "**SIGNAL FAULT.42**".

Reference Peak-to-Peak Low Fault

If the reference peak-to-peak signal is too low (<200), the display will indicate: "**SIGNAL FAULT.51**".

Active Peak-to-Peak Low Fault

If the active peak-to-peak signal is too low (<200), the display will indicate: "**SIGNAL FAULT.52**".

10.RS-485 Protocol

Detcon MicroSafe™ sensors feature Modbus™ compatible communications protocol and are addressable via rotary dipswitches for multi-point communications. Other protocols are available. Contact the Detcon factory for specific protocol requirements. Communication is two wire, half duplex 485, 9600 baud, 8 data bits, 1 stop bit, no parity, with the sensor set up as a slave device. A master controller up to 4000 feet away can theoretically poll up to 256 different sensors. This number may not be realistic in harsh environments where noise and/or wiring conditions would make it impractical to place so many devices on the same pair of wires. If a multi-point system is being utilized, each sensor should be set for a different address. Typical address settings are: 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B, 0C, 0D, 0E, 0F, 10, 11, etc.

In most instances, RS-485 ID numbers are factory set or set during installation before commissioning. If required, the RS-485 ID number can be set via rotary dipswitches located on the preamp circuit board. However, any change to the RS-485 ID number would require the sensor housing to be opened, thus declassification of the area would be required. See section 3.4 for details on changing the RS-485 ID number.

The following section explains the details of the Modbus™ protocol that the Detcon MicroSafe™ sensor supports.

Code 03 - Read Holding Registers is the only code supported by the transmitter. Each transmitter contains 6 holding registers which reflect its current status.

Register #	High Byte	Low Byte
40000	Gas type	Sensor Life

Gas type is one of the following:
01=CO, 02= H_2S, 03=SO_2, 04=H_2, 05=HCN, 06=CL_2, 07=NO_2, 08=NO, 09=HCL, 10=NH_3, 11=LEL, 12=O_2

Sensor life is an estimated remaining use of the sensor head, between 0% and 100%
Example: 85=85% sensor life

Register #	High Byte	Low Byte
40001	Detectable	Range

i.e. 100 for 0-100 ppm, 50 for 0-50% LEL, etc

Register #	High Byte	Low Byte
40002	Current Gas Reading	

The current gas reading is a whole number. If the reading is displayed as 23.5 on the display, this register would contain the number 235.

Register #	High Byte	Low Byte
40003	Alarm 1 Set point	

This is the trip point for the first alarm.

Register #	High Byte	Low Byte
40004	Alarm 2 Set point	

This is the trip point for the second alarm.

Register #	High Byte	Low Byte
40005	Status Bits	Status Bits

High Byte

Bit 7	Not used, always 0	
Bit 6	Not used, always 0	
Bit 5	Not used, always 0	
Bit 4	Not used, always 0	
Bit 3	1-Unit is in calibration	0-Normal operation
Bit 2	1-Alarm 2 is ascending	0-Alarm 2 is descending
Bit 1	1-Alarm 2 is normally energized	0-Alarm 2 is normally de-energized
Bit 0	1-Alarm 2 is latching	0-Alarm 2 is non-latching

Low Byte

Bit 7	1-Alarm 2 Relay is energized	0-Alarm 2 Relay is not energized
Bit 6	1-Alarm 1 is ascending	0-Alarm 1 is descending
Bit 5	1-Alarm 1 is normally energized	0-Alarm 1 is normally de-energized
Bit 4	1-Alarm 1 is latching	0-Alarm 1 is non-latching
Bit 3	1-Alarm 1 Relay is energized	0-Alarm 1 Relay is not energized
Bit 2	1-Fault is normally energized	0-Fault is normally de-energized
Bit 1	1-Fault is latching	0-Fault is non-latching
Bit 0	1-Fault Relay is energized	0-Fault Relay is not energized

The following is a typical Master Query for device # 8:

Field Name	HEX	DEC	RTU
Slave Address	08	8	0000 1000
Function	03	3	0000 0011
Start Address Hi	00	0	0000 0000
Start Address Lo	00	0	0000 0000
No. of Registers Hi	00	0	0000 0000
No. of Registers Lo	06	6	0000 0110
CRC	##	#	#### ####
CRC	##	#	#### ####

