IR-702 & 703
Gas Analyzers

Operator's Manual

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LIST OF ILLUSTRATIONS

SECTION 1

INTRODUCTION

1.1 GENERAL DESCRIPTION

The Summit Analyzers Model IR-702 is a non-dispersive infrared (NDIR) gas analyzer which is capable of continuously monitoring the concentration of two gases in a sample stream. The IR-702 is available with either dual range analog or single-range digital readouts.

Features include a solid-state detector, direct reading linear display, internal calibration, and corrosion resistant sample cell.

1.2 SPECIFICATIONS

Electrical:

Detectors	PbSe
Repeatability/Accuracy (1)	±1% of full scale
Linearity	±1% of full scale
Noise Level	1% of full scale
Zero Drift (2)	±1% of full scale/24 hr.
Span Drift (2)	±1% of full scale/24 hr.

Speed of Response:

Analog	90% of reading in 5 seconds (faster response time optional)
Digital	90% of reading in 1 second
Recorder Output	0-100 mv Standard (0-1 v optional - other outputs available)
Operating Line Voltage	117 ± 10% vac
Operating Temperature Range	32° to 120°F
Warm-up Time	15 minutes
Power Consumption	80 watts maximum

(1) Accuracy specification dependent upon absolute accuracy of the certified calibration gas.

(2) Performance specifications based on stable ambient conditions, and a sample stream which is clean, dry, and regulated to a flow rate of 2-6 SCFH.

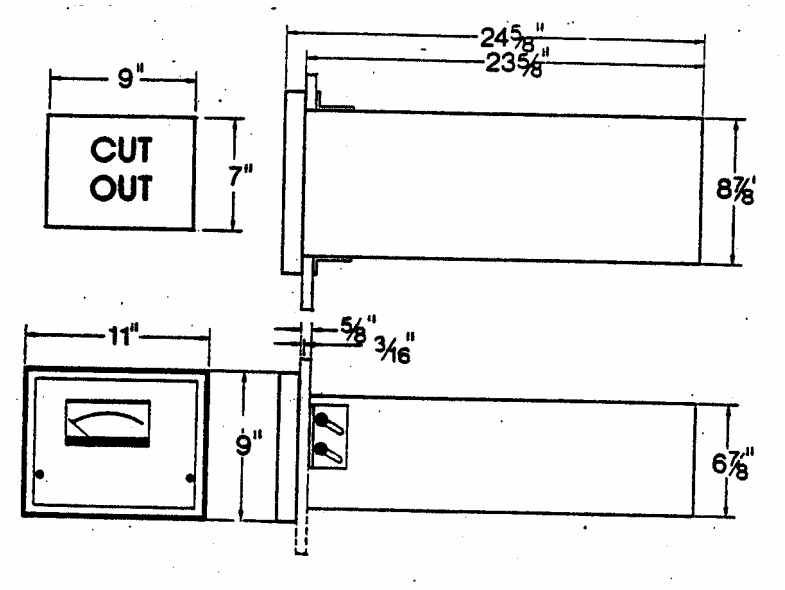

9"
CUT
OUT
7"
24 5/8"
23 5/8"
8 7/8"
11"
5/8"
3/16"
9"
6 7/8"

Figure 1: IR-702 Outline Dimensions

SECTION 2

UNPACKING AND VISUAL INSPECTION

2.1 UNPACKING INSTRUCTIONS

Open the shipping container and remove the top and side pieces of packing foam, leaving the protective end pieces in place. Turn the unit on its side and remove the two #8 sheet metal screws used to retain the drawer during shipping. Save the shipping container, screws and all protective foam pieces to be used in the event the unit has to be shipped back for repairs or modifications. After the unit is upright, remove the foam end pieces.

Open the unit by loosening the two captive retainer screws on the front panel (Figure 2). Pull the drawer out to provide access to the foam packing material. Carefully remove the protective paper covering the mirror nearest the front of the optical bench, and the foam packing from the inside of the drawer. Insure that the connectors to the printed circuit boards are firmly in place. Close the drawer making sure that the interconnect hoses and cables do not kink or interfere with the operation of the optical bench. Tighten the retainer screws finger-tight.

2.2 REPORTING DAMAGE

Should any damage have occurred due to shipping and handling, notify both the shipper and Summit Analyzers immediately. If there is visual damage to the shipping container or packing materials, these items should be saved for inspection by the shipper.

IMPORTANT: The #8 shipping screws should be installed before shipping of the instrument.
This is to prevent possible front panel damage to the instrument in transit.

