SUPPLEMENTAL OXYGEN

MANUAL FOR MODELS

100, 200, 300 ANALYZERS

gasanalyzers.com

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Preface

This instruction manual is supplemental to the Model 100/200/300 Operations and Maintenance Manual for infrared analyzers. It is sent whenever oxygen is one of the measured parameters of the analyzer.

The oxygen measurement information is divided into two parts:

- Part 1 – Oxygen by chemical fuel cell sensor techniques.
- Part 2 – Oxygen by paramagnetic oxygen sensor techniques.

Please refer to the appropriate part of this supplemental manual according to the method of oxygen determination for your particular analyzer.

Thank you.

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Part 1 – Oxygen by Chemical Fuel Sensor Techniques

1. FUEL CELL DETECTOR OPTION

1.1. Description Fuel Cell Detector Option

The fuel cell option utilizes a low cost replaceable fuel cell to determine the percent level of oxygen contained in the sample gas. A fuel cell analyzer features linear output with low noise and excellent repeatability from 0 to 100% O_2.

It is available in two versions, one for oxygen levels up to 25 % and the second for oxygen up to 100%.

Warning: This is a general-purpose analyzer, not suitable for hazardous areas. High-pressure oxygen is very dangerous. Virtually any material will burn in it, possibly explosively. It is essential that persons using this analyzer are aware of the dangers of oxygen, and take all appropriate precautions.

1.2. Product Specifications (Galvanic Fuel Cell Detector)

SAMPLE CONTACT MATERIAL: Stainless steel, Teflon* and Tygon**

RANGES: Standard fixed ranges, either A or B

A) Range 1: 0 to 5%; Range 2: 0 to 10%; Range 3: 0 to 25%

B) Range 1: 0 to 25%; Range 2: 0 to 40%; Range 3: 0 to 100%

RESPONSE TIME: 90% full scale in 5 seconds

NOISE: Less than 1% full scale

LINEARITY: Better than 1% full scale

REPEATABILITY: Better than 1% full scale

ZERO SPAN DRIFT: Less than 1% full scale in 24 hours

ZERO & SPAN ADJUSTMENT: Ten turn potentiometer

DISPLAY: 3 ½" digit panel meter

OUTPUTS: 0 to 10 VDC and 4 to 20 mA (0 to 20 mA)

AMBIENT TEMPERATURE: 5 to 45° C

SAMPLE TEMPERATURE: 0 to 50° C

SAMPLE CONDITION: Particles < 1µ, non-corrosive dry gas

FITTINGS: ¼" tube

SAMPLE FLOW RATE: 0.5 –2.0 L/Min

Power Requirements: 115/230 (± 10%) VAC, 50/60 Hz, 70 watts/channel

Relative Humidity: Less than 90% R.H.***

Specifications subject to change without notice

*Teflon is a registered trademark of DuPont.

**Tygon is a registered trademark of the Norton Performance Plastics Corporation

***Non-condensing

1.3. Principle of operation

The fuel cell option is designed to measure percent levels of oxygen. The analyzer uses a galvanic fuel cell, which is an electrochemical transducer. The fuel cell contains a cathode, anode, and an electrolyte. A permeable membrane holds the electrolyte in the cell. The sample flows over the membrane and oxygen diffuses in to the fuel cell where it reacts with the electrolyte. This reaction produces an electrical current. This current is directly proportional to the concentration of oxygen in the gaseous mixture surrounding the cell. The current output is linear with an absolute zero. The fuel cell produces no current in the absence of oxygen.

1.4. Oxygen Fuel Cells

The standard oxygen sensor (type PSR-39-11) has a shelf life of approximately three years. It is designed to measure oxygen in ambient air. The other gases contained in ambient air are low enough concentrations so as not to be a factor of concern. When used for ambient air measurement the manufacturer estimates the life of the sensor to be approximately three years.

If the standard PSR type sensor is used to measure pure oxygen, oxygen in flue gas or oxygen in stack emissions the life of the standard PSR type sensor will be shorter.

One of the most common emission gases is CO_2 and is usually found in concentrations of between 4-20 percent by volume. High levels Of CO_2 change the pH of the gel and thus shorten the life of the standard PSR type sensor. The life expectancy dramatically shortens from three years to approximately four weeks at CO_2 concentrations of 20% volume.

For the reason stated above, sensor type XLT-39-11 was developed. The XLT type sensor has an electrolytic gel that is strongly buffered and highly caustic. A caustic gel is required to combat the effects of high CO_2 concentrations. The average life of this type of sensor is approximately eight to ten months at CO_2 levels of 20% by volume; however, the caustic nature of the electrolytic gel creates vapors that clog the cell membrane within a very short time if the cell is not put into immediate use. The shelf life of this type of sensor is approximately two weeks if not stored at a cold, constant temperature. A shelf life of 30 days or so can be achieved if the sensor is kept refrigerated.

As previously stated the XLT-39-11 sensor was developed for use in sample gases containing high levels Of CO_2 (approximately 20% volume. or greater). It provides a longer life at high CO_2 levels, but the linearity of response has been sacrificed. Typical linearity with this type of sensor is within ± 1% Volume O_2.

Because of the non-linearity issue, a third type of sensor was developed. Type XLT-39-11-1 provides a signal that is linear to within ± 0.25% volume O_2. This sensor has an average life of eight to ten months at medium CO_2 levels of 10% by volume. Levels of CO_2 at 20% by volume will shorten the life of this sensor to approximately 3-4 months. The shelf life of this sensor is similar to the XLT-39-11.

2. Preparations for Operation

Warning: This is a general-purpose analyzer, not suitable for hazardous areas. High-pressure oxygen is very dangerous. Virtually any material will burn in it, possibly explosively. It is essential that any persons using this analyzer are aware of the dangers of oxygen, and take all appropriate precautions.

2.1. Power On

Turn ON the power switch located on the rear panel. The digital panel meter should illuminate. Allow the instrument to warm up for approximately 10 minutes. It is preferable, but not essential, that zero gas flow through the instrument during warm-up.