The following is a typical Slave Response from device # 8:

Field Name	HEX	DEC	RTU
Slave Address	08	8	0000 1000
Function	03	3	0000 0011
Byte Count	0C	12	0000 1100
Reg40000 Data Hi	02	2	0000 0010
Reg40000 Data Lo	64	100	0110 0100
Reg40001 Data Hi	00	0	0000 0000
Reg40001 Data Lo	64	100	0110 0100
Reg40002 Data Hi	00	0	0000 0000
Reg40002 Data Lo	07	7	0000 0111
Reg40003 Data Hi	00	0	0000 0000
Reg40003 Data Lo	0A	10	0000 1010
Reg40004 Data Hi	00	0	0000 0000
Reg40004 Data Lo	14	20	0001 0100
Reg40005 Data Hi	05	5	0000 0101
Reg40005 Data Lo	50	80	0101 0000
CRC	##	#	#### ####
CRC	##	#	#### ####

Additional Notes:

Communications are 9600 baud, 8 data bits, 1 stop bit, No parity, and half duplex 485.
The calibration LED will light when the transmitter is sending a response to a Master Query.

11.Low Flow Fault Options

Model 1000 Analyzers offer two low flow fault option PCB's. One monitors for low sample gas flow, and the second monitors for low airflow dilution. The Low Flow Fault option for sample gas flow is usually set for the relay contacts to fire at flow rates ≤ 100cc/min. The Flow Fault option for air dilution is usually set for the relay contacts to fire at flow rates ≤ 200cc/min. These set points are factory set. Should it become necessary to adjust the flow fault set points in the field, adjust the flow to the set point target (100 or 300cc/min.) at Rotameter(s) and adjust the potentiometer on the corresponding Low Flow Fault PCB until the fault LED toggles between "ON" and "OFF".

12.Sensor Replacement

Should the optical gas sensor element (part number 370-365878-111 for IR-640 or 370-287724-332 for IR-642) require replacement, use the following procedure:

1 - (A) If the sensor is mounted in a classified area, system power to the transmitter must first be removed before proceeding further.

(B) If the sensor is in an unclassified area, remove front enclosure cover and unplug transmitter module.

2 - Remove gas inlet adapter and tubing connections to expose sensor housing (see illustration page 35).

3 - Remove lower half of sensor housing using an Allen wrench (3 screws).

4 - Remove existing optical sensor and replace with new optical sensor.

5 - Re-install lower half of sensor housing.

6 - Restore system power (if classified) or plug in transmitter module and replace enclosure cover (if unclassified).

7 - As the unit reports "**WARMING UP**" message, use the magnetic programming tool and swipe across PGM1 or PGM2. This will take the unit into a one-time gain setting mode, which takes 1 minute to complete.

8 - Perform a new zero calibration followed by a new span calibration.

13.Troubleshooting

Reading higher or lower than anticipated
Probable Cause: No sample flow or bad Span or Zero Calibration.
1. Check for adequate sample and air f lows (per range table).
2. Check span gas is same as programmed AutoSpan value.
3. Check Span Calibration for valid concentration.
4. Re-calibrate with known good span gas.
5. Re-zero calibrate with CO_2 free gas.

"**Span Fault**" Error
1. Check for adequate sample flow and air flows (per range table).
2. Check span gas is same as programmed AutoSpan value.
3. Check Span Calibration for valid concentration.
4. Re-calibrate with known good span gas this should clear error.

"**Memory Fault**" or "**Error @ ######**" Message
Probable Cause: Microprocessor error that must be cleared.
1. Unplug transmitter module and re-plug transmitter, this may clear the fault. If not…..
2. Un-plug/Re-plug transmitter module and swipe magnet over PGM1 in the first 3 seconds.
3. This re-initializes the sensor in a process that takes 1-2 minutes.
4. Re-set programmed values for cal gas and alarms as these are lost in re-initializing.
5. Re-Zero and Re-span to restore normal operation.
6. This should clear any Memory or "**Error @ ######**" conditions.