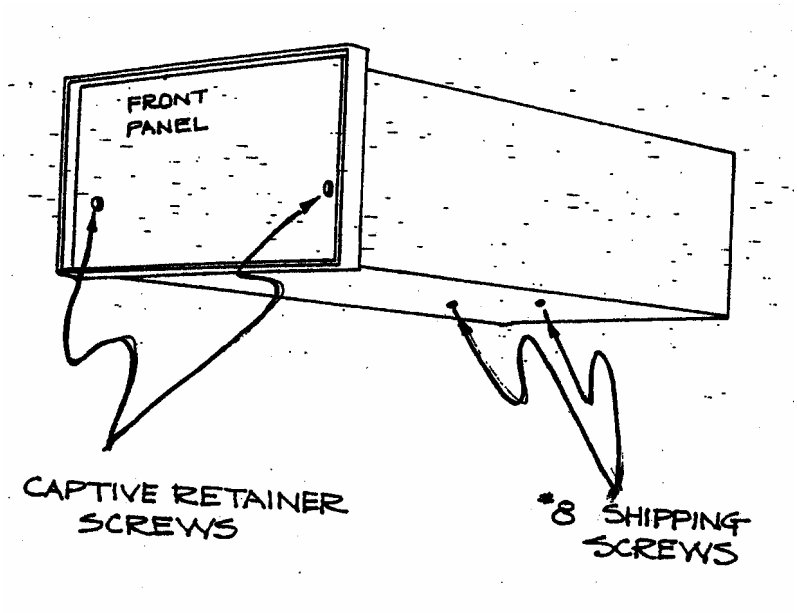


Figure 2: Unpacking Illustration

SECTION 3

INSTALLATION

3.1 GENERAL

The compact size and roll-out tray construction of the Summit Analyzers Model IR-702 allow for ease of maintenance and service. The instructions below are for a typical installation. The particular application and gas under analysis may require special handling and sample conditioning. If you have any doubts or questions regarding your application, consult our application engineer at the factory (510-443-4210).

3.2 PRECAUTIONS

To insure accurate operation of the instrument the following precautions must be taken. The area in which the instrument will be located should be free from excessive dust or humidity and should not be subject to direct sunlight or radiant heat. Rapid ambient temperature fluctuations should be avoided. Environmental temperatures should be maintained between 0-50°C. Provide a shield if any radiant heat source is present near the instrument. The IR-702 is not designed to be intrinsically safe and must be installed in a non-hazardous area or factory installed in a suitable enclosure. For recommendations on explosion-proof or other protective enclosures, contact the factory.

Do not install the instrument near electrical equipment which causes power source disturbances (radio-frequency furnaces, electrical welders, etc.), and do not connect the instrument's power line to the same power source used by such equipment. Be sure that the power source matches the rating specified before connecting the instrument.

3.3 MECHANICAL

The gas analyzer is designed to fit into vertical panels with a maximum thickness of 5/8 inches. The minimum depth behind the front panel should not be less than 25 inches to allow for external wiring, plumbing, and the air flow required for cooling. The recommended panel cut out dimensions are 9" W x 7" H. To mount the analyzer, remove the two side flanges and slide the analyzer in from the front of the panel. With the analyzer flush with the panel and level, reinstall the two side flanges and fasten tightly.

3.4 ELECTRICAL

At the rear of the unit, remove the protective cover from the power wiring terminal (Figure #3). Install a 3-wire, single-phase source of 115 VAC 60 Hz ± 15 VAC. Connect the hot wire (black) to the "AC" terminal, the neutral wire (white) to the "NEUT" terminal, and the grounding wire (green) to the "GND" terminal. Replace the protective cover.

To connect a recorder to the analyzer, remove the protective cover from the recorder terminal strip. Install the positive input to the "REC 1 +" terminal and the common to the "REC 1 -" terminal. The "Range 1" terminal provides an output to indicate the selected range. Referenced to the "IND C" terminal, +5 VDC indicates the channel is on the HI range. OVDC indicates the channel is set on Low range.

