

Dasibi Model 3008



MODEL 3008
GAS FILTER CORRELATION CO ANALYZER
OPERATING AND MAINTENANCE MANUAL

Model 3008

Instrument Serial Number: 895

Manual Checked By: AA **Date: 09/10/93**

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1992



Preface

This Operating and Maintenance (O&M) manual contains information for use by operating and service personnel regarding the Dasibi Environmental Corporation (Dasibi) Model 3008 Gas Filter Correlation Carbon Monoxide Analyzer (also referred to herein as the analyzer or instrument). This information includes a description of the design and operating principles of the analyzer, as well as its installation, operation, calibration, and maintenance.

Experience indicates that the user will obtain maximum performance and utility from the instrument when time has been spent to study the information provided herein. It is therefore recommended that this manual should be fully reviewed before proceeding with the installation and commissioning of the analyzer.

Dasibi continually strives to remain current with the latest electronic developments. Circuit and component improvements are incorporated into its products as soon as development and testing have been accomplished. Sometimes, due to printing and shipping requirements, these changes are not immediately incorporated into the manuals, but are rather presented as individual technical update pages in Appendix B. A single change may affect several sections.

This updated information is carried in the manual until all changes are permanently entered and, as a result, some duplication may occur. If no update pages are included in Appendix B, this manual is correct as printed. Any feature described in the Appendix B that is applicable to the unit shipped with this manual will have an "*" hand-written next to its listing in the Table of Contents when this manual is checked before shipment. Although every effort is made to keep the manuals accurate and up-to-date, it is possible that errors have been made. If an error in the manual is found, or for further information or assistance, contact Dasibi's sales department.

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This manual was prepared by Dasibi exclusively for use by the owners of the Model 3008 Gas Filter Correlation Carbon Monoxide Analyzer. The material contained herein is proprietary to Dasibi and is to be used only for the purpose of operating or servicing this product. Any other use or duplication without prior written consent of Dasibi is prohibited.

Any operational or hardware modifications that are performed on the unit not specifically stated in this manual without prior, written consent of Dasibi will void the following warranty.

Warranty

This warranty covers two specific areas that may occur after delivery to the original purchaser by Dasibi, or by an authorized Dasibi representative: 1) defective instrument operation according to guaranteed performance specifications and 2) defects in materials or workmanship.

The warranty is applicable provided that inspection and analysis by Dasibi discloses that any defects in instrument performance or defects in materials and workmanship developed under normal and proper use, and that the instrument was maintained and operated in accordance with the O&M manual supplied with the instrument. Dasibi will be released from all obligations under this warranty in the event repairs or modifications to the instrument have been made by persons other than Dasibi's own representatives, unless such repairs were made with the prior, written consent of Dasibi.

An item claimed to be defective must be returned to Dasibi, transportation charges prepaid, and will be re-shipped to the customer collect, unless the item is actually found to be defective, in which case, Dasibi will pay the transportation charges.

Defective Instrument Operation

Dasibi agrees to correct any unit that does not function within the limits of the published performance specifications, either by repair or, at the option of Dasibi, by replacement, for one year after delivery to the original purchaser, the only exception being consumable items.

Defective Materials or Workmanship

Dasibi agrees to correct any defects in materials or workmanship in any unit either by repair or, at the option of Dasibi, by replacement, subject to the following conditions:

1. Dasibi extends to the original purchaser a two year warranty on all Dasibi manufactured electronic parts and a one year warranty on all Dasibi manufactured mechanical parts.
2. Dasibi extends to the customer whatever dated warranty is given to Dasibi by the suppliers of component items purchased by Dasibi and incorporated into the instrument.
3. This warranty does not cover expendable items, because their duration and performance may vary from case to case.

Claims for Damaged Shipments and Shipping Errors

DAMAGED SHIPMENTS

Merchandise should be inspected immediately upon receipt. A packing list is supplied with every shipment, and all items received should be checked against this list. If there appears to be shipping damage, both the carrier and Dasibi should be notified immediately. (If the instrument appears to have only operational problems not associated with shipping damage, only Dasibi should be notified.)

CLAIMS FOR SHIPPING DISCREPANCIES

It is important to check contents of all shipments promptly against the packing list. Dasibi reserves the right to disavow all claims of deficiency that are not promptly reported.

If a claim is to be made, report the following:

1. Model Number
2. Serial Number
3. Sales Order Number
4. Purchase Order Number
5. Date Received

In addition, the following documents may be necessary to support a claim for shipping damage:

1. Copy of original invoice
2. Copy of packing list
3. Original freight bill and bill of lading
4. Photos of damaged equipment and container (if possible)

CONDITIONS OF SHIPMENT

F.O.B. DESTINATION means that Dasibi pays all expenses and assumes all risks until actual delivery of the merchandise at the point agreed upon with the buyer.

F.O.B. GLENDALE means that the purchaser will pay all expenses and assumes all risks of merchandise damage.

PROCEDURE FOR RETURNS/REPAIRS

- 1) Contact Dasibi to describe the problem. Obtain a return authorization number from the sales/service department. This number aids Dasibi in "tracking" returned items and in determining the exact nature of its return when received at our facilities.
- 2) Please enclose a written description of the exact problem as best as you can. If strip charts or other such test documents are available, please include copies of them in the return shipment as they will help our technicians in the swift troubleshooting of described problems. Such written descriptions also prevent any confusion from occurring in our repair department. Dasibi will only perform repair work on the requested areas. If additional repairs/upgrades are needed, Dasibi will alert the customer to obtain approval.
- 3) Upon receipt of the item, Dasibi will draft an estimate of the repair work required (there is no charge for this). The estimate will contain probable replacement parts/assemblies and the respective costs of each. In addition, there will be an estimate of "hands on" labor time.
- 4) Dasibi's sales/service department will then contact the customer with the estimate. Dasibi will not complete the required work until proper authorization is obtained. Because of the nature of some problems though, some repair work will have to be performed before authorization is obtained in order to draft the initial estimate.
- 5) If repair work is going to exceed the original estimate, Dasibi will draft a revision, provide an explanation for the additional work required, and submit this to the customer for approval. Once such approval is either given, or denied, work will commence. This prevents any unauthorized work from being performed and keeps the customer abreast of the situation.
- 6) Dasibi will ship the repaired items back to the customer with appropriate strip charts and quality control reports verifying performance, as well as a detailed listing of all replaced parts and assemblies. Dasibi will return any replaced component upon customer request.

Operating Warning Information

*** DANGER ***

TOXIC EXHAUST GAS

Route exhaust gas from rear panel outlet to outside vent or laboratory fume hood through tubing with an O.D. of 1/4-inch and an I.D. of 1/8-inch or greater.

*** DANGER ***

ELECTRICAL SHOCK HAZARD

There exists HIGH VOLTAGE within portions of this analyzer. Please refer to material contained within this manual before performing any servicing inside the unit, itself.

EPA Designation

The Dasibi Model 3008 Gas Filter Correlation (GFC) Infrared CO Analyzer has been designated by the United States Environmental Protection Agency as a reference method for the measurement of ambient air concentrations of Carbon Monoxide pursuant with the requirements defined in 40 CFR Part 53 (40 FR 7049, Feb. 18, 1975)

Designated Reference Method Number: RFCA-0488-067

EPA Designation Date: April, 1988

The Dasibi Model 3008 GFC Infrared CO Analyzer meets EPA designated reference method requirements when operated within the following parameters:

Range	0 - 50 PPM
Line Voltage Range	105 - 125 VAC
Temperature Range	20 - 30°C
Time Constant Setting	60 seconds

The Analyzer must be operated and maintained according to the operation and service manual to conform to the EPA Designation requirements

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* = Feature is included in unit shipped with this manual.

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1.0 INTRODUCTION

1.1 Purpose and Organization of Manual

This O&M manual presents operating and service information for the Dasibi Model 3008 Gas Filter Correlation Carbon Monoxide Analyzer. Past experience indicates that the user will obtain maximum performance from the instrument when time has been spent studying this information. It is therefore recommended that this manual be reviewed before installing, operating or servicing the analyzer.

The information is presented in seven sections which include a description of the instrument design and operating theory, as well as discussions of its installation, operation, and maintenance. Appendices include specialized information on the general instrument calibration procedures, and update information to this manual (when applicable). For each section, the information is presented as descriptive text, followed by the referenced figures, in order, at the end of the section. The information presented is outlined in Table 1-1, below.

TABLE 1-1
Outline of Organization of Manual

<u>Section</u>	<u>Topics Covered</u>
1	General instrument description, performance specifications, and physical characteristics.
2	Instrument installation.
3	Instrument description.
4	Theory of operation.
5	Routine operation.
6	Maintenance procedures.
7	Replacement parts list.
Appendix A	Instrument calibration.
Appendix B	Manual update information (as appropriate).
Appendix C	References

Included with this manual is the final factory quality control report for the analyzer. These data are of great value in determining if the analyzer, as received by the user, has experienced any change in performance due to shipping problems. The user is encouraged to re-check the performance of the instrument immediately after installation.

1.2 Description of Instrument

1.2.1 Functional Description

The Dasibi Model 3008 Carbon Monoxide Analyzer is a Non-dispersive Infrared (NDIR) Analyzer of advanced state-of-the-art design. Being a photometric device, it operates on the principle that the pollutant CO absorbs light at specific wavelengths and will decrease the intensity of the probing light beam in non-linear proportion to its concentration. A photometer, in its simplest form, consists of a source of wavelength specific light, a closed container or "chamber" to confine the gas being monitored, a light detector or transducer to convert light to electrical energy and a suitable set of electronics to manipulate electrical information so that CO content can be displayed in appropriate concentration units. Among the tasks required of the signal handling electronic system, is the linearization of the photometric signal, and the correction of the signal for changes in temperature and pressure, since gas concentration is a function of the latter two parameters (Gas Law Effects). For these reasons, the Model 3008 has a built-in computer, making use of the latest advances in microprocessor technology.

The analyzer is a component in a system whose end purpose is to provide a continuous stream of high quality, non-ambiguous, Carbon Monoxide concentration data. The feasibility of this system is predicated on good design, proper system maintenance and frequent performance checks.

1.2.2 Performance Parameters

The performance specifications of the analyzer are presented in Table 1-2. The instrument will operate within these specifications under the conditions listed.

TABLE 1-2
Performance Specifications
Physical Characteristics
Dasibi Model 3008

Standard Range:	0-50 ppm (EPA Approved)
Other Ranges Available:	0-10 ppm, 1000 ppm
Precision:	± 0.1 ppm

Linearity:	$\pm 1\%$
Noise (at zero concentration):	± 0.05 ppm
Lower Detectable Limit:	0.1 ppm
Rejection ratio: Water Vapor	Over 200,000 : 1
Zero Drift With Auto Zero:	Zero
Without Autozero:	0.2 ppm/24 hours
Span Drift: (25°C, Nominal line voltage)	$\pm 1\%$ /24 hours $\pm 2\%$ /week
Lag Time:	2 seconds
Rise Time to 95% Full Scale:	90 seconds
Operating Temperature:	5 to 40°C
EPA Temperature:	20 to 30°C
Operating Humidity (non-condensing):	0-95%
Flow Rate	1 LPM
Output:	0-10 VFS (Adjustable) 0-10 VFS (Adjustable)
Power:	105-125 VAC, 50/60 Hz 220-240 VAC, 50/60 Hz

1.2.3 Physical Characteristics

The physical characteristics of the analyzer are presented in Table 1-3.

TABLE 1-3
Physical Characteristics
Dasibi Model 3008
Carbon Monoxide Analyzer

Dimensions:	W - 17 in (43.2 cm) H - 7 in (17.8 cm) D - 20 in (50.8 cm)
Weight:	35 lbs (16.0 kg)
Options:	Rack Mounting, RS 232 C Interface, 4-20 mA output, Isolated Analog Output, and Remote Diagnostics Output.

2.0 INSTALLATION

2.1 General

This section of the manual describes installation of the instrument. It is advisable to read this section before installation is begun. The information presented includes receiving inspection, and pneumatic, and electrical connections.

2.2 Receiving Inspection

The instrument was carefully inspected and packed prior to shipment. After the instrument has been delivered, please check the following:

1. Verify that the package contents are complete as ordered.
2. Inspect the instrument for external physical damage due to shipping such as scratched or dented panel surfaces, broken knobs or connectors, etc.
3. Remove the instrument cover and remove all interior foam packing and save for future shipments. Make note of how the foam packing was installed.
4. Inspect interior of instrument for damage, broken components, loose circuit boards, etc. If no damage is evident, the instrument is ready for installation and operation. If any damage due to shipping is encountered, please contact Dasibi (see preface page iv, "Claims for Damaged Shipments and Shipping Errors").
5. If shipping damage is found, and it becomes necessary to return the instrument, please re-pack it in the same way it was delivered (using both the Dasibi shipping containers and the internal foam packing material).
6. The Dasibi shipping boxes and interior packing materials are specifically made for shipment of the analyzer. The materials should be retained for possible future re-shipments to Dasibi (such as subsequent service or repair requirements).
7. If it becomes necessary to return the instrument to Dasibi at some future time, and the original shipping materials and container cannot be found or were not saved, please contact the Dasibi sales office before re-shipment, with the model number of your instrument,

and Dasibi will offer for purchase the appropriate shipping container and materials to prevent damage to the instrument during shipping. It is not recommended that the instrument be shipped using shipping materials and containers unsuited for this purpose.

2.3 Pneumatic Fittings

The installation of the instrument consists of plumbing connections at the rear panel for the sample and span gas inlets and the flow system exhaust to the pump. The location of these items can be seen in Figure 2-1. To avoid damage to the fittings, teflon, nylon or kynar fittings should be tightened only finger tight and metal fittings should be tightened finger tight plus 1/4 of a turn for 1/4" fittings, or 1/8 extra turn on 1/8" fittings, with a wrench. In addition to the plumbing connections, primary power and recorder signal connections are also required.

2.3.1 Gas Sampling Requirements

The sample inlet line connection should be made with 1/4 inch (0.64 cm.) O.D. teflon or bev-a-line tubing (not supplied). Remove the nut on the inlet bulkhead connector and slip it over the end of the tube. Insert this into the connector marked SAMPLE and tighten the nut finger-tight. This connector is off-white in color, because it is made of Kynar, a fluoroplastic similar to teflon.

The entrance of the sampling system should have provision for a water drop-out, or some way to ensure that water (i.e., rain) cannot enter the system. It should be placed as far as possible from any sources that could contaminate the sample.

Since the analyzer is an optical instrument, it is possible that particulate in the gas sample could cause interference in the CO readings, although the sampling/referencing cyclic operation of the instrument is designed to eliminate such interference.

In order to avoid frequent cleaning of the optics and flow handling components, it is recommended that the teflon filter (that comes standard on the inlet port) should remain installed on the inlet line, especially if the monitoring site is in an area of high particulate concentrations. Carbon Monoxide will not be destroyed by the presence of dust, but a dirty filter pad will cause a drop in pressure which, according to gas laws, will make the CO monitor read high. Therefore, if a filter is to be used, it must be changed regularly (see Maintenance Schedule Check List, Table 6-2).

Some users feel that filter maintenance may not be reliably performed and that this will put an unknown factor into the data. Thus, they prefer to monitor without the use of a particulate filter. If a filter is used, all calibrations should be done with the filter in-line so that any effect the filter may have on the sample will be included in the span. Sample air should be drawn through a standard glass or teflon manifold with enough flow to ensure the sample residence time in the sampling train is less than 10 seconds.

The instrument does not use any reagents and is safe to vent into a working area. The exhaust is actually ambient air. For this reason, the exhaust should also be prevented from re-entering the sample system.

2.3.2 Primary Power Connections

The instrument is designed to operate on standard, single phase electrical current, 105 to 125 VAC, 50 to 60 Hz or 220 VAC, 50 to 60 Hz. Prior to connecting the AC power cord to the power source, ensure that the power switch on the instrument is in the off position.

To protect operating personnel, the National Electrical Manufacturer's Association recommends that the instrument be grounded. The instrument is equipped with a three-conductor power cable which automatically grounds the instrument when the appropriate outlets are used. The round pin on the power cable is the ground pin connection. To retain the protection feature when operating the instrument from a two-contact outlet, use a three-conductor to two-conductor adapter and connect the adapter grounding wire to a suitable ground.

HAZARD WARNING

Operating the instrument without properly connecting the ground lead is a dangerous electrical practice.

2.3.3 Recorder Connections

A terminal strip is located on the rear panel for the connection of one or two recorders. The standard instrument provides adjustable analog output signals at this terminal strip from 0 - 1 and 0 - 10 volts to record CO readings. Trimpots, accessible through holes located on the front panel permit both the recorder ZERO and SPAN to be set for each output. When connecting recorders, use shielded, twin-lead cable and observe the correct polarity.

2.3.4 Data Acquisition System (DAS)

The instrument analog output can be connected to a data acquisition system as well as a recorder at the terminal strip on the back panel. If a data acquisition system is connected, only one recorder can then be connected at the same time. There are ZERO and SPAN adjustments on the front panel for adjusting both a recorder output as well as for setting up the data acquisition system. When connecting the data acquisition system, use shielded, twin-lead cable and observe the correct polarity.

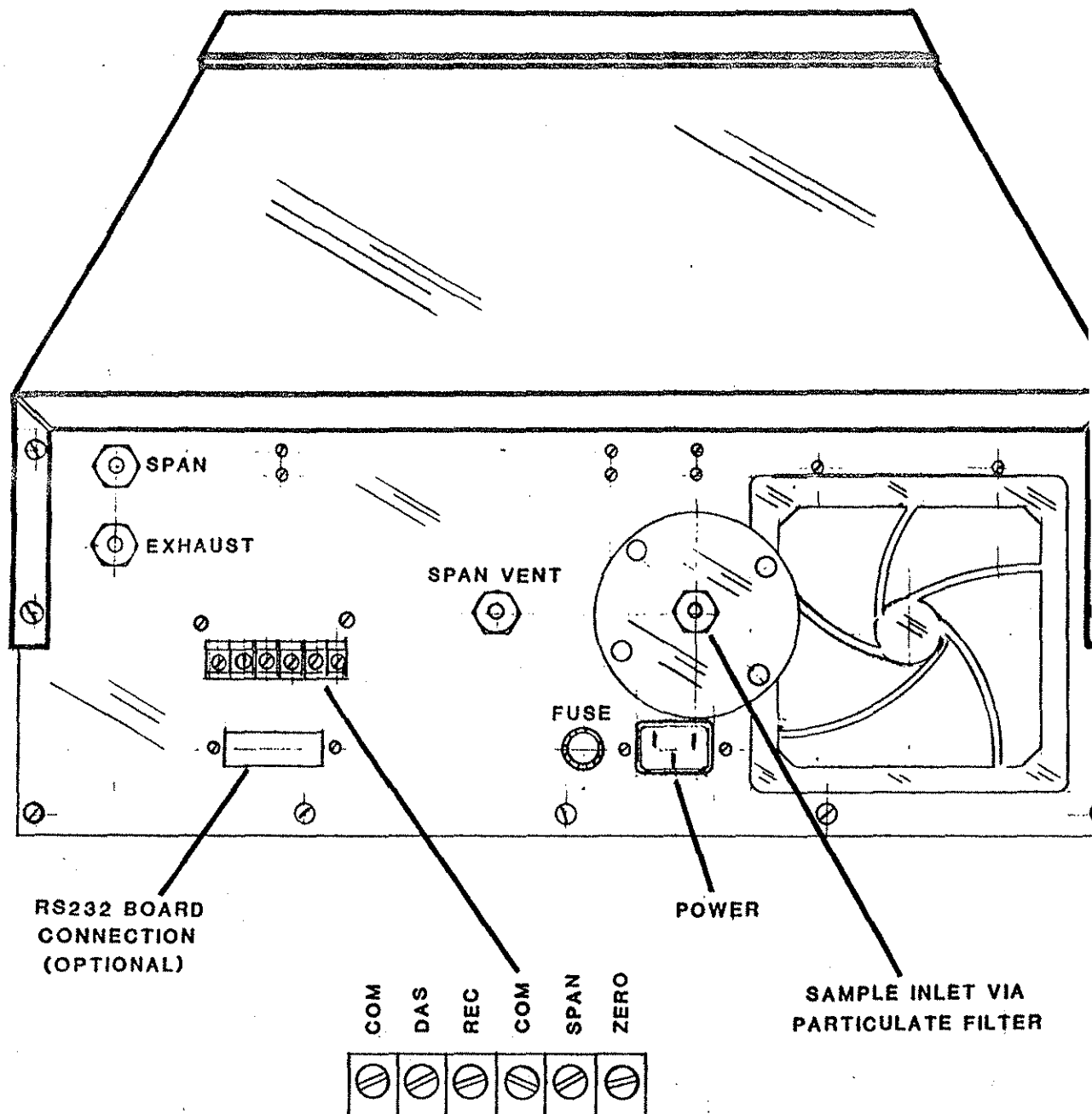


Figure 2-1 3008 Back Panel Diagram

3.0 INSTRUMENT DESCRIPTION

3.1 General

This section provides a brief physical and operational description of the instrument. Further operating details and theory are provided in Section 4.0, Principle of Operation. The two sections should be read together to obtain a full overview of the instrument's construction and capabilities. Section 5.0 describes instrument adjustments for routine operation.

The CO Analyzer Model 3008 is basically composed of three (3) functional subsystems:

1. The Flow System - Figure 3-1
2. The Optical System - Figure 3-2
3. The Electronic System - Figure 3-4

3.2 Flow System Descriptions (Refer to Figure 3-1)

This system is composed of:

1. Sample Solenoid Valve (3-way)
2. Reference Solenoid Valve (3-way)
3. Span Tank Solenoid Valve (2-way)

All three valves are connected to the optical unit, which in turn is connected to a flowmeter equipped with a needle valve. The flowmeter is connected to the suction side of a pump; the pressure side of the pump is connected to the exhaust port of the analyzer.

3.2.1 SAMPLE MODE

When the front panel mode switch labelled SAMPLE is pushed no solenoid valves are activated and the analyzer samples ambient air through the Sample port. From here, incoming gas enters the Sample valve, which is in an unenergized state and allows the sample gas to flow through the analyzer's optical bench. The sample gas is pulled out of the optical bench by the action of a vacuum pump located downstream of the bench, after it is passed through a flowmeter, and a needle valve flow controller that is set to maintain the flow at 1.0 LPM. The gas is then vented out of the instrument via the Exhaust port.

3.2.2 ZERO MODE

Pushing the ZERO mode switch activates the Sample Valve only, which connects to the unenergized Reference Valve, permitting the instrument to sample gas through the Zero Air Filter. The air is then drawn through the optical bench via the downstream pump.

The Zero Air Filter consists of a cartridge (mounted inside the instrument) containing a special catalyst able to remove carbon monoxide from ambient air, thus providing a source of zero gas for the instrument without the use of tanks. When the Reference valve is activated (manually or automatically) the instrument samples ambient air through the catalyst and a dynamic zero is achieved.

3.2.3 SPAN MODE

Pushing the SPAN mode switch activates all three valves simultaneously allowing the instrument to sample span gas coming from a pressurized cylinder.

The function of the span valve is to shut off the effluent of the standard gas cylinder so that it does not continue to flow through the capillary flow restrictor and out of the Vent Port when the instrument is no longer in the SPAN mode. This is especially necessary with the use of the remote control options. It also permits the user to have the span gas cylinder itself always open to the analyzer without the danger of wasting its contents. The capillary flow restrictor sets the gas flow at about 1.5 LPM, 1 LPM used by the analyzer and 0.5 LPM being vented through the Vent port. The span gas cylinder pressure is normally set at 15 - 20 PSIG.

3.3 Optical System Descriptions (Figure 3-2)

The optical system contains the following modules:

- A. Fore Optic Assembly Including Source Module and GFC Wheel.
- B. Multi-reflection Measurement Chamber
- C. Detector Module

The operation of the optical system is best described by tracing the path of radiation from the source where it emanates to the detector where it is converted to an analog electrical signal.

3.3.1 Fore Optic Assembly

Broadband radiation from the source strikes the GFC wheel, then passes through a narrow passband interference filter where it is converted from broadband radiation to narrow band radiation centered at 4.7 microns with a bandwidth of about 0.1 microns. The rotating gas filter wheel has two gas tight chambers 180 degrees apart, one containing CO gas and the other nitrogen. Thus, the narrow band radiation alternately passes through the CO gas-filled cell and the nitrogen gas-filled cell before entering the multipass optical chamber.

Between the times the 1800 RPM motor rotates one gas cell out of the beam, and the other in, there are two mechanical occlusions of the beam per revolution. These are designated as the dark portions and occur 60 times a second as compared to 30 repeats a second for the measure and reference portions of the beam. They are important in the electronic processing of the transduced signal.

The rotation of the motor shaft determines the timing of the optical events taking place in the optical module. In order for the measurement information to be synchronously decoded by the electronic system, the latter must be coordinated time-wise with the wheel rotation. This is done by a slotted disk which is mounted on the motor shaft. The disk interrupts a light beam generated in an optical position sensing device (PSD). This small assembly is positionable about an arc and controls the phase relationship between the electronic signal sampling, and the angular position with time of the correlation wheel.

3.3.2 Optics Chamber (Figure 3-32)

Upon entering the multipass chamber the radiation emanating from the narrow bandpass filter strikes mirror M1 which is a plane mirror that directs the radiation to mirror M2, thus traversing the length of the chamber. Concave mirror M2 is the first mirror of the multi-pass (White) configuration. It reflects the radiation to M4 making the second traversal of the optical chamber. Concave mirror M4 reflects the radiation back to concave mirror M3 (3rd traversal) and mirror M3 again reflects the radiation back to M4 (4th traversal).

At this point mirror M4 sends the radiation back to mirror M2 starting the whole process over again and repeating for 5 more sets of 4 traversals. Each set of traversals displaces the beam toward mirror M5. At the end of the sixth set of traversal (the 24th pass) the radiation from mirror M3 which would normally fall on mirror M4 is intercepted by small plane mirror M5 which reflects it onto the detector module.

3.3.3 Detector Module Assembly (Figures 3-28, 3-29, 3-30 & 3-31)

A Peltier element cools the detector and is powered from a 6 volt, 2 ampere regulated supply. The photoconductive detector can be thought of as a variable resistor which has high resistance at low light levels and low resistance at high light levels. The cooler current is regulated by a regulator mounted on a heat sink mounted on the chassis behind the recorder output board.

A Bias Voltage Board delivers 90 volts through the optimum source resistance. A square wave oscillator on the board, IC1, produces an output of ± 13 V at 10 KHz.

A Preamplifier provides amplification, phase inversion, AC coupling, and some high frequency noise attenuation. The signal output from the Detector Module is a series of "measure" and "reference" pulses with a "dark" level in between. Each pulse occurs 30 times per second.

3.4 Electronic System Descriptions (Figures 3-3 and 3-4)

A functional diagram of the electronic system is shown in Figure 3-4 and the front panel controls are shown in Figure 3-3. The following paragraphs contain a description of the printed circuit boards, electronic sub-assemblies and functional controls.

3.4.1 Main Power Supply Board (Figures 3-5 and 3-6)

Regulated power supplies deliver the various DC voltages to operate the unit. These include ± 15 Vdc for operational amplifiers, +5 Vdc for digital functions and +24 Vdc for solenoid valves. The +13 Vdc is used as an I.R. source supply. The optical chamber temperature regulation circuit is also on this board.

3.4.2 Signal/Logic Board (Figures 3-7, 3-8 and 3-8A)

The series of pulses from the detector is amplified and sampled to produce two DC levels by means of sample and hold circuits. These two DC levels are with respect to the dark level (taken as zero) and the net output is a lowpass filtered DC signal proportional to the difference between the measure and reference signals.

In order to sample the measure, reference and dark levels at the proper time, synchronizing signals are derived from a photocell which senses slots in the slotted disc. In conjunction with a signal board, the logic board sorts out the times of the Measure, Reference and Dark signals and provides sampling gates on three separate lines at optimum times for the signal.

3.4.3 I/F Board (Figures 3-9 and 3-10)

All analog signals developed within the monitor, whether relating to CO concentration, or from temperature and pressure sensors, etc. must be interfaced into the computer system in properly scaled units and in some cases signal conditioned by filters. Also, command signals from the computer which are supplied to activate solenoid valves, calibrate recorders and data acquisition systems, etc. must be coupled outside the computer environment by appropriate interfacing.

All of these tasks are undertaken by the I/F Board, which both receives and transmits information to the computer boards over separate lines for each function. These signals are physically transferred by means of ribbon cables which connect multi-pin connectors on the tops of the appropriate PC boards. In-going and outgoing signals from the computer, enter at the top of the I/F Board, generally receive some signal manipulation and are routed to appropriate destinations within the instrument through the board socket and mother board distribution.

In addition, the I/F board contains a signal simulator which allows the entire electronic system to be tested independently of the optical bench.

CAUTION

Switches S1 and S2 on the I/F Board must be in the up position for the analyzer to perform its normal, intended function.

3.4.4 Pressure Transducer Amplifier

The pressure is monitored by a pressure transducer located at the input gas stream of the flow meter. The circuit amplifying the output of the pressure transducer is located on the I/F Board.

The pressure transducer is used to measure the absolute pressure in the gas stream, and also to indicate flow interruption due to pump failure or other pneumatic problems. It is electrically connected to the I/F Board by means of a ribbon cable and plug. Its signal is amplified by dual op-amp A2, the first section of which is the pressure transducer's zero offset compensator, PZ, and the second section is the pressure transducer's span adjustment, PS. The zero adjustment must be made with the pump connected to the input of the pressure transducer. The span adjustment, PS, is set to make the pressure agree with a laboratory barometer while the transducer is exposed to the atmosphere.

3.4.5 Recorder Output Control Board (Figures 3-11 and 3-12)

Two analog output signals are provided, each with its own zero and span adjustment. This signal is adjustable from 0 to 10 volts full scale (or anywhere in-between). The scaling and zero adjustments can be made from the front panel using trimpots accessible through holes. The output signal is available from a terminal strip at the back of the analyzer. This signal is provided to operate recorders and data acquisition systems.

3.4.6 Valve Switch Board (Figures 3-13 and 3-14)

The solenoid valves are used in programmed modes such as in the "Start-up Program" and the "Auto-Cal Program," and as such are under the direction of the internal computer. The latter issues commands to the I/F Board which relays them via the Mother Board to the Valve Switch Board. This board has the capability to receive logic signals and to convert them to 24 volt drive signals to power the solenoid valves independently of each other for use with the gas cylinders. The Valve Switch Board is located on the back panel and contains terminals so that the valves can be remotely controlled.

3.4.7 Mode Switch Board (Figure 3-15)

The three blue push button switches on the front panel control the gas sampling modes: SAMPLE, ZERO and SPAN. They are mounted on a printed circuit board which receives computer commands that light appropriate LED's and also provides user directed input to the computer. This is the "keypad" of the instrument, and although it only has three buttons, the sequence in which these buttons are pressed allows a variety of user options. For example, a detailed sequence of instrument diagnostics can be called-up by pressing the ZERO and SPAN buttons simultaneously.

3.4.8 Alphanumeric Display Board

The alphanumeric display board on the front panel contains an entire, separate microprocessor system which accepts information in ASCII code and displays messages in a maximum of 20 digits. All displayed information is updated once each second.

3.4.9 Fan Temperature Control Circuit (Figures 3-16 and 3-17)

The internal temperature of the analyzer is regulated at $40^{\circ}\text{C} \pm 2^{\circ}\text{C}$ by a modulated fan controller which admits more outside cooling air as the internal temperature increases. In addition, a controlled heater in the wheel compartment maintains the temperature between 45 and 50°C .

3.4.10 DIAG (Diagnostic) Thumbwheel Switch (Figure 3-3)

The DIAG thumbwheel switch allows the user to call up precise measurements and information on the alphanumeric display board that will enable assessment of the performance of the components and systems in the analyzer. In addition, the switch is useful in the calibration of external read-out devices, by supplying accurate calibration voltages. The switch settings are shown in Table 3-1.

TABLE 3-1
DIAG Thumbwheel Switch Settings
Information Displayed

DIAG #	Information Displayed
0	Normal operating position. The front panel displays CO concentration in PPM.
1	The front panel display the Zero Signal in mV.
2	Gas temperature in $^{\circ}\text{C}$ is displayed.
3	Gas Pressure in mm Hg is displayed.
4	The gas law correction factor is displayed.
5	The measure and reference voltages are displayed in mV.
6	Wheel temperature in $^{\circ}\text{C}$ is displayed.
7	Not in use.
8	Chart recorder calibration signals are alternated in conjunction with use of the AUTO thumbwheel.
9	Not in use.

These parameters are normally read-out only on the display, and are not presented to the recorder or data acquisition system output. It is possible, however, to display the parameters on analog readout devices by closing position 8 on the CPU dipswitch.

3.4.11 AUTO (Autoprogram) Thumbwheel Switch (Figure 3-3)

The AUTO thumbwheel switch enables the user to have the unit either ZERO and SPAN itself or just ZERO itself at pre-set intervals (except for AUTO NO. 9) as shown in Table 3-2.

TABLE 3-2	
AUTO Thumbwheel Switch Settings	
AUTO. NO.	Set Time Interval
0	None
1	Zero and Span every 12 hours
2	Zero and Span every 24 hours
3	Zero and Span every 48 hours
4	Zero and Span every 45 minutes (test purposes)
5	Zero every 12 hours
6	Zero every 24 hours
7	Zero every 48 hours
8	Zero every 45 minutes (test purposes)
9	Zero and Span gas through Sample Inlet Port

3.4.12 SPAN NO. Thumbwheel Switch (Figure 3-3)

The SPAN NO. thumbwheel switch is used to adjust the gain of the unit and is analogous to a rotary span pot. It adjusts the display and output values to agree with a span calibration source.

3.5 Computer System Descriptions

The total computer system occupies two printed circuit boards and internal diagnostics which are described below.

3.5.1 I/O Board (Figures 3-22, 3-23 and 3-24)

The I/O board contains the system analog circuitry: D/A converters, V/F converter, a multiplexer, timers, etc. Its principle function is the conversion of analog to digital and digital to analog signals so they can be under computer control.

3.5.2 CPU Board (Figures 3-25, 3-26 and 3-27)

The CPU board consists mainly of the CPU, RAM and ROM, address decoding logic and input and output ports. It is the "director of events" and the processor of information and orchestrates much of everything that goes on in the instrument.

An eight position dipswitch is provided on the CPU board to allow initiation of various user functions. A description of these functions is shown in Table 3-3, below. When the CPU board is held so that the dipswitch package is at the top, position 8 is at the left. The individual switches are either open (down) or closed (up).

TABLE 3-3
CPU Dipswitch Settings

Position	Function
1	UP for or simulated frequency = 40 PPM.
2	DOWN for pressure/temperature correction.
3	DOWN for low, UP for high WTC.
4	UP for using Sample port for zero and span operation.
5	DOWN for Switch 6 averaging, UP doubles average time.
6	DOWN for 60, UP for 150 second averaging.
7	DOWN for enabling flashing messages.
8	UP to display diagnostic information from DIAG thumbwheel switch on analog outputs to recorders.

3.5.3 Flashing Messages

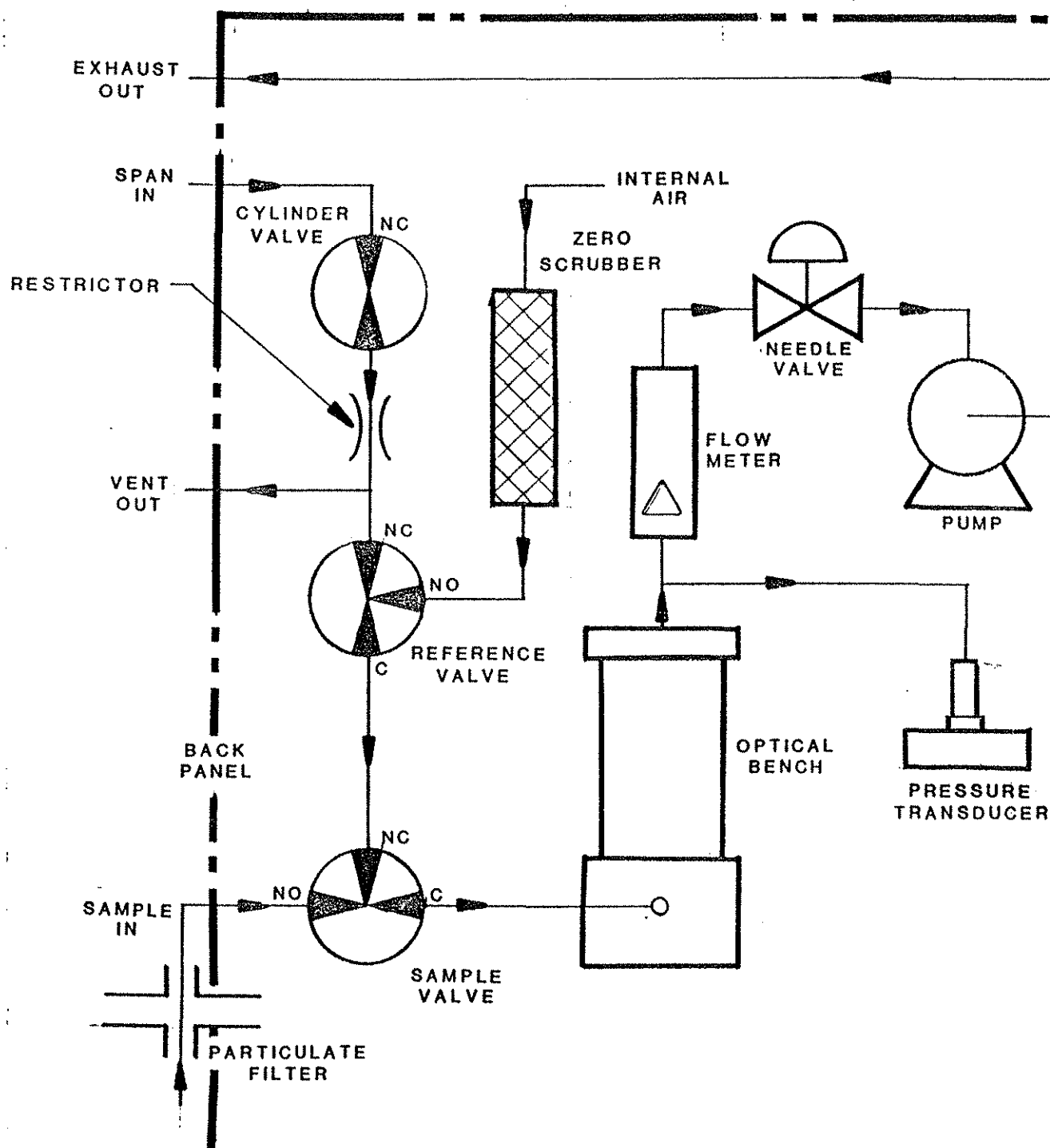
The following failures will be indicated by a message flashing on the Alphanumeric Display every few seconds.

1. Source Failure D5
2. Wheel Temperature Failure D6
3. Zero Offset Failure D1
4. RAM Failure CT
5. PROM Failure CT
6. V/F Failure CT
7. Thumbwheel Problem TW

NOTE

If "TW" flashes on the display (number 7, above), then the problem is either with the wiring going to the DIAG/AUTO thumbwheel (which would require replacing the thumbwheel), or a bad I.C. (U11, U16 or U17 on the CPU Board).

0 through 8. In addition, the diagnostics can be displayed on a strip chart recorder or data acquisition system by changing the position of dipswitch 8 on the CPU Board (down to up). See Section 3.3.10 for a listing of the diagnostics available and the thumbwheel setting for each.