"**Signal Fault ##**" Message
Probable Cause: Problematic IR sensor housing assembly or Faulty IR Sensor.
1. Unplug transmitter module and re-plug transmitter, this may clear the fault. If not…..
2. Un-plug/Re-plug transmitter module and swipe magnet over PGM1 in the first 3 seconds.
3. This re-initializes the sensor in a process that takes 1-2 minutes.
4. Re-set programmed values for cal gas and alarms, as these are lost in re-initializing.
5. Re-Zero and Re-span to restore normal operation.
6. This may clear any "**Signal Fault @ ######"** conditions.
7. Replace IR sensor and/or IR sensor housing assembly if necessary.

"**Lamp Fault**"
Probable Cause: IR Sensor in need of Replacement.
1. Unplug transmitter module and re-plug transmitter, this may clear the fault.
2. Remove lower section of IR Sensor housing and determine if IR light source is on and blinking.
3. If light source is not blinking replace IR sensor.

14.Spare Parts

14.1 IR Sensor

Part#	Description
942-400123-XXX	Calibration Span Gas (XXX% CO_2, balance air)
926-405502-XXX	IR-640 Transmitter Module (Where xxx is 0X3 = 0.3%, 0X5 = 0.5%, 001 = 1.00%, 003 = 3.00%, 005 = 5.00%, and higher ranges with air dilution.)
926-425502-XXX	IR-642 Transmitter Module (Where xxx is 010 = 10%, 025 = 25%, 050 = 50%, 100 = 100%)
500-002042-000	IR Connector board
017-26530H-000	O-Ring 1 3/16”ID X 1 3/8”OD X 0.103”W
370-365878-111	CO_2 Plug-in Optical Replacement Sensor (IR640)
370-287724-332	CO_2 Plug-in Optical Replacement Sensor (IR-642)
390-000088-000	IR-640 CO_2 Sensor Housing Assembly (does not include replacement cell)
390-000088-0HR	IR-642 CO_2 Sensor Housing Assembly (does not include replacement cell)
897-850901-010	Aluminum 3 port enclosure with window
960-202200-000	Condensation Prevention Packet (replace annually)

