INSTRUCTION MANUAL

MODEL 300M
CARBON MONOXIDE ANALYZER

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SAFETY MESSAGES

Your safety and the safety of others is very important. We have provided many important safety messages in this manual. Please read these messages carefully.

A safety message alerts you to potential hazards that could hurt you or others. Each safety message is associated with a safety alert symbol. These symbols are found in the manual and inside the instrument. The definition of these symbols is described below:

GENERAL WARNING/CAUTION: Refer to the instructions for details on the specific danger.

CAUTION: Hot Surface Warning

CAUTION: Electrical Shock Hazard

TECHNICIAN SYMBOL: All operations marked with this symbol are to be performed by qualified maintenance personnel only.

CAUTION

The analyzer should only be used for the purpose and in the manner described in this manual.

If you use the analyzer in a manner other than that for which it was intended, unpredictable behavior could ensue with possible hazardous consequences.

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1 INTRODUCTION

1.1 Preface

Teledyne API is pleased that you have purchased the Model 300M. This manual has been designed to allow easy commissioning and operation but if we may be of assistance Teledyne API will be pleased to provide you with any support required.

The Teledyne API Model 300M keyboard/operator interface is user-friendly. We hope you will not experience any problems with the Model 300M and the built-in tests and diagnostics should allow you to quickly and easily rectify any problems you may encounter. In addition, our customer service department is always available to answer your questions.

1.2 Warranty

WARRANTY POLICY (02024c)

Prior to shipment, Teledyne API equipment is thoroughly inspected and tested. Should equipment failure occur, Teledyne API assures its customers that prompt service and support will be available.

COVERAGE

After the warranty period and throughout the equipment lifetime, Teledyne API stands ready to provide on-site or in-plant service at reasonable rates similar to those of other manufacturers in the industry. All maintenance and the first level of field troubleshooting is to be performed by the customer.

NON-TELEDYNE API MANUFACTURED EQUIPMENT

Equipment provided but not manufactured by Teledyne API is warranted and will be repaired to the extent and according to the current terms and conditions of the respective equipment manufacturers warranty.

GENERAL

Teledyne API warrants each Product manufactured by T Teledyne API to be free from defects in material and workmanship under normal use and service for a period of one year from the date of delivery. All replacement parts and repairs are warranted for 90 days after the purchase.

If a Product fails to conform to its specifications within the warranty period, Teledyne API shall correct such defect by, in Teledyne API's discretion, repairing or replacing such defective Product or refunding the purchase price of such Product.

The warranties set forth in this section shall be of no force or effect with respect to any Product: (i) that has been altered or subjected to misuse, negligence or accident, or (ii) that has been used in any manner other than in accordance with the instruction provided by Teledyne API or (iii) not properly maintained.

THE WARRANTIES SET FORTH IN THIS SECTION AND THE REMEDIES THEREFORE ARE EXCLUSIVE AND IN LIEU OF ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR PARTICULAR PURPOSE OR OTHER WARRANTY OF QUALITY, WHETHER EXPRESSED OR IMPLIED. THE REMEDIES SET FORTH IN THIS SECTION ARE THE EXCLUSIVE REMEDIES FOR BREACH OF ANY WARRANTY CONTAINED HEREIN. TELEDYNE API SHALL NOT BE LIABLE FOR ANY INCIDENTAL OR CONSEQUENTIAL DAMAGES ARISING OUT OF OR RELATED TO THIS AGREEMENT OF TELEDYNE API'S PERFORMANCE HEREUNDER, WHETHER FOR BREACH OF WARRANTY OR OTHERWISE.

TERMS AND CONDITIONS

All units or components returned to Teledyne API should be properly packed for handling and returned freight prepaid to the nearest designated Service Center. After the repair, the equipment will be returned, freight prepaid.

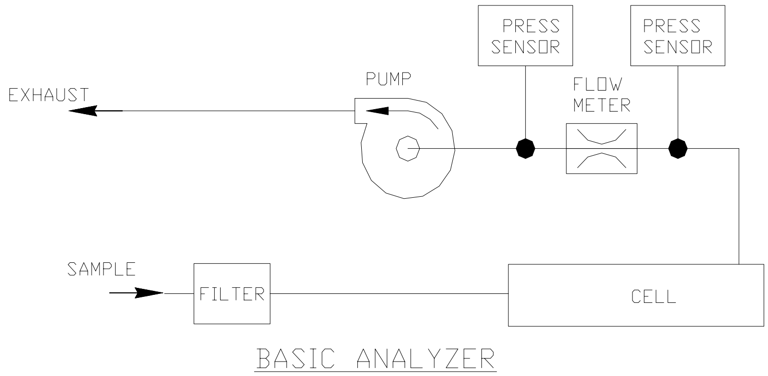
1.3 Principle of Operation

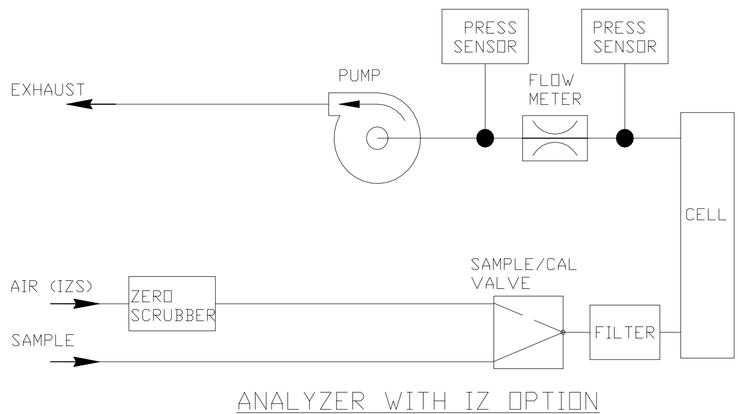
The detection and measurement of Carbon Monoxide in the Model 300M is based on the absorption of Infra Red (IR) radiation by CO molecules at wavelengths near 4.5 microns. As illustrated in Figure 1-1, the Model 300M uses a high energy heated element to generate broad-band IR light. This light is passed through a rotating Gas Filter Wheel causing the beam to alternately pass through a gas cell filled with Nitrogen, (the Measure Cell) and a cell filled with CO/Nitrogen Mixture (the Reference Cell). This alternation occurs at a rate of 30 cycles/second and causes the beam to be modulated into Reference and Measure pulses. During a Reference pulse, the CO in the gas filter wheel effectively strips the beam of all IR energy at wavelengths where CO can absorb. This results in a beam which is unaffected by any CO in the Sample Cell. During the Measure pulse, the Nitrogen in the filter wheel does not affect the beam which can subsequently be absorbed by any CO in the sample cell. The Gas Filter wheel also incorporates an optical chopping mask which superimposes a 180 Cycles/Second Light/Dark modulation on the IR Beam. This high frequency modulation is used to maximize detector signal-to-noise performance.

After the gas filter wheel, the IR beam enters the single pass sample cell. The beam then passes through a band-pass interference filter to limit the light to the wavelengths of interest. Finally, the beam strikes the detector which is a thermoelectrically cooled solid-state photo-conductor.

This detector, along with its pre-amplifier converts the light signal into a modulated voltage signal.

The detector output is electronically demodulated to generate two DC voltages, CO MEAS and CO REF. These voltages are proportional to the light intensity striking the detector during the Measure pulse and Reference pulse, respectively.





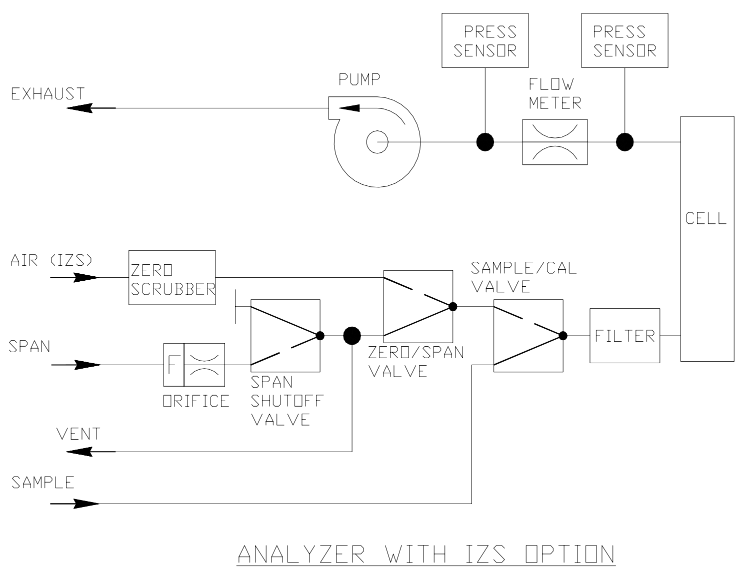


Figure 1-1: Pneumatic Diagram

1.4 Specifications

Ranges	User selectable to any full-scale range from 0 - 30 PPM up to 0 - 3,000 PPM
Zero Noise	< 0.1 PPM (rms)
Span Noise	< 0.5% of reading (rms) or 0.1 PPM (rms)
Lower Detectable Limit	0.2 PPM
Zero Drift (24 hours)	* <0.5 PPM
Zero Drift (7 days)	* <1.0 PPM
Span Drift (7 days)	* 1% of reading
Linearity	1% of Full Scale
Rise/Fall Time (95%)	<60 sec to 95%
Sample Flow Rate	800cc/min. ± 10%
Temperature Range	5-40°C
Humidity Range	0-95%RH, non-condensing
Dust	Sample must be dust free
Temp Coefficient	< 0.5 PPM per °C
Voltage Coefficient	< 0.5 PPM per Volt
Dimensions HxWxD	7" x 17" x 25" (178 mm x 432 mm x 635 mm)
Weight	50 lbs (22.7 kg)
Power	100 50/60 Hz, 115 60 Hz, 220V 50/60 Hz., 240 V 50 Hz. 250 Watts
Power, CE	230 V/50 Hz, 250 Watts
Recorder Outputs	± 100 mV, ± 1 V, ±5 V, ±10 V (Bi-Polar)
Status Output	9 status outputs from opt-isolators
Alarm output	3 opto-isolators to drive TTL relays

* at constant temperature and voltage

1.5 Installation and Overview

The Model 300M is shipped with the following standard equipment:

1. Power cord
2. Operation manual

> **CAUTION**
>
> **To avoid personal injury, always use two persons to lift and carry the Model 300M.**

Upon receiving the Model 300M please do the following:

1. Verify no apparent shipping damage. (If damage has occurred please advise shipper first, then Teledyne API.)
2. Before operation it is necessary to remove the shipping hold down screws. Remove the instrument cover, then refer to Figure 1-2 for screw location.
3. When installing the Model 300M, allow a minimum of 4 inches (10 cm) of clearance at the back of the instrument and 1 inch (2.5 cm) of clearance on each side for proper ventilation. Also, be sure that the clearance below the chassis is unobstructed by at least the height of the instrument feet.
4. Connect sample inlet line to the sample port on rear panel.

> **NOTE**
>
> **See Figure 1-3 for rear panel pneumatic connections. Sample gas should only come into contact with PTFE, glass or stainless steel. Leak check all fittings with soap solution.**

> **CAUTION**
>
> **Connect the exhaust fitting on the rear panel (see Figure 1-4) to a suitable vent outside the analyzer area.**

5. Connect a recording device to the terminal strip connections on the rear panel (See Figure 1-3).
6. Connect the power cord to an appropriate power outlet (see the serial number tag for correct voltage and frequency).

CAUTION

Check that analyzer is set up for proper voltage and frequency.

CAUTION

Power plug must have ground lug.

7. Turn on the M300M by switching the switch on the lower right corner of the front panel (See Figure 2-1). The front panel display should light with a sequence of messages, -API - M300M - software version number, then a normal display as shown in Figure 2-2.
8. Allow about 30 minutes for the temperatures to come up to their respective set-points, then press the left most button on the front keyboard to scroll through the TEST values. Compare these values to those noted during the final factory checkout listed in Table 1-2. The values observed should closely match the Table 1-2 values.
9. Select the range on which the analyzer will be calibrated.
   A. From the SAMPLE menu, press SETUP to enter the SETUP menu. (See Figure 2-2 for appearance of front panel.)
   B. Enter the PASSWORD (818).
   C. Press RNGE (RANGE).
   D. Press SET.
   E. Enter the derived full scale range for analog outputs and press ENTR.
   F. Press EXIT 2 times to return to the SAMPLE menu.
10. Adjust the analyzer zero point.
   A. Input zero air into the sample port.
   B. Press **CAL** from the SAMPLE menu and enter the password **(818)**.
   C. Press **ZERO.**
   D. It usually takes about 5 to 10 minutes for the reading to stabilize near zero. After a stable reading has been obtained press **ENTR**. The display should now read 0.0 PPM Carbon Monoxide.

NOTE

Repeatedly pressing enter during span/zero calibration does not improve the accuracy of the calibration, nor does it speed up stabilization Allow 5 - 10 minutes to establish an accurate average for the span/zero reading.

11. Adjust the analyzer span point.

    A. Input span gas of approximately 80% of the related full scale range concentration from a known source through the sample port of the analyzer.

    B. Go to manual calibration by pressing the **CAL** button while in the sample mode.

    C. Enter the operator password (818).

    D. The menu should now show **SPAN**, **CONC**, and **EXIT**. Enter the concentration of the CO calibration gas by pressing **CONC** and entering the value from the keyboard.

    E. Wait 10 minutes for a stable reading to be attained and then press **SPAN**, followed by **ENTR**. If the **SPAN** button is not displayed, this means that the analyzer is too far out of adjustment to do a reliable calibration and thus it is not permitted (see Section 3.1 for information on the calibration). The operator can exit the manual calibration procedure only by pressing the **EXIT** button.