**NOTES:**

1. SPAN GAS (40-50PPM) REGULATOR SET AT 10-20 PSIG.
2. VALVES UNDER COMPUTER CONTROL.

Figure 3-1 Flow Diagram

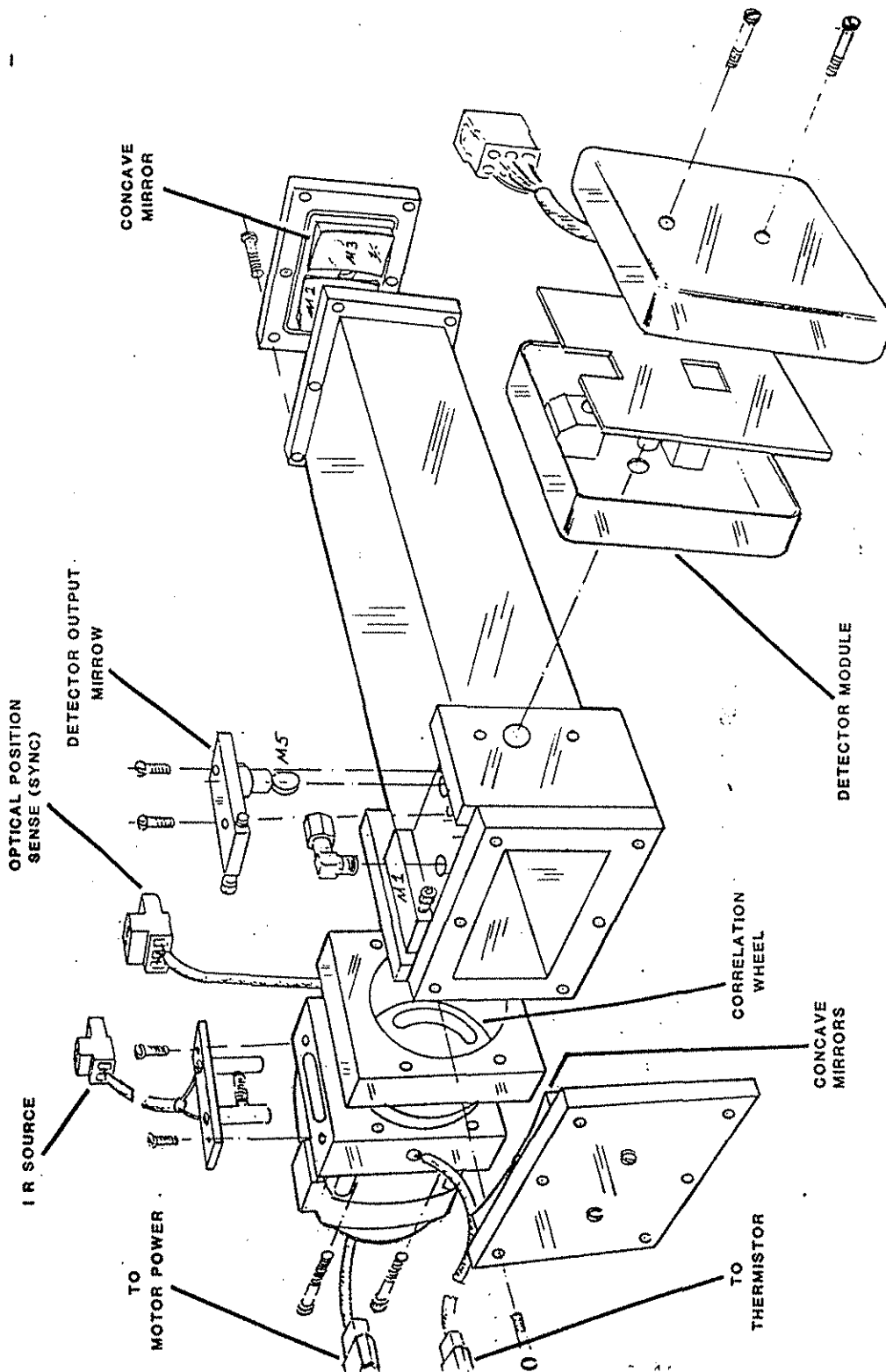


Figure 3-2 Optics Bench Assembly

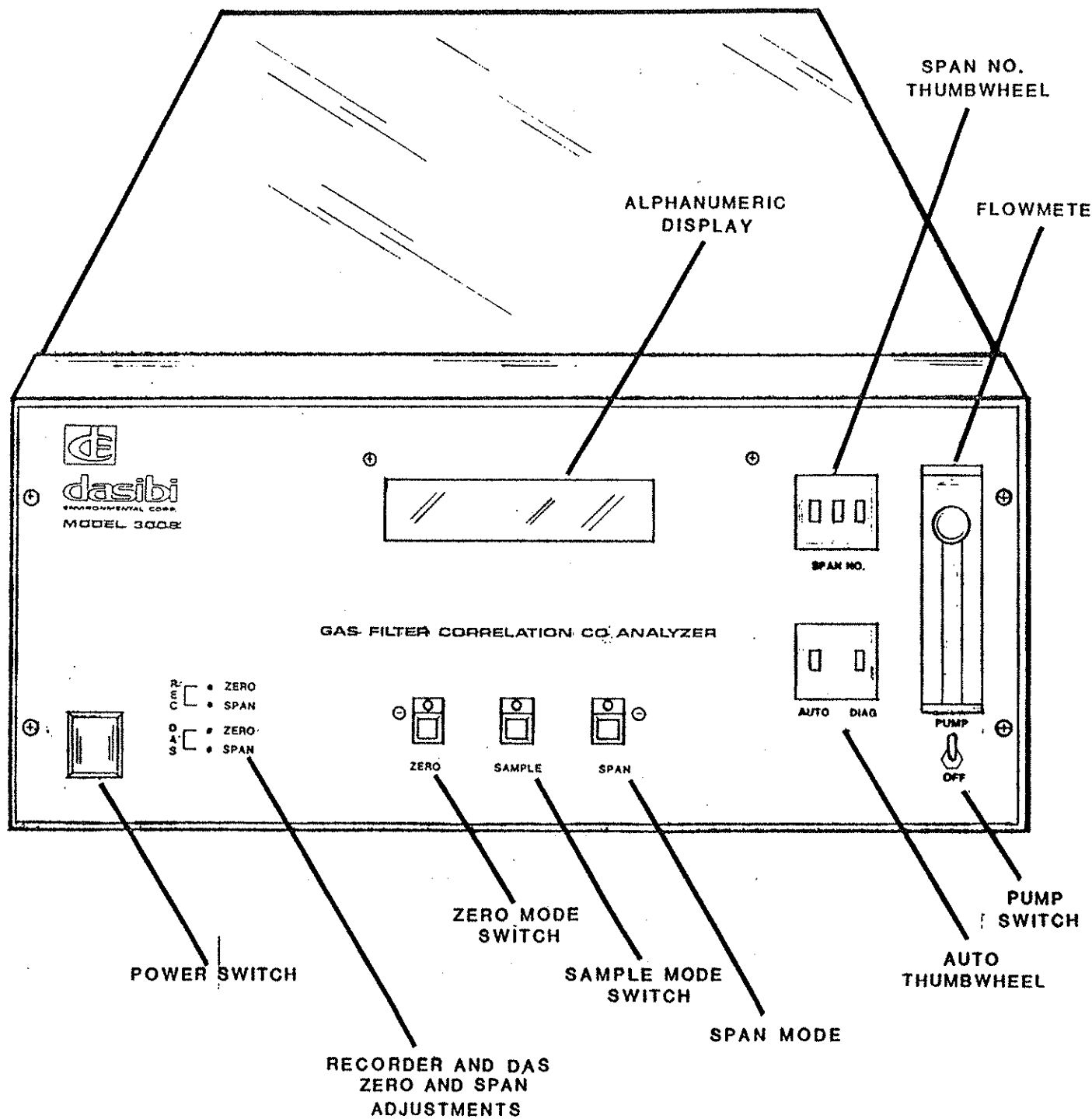


Figure 3-3 Front Panel Diagram

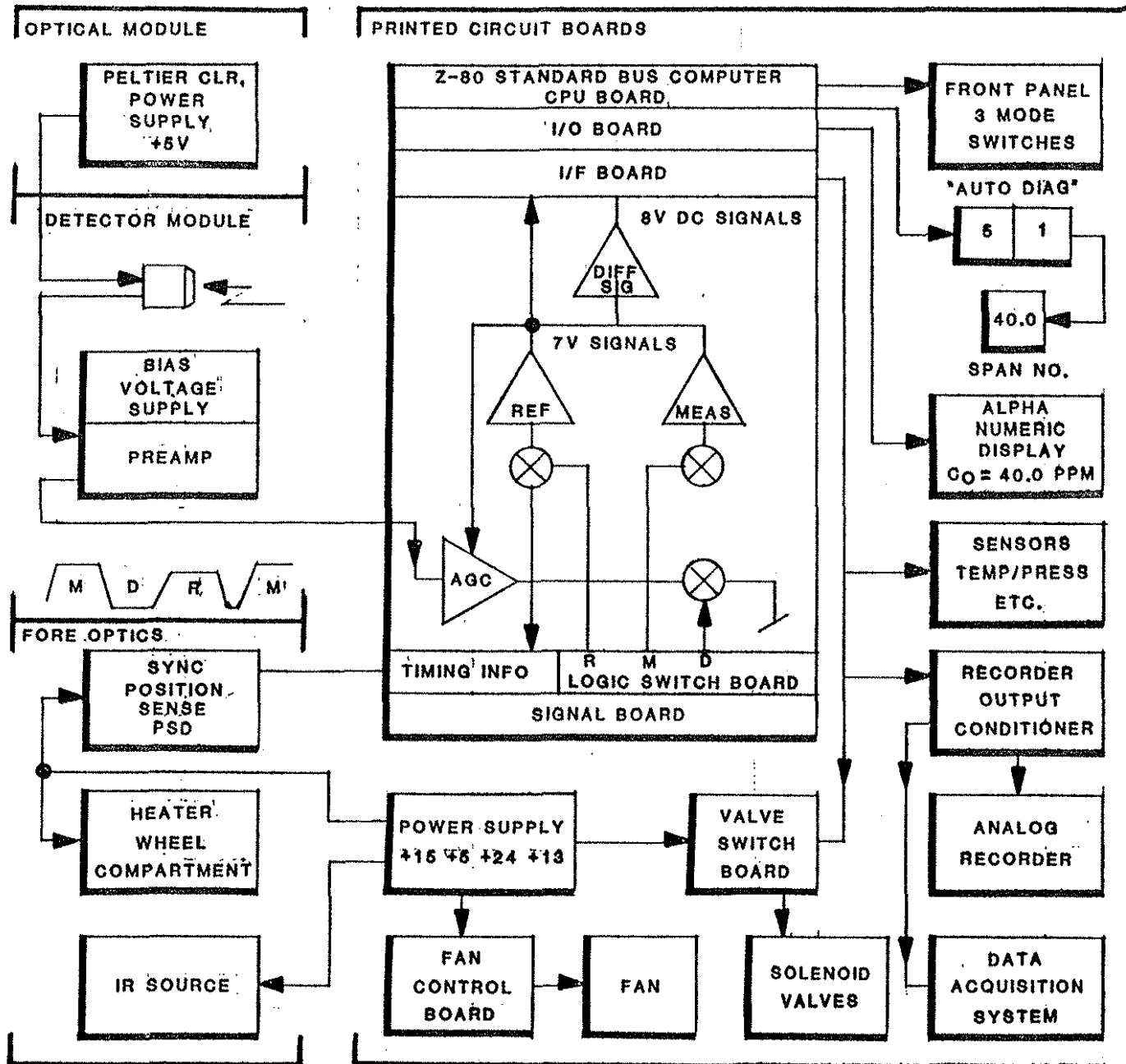


Figure 3-4 Functional Electronics Diagram

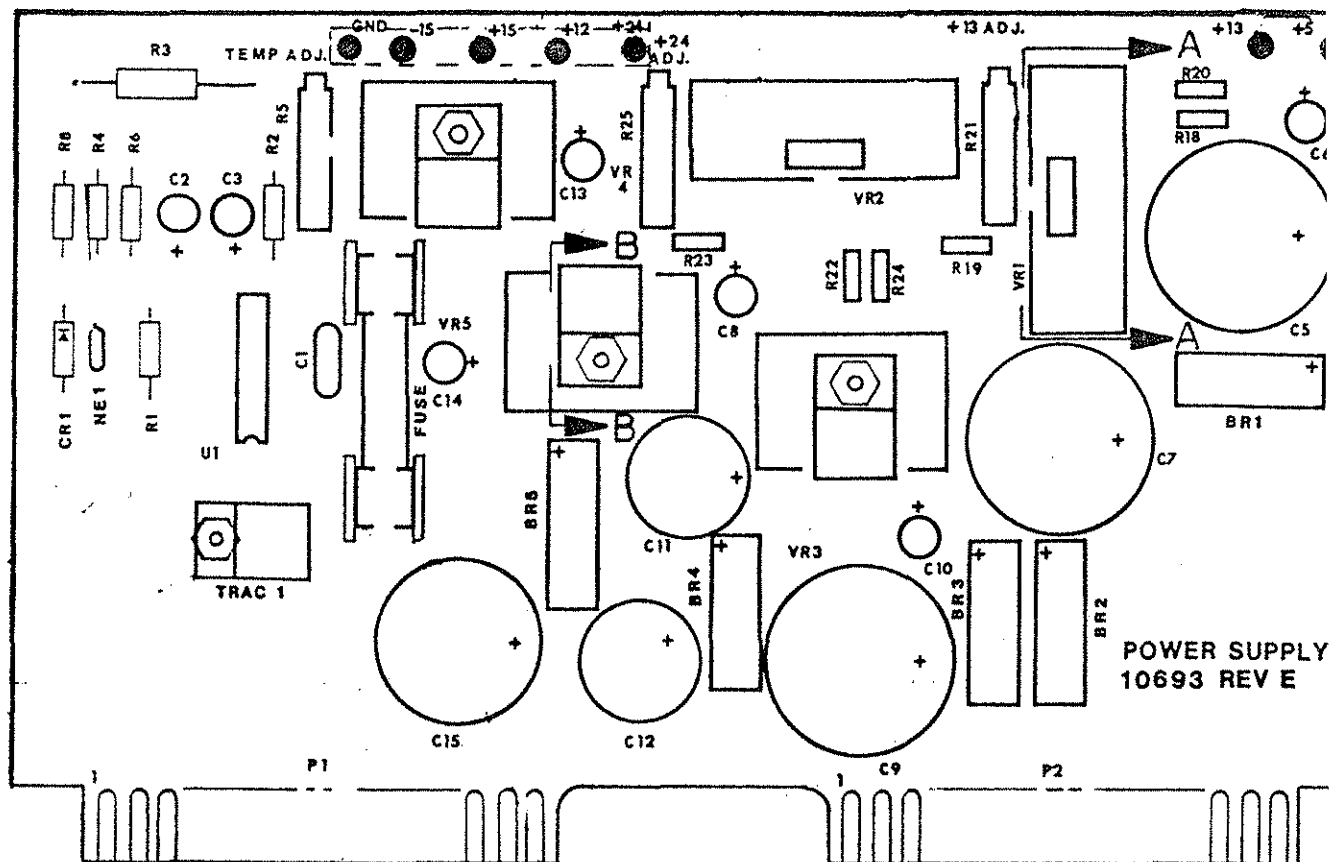
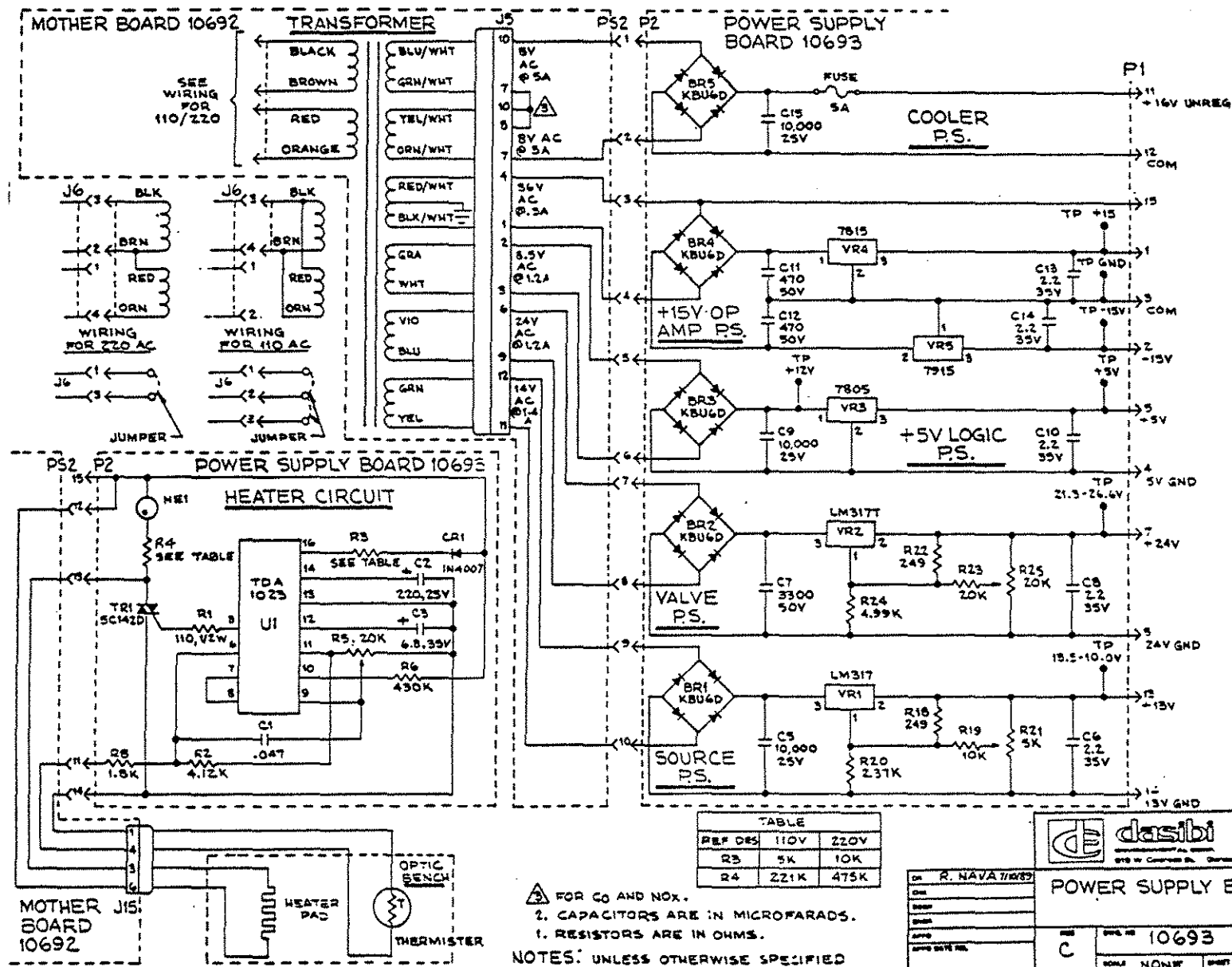


Figure 3-5 Power Supply Board Diagram

Figure 3-6 Power Supply Board Schematics

3-15



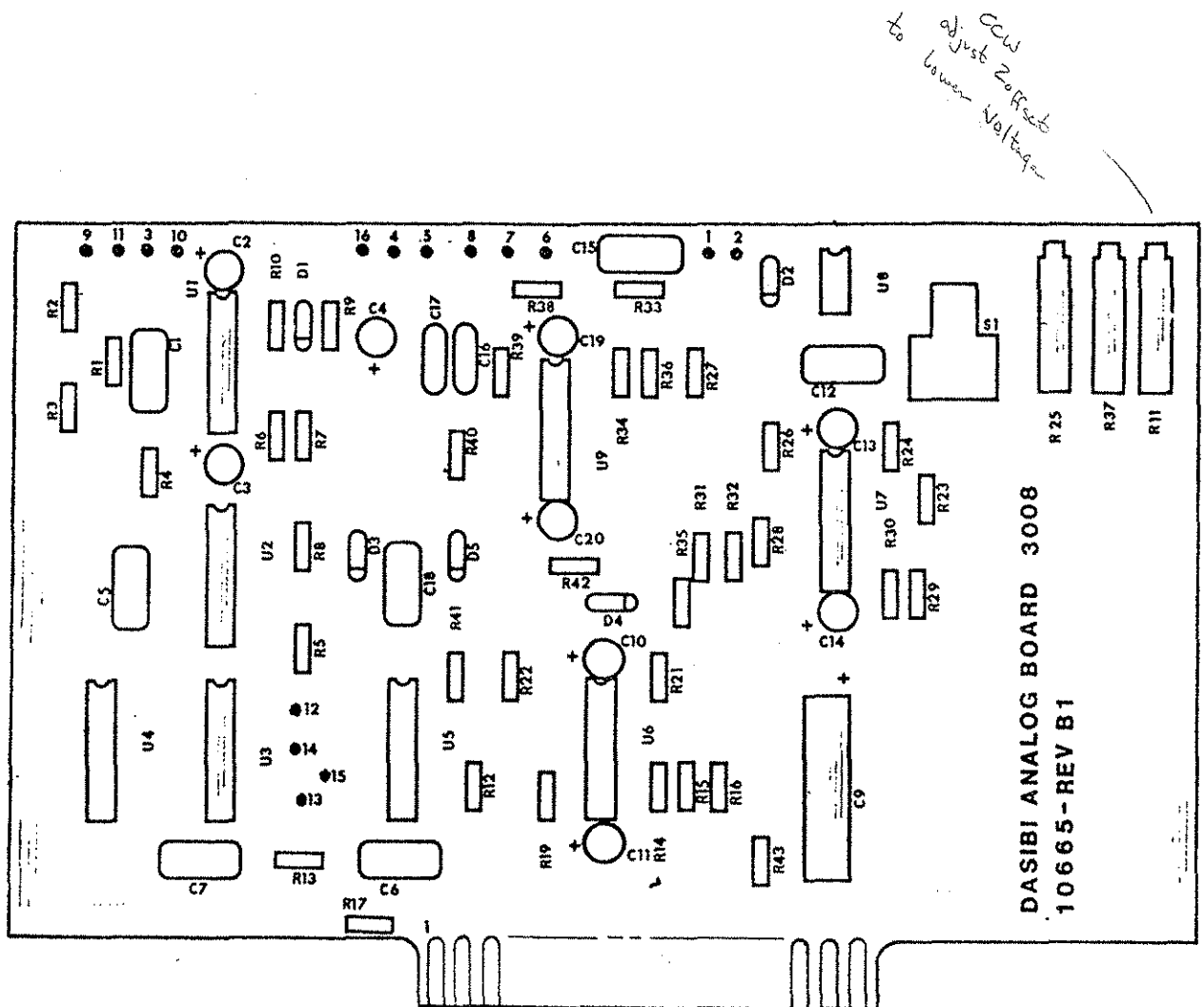


Figure 3-7 - Signal/Logic Board Diagram

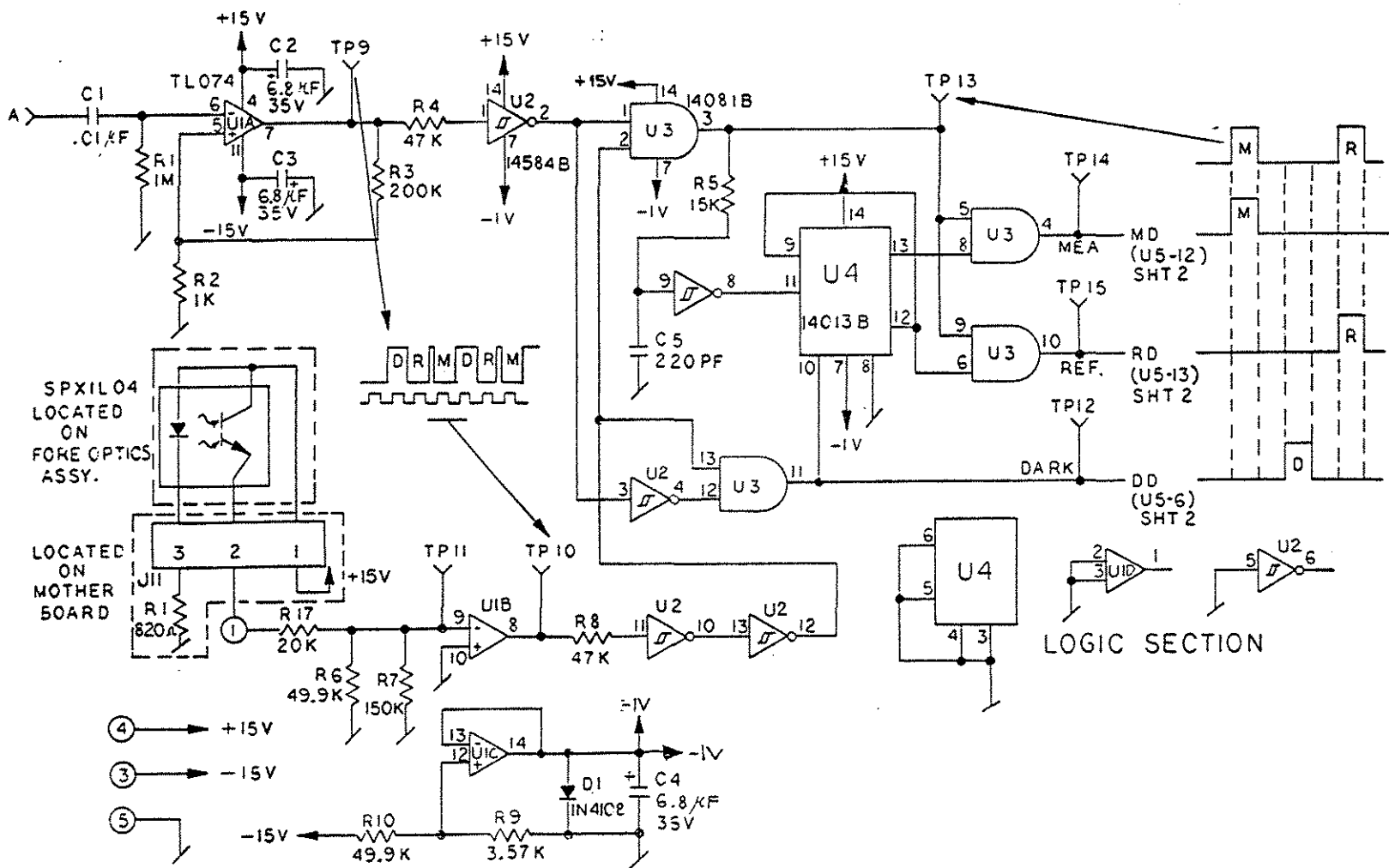


Figure 3-8 Signal/Logic Board Schematics (A)

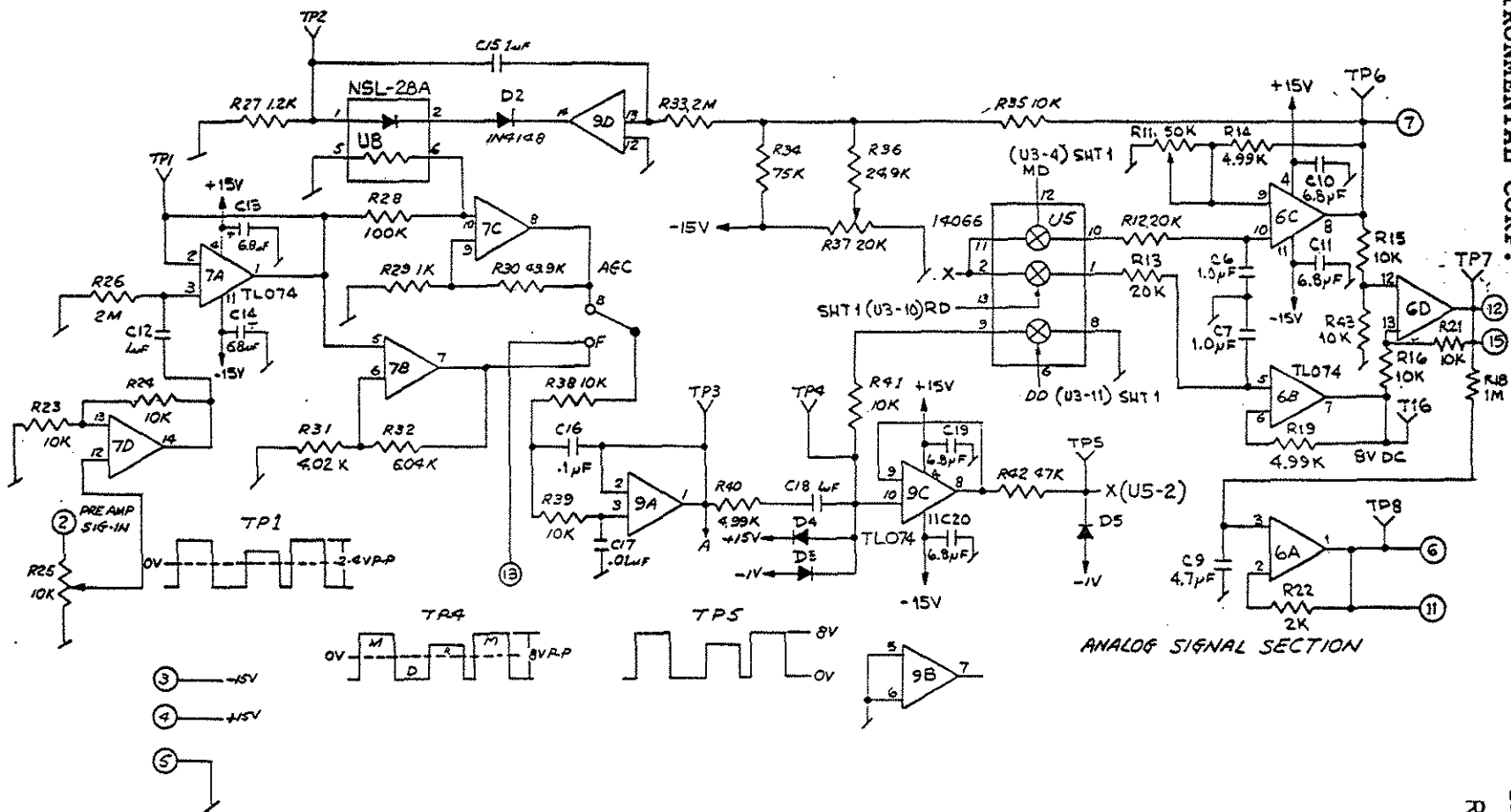


Figure 3-8A Signal/Logic Board Schematics (B)

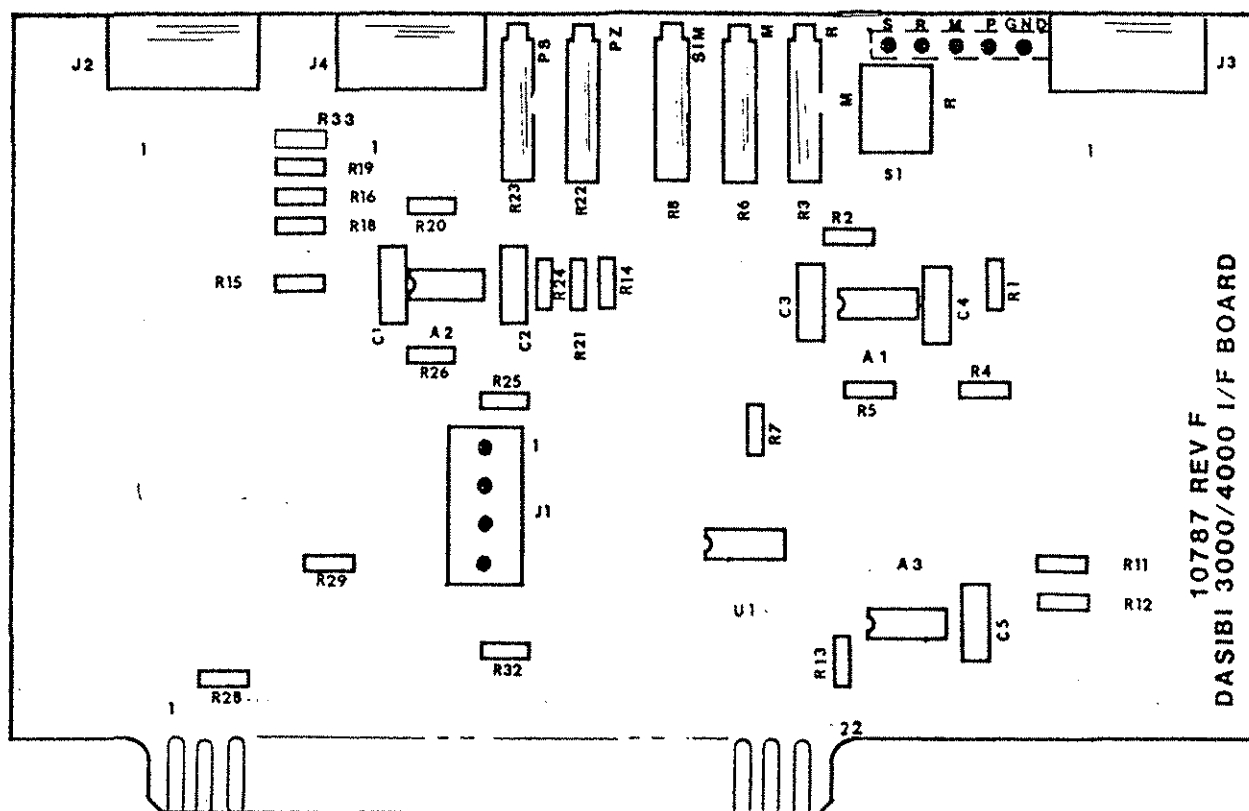
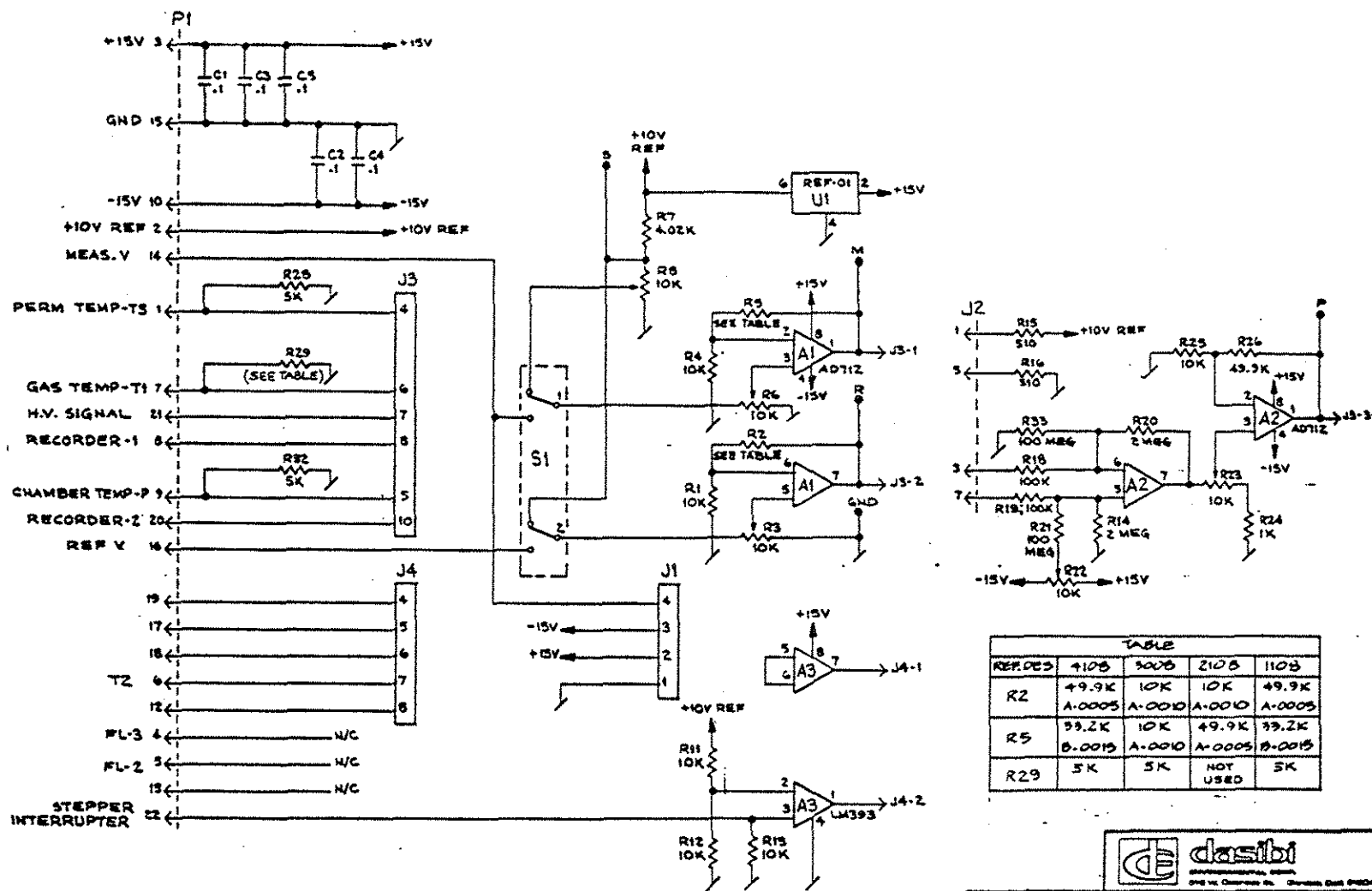


Figure 3-9 I/F Board Diagram



		dasibi <small>Environmental Control Systems Division</small>	
INTERFACE BOARD SCHEMATICS			
DESIGNED BY: E. NAVA 9/24/67 DRAWN BY: G. J. 6/24/67 CHECKED BY: APPROVED BY:	REV. NO. 10787 C	SHEET 1 OF 1	15 G.1

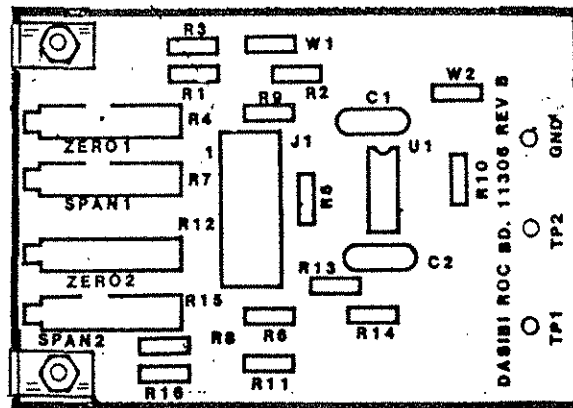


Figure 3-11 Recorder Output Board Diagram

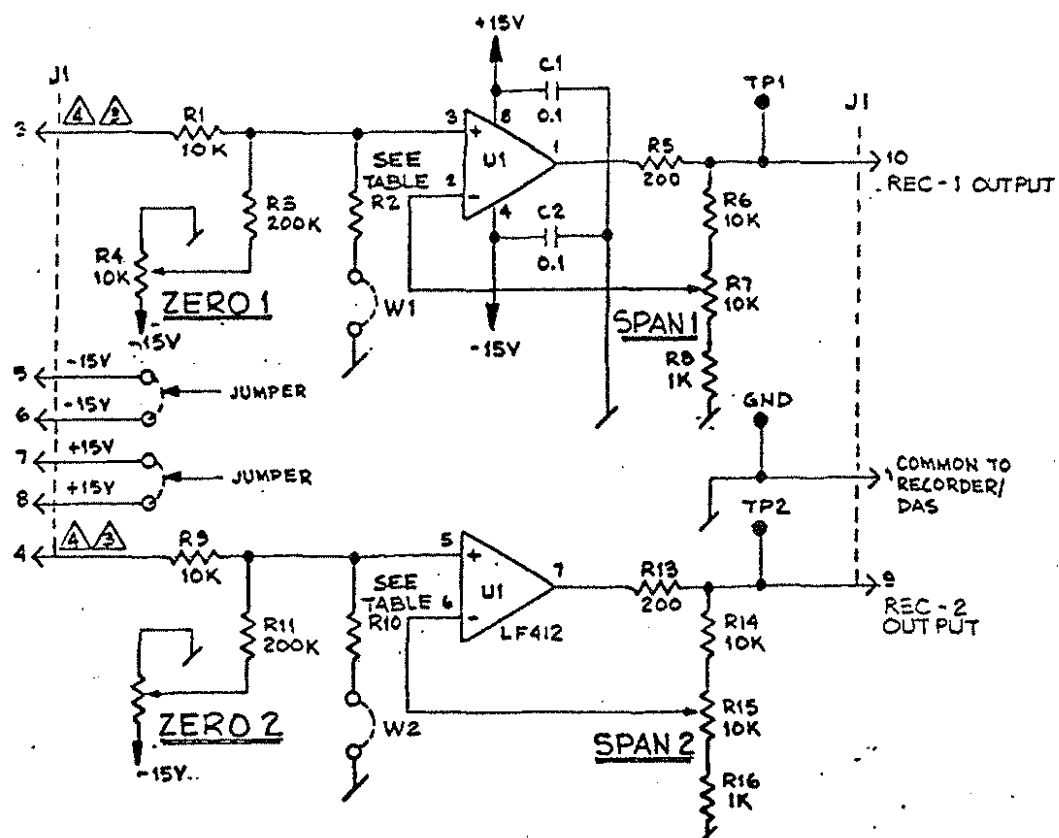


TABLE				
REF	MODEL	MODEL	MODEL	MODEL
DES	110B	300B	410B	210B
R2	3K	47K	2K, 1/10W	2K, 1/10W
R10	3K	47K	2K, 1/10W	2K, 1/10W

DIAGRAM FOR 300B AND 410B (JUMPER)

The diagram shows a switch J2 with two positions. In the upper position, terminal 3 is connected to resistor R1 and terminal 4 is connected to resistor R9. In the lower position, terminal 3 is connected to terminal 4, bypassing the resistors.