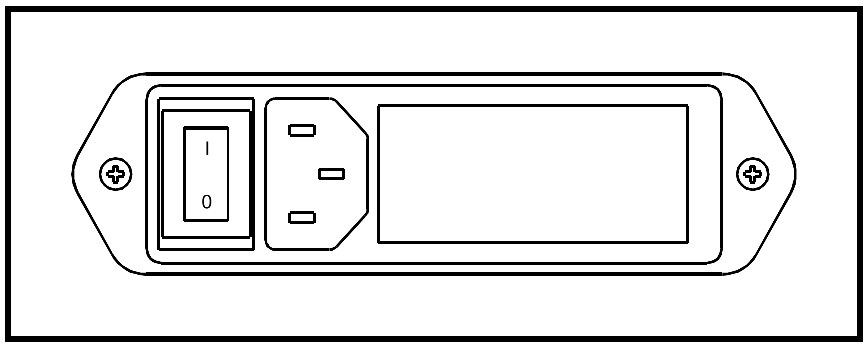


Figure 2-1 AC Power Switch, Connector, and Fuse

2.2. Zero Adjustment

Zero Adjustment: After the 10 minute warm-up period, flow nitrogen or other zero gas through the instrument at a rate of about 1 liter/min. After the reading stabilizes, adjust the zero control on the front panel until the digital meter (or analog output) is exactly at zero. Nitrogen is the preferred zero Gas.

2.3. Span Adjustment

Span Adjustment: Flow span gas through the instrument at about 1 liter/min. After the reading stabilizes, adjust the span control on the front panel until the digital meter or analog output is reading the value corresponding to the span gas concentrations.

Note: Span gas concentration should not be less than 80% of the range to be spanned.

Note: On the 0-25% range of the analyzer ambient air may be used as span gas. While ambient air is flowing to the analyzer, adjust the span potentiometer to 20.9% O_2.

2.4. Start-Up & Routine Maintenance

Prepare and check the sample system. Adjust the flow of sample gas to about 1 liter/min. Select an operating range that is suitable for the oxygen concentration of the sample. The instrument should show a meter indication. The analyzer is designed for extended operation and may be left switched ON continuously.

2.5. Zero and Span Calibration Frequency

The zero and span levels should be checked and/or calibrated daily or as often as mandated.

3. ADJUSTMENTS CHECKS AND REPAIRS

Note: A millivolt generator is required for this procedure.

3.1. Electrical Zero Adjustments

a) Disconnect the plug (P3) from J3 on the printed circuit board (PCB). (P3 is on the end of the cable assembly coming from the oxygen sensor.)

b) Connect a millivolt generator between pin no. 1 (-) and pin no. 2 (+) at J3 on the PCB.

c) Adjust simulator for 000.00 mv ± 0.01 mv input as measured at TP-8 (+) and common (-).

d) Adjust Front panel zero potentiometer for 000.00 mv ± 0.01 mv as measured between TP-9 and common

e) Set front-panel range switch to Range 1.

f) Adjust R8 for 000.00 mv ± 0.01 mv as measured at TP-4.

g) Adjust R12 for 0.000 VDC ± 0.001 VDC as measured between the 0-10 VDC (+) output terminal and common.

h) Adjust R20 for 4 mA ± 0.01 mA across the 4-20 mA output terminals.

i) Verify O_2 display reads 000.0 for all ranges.

j) Repeat steps a) through j) until no further adjustment is required.

3.2. Electrical Span Adjustments

Note: Electrical zero adjustments must be made before electrical span adjustments.

a) Adjust the millivolt generator and the front-panel span-potentiometer (as necessary) for exactly 50.00 mv as measured between TP-9 and common.

b) Set front-panel range switch to range 1.

c) Set O_2 display selector switch (SW2) to percent (%) O_2 mode. Display should read 5.0.

d) Adjust R4 for 1.000 VDC ± 0.001 VDC as measured at TP-4.

e) Set range switch to Range 2 and adjust R3 for 0.500 VDC ± 0.001 VDC at TP-4.

f) Set range switch to Range 3 and adjust R32 for 0.200 VDC ± 0.001 VDC at TP-4.

g) Set range selector to range 1 and verify 1.000 VDC ± 0.00 VDC at TP-4.

h) Adjust R33 for 10.00 VDC ± 0.01 VDC as measured across the 0-10 VDC output terminals.

i) Adjust R24 for 20 mA ± 0.01 mA as measured between the 4-20 mA output terminals. at TP-4

j) Repeat steps a) through j) until no further adjustment is required.

Note: the voltages given in steps e) and f) assume the analyzer is configured for the standard ranges of 0-5, 10, and 25% O_2. Consult the factory for the correct voltages required for other non-standard range configurations.

3.3. The Oxygen Sensor

The output of the oxygen sensor is a DC output of approximately –10 millivolts at 20.9 % O_2. As the sensor is used, it gradually becomes consumed and its voltage output slowly diminishes towards 0 millivolts. Periodic zero and span calibration should be preformed to insure accurate oxygen measurement over the sensor's life span. Whenever the front panel span potentiometer runs out of adjustment capability it will be necessary to perform a coarse-span-adjustment.

3.3.1. Coarse-Span-Adjustment

a) Lift the cover from the analyzer by first removing the retaining screws that secure the cover to the chassis.

b) Adjust the front panel potentiometer to its mid-setting. The span dial should indicate 5.0.

c) Flow N_2 into the analyzer at a flow rate of 1 L/MIN (± 0.5). After the reading stabilizes, adjust the front panel zero potentiometer for an indication of 0.0% O_2.

d) Flow an oxygen span gas into the analyzer at a flow rate of 1.0 L/MIN (± 0.5).

e) Locate R27 on the printed circuit board and adjust it as required to obtain a digital display that is equivalent to the value of the span gas being used.

3.3.2. Sensor Checks

a) Connect a DC voltmeter to TP-8 (+) and TP-2 common.

b) Introduce a span gas of 21%

c) The measured voltage at TP-8 should be between –3 mv and –13 mv.

d) Whenever the measured voltage is less than –3 mv (or whenever the signal stability becomes an issue) the sensor should be replaced.