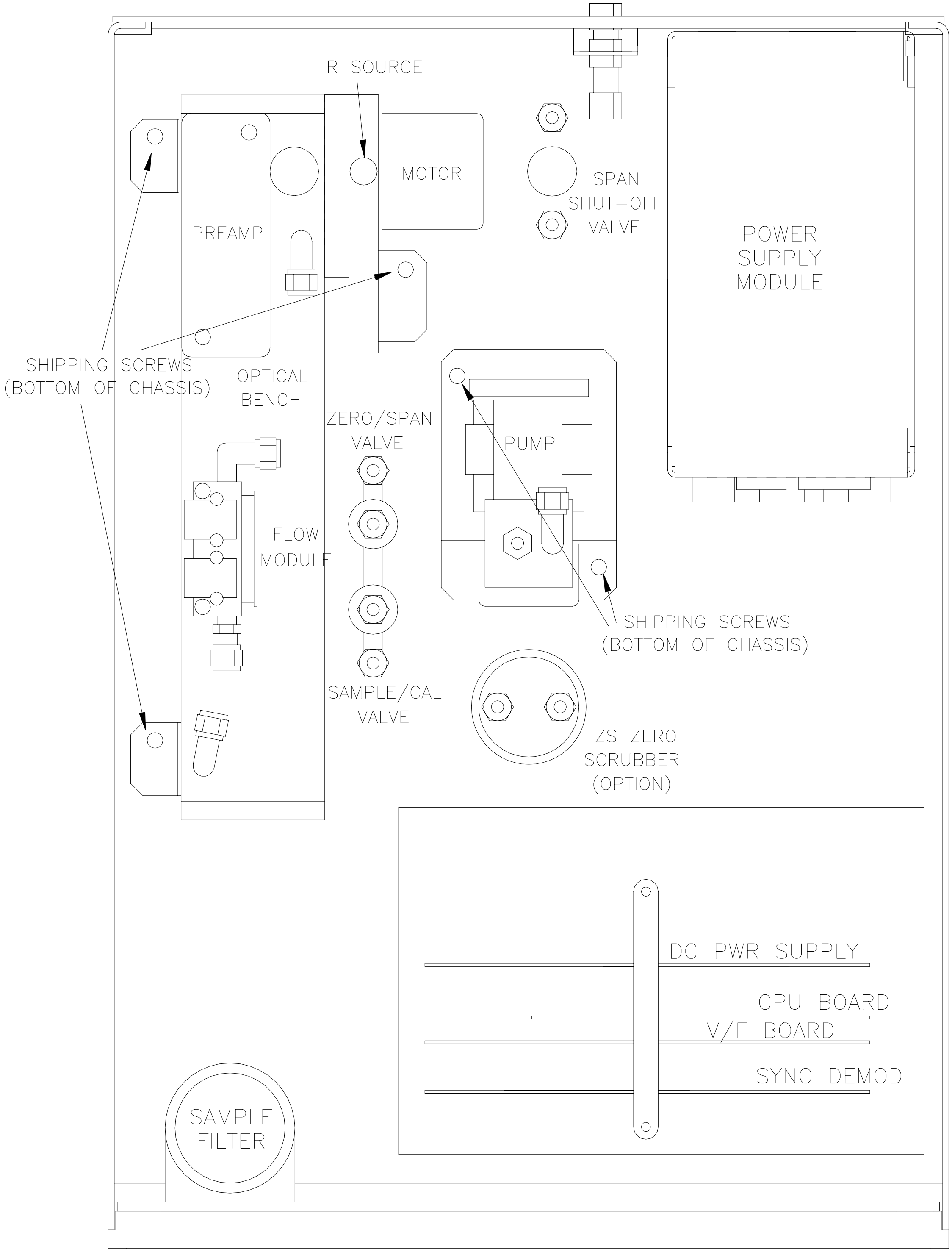


Figure 1-2: Carbon Monoxide Analyzer

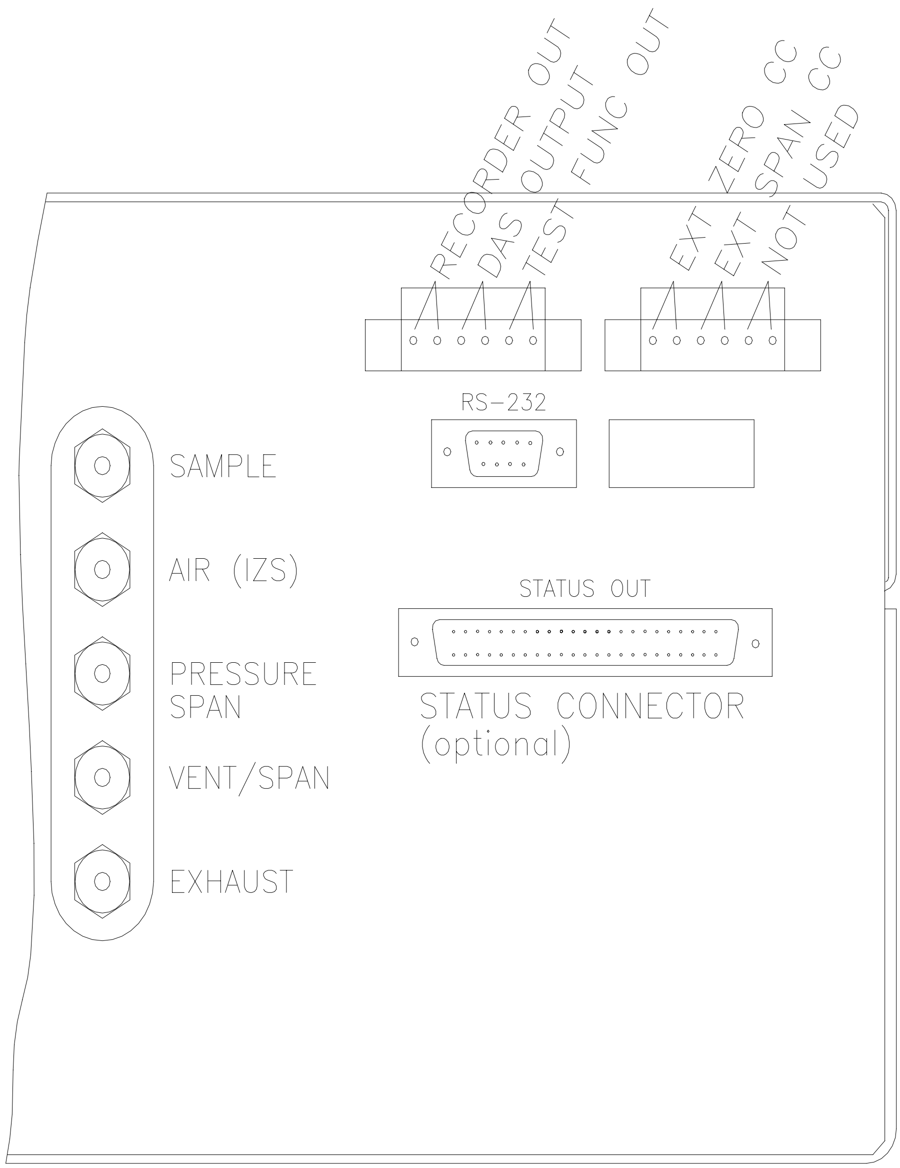


Figure 1-3: Rear Panel Electrical/Pneumatic Connections

1.6 Electrical and Pneumatic Connections

1.6.1 Electrical Connections

Output #1 Carbon Monoxide concentration - Chart Recorder (REC)

Output #2 Carbon Monoxide concentration - Data Acquisition System (DAS)

Output #3 Test function analog output

Input #4 Zero valve request

Input #5 Span valve request

Input #6 Not Used

There are 2 six-pin connector strips on the rear panel shown in Figure 1-3. The pins are divided into 3-plus/minus pairs and have the functions shown above.

Outputs 1 and 2 have identical signals and electrical characteristics. Output 3 is the same as 1 and 2 electrically, but has analog TEST function signals routed to it. See Diagnostics in Section 5 for details.

1.6.2 Remote Contact Closures Zero/Span Inputs

Remote contact closures can be used to remotely energize the zero/span valves to do a zero or span check. The external contact closure should be capable of switching 12 VDC at 50 ma.

Refer to Figure 1-3 for connection location. See Sections 1.8.2 and 3.6 for further details.

NOTE

Zero or span checks can be performed in any order.

1.6.3 Status Outputs (Optional)

Status outputs report analyzer conditions via contact closures located on the optional DB-50 connector on the rear panel. The contacts are NPN transistors which can sink 50 mA of DC current. The pin assignments are listed in Table 1-1.

Table 1-1: Status Outputs

Output#	Pin Pair (Low, High)	Definition	Condition
1	1,2	ALARM 1	Gas concentration is exceeding the Hi set limit.
2	3,4	ALARM 2	Gas concentration is exceeding the HiHi set limit.
3	5,6	SYSTEM OK	True if no alarm conditions exist
4	7,8	TEMP ALARM	True if any temp warning exists
5	9, 10	DIAG MODE	True if in diagnostic mode
6	11,12	POWER ON	True if main power is on
7	13,14	PRESS ALARM	True on low pressure
8	15,16	HIGH RANGE SELECTED	True if the auto-range function has switched the analyzer into high range.
9	17,18	FLOW ALARM	True if a flow warning exists
10	19,20	RESERVED	
11	21,22	SOURCE WARNING	True if the analyzer source intensity is out of limits.
12	23,24	RESERVED	

1.6.4 RS-232

The RS-232 connection is a male, 9-pin D-sub connector at the location shown in Figure 1-3. See also Appendix A for additional information.

1.6.5 Pneumatic System

The Model 300M is equipped with a vacuum pump capable of pulling 800 cc/min across a flow restrictor. This allows a smooth, stable flow of sample through the analyzer.

Sample enters the analyzer through a particulate filter element (47 mm diameter) mounted immediately behind the front panel. The sample then enters directly into the sample cell. Please see Figure 1-1 for a flow diagram and Figure 1-4 for pneumatic connections.

1.6.6 Sample Gas Connection

1/4" O.D. PTFE tubing is needed to connect the sample source to the analyzer. See Figure 1-4.

> **NOTE**
>
> **Use PTFE, glass, stainless steel or non-reactive materials for sample gas connections.**

> **NOTE**
>
> **Use vent line when sampling from pressurized manifold - sample pressure should not exceed ± 2 mm Hg.**

1.6.7 Zero/Span Valve Connections

Zero air and span gas manifolds should supply their respective gases in excess of 800cc/min demand of the analyzer. The manifold should be vented to the outside atmosphere and be of sufficient length and diameter to prevent back diffusion and pressure effects. See Figure 1-4.

1.6.8 Exhaust Connections

A single 1/4" O.D. tube should be connected from the analyzer sample exhaust to an area outside of the room the analyzer occupies. The maximum length of the exhaust line should not exceed 3 meters (See Figure 1-4).

> **CAUTION**
>
> **Connect the exhaust (and vent) fitting on the rear panel to a suitable vent outside the analyzer area and away from personnel.**

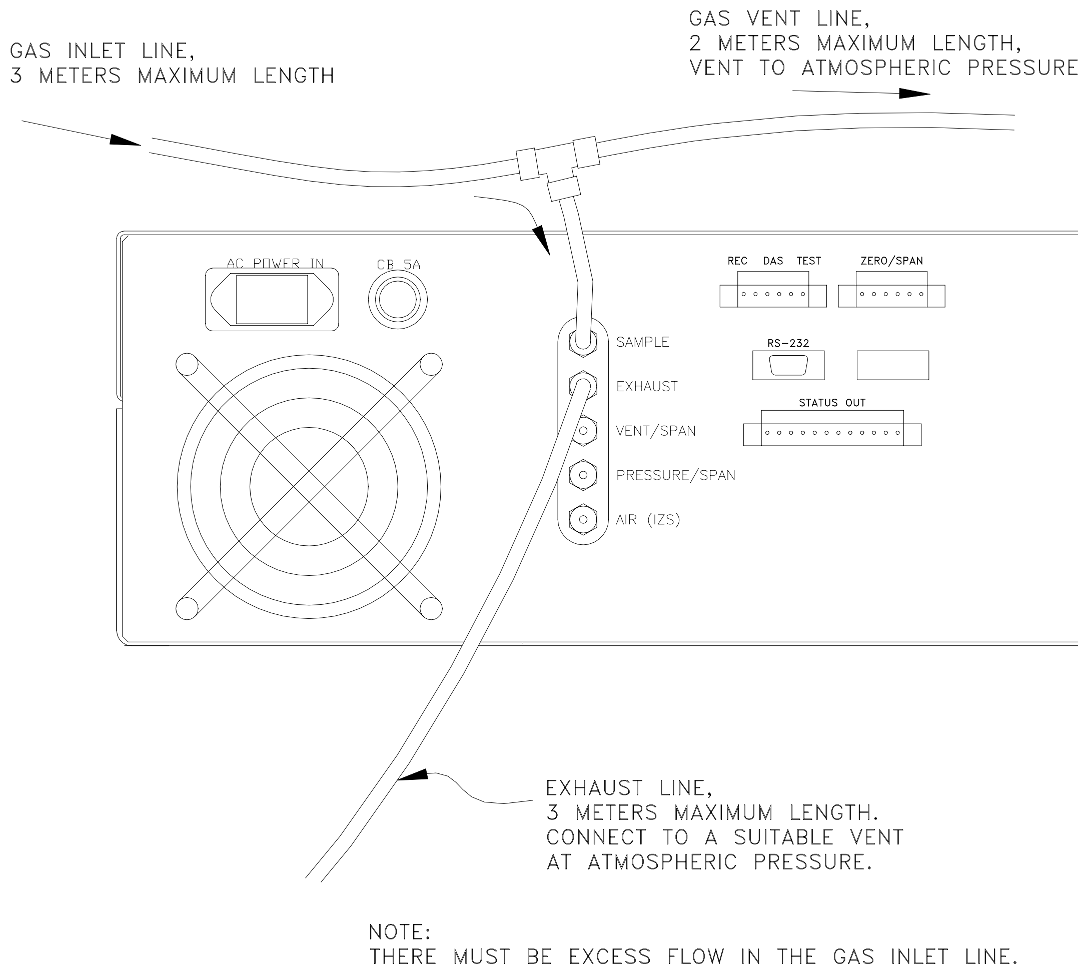


Figure 1-4: Rear Panel Pneumatic Connections

1.7 Operation Verification

The Model 300M Analyzer is now ready for operation.

1. Read Sections 1.3 and all of Section 4 of the manual to understand the analyzer operation.

2. Turn on the power by pressing the on/off switch on the front panel (see Figure 2-1). The display should turn on and green (sample) status LED should be energized. The green LED should blink indicating the instrument has entered the HOLD-OFF mode. Sample mode can be entered immediately by pressing the **EXIT** button on the front panel. The red "fault" light will also be on until the flows, temperatures and voltages are within operating limits. Clear the fault messages.

3. After a 30-minute warm-up, review the TEST function values in the front panel display by pushing the left most keyboard button labeled TEST. Not every TEST function is a diagnostic of correct analyzer operation, therefore TEST functions not covered below can be ignored for now.

4. CO REF, CO MEAS - TEST function values should be between 2500 mV and 4700 mV.

5. Pressure - 29 to 30 Inches-Mercury-Absolute at sea level. Other values will be displayed depending on altitude of analyzer.

6. Sample Flow - 800 cc/min ±20 %.

7. Sample Temp - Ambient temperature (10 - 40°C) ± 10°C.

8. Optical Bench Temp - 48°C ± 1° The computer drives the temp to this setpoint.

9. Filter Wheel Temp - 68°C ± 2° The computer drives the temp to this setpoint.

10. Box Temp - Ambient +10°C.

11. DC Power Supply - 2500 mV ± 200 mV - This is a composite of all of the DC voltages in the instrument. The value is not important but it should be within the range indicated.

12. If the TEST functions are within the limits given above, the instrument should function correctly. If there is a problem, please read the manual and check your setup and test values. The Model 300M is now ready for calibration (see Section 3.1).

Table 1-2: Final Test and Calibration Values

Test Values	Observed Value	Units	Nominal Range
CO MEAS		mV	2500 - 4700
CO REF		mV	2500 - 4700
MR RATIO			1.1 – 1.22
SAMPLE PRESS		in-Hg	27 - 30
VACUUM PRESS		in-Hg	10 ± 5
SAMPLE FLOW		CC/MIN	700 - 900
BENCH TEMP		°C	48 ± 1
DC POWER SUPPLY		mV	2500 ± 200
SAMPLE TEMP		°C	45-50
BOX TEMP		°C	8- 40
WHEEL TEMP		°C	68 ± 2
Diagnostic			
Dark Ref		mV	125 ± 50
Dark Meas		mV	125 ± 50
Electrical test		PPM	400 ± 4
Span and CAL Values			
CO Span Conc		PPM	400
CO Slope			1.0 ± 0.3
CO Offset			-0.1 to +0.1
Noise at Zero (p-p)		PPM	0.5
Noise at Span (p-p)		PPM	<1.0% of reading
Factory Installed Options		**Option Installed**	
Factory Installed Options		Option Installed	
Power Voltage/Frequency			
Rack Mount, w/ Slides			
Internal Zero Span Valves			
Analog Voltage Range		0 - V	

PROM # ____________________ Serial # ____________________

Date ____________________ Technician ____________________

1.8 Options

1.8.1 Rack Mount With Slides

This option, including slides and rack mounting ears, permits the analyzer to be mounted in a standard 19" wide x 30" deep RETMA rack.

NOTE

A 1¾ minimum separation between each instrument must be maintained to allow for air circulation. Blocking the air inlet vent on the bottom of the analyzer will result in internal overheating.

1.8.2 Span Valve

The Span Valve option consists of stainless steel solenoid valve mounted inside the analyzer connected to admit sample gas or customer-generated span gas.

The valve is controlled from the front panel push-buttons, the auto-timer via the RS-232 interface, or by remote contact closure.

A span gas manifold should supply at least 1000 cc/min. The manifold should be vented to the outside atmosphere away from the personnel.

A span gas manifold can be connected to the analyzer in either of two ways.

1. If it is desired to use span gas directly from a pressurized source (e.g. a gas cylinder) the connection can be made directly to the Pressure Span port on the analyzer rear panel. In this case the Vent/Span port at the rear panel should be vented to a suitable exhaust manifold at ambient atmosphere pressure. The pressure regulator on the gas source (cylinder should be sent to provide 20 - 25 PSI delivery pressure).

2. If it is desired to use span gas from a source which delivers gas at atmosphere pressure (e.g. a calibrator), the span gas manifold should be connected at the Vent/Span port at the analyzer's rear panel, and the Pressure/Span port should be capped.

INTENTIONALLY BLANK

2 OPERATION

2.1 Key Features

The important features of the Teledyne API Model 300M CO Analyzer are listed below.

2.1.1 CO Readout

The Teledyne API Model 300M CO Analyzer constantly displays the current Carbon Monoxide reading (in PPM) in the upper right hand corner of the alphanumeric display.

2.1.2 CO Analog Output

The Teledyne API CO Analyzer provides a buffered analog output of the current CO readings on each of two pairs of outputs on the rear panel (see Figure 1-3) for DAS and recorder reporting. The analog outputs provide for 20% over-range. For example, on the 500 PPM range the M300M will correctly report concentrations up to 600 PPM and output up to 6.00 volts to the DAS and recorder outputs. In addition TEST function values can be routed to a third analog output.

2.1.3 E^2ROM Backup Of Software Configuration

The Teledyne API CO Analyzer has a few jumpers that need to be set by the operator. Configuration of the analyzer is done under software control and the configuration options are stored in electrically erasable (E^2) ROM. Thus, configuration options are saved even when the analyzer is powered off.

There is one exception to this. The analog output voltage ranges are set by jumpers on the A/D-I/O board as shown in Section 10.6.3.

2.1.4 Adaptive Filter

The M300M CO Analyzer is able to provide a smooth, stable output by means of an adaptive filter. During conditions of constant or nearly constant concentration the filter is allowed to grow to 200 samples (1 minute) in length, providing a smooth, stable reading. If a rapid change in concentration is detected, the filter is cut to 20 samples to allow the analyzer to quickly respond to rapidly varying signals.

2.1.5 Data Acquisition (DAS)

The Model 300M contains a flexible and powerful built in data acquisition system (DAS) that enables the analyzer to store concentration data as well as many diagnostic parameters in its battery backed memory. For more information on programming custom Data Channels, a supplementary document containing this information can be requested from Teledyne API.

2.1.6 RS-232 Interface

The M300M CO Analyzer features an RS-232 interface which can output the instantaneous and/or average CO data to another computer. It can also be used as a command and status channel to allow another computer to control the analyzer. Refer to Appendix Figure A-1 or Appendix A for details on the RS-232 interface.

2.1.7 Password Protection

The M300M CO Analyzer provides password protection of the calibration and setup functions to prevent incorrect adjustments to the analyzer. There are two levels of passwords which correspond to operator, supervisor/maintenance, and analyzer configuration functions. When prompted for a password, any of the valid passwords can be entered, but the CPU will limit access to the functions allowed for that password level. Each level allows access to the functions of all the levels below plus some additional functions. Table 2-1 lists the password levels and the functions allowed for each level.

Table 2-1: Password Levels

Password	Level	Functions Allowed
No password	0	TEST MSG CLR
Calibration (512)	1	CALZ CALS CAL
Setup (818)	2	SETUP

NOTE

The operator and setup passwords can be disabled. To do this, enter setup-password and toggle "ON" to "OFF". Push "ENTR" and the passwords will be displayed.

2.2 Front Panel

This section describes the operator interface from the point of view of the front panel. The front panel consists of a 2-line by 40-character alphanumeric display, 8 push buttons, and 3 status LED's. Each of these features is described below.

2.2.1 Front Panel Display

The display is divided into 4 main "fields": the **mode** field in the upper left, the **message** field in the top center, the sample concentration field consisting of the most recent instantaneous Carbon Monoxide value field in the upper right, and the MENU field which occupies the entire bottom line of the display. A typical display is shown in Figure 2-1.