Figure 3-12 Recorder Output Board Schematics

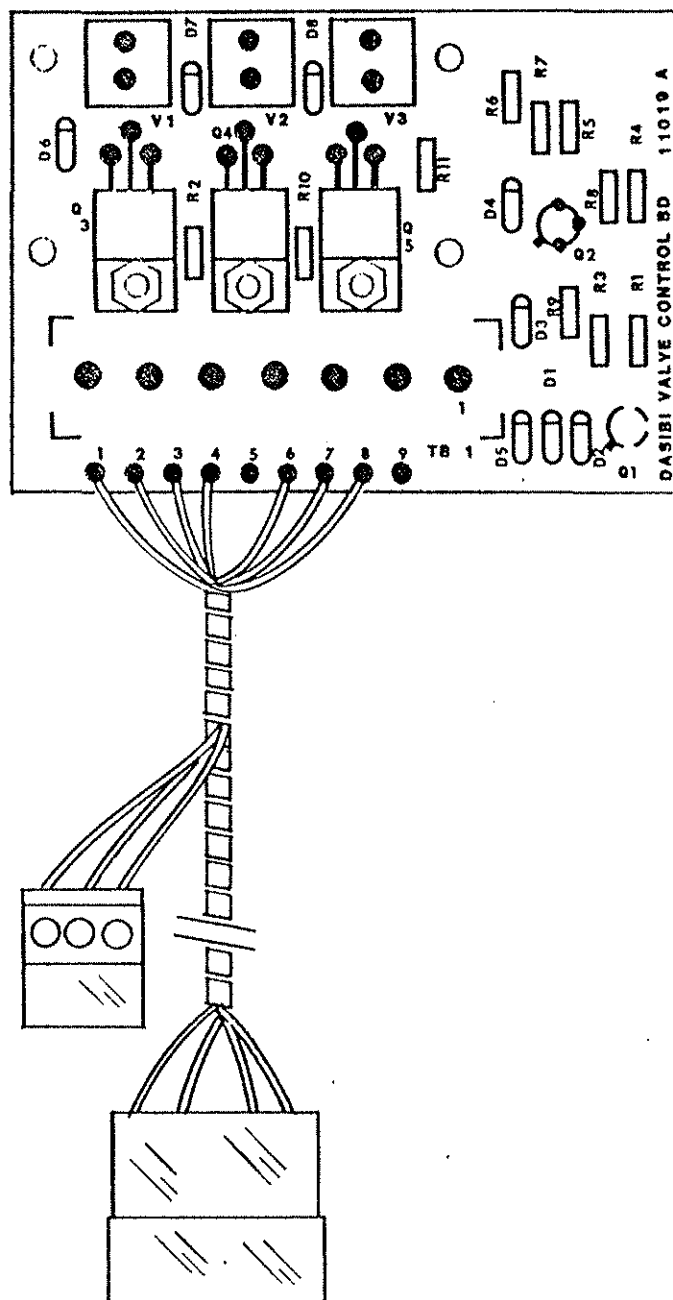


Figure 3-13 Valve Switch Board Diagram

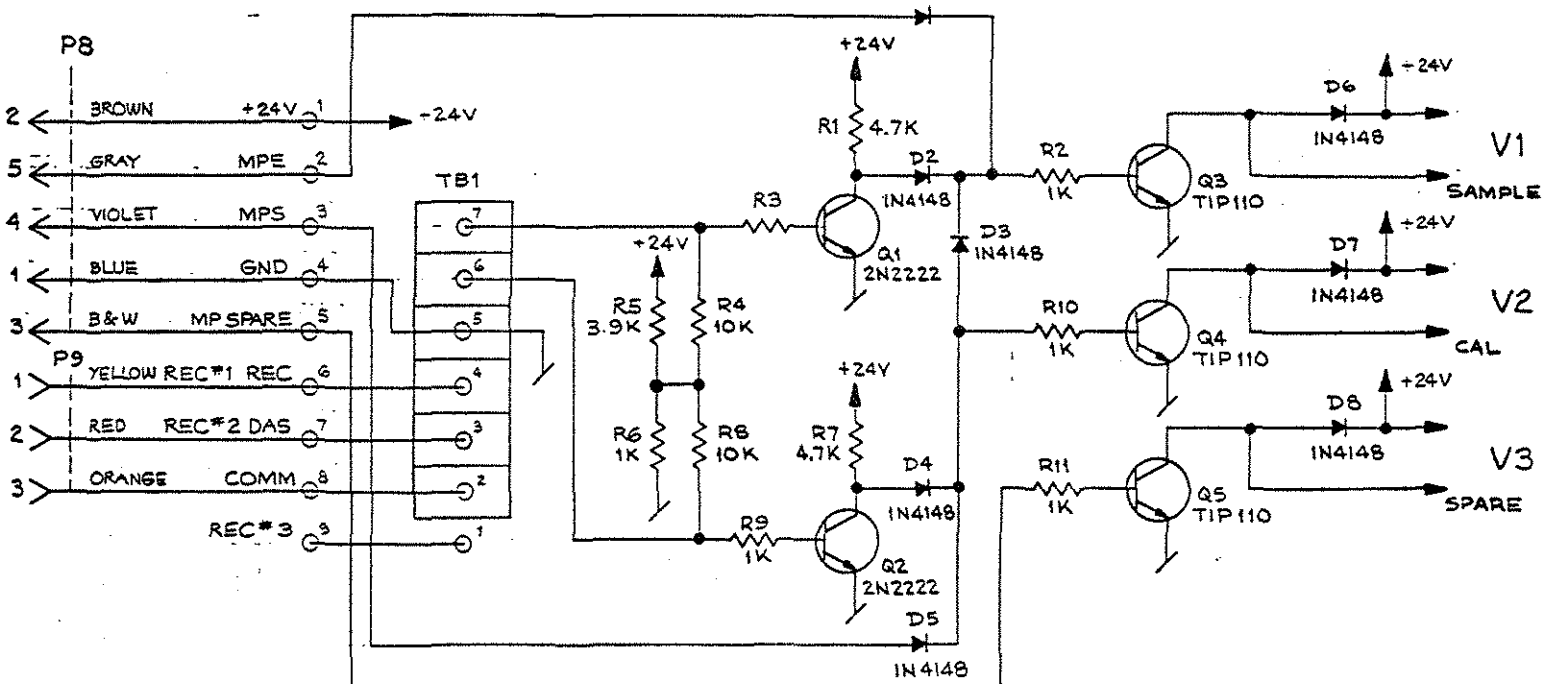
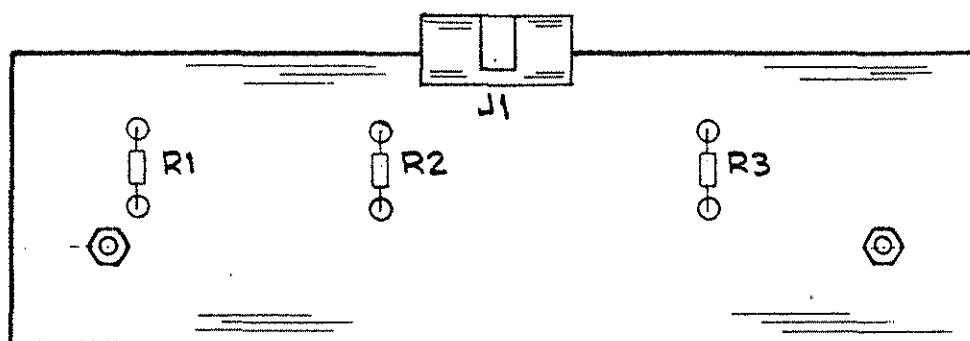
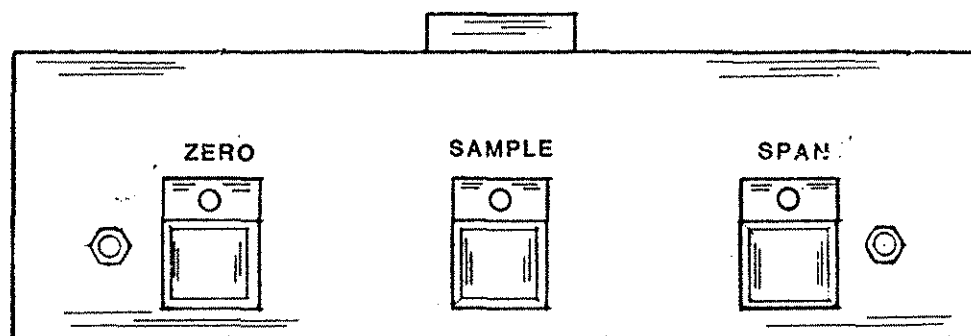


Figure 3-14 Valve Switch Board Schematics



CIRCUIT SIDE

Figure 3-15 Mode Switch Board Diagram

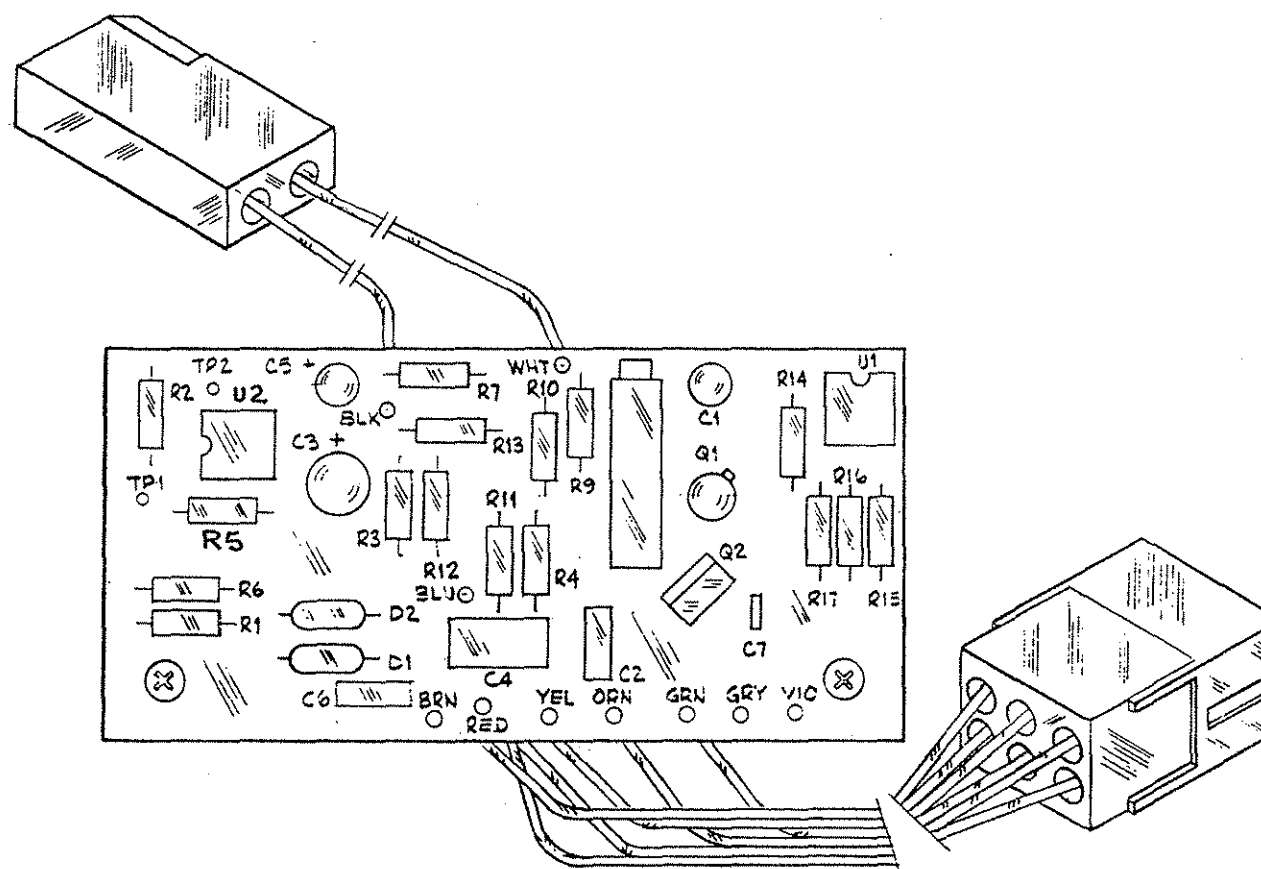


Figure 3-16 Fan Control Board Diagram

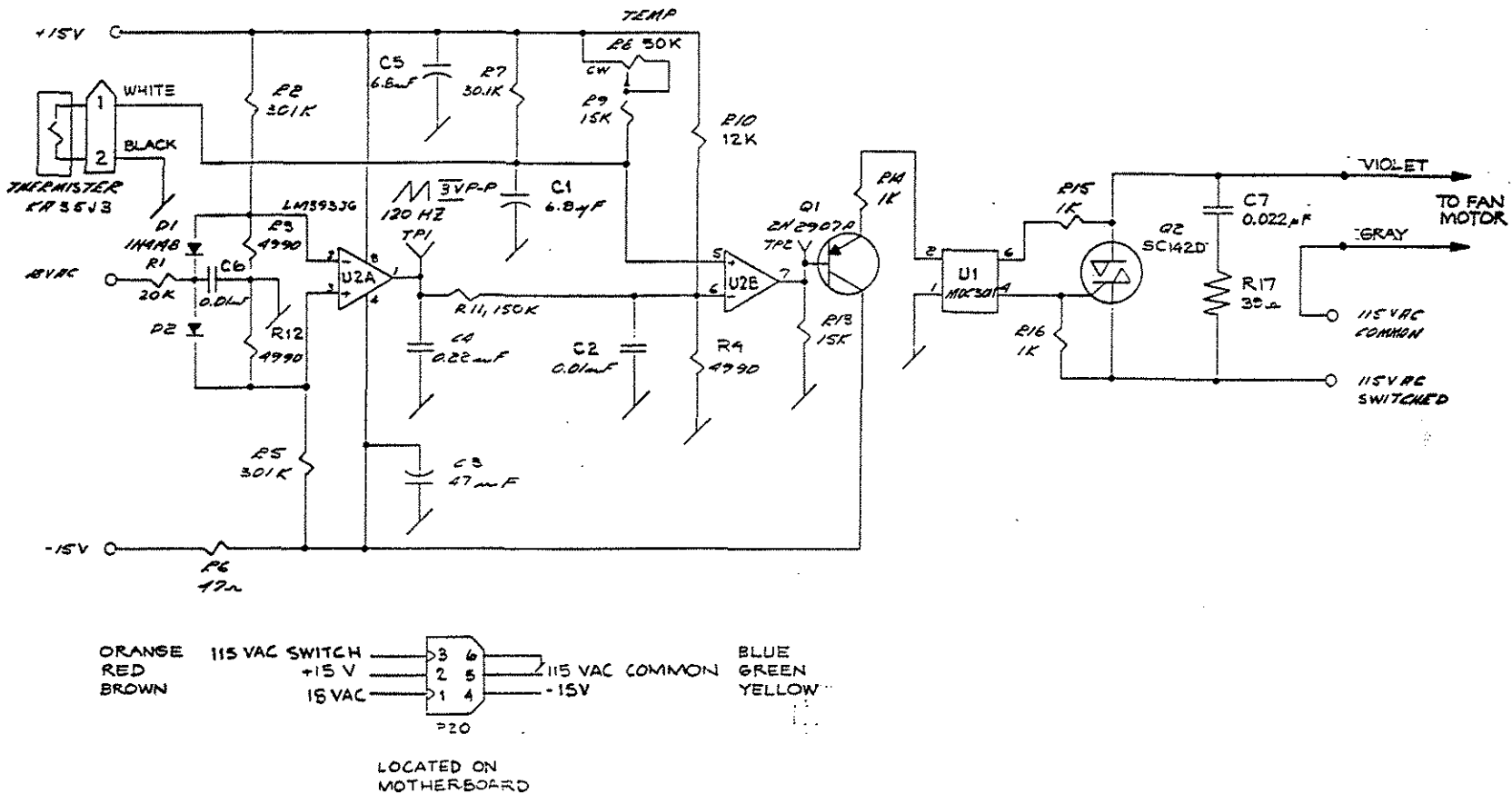


Figure 3-17 Fan Control Board Schematics

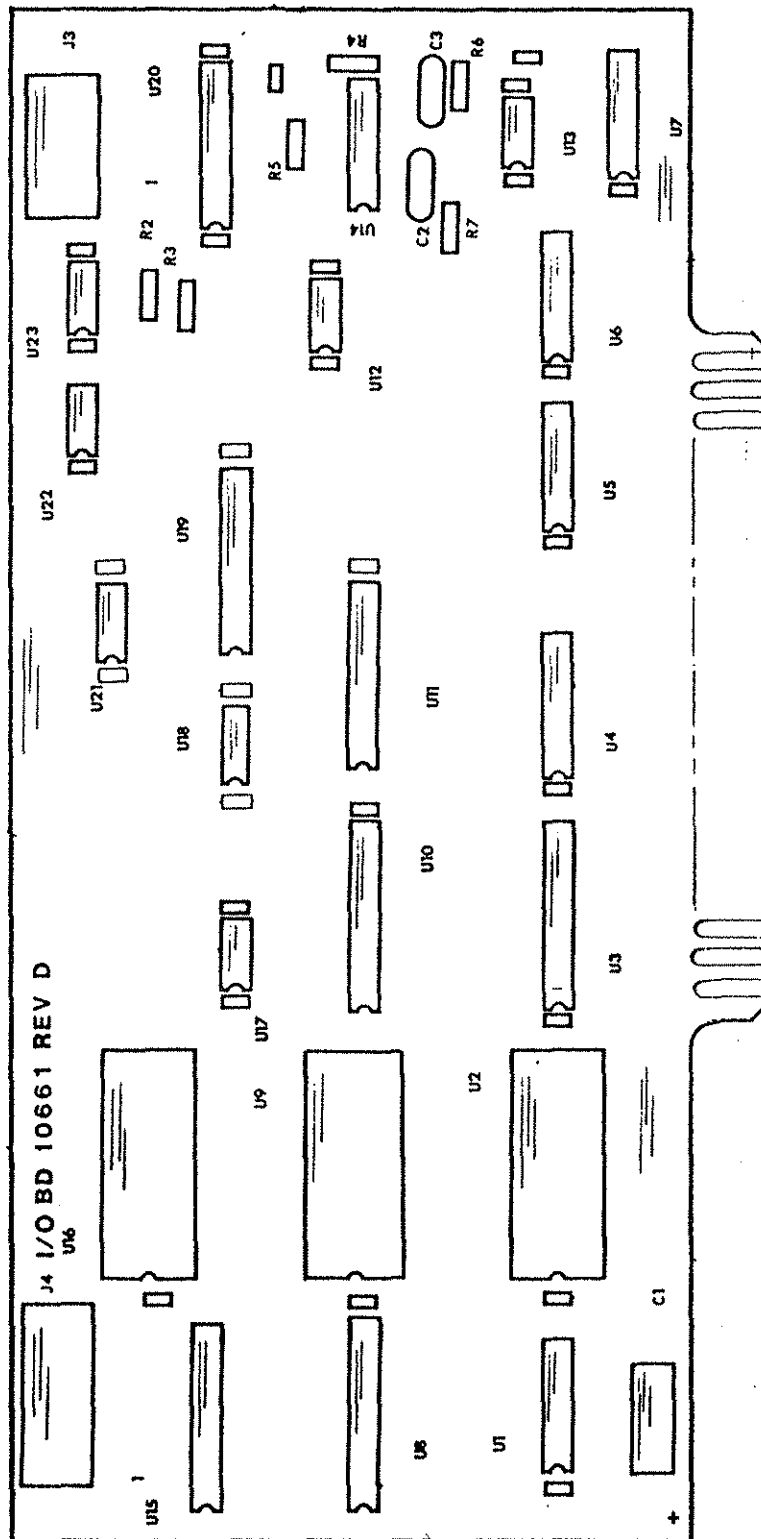
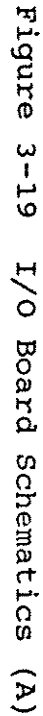
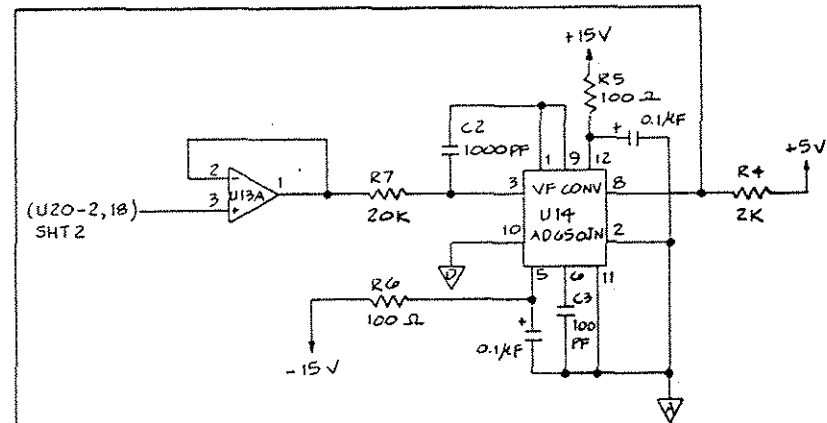


Figure 3-18 I/O Board Diagram



3-29

J3		3008
-1		CO MEAS.
-2		CO REF.
-3		CO PRESS.
-4		CO TEMP.
-5		CHAMBER TEMP.
-6		
-7		
-8		CO RECORDED
-9		
-10		



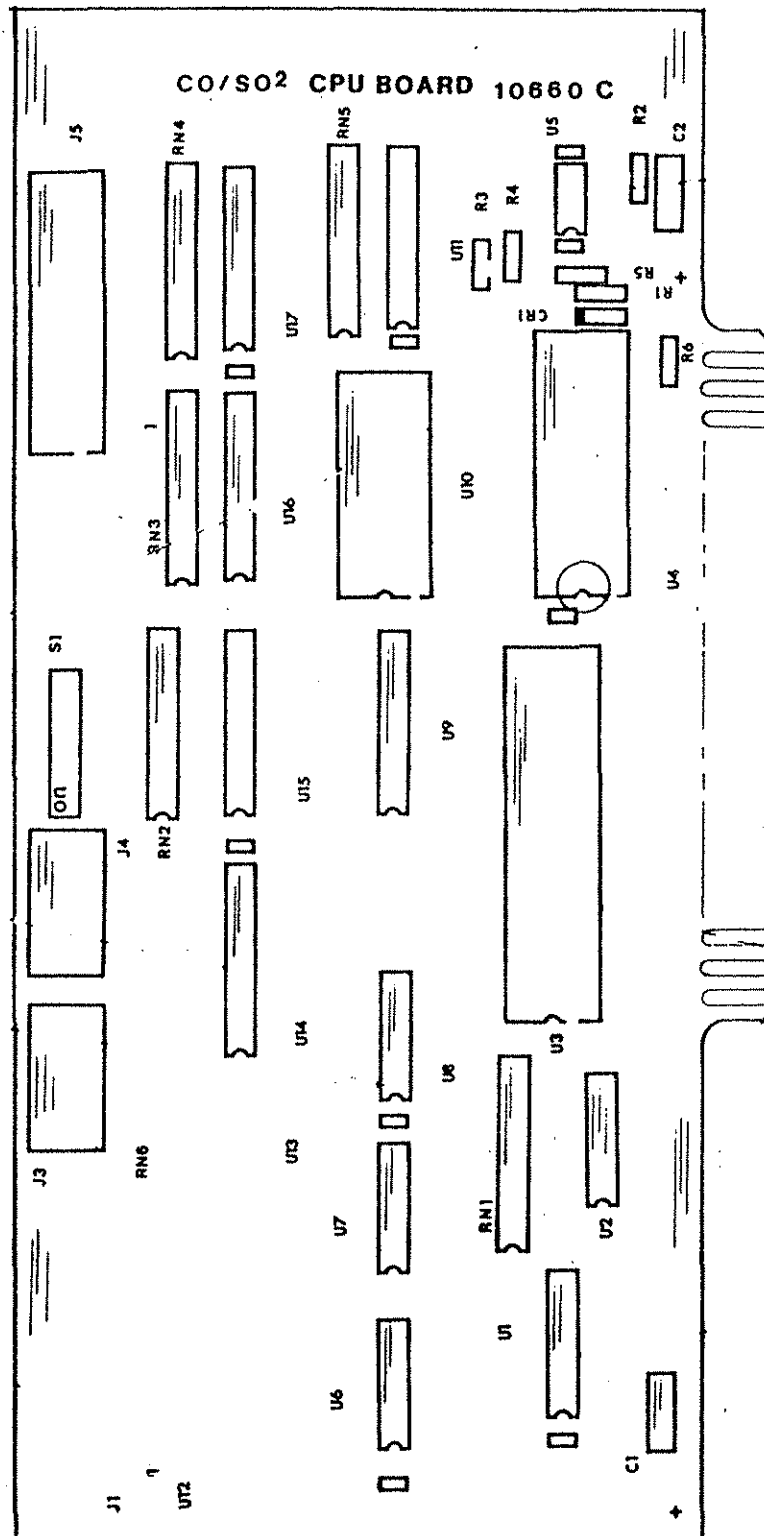


Figure 3-21 CPU Board Diagram

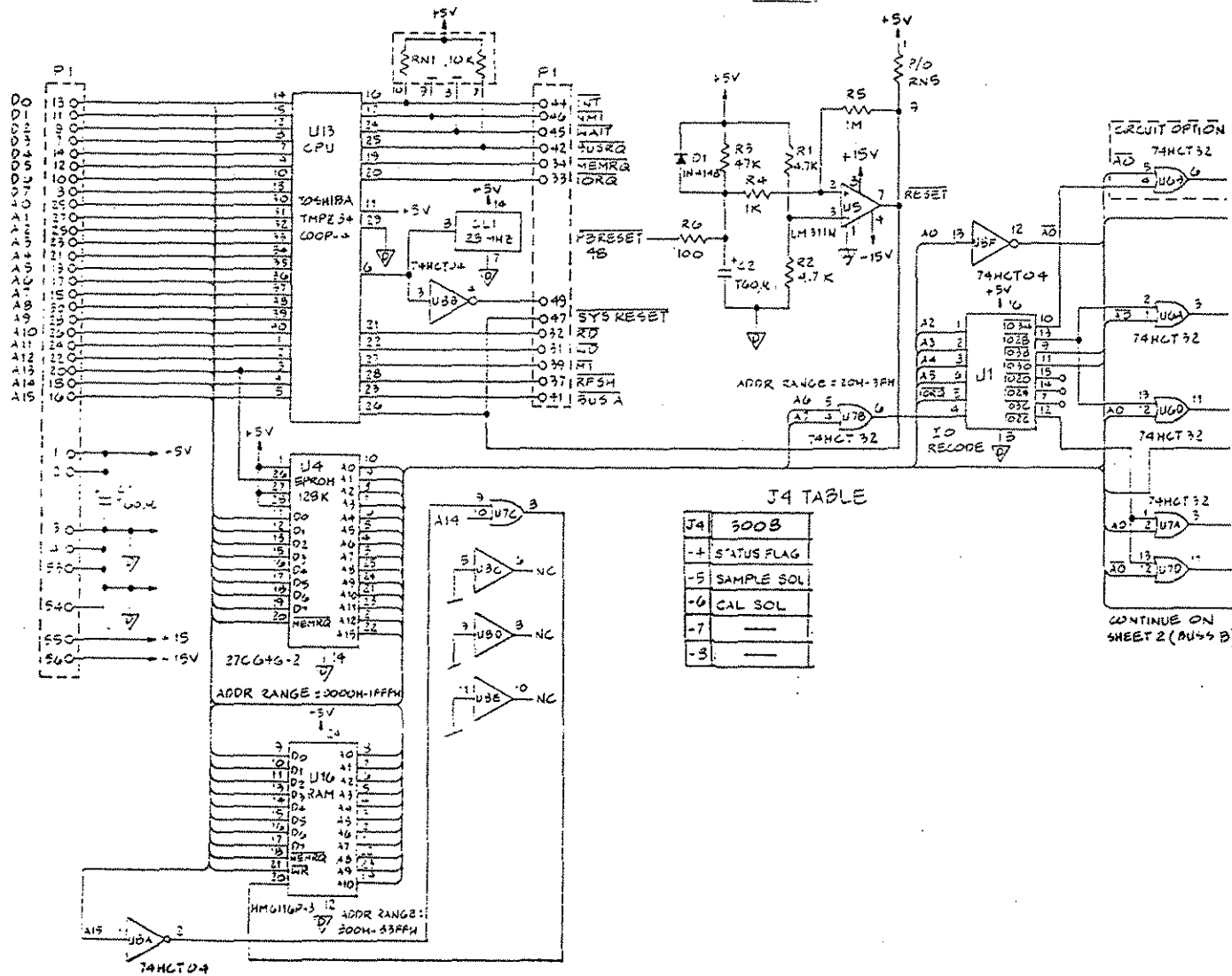
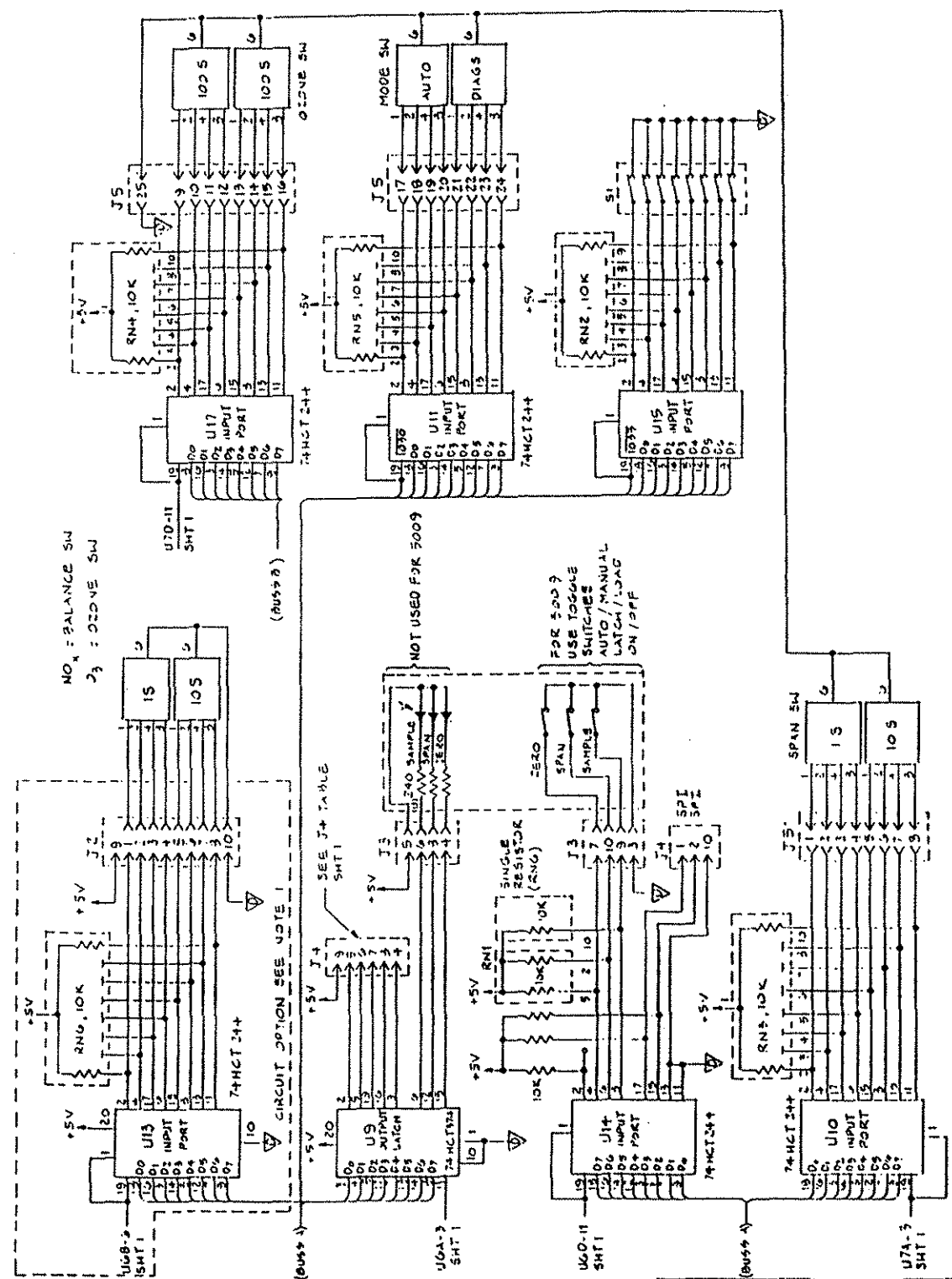


Figure 3-22 CPU Board Schematics (A)