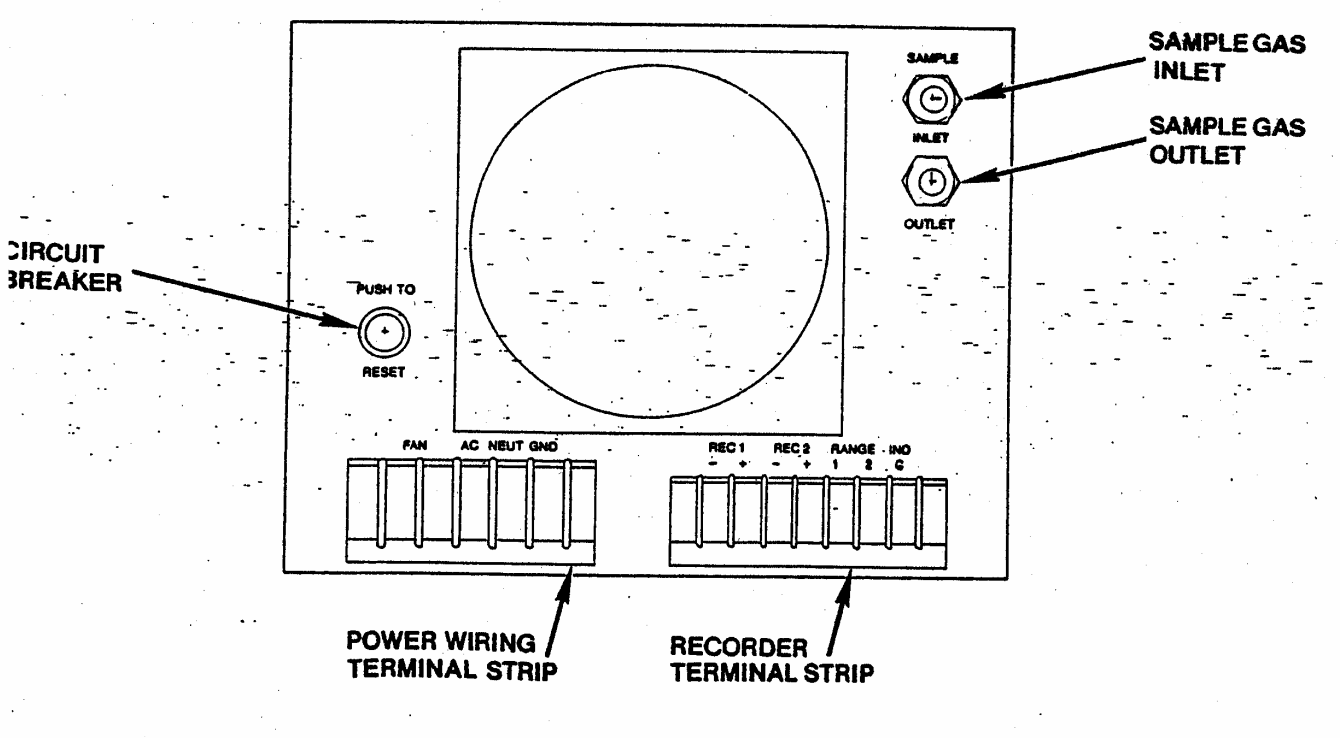


Figure 3: Rear Panel

3.5 GAS HANDLING SYSTEM

Summit Analyzers provides several pre-packaged sampling systems or will design a custom unit for your application. To maximize the utility and performance of your analyzer, provide the best sampling system you can afford. For installation of Summit Analyzer's sampling systems see the system manual.

The minimum requirement for the gas handling system (Figure 4), consists of a source of dry zero gas* for zeroing the instrument, a source of calibration gas for checking the calibration, and valves to select between the purge gas, the calibration gas, or the sample gas. Regulators should be used for all gas sources and set for approximately 5-10 PSIG. A flow meter must be installed in the inlet line to adjust the flow to 2-6 SCFH. The exhaust line should be kept free of unnecessary sharp bends to minimize backpresssure in the gas sample tube. Use 1/4" O.D. tubing of a material compatible with the sample gas stream. Keep the interconnecting tubing between the analyzer and the zero and calibration gas as short as possible to minimize the time required for purging the system. Avoid using rubber or soft vinyl tubing, as incorrect readings may result due to absorption. Use inline filters and driers as necessary to eliminate particulates from the sample and reduce the moisture content so that condensation will not occur within the analyzer. The fittings at the rear of the analyzer are 1/4" compression type. Installation instructions are given in the Appendix for this type of fitting.

*NOTE

Any gas which does not absorb infrared radiation, such as Nitrogen or Helium, is suitable for use as a zero gas. Care should be taken to insure that no unwanted contaminated are present in the zero gas. This is especially important for sensitive instruments operating in the PPM range. Bottled gases vary in the purity of the constituents. Prepurified grade Nitrogen is necessary as the zero gas for low level Carbon Dioxide analyzers.

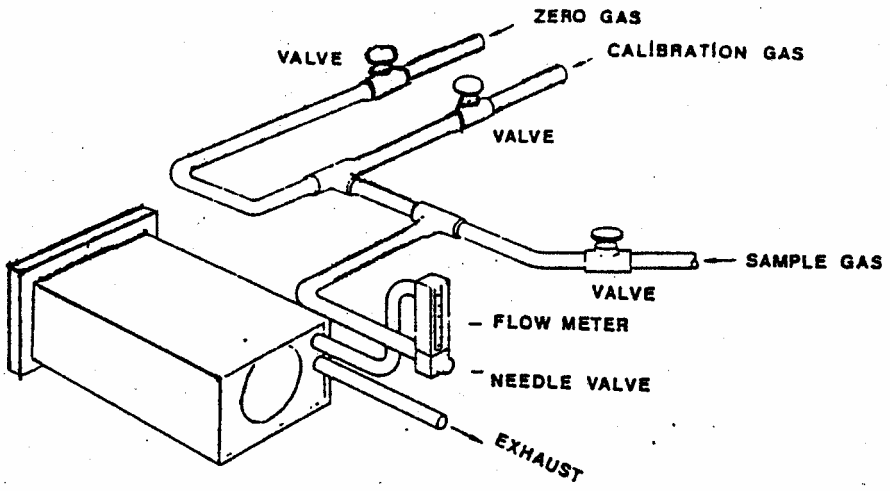


Figure 4: Typical Gas Handling System

SECTION 4

OPERATION

4.1 DESCRIPTION OF FRONT PANEL CONTROLS

(a) ON-OFF SWITCH

The on-off switch controls the application of AC power to the instrument. The switch is illuminated when the AC power is ON.

(b) CHECK SWITCH

The check switch actuates an internal span check. A mechanical flag is placed in front of the sample cell simulating attenuation of the infrared beam by full scale concentrations of the gases of interest. This provides a system check which verifies the function of the optics and electronics. The check switch is illuminated when actuated.

(c) RANGE SWITCH

The range switch, standard on analog display units, sets the concentration range of the channel. Each gas channel is separately controlled. The HI range is read on the top meter scale and the Low range on the lower meter scale. .

(d) ZERO ADJUSTMENT

The zero adjustment is used along with a zero gas, such as dry nitrogen, to obtain a zero reading on the meter. Each gas channel is controlled separately. The zero control corrects for drifts in the zero setting which may occur over extended periods of time.

(e) SPAN ADJUSTMENT

The span adjustment sets the electronic gain of the span amplifier. This control should be used in conjunction with the check switch to obtain a full-scale reading. Each gas channel is adjusted separately. This provides a reference which can be used to check for system drift over extended periods of time.