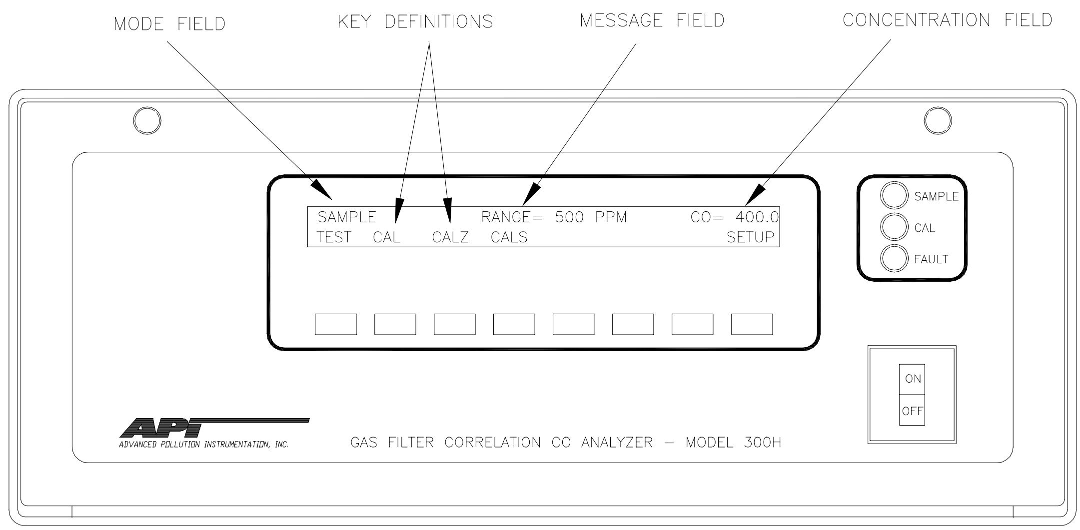


Figure 2-1: Model 300M Front Panel

The mode field indicates the current mode of the analyzer. Usually, it shows "SAMPLE", indicating that the instrument is in the sample mode. Manual span checking or calibration can only be performed by pressing the buttons on the front panel labeled "CALZ", "CALS", or "CAL". Automatic span check only occurs at the preset time. Dynamic span adjust can be performed during automatic or remote span checks. Remote span adjustment is performed via a command from the RS-232 or the external contact closure inputs. Calibration and span adjustments are discussed in greater detail in Section 3.1. Table 2-2 lists all the possible modes in the analyzer and their meanings.

Table 2-2: System Modes

Mode	Meaning
SAMPLE x (1)	Sampling normally
SAMPLE x (1)	Flashing indicates adaptive filter is on
ZERO CAL x (2)	Doing a zero check or adjust
SPAN CAL x (2)	Doing a span check or adjust
MP CAL	Doing a multi-point calibration
SETUP xxx (3)	Configuring analyzer (sampling continues)
DIAG DAS (4)	Data Acquisition configuration
DIAG I/O (4)	Test digital I/O signals
DIAG AOUT (4)	Test analog output channels
DIAG D/A (4)	Configure and Calibrate Digital to Analog converters
DIAG TCHN (4)	Configure Test Channel output
(1) x = A (auto) (2) x = M (manual), A (auto), R (remote) (3) xxx = software revision (e.g. A.9) (4) diagnostic test modes	

The message field shows test measurements or warning messages. Table 2-3 and Table 2-4 summarize the test measurements and warning messages and their meanings. Refer to Sections 4 and 5 for detailed information on viewing test measurements and warning messages and clearing warnings.

Table 2-3: Test Measurements

Test Message	Meaning
TIME=xx:xx:xx	Current time-of-day (HH:MM:SS)
RANGE=xxxx PPM	Analog output full-scale range
STABIL=x.xxx PPM	Standard Deviation of CO readings
CO MEAS=xxxxx MV	Current V/F measure channel (mV)
CO REF=xxxxx MV	Current V/F reference channel (mV)
MR RATIO=X.XXX	Ratio of the Reference and Measure values
AZERO OFFS=x.xxxxx	Autozero offset
PRES=xxx IN-HG-A	Absolute sample pressure – inches Hg
VAC = xxx IN-HG-A	Absolute vacuum pressure – inches Hg
SAMPLE FL=xxx CC/M	Sample flow through analyzer (cc/min)
SAMPLE TEMP=xxx C	Temperature in the absorption cell
BENCH TEP=xxx C	Optical Bench Temperature
WHEEL TEP=xxx C	Filter Wheel Temperature
BOX TEMP=xxx C	Internal box temperature (degrees C)
DCPS=xxxxxx MV	DC power supply (mV)
SLOPE=x.xxx	Internal formula - Slope
OFFSET=xx.x MV	Internal formula - Offset

Table 2-4: Warning Messages

Warning Message	Meaning
SYSTEM RESET	Issued whenever analyzer is powered on
RAM INITIALIZED	RAM was erased (incl. DAS reports)
SOURCE WARNING	IR source < 2500 OR >= 5000 mV
AZERO WARNING	
SAMPLE FLOW WARN	Sample flow < 500 cc/m or > 1200 cc/m
SAMPLE PRESS WARN	Sample pressure < 15 or > 35 In-Hg-A
SAMPLE TEMP WARN	Sample temperature < 10°C or > 50°C
BOX TEMP WARNING	Box temp. < 12°C or > 48°C
BENCH TEMP WARNING	Optical Bench < 43°C or > 53°C
WHEEL TEMP WARNING	Filter Wheel < 63°C or > 73°C
CANNOT DYN ZERO	CO offset < -1500 or > +1500 mV
CANNOT DYN SPAN	CO slope < 0.5 or > 2.0
V/F NOT DETECTED	A/D - I/O card not installed or bad
SYNC WARNING	No modulation on detector output
DCPS WARNING	

The menu field changes depending on the mode of the analyzer and the buttons that have been pressed. It indicates the current function of each of the 8 push buttons below the display. See Section 2.2.2 for information on using the push buttons.

2.2.2 Programmable Push Buttons

The 8 push buttons below the display are programmable by the CPU and their functions change depending on the mode of the analyzer or the operations being performed. The legend above a button identifies its current function. If there is no legend above a button, it has no function and will be ignored if pressed.

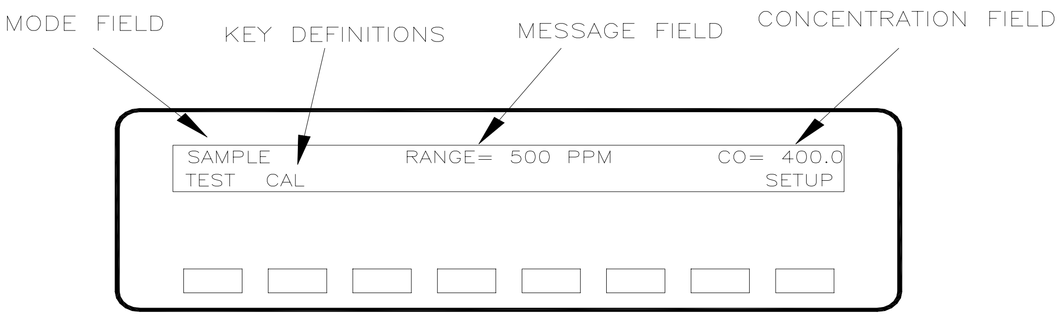


Figure 2-2: Illustration of Normal Display

If **TEST** is pushed, the upper center display cycles through the menu of test parameters, e.g. Sample flow.

CAL is used to initiate span setting using sample gas, such as during a formal calibration.

Pushing **MSG** will cause a message to appear on the upper center display.

Pushing **CLR** will erase a message, provided the condition causing the message has ceased.

Pushing **SETUP** changes the function of the push buttons and is used for setting basic parameters as described in Section 4.

2.2.3 Status LED's

The three status **LED's** to the right of the display indicate the general status of the Model 300M Analyzer. The green **SAMPLE LED** indicates the sampling status. The yellow **CAL LED** indicates the calibration status. The red **FAULT LED** indicates the fault status. Table 2-5 summarizes the meanings of the status **LED's**.

Table 2-5: Status LED's

LED	State	Meaning
Green	Off On Blinking	Not monitoring, DAS Disabled Monitoring normally, taking DAS data Monitoring, HOLD-OFF mode on, no data to DAS (1)
Yellow	Off On Blinking	Auto Cal disabled Auto Cal enabled Calibrating
Red	Off Blinking	No warnings exist Warnings exist
(1) This occurs during calibration holdoff, power-up holdoff and when in Diagnostic mode		

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3 PERFORMANCE TESTING

Zero/span checking and calibration of the Teledyne API CO Analyzer is divided into two sections. Chapter 3 discusses the different methods by which the analyzer's zero and span settings may be checked and adjusted. The emphasis in Chapter 3 is on the operation of the buttons and the internal adjustments they make in the instrument.

3.1 Manual Zero/Span Check

NOTE

Zero or span checks can be performed in any order.

NOTE

Span gas concentration may trigger gas alarms unless the analyzer is in the calibration mode. Press CAL button prior to introducing span gas into the analyzer.

Operators can manually check the zero and span set-points of the analyzer while in sample mode by allowing the instrument to sample calibration gas and pressing the **CAL** button. This is also referred to as a multi-point calibration.

3.1.1 Zero Check

Allow the analyzer to sample zero air through the sample port. Press **CAL** button. After a few minutes the CO reading should go to zero. If it doesn't, the operator may press the **ZERO** button followed by **ENTR**. This will force the CO reading to go to zero and modify the internal formulas used to compute the CO reading. If the **ZERO** button is not displayed, this means that the zero reading is too far out of adjustment to do a reliable calibration. The reason for this must be determined before the analyzer can be calibrated. See Section 10.5 for troubleshooting calibration problems. Pressing **EXIT** will bring you back to the sample menu or leave the instrument in CAL mode if you are also going to make a span check.

3.1.2 Span Check

Allow the analyzer to sample span gas through the sample port. Press **CAL** button. After a few minutes the CO reading should be at the expected concentration. If the correct concentration is not reached, then the instrument can be adjusted to read the correct value. To do this, press **CONC** and enter the expected concentration of the calibration gas. The **SPAN** button should now be displayed on the front panel. Pressing **SPAN** and **ENTER** will modify the internals formulas used to compute the CO reading. If the **SPAN** button is not displayed, this means that the span reading is too far out of adjustment to do a reliable calibration. The reason for this must be determined before the analyzer can be calibrated. See Section 10.5 for troubleshooting calibration problems.

3.1.3 Dual Range Calibration

If the analyzer is being operated in Dual Range mode or Auto-Ranging mode, then the High and Low ranges must be independently calibrated. When the analyzer is in Dual or Auto Range mode you will be prompted to enter the range to calibrate whenever you enter a calibration command from the front panel. Press **HIGH** or **LOW** followed by **ENTR** button to proceed with the calibration. To calibrate the other range you must exit to the sample menu and restart the calibration. See Section 4.6 for more information on the Range Modes. The following procedure shows an example of how to calibrate the two ranges with calibration gas coming in through the sample port:

Step	Action	Comment
1.	Press **CAL**	Analyzer enters M-P calibration mode. Calibration gas source should be set to deliver zero gas to the sample port.
2.	Press LOW-ENTR	Select range to calibrate.
3.	Wait 15 min.	Wait for CO reading to stabilize at zero value.
4.	Press ZERO-ENTR	Changes calibration equations for Low range so analyzer will read zero.
5.	Press **CONC**	Enter span gas concentration for Low range.
6.	Key in span concentration	Enter span gas concentration for Low Range. Set calibration gas source to deliver span concentration.
7.	Press **ENTR**	
8.	Wait 15 min.	Wait for CO reading to stabilize at span value.
9.	Press SPAN-ENTR	Changes calibration equations for Low range so analyzer will read span value.
10.	Press **EXIT**	Exits back to sample menu.
Repeat steps 1-10 for High range.		

3.2 Span Valve (Option)

If the span valve option is installed and a source of CO span gas from the cylinder (20-25 PSIG) has been connected, the operator can check the span setpoint of the analyzer at any time by pressing the **CALS** button. Zero calibration should be done, as described in Section 3.1.1, through the sample port. Refer Figure 1-1, M300M FLOW DIAGRAM with cylinder span valve and AUTOZERO. The pressure/vent port should be properly vented out of the analyzer area away from the personnel.

Pressing **CALS** switches the Sample/Cal valve and allows the analyzer to draw pressurized cylinder span gas through the pressure/span port (refer Figure 1-3). After a few minutes the CO reading should approach to the span value. If it doesn't, the operator may press the **SPAN** button followed by **ENTR**. The expected span gas concentration may be changed by pressing the **CONC** button.

3.3 Zero/Span Valves (Option)

If the Zero/Span Valves option has been installed the operator can check the zero and span setpoints of the analyzer at any time by pressing the **CALZ** or **CALS** button. Refer Figure 1-1, M300M flow diagram with Zero/Span valves and AUTOZERO. Note that both zero and span gas source should be delivered at ambient pressure.

Pressing **CALZ** switches the Sample/Cal valve and allows the analyzer to draw zero gas through the sample port. After a few minutes the CO reading should go to zero. If it doesn't, the operator may press the **ZERO** button followed by **ENTR**.

CALS works like **CALZ** except that externally supplied span gas is drawn through the analyzer. After a few minutes the CO reading should approach the span level. If it doesn't, the operator may press the **SPAN** button, followed by **ENTR**. The expected span gas concentration may be changed by pressing the **CONC** button.

3.4 Automatic Zero/Span Check

Automatic zero/span checking (Z/S check) must be enabled in the setup mode. The Teledyne API Model 300M Carbon Monoxide Analyzer with Zero/Span Valves option offers capability to check the zero and span point automatically on a timed basis, or through remote RS-232 operation (see Section 3.7).

Under the **SETUP-ACAL** menu, there are three separate auto-sequences called SEQ1, SEQ2, and SEQ3. Under each SEQ, there are four setup parameters that affect zero/span checking: the mode, the starting date of the check, the time of day for check, the number of delay days, time delay, the duration of the check, the range to check and whether to calibrate as well as check the range. These are described individually below. Use the **PREV** and **NEXT** buttons to scroll through the three sequences. The mode for each sequence is displayed. To change the mode for any of the sequences, scroll to the desired sequence and press the **MODE** button. Use the **PREV** and **NEXT** buttons to select one of the modes shown below and press **ENTR**.

Mode:

1. DISABLED (Sequence is disabled)
2. ZERO
3. SPAN
4. ZERO-SPAN

To change the setup parameters for a sequence, press the **SET** button. Pressing the **<SET** and **SET>** buttons allows you to scroll through the setup parameters and edit them by pressing the **EDIT** button. The function of each setup parameter is described below:

Timer Enabled: When set to **ON**, the sequence will be executed based on the internal timer, as specified in the following parameters. When set to **OFF** the sequence will be executed only upon an external (RS-232) command.

Starting Date: The starting date for the sequence is entered in the format of MM/DD/YY, where MM is the month, DD is the date, and YY is the year. Enter starting date and press **ENTR** or **EXIT** to leave the date unchanged.

Starting Time: To set the time of day for the sequence, enter in the format HH:MM, where HH is the hour in 24-hour format (i.e. hours range from 00 to 23) and MM is the minute (00 - 59). Enter the time of day for calibration check and then press **ENTR** to accept the new time or **EXIT** to leave the time unchanged.

NOTE

The programmed start time must be a minimum of 5 minutes later than the present time. (see Section 4.3 and 4.4 for setting present time)

Delta Days: The number of delta days is the number of days between each auto-sequence. Enter desired number of delay days (0-365) and press **ENTR**.

Delta Time: The delta time allows the automatic Z/S check time-of-day to be delayed in the format of HH:MM, where HH is the hour from 00 to 23 and MM is the minutes (00-59). The delta days and delta time are added together to determine the total delay between sequences. The delta time parameter allows you to advance or retard the starting time by a fixed amount each time the sequence is run. For example: Setting the delta days to 1 day and the delta time to 15 minutes will delay the starting time for the sequence by 15 minutes each day. If you want to have the sequence run at the same time every day, simply set the delta time to zero.

NOTE

Avoid setting two or more sequences at the same time of the day. Any new sequence which is initiated whether from a timer, the RS-232, or the contact closure inputs will override any sequence which is in progress.

Duration: The duration of each step of the sequence. Enter the duration in minutes (1-60) and press **ENTR**.

Calibrate: When set to **ON**, the sequence will adjust the internal formulas (slope and offset) in the analyzer to the value set in the span variable. If this feature is enabled along with the automatic zero/span check, the analyzer will re-adjust its formulas to match the predetermined zero and span settings once each day.

Range To Cal: This setup parameter is enabled only if the range mode is set to Dual or Auto. This parameter determines which range the sequence will check.

NOTE

The calibrate feature of auto sequences alter the formulas used to compute the carbon monoxide reading.

Examples of possible sequences are as following under any one of three available SEQx.

Example 1: To perform a 15 minute zero check once per day at 10:30 PM, 12/20/93.

1. MODE: ZERO
2. TIMER ENABLED: ON
3. STARTING DATE: 12/20/93
4. STARTING TIME: 22:30
5. DELTA DAYS: 1
6. DELTA TIME: 00:00
7. DURATION: 15
8. CALIBRATE: OFF

Example 2: To perform a 15 min zero span check once per day retarding 15 minutes everyday starting at 11:30 PM, 12/20/93.

1. MODE: ZERO-SPAN
2. TIMER ENABLED: ON
3. STARTING DATE: 12/20/93
4. STARTING TIME: 23:30
5. DELTA DAYS: 0
6. DELTA TIME: 23:45
7. DURATION: 15
8. CALIBRATE: OFF

Example 3: To perform span check once per week starting at 11:30 PM, 12/20/93.

1. MODE: SPAN
2. TIMER ENABLED: ON
3. STARTING DATE: 12/20/93
4. STARTING TIME: 23:30
5. DELTA DAYS: 7
6. DELTA TIME: 00:00
7. DURATION: 15
8. CALIBRATE: OFF

Example 4: to perform zero check once per day at 10:30 PM and a span check once per week starting at 11:30 PM, 12/20/93.

1. Select any one of SEQx and program as example 1.
2. Select any other SEQx and program as example.
3. Avoid setting two or more sequences at the same time of the day.

3.5 Summary of Front Panel Check and Calibration Controls

The calibration controls are summarized below in terms of the button sequences used to access them.