Note: A new sensor has a specification of –10 mv (± 3 mv) when measuring 21% O^2 at sea level. A correction factor (cf) must be applied to this specification whenever the measuring site is at higher elevations.

$$Corrected\ output = -10mv \times cf \quad Where: cf = \frac{site\ barometric\ pressure\ (''hg)}{30''hg}$$

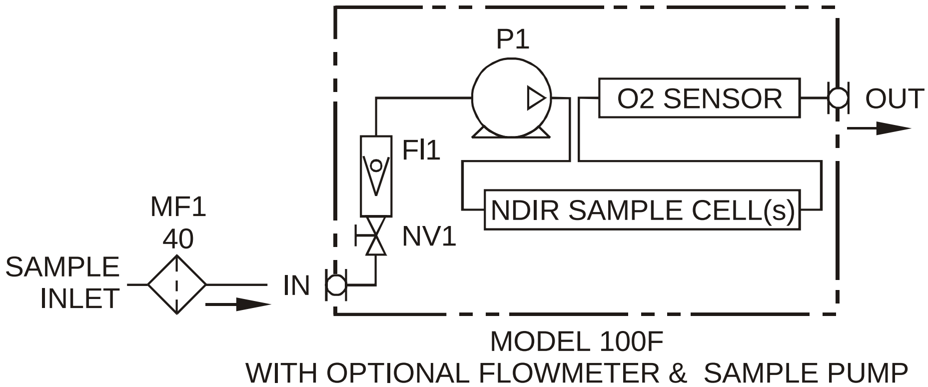
$$Where\ ''hg = inches\ of\ mercury$$

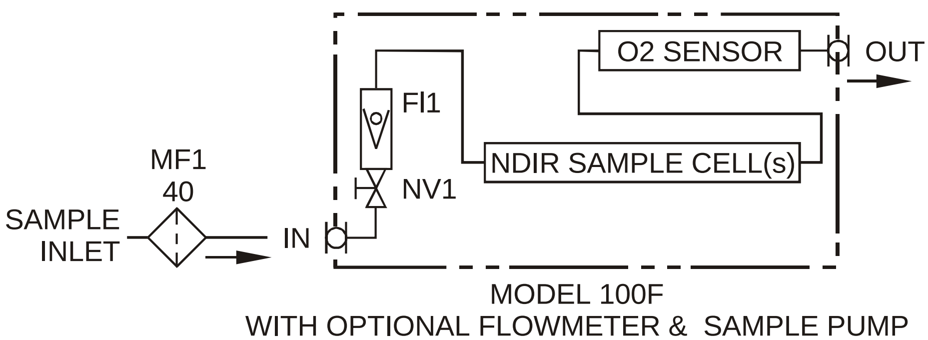
3.3.3. Sensor Replacement

a) Refer to section 2.1 of this manual for selection of the proper type of replacement sensor

b) After replacing sensor it will be necessary to perform a coarse-span-adjustment (refer to paragraph 5.3.1).

4. Chemical Fuel Cell Sample Flow (Supplemental)





4. IN-LINE FILTER (MF1) CUSTOMER SUPPLIED.

3. INLET & OUTLET CONNECTIONS ARE 1/4" OD TUBE.

2. SAMPLE FLOW RATE: 0.5 L/min to 2.0 L/min.

1. SAMPLE PRESSURE: 1-5 PSIG (NOT REQUIRED WITH OPTIONAL SAMPLE PUMP).

NOTES: UNLESS OTHERWISE SPECIFIED.

Figure 4-1 Chemical fuel cell sample flow

5. Electrical Drawings

- Figure 5-1 100F O2 analyzer wiring diagram
- Figure 5-2 100F O2 electrical schematic
- Figure 5-3 100F O2 PCB component locator