(f) CALIBRATE

After the electronic gain is normalized by the span adjustment, the calibrate potentiometer is set to obtain a correct gas concentration reading for each channel when a certified calibration gas is introduced.

4.2 IDENTIFICATION OF FRONT PANEL COMPONENTS

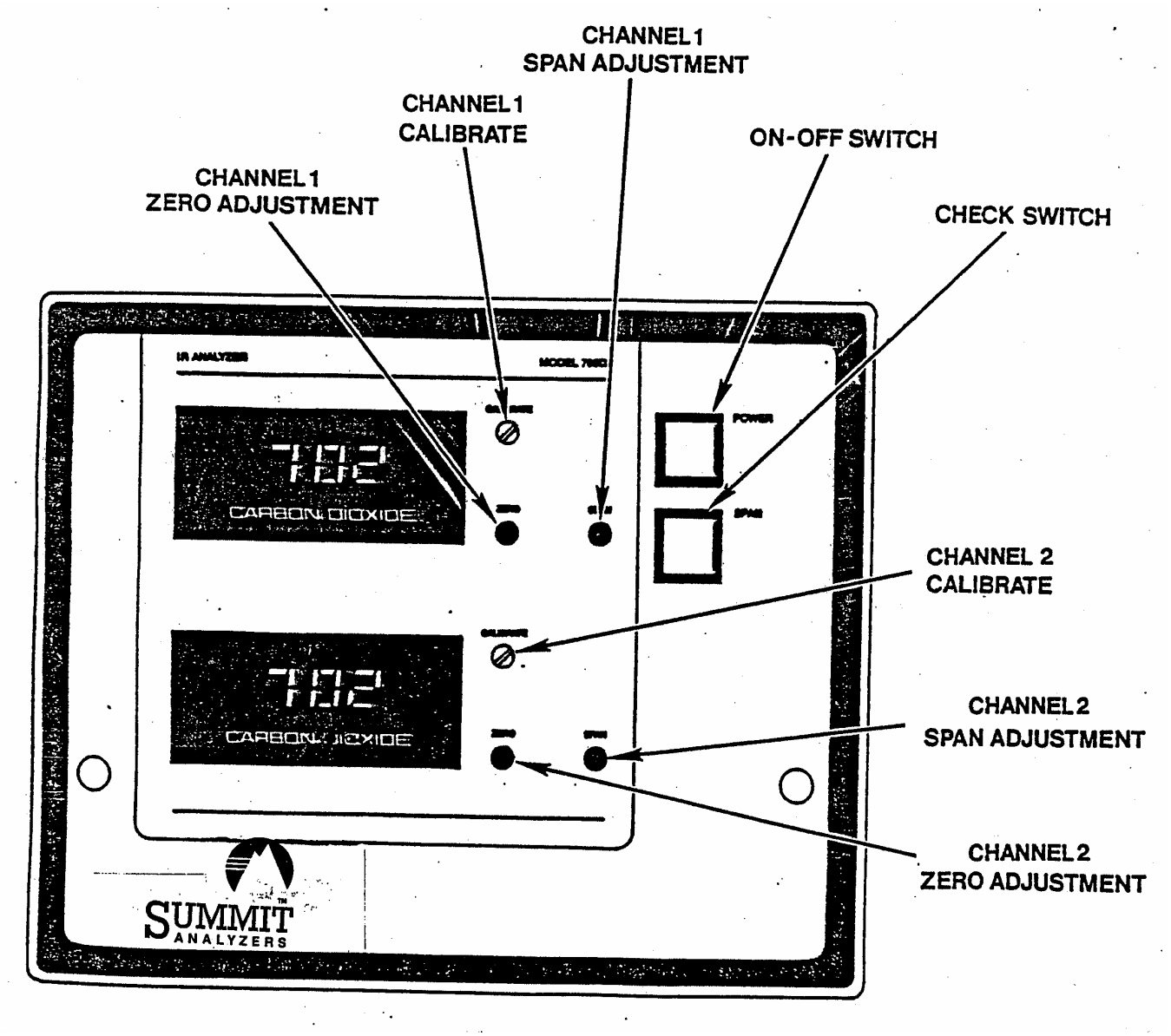


Figure 5: IR-702 Front Panel

4.3 ZERO PROCEDURE

Turn the instrument on and allow 15 minutes for complete warm-up and system stabilization. Allow the zero gas to flow through the sample cell at a flow rate from 2 to 6 SCFH. After the unit has stabilized and the sample cell is completely purged, place the range switch into the Low range, on analog units. Rotate the zero control on each channel for a zero reading on the appropriate meter.

4.4 SPAN PROCEDURE

After properly zeroing the gas analyzer, actuate the internal span check by pressing the Check Switch. Allow the readings to stabilize and set the Span Adjustment for a full-scale indication on each channel. Release the internal calibration by again pressing the Check Switch.

4.5 SAMPLE ADJUSTMENT

After zeroing and spanning the instrument, it is ready to be used for measuring gases. Although the digital models can display greater than the full-scale value listed in the data sheet supplied with the instrument, the accuracy is limited to the instrument's full-scale value. The meter is factory-set to blank when the displayed value rises approximately 10% above the calibrated range.

With the zero gas off, introduce the gas to be measured into the analyzer at 2 to 6 SCFH. The flow rate and temperature used in measurements should approximate that used to span and calibrate the instrument. Excessive flow rates (greater than 30 SCFH) may damage the sample cell.