Table 3-1: Calibration Controls

Button Sequence	Function	Default	Limits
CALZ	Begin zero check	-	-
CALZ-ZERO-ENTR	Adjust CO conc. to zero	-	-
CALZ-EXIT	Exit zero check	-	-
CALS	Begin span check	-	-
CALS-CONC-ENTR	Expected CO span value	400 PPM	1 - 20000 PPM
CALS-SPAN-ENTR	Adj. CO conc. to span val.	-	-
CALS-EXIT	Exit span check	-	-
CAL	Begin M-P cal.	-	-
CAL-ZERO-ENTR	Adj. CO conc. zero value	-	-
CAL-CONC-ENTR	Expected CO span value	400 PPM	1 - 20000 PPM
CAL-SPAN-ENTR	Adj. CO conc. to span val.	-	-
CAL-EXIT	Exit M-P cal.	-	-
SETUP-ACAL-SEQ1	Setup auto-cal SEQ1	Disabled	
SETUP-ACAL-SEQ2	Setup auto-cal SEQ2	Disabled	
SETUP-ACAL-SEQ3	Setup auto-cal SEQ3	Disabled	

3.6 Remote Zero/Span Check or Adjustment (Contact Closure)

In addition to adjustment via the front panel buttons, the analyzer can be adjusted by means of two contact closures called EXT_ZERO_CAL and EXT_SPAN_CAL. (See Figure 1-3 for the location of the terminals for connection of the contacts on the rear panel.) The CPU monitors these two contact closures every 1 second and looks for a positive transition (i.e. $0 \rightarrow 1$) on either signal. If a positive transition occurs on EXT_ZERO_CAL, the CPU will perform a zero check. If a positive transition occurs on EXT_SPAN_CAL, the CPU will perform a span check. When a negative transition i.e. $1 \rightarrow 0$) is detected, the CPU will go into hold-off.

Also, if a positive transition occurs on either signal while the M300M is in zero, span check or hold off, it will immediately switch to the specified mode. For example, if the analyzer is in zero check and a positive transition is detected on EXT_SPAN_CAL, then the instrument will immediately go into span check. To perform a zero check followed by a span check, first generate a positive transition on EXT_ZERO_CAL, and then when you want to do the span check, generate a positive transition on EXT_SPAN_CAL.

The remote calibration signals may be activated in any sequence, providing a virtually unlimited number of calibration types.

Remote adjustment is similar to automatic Z/S checking in that if dynamic calibration is enabled, the internal CO formulas will be modified following calibration. To enable or disable adjustment, press **SETUP-MORE-VARS** and press **NEXT** until the variable DYN_ZERO or DYN_SPAN is displayed. To change the setting, toggle the value between OFF - ON and press **ENTR** to store the new value or **EXIT** to leave the value unchanged.

NOTE

Teledyne API recommends that contact closures remain closed at least 10 minutes to allow for an accurate average zero or span value to be established.

NOTE

Remote zero and span adjustment alter the formulas used to compute the carbon monoxide readings if DYN ZERO or DYN SPAN are enabled.

3.7 Remote Zero/Span Check or Adjustment (RS-232)

Besides Z/S checking from the front panel, automatic Z/S checking, and remote Z/S checking via the contact closure inputs, the analyzer can also be checked via the RS-232 interface. Remote checking via the RS-232 interface supports zero, span, and zero followed by span check, and is identical to remote check via the contact closure inputs. This RS-232 control feature is provided mainly so that a host computer at another location can control the analyzer. See Section 7 for detailed information on using the RS-232 interface to do a remote Z/S check.

3.8 Power-On Hold Off

Whenever the Model 300M is powered on it will go through a HOLD-OFF sequence (see Section 3.9) like it does after a zero/span check.

3.9 Hold Off

Every type of check or adjustment (zero, span, manual, remote, etc.) is followed by a hold off period of from 1 to 20 minutes, during which time the internal data acquisition system (DAS) does not accumulate CO readings into the DAS average. To set the hold off time, press **SETUP-MORE-VARS** and press **NEXT** until the variable HOLDOFF_TIME is displayed. To change the setting, enter a number from 1 to 20 and then press **ENTR** to store the new value or **EXIT** to leave the hold off time unchanged.

4 SETUP MODE

This section describes the setup variables that are used to configure the analyzer.

4.1 Setup Mode Operation

ALL the setup variables are stored in the analyzer's EEPROM and are retained during power off and generally when new software revisions are installed.

> **NOTE**
>
> **If a variable is modified, but ENTR is not pressed, the variable will not be changed and the analyzer will beep when EXIT is pressed.**

4.2 Examining the Carbon Monoxide Formula Slope and Offset

The slope and offset parameters can be examined by pressing the **<TST** or **TST>** buttons until the slope and offset test functions appear. The slope and offset parameters are set only during zero and span calibration routines. These parameters are used to adjust the span and zero values to their exact values.

The current value of the Carbon Monoxide reading that is displayed on the front panel and output on the D/A terminals on the back panel is computed as follows:

1. Every 160 msec, the analyzer takes a CO MEAS reading (i.e. a reading of the detector output with the IR beam passing through the N_2 cell of the Gas Filter Wheel) and a CO REF reading (i.e. a reading of the detector output with the IR beam passing through the CO Cell of the Filter Wheel).

2. A raw (uncorrected, non-linearized) CO concentration value is calculated according to the following equation:

   concentration = gain_const x (1-CO_MEAS/CO_REF + Zero_Const)

3. Slope and offset corrections are made to the CO concentration according to the equation:

   Corrected concentration =
   Slope x Measured Concentration + Offset

4. The concentration value is linearized over the range of 0 to 20,000 PPM by a multi-point software look-up table and corrected for temperature and pressure.

5. An average of the last 200 samples is computed and converted to the number displayed on the front panel. This is the Carbon Monoxide concentration. The number is also routed to the D/A converter and the resulting voltage is output at the back panel to the recorder and DAS (datalogger).

4.3 Setting the Time-of-Day

To set the current time-of-day, which is used for determining when to do an automatic calibration and for time-stamping the RS-232 reports, press **SETUP-CLK-TIME**. The CPU will display the current time-of-day as four digits in the format "HH:MM", where "HH" is the hour in 24-hour format (i.e. hours range from 00 to 23) and "MM" the time-of-day and then press **ENTR** to accept the new time, or press **EXIT** to leave the time unchanged.

4.4 Setting the Date

To set the current date, press **SETUP-CLK-DATE**. The CPU will display the current date as "DD MMM YY". For example, April 1, 1999 would be displayed as "0 1 APR 9 9". Change the date by pressing the button under each field until the desired date is shown. Then press **ENTR** to accept the new date or press **EXIT** to leave the date unchanged.

4.5 Adjusting the Clock Speed

In order to compensate for clock which run a little bit fast or slow, there is a variable to speed up or slow down the clock by a fixed amount every day. To change this variable, press **SETUP-MORE-VARS**. Press **NEXT** until the CLOCK_ADJ variable is displayed. To change the setting, press the **EDIT** key and enter the value from the keyboard. Press **ENTR** to accept the change. This variable is set to the number of seconds per day by which to speed up or slow down the clock. It should only need to be set once for each analyzer. For example, if the clock is running 10 seconds fast each day, set the variable to -10 and press **ENTR**. (Note that -10 indicates that we want the clock to run 10 seconds slower each day.) If the clock is running 10 seconds slow each day, set the variable to +10, indicating that we want the clock to run 10 seconds faster each day.

4.6 Setting the CO Concentration Range

The CO concentration range is the concentration value that corresponds to the maximum voltage output at the rear panel (usually 5 volts). The M300M can operate in one of three analog output Range Modes. The Range Mode can be changed through the **SETUP-RNGE-MODE** menu. The modes are described below.

4.6.1 Single Range Mode (SNGL)

In this mode, both analog outputs (REC and DAS) are set to the same range. This range can be set to any value between 1 and 20,000 PPM and is accessed through the **SETUP-RNGE-SET** menu. This is the default range mode for the analyzer.

4.6.2 Dual Range Mode (DUAL)

Selecting dual range mode will allow you to select different ranges for the REC and DAS analog outputs. The two ranges are called Low and High. The REC output at the rear panel is used for the Low range and the DAS output is used for the High range. To set the ranges press **SETUP-RNGE-SET** and select which range you want to edit followed by **ENTR**.

The High and Low ranges have separate slopes and offsets for computing the Carbon Monoxide concentration. Therefore, the two ranges must be independently calibrated. See Section 3.1.3 for details on calibrating the two ranges.

4.6.3 Auto Range Mode (AUTO)

In auto range mode, the analyzer automatically switches between the Low and High range depending on the concentration. When the CO concentration increases to 98% of the Low range value, the analyzer will switch to the High range. The analyzer will remain in the High range until the CO concentration drops to 75% of the Low range value. It will then switch back to the Low range. Auto ranging changes the range for the REC and DAS outputs simultaneously. To set the ranges press **SETUP-RNGE-SET** and select which range you want to edit followed by **ENTR**.

The High and Low ranges have separate slopes and offsets for computing the Carbon Monoxide concentration. Therefore, the two ranges must be independently calibrated. See Section 3.1.3 for details on calibrating the two ranges.

4.7 Setting the Analog Output Offset

In order to permit the analyzer to connect to a wider variety of strip chart recorders and other instruments, the analog output of the Carbon Monoxide readings can be adjusted by up to ±500 mV for 0-5 V range (or ±10% of current analog output range) in software. The default output offset is 0 mV. To change it, press **SETUP-MORE-DIAG,** press **NEXT** until D/A CALIBRATION is displayed and press **ENTR.** Press **CFG** to enter the D/A configuration menu. Use the **NEXT** and **PREV** buttons to select the desired analog output and press **SET**. Enter a value of from -500 mV to +500 mV (other ranges will ratio accordingly), followed by **ENTR** to accept the change, or **EXIT** to leave it unchanged. The offset will be reflected immediately on the strip chart recorder or other instrument.

4.8 Setting the RS-232 Baud Rate

To set the baud rate for the RS-232 channel, press **SETUP-MORE-COMM-BAUD**. Press **300**, **1200**, **2400**, **4800**, **9600**, or **19.2** followed by **ENTR** to accept the new baud rate, or **EXIT** to leave the baud rate unchanged.

4.9 Setting the Analyzer I.D.

Each analyzer may be programmed with a unique I.D. number that appears on all RS-232 messages. To set the analyzer I.D., press **SETUP-MORE-COMM-ID**. Enter a 4-digit number from 0000 to 9999, followed by **ENTR** to accept the new I.D., or **EXIT** to leave the I.D. unchanged. If changed, the new I.D. number will appear on all RS-232 reports from this analyzer.

4.10 Disabling the Calibration Password

Normally, operators are required to enter the calibration password when doing a manual calibration via the **CALZ**, **CALS**, or **CAL** buttons. To allow calibration without entering the password, press **SETUP-PASS** and set it to OFF, and then press **ENTR** to accept the change, or **EXIT** to leave it unchanged. To enable the calibration password, set the variable to ON.

4.11 Data Acquisition System (DAS)

The Model 300M contains a flexible and powerful built in data acquisition system (DAS) that enables the analyzer to store concentration data as well as many diagnostic parameters in its battery backed memory. This information can be viewed from the front panel or printed out through the RS-232 port. The diagnostic data can be used for performing “Predictive Diagnostics” and trending to determine when maintenance and servicing will be required.

The logged parameters are stored in what are called “Data Channels.” Each Data Channel can store multiple data parameters. The Data Channels can be programmed and customized from the front panel. A set of default Data Channels has been included in the Model 300M software. These are described Section 4.11.1. For more information on programming custom Data Channels, a supplementary document containing this information can be requested from Teledyne API.

4.11.1 Data Channels

The function of the Data Channels is to store, report, and view data from the analyzer. The data may consist of Carbon Monoxide concentration, or may be diagnostic data, such as the sample flow or detector output.

The M300M comes pre-programmed with a set of useful Data Channels for logging Carbon Monoxide concentration and predictive diagnostic data. The default Data Channels can be used as they are, or they can be changed by the user to fit a specific application. They can also be deleted to make room for custom user-programmed Data Channels.

The data in the default Data Channels can be viewed through the **SETUP-DAS-VIEW** menu. Use the **PREV** and **NEXT** buttons to scroll through the Data Channels and press **VIEW** to view the data. The last record in the Data Channel is shown. Pressing **PREV** and **NEXT** will scroll through the records one at a time. Pressing **NX10** and **PV10** will move forward or backward 10 records. For Data Channels that log more than one parameter, such as PNUMTC, buttons labeled **<PRM** and **PRM>** will appear. These buttons are used to scroll through the parameters located in each record.

The function of each of the default Data Channels is described below:

CONC: Samples Carbon Monoxide concentration (Low Range) at one minute intervals and stores an average every hour with a time and date stamp. Readings during calibration and calibration hold off are not included in the data. The last 800 hourly averages are stored.

PNUMTC: Collects sample flow and sample pressure data at five minute intervals and stores an average once a day with a time and date stamp. This data is useful for monitoring the condition of the pump and critical flow orifice (sample flow) and the sample filter (clogging indicated by a drop in sample pressure) over time to predict when maintenance will be required. The last 360 daily averages (about 1 year) are stored.

CALDAT: Logs new slope and offset every time a zero or span calibration is performed. This Data Channel also records the instrument reading just prior to performing a calibration.

NOTE:
This Data Channel collects data based on an event (a calibration) rather than a timer. This Data Channel will store data from the last 200 calibrations. This does not represent any specific length of time since it is dependent on how often calibrations are performed. As with all Data Channels, a time and date stamp is recorded for every data point logged.

4.12 Software Configuration

The software configuration can be displayed by entering the button sequence SETUP-CFG-NEXT. For example the M300M could display:

MODEL M300M CO Analyzer

Stating that the instrument is Carbon Monoxide analyzer using the SBC40 computer. This feature is useful for showing any special features that are present in the currently installed PROM.

4.13 Gas Alarms

An alarm is activated if the gas concentration is above the set limit or an out of limit condition exists. When the gas alarm is triggered, either status output 1 or 2 is closed. See Table 1-1 for the status output.

NOTE

Span gas concentration may trigger gas alarms unless the analyzer is in the calibration mode. Press CAL button prior to introducing span gas into the analyzer.

There are two types of alarms called Hi ALARM and HiHi ALARM. The user can change the setting of each of the alarm concentration limit. Press SETUP-MORE-ALRM, then select either ALM1 or ALM2, and toggle ON-OFF followed by ENTR. When the concentration entry field is shown, enter the desired limit concentration value and press ENTR.

4.13.1 Summary of Setup Functions

The setup functions are summarized in Table 4-1 in terms of the button sequences used to access them.

Table 4-1: Setup Functions

Button Sequence	Function	Default	Limits
SETUP-CFG-NEXT	List Software Configuration	CO Mach	N/A
SETUP-ACAL-MODE	Define/Change AutoCal Sequences	Disabled	Zero, Span, Zero-Span
SETUP-DAS-EDIT	Define/Change DAS Data Channels		
SETUP-DAS-VIEW	View DAS Data	N/A	N/A
SETUP-RNGE-MODE	Set Range Mode	Single	Single, Dual, Auto
SETUP-RNGE-SET	Set D/A output range	500 PPM	1-20,000 PPM
SETUP-RNGE-UNIT	Set Measurement Units	PPM	PPM. mg/m^3, ug/m^3
SETUP-PASS	Password Enable	ON	OFF-ON
SETUP-CLK-TIME	Set Time-of-Day	00:00	00:00-23:59
SETUP-CLK-DATE	Set Current Date	01 JAN 00	31 DEC 99
SETUP-MORE-COMM-BAUD	RS-232 baud rate	2400 baud	300, 1200, 2400, 4800, 9600, 19.2
SETUP-MORE-COMM-ID	Analyzer ID number	0000	0000-9999
SETUP-MORE-VARS-DAS_HOLD_OFF	Set Hold-Off Interval	15 min	1 - 60 min
SETUP-MORE-VARS- DYN_ZERO	Enable Remote Dynamic Zero Adjustment	OFF	OFF-ON
SETUP-MORE-VARS- DYN_SPAN	Enable Remote Dynamic Span Adjustment	OFF	OFF-ON
SETUP-MORE-VARS- RS232_MODE	Set RS-232 Mode	8	
SETUP-MORE-VARS- CLOCK_ADJ	Set Clock Adjustment Rate	0	-15 to +15

Table 4-1: Setup Functions (Continued)

Button Sequence	Function	Default	Limits
SETUP-MORE-DIAG-SIGNAL I/O	View the state of internal signals	N/A	N/A
SETUP-MORE-DIAG-ANALOG OUTPUT	Generate Analog Output Test Pattern	N/A	N/A
SETUP-MORE-DIAG-D/A CALIBRATION	Calibrate D/A and A/D Converters	N/A	N/A
SETUP-MORE-DIAG-ELECTRICAL TEST	Generate Electrical Test Output	N/A	N/A
SETUP-MORE-DIAG-DARK CALIBRATION	Adjust Dark Offset	125mV	75 - 175 mV
SETUP-MORE-DIAG-FLOW CALIBRATION	Calibrate sample flowrate	800 cc/m	800 cc/m
SETUP-MORE-DIAG- TEST CHAN OUTPUT	Select TEST to Analog Output	None	
SETUP-MORE-DIAG-RS-232 OUTPUT	Generate RS-232 Output Test Pattern	N/A	N/A
SETUP-MORE-ALRM-ALM1	Enable alarm 1 and set limit	ON	100 PPM
SETUP-MORE-ALRM-ALM2	Enable alarm 2 and set limit	ON	300 PPM

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5 DIAGNOSTICS

The Teledyne API Carbon Monoxide analyzer contains two levels of diagnostics: test measurements which can be viewed at all times (except when in setup) by pressing **TEST**, and lower level diagnostic operations which can only be performed by pressing **SETUP-MORE-DIAG**.

5.1 Test Measurements

As stated, test measurements can be viewed at any time except when in setup. To view a different test measurement, simply press the **TEST** button. Table 2-3 lists the test measurements that are available. Viewing these test measurements does not interfere with the operation of the Model 300M or the Carbon Monoxide reading in any way, so they may be viewed freely.

NOTE

If the value of any test function is displayed as "XXXX", this indicates that the reading is off scale or otherwise non-valid.