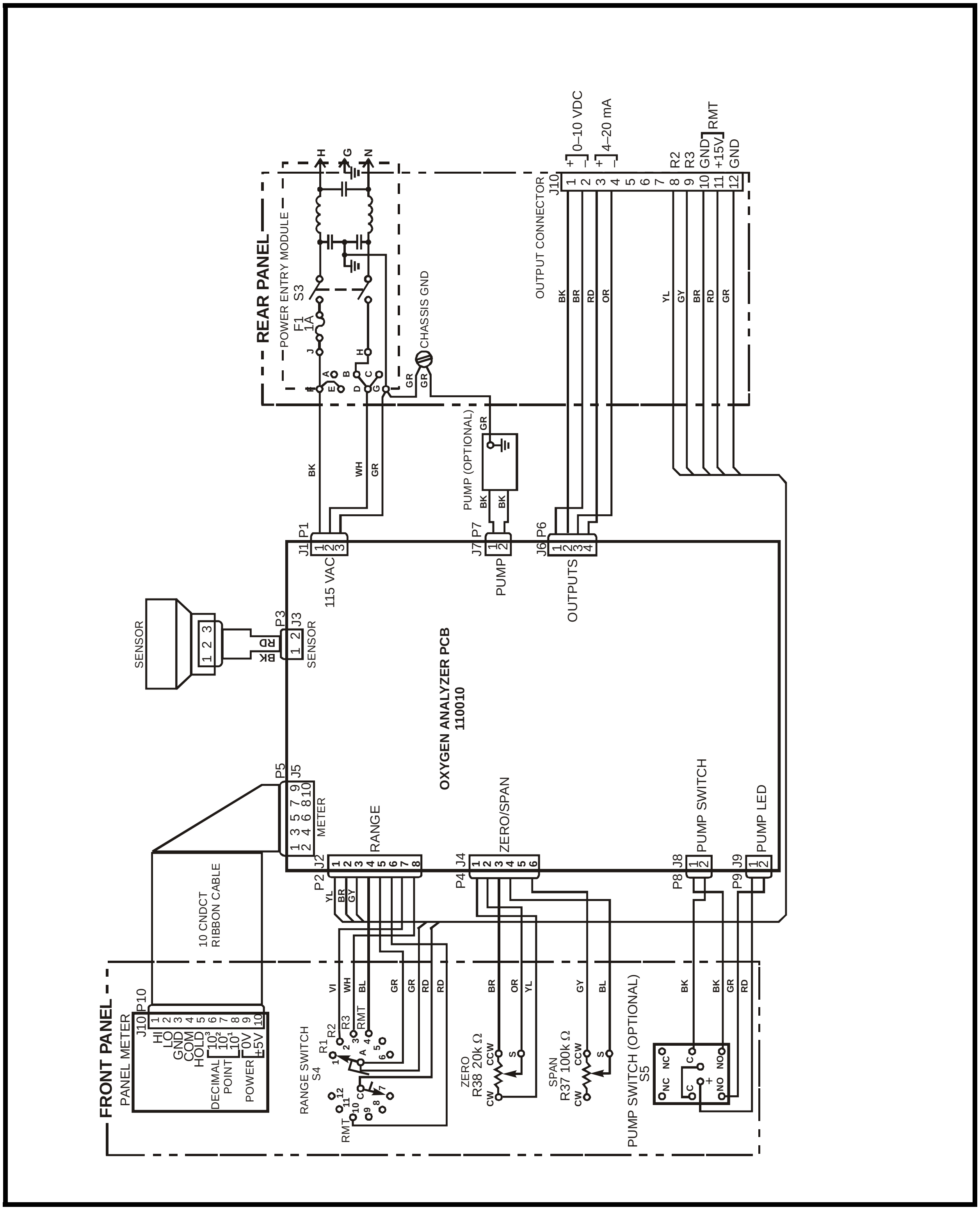


Figure 5-1 100F O_2 analyzer wiring diagram

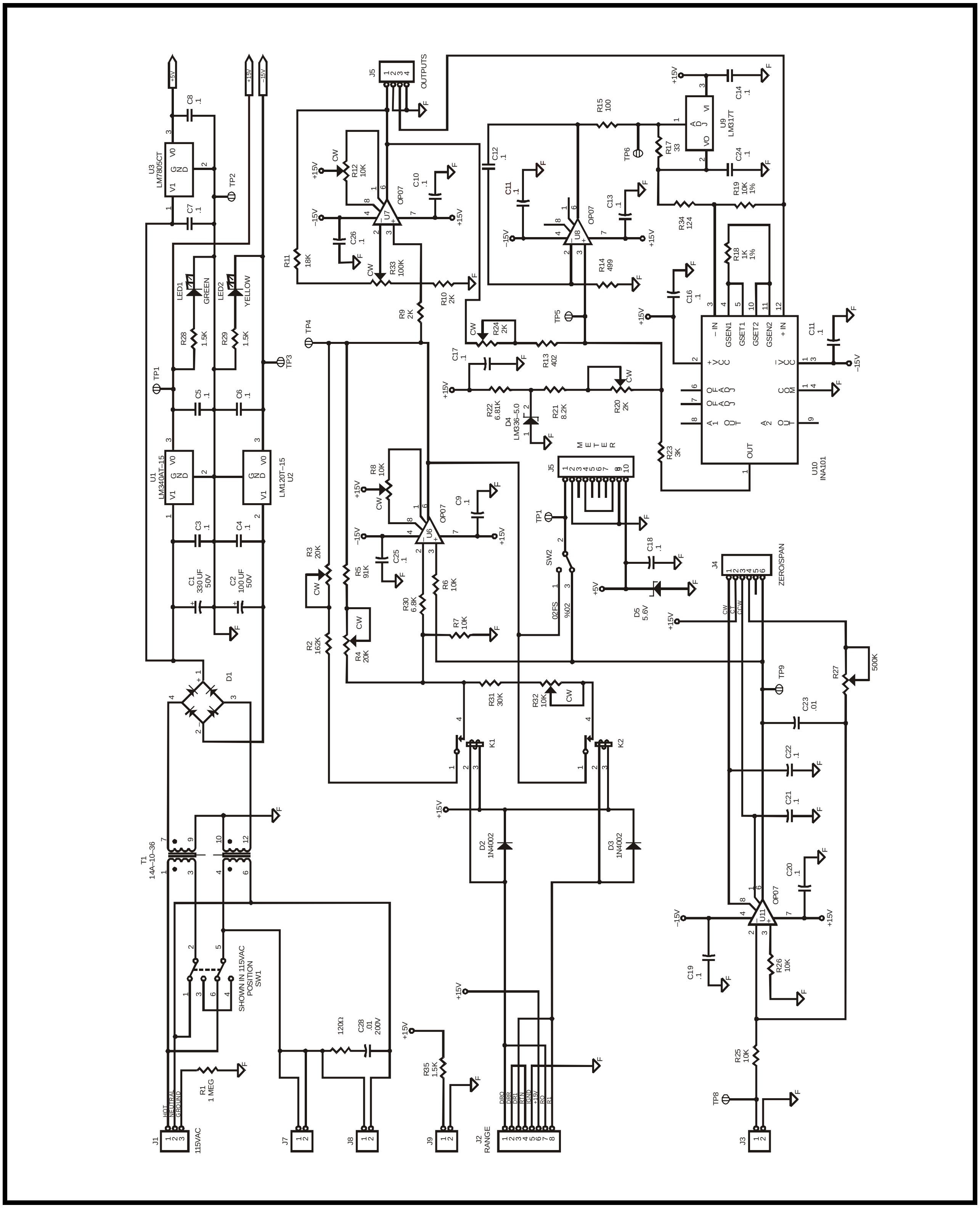


Figure 5-2 100F O_2 electrical schematic

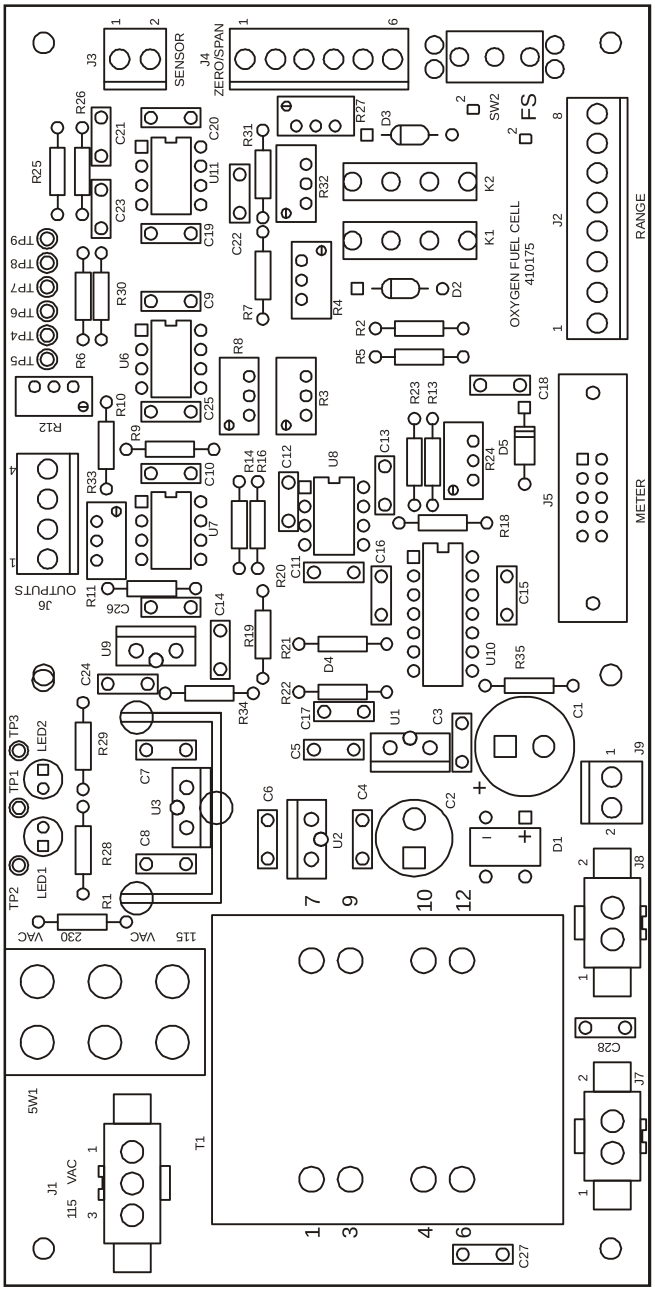


Figure 5-3 100F O_2 PCB component locator

Part 2 – Oxygen by Paramagnetic Oxygen Sensor Techniques

6. PARAMAGNETIC OXYGEN OPTION

6.1. Description

The Paramagnetic Oxygen detector is a thermostated device designed primarily for but not necessarily limited to stationary use. It is a ‘19” rack mount analyzer that is also suitable for bench top use. The operation of the analyzer is based upon the principle of the magneto-dynamic oxygen cell, which is the most accurate and reliable cell for determining the oxygen content of a gas mixture from 0-100 volume percent oxygen.

Warning: This is a general-purpose analyzer, not suitable for hazardous areas. High-pressure oxygen is very dangerous. Virtually any material will burn in it, possibly explosively. It is essential that any persons using this analyzer are aware of the dangers of oxygen, and take all appropriate precautions.

6.2. Product Specifications Paramagnetic Oxygen Detector

SAMPLE CONTACT MATERIAL: Platinum. glass, stainless steel and Viton, Teflon* and Tygon**

RANGES: Standard fixed ranges, either A or B or C

A) Range 1: 0 to 1%; Range 2: 0 to 15%; Range 3: 0 to 25%

B) Range 1: 0 to 5%; Range 2: 0 to 10%; Range 3: 0 to 25%

C) Range 1: 0 to 25%; Range 2: 0 to 40%; Range 3: 0 to 100%

RESPONSE TIME: 90% full scale in 2 seconds

NOISE: Less than 1% full scale