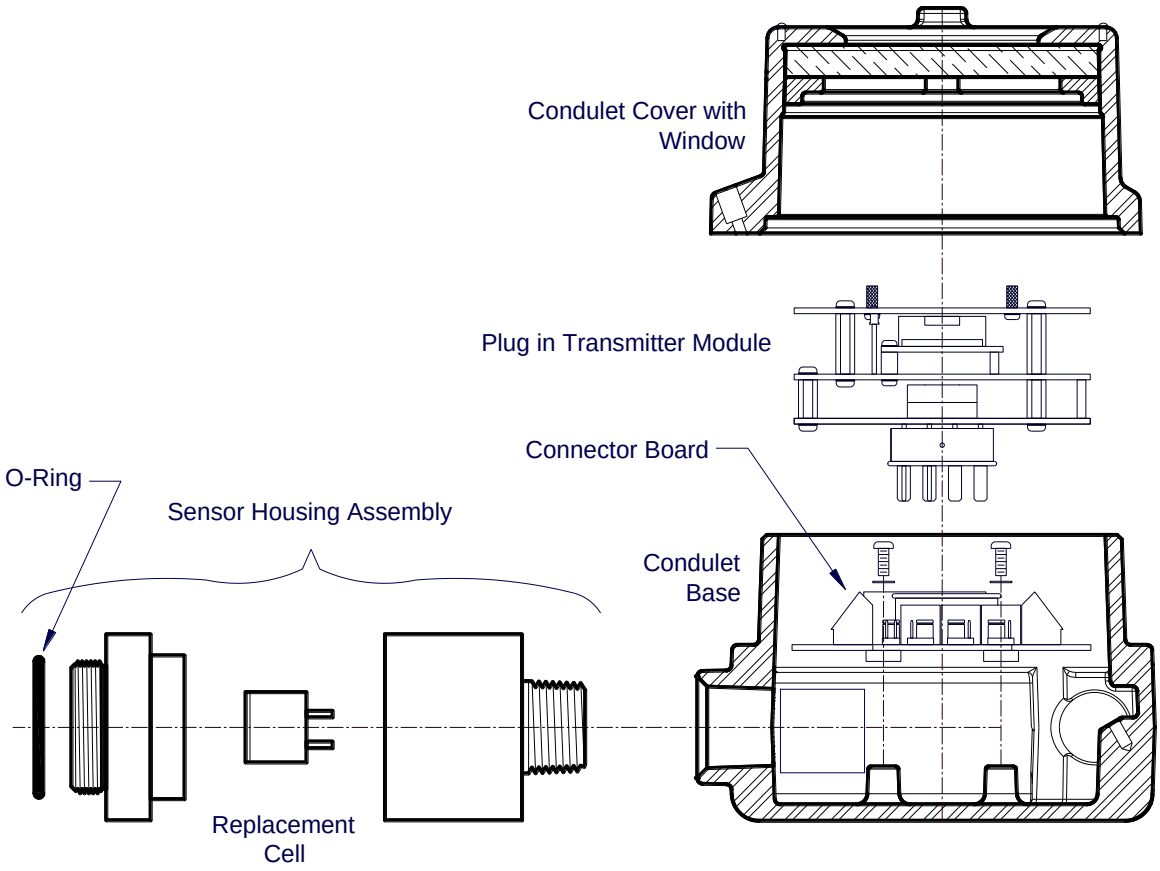

Figure 16 IR-640/IR-642 Replacement Parts

14.2 Analyzer Spare Parts

Part#	Description
327-000000-000	Programming Magnet
351-152021-400	24 VDC Pump Assembly
360-205421-024	24 VDC Power Supply Assembly
360-2424GH-030	24V DC-DC Converter
943-200000-000	Activated Carbon Scrubber
943-010013-505	500 CC Fixed Flow Regulator
823-101085-882	Genie Membrane Filter
350-300000-000	0.5Lpm Rotameter no valve
348-900000-000	1Lpm Rotameter with valve
350-523081-02K	Mass flow controller
500-005151-002	(Optional) Low Flow Fault Sensor and Switch Assy