Additionally, the values of most TEST functions can be output as an analog voltage at the instrument's rear panel (see Figure 1-3). The TEST function to be output is selected by pressing **SETUP-MORE-DIAG**. Press **NEXT** until TEST CHANNEL OUTPUT appears. Press **ENTR**. Select test channel function and press **ENTR**. Table 5-1 lists the Test functions available for analog output.

In addition to outputting a value to the analog output channel, these tests activate a new test measurement which displays the analog voltage reading on the front panel as:

TEST=XXXXX.X MV

When you exit the diagnostics, this test measurement is removed.

5.2 Diagnostic Tests

The diagnostic tests are used to help diagnose a problem in the analyzer and should only be used by skilled maintenance people since they can potentially interfere with the Carbon Monoxide reading. Table 5-1 lists low level diagnostic tests. To get into the diagnostic test mode, press **SETUP-MORE-DIAG**. When the diagnostic mode is entered, a message is sent to the RS-232 channel indicating entry into the diagnostic mode. The buttons that are available to the operator are described below.

The **TEST** button is used to scroll through the test measurements until the one of interest is displayed. To turn the test on, press the **OFF/ON** button. Viewing test measurements in the diagnostic mode is especially useful for viewing the results of a diagnostic test.

The **PREV** button goes to the previous diagnostic test. When pressed, the CPU turns the current diagnostic test OFF if it is ON. The **NEXT** button goes to the next diagnostic test. When pressed, the CPU turns the current diagnostic test OFF if it is ON. The **EXIT** button exits the diagnostic mode and turns all the diagnostic tests OFF. This ensures that a diagnostic test is not accidentally left ON. A message is also sent to the RS-232 channel to indicate that the diagnostic mode has been exited.

Table 5-1: Diagnostic Tests

TEST #	Name	Signal	Nominal Value
1.	NONE	No output	0 mV
2.	CO MEASURE	CO detector measure value	4500 mV
3.	CO REFERENCE	CO detector reference value	4200 mV
4.	SAMP PRESS	Sample pressure	3650 mV
5.	SAMP FLOW	Sample flowrate	2000 mV
6.	SAMP TEMP	Sample temperature	3000 mV
7.	BENCH TEMP	Optical bench temperature	3900 mV
8.	WHEEL TEMP	Outputs filter wheel temp.	3900 mV
9.	CHASSIS TEMP	Outputs Chassis temp	2740 mV
10.	DCPS VOLT	Outputs DC power	2500 mV
11.	DAS AVERAGE	Current DAS average	Any

5.2.1 Signal I/O

The signal I/O diagnostic mode gives the user access to the digital and analog inputs and outputs on the V/F board. The digital outputs can be controlled through the keyboard. Any signals manually changed through the signal I/O menu will remain in effect until you leave the signal I/O menu. At that time the analyzer will regain control of these signals. To enter the signal I/O test mode, press **SETUP-MORE-DIAG-ENTR**. When the diagnostic mode is entered, a message is sent to the RS-232 channel indicating entry into the diagnostic mode. Use the **PREV** and **NEXT** buttons to scroll through the signals. Edit buttons will appear for the signals that can be controlled by the user. Press **JUMP** to skip to a specific I/O Signal.

Table 5-2 lists the I/O signals available for the M300M.

Table 5-2: I/O Signals

#	Signal	Control	Description
0	DISP_BROWNOUT	NO	Display brownout is used to keep the display from getting corrupted during low line voltage conditions. Circuitry on the Power Supply board (00015) senses low line voltage and sets this bit. The CPU reads this and generates the BROWNOUT_RESET signal described below.
1	EXT_ZERO_CAL	NO	Shows state of status input bit to cause the M300M to enter Zero Calibration mode. Use to check external contact closure circuitry.
2	EXT_SPAN_CAL	NO	Shows state of status input bit to cause the M300M to enter the Span Calibration mode. Use to check external contact closure circuitry.
3	SYNC_OK	NO	Indicates that demodulation circuitry on the Sync/Demod Board (00798) is able to lock-in on the detector signal.
4	ZERO_SCRUB_VALVE	YES	Switches the Autozero scrubber valve. Use this bit to test the valve function.
5	CAL_VALVE	YES	Switches the Sample/Cal valve. Use this bit to test the valve function.
6	SPAN_VALVE	YES	Switches the ZERO/SPAN valve. Use this bit to test the valve function.
7	BENCH_HTR	YES	Shows the status of the optical bench heater. This has the same function as the LED in the power supply module.

(table continued)

Table 5-2: I/O Signals (Continued)

#	Signal	Control	Description
8	WHEEL_HTR	YES	Shows the status of the filter wheel heater. This has the same function as the LED in the power supply module.
9	DARK_CAL	YES	Turns off the detector input to the Sync/Demod board for electronics calibration.
10	ELEC_TEST	YES	Activates the Electric Test diagnostic circuitry
11	BROWNOUT_RESET	YES	Resets the DISP_BROWNOUT circuitry described above
12	ST_CONC_ALARM_1	YES	Status Bit - gas alarm 1 Logic high = M300M in alarm 1 mode Logic low = Not in alarm 1 mode
13	ST_CONC_ALARM_2	YES	Status Bit - gas alarm 2 Logic high = M300M in gas alarm 2 Logic low = Not in alarm 2 mode
14	ST_FLOW_ALARM	YES	Status Bit - Flow alarm Logic High = Sample flow out of spec Logic Low = Flows within spec
15	ST_TEMP_ALARM	YES	Status Bit - Temperature alarm Logic High = One or more temps out of spec Logic Low = Temps within spec
16	ST_DIAG_MODE	YES	Status Bit - In Diagnostic mode Logic High = M300M in Diagnostic mode Logic Low = Not in Diag mode
17	ST_POWER_OK	YES	Status Bit - Power OK Logic High = Instrument power is on Logic Low = Instrument power is off
18	ST_PRESS_ALARM	YES	Status Bit - Flow alarm Logic High = Sample pressure out of spec Logic Low = pressure within spec

(table continued)

Table 5-2: I/O Signals (Continued)

#	Signal	Control	Description
19	ST_HIGH_RANGE	YES	Status Bit - Autorange High Range Logic High = M300M in high range Logic Low = M300M in low range
20	ST_SYSTEM_OK	YES	Status Bit - System OK Logic High = No instrument warning present Logic Low = 1 or more alarm present
21	ST_BENCH_ALARM	YES	Status Bit - Bench Temperature Alarm Logic High = Bench Temp out of spec Logic Low = Bench Temp in spec
22	ST_SOURCE_ALARM	YES	Status Bit - IR Source Alarm Logic High = IR Source output too low Logic Low = IR Source output normal
23	ST_WHEEL_ALARM	YES	Status Bit - Wheel Temperature Alarm Logic High = Wheel Temp out of spec Logic Low = Wheel Temp in spec
24	CO_MEASURE	NO	IR detector reading during measure phase. Typically 2500 - 4500 mV.
25	CO_REFERENCE	NO	IR detector reading during reference phase. Typically 2500 - 4500 mV.
26	SAMPLE_PRESURE	NO	Sample pressure in mV. Typical sea level value = 4300 mV for 29.9" HG-A.
27	VACUUM_PRESSURE	NO	Sample flow in mV
28	SAMPLE_TEMP	NO	Sample temp in mV
29	BENCH_TEMP	NO	Optical Bench temp. typically 2270 mV for 48°C
30	WHEEL_TEMP	NO	Filter Wheel temp. typically 4770 mV for 68°C
31	BOX_TEMP	NO	Internal analyzer temp. in mV

(table continued)

Table 5-2: I/O Signals (Continued)

#	Signal	Control	Description
32	DCPS_VOLTAGE	NO	DC power supply composite voltage output. Typically 2500 mV.
33	DAC_CHAN_0	NO	Output of DAC 0(REC) in mV
34	DAC_CHAN_1	NO	Output of DAC 1(DAS) in mV
35	DAC_CHAN_2	NO	Output of DAC 2(TEST) in mV
36	DAC_CHAN_3	NO	Output of DAC 3(Spare) in mV
37	CONC_OUT_1	YES	CO Reading (REC) in mV
38	CONC_OUT_2	YES	CO Reading (DAS) in mV
39	TEST_OUTPUT	YES	Test Channel in mV
40	SAMPLE_LED	YES	Sample LED on/off
41	CAL_LED	YES	Calibration LED on/off
42	FAULT_LED	YES	Fault LED on/off

5.2.2 Analog Output Test

This test cycles the analog output channels from 0% to 100% of full scale in 20% full scale steps. It starts by outputting 0 volts to all channels and displaying a 0% button. Then, every five seconds, the output is increased 20% FS and the button is changed accordingly. Thus, the button (and the analog outputs) will cycle through the following value.

0%, 20%, 40%, 60%, 80%, 100%, 0%, ...

To pause the output at the current voltage, press the **n%** button. To resume automatic cycling, press the **n%** button again.

5.2.3 Electric Test

This test activates a diagnostic circuit located on the Synchronous Demodulator board which generates an artificial signal which simulates the output of the IR detector. This signal is injected in place of the detector output.

When activated, Electric Test will automatically switch the analyzer into a 5000 PPM range and result in the analyzer producing a constant, stable output (i.e. CO reading) of about 2500 PPM. This test is particularly useful in isolating problems, since it exercises essentially all electronic sub-systems of the analyzer but does not depend on the proper function of optical or pneumatic subsystems.

5.3 M300M Internal Variables

The M300M software contains many adjustable parameters. Many of the parameters are set at time of manufacture and do not need to be adjusted for the lifetime of the instrument. It is possible to change these variables either through the RS-232 port or the front panel. **Altering the values of many of the variables, especially those not listed on Table 5-3, will adversely affect the performance of the instrument.** Therefore it is recommended that these variables not be adjusted unless you have a clear understanding of the effects of the change.

To access the VARS menu press SETUP-VARS-ENTR. Use the PREV-NEXT button to select the variable of interest and press EDIT to examine/change the value, then press ENTR to save the new value. If no change is required, press EXIT.

Table 5-3: M300M Variables

No.	Name	Units	Default Value	Value Range	Description
0	DAS_HOLD_OFF	MIN	15	0 - 20	DAS hold off duration after calibration or diagnostic
1	DYN_ZERO		OFF	OFF/ON	Enable to adjust zero calibration through remote contact closure
2	DYN_SPAN		OFF	OFF/ON	Enable to adjust span calibration through remote contact closure
3	RS232_MODE	Bit Field	8	0 - 99999	Value is SUM of following decimal numbers: 1=enable quiet mode 2=enable computer mode 4=enable security feature 8=enable front panel RS-232 menus (API protocol) 16=enable alternate protocol 32=enables multi-drop support 64=Enable modem 4096=enable command prompt
4	CLOCK_ADJ	Sec.	0	±60	Real-time clock adjustment

INTENTIONALLY BLANK

6 HANDLING WARNINGS

When a system warning occurs, a warning message is displayed and the **FAULT LED** blinks. A warning indicates that something in the system needs to be checked or adjusted. Failure by the operator to respond to a warning may result in poor system performance and/or less accurate data acquisition. Warnings should be taken seriously. See Section 4.13 for the gas alarms.

When a warning is displayed, the **MSG** and **CLR** buttons will appear on the menu line (when not in setup mode). Pressing **MSG** will scroll through the warning messages if there is more than one. **CLR** will clear the currently displayed warning message, and if there are no more warning messages remaining, the **MSG** and **CLR** buttons will disappear and the FAULT LED will be turned OFF. If after pressing **CLR**, warning messages still exist, the FAULT LED will continue to blink and the **MSG** and **CLR** buttons will remain on the menu line.

If after clearing a message, the warning condition for that message still exists, the message will reappear after a period of time which depends on how frequently the condition is checked by the CPU (usually every few seconds). If a warning message reappears every time after **CLR** is pressed, the problem should be solved and the analyzer restarted. Some problems may be temporary and may not reappear after **CLR** is pressed (e.g. temperature too high, too low, etc.).

To ignore the warning messages and display the test measurement again, simply press **TEST**. The warning messages will remain active and may be viewed again by pressing **MSG**.

INTENTIONALLY BLANK

7 RS-232 COMMUNICATIONS

The Model 300M features a powerful RS-232 interface that is used both for reporting test results and for controlling the analyzer from a host computer. Because of the dual nature of the RS-232 interface, the message format has been carefully designed to accommodate both printers and host computers.

Setup from the Front Panel

There are 2 additional RS-232 setups that can be done via the front panel.

1. Set the Instrument ID number by SETUP-MORE-COMM-ID, and enter a 4 digit number from 0000-9999. This ID number is part of every message transmitted from the port.

2. Set the RS-232 mode bit field in the VARS menu. To get to the variable press, SETUP-MORE-VARS-ENTR and scroll to RS232_MODE, then press EDIT. The possible values are:

Table 7-1: RS-232 Port Setup - Front Panel

Decimal Value	Description
1	Turns on quiet mode (messages suppressed)
2	Places analyzer in computer mode (no echo of chars)
4	Enables Security Features (Logon, Logoff)
8	Enables RS-232 menus display on M300M front panel display
16	Enables alternate protocol and setup menu
32	Enables multi-drop support for RTS

NOTE

To enter the correct value, add the decimal values of the features you want to enable. For example if logon and front panel RS-232 menus were desired the value entered would be 4 + 8 = 12.

All message outputs from the Model 300M have the following format:

X DDD:HH:MM IIII MESSAGE<CRLF>

The "X" is a character indicating the message type (see Table 7-2).

Table 7-2: RS-232 Message Types

Character	Message Type
W	Warning
C	Control/status
D	Diagnostic
T	Test measurement
V	Variable value
?	HELP screen

The "DDD:HH:MM" is a time-stamp indicating the day-of-year ("DDD") as a number from 1 to 366, the hour of the day ("HH") as a number from 00 to 23, and the minute ("MM") as a number from 00 to 59.

The "IIII" is a 4-digit analyzer I.D. number.

The "MESSAGE" field contains variable information such as warning messages, test measurements, DAS reports, etc.

The "<CRLF>" is a carriage return-line feed combination which terminates the message and also makes the messages appear neatly on a printer.

Input messages to the Model 300M have a format which is similar to that for output messages:

X COMMAND<CRLF>

The "X" indicates the message type as shown above in Table 7-2 and "COMMAND" is the command type, each of which is described individually below.

The "<CRLF>" is used to terminate the command. Typing "<CRLF>" a few times by itself is a good way to clear the input buffer of any extraneous characters.

7.1 DAS Reporting

Data from individual Data Channels in the DAS system can be retrieved through the RS-232 interface. The command format for printing the data for a Data Channel is shown below:

D [id] REPORT “name” [RECORDS=number] [COMPACT|VERBOSE]

parameters in [ ] are optional

id is the analyzers ID number (**SETUP-MORE-COMM-ID**)

name is the Data Channel name(must be enclosed in quotes)

number is the number of records to print, beginning with the most recent (if this parameter is not specified then all available records for the Data Channel are printed)

COMPACT|VERBOSE refers to the report format

Verbose Data Report Format

There are two kinds of data reports: verbose (with a lot of detail) and compact (with just the data point values). The verbose format looks like the following:

D   31:10:06 0412 CONC : AVG COCNC1=6.8 PPM

This report uses the format of a leading first character ("D" in this example), a time stamp ("31:10:06"), and the instrument ID ("0412").

The other fields in the report are the data collector name ("CONC"), the sampling mode ("AVG"), the data point ("COCNC1"), the data point value ("6.8"), and the units ("PPM"). Due to the length of the message, only one data point may be printed per line.

Compact Data Report Format

The compact format looks like the following:

D   31:10:06 0412 CONC : 1 6.8

The fields up to the colon are the same as for the verbose format, but the next fields are different. The fields following the colon are the line number ("1" in the example), and the data point value ("6.8"). Presumably the user (or remote computer) knows all of the other information about the data point value.

This report format is particularly useful when you are sampling more than one data point because up to five data points may be printed per line. The line number field is necessary because a single report may span multiple lines. A compact report with two data points, such as the PNUMTC Data Channel, looks like this:

D   31:10:06 0412 PNUMTC: 1 800.0 29.7

Example 1: To report the last 100 records from the CONC Data Channel in Verbose format type:

D REPORT "CONC" RECORDS=100 VERBOSE

Example 2: To report all the records from the PNUMTC Data Channel in Compact format type:

D REPORT "PNUMTC" COMPACT

7.2 Warnings

Whenever a warning message is displayed on the display, it is also sent to the RS-232 output. See Table 2-4 for a list of the warning messages. These messages are very helpful when trying to track down a system problem and for determining whether or not DAS average data is actually valid. The message format is:

W DDD:HH:MM IIII WARNING MESSAGE<CRLF>

An example of an actual warning message is:

W 194:11:03 0000 SAMPLE FLOW WARN<CRLF>

Warnings may be cleared via the RS-232 interface by issuing a command of the form:

W COMMAND<CRLF>

Where "COMMAND" indicates which warning message to clear. For example, to clear the "SAMPLE FLOW WARN" message, the host computer can issue the command:

W WSMPFLOW<CRLF>

Attempting to clear a warning which is not active has no effect. The Table 7-3 lists the command to use to clear each possible warning message.

Table 7-3: RS-232 Warning Message Clear Commands

Command	Warning Message Cleared
"W WSYSRES<CRLF>"	SYSTEM RESET
"W WRAMINIT<CRLF>"	RAM INITIALIZED
"W WSOURCE<CRLF>"	SOURCE WARNING
"W WSUTOZERO<CRLF>"	AUTOZERO WARNING
"W WBENCHTEMP<CRLF>"	BENCH TEMP WARNING
"W WWHEELTEMP<CRLF>"	WHEEL TEMP WARNING
"W WSAMPFLOW<CRLF>"	SAMPLE FLOW WARNING
"W WSAMPPRESS<CRLF>"	SAMPLE PRESSURE WARNING
"W WASMPTEMP<CRLF>"	SAMPLE TEMP WARNING
"W WBOXTEMP<CRLF>"	BOX TEMP WARNING
"W WSYNC<CRLF>"	SYNC WARNING
"W WDCPS<CRLF>"	DCPS WARNING
"W WDYNZERO<CRLF>"	CANNOT DYN ZERO
"W WDYNSPAN<CRLF>"	CANNOT DYN SPAN
"W WVFDET<CRLF>"	V/F NOT INSTALLED

7.3 Status/Control

This subset of messages is concerned with reporting the status of the analyzer and controlling the analyzer remotely. Whenever the analyzer does a calibration it issues a report to the RS-232 output. The table on the following page summarizes the status reports.