Periodically remove the sample gas flow and purge the analyzer with dry zero gas. Verify zero after allowing sufficient time to completely purge the sample cell and readjust zero if necessary. It is important that span and zero be verified occasionally to assure that the sample cell is not being contaminated by improperly filtered sample gas.

SECTION 5

CALIBRATION

5.1 GENERAL

Changes in the temperature, pressure, or flow rate of the gas sample can necessitate recalibration of the gas analyzer. The calibration procedure involves setting the electronic zero and span adjustments, then performing a gas calibration with a certified calibration gas.

A calibration verification is warranted any time there is a significant change in ambient or sample gas conditions.

5.2 PROCEDURE

With a flow of zero gas through the analyzer, zero the instrument as described in Section 4.3. Next activate the internal span check and set the span adjustment potentiometers for a full-scale indication on the appropriate meters. Deactivate the check switch.

Turn off the zero gas and allow a calibration gas for channel 1 to flow through the analyzer at 2-6 SCFH. The calibration gas mixture should have a concentration close to the channel 1 HI range full-scale value. Allow sufficient time for the reading to stabilize. Adjust the channel 1 calibrate potentiometer so the meter reading agrees with the certified concentration on the gas bottle. Repeat the gas calibration procedure with a calibration gas for channel 2. The flow rate used for the gas calibration procedure should approximate the expected sample gas flow rate.

SECTION 6

MAINTENANCE

6.1 ROUTINE MAINTENANCE

DAILY:

Adjust zero and span controls at least once a day to insure optimum instrument performance.

ONCE EVERY THREE MONTHS:

1.) Disconnect all power to the instrument. Remove the sample cell and inspect for contamination of both the sample cell and its window.

2.) If previous samples have contaminated the cell, it may be disassembled and cleaned with alcohol.

3.) The windows should be cleaned (when necessary) with either alcohol or acetone on a cotton swab, and dried with a soft, lint-free cloth or tissue.

AS NEEDED:

The exterior of the analyzer should be cleaned with a mild detergent. Solvents should be avoided due to their incompatibility with several materials used on the front panel.

6.2 TROUBLE SHOOTING GUIDE -GENERAL

NOTE: This guide has been prepared for use by qualified instrument technicians; and servicing of any internal component, which could present a significant hazard due to the possibility of electrical shock, should be referred to personnel who are thoroughly familiar with the equipment.

SYMPTOM	CORRECTIVE ACTION
Power does not turn on when actuating power switch.	(a) Check for tripped circuit breaker. Reset if necessary. (b) Check AC voltage at outlet for correct voltage. Reset breaker or switch supply power to receptacle. (c) Check power to terminal board (TB70) located inside cabinet. ***CAUTION:*** *Terminal board contains 115 volt line voltage which can be hazardous. Check for loose terminal to one of the terminal board lugs. Replace as required.* (d) Check that chopper motor is energized. If energized, check wiring to pilot light located on control panel.
Meter pointer at zero, no zero control.	(a) Check that the power is ON and chopper motor is energized. (b) When only one meter does not move, check for broken lead to meter. Correct wiring as required. (c) Check that sync assembly connector (P301) is properly and securely mated. (d) Check Main PCB Input Voltage C401 pos. lead shield should be 24 V.D.C. C402 pos. lead should be 24 V.D.C. (e) Check Main PCB Power Supply — Requirements are +15 V.D.C. ± .5V and -15 V.D.C. ± .5V, jumpers are on Main PCB. Balance between supplies must be within .30V.

6.2 TROUBLESHOOTING GUIDE (continued)

SYMPTOM	CORRECTIVE ACTION
Meter pointer at zero, no zero control (con't)	(f) Check sync assembly output (Main PCB) R303 (bottom) pos. greater than +.5V and neg. between -1.18V to -1.57V. Check R307 (right) for same output. (g) Check sync op. amps (Main PCB) A301, TP301 24-32 VPP (peak to peak) A302, TP302 24-32 VPP. (h) Check input to preamplifier with high impedance oscilloscope. The signal swing can range from 2 mv to 100 mv. Replace detector assembly where either signal is absent. (Check at R101, R201). (i) Check output of preamplifier (TB101 & TP201). Peak to peak voltage should be 1 volt. Adjust gain of preamp (R104 and R204) for 1 volt output. (j) Check output of AGC circuit (TP103 and TP203). Adjust R116 and R216 to 1 volt setting. If signal is 10-15 volts peak to peak and is not adjustable, suspect U101/U201 defective. (k) Check "zero" pots R123 and R223. Adjust to "zero" volts at J703, pins 5 and 11. (Be certain front panel controls are centered, 5 turns from either extreme.) (l) Check for open diode CR104, CR204. Replace if open.

6.2 TROUBLESHOOTING GUIDE (continued)

SYMPTOM	CORRECTIVE ACTION
Meter pointer below zero.	(a) Ajust Zero panel control. (b) Check that infrared radiant source (L301) is glowing a dull orange color. Replace if burned out. (c) Check that the reference beam path is not obscured. Remove obstruction. Check position of cal flag.
Meter pointer up scale.	(a) Adjust zero panel control. (b) Check for obstruction in sample beam path. Check cal flag does not obscure path. Remove foreign object. (c) Check for excessive moisture or contaminants in plumbing and/or sample cell. Clean or replace as required.
Insufficient span control	(a) Check cal flag operaton. (b) Check wave shape of signals with zero gas (N_2) flowing to ensure symmetry of reference and sample signals. Symmetry should be less than 150 MV difference between the two negative signals as measured on an oscilloscope at TP103 and TP203. Verify sample cell, reference cell, mirrors and detector assemblies are clean. Remove sample and reference cells and re-check symmetry. Re-adjust detectors until 150 MV specification is obtained. Re-install sample and reference cells.