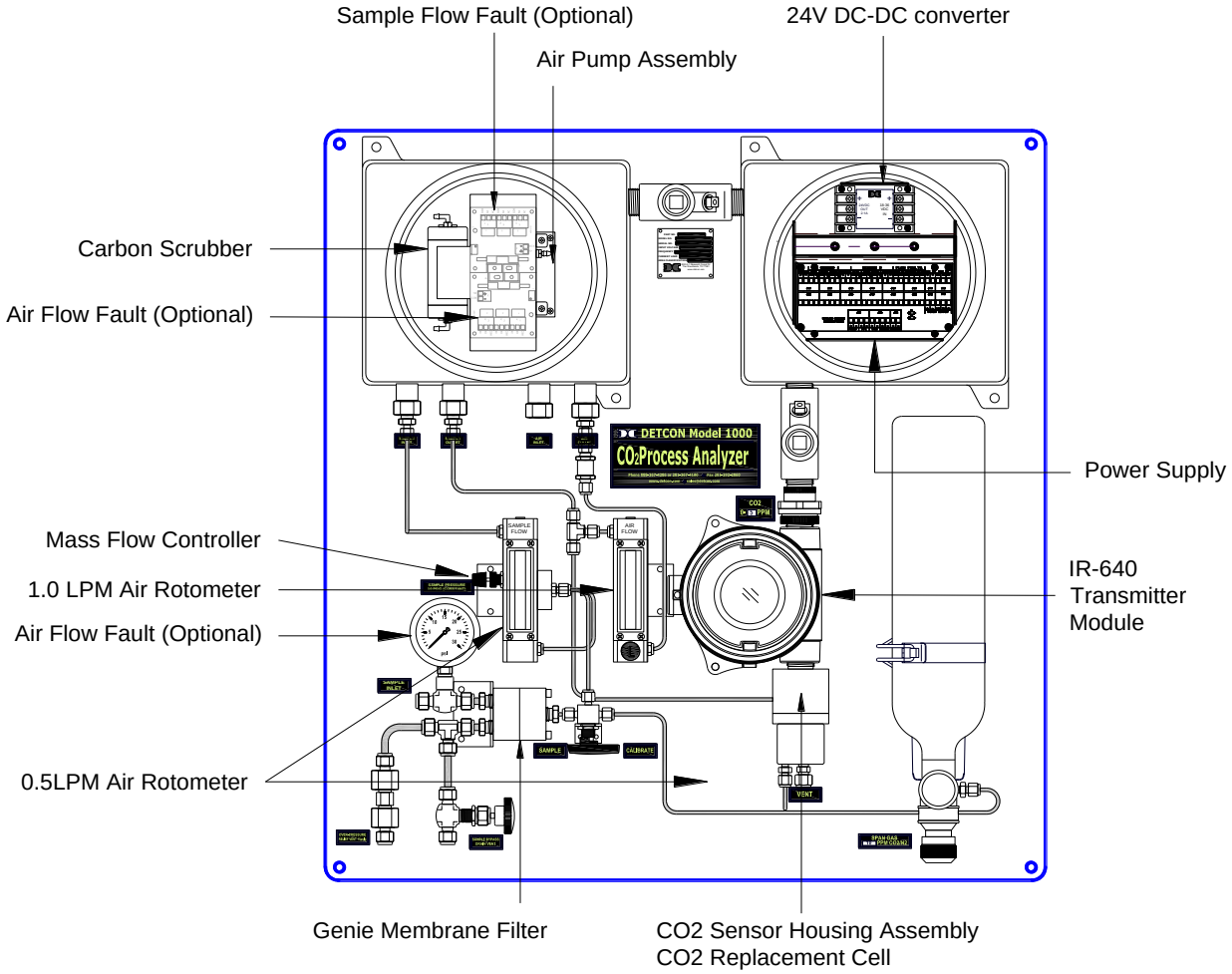

Figure 17 Analyzer Spare Parts

15.Warranty

Detcon Inc., as manufacturer, warrants under intended normal use each new Model 1000 Series H_2S Process Analyzer gas detection system to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. All warranties and service policies are FOB the Detcon Inc. facility located in The Woodlands, Texas.

Sensor Transmitter

Detcon, Inc., as manufacturer, warrants under intended normal use each new MicroSafe™ plug-in control circuit to be free from defects in material and workmanship for a period of two years from the date of shipment to the original purchaser.

Detcon, Inc., further provides for a five year fixed fee service policy wherein any failed transmitter shall be repaired or replaced as is deemed necessary by Detcon, Inc., for a fixed fee of $65.00. The fixed fee service policy shall affect any factory repair for the period following the two-year warranty and shall end five years after expiration of the warranty. All warranties and service policies are FOB the Detcon facility located in The Woodlands, Texas.

IR-640/IR-642 CO_2 Plug-in Sensor Warranty

Detcon, Inc., as manufacturer, warrants each plug-in optical sensor to be free from defects in material and workmanship under intended normal use for a period of 5 years according to the following schedule:
2 Years No Charge
3rd 25% of replacement charge
4th 50% of replacement charge
5th 75% of replacement charge
Beyond 100%% of replacement charge