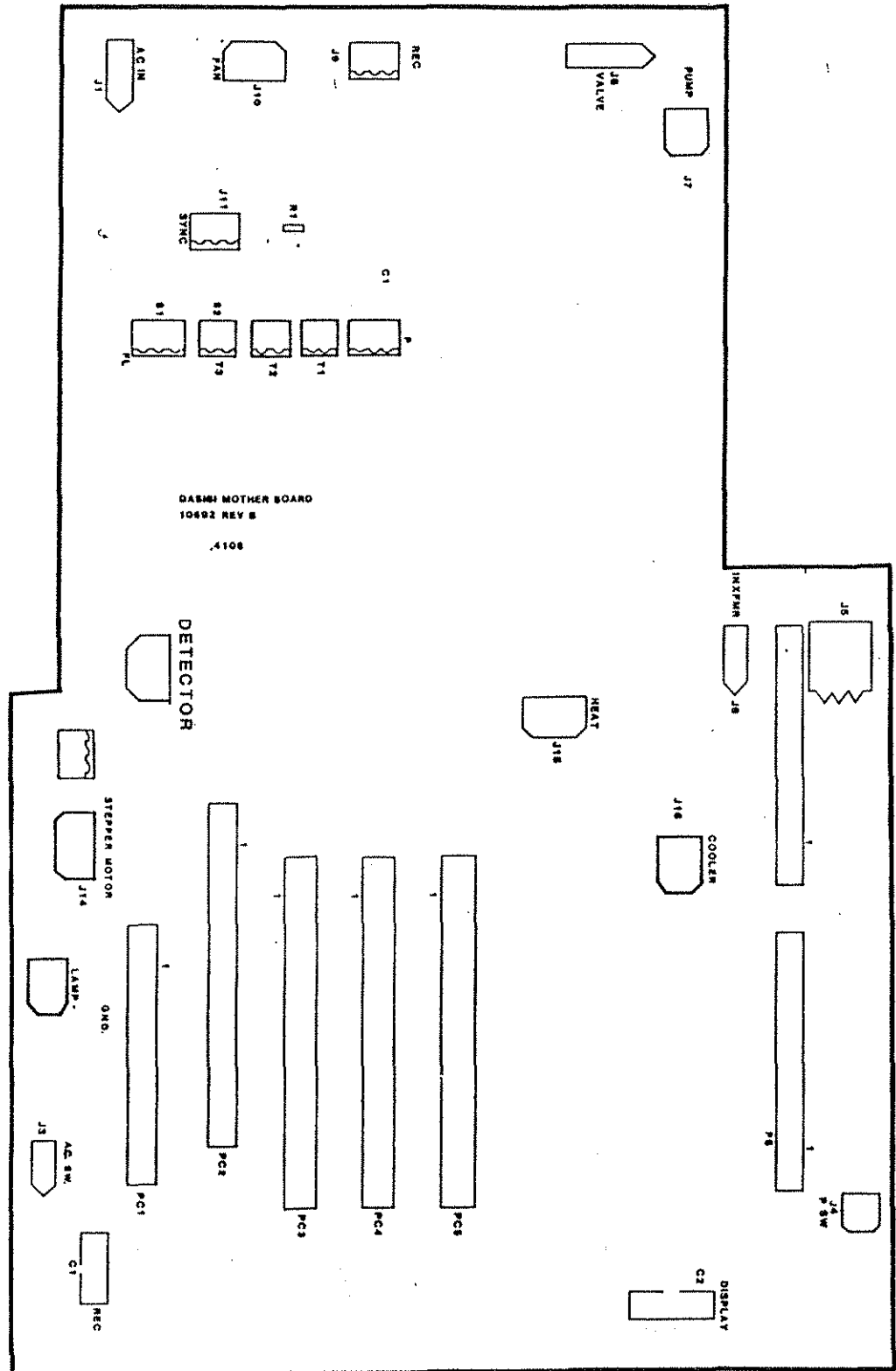


Figure 3-24 Mother Board Diagram

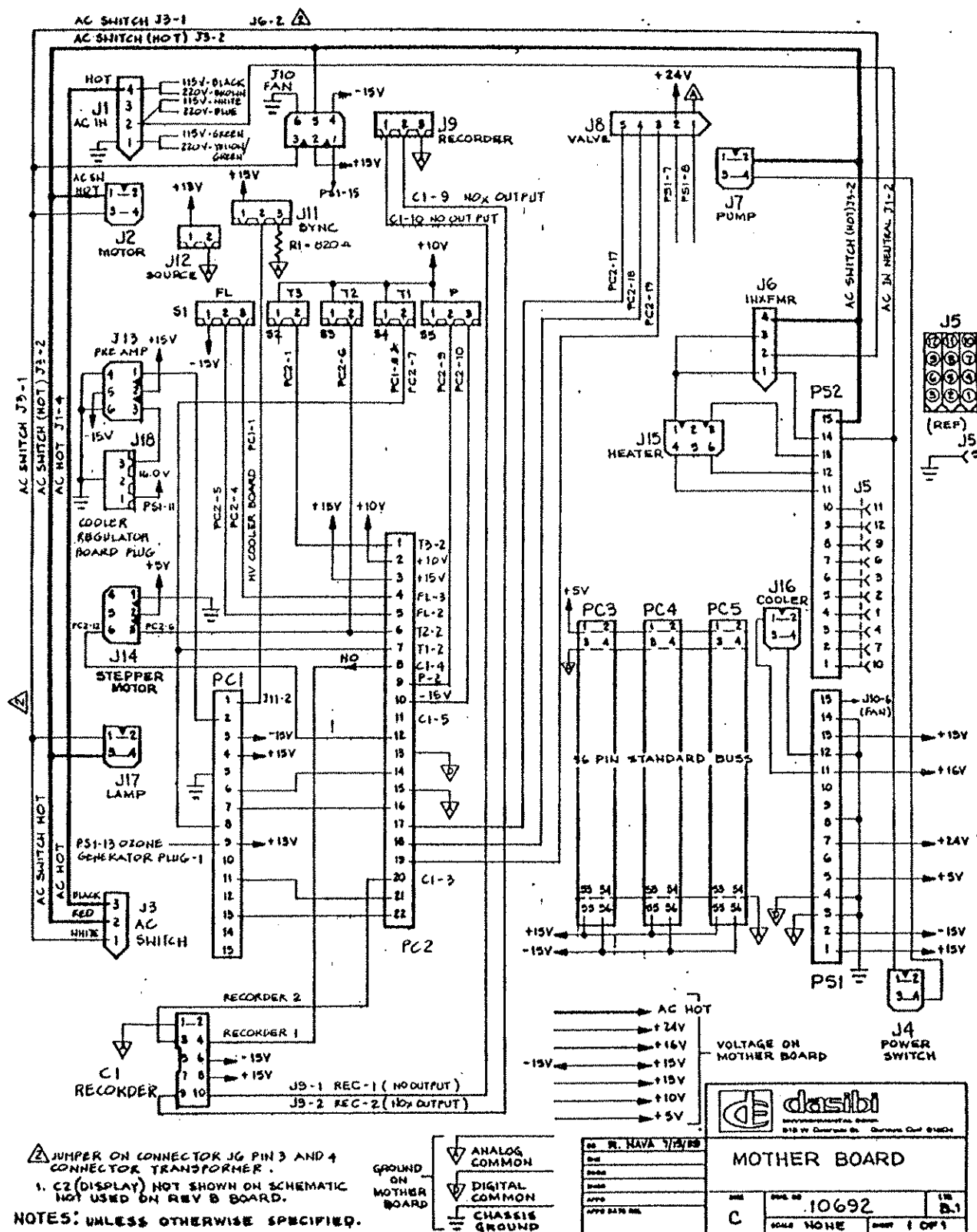


Figure 3-25 Mother Board Schematics

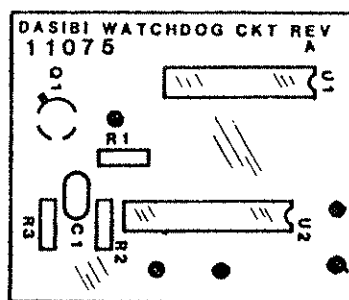


Figure 3-26 CPU Watchdog Board Diagram

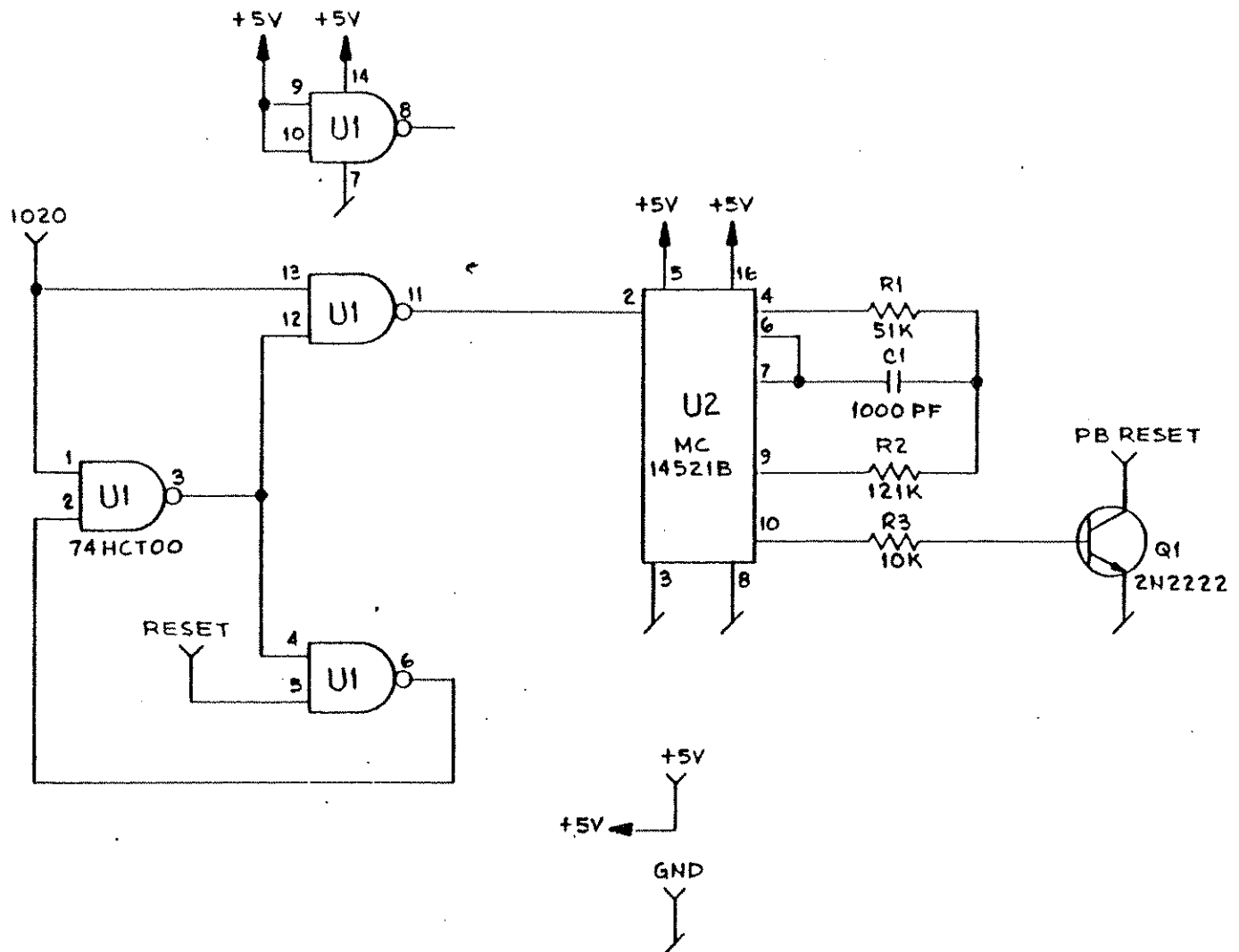


Figure 3-27 CPU Watchdog Board Schematics

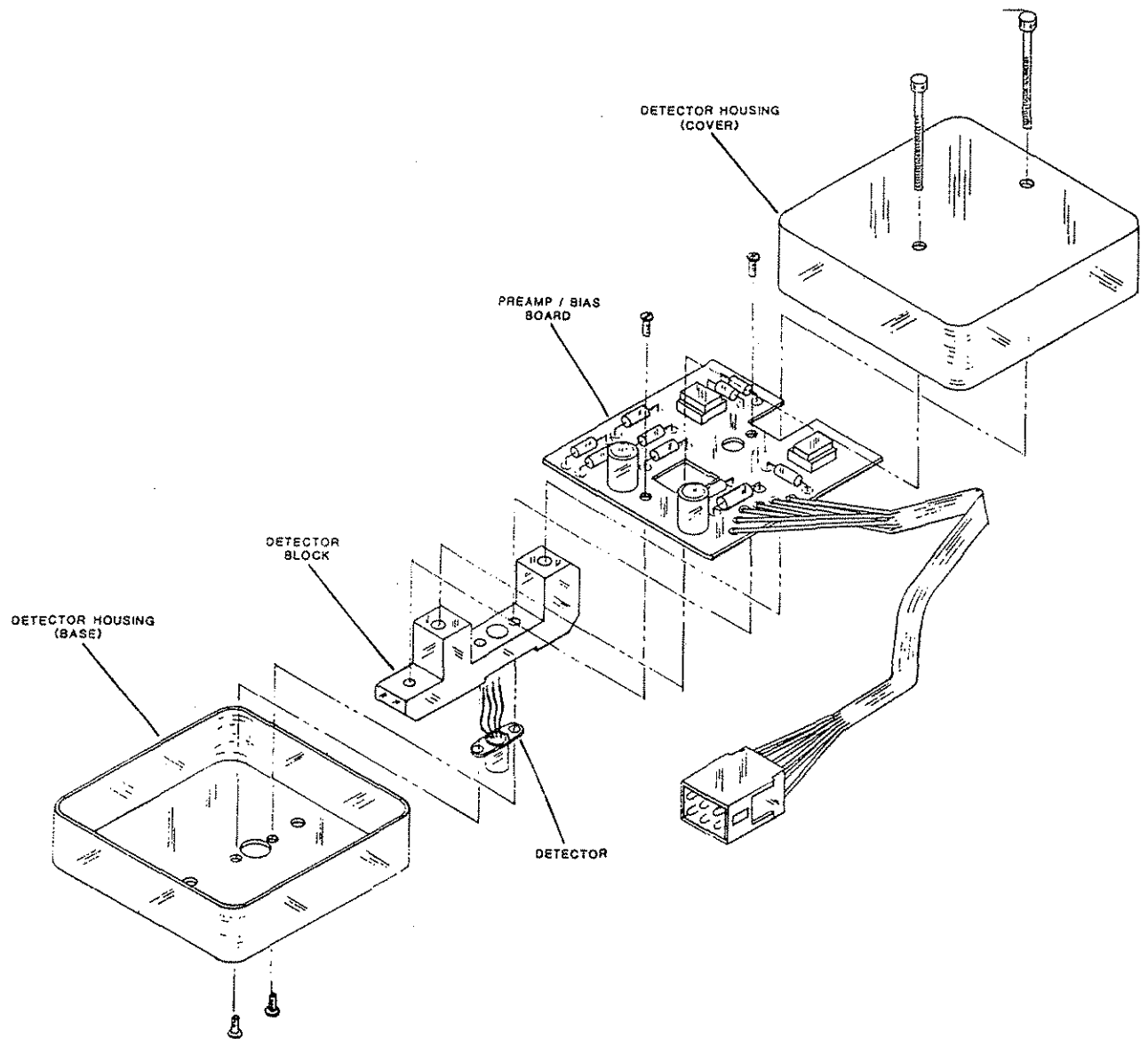


Figure 3-28 Detector Module Diagram

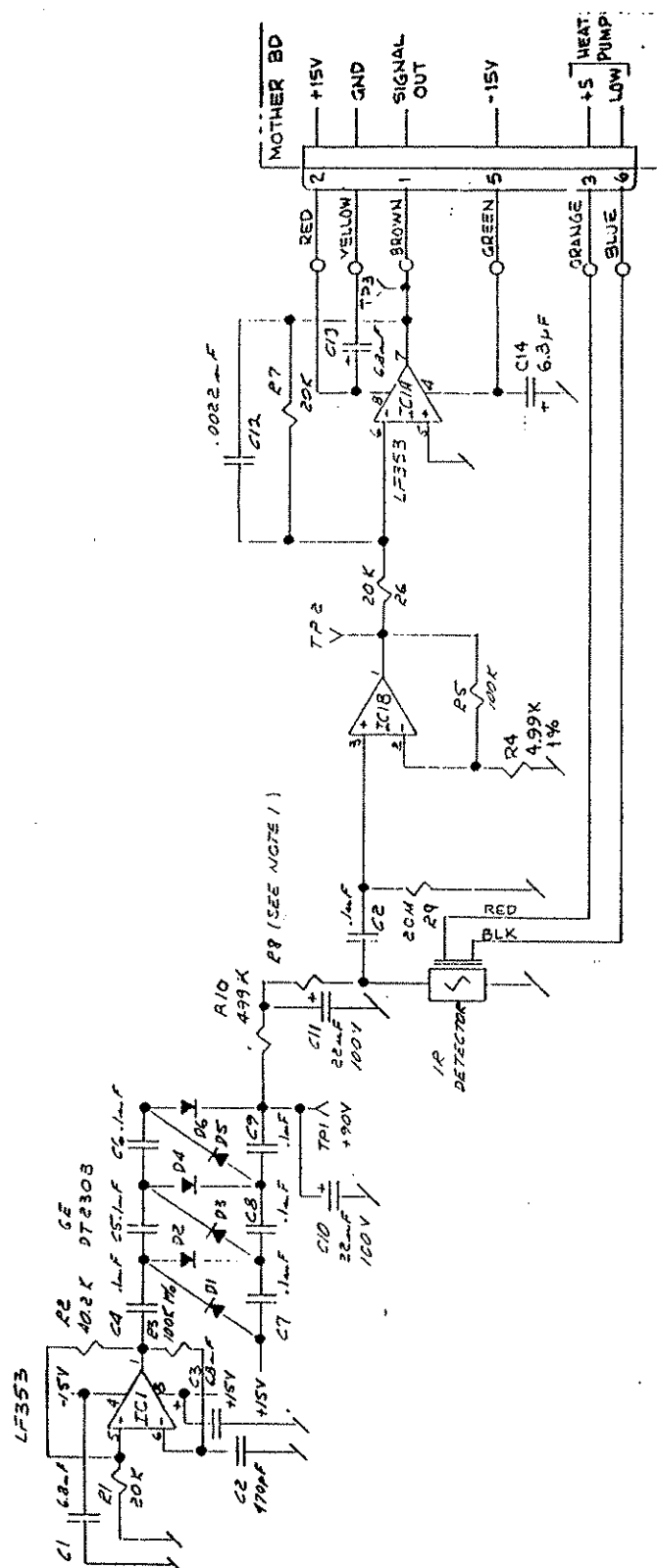


Figure 3-29 Detector Pre-Amp Schematics

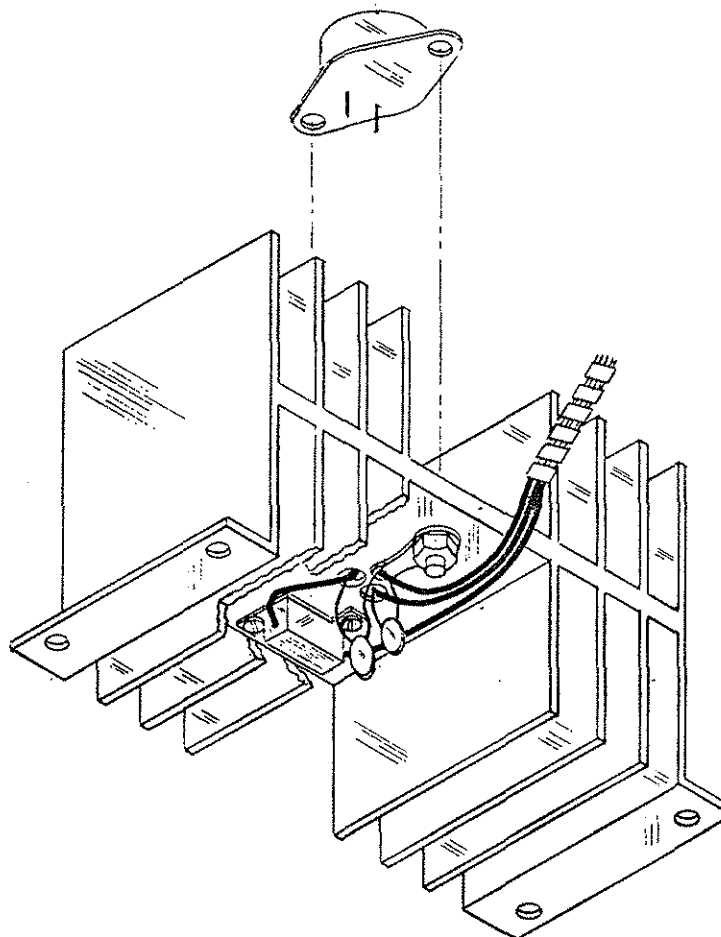


Figure 3-30 Cooler Regulator Diagram

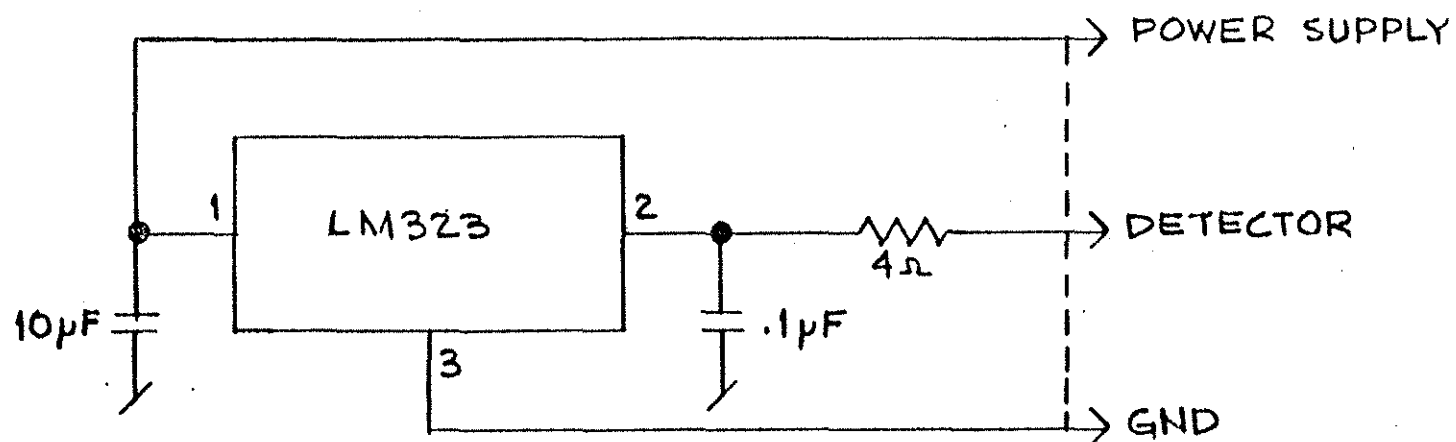


Figure 3-31 Cooler Regulator Schematics

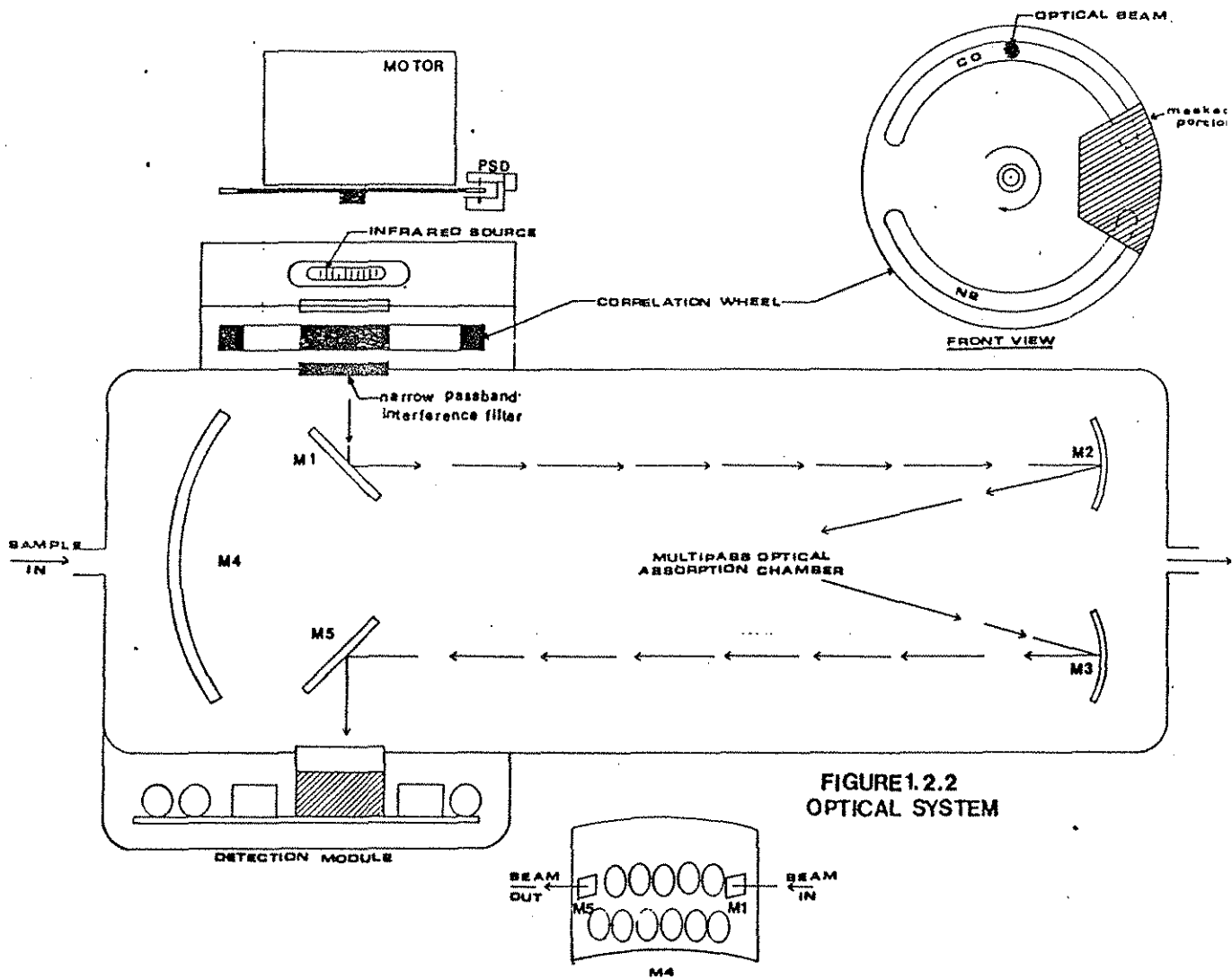


FIGURE 1.2.2
OPTICAL SYSTEM

Figure 3-32 Optics Chamber

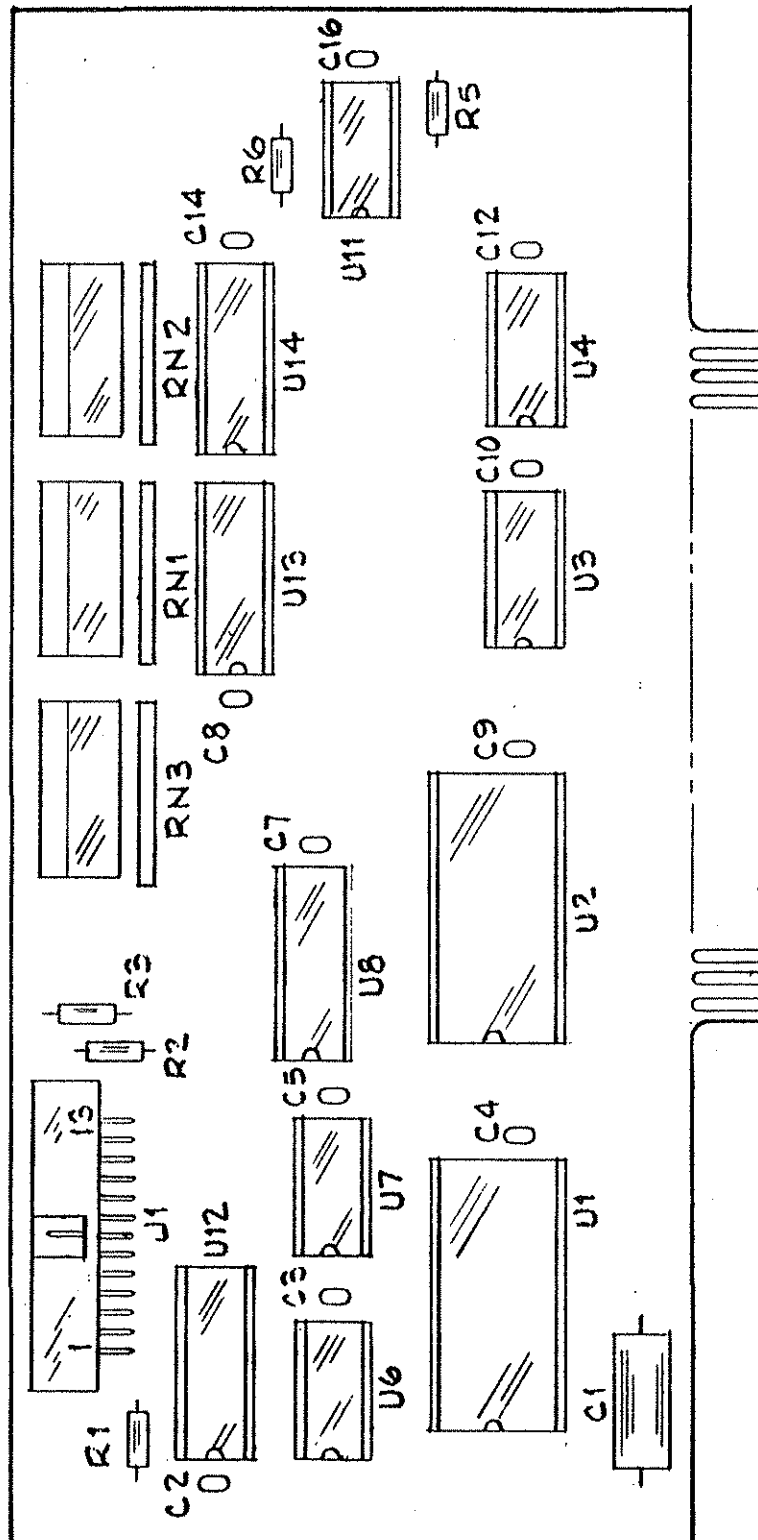


Figure 3-33 RS232 Board (Optional) Diagram

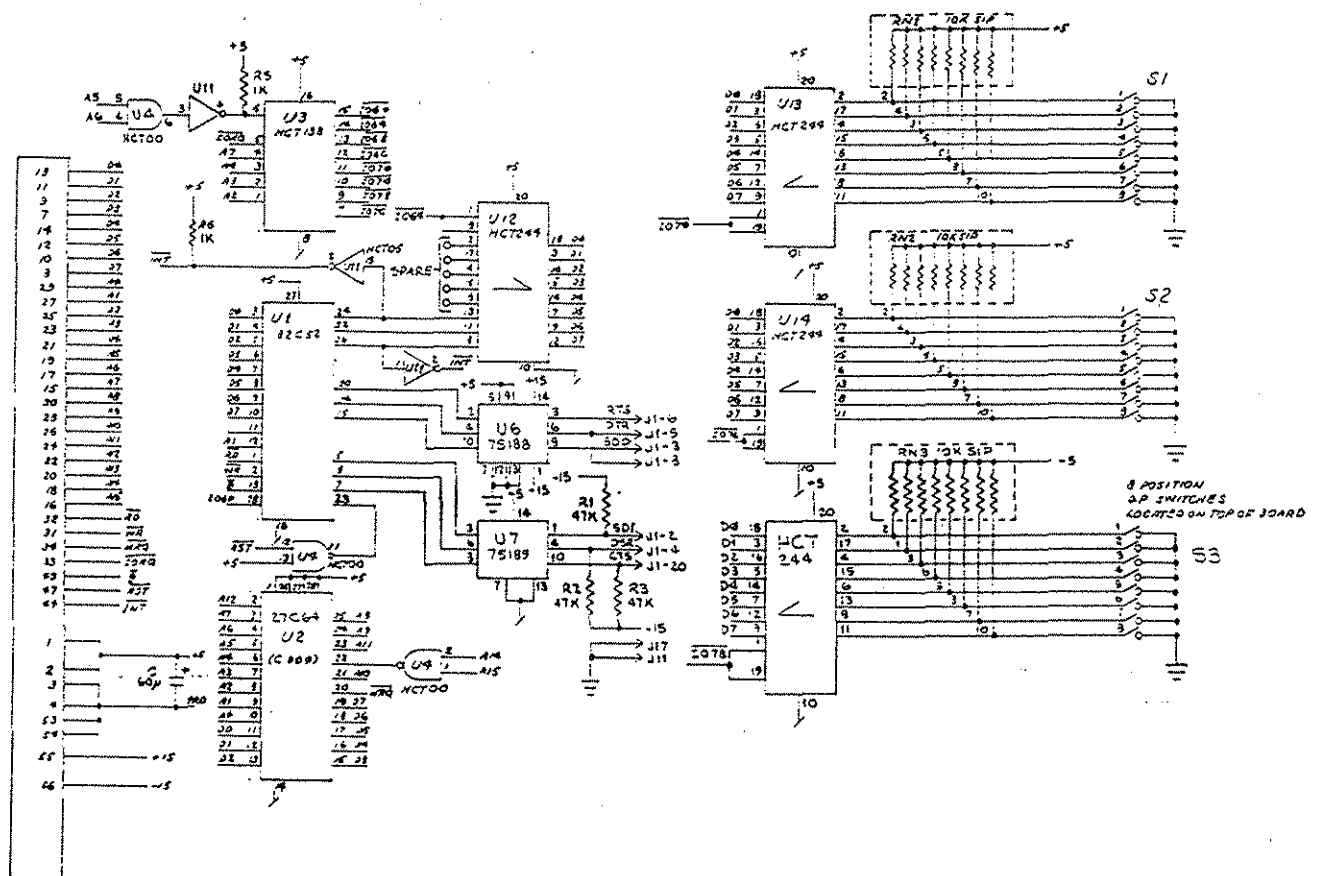


Figure 3-34 RS232 Board (Optional) Schematics

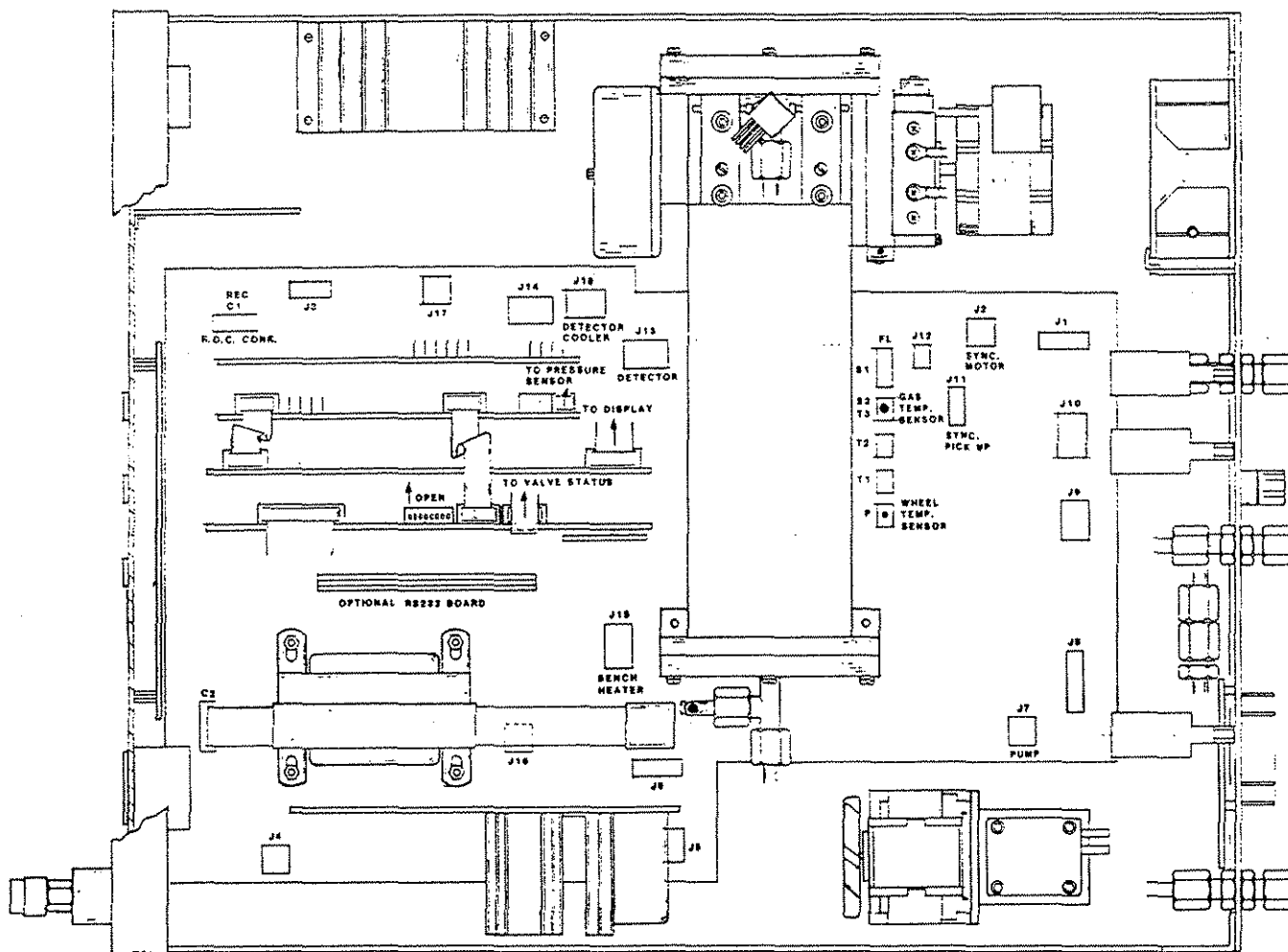


Figure 3-35 Model 3008 Interior

4.0 PRINCIPLES OF OPERATION

4.1 General

This section provides descriptions of the operating principles employed by Dasibi 3008 Carbon Monoxide Analyzers.

4.2 Theory of Operation

The Dasibi Model 3008 Carbon Monoxide Analyzer is a Non-dispersive Infrared (NDIR) Analyzer of advanced state-of-the-art design. Being a photometric device, it operates on the principle that the pollutant CO, absorbs light at specific wavelengths and will decrease the intensity of a probing light beam in non-linear proportion to its concentration.

The source of wavelength specific light referred to above, is the primary device that determines the specificity of an analyzer to the pollutant it must measure. Dasibi carbon monoxide analyzers employ the technique of Gas Filter Correlation (GFC). In this technique, a highly specific light probe, is created by causing a beam of infra-red light of narrow spectral bandwidth to be intercepted by a rotating wheel containing two different entrapped gases; carbon monoxide and nitrogen.

When the light beam is intercepted by the carbon monoxide portion of the wheel, the carbon monoxide, which is at relatively high concentration, absorbs all wavelengths that are CO-specific, creating an emanating light beam that is "CO blind". This "optically scrubbed" portion of the beam is designated the Reference beam, as compared to the nitrogen-intercepted portion of the beam which is "CO sensitive" and therefore, is designated the Measure beam.

The single, time-shared Reference (R) and Measure (M) beam is reflected many times back and forth across the photometer chamber where more of its light energy is absorbed by sampled CO with each traversal (See Figure 4-1). In the absence of CO no attenuation of the R and M portion of the beam will occur. Gaseous species other than CO will cause an equal attenuation of both R and M portions of the beam. If CO is present in the air being sampled, then the beam portion generated by the CO side of the wheel will experience no attenuation, but the beam portion generated by the N₂ portion of the wheel will be attenuated to the degree dictated by the level of CO concentration.

A third portion of the time-shared beam is also produced. This is the "dark portion", which is simply the period of time in the rotation of the GFC wheel in which the light beam is totally blocked off or "dark". This provides a zero light reference point to compensate for the "dark current" of the detector.

The rotation of the motor shaft determines the timing of the optical events taking place in the optical bench. In order for the measurement information to be synchronously decoded by the electronic system, the latter must be coordinated time-wise with the wheel rotation. This is done by a slotted disk mounted on the

motor shaft, which interrupts an optical switch. The latter provides a signal to digital logic which then encodes the time-shared electronic analog signal of the optical probing beam.

The unit's computer records the imbalance between the R and M beams portions, performs a data linearization, corrects for changes in temperature and pressure, and displays the CO content.

4.3 Temperature/Pressure Correction

When a gas is confined to a fixed volume as is the case of a photometric analyzer such as the Model 3008, and the pressure and temperature of the gas in the chamber is free to vary with the external atmosphere, the readout concentration of pollutant will be influenced by the variation of these parameters.

The 3008 is able, by means of its built-in computer and appropriate transducers, to correct for the variation of temperature and pressure, and to present a concentration reading of CO under standard conditions. The standard conditions set by the EPA for air monitoring are 25 degrees Celsius for temperature and 760 Torr for pressure. The equation used for correcting observed readings of the Model 3008 to be corrected readings is known as the GAS LAW. It can be expressed as follows:

$$CO \text{ (Correct)} = CO \text{ (Observed)} \times P_0/P_1 \times T_1/T_0^*$$

where, P_0 = The standard pressure of 760 Torr
 P_1 = The actual pressure in the measurement chamber when a reading is being taken.
 T_1 = The actual temperature* in the measurement chamber when a reading is being taken.
 T_0 = The standard temperature* of 25° + 273° or 298° Kelvin.

*All temperature readings must be converted to ABSOLUTE temperature (Kelvin) by adding 273 to the normal Celsius reading.

In the Model 3008, the computer automatically corrects each reading taken by performing a calculation according to the above equation. The pressure and temperature data are provided by appropriate transducers linked to the optical chamber. The following considerations apply:

1. The source of span gas must be a certified tank in which the concentration listed has been converted to Standard Temperature and Pressure (STP) conditions. This is standard practice with all major gas suppliers.
2. When a span is taken, the computer will apply the Gas Law calculation so that the concentration readout takes into account that conditions within the chamber are not at STP. It does this by letting the user adjust the display value to equal the span tank listed value by means of the SPAN

No. thumbwheel switch. The computer simultaneously records and places in memory the pressure and temperature, P_0 and T_0 , that existed when the span operation took place. As subsequent measurements are made, the pressure and temperature P_1 and T_1 are continuously monitored and the computer calculates a P/T correction factor to accommodate any changes that have taken place since the span operation. The correction factor, which can be accessed on position 4 of the DIAG thumbwheel, is continuously applied to all concentration readings.

3. Each time a span is taken, the values for P_0 and T_0 are updated.
4. If it is desired that P/T corrections are not made, this feature can be disabled by changing dipswitch 2 on the CPU Board from the open to the closed position.

4.4 Flow System

The gases utilized by the analyzer are introduced into the instrument at bulkhead fittings on the back panel. There are three different gases used during various modes of analyzer operation: ambient air, zero gas and span gas. The plumbing utilized within the analyzer is either teflon, Bev-a-line, or stainless steel to maintain the purity of the sample gas prior to measurement. In addition, teflon tubing should be used to connect the span and zero gases to the instrument to maintain their purity.

4.5 Optical System

The optical system is designed to withstand shock, vibration and the effect of thermal gradients. All optical elements are cemented on self-aligning aluminum mounts. Since infrared radiation of 4.7 microns is monitored, all optical elements including windows must either reflect or transmit radiation efficiently at this wavelength. Mirrors are precision ground and polished and are coated with protected aluminum. Windows are either sapphire or coated silicon.

4.6 Electronic System

The electronic system is composed of a mother board and plug-in printed circuit boards which power the photo-detector and amplify and process its signal to produce a linearized analog DC output which can be read on a built-in alphanumeric display or on an external analog chart recorder and/or data acquisition system. To aid repair and maintenance each module is dedicated to specific function.

4.7 Computer System

The self-contained computer is a powerful 8-bit system using a Z-80 CMOS microprocessor, 8K of RAM and 8K of ROM. It makes use of an industry standard STD bus structure. This allows for auxiliary circuit board plug-in to augment the functions of the instrument. An RS232 Board can be provided to supply information to microcomputers and other peripheral equipment.

Capabilities of the computer include mathematical functions such as computing ratios, diagnostic functions such as failure identification, and control functions such as periodic auto-calibration sequencing.

In addition, there are built-in programs contained in ROM to make the instrument "user friendly." An example of this is the START-UP program, which places the instrument in a structured routine each time the unit is turned on. This routine provides for recorder and instrument calibration and also gives pertinent diagnostic information.

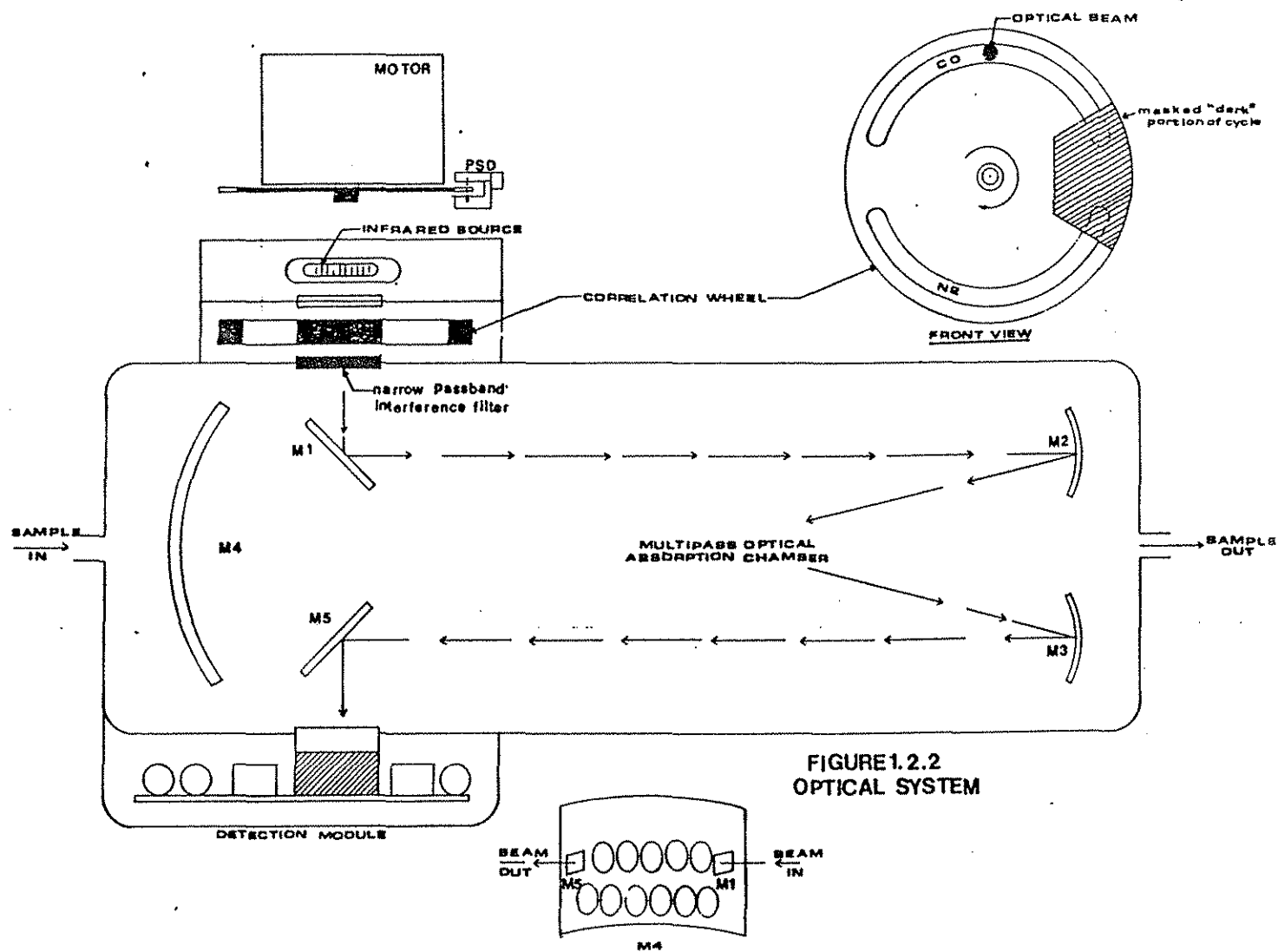


Figure 4-1 Model 3008 Optical System

5.0 OPERATION

5.1 General

This section contains information for the operation of the front panel controls and indicators. Also described are the turn-on procedure and shutdown procedure.