6.2 TROUBLESHOOTING GUIDE (continued)

SYMPTOM	CORRECTIVE ACTION
Insufficient span control (continued)	(c) Check for shorted output diodes CR106 (CR206) or CR107 (CR207). Replace if shorted. (d) Check for shorted clipping diode CR105 (CR205). Replace if shorted. (e) Check gain of last amplifier stage (A107, A207). Gain variation should span potentiometer. Replace operational amplifier A107 (A207) if defective.
Noisy of Erratic Operation	The most common sources of noise are: (a) Reduced output of infrared source. (b) Noisy motor (chopper). (c) Noisy detector. (d) Incorrect grounding of printed circuit board. (e) Optical bench not grounded to cabinet. (f) Detector cable not secured to cable clamp and plug. (g) Faulty pre-amplifier. (h) Connector to control panel not properly mated.

SECTION 7

THEORY AND PRINCIPLE OF OPERATION

7.1 THEORY OF OPERATION

Most gases absorb radiation in the infrared region of the electromagnetic spectrum. Exceptions are those diatomic molecules which consist of two like elemental atoms such as Nitrogen (N_2) and Oxygen (O_2) or the noble gases such as Neon (Ne), Argon (Ar), and Helium (He).

The principle components of dry air - Nitrogen (78.08%), Oxygen (20.95%), and Argon (0.93%) do not absorb in the infrared. Other gases, such as Carbon Monoxide, Carbon Dioxide, Ammonia, Methane, Sulfur Dioxide, and literally hundreds more do absorb infrared radiation and their presence and concentration can be determined by measuring the amount of infrared radiation absorbed in a known path length. The amount of absorption is related to the gas concentration and the path length in which the absorption is measured. The higher the concentration or longer the path length, the greater the absorption.

The particular wavelengths of infrared radiation absorbed by a gas are determined by the structure of the gas molecule. Each gas is characterized by a different absorption spectrum. The Summit Analyzers Gas Analyzers utilize an infrared light source and a solid state detector sensitive to the infrared spectrum.

The gas to be measured is placed between the infrared source and the detector. By properly limiting the spectral range of the infrared source with a spectral filter, the gas analyzer can be made sensitive to a particular gas while insensitive to others. The amount of absorption can then be measured, electronically processed, and a reading displayed which is related directly to the amount of the gas concentration.

Care is always taken in the selection of the appropriate filter if other gases having a similar absorption spectrum are known to be in the sample stream of interest. The Summit Analyzers Gas Analyzers utilize sophisticated computer designed spectral filters which allow for exceptional selectivity between gases. In order to take full advantage of the flexibility of this technique of filtering, it is important that all major constituents of the sample stream be taken into account when specifying a Gas Analyzer for a particular application.

7.2 OPERATING PRINCIPLE

The Summit Analyzers Model IR-702 is a dual beam, non-dispersive infrared (NDIR) Gas Analyzer. The Model IR-702 is designed for the measurement of two gases.

The analyzer system consists of an optical bench assembly for monitoring the gas concentrations and electronic circuitry to process and display the measured results.

The optical bench assembly is the heart of the analyzer system. It contains the infrared source, a 50 hertz coaxial optical chopper, sample and reference tubes, and a detector assembly complete with spectral filters for the gases of interest. These components are mounted on a self-supporting optical bench to rigidly support and accurately maintain alignment of these parts over the operating conditions.

The circuitry with the optical bench contains the electronics for demodulating the signals from the detectors, and a power supply for the electronics.

Directly behind the front panel is additional circuitry which process the non-linear output signals from the optical bench, and linearizes them to provide the output for the direct-reading meters.

In general, the system compares the optical (infrared) transmittance of two identical optical paths. One optical path passes through the sample or unknown gas, the other optical path passes through the reference path. The difference in optical transmittance between these paths then is a measure of the optical absorption. These variations in transmittance are sensed by photon detectors. The signals from the detectors are processed and used to drive the output meters as a direct measure of the concentration of the unknown gases.

The infrared source is a metal sheathed heater element operating at a temperature of about 1500°F (bright red color) where it emits infrared radiant energy optimized for the spectral bands of interest and long life. The emitted energy is directed to a concave front-surface mirror. The infrared source surface being at the focal plane of the mirror, the reflected energy is collimated so that the rays leaving the mirror surface are essentially parallel.

7.2 **OPERATING PRINCIPLE** (continued)

The reflected or collimated radiant energy forms two identical infrared beams. (Figure 6). These beams of radiant energy are chopped by the coaxial chopper or beam interrupter to effect an alternate ON-OFF sequencing of each beam. The beams then pass through two parallel tubes which are rigidly mounted to the optical bench. One of these tubes contains the sample or unknown gas; the other tube, the reference tube, contains ambient air. The length of the gas sample tube has been selected based on the strength of the absorption bands and the calibration ranges of the instrument. The radiant beams, after passing through the two tubes, are reflected and imaged by a second mirror onto two photon detectors. Spectral filters are located just in front of the detectors.These optical filters represent precise "windows" of the absorption bands for the specific gases of interest. In effect, then, the system is tuned to see only energy in the unique absorption bands which represent those gases. Energy outside the bands is eliminated.