Table 7-4: Status Reports

Report
"C DDD:HH:MM IIII START ZERO CALIBRATION"
"C DDD:HH:MM IIII FINISH ZERO CALIBRATION"
"C DDD:HH:MM IIII START SPAN CALIBRATION"
"C DDD:HH:MM IIII FINISH SPAN CALIBRATION"
"C DDD:HH:MM IIII START MULTI-POINT CALIBRATION"
"C DDD:HH:MM IIII FINISH MULTI-POINT CALIBRATION"
"C DDD:HH:MM IIII START CALIBRATION HOLD"
"C DDD:HH:MM IIII FINISH CALIBRATION HOLD"

To do a remote adjustment via the RS-232 interface, the host computer should issue a message with the following format:

C COMMAND<CRLF>

The commands are summarized in Table 7-5.

Table 7-5: Control Commands

Command Message	Meaning
"C ZERO<CRLF>"	Do a zero check
"C COMPUTE ZERO<CRLF>"	Calibrate Zero point[1]
"C SPAN<CRLF>"	Do a span check
"C COMPUTE SPAN<CRLF>"	Calibrate Span point[1]
"C ASEQ1<CRLF>"	Do a auto-cal sequence[2]
"C ASEQ2<CRLF>"	Do a auto-cal sequence[2]
"C ASEQ3<CRLF>"	Do a auto-cal sequence[2]
"C ABORT<CRLF>"	Aborts auto-cal sequence
"C EXITZ<CRLF>"	Exit zero cal only
"C EXITS<CRLF>"	Exit span cal only
"C EXIT<CRLF>"	Exit zero span or hold

[1] Executed only if the instrument is in the proper calibration mode and concentration is within calibration limits. This command adjusts slope and offset values.

[2] Initiated only If automatic calibration sequence setup is programmed and enabled.

NOTE

The commands in Table 7-5 can only be entered via the RS-232 port when the analyzer is in the sample mode.

When a control command is issued, the CPU will respond by issuing a status report. For example if the host computer issues the command.

C CALZ<CRLF>

to do a zero check, the CPU will send the status report

C DDD:HH:MM IIII START ZERO CALIBRATION<CRLF>

to the RS-232 output.

7.4 Diagnostics

The diagnostics mode can be entered from the RS-232 port as well as from the front panel. The diagnostics commands available are listed on Table 7-6.

Table 7-6: Diagnostic Commands

Command	Function
D ENTER SIG	Enter diagnostic Signal I/O mode
D EXIT	Exit diagnostics mode
D LIST	Prints all Signal I/O values. See Table 5-2 for Signal Definitions
D name[=value]	Examines or sets I/O signal. See Table 5-2 for a list of signals. Must issue D ENTER SIG before using this command.

NOTE

The diagnostics mode may only be entered via the RS-232 port when the analyzer is in sample mode.

These commands may be used whether the diagnostics have been entered from the keyboard (SETUP-DIAG) or the RS-232 ("D ENTER <CRLF>"). However, when the diagnostics are entered via the keyboard, no feedback is sent to the RS-232 channel. This prevents the RS-232 output from getting unnecessarily cluttered with diagnostic data.

Whenever the diagnostic mode is entered or exited, a report is issued to the RS-232 output. The table below summarizes the diagnostic reports.

Table 7-7: Diagnostic Reports

Report
"C DDD:HH:MM IIII ENTER DIAGNOSTIC MODE"
"C DDD:HH:MM IIII EXIT DIAGNOSTIC MODE"

7.5 Test Measurements

All the test measurements which can be displayed by pressing the TEST button are also available to the host computer via the RS-232 interface. The host computer should issue a request for a test measurement, and then the CPU will send the current value of the test measurement to the RS-232 output. The format of the test measurement message is:

T DDD:HH:MM IIII TEST MEASUREMENT<CRLF>

For example, the format of the DC Power Supply output in mV would be:

T 194:11:29 0000 DCPS= 2500 MV<CRLF>

To request a test measurement, the host must issue a command of the form:

T MEASUREMENT<CRLF>

For a summary of all test functions issue the command "T LIST". Table 7-8 lists the commands and the corresponding test measurements which will be returned.

Table 7-8: Test Measurement Request Commands

Command	Test Measurement
"?<CRLF>"	RS-232 HELP screen
"T LIST<CRLF>"	Summary of all TEST's
"T CO<CRLF>"	Current CO reading
"T COMEAS<CRLF>"	Current CO MEAS mV
"T COREF<CRLF>"	Current CO REF mV
"T MRRATIO<CRLF>"	Current MR RATIO
"T SAMPPRESS<CRLF>"	Sample pressure
"T VACUUM<CRLF>"	Vacuum pressure
"T SAMPFLOW<CRLF>"	Sample flow rate
"T SAMPTEMP<CRLF>"	Sample temperature
"T BENCHTEMP<CRLF>"	Optical Bench temperature
"T WHEELTEMP<CRLF>"	Filter Wheel temperature
"T BOXTEMP<CRLF>"	Internal box temperature
"T DCPS<CRLF>"	DC power supply output
"T COSLOPE<CRLF>"	Slope value
"T COOFFSET<CRLF>"	Offset value
"T CLOCKTIME<CRLF>"	Current time-of-day

7.6 Viewing and Modifying Variables

The most powerful feature of the RS-232 interface is the ability of a host computer to view and modify the analyzer's internal variables. Just as the operator modifies the variables by means of the setup mode, the host computer modifies them by means of the RS-232 interface.

To view a variable's value, the host computer issues a command of the following format:

V VARIABLE<CRLF>

The CPU will respond by sending a message of the following format to the RS-232 output:

V VARIABLE=VALUE WARNLO WARNHI <DATALO-DATAHI> <CRLF>

In both cases "VARIABLE" is the name of the variable that is being viewed. "VALUE" is the current value of the variable. "WARNLO" and "WARNHI" are the low and high warning limits, respectively, but may not appear for all variables since some variables do not have warning limits. "DATALO" and "DATAHI" are the low and high data entry limits, respectively, and are given for all variables. The CPU will not set a variable's value or warning limits to values that are outside of the data entry limits.

For example, to see the optical bench temperature set point, the host computer would issue the command:

V BENCH_SET<CRLF>

the CPU would respond with something like:

V DDD:HH:MM IIII BENCH_SET=50 45 55 <0-100> <CRLF>

indicating that the current set point is 50 degrees, the warning limits are 45 to 55 degrees, and the data entry limits are 0 to 100 degrees.

To modify a variable's value, almost the same format of command is used:

V VARIABLE=VALUE WARNLO WARNHI<CRLF>

The "VARIABLE" field is the name of the variable being modified, and the "VALUE" field is the new value. "WARNLO" and "WARNHI" are the low and high warning limits, respectively, and may only be given if the variable uses warning limits. They are optional for variables that use warning limits and, if not given, the warning limits are not changed.

After changing the variable's value, the CPU will respond with:

V VARIABLE=VALUE WARNLO WARNHI [DATALO-DATAHI] <CRLF>

which should reflect the new value. The values in square brackets are not required for all variables. If needed, the values are included on the command line, separated by spaces. For example, to change the instrument ID, the host computer would issue a command like this:

V MACHINE_ID=1234<CRLF>

and the CPU should respond with:

V DDD:HH:MM IIII MACHINE_ID = 1234 (0-9999)<CRLF>

Table 7-9 lists the variable names that are variable through the RS-232 interface and their corresponding button sequences.

Table 7-9: RS-232 Variable Names

Variable Name	Button Sequence	Legal Values
MACHINE_ID	SETUP-MORE-COMM-ID	0000 - 9999
BAUD_RATE	SETUP-MORE-COMM-BAUD	300, 1200, 2400, 4800, 9600, 19.2
CURR_TIME	SETUP-CLK-TIME	00:00 - 23:59
CURR_DATE	SETUP-CLK-DATE	01/01/00 - 12/31/99

8 CALIBRATION

This section describes a method of performing a multi-point calibration of the Model 300M CO Analyzer and a method of performing a zero-span check.

8.1 Required Equipment and Gas Standards

Zero air must be free of CO (less than 0.1 PPM of CO).

CAUTION

Be careful when pulling in outside air particularly if outside humidity and temperature are high. Condensation may result which can lead to unstable operation, or at worst, water contamination in the cell.

Calibration gas concentrations must be generated from an NIST-traceable cylinder of CO -in-air. Carrier air for transporting the CO must be the same as the zero air. A suggested calibration gas generating system is shown in Figure 8-1.

The materials in the calibration gas delivery system should be stainless steel, TFE and FEP (Teflon). The system must be clean.

The calibration gas delivery system (or manifold) must be properly vented to a suitable vent outside the analyzer area and near the analyzer inlet to avoid imposing a pressure or vacuum at the inlet. The recommended venting method is shown in Figure 8-2.

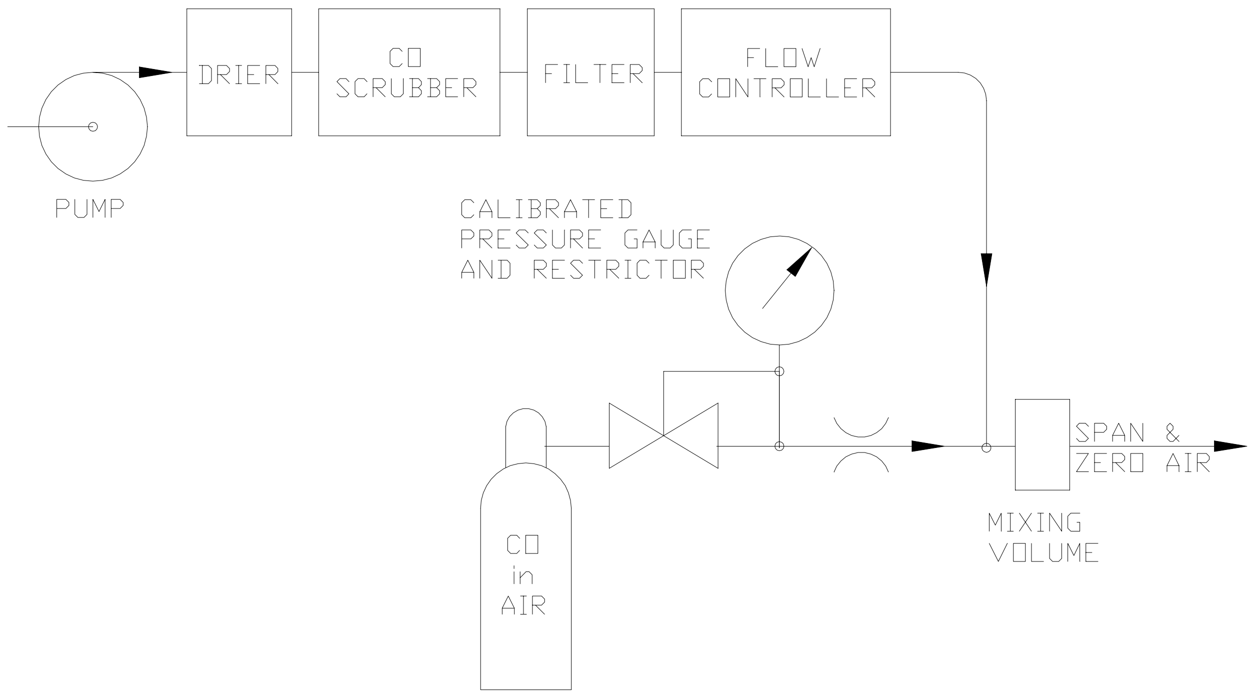

Figure 8-1: Gas Generation System

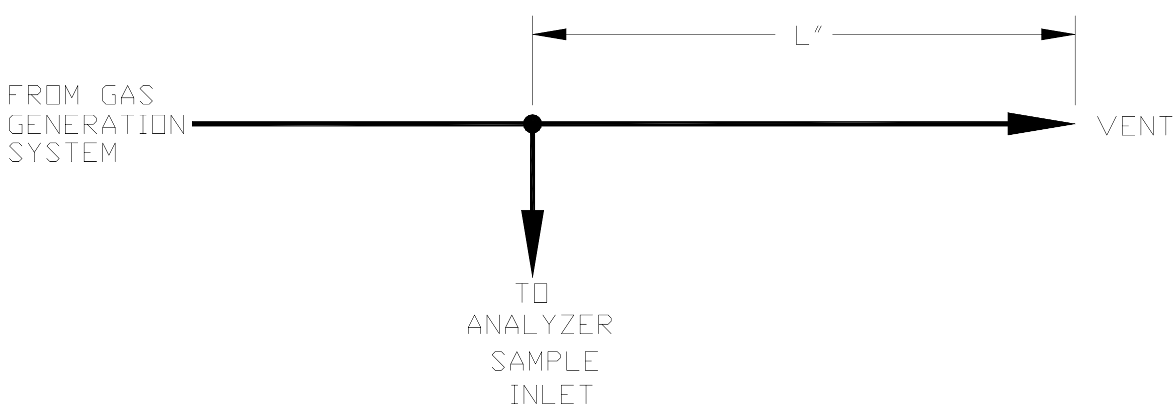

Figure 8-2: Inlet Venting Recommendations

For minimum back-diffusion through the vent and for minimum back-pressure in the manifold, the following relationship should be met:

$$\frac{Q_v \times L}{Q_a \times D} = 500$$

Where Q_v is the vent flow in cc/min

Q_a is the analyzer flow in cc/min

L is the vent line length in inches

D is the ID of the vent line in inches

For Q_v of 1000 cc/min

Q_a of 800 cc/min

D of .188 inches

L = approximately 72”

8.2 Multi-Point Calibration

Multi-point calibration requires seven approximately equally spaced calibration points, including zero, using an NIST-traceable CO source.

The calibration must be carried out:

1. After maintenance
2. Every three months (recommended)

CAUTION

The test gas must be introduced into the analyzer through the sample inlet port. All flow measurement devices must be calibrated against an nist-traceable standard such as a bubble-flowmeter that has been calibrated against an nist-traceable volume standard.

There are two acceptable methods of generating accurate CO concentrations for calibrating the Model 300M.

One method uses a single cylinder of CO -in-air and a means of accurately diluting the cylinder gas with zero air. This is illustrated in Figure 8-1. Alternatively, several cylinders of CO -in-air, of appropriate concentrations, may be used without dilution. The cylinder concentrations must be traceable to NIST standards. Flow correction for standard temperature and pressure (STP) is not required with either method. With dilution, the correction is self-canceling. With the multi-cylinder method, the correction is not applicable.

8.2.1 Procedure

1. Set the analyzer to the desired range.
2. Set the calibration system to deliver a flow of at least 1000 cc/min. The Model 300M draws approximately 800 cc/min. (See Section 8.1 and Figure 8-2 for vent flow calculation.)
3. Pre-calculate the calibrator flow to be sure that a CO concentration of 80% of URL (upper range limit) can be produced with enough surplus flow to provide an adequate vent flow.
4. Connect the analyzer REC (recorder) terminals to a calibrated strip-chart recorder. For best accuracy, connect a DVM to the same terminals or to the DAS (Data Acquisition System) terminals.

The standard output voltage of 0-5.0 VDC.

If, in service, data is to be collected from a device (printer) connected to the RS-232 port, then the calibration data must be collected from the RS-232 port.

5. Set the calibrator to deliver zero air to the manifold.
6. Push “CAL” on the analyzer front panel.
7. Enter password. (If Enabled)
8. Wait 10 minutes for the analyzer to stabilize.
9. Push “ZERO” and “ENTR” on the front panel. The analyzer is now “zeroed.”
10. Push “EXIT”. (Return to sample mode.)
11. Record the DVM reading and the percentage chart reading or the RS-232 output.
12. Set the calibrator to produce 75% to 85% of the URL (upper range limit). This will be 400 PPM ±25 PPM on the 500 PPM range.

13. Allow the analyzer to sample the CO concentration.

14. Push “CAL”.

15. Enter password. (If enabled)

16. Push “CONC”.

17. Change the span value in the display to the calculated CO concentration in the manifold in PPM units, and push “ENTR”.

18. Wait 10 minutes for the analyzer to stabilize.

19. Push “SPAN” and “ENTER.” The analyzer is now spanned. Record the calculated CO concentration, the DVM reading and the percentage chart reading, or the RS-232 output.

20. Push “EXIT,” “EXIT.” The analyzer is now returned to the normal Sample mode.

21. Introduce at least five (5) more approximately evenly spaced CO concentrations into the manifold to complete the manual calibration.

22. Record all calculated CO concentrations, DVM reading and strip-chart recorder readings or RS-232 output readings.

23. Plot the calculated CO concentrations (X-axis) versus output voltages and/or percentage chart readings (Y-axis).

Calculate the curve equations:

[CO] PPM = (Volts - ***b***) / ***m***

where ***b*** is the offset (should be within ± 0.05 volts of zero setting)

and ***m*** is the slope (should be .98 to 1.02 based on 0-5 V full scale)

or

[CO] = (% chart - ***b***) / ***m***

(***b*** should be within ±1% of chart and ***m*** should be 1.96 to 2.04)

The correlation coefficient should be 0.998 or higher.

The analyzer is now calibrated. All CO concentration data should be obtained by reading the analyzer output in volts or percentage of chart and converting to PPM from the appropriate equation or curve.

If poor correlation exists, check for

1. Flow calculation errors
2. Concentration calculation errors
3. Leaks in manifold
4. Dirt in the manifold
5. Proper manifold venting
6. Zero air system

If none of these help, see the TROUBLESHOOTING SECTION 10.

Record all the analyzer setup data from the display.