LINEARITY: Better than 1% full scale

REPEATABILITY: Better than 1% full scale

ZERO SPAN DRIFT: Less than 1% full scale in 24 hours

ZERO & SPAN ADJUSTMENT: Ten turn potentiometer

DISPLAY: 3 ½" digit panel meter

OUTPUTS: 0 to 10 VDC and 4 to 20 mA (0 to 20 mA)

AMBIENT TEMPERATURE: 5 to 45° C

SAMPLE TEMPERATURE: 0 to 50° C

SAMPLE CONDITION: Particles < 1μ, non-corrosive dry gas

FITTINGS: ¼" tube

SAMPLE FLOW RATE: 0.5 –2.0 L/MIN

Power Requirements: 115/230 (± 10%) VAC, 50/60 Hz, 70 watts/channel

Relative Humidity: Less than 90% R.H.***

Specifications subject to change without notice

*Teflon is a registered trademark of DuPont.

**Tygon is a registered trademark of the Norton Performance Plastics Corporation

***Non-condensing

6.3. Principle of operation

The paramagnetic susceptibility of oxygen is significantly greater than that of other common gases, and consequently, the molecules of oxygen are attracted much more strongly by a magnetic field than the molecules of the other gases. Most of the other gases are slightly diamagnetic which means that their molecules are then repelled by a magnetic field.

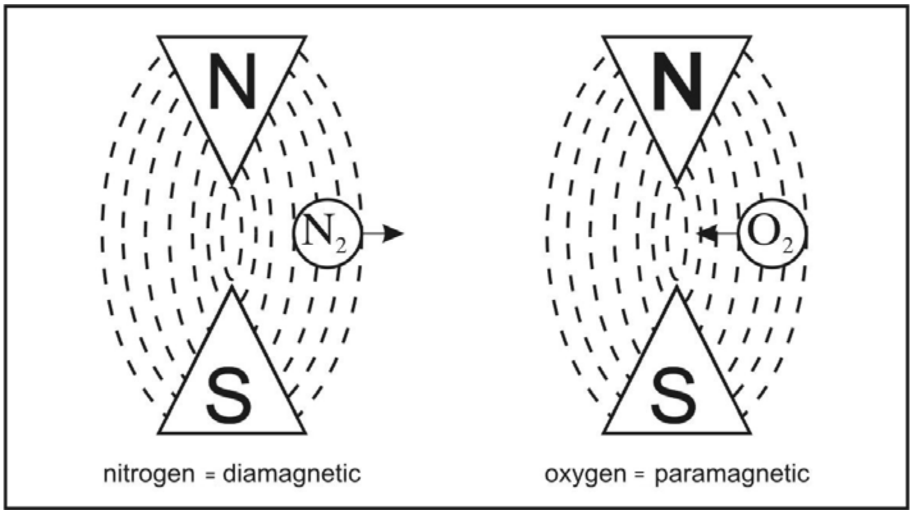


Figure 6-1 Magnetic Susceptibility of gases

The principle of the magneto-dynamic cell is based upon Faraday's method of determining the magnetic susceptibility of a gas. The cell consists of two nitrogen-filled quarts spheres arranged in the form of a dumbbell. A single turn of platinum wire is placed around the dumbbell that is suspended in a symmetrical non-uniform magnetic field.