The detectors convert the optical energy from the radiant beams into electrical signals. The electrical signals are the analog of the optical beams and differences in amplitude are converted to dc signals. These output signals are generally non-linear. The signals are then linearized and used to drive electrical output meters.

In operation then, with the system turned on and warmed up, sample gas (unknown) is introduced into the sample chamber. The alternating beam of radiant energy is directed first through the reference tube and then to the sample tube in a continual half-cycle interruption at the rate of 50 cycles per second. As the beam passes through the reference chamber, the energy of the beam is unattenuated and provides a standard of measurement. On the second half-cycle, as the beam passes through the sample tube, the beam will be selectively attenuated by the gas sample. If the gases of interest are present in the sample tube, the beam energy will be attenuated within the spectral bands, and the detector signal will be modulated in proportion to the gas concentrations.

In this way, the detectors generate two electrical impulses per chopper revolution, one representing the reference level, the other the sample gas level. These signals are amplified, demodulated, linearized and then read directly on the panel meters.

7.2 OPERATING PRINCIPLE (Continued)

The reference channel allows a stable output to be maintained if changes should occur in the radiance of the infrared source or the sensitivity of the detectors. An automatic gain control (AGC) circuit monitors the signal strength in this reference channel and compensates for any such changes.

The Summit Analyzers Gas Analyzer is equipped with an internal calibration system. When the internal calibration is activated by the front panel control, a mechanical attenuator is introduced into the sample beam. This known attenuation level simulates the attenuation of the infrared beam by the gases of interest. This feature allow the analyzer to be spanned without the need of calibration gases.

However, the absorption strength of a gas in a volume is affected by temperature and pressure changes. The effective concentration will increase as the pressure is increased (Boyle's Law) and decrease as the temperature is increased (Charles Law). If the Gas Analyzer is spanned with a gas at a particular temperature and pressure, the internal calibration may be used in lieu of a calibration gas to span the analyzer under similar conditions of temperature and pressure. If either the temperature or pressure of the gas sample is known to change significantly, the analyzer should be recalibrated with span gas to assure accuracy.

The Summit Analyzers Gas Analyzer is not affected by the major constituents of dry air - Nitrogen and Oxygen. However, care should be taken to limit the presence of the gas under analysis in the ambient air around the instrument. A Carbon Dioxide analyzer will, for instance, be affected by variations in the ambient Carbon Dioxide concentrations. When such variations are expected to occur, the optional sealed analyzer should be selected. If the Gas Analyzer is to be used in a potentially explosive atmosphere, an optional explosion-proof enclosure is available.