Range

DCPS

Box Temp

Wheel Temp

Bench Temp

Sample Temp

Sample Flow

Sample Pressure

Vacuum Pressure

MR ratio (Measure/reference ratio)

CO Reference

CO Measure

These data can be useful in future troubleshooting.

8.3 Zero/Span Checking

It is recommended that the Model 300M be checked daily for zero and span drift.

With the **Automatic Zero/Span Check** and **Remote Zero/Span Check** features of the Model 300M, daily zero and span checks are easy.

For **Automatic Zero/Span Check** and **Remote Zero/Span Check** to be effective, it is necessary that the analyzer have the Zero/Span valve option. This option includes the two three-way stainless steel valves and requires user-supplied sources of zero air and span gas delivered at ambient pressure.

Operating instructions for **Automatic Zero/Span Check** and **Remote Zero/Span Check** are described in Sections 3.3 through 3.6.

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9 ADJUSTMENTS

NOTE

The operations outlined in this chapter are to be performed by qualified maintenance personnel only.

All adjustments to the Model 300M are easy to make. Pots and test points are readily accessible without removing any components. Figure 1-2 is a plan view of the Model 300M CO analyzer showing all the major components. Figure 9-1 is an electrical block diagram of Model 300M CO Analyzer.

9.1 Power Supply Board Adjustment

The power supply board provides ±15 v, +12 v, and +5 v DC power to the analyzer. Also four temperature linearization circuits for the bench temperature, sample temperature, box temperature, and the gas wheel temperature are located on the power supply board.

Each circuit is a Whetstone bridge with the measuring thermistor being one leg. A feedback circuit performs the required linearization. Zero adjust pots have been factory set and no field adjustment should be required.

9.1.1 Box Temperature Limits

The box temperature is measured by a thermistor located on the motherboard. The box temperature is not controlled in the Model 300M. The temperature is measured and displayed as a TEST function on the front panel (see Section 5.1). The alarm limits can be set via an RS-232 port command.

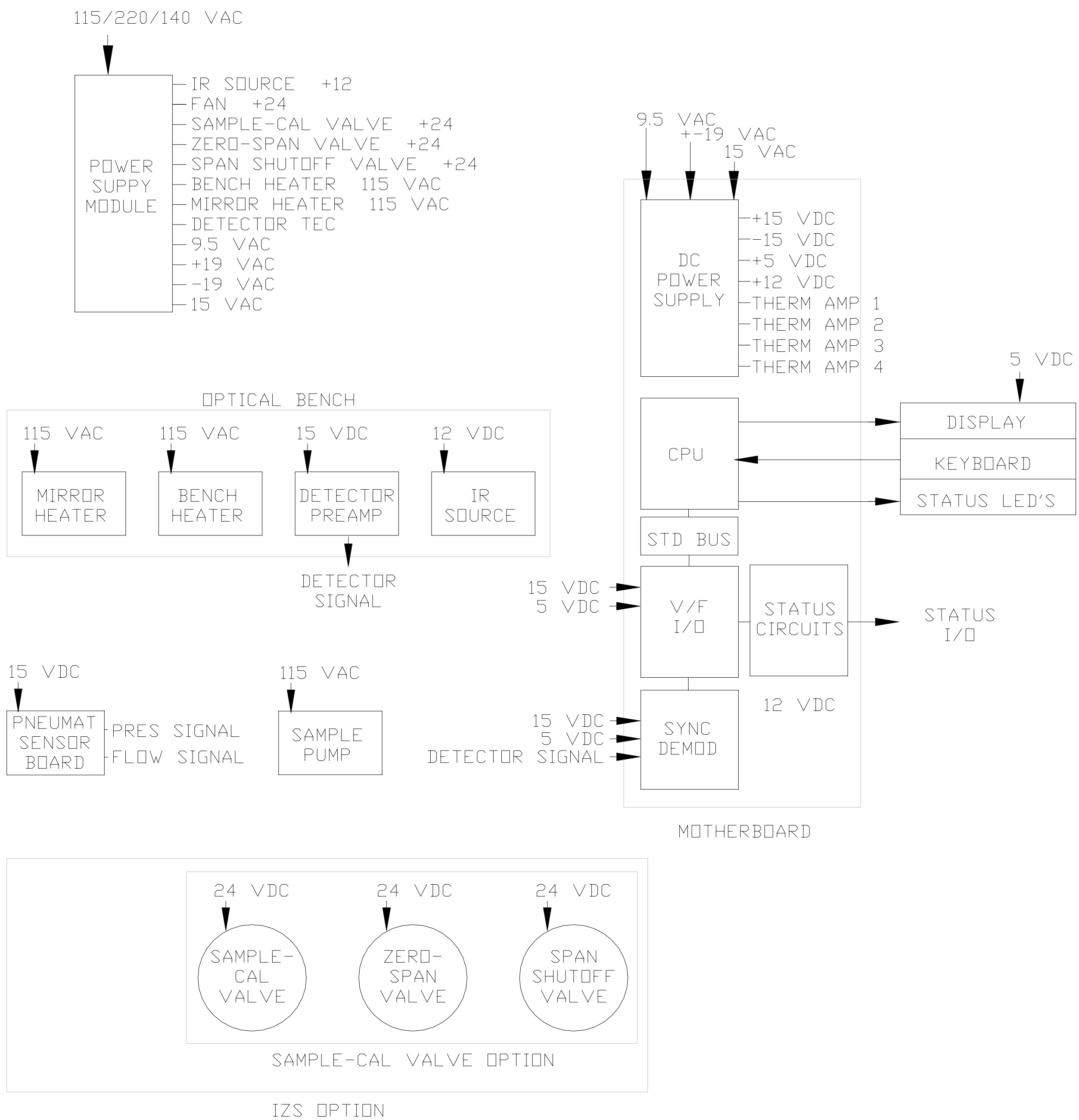

Figure 9-1: M300M Electrical Block Diagram

9.2 A/D - D/A Calibration Procedure

Due to the stability of modern electronics, this procedure should not have to be performed more than once a year or whenever a major sub-assembly is exchanged or whenever analog output voltage range is changed.

To calibrate the voltage output, do the following: 4 - 20 mA current output calibration procedure should follow after voltage calibration.

1. Press SETUP-MORE-DIAG.
2. Enter Diagnostic password and press NEXT until D/A CALIBRATION appears in the display and press ENTR.
3. Press ADC to perform the A/D Cal.
4. The M300M display will read "ADJUST ZERO:A/D=xx.x MV." Put the probe of a voltmeter between TP3 (AGND) and TP9 (DAC #0) on the top of the V/F card (See Drawing 00514, Appendix C).
5. The value displayed by the voltmeter should be close (± 2 mV) to the value on the M300M display. If they are not close then the V/F card has probably been configured improperly.
6. Adjust the Zero pot (R27) on the V/F card until the value on the M300M display matches the value on the voltmeter to within ± 2 mV.

NOTE

When adjusting R27, the value on the M300M display will change, the value on the voltmeter will remain constant.

7. Press ENTR.
8. The M300M display will now read "ADJUST GAIN:A/D=xx.x MV."
9. Adjust the Span pot (R31) on the V/F card until the value on the M300M display matches the value on the voltmeter to within ± 2 mV.
10. Press ENTR.
11. The ADC is now calibrated and the M300M will automatically calibrate all the DAC's. This process takes only a few seconds.
12. Press EXIT 4 times to return to the sample menu.

To calibrate the 4-20 mA current output, do the following:

Verify 5 volt output DIP switch setting (refer to Table 10-4) for 4-20 mA output, since the input voltage of the 4-20 mA IC is configured for 0 - 5 volt range, before proceeding following procedure. Verify the jumper setting on the motherboard from 2-3 to 1-2.

1. Connect the 200 - 450 ohm resistor to the 4-20 mA recorder output (refer to Figure 1-3). Connect in series the DC current meter between the resistor and other terminal of the recorder output with proper polarity.

2. Press SETUP-DIAG-ENTR and scroll down to the D/A CALIBRATION diagnostic mode, press ENTR to start the procedure. Press CFG and scroll by pressing NEXT to select current output channel (1), press SET-CURR-ENTR to define current output channel. Press EXIT. Now channel 1 is defined as current output.

3. Press CAL to start the current output calibration. The M300M display will read "CAL CONC_OUT_1,CURR,ZERO", where CURR means current output and ZERO means zero analog output calibration. Press UP (UP10, U100) or DOWN (DN10, D100) buttons on the front panel until the current meter displays 4.0 mA (±0.1 mA). When the current meter shows a stable 4.0 ± 0.1 mA, press ENTR.

4. The M300M display will now show "CAL CONC_OUT_1, CURR, GAIN". As before, press the up/down buttons on the M300M front panel until the current meter reads 20.0 ± 0.1 mA.

5. When completed press EXIT to return to upper level menus.

6. Verify that the analog output is correct by performing SETUP-DIAG-ANALOG OUTPUT. The current meter should read 4, 7.2, 10.4, 13.6, 16.8, and 20 mA accordingly.

9.3 Dark Current Signal Adjust Procedure

The detector dark current change is negligible as the detector ages. Therefore this procedure should not need to be performed more than once per year or whenever a major sub-assembly is changed. To calibrate the dark current signal, press **SETUP-MORE-DIAG-DARK-CAL** and the analyzer will automatically do the following:

1. Disconnect the detector output from the signal processing electronics.
2. Wait 2 minutes for electronics to stabilize at the dark value.
3. Average CO MEAS and CO REF reading for 1 minute.
4. Reconnect the detector output to the processing electronics to the processing electronics.

The average CO MEAS and CO REF dark reading are stored as offsets which are subtracted from all future CO detector readings.

Press **SETUP-MORE-DARK-VIEW** to view the current dark offset**.** Typical dark offset value is 125 ± 50 mV. Press **EXIT** when finished. No password is required to view the dark offset, only to change it.

9.4 Output Voltage Range Changes

Output voltage ranges are set by DIP Switch settings on the V/F board. To change the range for the analog outputs:

1. Turn off instrument power. Remove the instrument cover. Locate the V/F board near the top of the drawing using Figure 1-2.
2. Locate switches S1, S2, and S3 along the top edge of the card. Select the desired range by setting the switches as shown in Table 10-4.

NOTE

To adjust analog recorder offset, see Section 4.7.

9.5 Flow Readout Adjustment

The flow/pressure sensor board consists of 2 pressure sensors. The flow rate value is computed from these two pressure sensors and displayed on the front panel TEST function including two pressure readings. They are:

1. Inlet sample gas pressure - sensor S1
2. Vacuum pressure - sensor S2

The above pressures and flow are filtered to produce the front panel readings. Several minutes may be required for a steady reading if observing the TEST functions.

1. Check pressure:
   A. Remove the 1/4" fitting from the pump inlet.
   B. Check the readings of VAC or PRES of the TEST functions.
   C. Check if the pressure readings are close to the current absolute ambient pressure (typical value at sea level is 29.9 in-Hg). Notice that it must be absolute pressure reading. Check if both readings do not differ more than 2% from each other. Replace the pressure/flow sensor board if defective.
2. Check Flow rate:

   To check the sample flow, proceed as follows:

   A. Scroll to select SAMP FL of the TEST functions.
   B. Using calibrated independent flowmeter, verify the flow rate into the optical bench.
   C. If the actual flow differs more than 10% on the displayed flow, proceed to flow calibration.
3. Flow calibration:
   A. Press SETUP-MORE-DIAG-ENTR and scroll to select FLOW CALIBRATION and press ENTR.
   B. Enter the actual flow value of independent flowmeter.

9.6 DC Power Supply

Overall performance of the DC power supply may be checked by observing the value displayed during test DCPS. If this value, a composite of the five (5) regulator outputs, deviates by more than 10% from the value recorded in Table 1-1 of this manual under Test Values, the outputs of the individual regulators should be measured.

Test points 1, 2, 3 and 4 provide connection to the temperature outputs on drawing no. 00016 in Appendix C.

9.7 CPU

If the display is operating and the green sample light is on, the CPU should be operating. If not, check for +5 v to the CPU. Refer to Section 10.6.4 Checking DC power supply.

CAUTION

Do not disconnect CPU or other digital cards while under power.

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10 TROUBLESHOOTING

NOTE

The operations outlined in this chapter are to be performed by qualified maintenance personnel only.

10.1 Overview

The Model 300M has been designed to rapidly detect possible problems and allow their quick evaluation and repair. During operation, the analyzer continuously performs self-check diagnostics and provides the ability to monitor the key operating parameters of the instrument without disturbing monitoring operations. These capabilities will usually allow the quick isolation and resolution of a problem.

A systematic approach to troubleshooting will generally consist of the following four steps, performed in order:

1. Confirm the proper operation of fundamental instrument sub-systems (Power Supplies, CPU, Display).

2. Note any warning messages and take corrective action as required.

3. Examine the values of all TEST functions and compare to factory values. Note any major deviations from the factory values and take correction action as required.

4. Address any dynamic (sample related) problems.

The following sections provide a guide for performing each of these steps. Figure 1-2 in this manual shows the general layout of components and sub-assemblies in the analyzer and can be referenced in performing the checks described in the following sections.

10.2 Troubleshooting Fundamental Analyzer Operation

When the analyzer is turned on, several actions will normally occur which indicate the proper functioning of basic instrument sub-systems. These actions are:

1. The sample pump should start.
2. The green sample light on the front panel should turn on.
3. The display should energize and display a log-on message followed by a standard “Sample" display (See Figure 2-2 for illustration of a normal display).

If these actions all occur, it is probable that the analyzer's Power Supplies, CPU, and Display are working properly.

If any of these actions fail to occur, power and/or CPU operation should be checked as follows:

10.2.1 Checking the Power Sub-Systems

WARNING

Hazardous voltages exist within the instrument chassis - use caution.

1. Check incoming line power for proper Voltage and Frequency.
2. Check the Circuit breaker on the analyzer's rear panel.
3. Check the 3-wire safety power-input plug on the analyzer's rear panel.
4. Check for proper internal AC power by confirming that the Red (right-most) LED on the Power Supply Module is lit. If this LED is not lit, replace the fuse at the bottom center of the Power Supply Module.
5. Check for proper DC Voltages by measuring for the following voltages on the V/F Board:

   +5 V between TP4 and TP5

   +15 V between TP1 and TP3

   -15 V between TP2 and TP3

   If any of these voltages are incorrect, check the DC Power Supply as described in Section 10.6.4.

10.2.2 Checking the CPU and Display

When the analyzer is turned on, the front panel display should energize and the green "Sample" LED should light. If proper DC power is present (see Section 10.2.1), the absence of these actions will usually indicate either a CPU or Display failure. To determine which module is defective, perform the following procedure:

1. Turn off power.
2. Remove the ribbon cable from the CPU board to the Display.
3. Turn Power on.
4. A cursor character should appear in the upper left corner of the display. If it does not, the display is defective and should be replaced. If the cursor does appear, it is probable that the CPU is faulty.

10.2.3 Checking the Keyboard

During normal analyzer operation, depressing the right most key of the keyboard should cause a change of display modes. If it does not, check:

1. Cable connections
2. CPU and Display operation (see Section 10.2.2)

If these checks are satisfactory, it is probable that the keyboard is defective and should be replaced.

10.3 Troubleshooting Using Warning Messages

The most common and/or serious instrument failures will result in a warning message (or messages) being displayed on the front panel. Table 10-1 lists the warning messages which the analyzer may display, along with their meaning and the recommended corrective action. It should be noted that if multiple (more than 2 or 3) warning messages occur at the same time, it is often an indication that some fundamental analyzer sub-system (power supply, V/F board, CPU) has failed rather than an indication of the multiple failures referenced by the warnings. In this situation, it is recommended that proper operation of power supplies (see Section 10.6.4) and the V/F Board (see Section 10.6.3) be confirmed before addressing the specific warning messages.

Table 10-1: Warning Messages

Warning Message	Meaning	Corrective Action
SOURCE WARNING	The CO REF value is greater than 5000 mV or less than 2500 mV	Check and adjust the Sync Demodulator and optical alignment as described in Section 10.6.6 and 10.6.5
SYNC ERROR	No modulation is present on the output of the IR detector.	Check IR source, IR detector/pre-amp, and Opto interrupter
BENCH HEAT SHUTDOWN	Temperature control of the Optical bench cannot be maintained at its 48°C set point	Check Optical Bench heater and thermistor
SAMPLE PRESSURE WARNING	The Sample Pressure is less than 15"Hg or is greater than 35"Hg	Check for pressure transducer problems as described in Section 10.6.5 and Section 10.6.1
SAMPLE FLOW WARNING	The sample flow is less than 500 cc/min or greater than 1200 cc/min.	Check for pneumatic system problems as described in Section 10.6.1. Check for flow transducer problems as described in Section 10.6.5
BOX TEMP WARNING	The inside chassis temp is less than 10°C or is greater than 50°C	See Section 10.6.2
SAMPLE TEMP WARNING	The Sample Temperature is less than 10°C or is greater than 50°C	See Section 10.6.2
CANNOT DYN ZERO	An offset of more than ±5 PPM would be required to Zero adjust the analyzer	See Section 10.5.5
CANNOT DYN SPAN	A slope of less than 0.5 or greater than 2.0 would be required to Span adjust the analyzer	See Section 10.5.6
V/F NOT INSTALLED	The CPU is unable to communicate with the V/F Board	Check and re-seat CPU and V/F board. See Section 10.6.3
SYSTEM RESET	A power Off-On cycle has occurred	None required
RAM INITIALIZED	Dynamic memory has been re-initialized in response to the installation of a new PROM or memory chip	None required

NOTE

If the value of any test function is displayed as “XXXX”, this indicates that the reading is off scale or otherwise non-valid.

10.4 Troubleshooting Using Test Function Values

The Model 300M provides the capability to display, on operator demand, the values of Test Functions which allow the observation of key analyzer operating parameters. These Test Functions can be accessed by depressing the TEST Button on the instrument's front panel causing the next test function to be displayed. By comparing the values of Test Functions to acceptable operating limits, it is possible to quickly isolate and correct most problems.

Table 10-2 provides a list of available Test Functions along with their meaning, their range of acceptable values, and the recommended corrective actions if the value is not in the acceptable range. Additionally, Table 1-1 in this manual provides a list of the values of all Test Functions at the time the analyzer left the factory.