5.2 Controls and Indicators

The operating controls are described below. Refer to the diagram of the front panel of the instrument shown in Figure 3-3.

1. POWER SWITCH - This pushbutton switch turns the instrument on and off.
2. RECORDER AND DAS ZERO & SPAN ADJUSTMENTS - Used for adjusting the recorder and DAS systems.
3. MODE SWITCH "ZERO" POSITION - Used to autozero the unit via computer control.
4. MODE SWITCH "SAMPLE" POSITION - Ambient air is sampled by the instrument.
5. MODE SWITCH "SPAN" POSITION - Used to perform a 10 percent to 90 percent upscale analyzer response check.
6. "AUTO" THUMBWHEEL - This thumbwheel switch automatically sets the computer controlled zero and zero/span check intervals.
7. "DIAG" THUMBWHEEL - This thumbwheel allows the user to look at different subsystems of the instrument.
8. FLOWMETER - The flowmeter displays the flow rate through the pneumatic system.

NOTE

The flow rate must be set at 1 LPM as any change to this flow rate may cause the linearity of the unit to be adversely affected.

9. "SPAN NO." THUMBWHEEL - This thumbwheel switch is used to set the gain of the analyzer (it works like a conventional rotary span potentiometer).
10. ALPHANUMERIC DISPLAY - This display shows the digital value of the CO gas concentrations and other information requested by user diagnostics.

5.3 Turn On

Connect the instrument as described in Section 2 and turn the power switch on. The pump switch must also be on at this time. The AUTOSTART program as described in Section 5.6.1 will facilitate putting the total system in proper operation.

NOTE

Allow at least 60 to 90 minutes warm-up time before performing a preliminary calibration (see Appendix A).

5.4 Turn Off

If the analyzer will not be used for an extended period of time, turning it off will extend the life of the I.R. source and all moving parts. To do so, simply push the power switch to the off position.

5.5 Modes of Operation

The modes of operation of the analyzer are all under direct control of the self-contained computer. Three separate programmed modes of operation described next are available to the user.

1. An AUTOSTART program, which aids the user to place the instrument on-line.
2. A MANUAL mode, which is similar to conventional analog monitors except that three pushbuttons do all the work and no dial adjustments other than a thumbwheel SPAN setting have to be made.
3. An AUTO mode, which allows a program sequence of ZERO or ZERO/SPAN operations to be performed at user selectable intervals.

5.5.1 AUTOSTART Program

The AUTOSTART program is automatically initiated each time the analyzer is powered-up. Its purpose is to assist the operator in making the normal adjustments and checkout tests when placing the instrument on-line from an un-powered state. A structured protocol for the AUTOSTART program functions has been programmed into the instrument's computer via a PROM IC. Although there is no way the operator can change this program, it can be bypassed simply by pressing the SAMPLE button after the analyzer has begun to zero itself (Step 11 as described in Section 5.5.1.2), in which case the unit switches to the MANUAL mode and the user assumes immediate, direct operational control.

5.5.1.1 Instrument Start-up Using The AUTOSTART Program

1. The AUTO thumbwheel switch should be on 0.
2. The DIAG thumbwheel switch should be on 0.
3. Connect recorder(s) and/or data acquisition system(s) to appropriate terminals on the rear panel. Up to two devices can be installed.

5.5.1.2 The AUTOSTART Program Protocol

The AUTOSTART program protocol is given in Table 5-1, below.

TABLE 5-1 AUTOSTART Program Protocol				
<u>Step</u>	<u>Function</u>	<u>Time</u>	<u>Note</u>	
1	Dasibi CO Monitor	2 sec	1	
2	Model 3008 Ambient	2 sec		
3	RFCA # 0488-067	2 sec		
4	Range 50 (EPA) & 199 PPM	2 sec		
5	Software Rev. No.	2 sec		
6	Computer Test (Pass/Fail)	4 sec		
7	AUTOSTART PROGRAM	5 sec		
8	Recorder Cal 0 PPM	120 sec	2	
9	Recorder Cal 40 PPM	60 sec		
10	Recorder Cal 0 PPM	60 sec		
11	Zero Calibration	30 sec	3,4	
12	Zero Offset	2 sec		
13	Sample Mode	Indefinite	5	

Notes On The AUTOSTART Program:

1. Steps 1-7 take place quickly and are informational.
2. Steps 8-10 are for the Recorder Test program and are intended to allow the user to calibrate a recorder and/or data acquisition system (DAS).
3. Step 11 is the Zero Cycle and sets the Zero condition of the analyzer using the internal scrubber. During step 12, the Zero Offset is displayed, which is an indication of the non-CO instrument offset signal. If the unit is not already warm when turned on, then it should be put into the Zero mode after the Autostart program finishes for about 12 minutes to obtain a stable zero.

4. If the AUTO thumbwheel switch is set on an auto-cycle program, i.e. positions 1-9, then when the unit enters the Zero Cycle, or Operation # 11, the Auto Program that is dialed will take place.
5. When Operation 13 or Sample Mode is achieved, the instrument is automatically switched back to the manual mode, and the user is free to go back and check the Zero, to Span the instrument, etc.
6. During the time the AUTOSTART program is taking place, the source resistor is warming up, a process that takes about 8 to 10 minutes (if the unit is already warm; it may take up to 90 minutes if cold). Therefore, it is recommended that the entire process be permitted to take place, so that a good stable zero is achieved.

NOTE

If flashing message(s) appear during AUTOSTART program, the operator should check the table of contents for the appropriate manual discussion of the flashing fault.

NOTE

The unit does not require span gas to be supplied in order to be functional. If a calibration is not required, due to the instrument serving a demonstration or test purpose, set the Span No. thumbwheel switch on 100. This will give approximate values of CO, but calibration is required before ambient monitoring is begun.

5.5.2 MANUAL Mode

To view CO concentrations when in this mode, the DIAG thumbwheel switch must be set to 0. In the MANUAL mode, the instrument is quite easy to use: simply press one of the three pushbuttons for whichever function is desired. All pushbuttons turn on LED's mounted on them when they are activated, and each remains activated until another pushbutton is pressed.

ZERO: When this button is pressed, a red LED will light up on the button, an appropriate solenoid valve will activate, and zero gas will be sampled from the internal zero scrubber. The display will read:

"CO = X.X PPM"

where the number as indicated in place of the X's will normally descend as zero gas replaces the air in the optical bench chamber.

SAMPLE: When the SAMPLE pushbutton is pressed, after approximately 1 minute, a message will flash:

"Z Offset = 10 mV"

(or a number as high as 60), then the display will automatically be set to CO = 0.0 PPM, ± 0.1 PPM. Gas is then sampled from the inlet port and the concentration is instantly read out on the alphanumeric display. This process will continually repeat until the user presses one of the other mode pushbuttons.

SPAN: The SPAN pushbutton behaves much the same way as the SAMPLE button, except that it activates a pair of solenoid valves so that span gas can be sampled from a tank. The SPAN NO. thumbwheel switch can then be used to make the reading on the display correspond with the tank concentration.

In the MANUAL mode, all pushbuttons turn on LED's mounted on them when they are activated, and each remains activated until another is pressed. If it is known that the optical chamber is filled with zero or span gas, an instantaneous zero or span adjustment can be made by pressing the SAMPLE pushbutton, then the ZERO or SPAN, and then going back to the SAMPLE mode.

5.5.2.1 On-Board And External Operation

Two different methods of supplying span and other calibration gases are presently used with monitors. The most common is to connect a tank of span gas to the span port of the monitor, and to use the internal zero scrubber. This is the preferred method to be used with the 3008, and is designated the INCAL method.

Often, however, it is desired to supply all gases from a common manifold into the sample port at ambient pressure. This is especially true when a multi-point calibration is being performed. If zero gas is to be sampled from the sample port, a mode of operation called EXCAL must be used. This is caused by the fact that the AUTOZERO feature normally cannot be used when zero gas goes through the sample port because it is combined with a specific valve activation process.

The EXCAL mode is engaged by placing dipswitch 4 on the CPU Board in the CLOSED position. When this is done, no solenoid valves receive activation when mode buttons are pressed, so that all gases sampled are received through the sample port. If the monitor is only going to be used in the manner occasionally, position 9 on the AUTO thumbwheel allows for the same results to be

achieved. Making either of these modifications allows the user to establish a zero reading on the display by first pressing the ZERO pushbutton, and then the SAMPLE in sequence, after sufficient zero gas from an external source has been supplied to the monitor to give a stable reading.

In using the MANUAL mode during multipoint calibrations, all calibration gases should enter the Sample inlet. This should be done preferably from a common manifold, or calibration unit. The use of the front panel pushbuttons remains very much the same as in normal operation, except attention should be paid to a few points.

5.5.2.2 Using Manual Mode Controls During Multipoint Calibrations

The AUTO thumbwheel should be set on position 9:

ZERO: This button should be used the same as in normal MANUAL mode, except that it only has to be momentarily pressed after sufficient zero gas has been sampled to give a stable reading. Pressing the SAMPLE button after this has been pressed, will cause a reading of 0.0 PPM to be displayed as concentration.

SAMPLE: Once the analyzer has been properly challenged by a zero gas source, and the ZERO button pressed, the unit should be placed in the SAMPLE mode by pushing the SAMPLE button. It should remain in this state during the entire multipoint calibration, unless the Zero of the analyzer is desired to be re-checked.

SPAN: This pushbutton should not be used during the multipoint calibration. The SPAN NO. thumbwheel switch, however, can be used to make the display concentration agree with the actual concentration of a standard gas reference.

5.5.3 AUTO MODE

In the AUTO MODE, the user can select from a menu, a sequence program that will permit the monitor to zero only or zero and span itself at fixed time increments. This periodic calibration sequence will take place with the unit unattended. If the zero and span option is desired, a tank of span gas set open at an appropriate pressure of 15-20 PSIG is required. The following options are available and selection is made by setting the appropriate number of the thumbwheel switch labeled AUTO.
AUTO FUNCTIONS:

<u>Switch</u>	<u>Function</u>
0	Zero at turn-on only
1	Zero and span every 12 hours
2	Zero and span every 24 hours
3	Zero and span every 48 hours
4	Zero and Span every 45 mins.

- | | |
|---|---------------------------|
| 5 | Zero every 12 hours |
| 6 | Zero every 24 hours |
| 7 | zero every 48 hours |
| 8 | Zero every 45 mins. |
| 9 | Zero/Span via Sample port |

The AUTO programs that are recommended to be the most practical are the ones on Switch setting 5 and 6 (AUTOZERO). This is because the nature of a GFC Monitor such as the 3008 is that it has a good span stability by nature of design. The zero stability is harder to control, and if there is likely to be drift due to temperature variation it will more likely be zero drift. Also, since an internal non-consumable scrubber is used for zero gas generation, no penalty is paid for operating in this mode and the user is assured of good zero stability month after month.

The sequence of events that take place during an AUTOZERO, or AUTO ZERO/SPAN is as follows:

AUTO ZERO:

1. The program is engaged by setting the AUTO thumbwheel on a chosen time interval.
2. The analyzer will then enter the ZERO mode, and remain there for 12 minutes.
3. During this time, CO-scrubbed air will be sampled from the internal catalytic converter for the complete 12 minutes.
4. After 2 minutes, the readout will be adjusted to 0 PPM, after which it will continue sampling scrubbed air for the remaining ten minutes.
5. At the end of the ten minutes, the microprocessor will again set the readouts to 0 PPM, and the analyzer will be automatically switched back to the SAMPLE mode.
6. This process will be repeated at the frequency setting selected on the AUTO thumbwheel.

AUTO ZERO/SPAN:

- 1-4. These steps are the same as in the AUTOZERO mode.
5. At the end of 10 minutes, the readouts are set to 0 PPM, and the analyzer is automatically switched to the SPAN mode.
6. The analyzer at this point will sample span gas from an appropriately set up cylinder for 12 minutes.
7. At the end of the 12 minutes, the analyzer will automatically set itself to the SAMPLE mode.
8. The process will repeat at intervals determined by the AUTO thumbwheel setting.

5.5.3.1 Recommended Use of The AUTO Mode

1. The user is free to decide what Auto Program best suits his needs, and experience is the best guide.

2. Too frequent periodic checking of zero and span causes a loss of monitoring data and may be objectionable.
3. Periodic checks every 24 hours are quite customary and are recommended. Checks every 12 hours are a suitable alternative if tighter control of measurement accuracy is desired.
4. It is recommended that the user consider the use of the AUTOZERO mode in preference to the AUTO ZERO/SPAN mode. This is because a GFC monitor is more prone to have zero drift as opposed to span drift. It will generally be noted, that the Span value "tracks" the zero value. In other words, the difference in value between the zero and span values remains constant. Also, since the internal catalytic scrubber is used in the ZERO mode, the operation is free of the use of consumables, and the analyzer needs very little attention.

NOTE

Position 9 on the AUTO thumbwheel will disable the zero/span valves. This selection is useful when the operator wants to zero and span the analyzer via the Sample inlet. When this feature is activated, the flashing "checker" sign is replaced with a flashing "S" meaning Sample inlet. This feature comes in handy when the operator wants the computer to re-set the zero value on the basis of an external zero source being supplied to the sample inlet. Therefore, it is VERY IMPORTANT to have a very good zero air source.

5.6 Recorder and Data Acquisition System (DAS) Connections

Many types of recorders and data acquisition systems are available to the Model 3008 user (including Dasibi's 8001 or 8003 dataloggers). The most common recorder range is 1 volt full scale, and data collectors often are either 1 volt or 5 volts. In the Model 3008, provision has been made to accommodate virtually any analog input device. Two identical, but independent outputs are provided, and each can be set for any range under 10 volts by means of front panel adjustments. Recorders generally contain their own zero adjustment, and this is preferably used to offset the signal so readings below zero can be recorded. Some older recorders do not have a zero adjustment, so the analyzer's zero adjustment can be used in this case.

The Model 3008 provides both a recorder and a DAS with calibration signals via the computer. On initial set up of the monitor, the AUTOSTART program will provide fixed DC signals to the recorder of 0%, 80%, and then back to 0%. During each of these voltage readings, the user may not have sufficient time to set the recorder span by adjusting the appropriate trimpot accessible from a hole in the front panel. If sufficient time is not available to optimize the trimpot setting, the unit should be given sufficient time to exit the AUTOSTART program and enter normal operation. The user can then set the DIAG thumbwheel switch to supply the recorder with 10 exact calibration voltages. The following table gives the appropriate values.

AUTO NO.	% FULL SCALE	PPM CO (1)	VOLTS (2)
0	0	0.0	0
1	2	1.0	.02
2	4	2.0	.04
3	8	4.0	.08
4	10	5.0	.10
5	20	10.0	.20
6	40	20.0	.40
7	80	40.0	.80
8	NA	120.0	2.40
9	NA	150.0	3.00

(1)= For use of the analyzer as an EPA air monitor, it is recommended that the 0-50 PPM range be used, in which case, full scale (100%) on the recorder corresponds to 50 PPM. In this case, only positions 0-7 would be used for recorder calibration purposes.

(2)= These voltages are based on the use of a 1 volt full scale recorder being used for a total coverage of the 50 PPM range.

It is always best, if the recorder has a Zero adjustment, to adjust this first, either by control on the recorder, if one exists, or by shorting the recorder's input terminals (any signal input should be temporarily disconnected). The Model 3008's 0 volt signal is made to coincide with the recorder zero by means of the zero trimpot on the front panel. It is EPA recommended that recorders be set 5% upscale, so that excursions below the zero line can be displayed. This operation can be performed at any time, either on recorders containing a zero control or, if the recorder has no zero adjustment, this can be conveniently done with the analyzer's zero adjustment.

NOTE

Always exit the recorder calibrate mode by first turning the AUTO thumbwheel switch back to 0, then set the DIAG. switch back to position 0.

5.7 Selection of Averaging Time

The electronic averaging time (time constant) of the Model 3008 can be optimized to user needs. Four choices of averaging times are available: 60 seconds, 120 seconds, 150 seconds and 300 seconds. The longer the averaging time, the lower the "noise" level of the analyzer, and the lower the detection limit that can be achieved. The price paid for the long averaging time, is that the analyzer's response time to CO changes is slowed down. The fastest time that the analyzer can respond is controlled by the gas flow through the system. At the recommended flow rate of 1 LPM, it takes about 45 seconds for the instrument to respond so that the span gas of 40 PPM is measured to within 95% of its true value. To achieve this response time, the electronic (computer) system should be set on a 60 second time constant, which is the setting that is factory-set when shipped.

The averaging time selections are made through the use of the dipswitch located on the CPU Board as follows:

DIPSWITCH 5	DIPSWITCH 6	AVERAGING TIME
Down	Down	60 seconds
Down	Up	150 seconds
Up	Down	120 seconds
Up	Up	300 seconds

NOTE

A 60 second time constant must be used for "compliance monitoring".

6.0 MAINTENANCE

6.1 General

In this section, preventive maintenance and maintenance schedules are detailed. An introduction to corrective maintenance explains the general approach to trouble isolation. Performance checks are also described.

6.2 Preventive Maintenance

Preventive maintenance is a quality control procedure and must be done periodically in order to maintain the integrity of the instrument.

6.2.1 Maintenance Schedules

It is highly recommended that a log be kept with the instrument, since the maintenance schedules are in accordance with total instrument ON time. Dasibi provides such a record-keeping log in Table 6-5 for use by the customer at their discretion. The life span of the scrubbing components cannot be predicted accurately since they depend on the pollutants flowing through the systems, the level of those pollutants, and the flow rate used. So, the user should determine an average life span based upon experience. In Table 6-4 at the end of this section, Dasibi provides an initial replacement time frame until such an average has been determined.

By periodically recording the values obtained in the DIAG. switch positions, trends can be evaluated which will indicate the possibility of problems occurring. Unexpected shifts in specific parameter readings often indicate a problem, or the beginning of one. For example, a large change in the Offset value may indicate that the gas filter correlation wheel has begun to leak and may need replacement. Figure 6-8 provides a chart that can be photocopied and used for recording these diagnostic values.

6.2.2 Leak Check

Any leaks in the system can cause inaccurate data collection. The system should be leak checked by blocking off various inlet ports and observing the flowmeter ball to see if it drops to the bottom of the flowmeter.

Leaks are most easily found by a process of systematic elimination. In the procedure that follows, the analyzer is divided into two functional sections, the valving system, which is located on the back panel, and the analyzer proper, which is included in the valving system.

6.2.2.1 Checking For Leaks in the Valving System

The valving system is shown in Figure 3-1 as the components on the left side of the figure including the CO scrubber.

1. Place the analyzer in the SAMPLE mode, cap the Sample inlet with a plug fitting, and observe if the ball in the flowmeter goes to the bottom of the unit. If it does not, the leak is anywhere in the system.
2. If the flowmeter ball bottoms, unscrew the plug from the Sample inlet, unscrew the tubing connection to the internal CO scrubber and block it with a plug fitting. Press the ZERO pushbutton and observe if the ball bottoms. If it does, the Sample is not leaking. If the ball does not bottom there is a leak anywhere in the valving system.
3. Carry out a similar test by blocking the Span inlet and the Vent outlet, and pressing the front panel's Span pushbutton. If the flowmeter ball bottoms, the cylinder valve, and the tubing connections leading from it to the reference valve are gas tight. In addition, the sample valve is not leaking.
4. If step 3 indicated no leak, and step 2 does, the leak is probably located in the reference valve or its tubing connection to the scrubber.

6.2.2.2 Locating a Leak Exclusive of the Valving System

1. Start the testing at the Sample inlet while the analyzer is set to the Sample mode. Progressively block off each pneumatic connection, following the path that air travels through the analyzer after being sampled, until a place is found where the flowmeter ball bottoms.
2. At this point work back to the Sample inlet to isolate the component that is leaking.
3. If leaks persist that cannot be traced, contact the factory for specific instructions.

6.2.3 Replacement of Components

The following items of the instrument's components should be considered of limited life span and therefore may require replacement:

1. Ambient air teflon filter pad.
2. Zero scrubber.
3. Pump.
4. Solenoid valves.

The following items may require cleaning, dependent upon conditions of usage:

1. Optical elements.
2. Capillary.

6.2.3.1 Teflon Filter Pad Replacement (Figure 6-9)

It is possible that a flashing message indicating a pressure problem could be caused by a clogged air filter. The ambient air filter contains a teflon element. This element should be inspected weekly and replaced monthly in an average environment. However, more frequent replacement will be necessary in a dirty or high particle concentration area.

Replace the element as follows:

1. Remove the Filter Holder Assembly located on the Sample inlet port by loosening the nut on the Sample port fitting.
2. Remove the four thumbscrews and open the filter assembly.
3. Remove the teflon filter element.
4. Install the new filter element making sure it is centered, close the assembly and re-fasten the thumbscrews loosely. Then tighten each thumbscrew one-quarter turn in succession until all four are finger tight. This will prevent "cocking" which leads to leaks.
5. Re-apply power and check the flow in Zero and Span.

6.2.3.2 Zero Air Tube Element Replacement (Figure 6-1)

The efficiency of the catalytic CO scrubber may become unacceptable at some time in the use of the analyzer. This will become apparent when the efficiency test is run at the end of each multipoint calibration. This section is discussed in detail in Appendix A. If the scrubber efficiency becomes unacceptable, the scrubber capability can be regenerated by means of heating it at 100° to 125°C, while passing a stream of dry air through it. The following procedure is given for guidance since there are many ways to apply heat to the catalyst tube:

1. Arrange a flow system so that ambient air can be pulled through the scrubber at a flow rate of 1-2 LPM.
2. Choose a convenient means of heating the catalyst tube. Possibilities include putting the tube in an oven, wrapping a heating tape controlled by a Variac around it, or blowing hot air over it. The tube can be heated in the analyzer by means of a heating tape, while using the analyzer flow system.
3. Heat the tube for at least two hours and re-test.

If the efficiency of the element remains unsatisfactory, replace the chemical as follows:

1. Turn power off.
2. Disconnect the zero air tube by unscrewing the two screws holding the tube bracket to the mother board transformer.

3. Pull the tube assembly and bracket out of the unit.
4. Unscrew the end cap, being careful not to allow the internal spring to fall, and empty the chemical.
5. Refill the tube (refill packages are available from Dasibi in pre-measured amounts, stock number S-0138).
6. Replace the tube spring and screw the end cap back on.
7. Re-install tube assembly by reversing the above instructions and re-apply power.
8. Re-check Flow, Zero and Span.

6.2.3.3 Pump Replacement (Figure 6-2)

A flashing message on the alphanumeric display of PRESSURE can indicate a pump fault. The pump should be replaced or repaired if it exhibits any sign of malfunction, i.e., excessive noise, erratic operation or lack of pressure drop as indicated on the front panel display while the diagnostic switch is set on position 3.

Diaphragms can be cleaned or replaced by the following procedure:

1. Disassemble the head by removing the four fastening screws.
2. Inspect the orientation of head components during disassembly so that they can be re-assembled appropriately.
3. Clean or replace the diaphragms as required.
4. Re-assemble in reverse order.

6.2.3.4 Solenoid Valve Replacement

The solenoid valves are very reliable, and both mechanical and electrical failures are rare. However, if problems are suspected, they can be checked by listening for audible clicks when the ZERO pushbutton is pressed (which activates the SAMPLE solenoid), and then when the SPAN pushbutton is pressed (which activates the reference solenoid). If the valves fail to activate, a check to ensure that voltage is reaching them can be made by voltmeter readings on the valve control board on the rear panel of the instrument.

The valves are removed for servicing as follows:

1. Remove their inlet and outlet tubes, unplug their electrical connections and remove the screws that bolt them to the rear panel.
2. The valves can be inspected and cleaned, by undoing two screws at their base, and separating the solenoid upper portion from the valve lower portion.
3. Inspect for damage, brush out any particulate matter, and clean with methyl or ethyl alcohol.
4. Re-assemble and test, or replace valves.

6.2.3.5 Gas Filter Correlation Wheel Replacement

Evidence of a defective gas filter correlation wheel is outlined in the Corrective Maintenance Section following this section. Wheels generally last many years, however, they have been known to fail due to extreme temperature cycling, which destroys the epoxy seals holding the sapphire windows to the metal wheel body. It is recommended that defective gas correlation wheels be replaced at the factory.

6.2.3.6 Infrared Source Replacement (Figure 6-10)

The source is expected to give more than one year's service. Its intensity does not decrease during operation with time. When it fails, it suffers catastrophic failure and must be replaced. When this happens, a SOURCE FAILURE message will flash on the display. The source failure can be further diagnosed by the following four tests:

1. If the user has a voltmeter, then unplug the I.R. source from the Mother Board and test its impedance across the plug terminals; it should be 15 ohms. If the impedance is infinite, the source is open (failed).
2. If the user does not have access to a voltmeter, then look through the hole located in the I.R. source's block to see if there is a dull red glow. If not, the source has failed. If there is, go to step 3.
3. Put the DIAG switch on position 5 and read the Reference Voltage (R). A steady voltage (fluctuations less than 1 volt) from 6 to 10 volts after the letter "R" indicates a good source.
4. The voltage supply to the source can be checked at its terminals. It should be from 11 to 13.5 Vdc. Higher voltage lowers the analyzer noise, but shortens the source lifetime. The voltage is controlled by trimpot R21 on the Power Supply Board.

CAUTION: SOURCE IS HOT!

To replace the source, proceed as follows:

1. Obtain either a replacement source assembly from Dasibi (stock number Z-0001-B) or a source itself (stock number D-0041).
2. Remove the infrared source assembly by means of the two screws that straddle the power connections.
3. Unplug the source power connector, and either discard the entire assembly, or remove the source itself by unscrewing the two sets screw which hold it in place.

4. Replace the old source with the new one. Make sure that the bare wire portion of the resistor faces away from the "lip" of source assembly's bracket, and that this lip faces the fan located on the back panel when it is re-installed.
5. Before placing the source assembly back into the foreoptics, allow it to burn in for at least 30 minutes to prevent "fogging" on the mirrors during this time.
6. Re-connect mounting screws and power cable connector.

6.2.3.7 E-Prom Replacement (Figures 6-3 and 6-4)

The analyzer operates from instructions contained in Read Only Memory (ROM). This software is contained in one of the integrated circuits in the instrument called a PROM (Programmable Read-Only Memory). The analyzer can be made to operate in different modes, and to different specifications, by changing the PROM (installing a new program). For example, it could be made to be more "user friendly", or give more diagnostic information. Also, operational parameters such as time constant or concentration range could be changed by modifying the program in the PROM.

For this reason, users of the analyzer may wish to change the program, as new programs evolve based on new developments. Dasibi will contact users if improved or more versatile programs become available. The steps outlined below, should be followed in installing a new PROM.

1. Turn off power to the instrument before removing PC boards. Damage to circuit IC's will almost always result if cards are pulled out when the instrument is under power.
2. Disconnect the cables to the CPU Board, and make note of their positions, so they can be reconnected correctly.
3. Place the CPU board on a flat static-free surface.
4. Carefully pry out the PROM with a small screwdriver, and replace it with the new PROM, observing the correct orientation.
5. Replace the CPU Board and re-connect the cables.

6.2.3.8 Cleaning of Mirrors

There are five mirrors in the Model 3008 optical bench (refer to Figure 4-1). With use, dust and other contamination can deposit on these mirrors. When this becomes severe, the energy throughput of the system is lowered, and the analyzer may become noisy. This condition is diagnosed by the Bench Efficiency Test (BET) which is described in the Corrective Maintenance Section. The mirrors' reflective surface is a layer of aluminum deposited on the upper surface of a polished glass plate. Although a protective coating is applied to the aluminum surface to permit cleaning, the surface should still be considered delicate and not touched or rubbed with pressure.

Cleaning of the mirrors should be done with suitable solvents and "Q" tips. The following solvents are recommended for cleaning the mirrors:

1. Windex or equivalent window detergent
2. Methyl Alcohol
3. Distilled or Deionized Water

Procedure For Cleaning Mirrors:

A. Preparing the mirrors for cleaning:

1. Turn off power and unplug the power cord.
2. Place analyzer on its right side (facing the unit).
3. Using an 8-32 nutdriver, remove the five nuts holding the bench to the bottom of the chassis, while supporting the bench with one hand.
4. Place the analyzer back in a normal upright position.
5. Elevate the end of the optical bench facing the power supply.
6. Remove the 1/4 " tubes connected to the "tee" located on the mirror plate at the foot of the bench which faces the power supply. DO NOT remove the "tee" itself.
7. Unscrew the five screws and one nut that hold the plate containing mirror pair M2 and M3 in place.
8. Place the mirror assembly, mirror side down, on a clean flat surface.
9. Elevate the upper end of the bench, and remove the six screws that hold the single large concave mirror M4 in place.
10. Place this mirror assembly, mirror side down, on a clean flat surface.

B. Cleaning of mirrors with a pressurized stream of dry gas.

1. Use a source of clean dry gas such as a cylinder or a rubber bulb blower used to clean photo lenses. Remove as much particulate matter as possible by blowing it off.
2. Inspect the mirrors for cleanliness.
3. If the mirrors have no obvious deposits of dirt or oil film after this operation, they should be re-installed, and no further cleaning attempted.

C. Cleaning of mirrors with solvents.

1. Using "Q" tips, gently brush the mirror surfaces with one of the solvents or detergents listed above.
2. Always use, as a final solution, Distilled or Deionized water.
3. The drying of the cleaned mirrors can be speeded by blowing dry clean air over their surface.

4. The mirrors are re-installed by reversing the procedure used to remove them.

D. Cleaning of Beam Steering Mirrors M1 and M5.

1. The beam steering mirrors can be removed by the pair of screws that hold each of them.
2. They should be inspected and cleaned if necessary. Take the same precautions cited for other mirrors.
3. Re-assemble the mirrors using the position stop screws to preserve alignment.

6.3 CORRECTIVE MAINTENANCE

Corrective maintenance on the instrument is aided by the powerful diagnostic capabilities of the integral computer. Investigation of a problem can be explored by employing the DIAG thumbwheel switch, which permits the user to isolate and display the values associated with various, individual instrument functions for analysis and correlation purposes.

In many cases, the failure or malfunction of a component will be indicated by a periodic message flashing on the alphanumeric display. Flashing messages are a user option, and dipswitch 7 on the top of the CPU PC Board controls activation of this feature. It is recommended that dipswitch 7 be in the DOWN position so that the flashing message option will be activated during normal operation.

The Start-Up program provides ease of operation during start-up. It checks out a number of analyzer functions on a pass/fail basis.

6.3.1 General Troubleshooting Techniques

In presenting the following troubleshooting procedures, directions are given for locating malfunctions in a sequential manner. This process is facilitated by the use of built-in computer diagnostics. These diagnostic functions can be called-up at any time by using the DIAG thumbwheel switch. Refer to Table 6-1 for a description of the functions available with the DIAG thumbwheel switch.

By calling-up each of the individual diagnostic tests, information will appear on the alphanumeric display which will allow the faulty module or PC board to be identified and replaced. This computer diagnostic capability is quite useful, since it is generally true that the proper diagnosis of a problem is the greater part of its overall solution.

NOTE

When performing troubleshooting and maintenance procedures, it is recommended that common shop-level hand tools be available. In addition, a piece of test equipment that is very useful in troubleshooting the instrument is a digital voltmeter capable of 10 mV resolution or better.

After a diagnosis has been made, the corrective action that is generally recommended is replacement of the faulty module or PC board, whenever possible. To facilitate rapid repair, it is recommended that users of the instrument maintain spare replacement components. A list of recommended spares is given on Page 7-1. However, spare PC boards and other modular components for replacement are also maintained at Dasibi for prompt shipment upon request.

6.3.2 General Diagnostic Information

The analyzer has three separate means of presenting diagnostic information to the user. These are:

1. Flashing messages.
2. Diagnostics dialed via the DIAG thumbwheel switch.
3. Special test functions of computer system - COMPTST.

6.3.2.1 Flashing Messages

The analyzer provides flashing messages as intermittent interruptions of the concentration readings on the alphanumeric display on the front panel when operation of a key component is not within the proper range. Position 7 on the CPU board dipswitch controls the flashing messages, and they can be eliminated by placing the switch in the UP or CLOSED position. The following messages may appear:

1. Source Failure D5
2. Wheel Temperature Failure D6
3. Zero Offset Failure D1
4. RAM Failure CT
5. PROM Failure CT
6. V/F Failure CT

6.3.2.2 PROM Failure

This message can mean that the EPROM is faulty or poorly connected into the circuit board. Inspect the CPU Board for faults.

6.3.2.3 V/F Failure

This message usually indicates that either the voltage-to-frequency converter has failed or the 10 V reference which powers the converter and the multiplexers has failed.

6.3.3 Diagnostics Dialed Via The DIAG Thumbwheel Switch

In troubleshooting the analyzer, the built-in diagnostics are generally the fastest and easiest way to identify a problem area. The diagnostics are displayed by setting the DIAG thumbwheel switch on numbers 1 through 9. In addition, some diagnostics can be displayed on a strip chart recorder or data acquisition system by changing the position of dipswitch 8 on the CPU PC Board (DOWN to UP).

Table 6-1 is a listing of the diagnostics available and the DIAG thumbwheel switch setting for each. This list gives the operational range of each parameter displayed for the appropriate DIAG NO. It is useful during troubleshooting to display the performance of modules under examination on a strip chart recorder, and the table identifies which parameters are available for a recorder.

TABLE 6-1
Diagnostic Functions Using DIAG Thumbwheel Switch

DIAG. NO.	Parameters Displayed	Operational Range	Recorder
0	Reads CO concentration in PPM	N/A	Yes
1	Zero Offset in mV	10-100 mV	No
2	Gas Temperature in degrees C	30-45	Yes
3	Gas Pressure in mm Hg	700-800	Yes
4	Gas Law Correction factor	.80-1.20	No
5	Difference Signal in mV	10-100	Yes
	Reference Signal in mV	6K-10K	No
6	Wheel Temperature in degrees C	45-50	Yes
7	Bench Temperature in degrees C	40-50	Yes
8	Recorder and DAS calibrate signal using AUTO Switch in volts	0-10	Yes
9	Not in use		

6.3.3.1 DIAG 0

In this mode, the analyzer displays the concentration of CO.

6.3.3.2 DIAG 1

The zero offset (ZO) is defined as:

$$ZO = V (\text{Ref}) - V (\text{Meas})$$

Where V (Ref) is the voltage Automatic Gain Controlled reference channel in millivolts, and V (Meas) is the voltage of the measurement channel in millivolts, when the instrument was last zeroed USING ZERO AIR. It represents the amount of offset voltage the computer system measures in the absence of any CO. The computer system cannot measure negative quantities, and therefore a small positive offset must always be present. If the Zero Offset value becomes ZERO, erroneous readings will be made. This condition will be signaled by a flashing message. The nominal value for the zero offset is 55 mV, and acceptable values can be between 10 and 100 mV. The zero offset is controlled by trimpot R11 on the Signal/Logic Board.

6.3.3.3 DIAG 2

In this mode, the analyzer displays the temperature of the gas sampled by the analyzer. This measurement is used to make a correction factor to the value of the CO concentration read so that the Gas Law relationship is followed.

6.3.3.4 DIAG 3

A pressure transducer is included in the flow monitoring system which measures the pressure of the gas sampled by the analyzer. This measurement is used along with the temperature to calculate a correction factor for the Gas Law relationship.

6.3.3.5 DIAG 4

Since the analyzer is calibrated at one point in time and makes measurements at other times, changes in pressure and temperature that are time dependent can influence the measurement accuracy. In the Model 3008 analyzer, the microprocessor receives continuous temperature and pressure information, and corrects the measurement made, so that it is always referenced to standard temperature and pressure, which for an ambient monitor is taken to be 25°C and 760 torr.

6.3.3.6 DIAG 5

The measurement of CO is obtained by taking the difference of two DC signals, the measurement signal and the reference signal. The difference voltage read on DIAG. 5 is this difference read out in millivolts. It is proportional to the concentration of CO being measured in the analyzer. Super-imposed on this voltage, is the Zero Offset voltage, which is a fixed constant of nominally 55 mV used to insure that readings are always positive. The value of the offset is not critical, but should be within 10 and 100 mV. The reference voltage is maintained constant by an Automatic Gain Control (AGC) circuit which is part of the analog signal conditioning circuitry. It is nominally set at 8.0 volts, but values between 6 to 10 volts are acceptable for use.

6.3.3.7 DIAG 6

The Gas Filter Correlation Wheel is temperature sensitive, and should be maintained with a temperature variation as small as possible to minimize instrument zero drift with temperature. In average use, the wheel temperature should stay within the range of 45 to 50°C. The regulation of the temperature of the wheel is largely controlled by the modulated fan blowing outside air upon it. The fan, in turn, is controlled by a thermistor sensor located near the wheel compartment.

6.3.3.8 DIAG 7

The optical chamber is kept at a temperature between 40-50°C. The temperature adjustment is made by trimpot R17 labelled "Temperature Adjustment" on the Power Supply Board.

6.3.3.9 DIAG 8

In this position, an analog signal is sent to the recorder and/or the data acquisition system for calibration purposes. The level of the electrical signal is determined by the position on which the AUTO Thumbwheel Switch is set. Table 6-2 gives the appropriate values.

TABLE 6-2
AUTO Thumbwheel Switch Settings
For Calibration Signals
At DIAG NO. 8

AUTO NO.	Percent Full Scale	CO Concentration (PPM)	Output Volts*
0	0	0	0
1	2	1.0	0.02
2	4	2.0	0.04
3	8	4.0	0.08
4	10	5.0	0.10
5	20	10.0	0.20
6	40	20.0	0.40
7	80	40.0	0.80
8	NA	120.0	2.40
9	NA	150.0	3.00

* The voltage output is controlled by setting of the trimpots accessible through holes in the front panel. In the table listed here, it was assumed that the recording device had a range of 1 volt full-scale and that 50.0 PPM was to be displayed full scale. If 100 PPM were desired to be displayed full-scale, the AUTO switch would be set on POSITION 7 (after zero had been first established) and the SPAN trimpot would be set so that the recording device read full-scale.

6.3.3.10 DIAG 9

Not in use at this time.

6.3.4 Special Test Functions of Computer System - COMPTTEST

It is possible to activate a special set of test functions by pressing the ZERO and SPAN buttons simultaneously. These test functions deal exclusively with the computer. To exit the COMPTTEST, the ZERO and SPAN buttons are again pushed simultaneously. The following functions or components are tested:

1. CPU IC
2. V/F converter IC
3. DAC IC
4. Clock
5. CPU Board dipswitch
6. All front panel thumbwheel switches
7. CPU "Watchdog" counter test
8. RS 232C Board, if present

Once the ZERO and SPAN buttons are pushed, and the analyzer enters the COMPTTEST mode, the various tests are engaged by pressing the appropriate front panel push buttons.

Pressing the "ZERO" mode pushbutton initiates the following sequence:

1. Displays software revision number.
2. Performs CPU test.
3. Performs V/F test.
4. Displays thumbwheel settings in hexadecimal code.

Pressing the "SAMPLE" mode pushbutton initiates the following:

1. The DIAG NO. thumbwheel switch can now select each of the six multiplexed (MUX) inputs to the V/F converter, and they will be displayed as millivolt readings. Position 7 is set to read 10,000 as the voltage standard.
2. The value set on the SPAN NO. thumbwheel switch is used to test the digital-to-analog converters (DACS). By connecting a recorder, DVM, or a Data Acquisition System (DAS) to the analog output(s), the DACS can be checked for linearity by changing the value set on the SPAN NO. thumbwheel switch in a sequential manner. By stepping the switch from 000 to 999, corresponding linear output voltages from 0 to 10 volts (or whatever the user-selected maximum analog output value is) will be obtained.