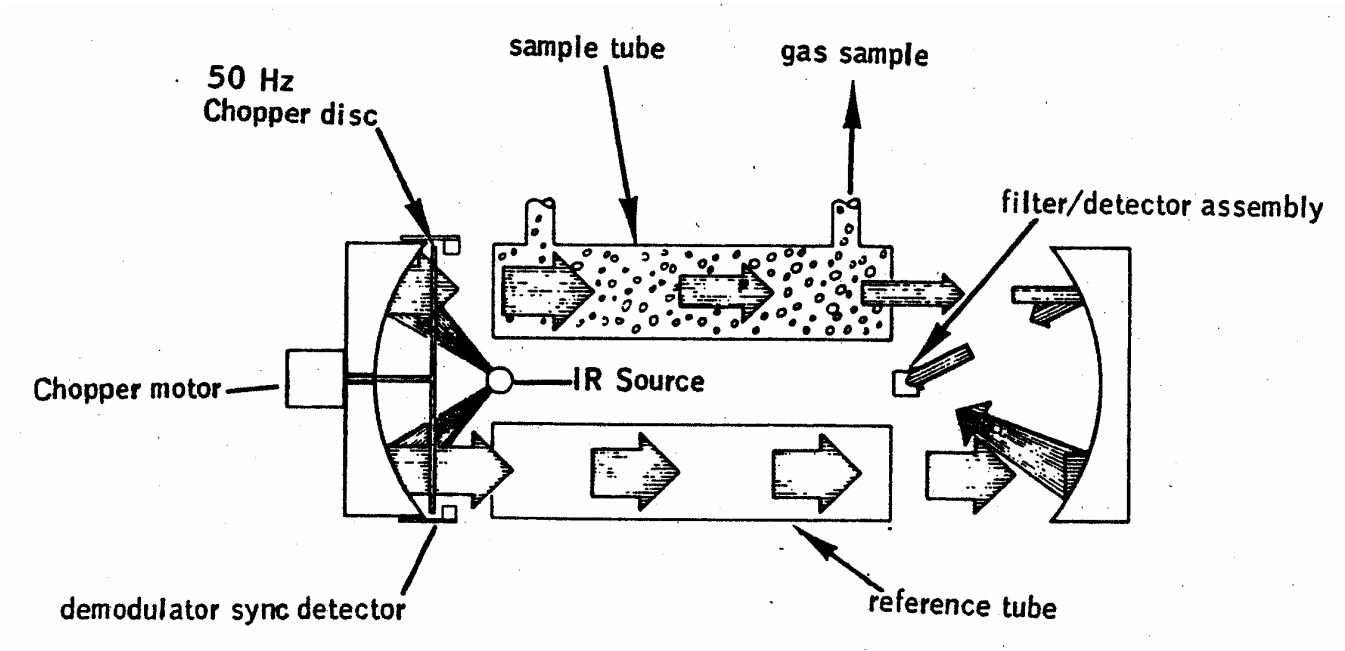


Figure 6: Optical Bench Schematic

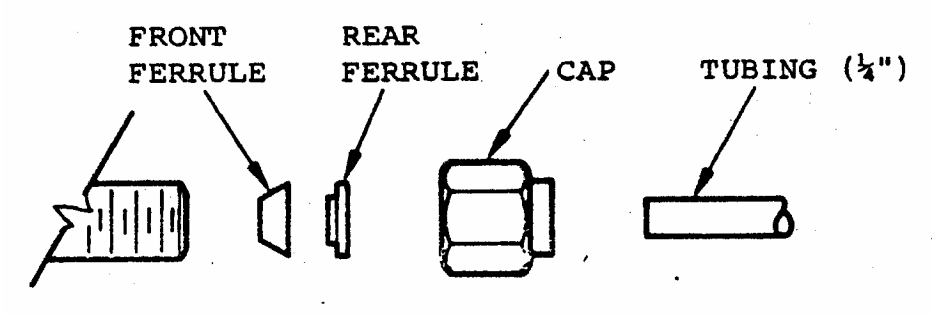
SECTION 8

APPENDIX

8.1 COMPRESSION FITTING INSTALLATION INSTRUCTION

1. Cut the tubing square and deburr it if necessary.
2. Insert the tubing into the fitting as far as it will go (approximately 1/2 inch).
3. Use an open-end wrench to hold the body of the fitting to prevent it from rotating.
4. Use a 1/2" open-end wrench to tighten the cap and retain the tubing. Rotate the fitting 1-1/4 turns. DO NOT OVER TIGHTEN.

When reinstalling the tubing after it has been initially retained, tighten the fitting only about 1/8 turn or until the fitting feels snug.



Compression Fitting

8.2 WARRANTY INFORMATION

This analyzer is warranted against defects in materials and workmanship under normal use and service for one year from the date of delivery to the original purchaser.
The sole obligation of the seller and/or manufacturer under this warranty is limited to repairing or replacing as the seller or manufacturer may elect, free of charge at the place of business of the seller or manufacturer, any parts that prove, in the seller or manufacturers judgment, to be defective in materials or workmanship within one year after delivery to the original purchaser.

This warranty shall not apply and is void if, in the opinion of the seller and/or manufacturer, the portable analyzer or any component thereof has been damaged by accident, other causes not arising out of defects in materials or workmanship.

Before purchasing and using this analyzer, the user should determine the suitability of the product for his or her intended use and, the user assumes all risks and liabilities whatsoever in connection therewith.

If a product malfunction should occur, you may contact the seller or the manufacturer at:

Infrared Industries, Inc.
25590 Seaboard Lane
Hayward, Ca. 94545
Voice: 510-782-8100 or 800-344-0321
E-mail: service@infraredindustries.com

If it is necessary to return the analyzer, notify the seller in your area or Infrared Industries at the address above. Contact Infrared Industries for an RMA number, which is your authorization to send the unit. Note the RMA number on the outside of the box. Package the instrument carefully and securely. Do not ship the instrument with accessories. **Please include a written description of any observation of the malfunction along with your name, address, and phone number.** Then proceed to ship the instrument with freight prepaid to the address above.

WARRANTY EXCLUSIONS

THIS WARRANTY AND THE SELLER AND/OR MANUFACTURER'S OBLIGATION HEREUNDER IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING WITHOUT LIMITATION, THE WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE, AND ALL OTHER REPRESENTATIONS CONCERNING THE SALE, USE AND/OR PERFORMANCE OF THE ANALYZER.

No person is authorized to give any other warranties or to assume any other liability on behalf of the seller or manufacturer. This warranty shall not be extended, altered or varied except by written agreement signed by the seller and the buyer.

LIMITATION OF DAMAGES

IN NO EVENT SHALL THE MANUFACTURER OR SELLER OF THE PORTABLE ANALYZER BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR IN CONNECTION WITH ANY OBLIGATION IMPOSED UPON THE SELLER OR MANUFACTURER IN CONNECTION WITH THIS WARRANTY. SUCH INCIDENTAL AND CONSEQUENTIAL DAMAGES SHALL INCLUDE, WITHOUT

LIMITATION, LOSS OF USE, LOSS OF INCOME, LOSS OF PROFIT (INCLUDING LOSSES TO BUSINESS INTERRUPTION), LOSSES SUSTAINED AS THE RESULT OF INJURY (INCLUDING DEATH) TO ANY PERSON, AND LOSS OF OR DAMAGE TO PROPERTY. THE LIABILITY OF THE SELLER AND/OR MANUFACTURER ON THIS WARRANTY IS LIMITED TO ACCEPTING RETURN OF THE PORTABLE ANALYZER, REFUNDING ANY AMOUNT PAID THEREON AND CANCELING ANY BALANCE STILL OWING ON THE EQUIPMENT. THIS REMEDY IS EXCLUSIVE-REPAIR OR REPLACEMENT PROCEDURE