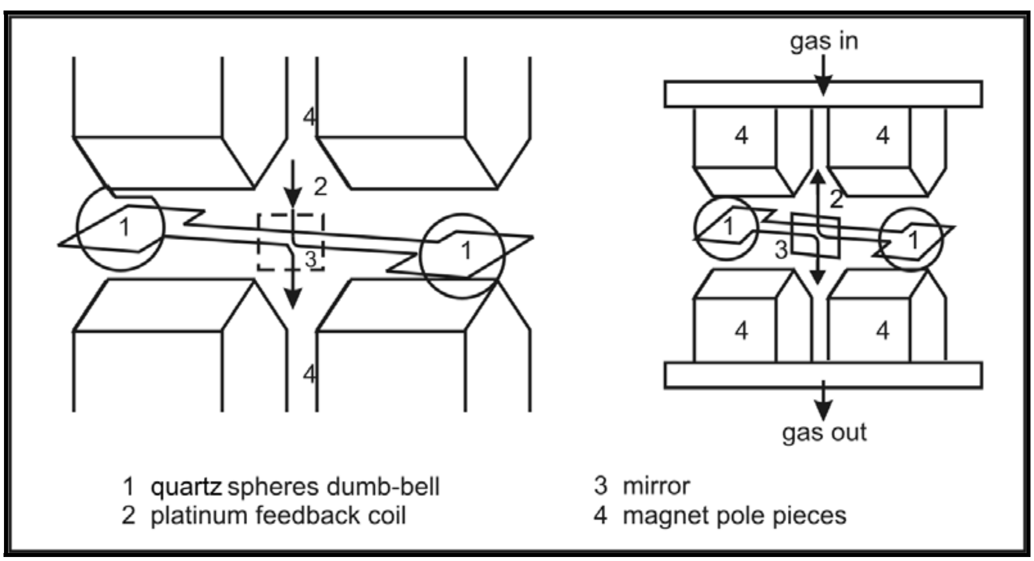


Figure 6-2 The Measuring cell in theory

When the surrounding gas contains oxygen, the dumbbell spheres are pushed out of the magnetic field by the change in the field that is caused by the relatively strong paramagnetic oxygen. The torque acting on the dumbbell will be proportional to the paramagnetism of the surrounding gas and, therefore, it can be used as a measure of the oxygen concentration.

The distortion of the dumbbell is sensed by a light beam and projected on a mirror attached to the dumbbell whereof it is reflected to a pair of photocells. When both photocells are illuminated equally, the output will be zero. The output from the photocells is connected to an amplifier, which in turn is fed to the feedback coil of the measuring cell. If the oxygen content of the gas sample changes, the corresponding current output of the amplifier, which is proportional to the oxygen content, produces a magnetic field in the feedback coil opposing the forces and thereby causing the dumbbell to rotate.

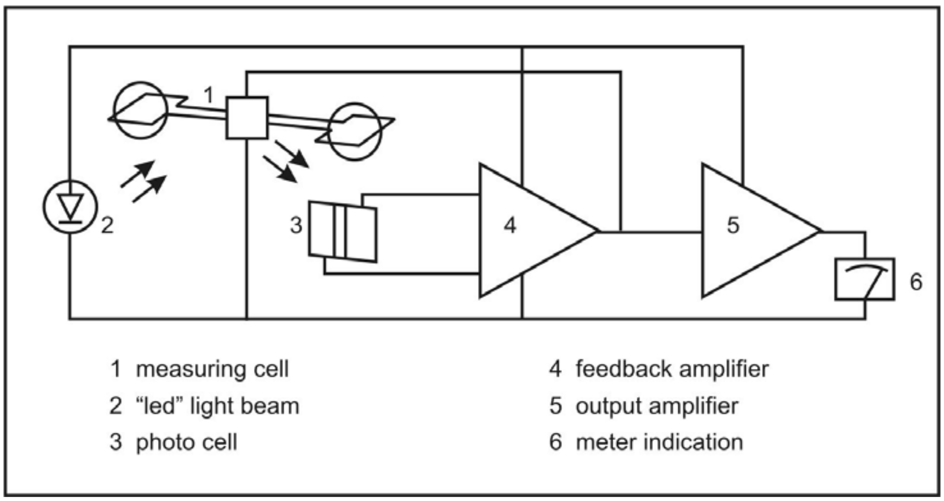


Figure 6-3 Principle of operation

Since the feedback current from the amplifier is proportional to the oxygen content of the gas sample, the output signals that are produced by the amplifier will be accurate and linear. The paramagnetic susceptibility of oxygen varies inversely as the square of the absolute temperature. To provide compensation for changes in analyzer temperature, a temperature sensitive element in contact with the measuring cell assembly, is included in the feedback current circuit.

7. Preparations for Operation

Warning: This is a general-purpose analyzer, not suitable for hazardous areas. High-pressure oxygen is very dangerous. Virtually any material will burn in it, possibly explosively. It is essential that any persons using this analyzer are aware of the dangers of oxygen, and take all appropriate precautions.

7.1. Power On

Turn ON the power switch on the rear panel. The digital panel meters should illuminate. Allow the instrument to warm up for approximately one hour. It is preferable, but not essential, that zero gas flow through the instrument during warm-up.