Pressing the "SPAN" mode pushbutton initiates the following:

1. When the DIAG NO. thumbwheel switch is set on 0, the dipswitch positions on the CPU Board are read out on the alphanumeric display in binary code (1 = "switch open," 0 = "switch closed"). Dipswitch position 8 is in the left most position on the display.
2. When the DIAG NO. thumbwheel switch is set on 1, a clock check is made. The display is updated every five seconds.
3. DIAG NO. 2 will display the communication parameters of the RS232 port, if this option is present.
4. DIAG NO. 3 will proceed with the "Watchdog" counter test (designed to reset the computer in case of a lock-up). If the counter is working, the analyzer will be reset within 30 seconds.

6.4 Troubleshooting Procedure (Figure 6-12)

TABLE 6-3
Troubleshooting Procedures

Step	Function Test	DIAG NO.	Maintenance Action
1	Physical Examination	N/A	Repair/Replace
2	Main Power Supply	ALL	Replace
3	E-SYS TEST	0	Continue
4	I/F Board	ALL	Repair/Replace
5	C-SYS Test	0	Continue
6	CPU Board	0	Replace
7	I/O Board	0	Replace
8	Detector Module	5	Replace
9	Signal/Logic	5	Replace
10	Optical Bench	5	Replace
11	GFC Wheel	5	Replace
12	Gas Handling System	N/A	Repair/Replace
13	Recorder Output Board	8	Repair/Replace
14	Fan & Control Board	6	Replace
15	Valve Control Board	N/A	Replace

6.5 Stepwise Troubleshooting Procedures

6.5.1 Physical Examination

Remove the instrument cover. Inspect inside for visual signs of problems, making sure that all PC boards are pushed firmly in their sockets. Turn on the instrument and observe operation.

An instrument that fails to operate properly should be carefully checked first for indicators of malfunctions. For example, an unlit front panel display and no internal sounds indicate no line power. Turning the pump on and off audibly

indicates line power is getting within the instrument. A dead front panel display therefore under this circumstance can make the low voltage power supply or display itself suspect, since the display operates off the 5 volt power supply within the unit.

Other visual, audible and tactile tests are appropriately done with the units cover removed. The motor that rotates the Gas Correlation Wheel is mounted on the optical module and should exhibit a smooth humming noise. The pump should be turned off for this test. Erratic sounds from the area of the motor are indicative of mechanical malfunctions due to damaged bearings or slipping shafts, etc.

In general, all I.C.'s should be cool to the touch with a few exceptions that are described in the troubleshooting section. Components with finned heat sinks should exhibit some heat, and if they are cool to the touch they should be further investigated. A caution to be exercised is to always turn power off before removing any component including PC boards.

6.5.2 Main Power Supply

The first step in locating a faulty electronic module is to determine if the main power supply is operating. If the alphanumeric display on the front panel lights up normally, the +5v regulated supply (which powers the display), is likely to be operating properly. If the fan operates at moderate to full speed, there is a good chance that the $\pm 15v$ supplies are operating. All the supply voltages (+5v, $\pm 15v$, +24v, and +13v) can be checked with a digital voltmeter via testpoints on the top of the power supply board (see Figure 3-5). They should be within ± 5 percent of their nominal value.

6.5.3 E-SYS TEST

If a unit is exhibiting excessive drift or noise fluctuations, a useful technique to zero-in on the problem is to distinguish whether the fault is associated with the system leading up to the electronic signal processing, or whether the problem occurs beyond this stage. The Model 3008 is provided with a diagnostic capability which permits the electronic system to be tested exclusive of the optical bench and its associated analog circuits. A signal simulator is incorporated on the I/F Board which provides analog signals that replace the difference and reference signal that normally comes from the analog circuitry that performs the detector's signal conditioning. By making use of these DC test signals, the performance of the electronics with the exception of the analog detection system can be evaluated. This feature is called the E-SYS TEST and is engaged as follows:

1. Set the SPAN NO. thumbwheel to 100.
2. Position the two dip toggle switches on the I/F Board in the DOWN position.

3. Set the DIAG. thumbwheel on Position 5, Diff. Signal/Reference Signal.
4. Turn trimpot SIM on the I/F Board counter-clockwise until clicks are heard. The display should read 0 mV.
5. Turn trimpot SIM on the I/F Board clockwise to establish 20 mV as the Diff. Signal on the display.
6. Set the DIAG. thumbwheel on position 0, press the ZERO pushbutton, wait a few seconds and press the SAMPLE pushbutton. The display should first flash "ZERO OFFSET = 20 mV" and then "CO = 0 PPM".
7. Set the DIAG. thumbwheel back on position 5. Now, turn trimpot SIM clockwise until the display reads approximately 70 mV for the Diff. Signal.
8. Set the DIAG thumbwheel on position 0. The display should read approximately 14 to 15 PPM, within several minutes.
9. Turning the SIM trimpot on the I/F Board clockwise will now let you simulate CO, and you can dial in as much as 40 PPM. In this position, display readings should show no noise fluctuations, and drift due to thermal effects should not be observed.

If the tests described above are re-produced, the electronic system is working satisfactorily. This includes the I/F, CPU, and I/O Boards, but not the Detector Module or the Signal/Logic Board.

Be sure at this point to return the two switches on the I/F Board to the up position.

If the E-SYS TEST did not pass, the unit should be subjected to the C-SYS TEST, which tests out the computer system.

6.5.4 I/F Board

If the E-SYS TEST was passed, it is likely that the I/F Board is working satisfactorily. A few amplifiers that deal with transducers, such as the Pressure Transducer are not tested by the E-SYS TEST. If there is evidence that the E-SYS TEST was not satisfactory, it may indicate that the I/F Board should be replaced. Alternatively, the op-amps (A1) can be replaced.

6.5.5 C-SYS Test

The computer section consists of the CPU Board and the I/O Board. The CPU contains the Z-80 microprocessor CPU system including the system program which resides in an EPROM. The I/O functions to translate all incoming and outgoing signals so they are compatible with both the computer and the connecting circuitry. The C-SYS test applies to both boards and cannot isolate problems to a individual board. The test is performed as follows:

1. Locate the red, 8-position dipswitch at the top center of the CPU Board. When the levers of this switch are in the UP position, the switches are CLOSED, or conducting, and when they are in the DOWN position, they are OPEN, or non-conducting.
2. Close switch 2 (UP position). In this mode, the computer supplies equivalent voltages to voltages normally from the I/F Board to result in a reading of 40.0 PPM.

If the test described above is reproduced, the computer system is working satisfactorily, with the exception of the exclusion to be discussed below. If the test did not perform satisfactorily, it may indicate that either the I/O or CPU Board should be replaced.

Exclusion to C-SYS Test:

The analog-to-digital conversion of signals coming from the I/F Board is performed on the I/O Board. This is done by a signal multiplexer (MUX), which switch-selects on a time-share basis the different analog signals to be converted to digital form. The time-shared analog signals are then fed to a voltage-to-frequency converter which converts them to digital form. In the C-SYS test, this portion of the circuit of the I/O Board is not used. Therefore, if the C-SYS test passed, but the COMPTST Span mode test failed, it is likely that either the HI1-0158-5 MUX or the AD650 V/F Converter has failed and should be replaced. It is recommended that in this case the entire I/O Board be replaced.

NOTE

At instrument TURN-ON, the alphanumeric display on the front panel will read the status of the computer system. If the V/F converter is faulty, it should give a flashing message.

6.5.6 CPU Board

The diagnosis of this board is best done by the C-SYS test described above. In addition, there are other indications that can be used to rule out problems on this board. If the analyzer displays diagnostic information it is a favorable sign about the status of this board. Also, at turn-on a message will appear "COMPUTER PASS" or "COMPUTER FAIL" which is indicative of the status of this board. Finally, if there is a problem in the EPROM on this board, a flashing message will indicate "PROM FAILURE."

6.5.7 I/O Board

This board is diagnosed by the C-SYS test, bearing in mind the exclusion discussed above. A failure of the V/F converter which does the analog to digital conversion, is indicated by a flashing message: "V/F FAILURE."

6.5.8 Detector Module

The Detector Module must be diagnosed with an oscilloscope, since the signals it produces are AC waveforms. The output signal of the detector module can be examined on test point 1 of the Signal/Logic Board.

NOTE

It takes several minutes after power is applied for the Bias Voltage necessary to power the detector to become active, due to its oscillator circuit. Therefore, it is necessary to wait several minutes after power up to test the detector.

Procedure:

1. Set the scope sweep for 5 ms/div.
2. Set the scope volts/div at 1 volt.
3. Compare waveform observed with that in Figure 6-5.
4. The waveform should have the same shape, be stable, and be between 2 and 5 volts peak to peak.
5. If the voltage is not correct it can be adjusted by R25 on the Signal/Logic Board.
6. If the voltage cannot be raised to 2 volts peak to peak, the analyzer will be noisy, and either there is an alignment problem in the optical bench, or the detector module has a problem.

Isolating a problem between the optical bench and detector module:

1. If a low, or no signal is obtained on test point 1, it is necessary to isolate the problem to either the bench or the Detector Module.

2. Remove the beam steering mirrors by the four retaining screws that fasten them from the top (Figure 6-11). Before doing this, check that the set screws shown in the figure are tight, and that positioning screws are screwed to the point of contact with the bench side plates. This allows the mirrors to be removed, and replaced in optical alignment.
3. With the mirrors removed, test point 1 is again checked for a waveform of the proper shape and voltage.
4. If an acceptable signal is present, the problem is in the bench alignment. If not, the problem is in the Detector Module.

Testing the Detector Module's cooler circuit:

1. The detector has a solid state cooler, which must perform correctly for the detector to function properly. The circuit that powers the cooler is located on the main power supply as well as a heat sink module on the left front corner of the chassis.
2. The cooler power supply can be checked by reading the DC voltage on the power regulator mounted on the heat sink. This can be done by touching the case of the regulator with the positive probe of a voltmeter. The negative probe should be placed on ground. The voltage should read + 50 mV.
3. If no voltage is read, touch the positive probe on the first contact facing the front of the analyzer on the orange plug leading from the heat sink module to the Mother Board. The voltage read here should be + 13 to 14 Volts. If this reading is obtained, the voltage regulator mounted on the heat sink is defective.
4. If no voltage is obtained in Step 3, or if the voltage is less than 4 volts, a problem exists on the main Power Supply Board.
5. There is a three (3) Amp fuse on the Power Supply Board, and it is functioning in the cooler circuit. It can be tested with a voltmeter to see if the + 13 to 14 Volts can be measured on both the upper and lower clip terminals. If the voltage is on the upper terminal, but not the lower terminal, the fuse should be replaced.
6. If there is no voltage on the upper fuse terminal, the main power supply is defective and should be replaced.

The Detector Module itself:

It has been general experience that a defective detector module almost always is caused by the detector element itself malfunctioning. This is not a field repairable situation. Therefore, it is recommended that if the problem is isolated to the detector module, either the entire module should be replaced or sent to Dasibi for determination of exact causes. If it is the detector itself, Dasibi will be able to replace it for less expense than that of replacing the whole assembly.

6.5.9 Signal/Logic Board

1. Use an oscilloscope to check if a signal is present on TP1 that agrees with the waveform shown in Figure 6-5. If no oscilloscope is available it is suggested that the board be checked by means of a DVM, and the values listed on Figure 6-6 be verified.
2. Place the scope probe on TP 5. The waveform form should, again, be shown as in Figure 6-5.
3. Now, flip the AGC toggle switch mounted on the board back and forth. Three flat regions on the waveform, two at the tops of the waveform, one at the wide bottom section should be seen to first separate and then merge. These are the sampled portions of the waveform separated by the sample/hold switches. Their position is indicated by dotted lines in the waveform shown in Figure 6-5. For phasing to be correct, the wide bottom flat should be centered on the same mid-point for the switched, and unswitched section.*

* Be sure, when this test is finished, that the lever of the toggle switch is facing away from the front of the panel, so that the AGC circuit is engaged.

4. If the waveform behaves as described, all of the digital logic functions that control the sample/hold switches are functioning, and the sample/hold switch itself (U5) is operational. If the proper behavior is not observed the problem is likely to be in a defective logic IC, or the switch IC. The faulty unit can usually be located by monitoring the various test points on the Signal/Logic Board using the information contained in Figures 6-5, 6-6 and 3-8 & 3-8A.
5. Measure the voltage on TP 6 using a DVM or a scope, and check to see if it is 8 to 9 volts. If it is not, set it to 8 volts by means of trimpot R37.
6. Measure the voltage on TP 7 using a DVM or scope, and set it to 80 mV by means of trimpot R11.

7. Challenge the analyzer with span gas, while monitoring TP 7. The voltage should rise proportionally with the span gas concentration, and reach a steady value approximately 2 volts for 40 PPM. If this is observed, the Signal/Logic Board is satisfactory.

6.5.10 Optical Bench

If no signal is indicated in Section 6.5.8, the problem may be in the optical bench. To check the optical bench, proceed as follows:

1. Check to see if the motor rotating the Optical Interrupter Blade and the GFC wheel is working by observing the rotation of the interrupter blade, or listening to the motor with the pump off.
2. Refer to Steps 1-4 in Section 6.2.3.6.
3. If steps 1 and 2 pass, light is most likely striking the first beam bending mirror. This mirror's alignment can be checked to a degree by steps 5 and 9.
4. With a fine tipped pencil, run the tip along the sides of the mirror mount plates to indicate their position.
5. Make sure the set screws and positioning screws are properly fastened. Remove the two set screws that hold the Source Beam Bending mirror and extract it for inspection.
6. If the mirror appears dirty, clean it as instructed in Section 6.2.2.8.
7. Re-install the mirror (with "O" Ring in place), after the positioning screw is rotated 3 turns counter-clockwise to allow for mirror adjustment to be made.
8. Looking at the detector signal on a scope, rotate the mirror's top plate to see if a signal appears. If so, leave the unit in the position giving the maximum signal. Do not screw down the unit at this point. If no scope is available, make use of the ENERGY TEST MODE, in step 17.
9. Repeat steps 4-8 for the detector's beam bending mirror.
10. If a signal is obtained at this point, position the two beam bending mirrors to obtain the largest signal that matches the waveform at TP1 in Figure 6-5.
11. If no signal is obtained at this point, re-install the mirrors in their original position, based upon the pencil markings, and contact Dasibi for further instructions.

12. If a proper waveform was obtained on the scope at Step 10, carry out the Bench Efficiency Test (BET) described next.

Bench Efficiency Test (BET):

13. Measure the peak to peak voltage of the detector signal with both beam bending mirrors out of the bench.
14. Place both mirrors back into the bench in optimum position and screw the mounting plates in place.
15. Re-measure the peak to peak voltage of the detector signal.

BET Ratio = Multipass Reading / Bypass Reading = 1 or larger

16. Values of less than 1 indicate a bench alignment problem or mirror cleaning is required.
17. If no oscilloscope is available, some troubleshooting can be done with a DVM, or if this is not available, using the analyzer's display. This mode of measurement is termed the ENERGY TEST MODE (ETM). By switching off the AGC operation by means of the AGC switch on the Signal/Logic Board, it is possible to make DC measurements in place of examining waveforms via a scope. The heavy line in Figure 6-7 shows the signal path in use in the ENERGY TEST MODE.
18. The BET ratio can be measured by reading the voltage of the Reference beam on DIAG. 5, or test point REF on the I/F Board or test point 6 on the Signal/Logic Board.

6.5.11 Gas Filter Correlation Wheel

If the GFC Wheel is leaking its confined CO gas, a steady increasing zero offset will be observed over several days (or even weeks) when ZERO GAS is sampled. If all the gas has left, the analyzer will read "Z" for offset fault, but this fault is not unique to wheel problem and further tests are required to confirm an empty wheel. To do this, follow these procedures:

1. Put a scope probe on TP1, and examine the waveform and, once again, compare them to those in Figure 6-5. The Reference (R) portion of the waveform should be 12 to 15% lower than the measure (M) portion of the waveform. If no scope is available, use the ENERGY TEST MODE. Set the DIAG switch on position 5, and turn trimpot R11 on the Signal/Logic Board full counter-clockwise. The difference (DIFF) reading should be greater than 12% of the reference beam (REF). The original fill value should be referred to if available.
2. If the condition stated in Step 1 is not met, the wheel is defective and Dasibi should be contacted for instructions.

3. If the wheel is removed from the unit, it should be examined under good lighting. Any coloration or rainbow effects that can be seen as the wheel window is viewed at an angle, is evidence of the cement failing.

6.5.12 Gas Handling System

The gas handling system is most vulnerable to problems associated with leaks, and dirt contamination. Routine preventive maintenance is necessary to prevent problems. Please refer to Preventive Maintenance Section.

6.5.13 Recorder Output Board

If the analog read-out systems such as recorder or DAS do not respond properly, the first thing to be determined is if the problem resides in the read-out device itself, or in the signals supplied to it from the analyzer. This can conveniently be diagnosed by setting the DIAG thumbwheel switch on Position 8, and then using the AUTO switch to dial in fixed voltages to a DVM that is connected to the appropriate analog output terminals. If the signals are noisy, incorrect (be aware that they are controlled by the front panel trim pots), or simply don't exist, the problem could be a fault in the Recorder Output Board.

To diagnose this board, refer to the circuit diagram, Figure 3-12. Test points are provided on the Recorder Board, and a voltmeter should read correct values of voltage on this board, when the AUTO switch is engaged in its various positions. If it does not function, or is erratic, it should be replaced in its entirety, or the AD712 (U1) should be replaced. It is important to make sure that a signal is getting to this board, and this can be checked by placing the DVM meter probe on Pins 3 or 4 on the connector socket J1 (these are the second pair of pins from the top). The I/F Board must be installed in the instrument to supply a signal to the Recorder Board. If there is no signal getting to the I/F Board, the problem may be in the computer I/O Board, such that either the DAC, itself, or the AD712 is faulty.

6.5.14 Fan and Fan Control Board

The cycling of the fan is controlled by the temperature of a thermistor located inside the analyzer. Heat applied to the thermistor should increase the duty cycling of the fan. If this is not observed, the fan and Fan Control Board assembly should be replaced as an entire unit.

6.5.15 Valve Control Board

The valve control board is located on the back panel. It can be diagnosed by listening to the valves as they are actuated. Problems can be isolated by checking for incoming 5V logic commands and checking for 24V activation signals to the valves themselves.

6.5.16 Heater Control Circuit

This circuit is used to control the temperature of the reaction chamber, and it resides on the Power Supply Board. The trimpot that controls the temperature regulation of the bench heater is R17 on the power supply. The bench heater is set for operation at 40-45°C.

Proper operation of the heater control circuit is indicated by the blinking neon lamp once the regulation temperature is reached. Prior to that, the lamp should be lit continuously.

If the circuit fails to operate, IC U1 (stock number S-0239) on the Power Supply Board should be replaced.

CAUTION

This circuit is operated at line voltage. Shock hazard exists in this area.

MAINTENANCE SCHEDULE TABLE 6-4

6.2.2	Leak Check	168 hrs *
6.2.3.1	Teflon Filter Pad Replacement	168 hrs *

* See Table 6-2 for check lists.

MAINTENANCE SCHEDULE													
Section	Performance Check							Performance Time Schedule					
6.2.2	Leak Checks							168 hrs					
6.2.3.1	Teflon Filter Pad Replacement							168 hrs					

TABLE 6-5
Maintenance Check List

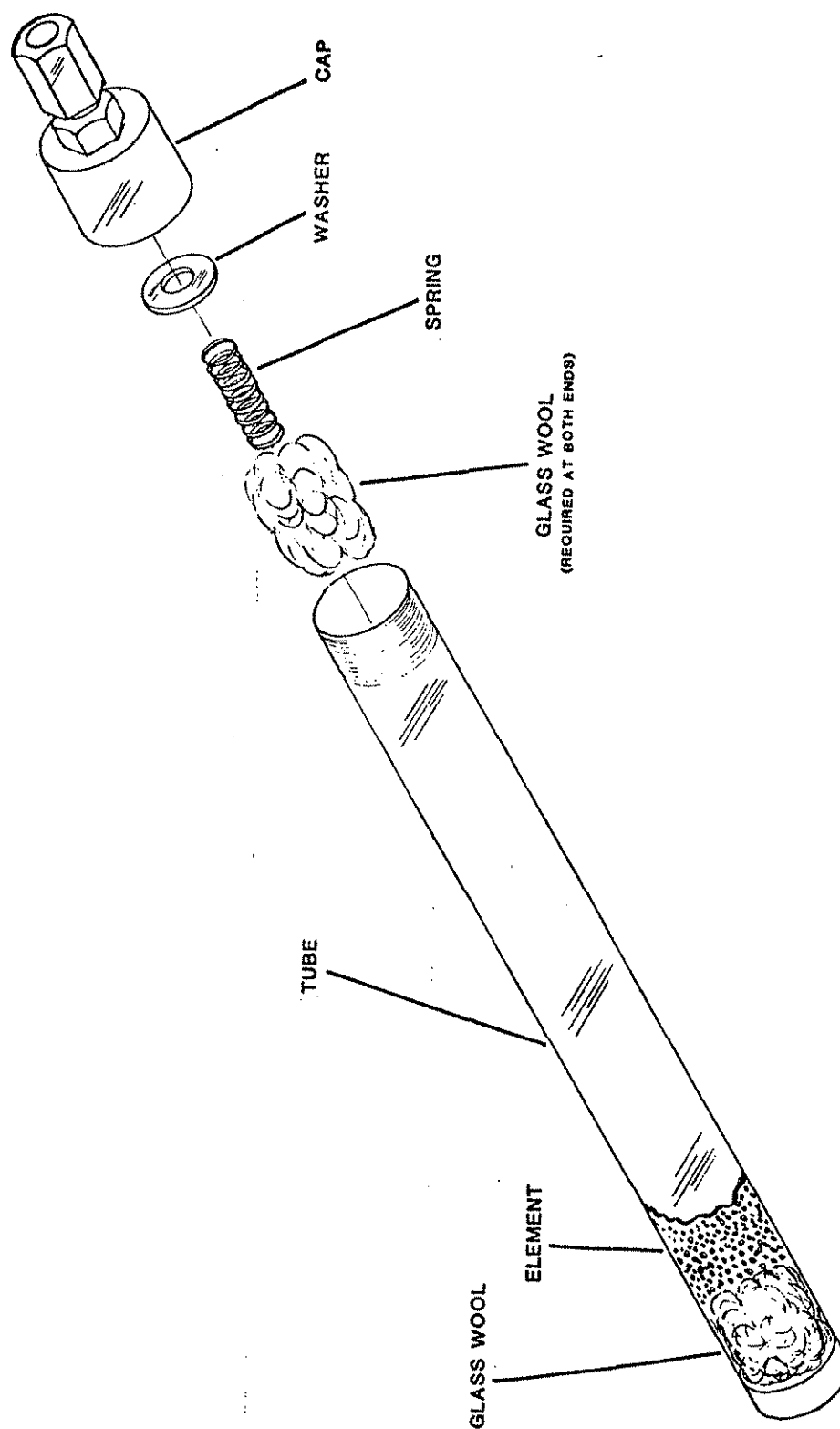


Figure 6-1 Zero Air Tube Element Replacement

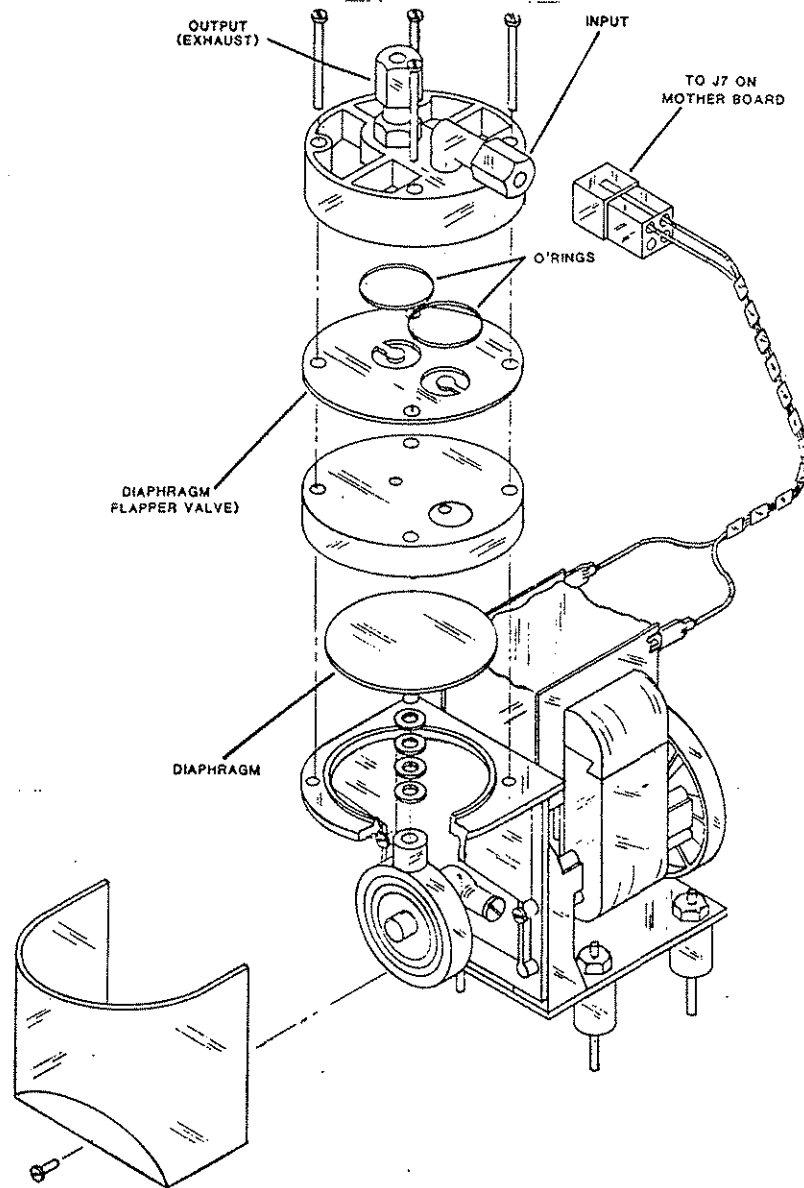


Figure 6-2 Pump Replacement

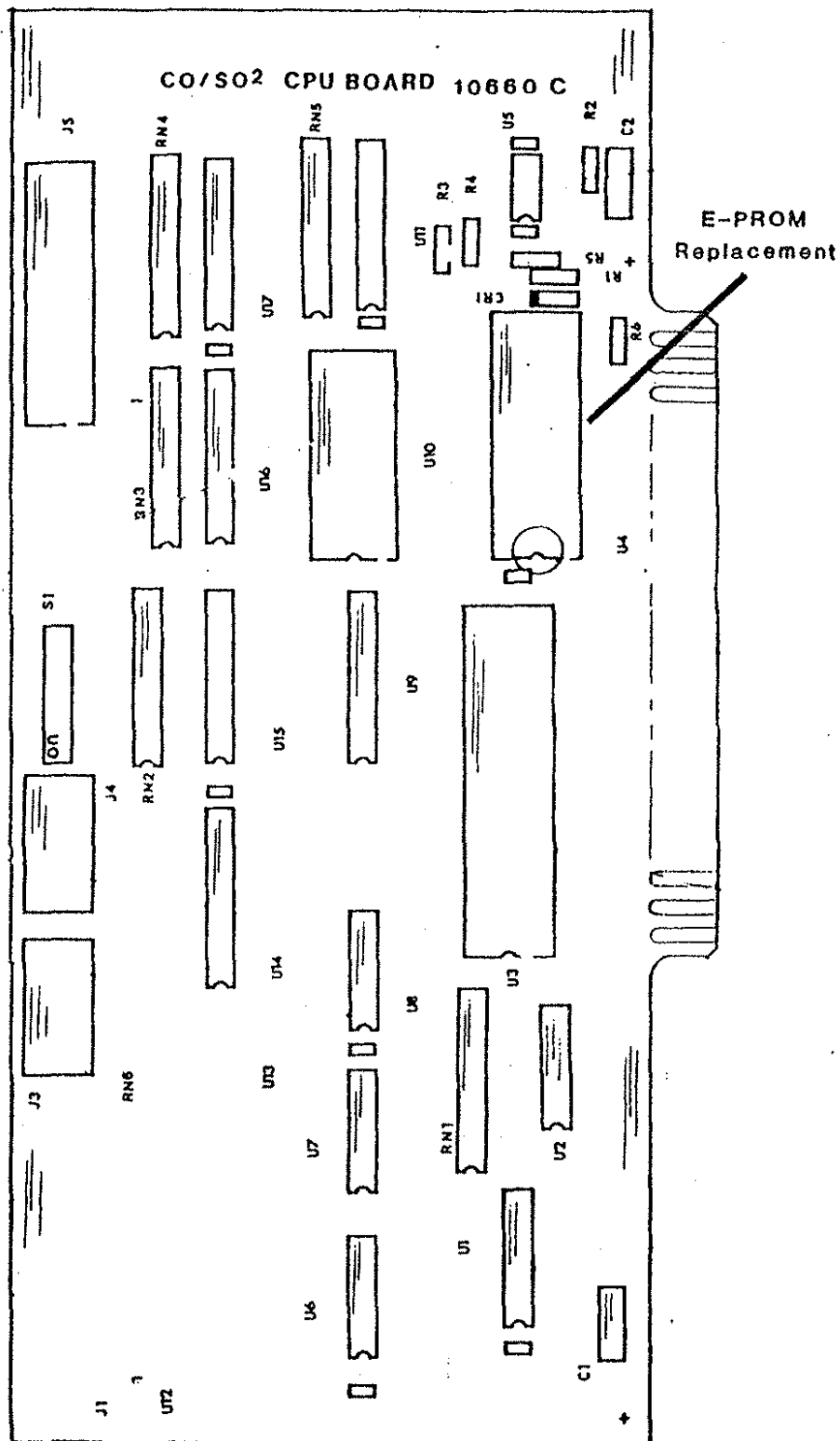


Figure 6-3 E-PROM Replacement

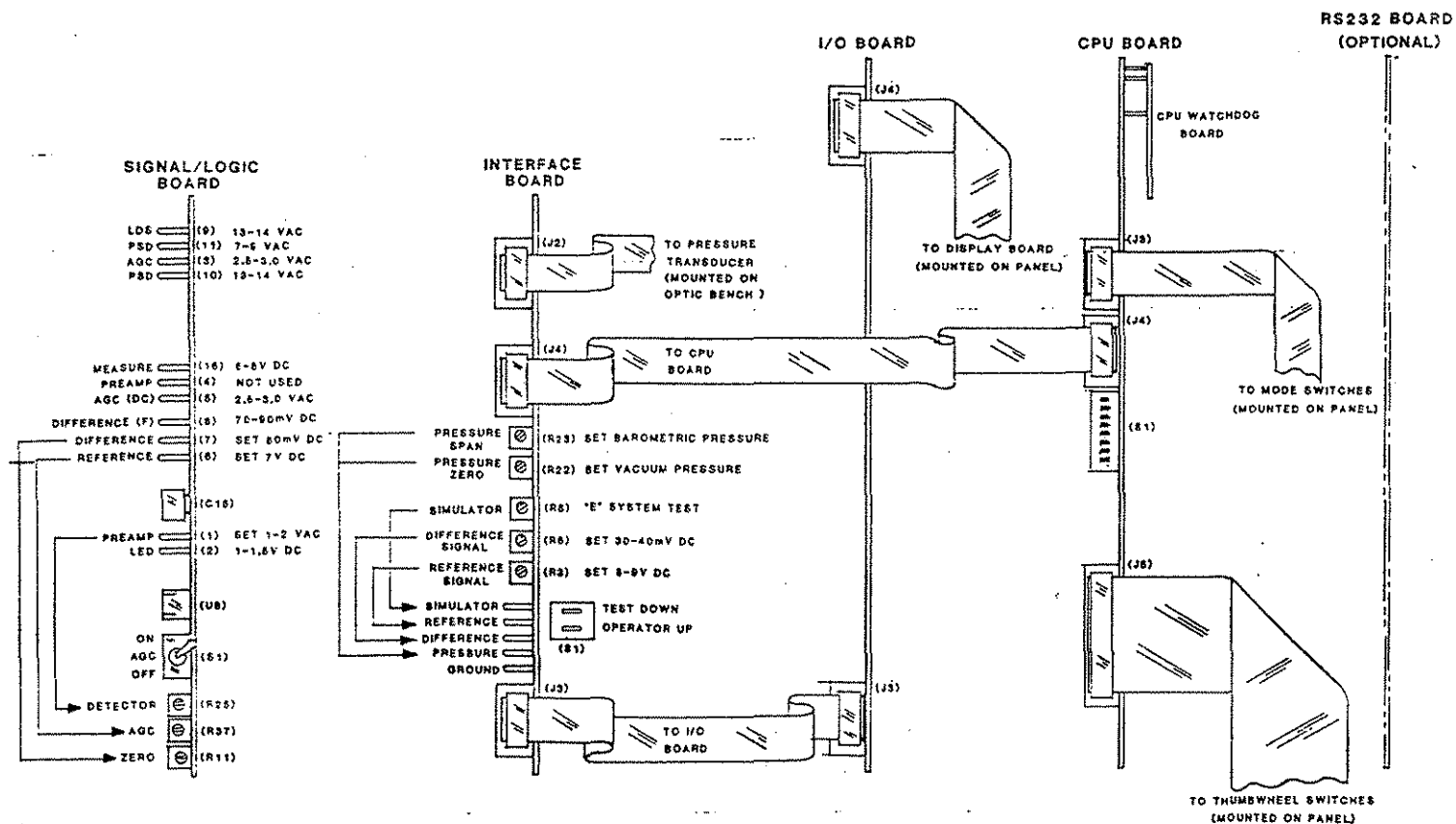


Figure 6-4 Cable Connections To Microprocessor

SIGNAL BOARD				
TEST POINTS	NORM DC V MAX	NO.	P-P V #	OBSERVED WAVEFORM ON OBCILLOSCOPE
TP1	0 \pm 1Volt	1	+ 2V	
IC7A (TP1)	0 \pm 30mV		0 - 2V	
TP4	0 \pm 1.6V	2	+ 3.5	
IC9C (TP10)	0 \pm 1.6V		0 -3.5	
TP5	3.5 \pm 1volt	3	+ 7	
			0	
LOGIC BOARD				
TEST POINTS	FUNCTION	NO.	P-P V	OBSERVED WAVEFORM ON OSCILLOSCOPE
TP9 THRU	Optical measurement signal thru comparator IC2 (3)	4	+ 15 -1	
TP10	Wheel position sensing device thru comparator	5	+ 12 -12	
TP13	NO. 4&5 Anded	6	+ 15 -1	
IC4 (TP13)	Binary Flip-flop Q	7	+ 15 -1	
IC4 (TP12)	Binary flip-flop Q	8	+ 15 -1	
TP12	NO. 5 and Inverted 4 Anded	9	+ 15 -1	
TP15	NO. 6 and 7 Anded	10	+ 15 -1	
TP14	NO. 6 and 8 Anded	11	+ 15 -1	