16.Flow Diagrams

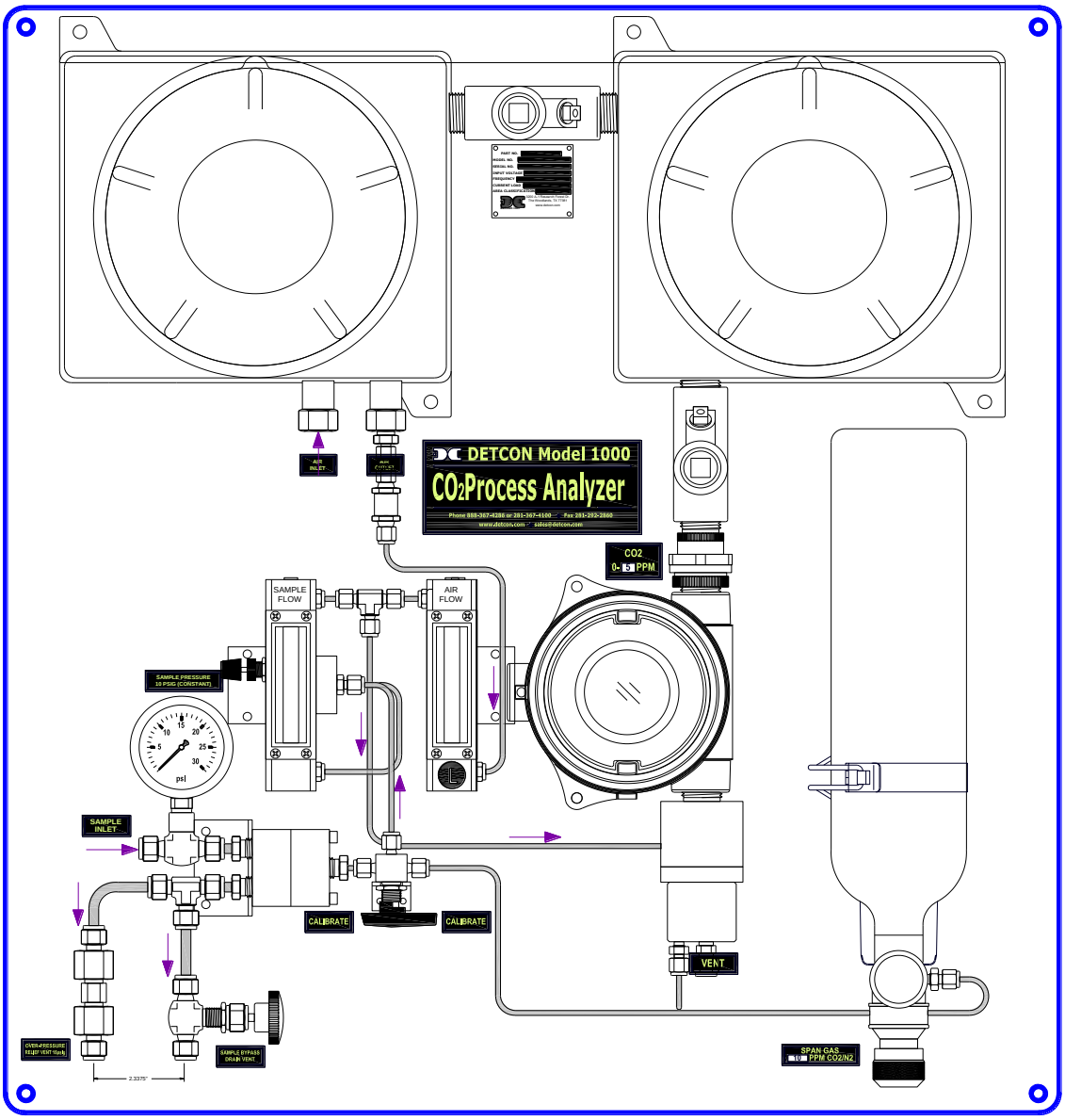

Figure 18 Unit Flow Diagram

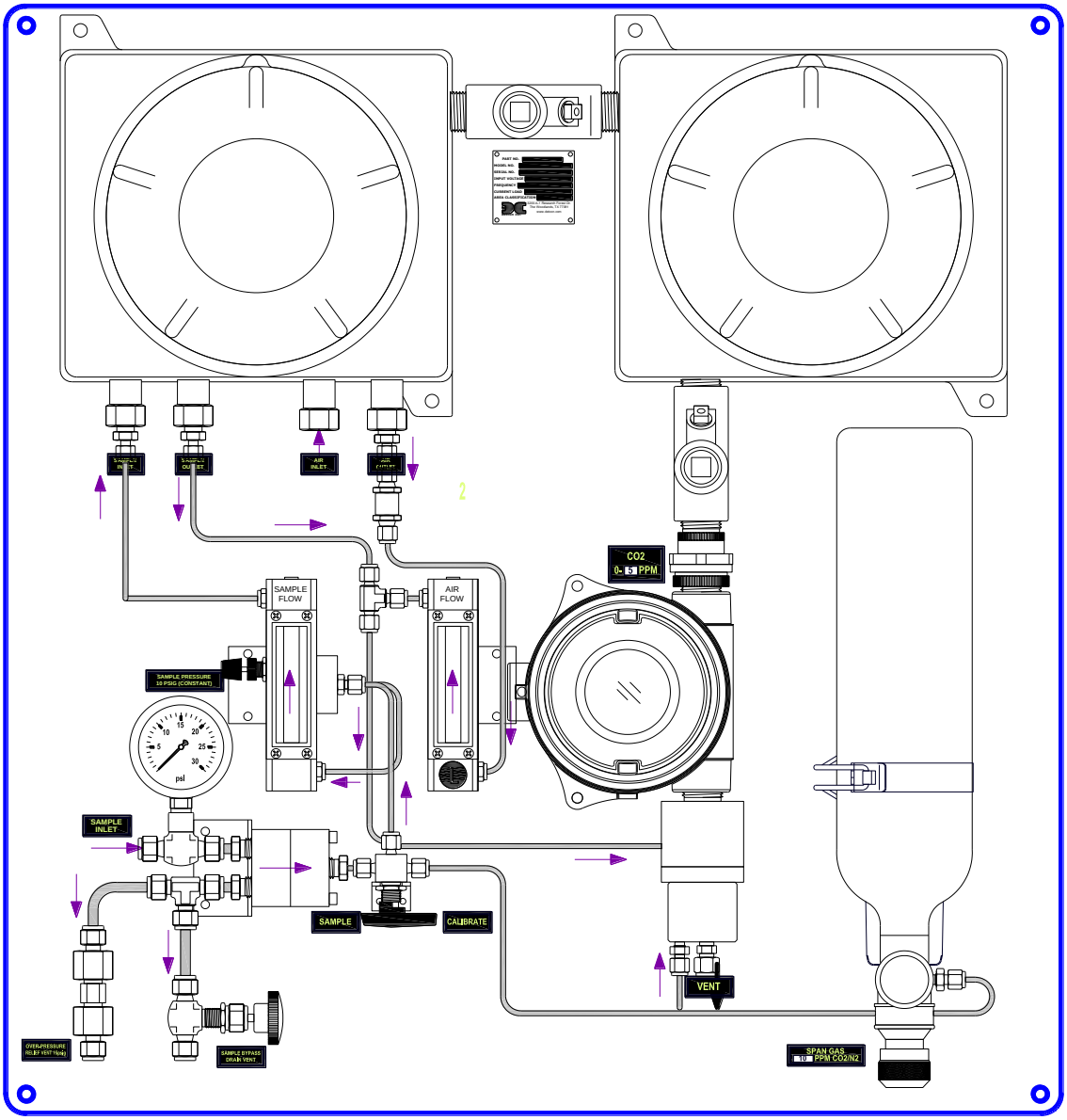

Figure 19 Unit Flow Diagram with Flow Fault

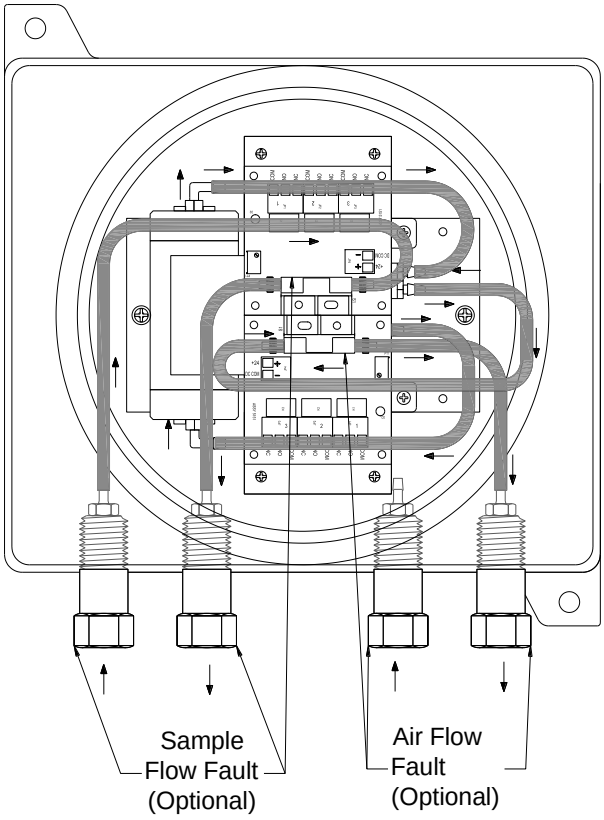

Figure 20 Pump Box Flow Diagram

17.Wiring Diagram

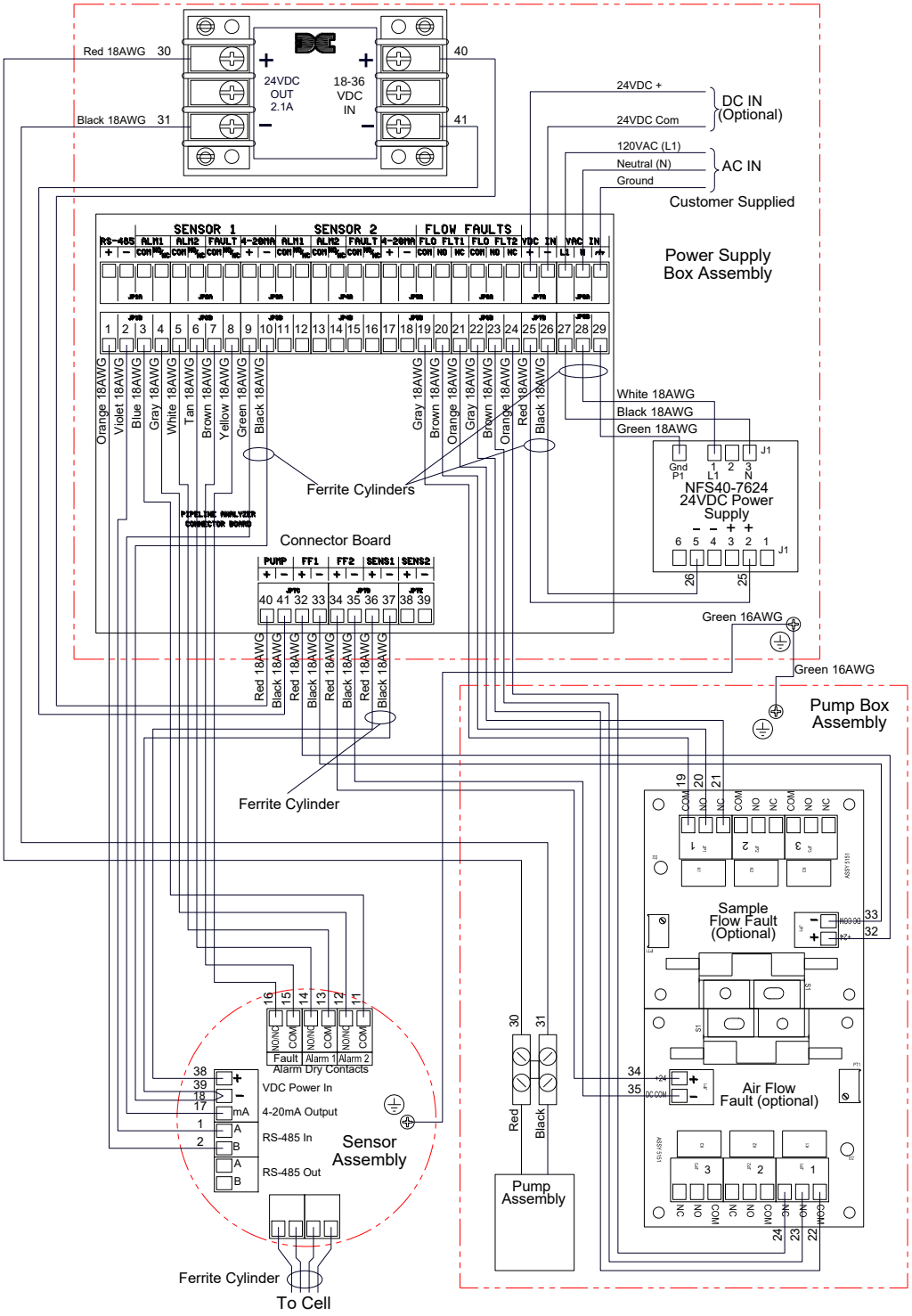

Figure 21 Wiring Diagram

Appendix C

Revision Log

Revision	Date	Changes made	Approvals
2.0	03/30/09	Combined low range and high range CO2 manuals into one	BM
2.1	06/01/11	Updated drawings and spare parts. Added Revision Log	LU
2.2	09/19/11	Updated annotation regarding VDC input in section 3 to match wiring diagram	LU
2.3	04/13/13	Addition of Air Dilution for high ranges of gas	LU
2.4	07/13/13	Correction to Table 2, and other references to Table 2	LU
2.5	04/25/17	Update parts list to cover New 0-5% Plugin Cell Clarifications related to the 0-15% air dilution configuration	BM
2.6	05/03/18	Classifications Updated	MM
2.7	12/04/18	Revert to prior validated plug-in cell and associated spares	JG

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