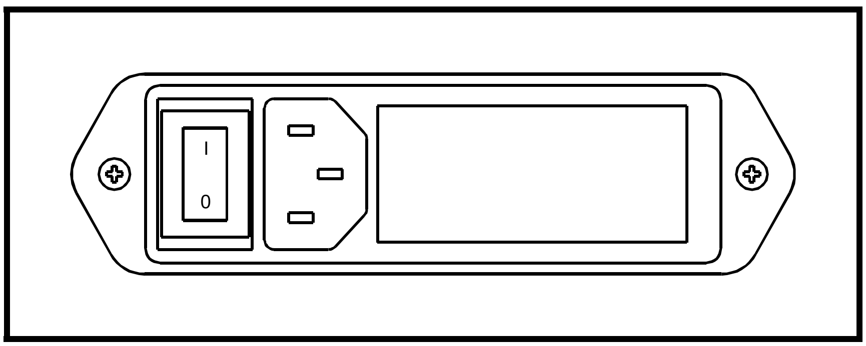


Figure 7-1 AC Power Switch, Connector, and Fuse

Note: DO NOT introduce the sample gas UNTIL the analyzer has *warmed-up. This will help prevent condensation from forming in the sample cell.*

7.2. Zero Adjustment

After the one-hour warm-up period, flow zero gas (see Section - Gases) through the instrument at a rate of about 1 liter/min. Adjust the zero control on the front panel until the digital meter (or analog output) is exactly at zero. To achieve final stability, the analyzer may require some additional warm-up period/up to four hours (depending on variables in the analyzer's environment).

7.3. Span Adjustment

Flow span gas through the instrument at about 1 liter/min. Adjust the span control on the front panel until the digital meter or analog output is reading the value corresponding to the span gas concentrations.

Note: Span gas concentration should not be less than 80% of the range to be spanned.

Note: On the 0-25% range of the analyzer ambient air may be used as span gas. While ambient air is flowing to the analyzer, adjust the span potentiometer to 20.9% O_2.

7.4. Zero and Span Calibration Frequency

The zero and span levels should be checked and/or calibrated daily or as often as mandated.

8. Start-Up & Routine Operation

Prepare and check the sample system. Adjust the flow of sample gas to about 1 L/min. The instrument should show a meter indication. The paramagnetic oxygen analyzer is designed for extended operation and may be left switched ON continuously.

8.1. Sampling System

Note: High-pressure oxygen is very dangerous. Virtually any material will burn in it, possibly explosively. It is essential that any person using this analyzer is aware of the dangers of oxygen, and take all appropriate precautions.

The analyzer's sampling system consists of:

1. An internally mounted in line particulate filter
2. A sample pump and flow meter (optional)
3. A sample capillary that controls the sample flow rate to the sensor at 0.2 LPM (or 0.5 depending upon model of O_2 sensor.
4. A precision controlled relief valve.

The relief valve maintains a constant inlet pressure to the sample capillary and reduces response time by providing a bypass loop to the exhaust for excess sample.

The analyzer is designed to measure a clean dry sample gas that has been conditioned to remove moisture to prevent condensation in the analyzer. Some applications may require additional sample conditioning, dependent upon the specifications of the sample gas to be measured.

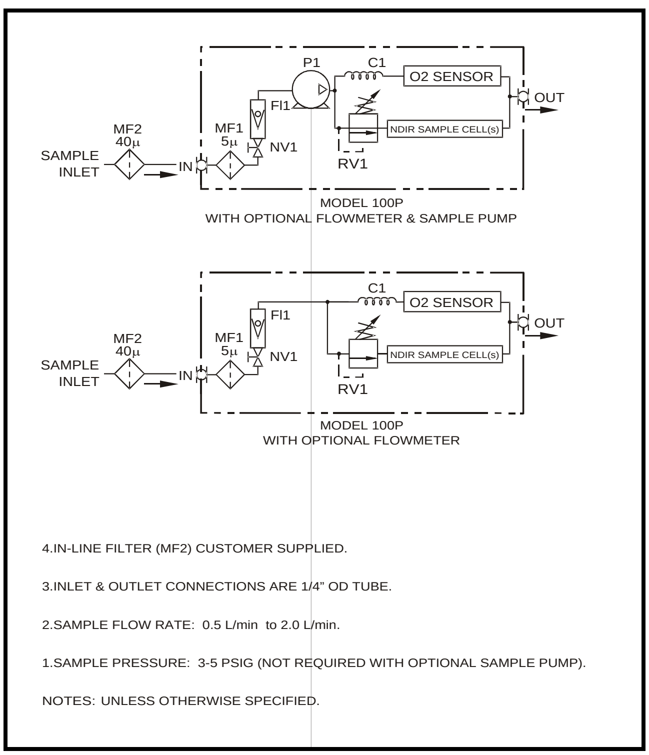


Figure 8-1 Paramagnetic Oxygen Sample flow

8.2. Cross sensitivity of gases

The paramagnetic measuring principle is based on the very high magnetic susceptibility of oxygen. In comparison to oxygen, other gases have such a minor susceptibility that most of them are insignificant. Exceptions to this are the nitrogen oxides. However, as this gas is in most cases present in a very low concentration, the error is still negligible.

8.2.1. Example 1

The residual oxygen percentage is measured in a closed carbon dioxide (CO_2) atmosphere. The "zero calibration" is done by means of nitrogen (N_2).

According to the list of cross-sensitivities, the error for 100 % CO_2 at 200°C is -0.27%. In order to obtain a higher accuracy, this means for the zero calibration that the reading should be adjusted at +0.27% with N_2, in order to compensate the error of CO_2.

Since the values of cross-sensitivities are based on 100 Volume percentage of that particular gas, the error at 50% by volume CO_2 and 50% by volume N_2 is - 0.135%.

8.2.2. Example 2

Given the following gas composition at a temperature of 20° C:

5% volume Oxygen (O_2)	$+100.00 \times 10^{-2} \times 5$	=	+5.0000
40% volume Carbon Dioxide(CO_2)	$-0.27 \times 10^{-2} \times 40$	=	-0.1080
1% volume Ethane(C21-14)	$-0.43 \times 10^{-2} \times l$	=	-0.0043
54% volume Nitrogen (N2)	$0.00 \text{ X } 10^{-2} \times 54$	=	0.0000
Gives a reading (%by volume) of:			+4.8877

As this example shows, the total error (5.000 minus 4.8877) is - 0.1123.