Figure 6-5 Detector Module Waveform Comparison

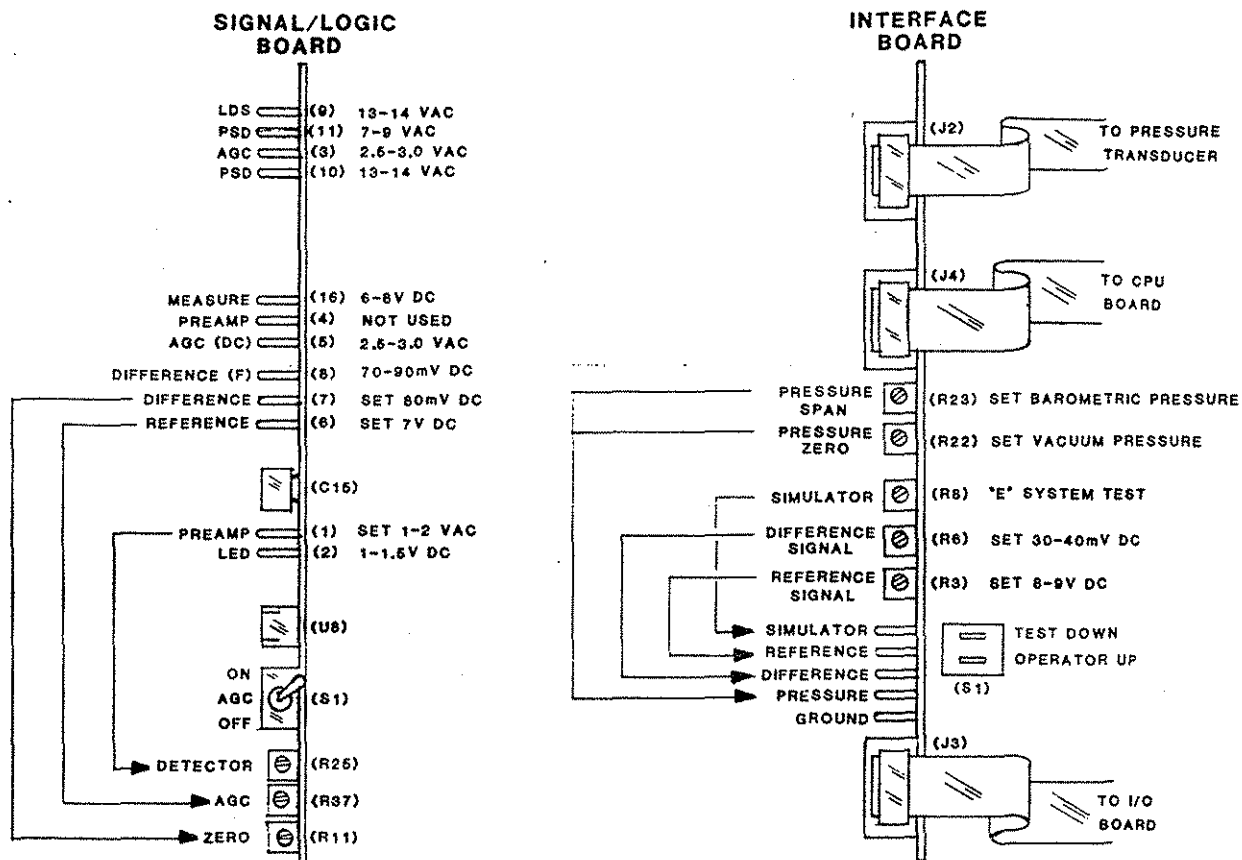


Figure 6-6 Checking Trimpots and Test Points With DVM

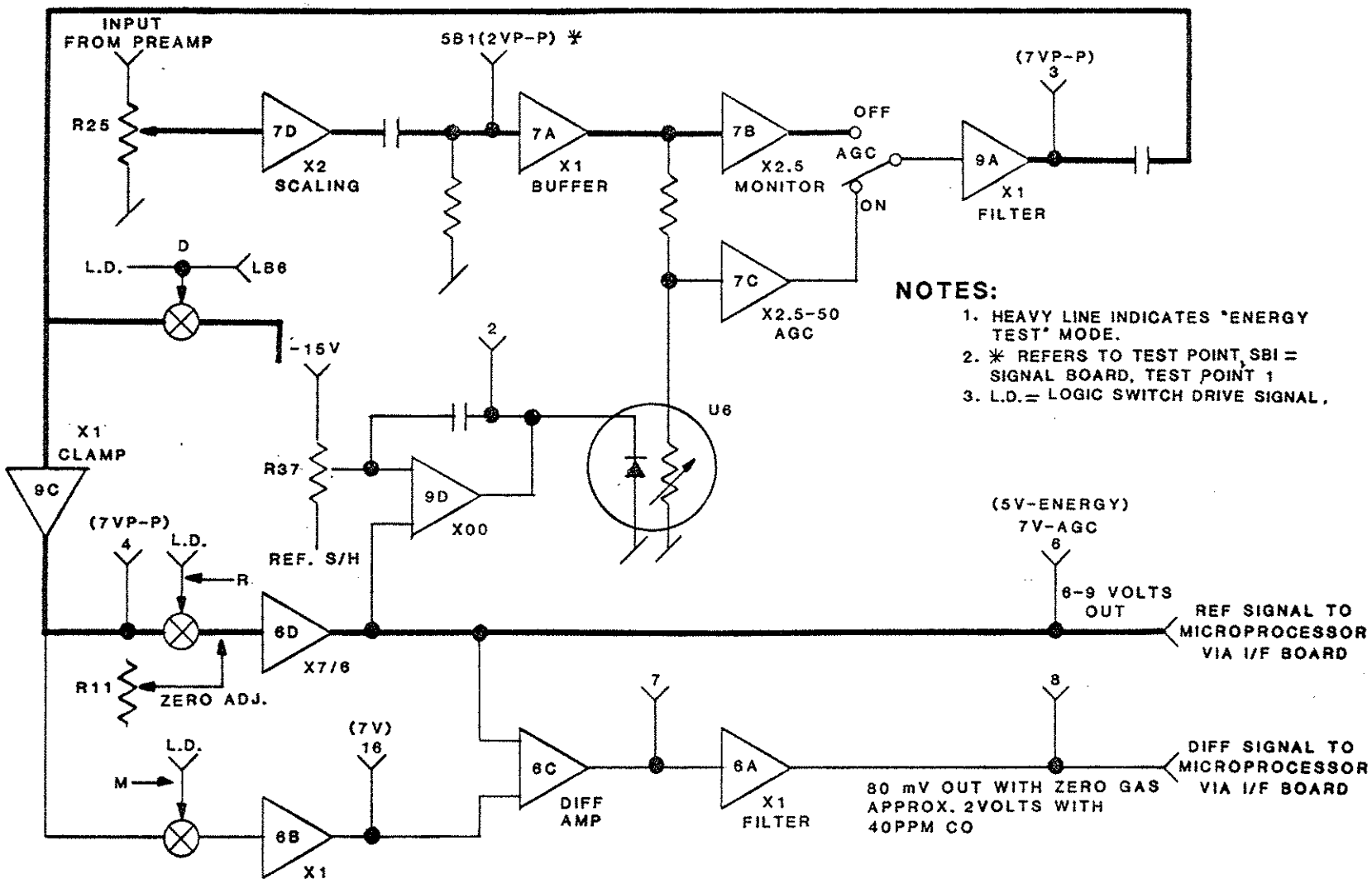


Figure 6-7 Simplified Circuit Diagram:Signal/Logic Board

Figure 6-8 Diagnostics Performance chart

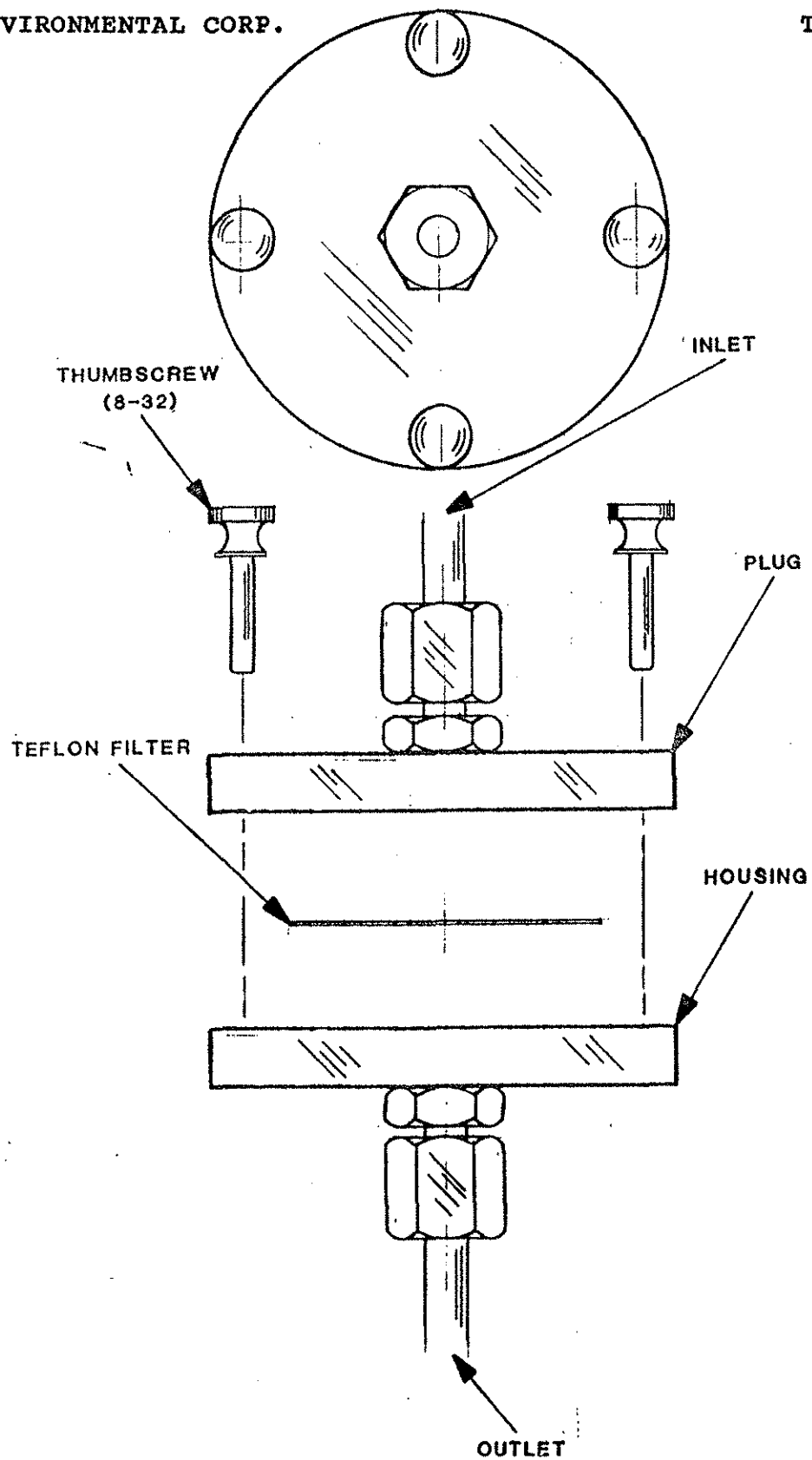


Figure 6-9 Teflon Filter Pad Replacement

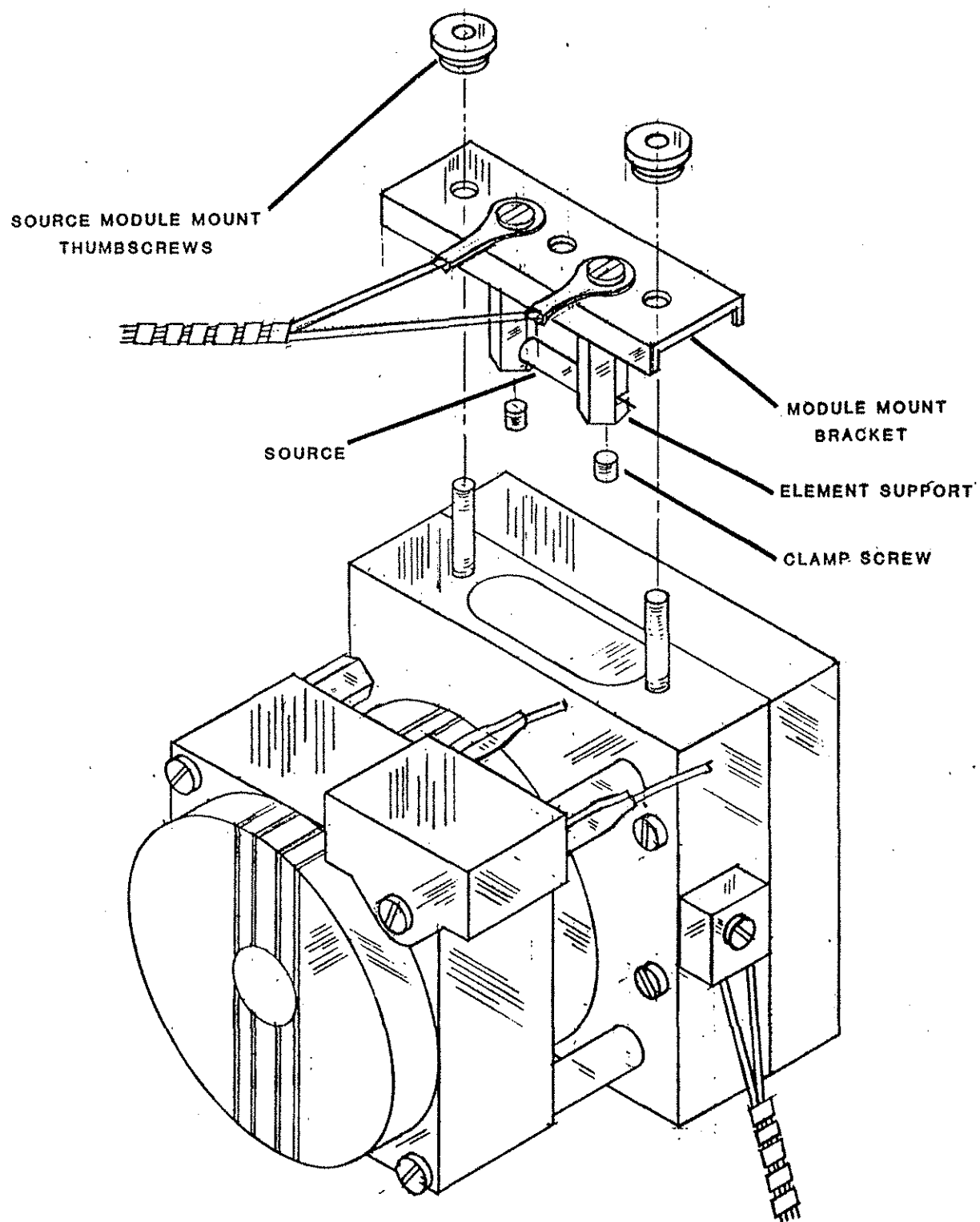


Figure 6-10 I.R. Source Replacement

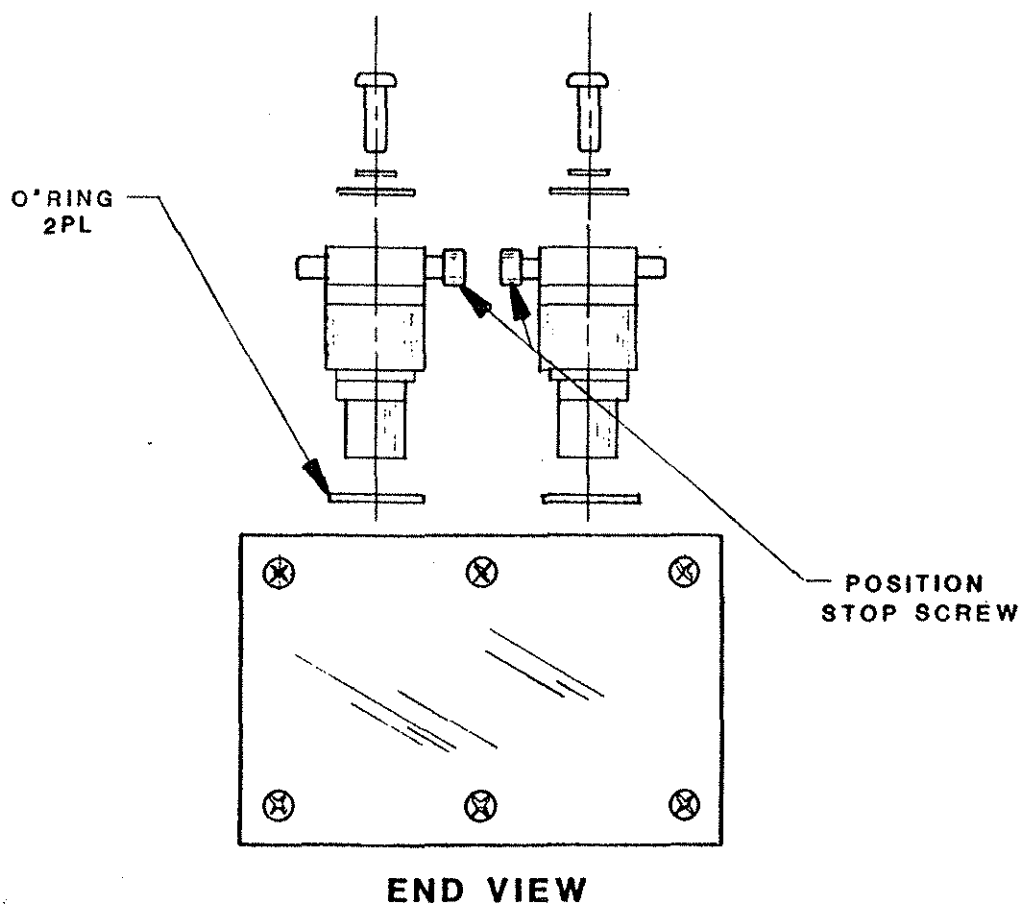
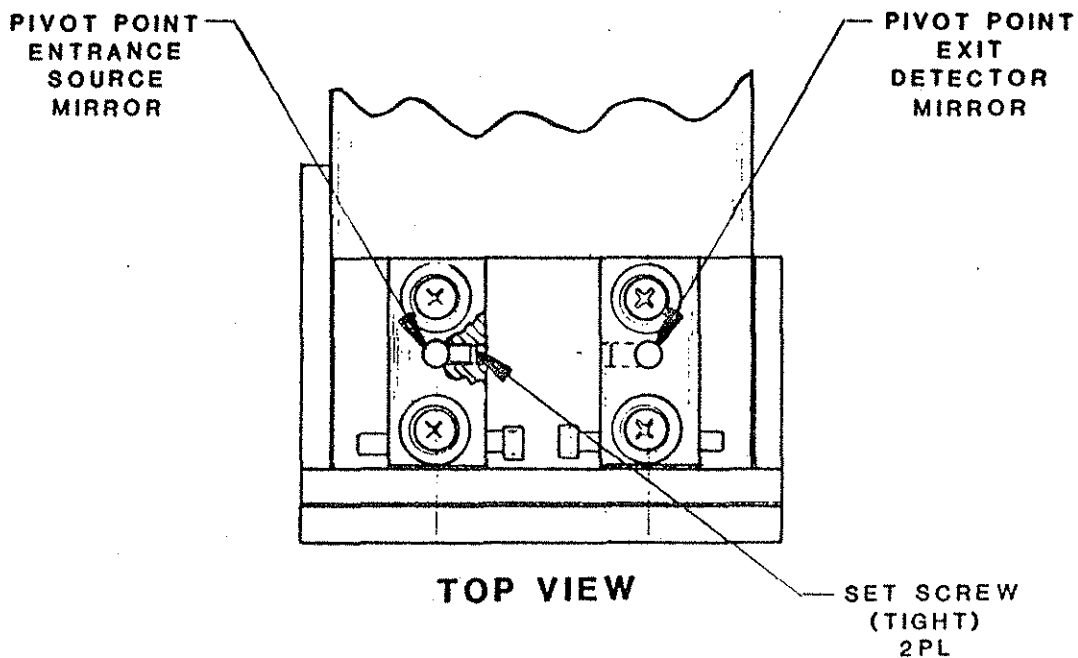


Figure 6-11 Removal of Beam Steering Mirrors

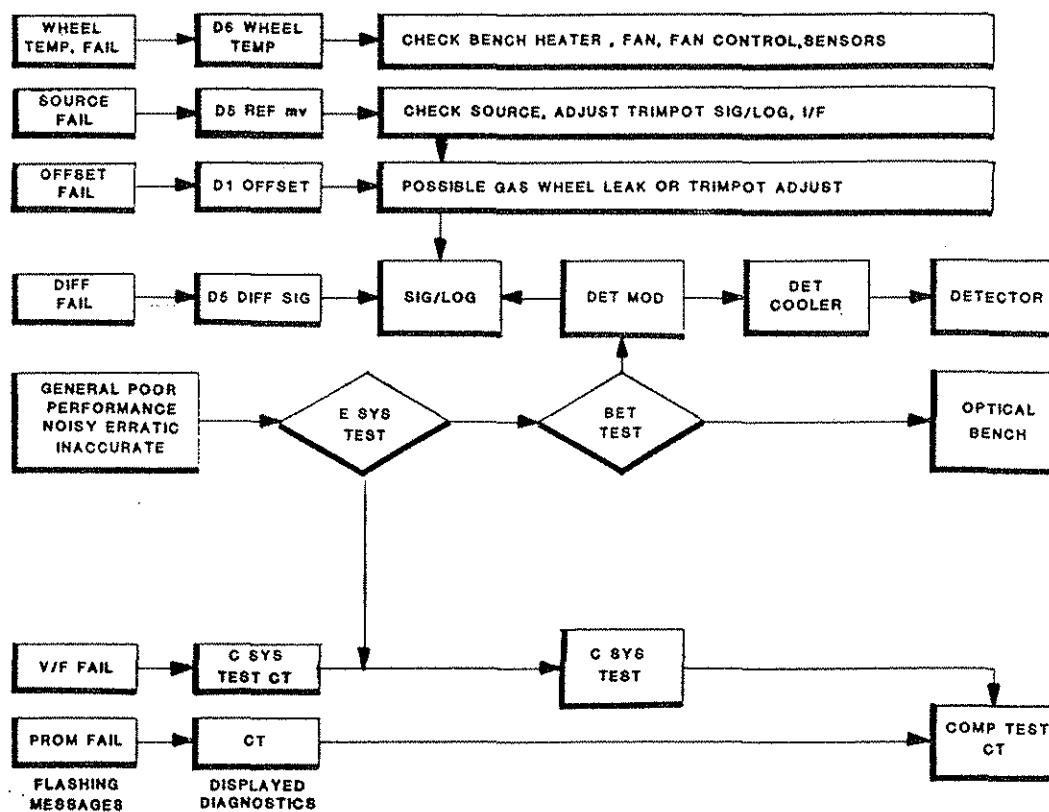


Figure 6-12 Flow Diagram of Troubleshooting

7.0 REPLACEMENT PARTS LISTS

7.1 General

This section contains a listing of stock numbers for both major components/assemblies utilized in the instrument, as well as for recommended "consumable" items for one & two years' operation.

7.2 Ordering Information

All inquiries regarding ordering spare parts should be addressed to:

Dasibi Environmental Corporation
515 West Colorado Street
Glendale, CA 91204
Phone: (818) 247-7601
 or
Fax: (818) 247-7614

7.3 Service Kit for One Year of Operation:

One (1) I.R. Source Resistor	D-0041
Fifty (50) Teflon Filter Pads	A-0000

7.4 Service Kit for Two Years of Operation:

Three (3) I.R. Source Resistors	D-0041
One (1) Zero Air Source Refill (.3 lbs)	S-0138
One (1) Photometer Pump Repair Kit	R-0089
One Hundred (100) Teflon Filter Pads	A-0000

7.5 Replacement Component/Assembly Stock Numbers*

<u>Description</u>	<u>110 Volt</u>	<u>220 Volt</u>
Mechanical Parts/Assemblies:		
Fuse	A-0438	A-0111
Power Cord	A-0224	Same as 110V
Power Switch Assembly	B-0098-M	"
Thumbwheel Assembly (Span/Diag)	S-0079-B	"
Flowmeter Assembly (0-3 LPM)	A-0271-1	"
Pump Switch Assembly	A-0173-B	"
Display Board	A-0499A	"
Display Cable Assembly	S-0080-A	"
Valve Assembly (All Valves are the Same)	S-0058-A	"
Pump Assembly	A-0218J-110VM	A-0218J-220VM
Zero Air Tube Assembly	Z-0036-A	Same as 110V
Micro-computer Cable Assembly (Long)	A-0423-A	"

Replacement Component/Assembly Stock Numbers* (Continued)

Description110 Volt220 V**Mechanical Parts/Assemblies (Continued)**

Micro-computer Cable Assembly (Short)	A-0423-B	Same as 11
Transformer Assembly	A-0311-B	A-0311-B-22
Cooler Regulator Assembly	S-0115-A	Same as 11
Pressure Sensor Assembly	S-0083-A	
Optics Bench Assembly	Z-0014-D	
Synchronous Motor Assembly	D-0129-B	
Optical Interrupter Assembly	D-0113-C	
Thermistor Block Assembly	Z-0092-A	
Thermistor Tube Assembly	A-0180-A	
Focusing Mirror Assembly (M1)	D-0118-A	
Focusing Mirror Assembly (M5)	D-0119-A	
Focusing Mirrors (M1 & M5) O-Ring	A-0416	
Front Mirror Assembly (M2/M3)	D-0117-A	
Rear Mirror Assembly (M4)	D-0116-A	
Front & Rear Mirror Assembly O-Ring	A-0571	
Window	D-0120	
Narrow Band Filter	D-0128	
I.R. Source Assembly	Z-0001-B	
Source Block O-Ring	S-0383	
Gas Filter Correlation Wheel Assembly	D-0150-A	
Wheel Shaft	D-0152	
Heater Pad Assembly	Z-0099-B	
Particulate Filter Holder (W/Filter Inside)	B-0101-A	

Pneumatic Parts/Assemblies:

1/4" Bev-A-Line Tubing (Price/Foot)	S-0118	Same as 110
1/4" Teflon Tubing (Price/Foot)	N-0034	
1/4" Tygon Tubing (Price/Foot)	S-0021	

Electronic Parts/Assemblies:

Mother Board Assembly	A-0506-B	A-0506-B-220
Recorder Output Board Assembly	A-0501-B	Same as 110
I.C. (U1)	A-0357	
Mode Switch Board Assembly	A-0510-A	
Switch	A-0331	
CPU Board Assembly	A-0505-B	
I.C. (U1)	A-0356	
I.C. (U2)	A-0525	
I.C. (U3)	A-0524	
E-Prom (U4:Specify Revision Number)	A-0523	
I.C. (U5)	A-0340	
I.C. (U6 & U7)	A-0353	

Replacement Component/Assembly Stock Numbers* (Continued)

<u>Description</u>	<u>110 Volt</u>	<u>220 Volt</u>
Electronic Parts/Assemblies (Continued)		
I.C. (U8)	A-0352	Same as 110V
I.C. (U9)	A-0354	"
I.C. (U10)	A-0528	"
I.C. (U11, U13, U14, U15, U16 & U17)	A-0355	"
CPU Watchdog Board Assembly	N-0070-A	"
I.C. (U1)	N-0060	"
I.C. (U2)	N-0071	"
I/F Board Assembly	A-0503-B	"
I.C. (A1 & A2)	A-0357	"
I.C. (A3)	D-0073	"
I.C. (U1)	A-0527	"
Power Supply Board Assembly	A-0502-B	A-0502-B-220V
Lamp	A-0185	Same as 110V
Fuse	N-0077	"
Regulator (TR1)	A-0141	"
I.C. (U1)	S-0239	"
Detector Module Assembly	D-0125-A	"
Bias Pre-Amp Board Assembly	D-0170-A	"
Detector	D-0125	"
I.C. (U1 & U2)	D-0092	"
Detector Module O-Ring	D-0156	"
I/O Board Assembly	A-0504-B	"
I.C. (U1)	A-0352	"
I.C. (U2, U9 & U16)	A-0361	"
I.C. (U3 & U15)	A-0354	"
I.C. (U4)	A-0356	"
I.C. (U5 & U6)	A-0353	"
I.C. (U8)	A-0355	"
I.C. (U10)	A-0359	"
I.C. (U12,13,17 & 23)	A-0357	"
I.C. (U14)	A-0358	"
I.C. (U20)	A-0526	"
I.C. (U22)	A-0527	"
Signal/Logic Board Assembly	A-0508-A	"
I.C. (U1, U6, U7, & U9)	A-0521	"
I.C. (U2)	D-0066	"
I.C. (U3)	D-0067	"
I.C. (U4)	D-0068	"
I.C. (U5)	D-0070	"
I.C. (U8)	D-0072	"
Valve Control Board Assembly	S-0420-B	"
I.C. (U1)	C-0114	"
I.C. (U2)	T-0277	"
Diode (D1, D2 & D3)	A-0121	"

Replacement Component/Assembly Stock Numbers* (Continued)

<u>Description</u>	<u>110 Volt</u>	<u>220 V</u>
Electronic Parts/Assemblies (Continued)		
Fan Control Assembly (w/fan)	D-0176-B	Same as 11
Fan Control Board Assembly (w/o Fan)	D-0176-S	
I.C. (U1)	D-0074	
I.C. (U2)	D-0073	
Fan	S-0168	
If Unit is Integrated Into Dasibi System 1000:		
CPU Board Assembly	A-0505-BS	Same as 11
I.C. (U1)	A-0356	
I.C. (U2)	A-0525	
I.C. (U3)	A-0524	
E-Prom (U4:Specify Revision Number)	A-0523	
I.C. (U5)	A-0340	
I.C. (U6 & U7)	A-0353	
I.C. (U8)	A-0352	
I.C. (U9)	A-0354	
I.C. (U10)	A-0520	
I.C. (U11, U13, U14, U15, U16 & U17)	A-0355	
CPU Watchdog Board Assembly	N-0070-A	
I.C. (U1)	N-0060	
I.C. (U2)	N-0071	
Components For Options:		
4-20 mA Output Board Module (U2)	S-0228	Same as 110
Isolated Analog Output Board I.C.(U1)	S-0227	
RS232 Interface Board Assembly	T-0501-A	
Cable Assembly	S-0362-A	
I.C. (U1)	T-0156	
I.C. (U2)	T-0263	
I.C. (U5)	T-0102	
I.C. (U8)	T-0259	
Crystal (Y1)	T-0104	
LIS Germany Diagnostic Board Assembly	T-0501-B	
Cable Assembly	N-0057-A	
Cable Assembly	N-0058-A	
I.C. (U1)	T-0156	
I.C. (U2)	T-0558	
I.C. (U5)	T-0102	
I.C. (U8)	T-0259	
I.C. (U9)	S-0325	

Replacement Component/Assembly Stock Numbers* (Continued)

<u>Description</u>	<u>110 Volt</u>	<u>220 Volt</u>
Components For Options (Continued):		
I.C. (U11, U12, U13 & U14)	T-0504	Same as 110V
Crystal (Y1)	T-0104	"
External Diagnostics w/Isolated Analog Output		
for Relays	T-0501-G	"
Cable Assembly	N-0057-A	"
I.C. (U2)	T-0263	"
I.C. (U5)	T-0102	"
4-20 mA Output Board Module (U6)	S-0228	"
I.C. (U8)	T-0259	"
I.C. (U11 & U13)	T-0504	"
I.C. (U12 & U14)	S-0398	"
Crystal (Y1)	T-0104	"

Please consult factory for additional stock numbers.

APPENDIX A

INSTRUMENT CALIBRATION

A.1 General

The analyzer, when operated according to this manual, will provide excellent data, but data quality assurance will depend upon a sound calibration and zero/span check program. This calibration should be performed at least once a month, or until the user establishes his own quality assurance calibration frequency.

A.2 Quick Calibration

This calibration is a quick verification process of the unit's accuracy. These steps should only be used to perform swift, on-site calibrations and should not be utilized in lieu of the following highly "formal" multipoint calibration procedures.

1. Run the instrument for 5 to 10 minutes on the ZERO mode. Set the SPAN number to 100, AUTO to 0 and DIAG to 0.
2. Connect the scope to TP1 on the Signal/Logic Board and ground on the I/F Board.
3. Adjust R25 for 4 volts P-P (minimum 3 volts P-P). If you do not obtain the correct voltage, refer to section 6.3.3.6 on page 6-11, section 6.5.10 on page 6-21, and diagram 6-11 on page 6-36.
4. Make sure the AGC switch is in the ON position (refer to diagram 6-6 on page 6-31).
5. Connect the voltmeter to TP6 on the Signal/Logic Board and adjust R37 for 8 volts.
6. Connect the voltmeter to TPR on the I/F Board and adjust R3 pot on the I/F Board for 8 volts, or adjust TPR for R = 8000 mV on the display using DIAG 5.
7. Connect the voltmeter to TPM on the I/F Board and adjust R11 on the Signal/Logic Board between 50-90 mV, or adjust R11 for D = 65 mV on the display using DIAG 5.
8. Connect the scope to TP5, the signal should be ground clamped 0 to 8 volts. Turn the AGC switch OFF and then ON. Make sure the AGC switch works.
9. Go to the SAMPLE or SPAN mode and put in span gas at 40 PPM.
10. Adjust M pot on the I/F Board until the CO reading on the display matches the span gas.
11. Go back to the ZERO mode and re-adjust R11 on the Signal/Logic Board for 65 mV on TPM on the I/F Board, or adjust R11 for D = 65 mV on the display using DIAG 5.

A.3 "Formal" Calibration

Performing a "formal" calibration on the instrument involves a complete multipoint definition of the analyzer's response to accurate, reliable standards over the entire analyzer range. Such calibration must be performed dynamically by allowing the analyzer to measure, in its normal mode of operation, air containing accurately known concentrations of carbon monoxide.

Either of two methods may be used for dynamic multipoint calibration of the analyzer. One method (illustrated in Figure A.1) uses a single certified standard cylinder of CO, diluted as necessary with zero air to obtain the various calibration concentrations needed. An alternate method uses individual certified standard cylinders of CO for each concentration needed.

The multipoint calibration, contrary to zero/span checks, must be performed through the analyzer's sample port, and in the analyzer's sample mode of operation. This requires that the AUTO thumbwheel switch be set on position 9.

A.3.1 Apparatus Needed For Calibration

1. A dilution system similar to the one depicted in Figure A.1 (such systems as Dasibi Models 5009-CP or 1005-C2 or 5008) provide accurate and repeatable calibration atmospheres.
2. A compressed gas cylinder containing zero (clean) air with less than 0.1 PPM of carbon monoxide that also contains approximately 350 PPM of CO₂. The latter is preferred so that the zero air is similar in composition to atmospheric air. GFC analyzers do sometimes have a very small but detectable response to CO₂. The source of zero air can either be a cylinder, or a catalytic converter (such as that found in Dasibi Model 5011-B Zero Air Unit). Air passed through a heated (250°C) catalytic converter such as palladium on alumina is satisfactory, however, the air should be supplied under positive pressure by means of a pump. Pollutants in the air other than CO do not affect the accuracy, as the GFC analyzer does not respond to them.
3. A compressed gas cylinder containing a high concentration (such as 2500 PPM) of CO, traceable to NBS-SRM.
4. Pressure regulators with non-reactive diaphragms and internal parts and a suitable delivery pressure.
5. Flow meters (with flow controllers) able to measure and monitor flow rates with an accuracy of $\pm 2\%$ of the measured value.
6. Mixing chamber, constructed of glass, teflon or other non-reactive material and designed to provide thorough mixing of CO and diluent air for the dilution method.

6. Mixing chamber, constructed of glass, teflon or other non-reactive material and designed to provide thorough mixing of CO and diluent air for the dilution method.
7. Output manifold, constructed of glass, teflon or other non-reactive material and with sufficient diameter to insure an insignificant pressure drop at the analyzer connection. The system must have a vent designed to insure atmospheric pressure at the manifold and to prevent ambient air from entering the manifold.

A.3.2 Model 3008 Checkout

Before starting a multipoint calibration, the analyzer should be completely warmed up and checked out. It is recommended to let the unit run overnight to check the baseline stability. Before commencing with the calibration, run through all the diagnostic settings on the DIAG thumbwheel switch, check if they are within limits, and record their values. The analyzer should be connected to some form of data recording device, and the device should be calibrated using DIAG switch setting 8 and the appropriate settings on the AUTO switch.

A.3.3 Step-By-Step Dynamic Multipoint Calibration Procedure (By Dilution)

1. Assemble a dynamic calibration system such as shown in Figure A-1. References to analyzer responses in the procedure given below refer to recorder to data device responses.
2. Disconnect the analyzer sample port from the sampling manifold and connect it to the calibration system's manifold. The particulate filter cartridge must remain connected to the analyzer sample port. Set the analyzer flow at 1 LPM.
3. Generate at least 2 liters per minute (LPM) of zero air. Verify that there is flow coming out of the manifold vent; if not, increase the zero air flow until you can measure at least 0.5 liters/minute at the vent.
4. Allow dilution air alone to flow from the manifold into the analyzer. If mass flow controllers are used it may be necessary to disconnect the CO line and cap it since not all mass flow controllers have a positive shut off. A valve in this line, will be convenient to achieve the same effect.
5. Allow the analyzer to sample zero air until a stable response is obtained (5 - 10 minutes). After a stable response is obtained, adjust the front panel "REC ZERO" potentiometer. Offsetting the analyzer zero adjustments

to +5% of scale is recommended to facilitate observing negative zero drift (the zero offset can be obtained with the recorder zero or the analyzer zero). Record the stable zero air response as Z.

6. Generate 80% of full scale CO concentration, or 40.0 PPM. Allow the instrument to sample for 5 - 10 minutes and obtain a stable reading. Again, make sure that the total flow from the calibration system is equal or greater than the analyzer's flow rate plus manifold vent flow. The exact CO concentration is calculated from:

$$[CO]_{out} = ([CO]_{std} \times F_{co}) / (F_{co} + F_d)$$

where,

- [CO]_{out} = diluted CO concentration at the output manifold, PPM
[CO]_{std} = concentration of the undiluted CO standard, PPM
F_{co} = flow rate of the CO standard corrected to 25°C and 760 mm Hg, l/min.
F_d = flow rate of the dilution air corrected to 25°C and 760 mm Hg, l/min.

7. Allow the analyzer to sample this CO concentration until a stable response is obtained.
8. Adjust the SPAN NO. thumbwheel switch to obtain a recorder response as indicated below:

$$\text{Recorder response (\% Scale)} = (([CO]_{out} \times 100) / URL) + Z_{co}$$

where,

URL = Nominal upper range limit of analyzer's operating range.

Z_{co} = Analyzer response to zero air, percent scale.

9. Repeat Steps 4-8 for CO concentration of 40, 20, 10 and 5 PPM. Record the CO concentration and analyzer's response for each concentration. Plot the analyzer's response versus the respective calculated CO concentrations and plot a linear regression curve.
10. Record the SPAN NO. in the instrument log. Re-connect the analyzer to its sampling manifold. It is recommended that the calibration of a newly installed 3008 be repeated after 24 hours of operation in order to verify that the unit is working well.

A.3.4 Frequency of Calibrations

It is recommended that a multipoint calibration be performed:

1. Every six months.
2. At any time following a major servicing of the unit.
3. Any time excessive variation occurs in the zero and span values of the analyzer.

In addition, calibration documentation should be maintained with the analyzer, and it should include calibration data (or curve), analyzer identification, calibration date, analyzer location, calibration standards used and their traceability, and calibration equipment used in the calibration.

A.4 Zero/Span Check

Zero/Span check consists of a zero baseline check and an upscale check of the analyzer response, usually between 70% and 90% of the measurement range.

A.4.1 Use of Internal Catalytic CO Scrubber

It is extremely convenient to utilize the internal CO scrubber for a zero check. However, it is recommended to always check the scrubber efficiency every time a multipoint calibration is performed. The following procedure is suggested for this purpose:

1. Establish a Zero reading on the analyzer using the diluent gas employed for the multipoint calibration. This is conveniently done by having the AUTO thumbwheel switch on position 9, so that the ZERO solenoid is not activated in the process of setting the display to zero.
2. Set the AUTO thumbwheel switch back to 0, and press the front panel ZERO pushbutton so that zero gas from the scrubber is sampled.
3. Allow the scrubbed air from the catalytic CO scrubber to be sampled long enough to assure a stable reading (at least five minutes). Do not, during this time, press the SAMPLE button. This will cause the panel display to go to zero.
4. The value for CO that the internal scrubber registers on the display or recording device should not exceed + 0.2 PPM. It should be recorded along with other calibration data, and should remain constant from one calibration interval to the next. If it does not, the scrubber needs regeneration (refer to Section 6.2.3.2).

The Model 3008 is configured to conveniently do the following checks by either pressing the ZERO or SPAN pushbutton. All sampled gases must be done at atmospheric conditions. The three solenoid valves located on the back panel can be operated manually by pressing the ZERO and SPAN buttons, remotely from external commands, or automatically by use of the AUTOPROGRAM. In all three cases, the red LED's on the pushbuttons indicate the mode that is active.

1. Zero Check: This is done via the internal CO scrubber. Record the analyzer's response in percent of scale as A_0 . Compute the zero drift for the following:

$$\text{Zero Drift \%} = A_0 - Z_{CO}$$

where Z_{CO} is the recorder response obtained at the last calibration for zero air, 5% scale.

2. Span Check: This check is usually made with a cylinder of CO at approximately 80% of the URL, which translates to about 40 PPM for the EPA range of 50 PPM for CO. A higher concentration suitably diluted will also serve, but this adds another source of potential error to the measurement and is therefore not highly recommended. In either case, the source of CO should be checked against an SRM or CRM. Record the analyzer's response in % scale as A_{80} . Calculate the span error as follows:

$$\text{Span error, \%} = ((A_{80} - Z) \text{URL}/100) - [\text{CO}] \times 100/[\text{CO}]$$

where,

Z = Recorder response obtained at last zero calibration in %.
 $[\text{CO}]$ = Span concentration.

The level of acceptance is as follows:

<u>ZERO DRIFT</u>		<u>SPAN DRIFT</u>
+3.0 ppm	Calibrate Analyzer	+6%
+1.0 ppm	Adjust Analyzer	+2%
0 ppm	No Adjustment Required	0%

For more information about zero/span checks refer to number 3 in Section C, References, of this manual.