Table 8-1 Cross Sensitivity of gases

All values based on nitrogen 0% / oxygen 100%

Gas	Formula	20°C	50°C
Argon	Ar	-0.23	-0.25
Acetylene	C_2H_2	-0.26	-0.28
Acetone	C_3H_60	-0.63	-0.69
Acetaidehyde	C_2H_4O	-0.31	-0.34
Ammonia	N_3	-0.17	-0.19
Benzene	C_6H_4	-1.24	-1.34
Bromine	Br_2	-1.78	-1.97
Butadiene	C_4H_6	-0.85	-0.93
Isobutylene	$(CH_3)2CH{=}CH_2$	-0.94	-1.06
n-Butane	C_4H_{10}	-1.10	-1.22
Chlorine	CL_2	-0.83	-0.91
Hydrogen Chloride	HCL	-0.31	-0.34
Nitrous Oxide	N_2O	-0.20	-0.22
Diacetylene	$(CHCl)_2$	-1.09-	-1.20
Ethane	C_2H_4	-0.43	-0.47
Ethylene Oxide	$C_2H_4O_2$	-0.54	-0.60
Ethylene	C_2H_4	-0.20	-0.22
Ethylene Glycol	CH_2OHCH_2OH	-0.78	-0.88
Ethylbenzene	C_8H_{10}	-1.89	-2.08
Hydrogen Fluoride	HF	+0.12	+0.14
Furan	C_4H_40	-0.90	-0.99
Helium	He	+0.29	+0.32
n-Hexane	C_6H_{14}	-1.78	-1.97
Krypton	Kr	-0.49	-0.54
Carbon Monoxide	CO	-0.06	-0.07
Carbon Dioxide	CO_2	-0.27	-0.29
Methane	CH_4	-0.16	-0.17
Methanol	CH_4O	-0.27	-0.31
Methylene Chloride	CH_2Cl_2	-1.00	-1.10
Neon	Ne	+0.16	+0.17
n-Octane	C_8H_{18}	-2.45	-2.70
Phenol	C_6H_6O	-1.40	-1.54
Propane	C_3H_8	-0.77	-0.85
Propylene	C_3H_6	-0.57	-0.62
Propene	$CH_3CH{=}CH_{12}$	-0.58	-0.64
Propylene Oxide	C_3H_6O	-0.90	-1.00
Propylene Chloride	C_3H_7Cl	-1.42	-1.44
Silane	SiH_4	-0.24	-0.27
Styrene	$C_7H_6{=}CH_2$	-1.63	-1.80
Nitogen	N_2	-0.00	-0.00
Nitrogen Monoxide	NO	+42.70	+43.00
Nitrogen Dioxide	NO_2	+5.00	+16.00
Oxygen	O_2	+100.00	+100.00
Sulfur Dioxide	SO_2	-0.18	-0.20
Sulfur Fluoride	SF_6	-0.98	-1.05
Hydrogen Sulfide	H_2S	-0.41	-0.43
Toluene	C_7H_8	-1.57	-1.73
Trichloroethylene	C_2HCl_3	-1.56	-1.72
Vinyl Chloride	C_2H_3CI	-0.68	-0.74
Vinyl.Fluoride	CH_3F	-0.49	-0.54
Water	H_2O	-0.03	-0.03
Hydrogen	H_2	+0.23	+0.26
Xenon	Xe	-0.95	-1.02

9. Mechanical Zero Adjustment (Not required with some sensor models)

This adjustment depends upon sensor model and may be periodically required over the life span of the analyzer, or whenever the front panel zero adjustment has reached its limit.

Note: Always check for gas leaks prior to making this adjustment, especially when the zero potentiometer is at its counter-clockwise limit.

a) Place the front panel zero adjustment to its mid-setting (5.0 on the dial.)

b) Introduce N2 into the analyzer at a flow rate of 0.5-2.0 L/MIN.

c) Remove the screws securing the top to the chassis and lift off the cover of the analyzer

d) Locate and remove the rubber 'boot' that covers the O2 sensor.

e) Loosen the locking screw that secures the adjusting screw for positing the photo-sensor on the detector assembly. Only loosen the locking screw enough to permit the necessary adjustment (see Figure 8-1.)

f) Turn the adjusting screw as required to give an indication of approximately 0.00 on the digital display.

g) Carefully tighten the locking screw and replace the rubber 'boot' removed in step d).

h) Observe the digital display and turn the front panel zero adjustment to achieve reading of 0.00 in the display.

i) The zero adjustment should be between 4.0 and 6.0 on its dial. If not, repeat steps d) though h) until no further adjustment is required.

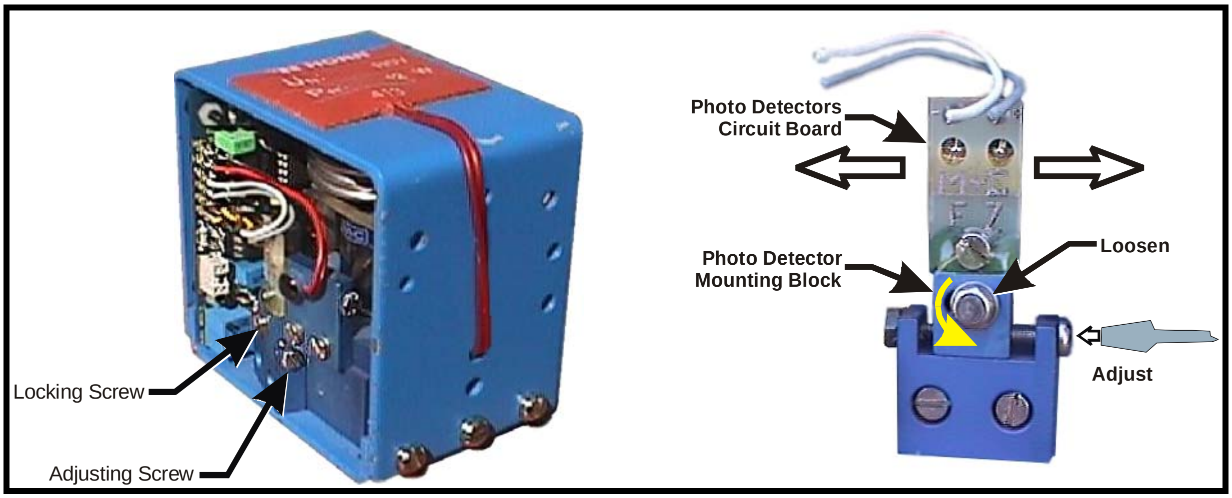


Figure 9-1 Oxygen sensor adjustment