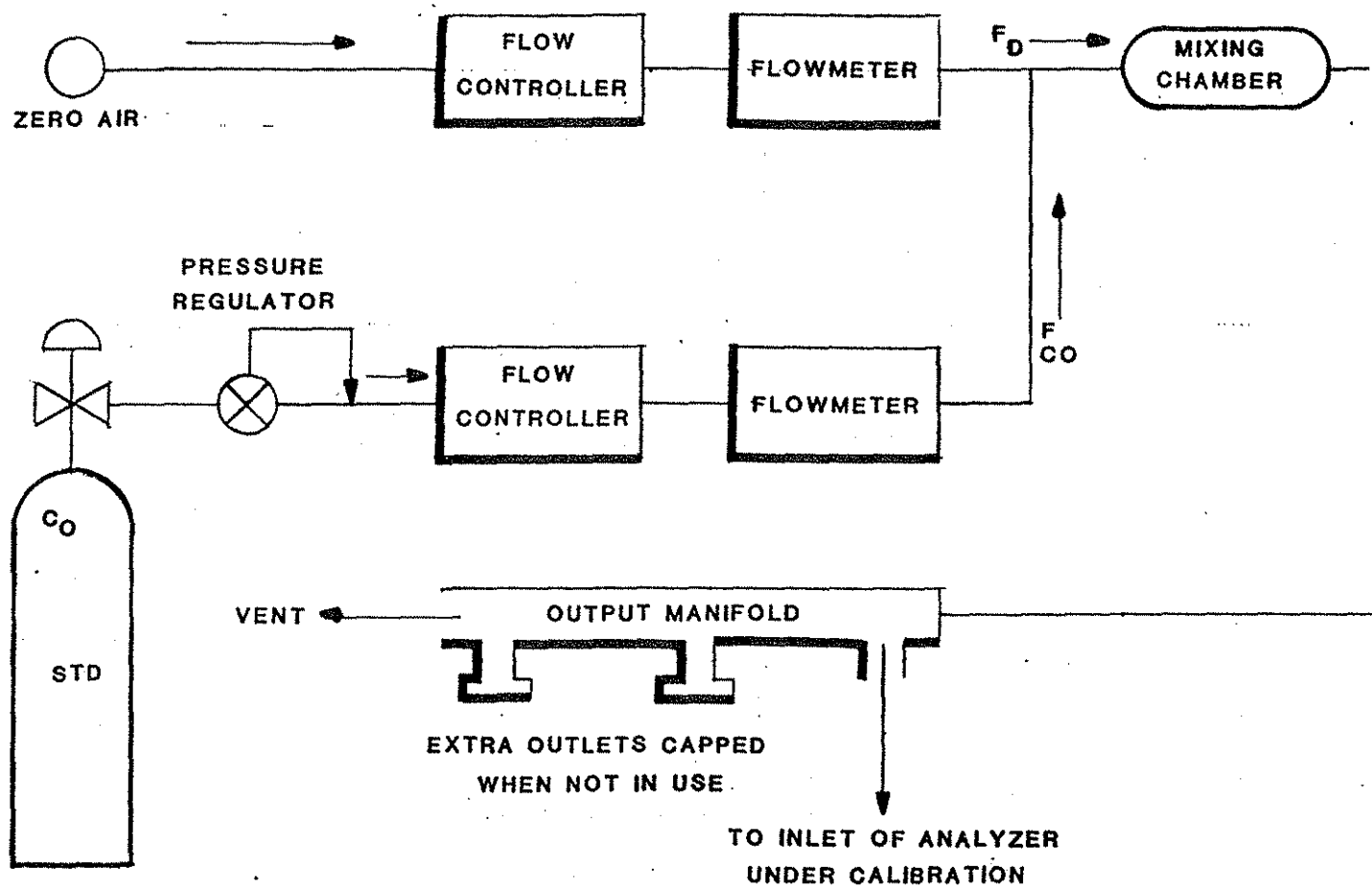


Figure A-1 Multipoint Calibration Set-up

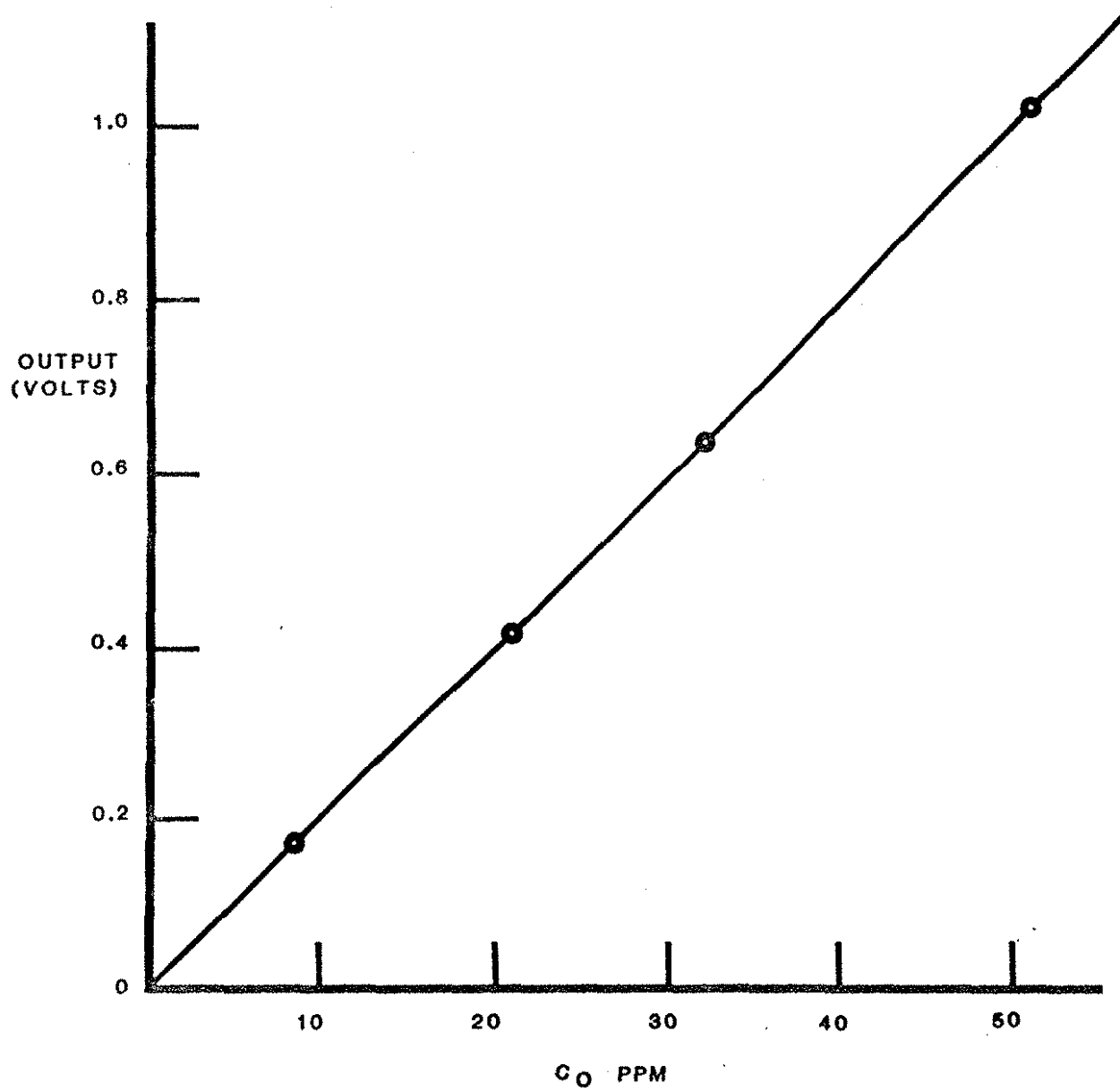


Figure A-2 Sample Calibration Curve

APPENDIX B

MANUAL UPDATE INFORMATION

B.1 New Valve Control Board (Figures B-1 and B-2)

There is a new version of Valve Control Board that is in the process of being implemented into production and may or may not be contained in this unit. If the number on the Valve Control Board contained in this unit is # 11019, then this information will not pertain to your unit. This section describes the new board's operational capabilities.

Internal solenoid valves allow zero or span gases to be directed into the instrument for calibration purposes. These valves are controlled by the Valve Control Board, which is mounted to the rear panel and can be commanded either by signals from the internal computer or from zero or span remote control inputs on the rear panel.

The internal computer activates the solenoid valves during the "Start Up" program and the "Auto Cal" program or when the front panel ZERO or SPAN buttons are pressed. Any zero calibration activated via the internal computer causes the zero offset to be re-calculated. Calibrations activated externally, via the rear panel, do not change the zero offset and are not indicated on the front panel of the instrument.

The rear panel zero and span terminals provide a dual function. When either of these terminals are connected to ground, the corresponding calibration function is activated. In addition, when the internal computer activates a calibration, these terminals, which are normally pulled to +5V, are held low by an open collector transistor. A datalogger monitoring these terminals can, therefore, distinguish sampled data from the calibration data, whether the calibration is activated internally or externally.

B.2 Optional Advanced Diagnostic Board (Figures B-3, B-4, B-5 & B-6)

Dasibi's Advanced Diagnostic Board is a plug-in printed circuit board which adds the capability for several remote outputs and controls to Dasibi's line of microprocessor-based gas analyzers. It may be purchased in several different configurations, depending upon the requirements of the end user. Capabilities for diagnostic status outputs and controls, serial RS 232 interface, internal data storage and isolated analog output(s) are all available for connection to remote equipment, either directly or via modem.

The Advanced Diagnostic Board is easily installed in the field, requiring only a pair of long-nosed pliers and a phillips screwdriver. The board plugs into the spare STD bus slot in 3008 analyzers. It can support one 9 pin and one 25 pin D subminiature connector on the rear panel: one male connector for RS 232 communications and one connector female for diagnostic connections, respectively. Alternatively, connections to a 50 pin D subminiature connector can be provided to support the requirements of the German LIS field bus system. Ribbon cables extend from the connectors on the Advanced Diagnostic Board to the rear panel, which is able to accept either one 25 pin or one 9 pin connector.

If both the serial and diagnostic connectors are required, an adapter plate will allow both connectors to be mounted on the rear.

B.2.1 Isolated Status Input/Control Output Signals

The Advanced Diagnostic Board may be configured to utilize a diagnostic connector which provides a convenient means of interfacing remote equipment to the analyzer via a single connector. This connector supports status outputs, remote control inputs and two analog outputs. All diagnostic signals are capable of being isolated, eliminating possible ground loop problems.

The status outputs can be used to flag error conditions to an attached datalogger or to otherwise indicate a system malfunction. Status outputs are isolated transistor contact closures. A pull-up resistor is provided on each output so that a "good" condition is high (+5V). Jumpers (J1 & J2) allow selection of the source of 5 Volts; either from the analyzer or, if complete isolation is required, from an external power supply. The individual status signals supported by the 3008 CO analyzer are described below:

Power off pin 2 ---

This output is pulled to the analyzer ground when the instrument is turned off. The power off signal is not isolated.

Manual Mode pin 3 continuous

Indicates that the instrument is in a manual operating mode and not collecting data.

Zero mode pin 4 continuous

Indicates the instrument is performing a manual, automatic or remote zero calibration.

Span mode pin 5 continuous

Indicates the instrument is performing a manual, automatic or remote span calibration.

Diagnostic error pin 6 continuous/power up

This output is active when any diagnostic error condition exists.

Computer failure pin 7 power up

Indicates an EPROM, RAM, V/F or stepper diagnostic failure.

Not Presently Used pin 8

Flow failure pin 9 continuous

Flags a probable pump failure as indicated by the pressure transducer.

The remote control inputs allow remote instrument control by means of isolated, contact closures. Since the control inputs are isolated, they can be referenced either to internal ground and 5 Volts, or to the ground an +5 of the controlling instrument. Control inputs can be activated by CMOS or TTL output levels. The active condition for all control signals is low (0 Volt).

A dipswitch is provided on the board which allows the controls to be activated manually when the diagnostic connector is unplugged (or the control pins are not pulled low). When a switch is turned on, it overrides the control input. The functions controlled via the remote inputs are described next:

Instrument calibration (pins 10 thru 13)

An instrument zero or span can be controlled remotely by activating (pulling to ground) the zero or span control inputs. When both calibration input pins are left open (or pulled high) the instrument will be in sample mode (unless a manual calibration is being performed). The calibration mode will be active while the control input is pulled low, but can be overridden by pressing the corresponding front panel button. The functions of the calibration control pins are listed next:

- pin 10** Activate a span calibration. The span control pin must be held low for the span to remain active.
- pin 11** Activate an audit zero. No adjustment will be made to the internal zero. This zero is only active while the control pin is held low.
- pin 12** Activate a zero calibration. An internal zero adjustment will be made upon completion. Once initiated, this zero will continue for the minimum time required for a valid zero adjustment, however the duration can be extended by holding the control pin low past this time period.
- pin 13** Initiate a power-up diagnostic test. Some diagnostic tests are only performed during the initial power-up sequence. Pulling this pin low, then back high causes the power up sequence to be re-activated, remotely, without cycling power to the instrument.

Diagnostic analog output selection (pins 14 thru 17)

Control pins 14 through 17 select a diagnostic signal level to be presented on the diagnostic analog output (pins 23 & 24). The table presented next indicates which signal is selected for each combination of the control bits. A one represents a pin pulled to ground, while a zero indicates a high (+5V) signal or open pin.

<u>17-14</u>	<u>function</u>
1 1 1 1	Full scale output
1 1 1 0	Zero offset
1 1 0 1	Gas Temperature
1 1 0 0	Gas Pressure
1 0 1 1	Difference Signal
1 0 1 0	Reference Signal
1 0 0 1	Wheel Temperature
1 0 0 0	Chamber Temperature
0 1 1 1	Zero Output
0 1 1 0	Zero Output
0 1 0 1	Span Thumbwheel Setting
0 1 0 0	Zero Output
0 0 1 1	Zero Output
0 0 1 0	Full Scale (both analog outputs)
0 0 0 1	Half Scale (both analog outputs)
0 0 0 0	Zero (both analog outputs)

Remote +5V reference (pin 19)

This pin may be connected to the 5V supply of a controlling instrument in order to provide full isolation. Jumper J1 should be installed for full isolation (with pin 18 connected to an external 5V source). If isolation is not necessary, J2 should be installed instead and pin 18 left unconnected.

Analog outputs (pins 20 thru 25)

Two analog outputs are provided on the diagnostic connector. The standard outputs can be selected, via jumpers, for 1V, 5V or 10V. Isolated voltage or current outputs are provided as an option. The functions of the two outputs are described next:

Primary analog output (pins 20 thru 22)

The first analog output always indicates the primary gas concentration.

Diagnostic analog output (pins 23 thru 25)

The second analog output can be remotely controlled via pins 14 through 17, to present one of up to sixteen different diagnostic signals (see description previously). Most of these signals can

also be viewed on the front panel by using the diagnostic thumbwheel switch. Headers P3 or P4 should be used for the diagnostic connections, depending upon whether a 25 pin (P3) or 50 pin (P4) diagnostic connector is needed.

Diagnostic connector pinout

Standard Connector (25 pin)	LIS field bus (50 pin)	signal direction	signal description
1	1	--	Ground
2	18	out	Power off
3	19	out	Manual mode
4	20	out	Zero mode
5	21	out	Span mode
6	36	out	Diagnostic error
7	37	out	Computer failure
9	35	out	Flow failure
10	6	in	Span cal
11	5	in	Zero cal
12		in	Zero adjust
13		in	Perform power-up test
14		in	Diagnostic output select 0
15		in	Diagnostic output select 1
16		in	Diagnostic output select 2
17		in	Diagnostic output select 3
18		in	no connection
19		in	Remote +5V reference
20	15	out	Primary analog output (+)
21	14	out	Primary analog output (-)
22	12	--	Ground
23		out	Diagnostic analog output (+)
24		out	Diagnostic analog output (-)
25		--	Ground

Switch-connector SW2 allows the operator to manually activate the diagnostic functions of the system; functions which, during normal operations, are controlled by control inputs. Switch numbers 1-4 on the switch-connector activate instrument calibration functions. These switches, and the corresponding remote control signals, can override the front panel button, but not vice versa. Only one of the four functions can be activated at a time (switch number one is located on the right-hand side of the connector when looking at the front face of the board; "off" is when the switch is in the down position):

Switch #1 While this switch is on (up position), the instrument performs span calibration.

Switch #2 While this switch is on, the instrument performs zero audit. No adjustment is made to the internal zero.

Switch #3 While this switch is on, the instrument initiates a zero calibration cycle in which an adjustment will be made to the internal zero.

Switch #4 While this switch is on, the instrument initiates a power-up system wide diagnostic test.

Switch numbers 5-8 set the second analog output to reflect the instrument internal parameters listed next, depending upon the combination of the four switches. These switch settings can also be set both the analog outputs to a fixed value, in the event that the operator needs to adjust the analog output circuitries. The table provided next, applies only if there are no active control input signals on pin numbers 14-17 of the 25-pin connector located on the rear panel of the instrument.

Switch SW2				Diagnostic Function
#5	#6	#7	#8	
off	off	off	off	Zero Output**
on	off	off	off	Half Scale Output**
off	on	off	off	Full Scale Output**
on	on	off	off	NO ₂ Concentration*
off	off	on	off	NO _x Concentration*
on	off	on	off	Span Number*
off	on	on	off	Cooler Temperature*
on	on	on	off	Converter Temperature*
off	off	off	on	Chassis Temperature*
on	off	off	on	High Voltage(in V)*
off	on	off	on	Pressure (mmHg)*
on	on	off	on	PMT Signal, NO _x (mV)*
off	off	on	on	PMT Signal, NO ₂ (mV)*
on	off	on	on	NO _x Zero Offset(mV)*
off	on	on	on	NO ₂ Zero Offset(mV)*
on	on	on	on	Full Scale Output*

* Applies only to second (diagnostic) analog output; the first (primary) analog will indicate the primary gas concentration.

** Applies to both first and second analog outputs.

NOTE

If no control inputs are connected to the Advanced Diagnostic Board, switch numbers 5-8 on SW2 must be set to the correct combination during normal operation in order to have the desired output for both the first and second analog output.

Resistor trimpots R10, R17, R26 and R33 on the Advanced Diagnostic Board are used for fine tuning the analog outputs to correct for Op Amp zero offset and gain inaccuracies per the following chart (followed by the procedure to accomplish this:

R10 Analog zero offset adjustment for the first analog output.
R17 Analog gain adjustment for the first analog output.
R26 Analog zero offset adjustment for the second analog output.
R33 Analog gain adjustment for the second analog output.

- 1) Set the switch numbers 5-8 to the off (down) position.
- 2) Use a four-digit volt meter to measure the first analog output, and adjust **R10** until the meter reads zero (or 4 mA is the unit contains 4-20mA output).
- 3) Also measure the second analog output and adjust **R26** until the meter reads zero (or 4 mA is the unit contains 4-20mA output).
- 4) Flip switch number 6 on **SW2** to the on (up) position.
- 5) Measure the first analog output and adjust **R17** until the meter reads full scale.
- 6) Measure the second analog output and adjust **R33** until the meter reads full scale.

B.2.2 RS232 Interface Communications

The serial 9-pin male connector used for the RS232 interface connection may be attached to any standard serial device. The port is configured to accept widely available cables and peripherals compatible with the standard IBM PC computer. A 9-to-25 pin adapter may be procured from Dasibi for situations in which the IBM 9 pin connection is not available. Several useful cable wiring diagrams are shown in figures provided at the end of this section. The serial ribbon cable should be connected to ribbon header P2 on the Advanced Diagnostic Board.

Switch-connector SW1 on the board determines the communication baud rate for the serial port per the following chart (switch #1 is located on the right-hand side of the connector when looking at the board's front; "off" is when the switch is in the down position):

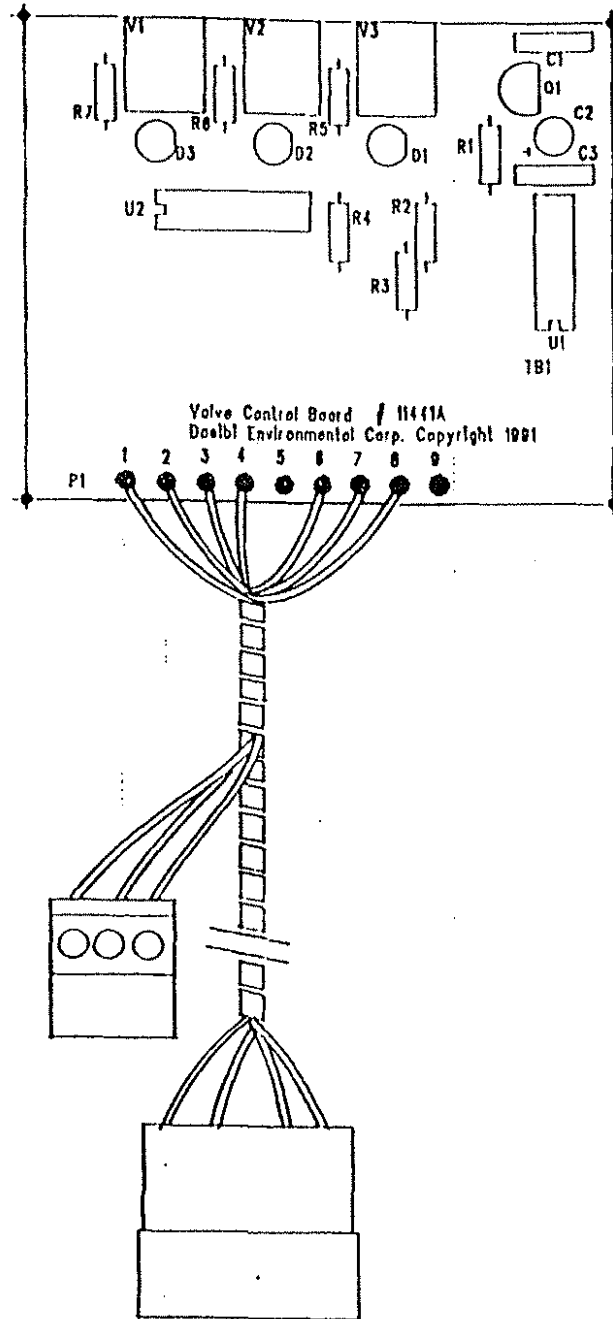


Figure B-1 Valve Control Board Diagram

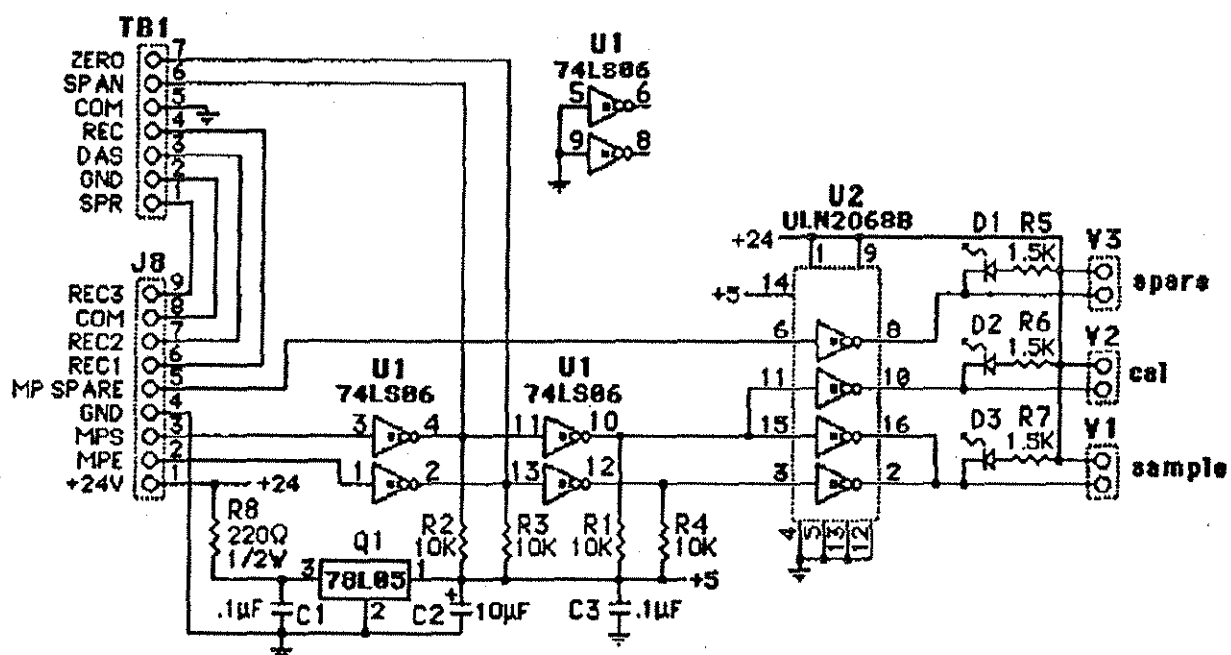


Figure B-2 Valve Control Board Schematics

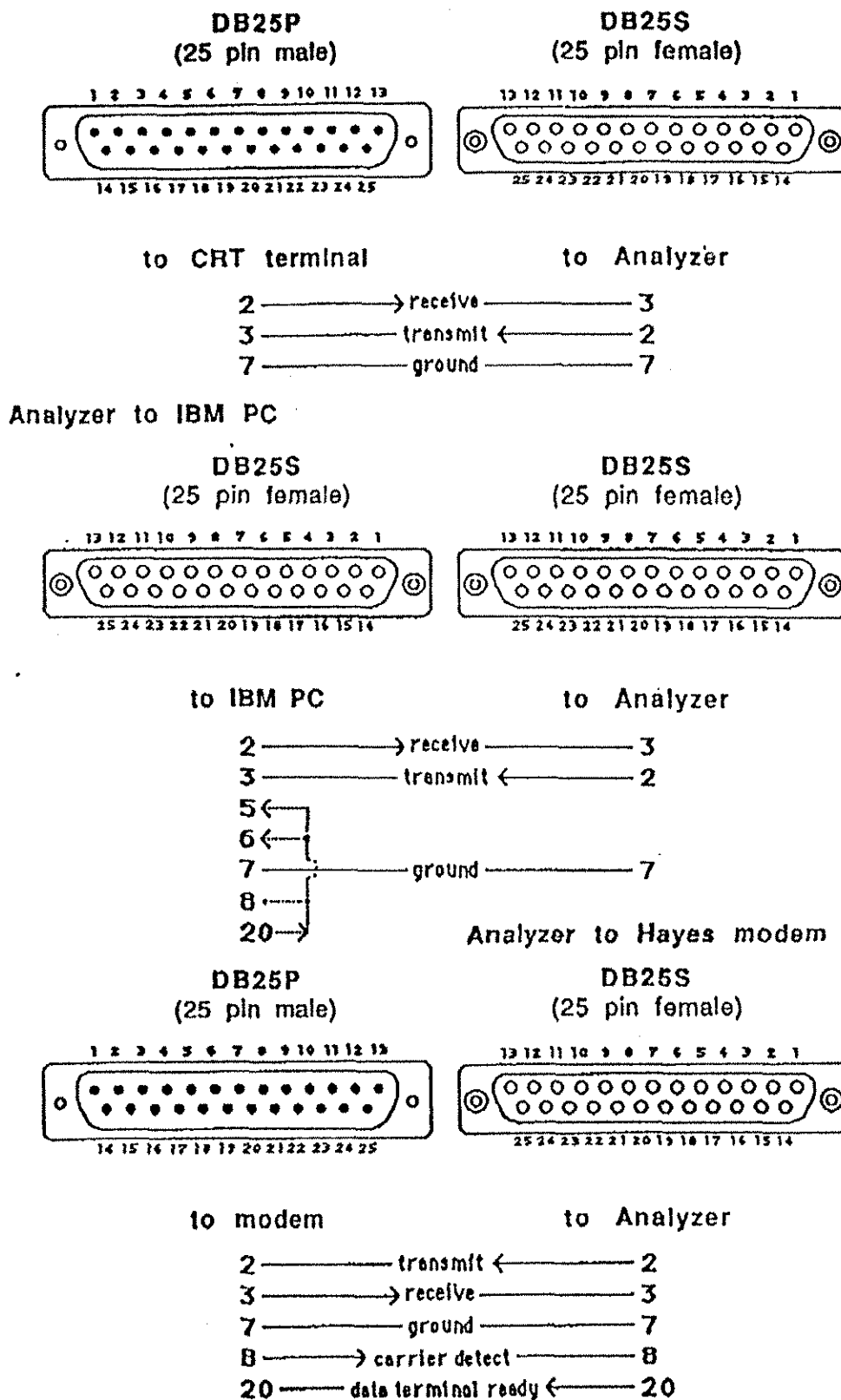


Figure B-3 Diagnostic Board Connections

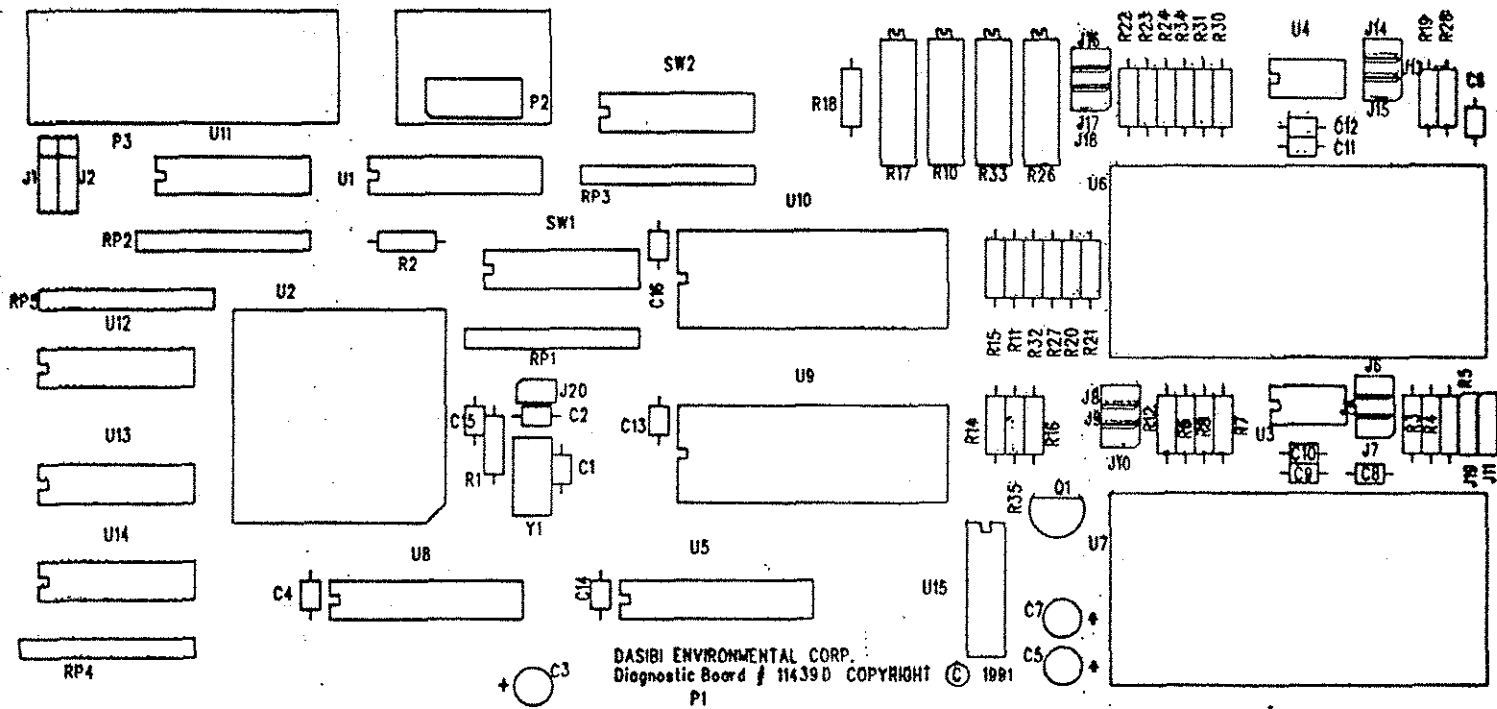


Figure B-4 Diagnostic Board Diagram

BD-4

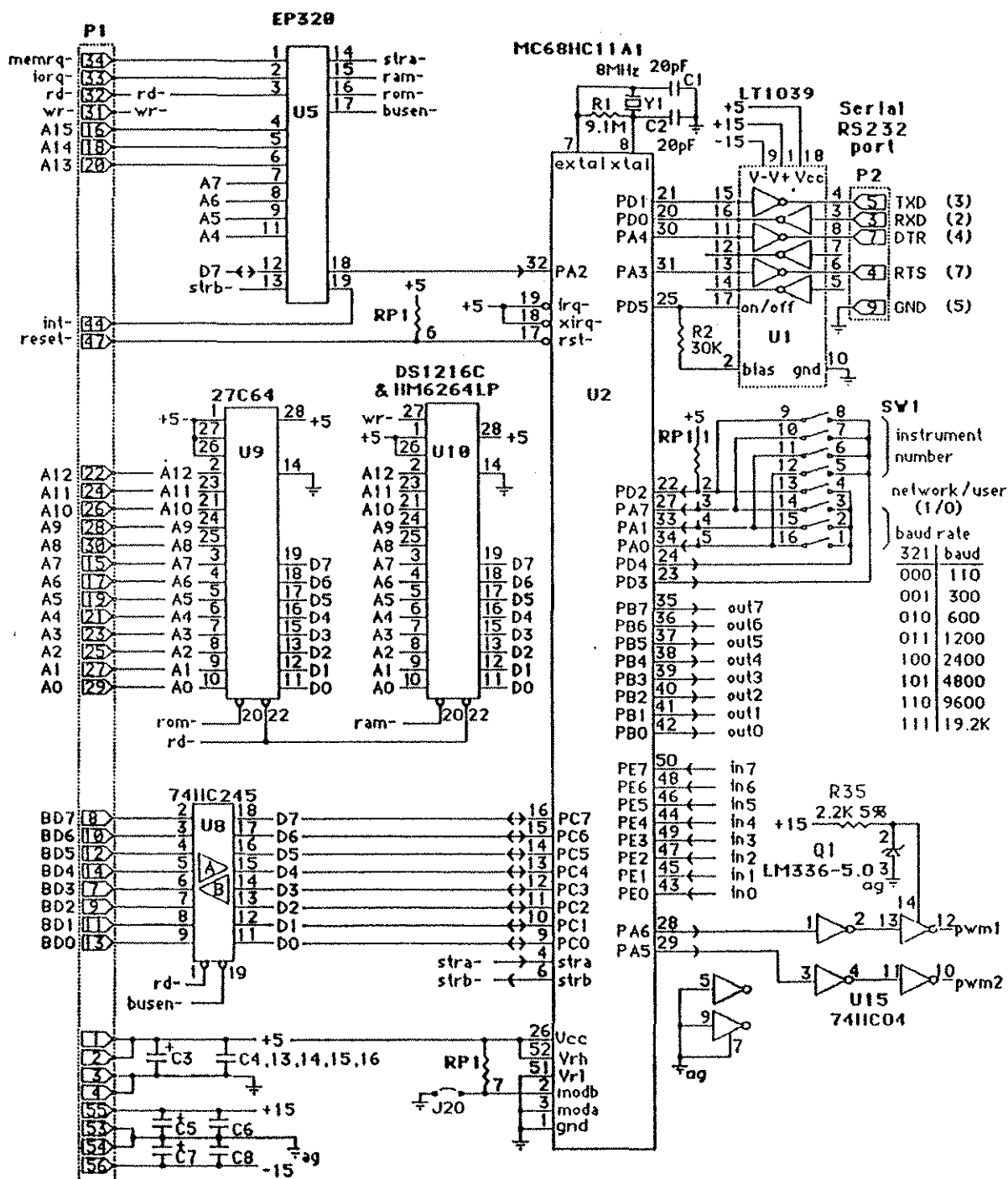


Figure B-5 Diagnostic Board Schematics (A)

BD-5

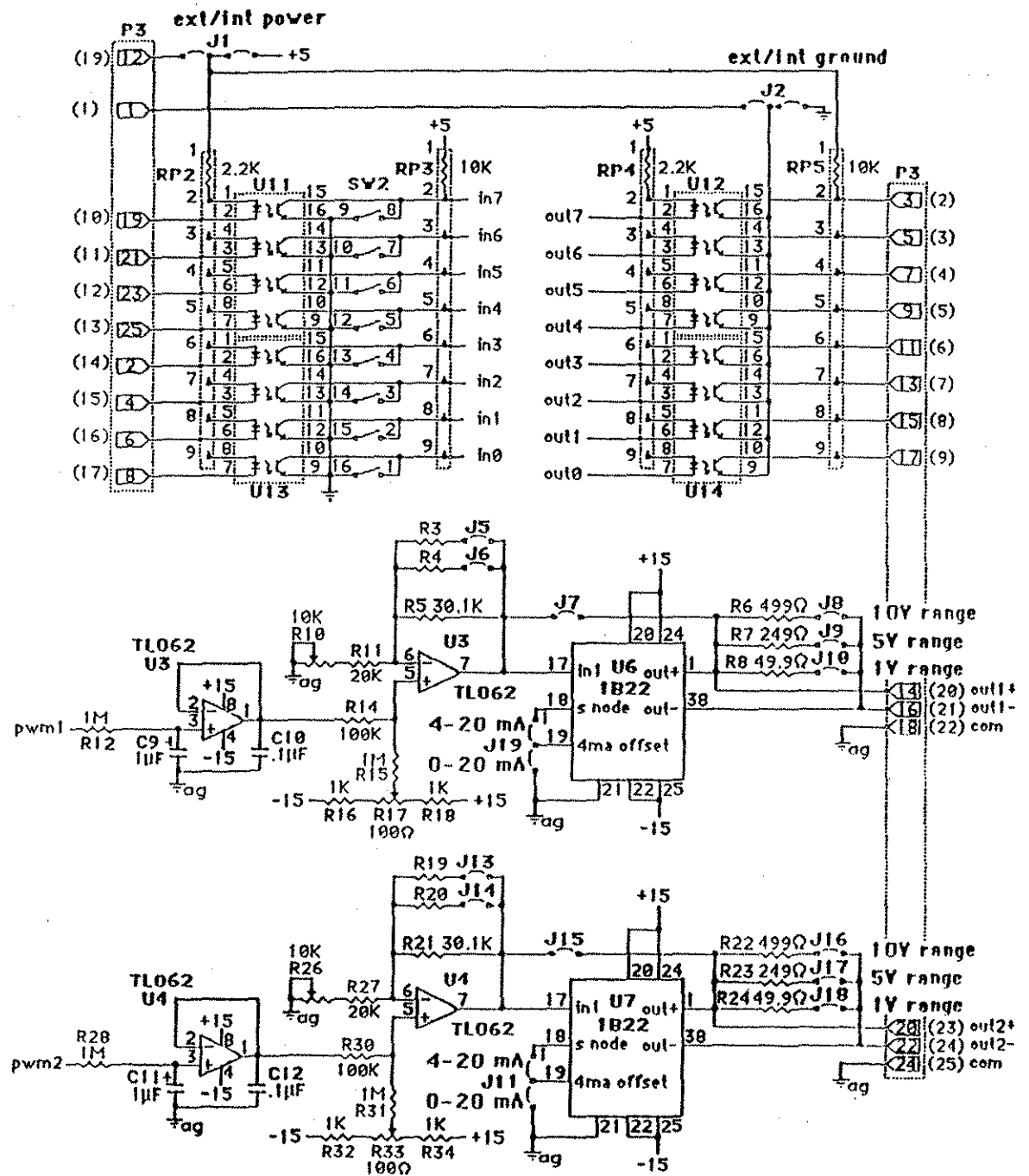


Figure B-6 Diagnostic Board Schematics (B)

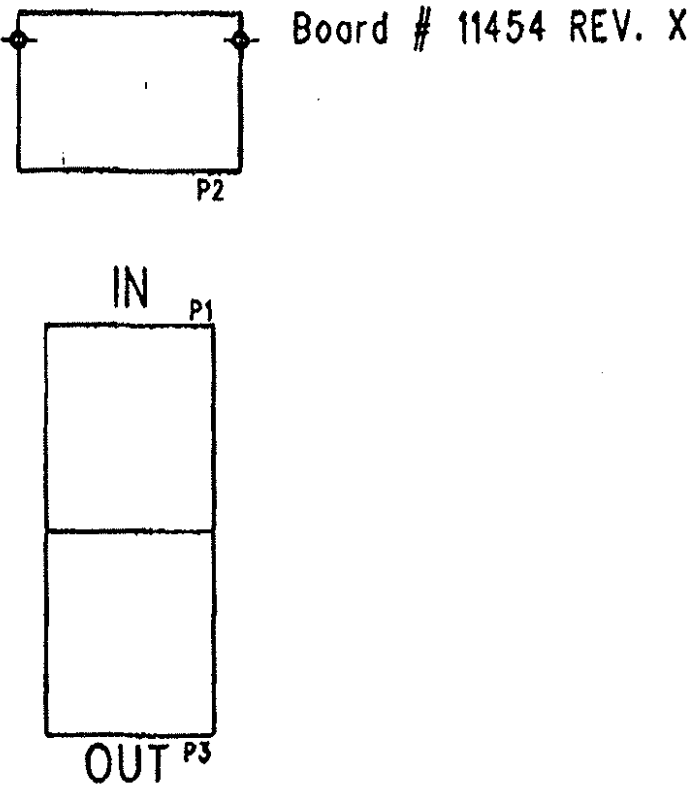


Figure B-7 Network Interface Board Diagram

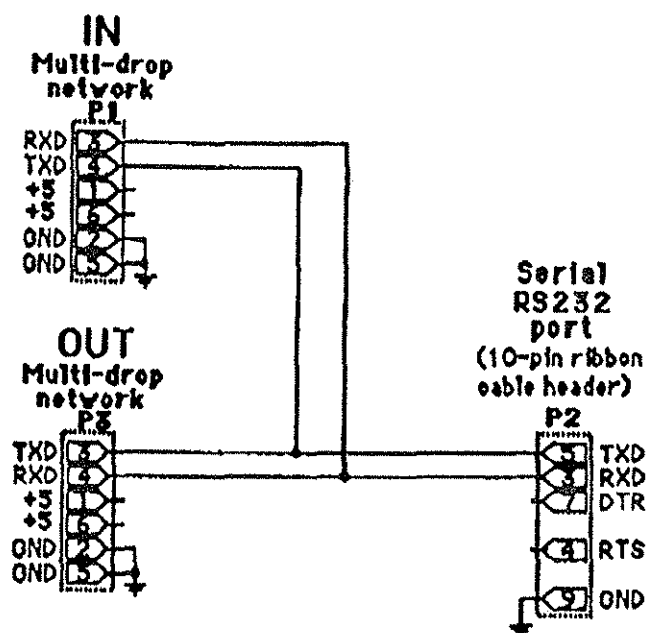


Figure B-8 Network Interface Board Schematics

APPENDIX C

REFERENCES

C.1 General

1. "Traceability Protocol for Establishing True Concentrations of Gases Used for Calibration and Audits of Air Pollution Analyzers," (protocol No. 2), June 1978. Available from U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory (MD-77), Research Triangle Park, North Carolina 27711.
2. G. O. Nelson, Controlled Test Atmospheres, (Ann Arbor Science Publishers, Inc., Ann Arbor 1971).
3. EPA-600/4-77-027a
Quality Assurance Handbook
For Air Pollution Measurement Systems
Volume II - Ambient Air Specific Methods

This document can be obtained from:

U.S. Environmental Protection Agency Office of
Research and Development E.M.S.L.
Research Triangle Park, North Carolina 27711

***** End of Manual *****