Table 10-2: Test Function Values

Test Function	Meaning	Acceptable Values	Corrective Action for Unacceptable Values
RANGE	The Current Full Scale Range Setting of the analyzer's analog outputs	Any	None required
CO MEAS	The most recent detector reading taken in Measure mode	2500-4800 mV	Check and adjust IR source and Sync Demodulator as described in Section 10.6.5 and 10.6.6
CO REF	The most recent detector reading taken in Reference mode	2500 - 4800 mV	Check and adjust IR source and Sync Demodulator as described in Section 10.6.5 and 10.6.6
MR RATIO	The ratio of the CO MEAS value to CO REF value	1.00 - 1.5	Check CO REF and CO MEAS values as described above.
PRES	The absolute pressure of the sample gas in the absorption cell	0" - 1.0" Hg below ambient pressure	Check for pneumatic system problems. See Section 10.6.1. Check for pressure transducer problems. See Section 10.6.5
SAMPLE FLOW	Sample flow rate	700 - 900 sec/min	Check for pneumatic system problems. See Section 10.6.1. Check for flowmeter problems. See Section 10.6.5
SAMPLE TEMP	The temperature of the sample gas in the absorption cell	30° - 50°C (After warm-up)	See Section 10.6.2
BENCH TEMP	The temperature of the Optical Bench	50°C (After warm-up)	See Section 10.6.2
WHEEL TEMP	The temperature of the Gas Filter Wheel	68°C (After warm-up)	See Section 10.6.2
BOX TEMP	The temperature inside the analyzer chassis	up to 10°C above ambient	See Section 10.6.2
DCPS	DC Power Supply reference - A composite of all voltages provided by the DC Power Supply	2500 ± 200 mV	See Section 10.6.4

10.5 Troubleshooting Dynamic Problems

Dynamic problems (i.e. problems which only manifest themselves when the analyzer is monitoring sample gas) can be the most difficult and time consuming to isolate and resolve. Additionally, analyzer behavior that appears to be a dynamic problem is often a symptom of a seemingly unrelated static problem. For these reasons, it is recommended that dynamic problems not be addressed until all static problems and warning conditions, as described in the preceding sections, have been isolated and resolved.

If all the checks described in the preceding sections have been successfully performed, the following will provide an itemization of the most common dynamic problems with recommended troubleshooting checks and corrective actions.

10.5.1 Noisy or Unstable Readings at Zero

1. Check for leaks in the pneumatic system as described in Section 11.3.
2. Confirm that the Zero gas is free of Carbon Monoxide.
3. Check for a dirty particulate filter and replace as necessary as described in Section 11.2.

10.5.2 Noisy, Unstable, or Non-Linear Span Readings

1. Check for leaks in the pneumatic systems as described in Section 11.3.
2. Check for a dirty particulate filter and replace as necessary (see Section 11.2).
3. Check for dirty pneumatic system components and clean or replace as necessary.
4. Check for proper adjustment of DAC and ADC electronics by performing the adjustment procedure in Section 9.2.
5. Check for proper adjustment of the detector dark current electronics by performing the adjustment procedure in Section 9.3.
6. Confirm the sample temperature, sample pressure, and sample flow readings are correct. Check and adjust as required.
7. If Non-Linear readings persist, contact Teledyne API Customer Service for advanced linearity adjustment techniques and procedures.

10.5.3 Slow Response to Changes in Concentration

1. Check for dirty pneumatic components and clean or replace as necessary.
2. Check for pneumatic leaks as described in Section 11.3.
3. Check for proper flow (see Section 10.6.5).

10.5.4 Analog Outputs Do Not Agree With Front Panel Readings

1. Confirm that the DAC offset (SETUP-MISC-D/A-OFFS) is set to zero.
2. Perform a DAC/ADC adjustment and Dark Signal adjustment by following the procedure described in Sections 9.2 and 9.3.

10.5.5 Cannot Zero or Cannot Dynamic Zero

1. Check for leaks in the pneumatic system as described in Section 11.3.
2. Confirm that the Zero gas is free of Carbon Monoxide.
3. Check for a dirty particulate filter and replace as necessary as described in Section 11.2.

10.5.6 Cannot Span or Cannot Dynamic Span

1. Check for leaks in the pneumatic systems as described in Section 11.3.
2. Check for a dirty particulate filter and replace as necessary as described in Section 11.2.
3. Check for dirty pneumatic system components and clean or replace as necessary.
4. Check for proper adjustment of DAC and ADC electronics by performing the adjustment procedure in Section 9.2.
5. Confirm the sample temperature, sample pressure, and sample flow readings are correct. Check and adjust as required.

10.6 Troubleshooting Individual Sub-Assemblies and Components

The following sections provide troubleshooting/check-out methods for the specific sub-assemblies and components of the analyzer.

10.6.1 Troubleshooting Flow Problems

When troubleshooting flow problems, it is a good idea to first confirm actual flow of the analyzer. If available, use an independent flow meter rotameter or mass flow meter to measure flow(s). Sample flow can be measured at the sample inlet port at the instrument's rear panel. If no independent flow meter is available, placing a finger over an inlet port and feeling for a vacuum will at least give an indication whether flow is present.

If the independent flowmeter shows to be correct, check the pressure/flow sensor assembly as described in Section 10.6.8.

In general, flow problems can be divided into 3 categories:

1. Flow is zero (no flow)
2. Flow is greater than zero, but is too low, and/or unstable
3. Flow is too high

Figure 1-1 in this manual provides a schematic diagram of the flow in a Model 300M.

WARNING **Hazardous voltages present - use caution.**

Flow is zero:

1. Confirm that the sample pump (sample flow) is operating (turning). If not, check the 115V power to the pump. If the pump does not operate with 115V present at its terminal, replace the pump. Check for plugged pneumatic lines, filters, or orifices.

2. If the pump is over-heated due to the line voltage (exceeding 119 VAC, etc) or high ambient temperature, it will run intermittently causing flow failure.

Low Flow:

1. Check for leaks as described in Section 11.3. Repair and re-check.
2. Check for dirty sample filter or dirty sintered filter.
3. Check for partially plugged pneumatic lines, flow restrictor, or valves.

High Flow:

1. The most common cause of high flow is a leak around the flow restrictor. To correct, remove the flow restrictor and replace O-rings, and re-assemble.

10.6.2 Troubleshooting Temperature Problems

The Model 300M has been designed to operate at ambient temperatures between 10°C and 40°C. As a first step in troubleshooting temperature problems, confirm the ambient temperature is within this range and that the air inlet slots on the sides of the cover and the fan exhaust on the rear panel are not obstructed.

The instrument monitors four temperatures:

1. Sample Temperature
2. Inside Chassis Temperature
3. Optical Bench Temperature
4. Gas Filter Wheel Temperature

and controls the temperatures of two components by heating:

1. Optical Bench
2. Gas Filter Wheel

If any of the temperature readings appear to be incorrect, check for proper thermistor operation by measuring the resistance of the thermistor(s). This resistance should be in the range of 7.6K ohms to 95 ohms. If it is not, the thermistor is defective and should be replaced. Points for measuring thermistor resistance are as follows:

Sample Temperature:

Unplug the connector at Motherboard J2 and measure across the leads.

Optical Bench Temperature:

Unplug the connector at Motherboard J4 and measure across the leads.

Gas Filter Wheel Temperature:

Unplug the connector at Motherboard J5 and measure across the leads.

Chassis Temperature:

Turn the analyzer off and remove the DC Power Supply Board. Measure across Motherboard J21 pins A30 and C30.

If thermistor resistance(s) are within the proper range, check the temperature linearzation circuits on the DC Power Supply Board as described in Section 10.6.4.

If temperature sensor readings appear accurate but control temperatures are not being maintained at their proper value, check the operation of the heaters as follows:

1. Observe the indicator LED's on the Power Supply Module and confirm that the red (right-most) LED is lit, and that the "CEL HTR" LED is lit or cycling (turning off and on). If these indicators are not correct, it is probably that the Power Supply Module, or the V/F Board is faulty. Check as described in Sections 10.2 and 10.6.3.
2. Unplug the heater element from Power Supply Module and confirm that 115 VAC is present. If 115 VAC is present, the heater element has failed and should be replaced.

WARNING

Hazardous voltages present - use caution.

10.6.3 Checking the V/F Card

A schematic and physical diagram of the V/F card are shown on Drawings 514 and 515 in Appendix C. The V/F is a multi-function I/O card that connects to the microprocessor via a STD Bus interface, and acts as the primary I/O interface between the microprocessor and the rest of the analyzer. All functions of the board are performed under control of the microprocessor.

Proper operation of the V/F board can be confirmed by performing an ADC calibration procedure as described in Section 9.2. If this calibration procedure can be performed correctly, it is highly probable that the V/F card is functioning properly.

If the V/F does not function properly, check the following:

1. Confirm the presence of appropriate power by checking for:
   A. +5 V between TP 4 and TP 5
   B. +15 V at TP 1 and TP 3
   C. -15 V at TP 2 and TP 3

If any of these voltages are incorrect, check the DC Power Supply as described in Section 10.6.4.

2. Confirm that all jumpers and switches on the V/F board are set properly, as follows in Table 10-3.

Table 10-3: V/F Board Jumpers - Factory Settings

Factory Set Jumpers	
Jumper	**Setting**
JP1	1-2
JP2	1-2
B12	3-4
B14	ON
B15	Set to match input line frequency

Table 10-4: V/F Board Switch Settings - Ranges for Analog Output

User Set Switches				
Switch	**100 mV Full Scale**	**1 V Full Scale**	**5 V Full Scale**	**10 V Full Scale**
S1 (Recorder Output)	1, 6	1, 5	1, 4	1, 3
S2 (DAS Output)	1, 6	1, 5	1, 4	1, 3
S3 (Test Output	1, 6, 7	1, 5, 7	1, 4, 7	1, 3, 7
S4 (Spare)	1, 6, 7	1, 5, 7	1, 4, 7	1, 3, 7

3. If voltages and jumper settings are correct, the V/F card is faulty and should be replaced.

The primary functions of the board can be divided into three areas:

1. Channels of Multiplexed Analog input to an Analog to Digital converter
2. Independent Digital to Analog converters
3. Digital I/O Lines configured as 24 outputs and 8 inputs

The following sections describe each of these functional areas.

10.6.3.1 Analog Inputs

16 Analog channels (0-5 VDC) are multiplexed under microprocessor control by IC U26 and transmitted via buffer amp U29 to the V/F converter section of the board for A/D conversion.

Analog to Digital (A/D) conversion is accomplished by performing a Voltage to Frequency (V/F) conversion on the input signal at IC U17 and running the frequency output to a counter comprised of IC's U20, U21, U22.

The full scale digital output of the counter section is 80,000 counts, giving an A/D resolution of 1 part in 80,000.

The combination of V/F converter and counter inherently provides an integrating Analog to Digital conversion. The time base for this integration is controlled by the microprocessor using the clock oscillator, U36. Jumper B15 allows the selection of either a 4.0 MHz or 4.8 MHz frequency to minimize electrical pickup at the operating line frequency. Pots R27 and R31 provide offset and gain adjust respectively to the analog input of the V/F converter, allowing the A/D section to be adjusted to match an external voltage standard.

10.6.3.2 Digital to Analog Converters

Four Independent Digital to Analog Converters (DAC's) are contained in IC's U10 and U11 and are used to generate the instrument's analog outputs. These DAC's have 12 bit resolution and are fully buffered by OpAmps at U8 and U9. The outputs of the DAC's are jumper selectable for full scale range at jumpers B6, B7, B8 and B9. The Full Scale Ranges supported are:

0 - 100 mV

0 - 1 V

0 - 5 V

0 - 10 V

In the M300M the use of these four DAC's is:

DAC Channel	Signal
0	Strip Chart Analog Output
1	DAS Analog Output
2	Spare
3	Test Function Analog Output

The DAC's are operated in bipolar mode allowing a "live zero" on all output. In addition, DAC's 0 and 1 (Strip Chart and DAS) physically provide a Full Scale of 120% of the nominal selected value with the microprocessor providing pre-scaling to achieve the nominal value. This combination provides 20% over-range capability. The microprocessor is also used to adjust for offset and gain needed to match DAC outputs to external voltage standards, and no on board adjustments are needed or provided for this function.

The outputs of all DAC's are "looped-back" to Analog input (via the Mother Board) channels. This loop back allows for automatic microprocessor checking of A/D.

10.6.3.3 Digital I/O Lines

32 Digital Lines are used to provide the primary means for the microprocessor to control various analyzer functions(valves, heaters, etc.) and to send and receive status conditions to/from external equipment. These lines are configured as 8 digital inputs and 24 digital outputs. The convention for all Digital I/O Lines is High (+5V)-True, Low (0V)-False.

10.6.4 Checking the DC Power Supply Board

A schematic and physical diagram of the DC Power Supply Board are shown on Drawings 015 and 016 in Appendix C.

The overall performance of the DC Power Supply Board can be checked by observing the value of the DCPS test functions. If this value, a composite of five regulator value recorded in Table 1-1 of this manual under Test Values, the outputs of the individual regulators should be checked by measuring for the following voltages:

1. Remove Plugs J8, J6, and J13 from the front of the Power Supply Module. Verify that the following voltages are present:
   A. +11.6VDC between J8 pins 2 and 4
   B. +24VDC between J6 pins 12 and 13
   C. 9.5VAC between J13 pins 4 and 5
   D. 15VAC between J13 pins 3 and 2
   E. 38VAC between J13 pins 6 and 7

If any of these voltages is not present, the Power Supply Module is defective and should be replaced.

2. Confirm that the following voltages are present on the V/F Board:
   A. +5V between V/F TP 4 and V/F TP 5
   B. +15V between V/F TP 1 and V/F TP 3
   C. -15V between V/F TP 2 and V/F TP 3
   D. +12V between Mother Board Pad J13,6 and J13,7

If any of these voltages is incorrect, it is probable that the DC Power Supply Board is faulty and should be replaced.

Four Temperature linearization circuits are contained on the DC Power Supply board. The outputs of these circuits can be checked measuring the voltages at test points on the board as follows:

TP1 Sample Temp	30°C=2.5 V, ± 0.125 V/°C
TP2 Optical Bench	50°C=2.5 V, ± 0.125 V/°C
TP3 Filter Wheel Temp	50°C=2.5 V, ± 0.125 V/°C
TP4 Chassis Temp	20°C=2.5 V, ± 0.125 V/°C

If any of these voltages is incorrect, check thermistor operation as described in Section 10.6.2. If thermistors are operating correctly, it is probable the DC Power Supply Board is defective and should be replaced.

10.6.5 Checking the Synchronous Demodulator Board

A schematic and physical diagrams of the Synchronous Demodulator Board are shown in drawings 798 and 799 in Appendix C.

Proper operation of the Synchronous Demodulator can best be confirmed by performing the Electric Test under Diagnostic menu.

When activated, the Electric Test Diagnostic should produce a constant, stable analyzer output of approximately 400 PPM. If this stable output is produced it is probably that the Synchronous Demodulator is functioning properly.

If Electric Test does not produce a stable output, check the following:

1. Confirm proper operation of the V/F Board as described in Section 10.6.3.
2. Confirm that during Electric Test the values of the CO MEAS and CO REF test functions are between 2500 mV and 4500 mV.

10.6.6 Checking the Opto Interrupter

Correct operation of the Opto Interrupter on the gas filter wheel can be confirmed by connecting an oscilloscope U6, Pin 11 on the Sync Demodulator board and comparing the waveform to Figure 10-1. The waveform should be symmetrical and 5 Volts peak to peak.

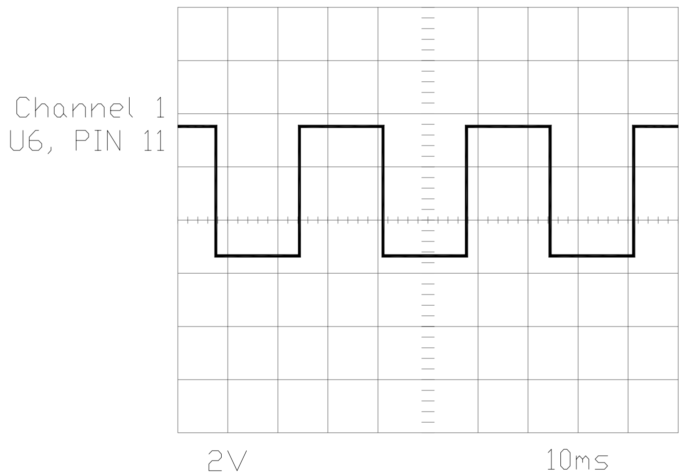


Figure 10-1: Opto Pickup Waveform

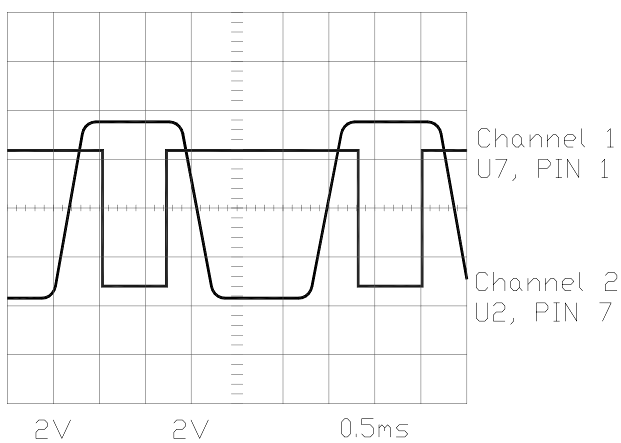


Figure 10-2: Detector Waveform

10.6.7 Flow/Pressure Sensor

The flow/pressure sensor board consists of 2 pressure sensors. The flow rate value is computed from these two pressure sensors and displayed on the front panel TEST functions including two pressure readings. Several minutes may be required for a steady reading if observing the TEST functions. They are:

Inlet sample gas pressure – measured directly S1

Reaction cell pressure – measured directly S2

1. Check pressure:
   A. Remove the 1/8" fitting from the reaction cell and remove sample inlet tubing for the sample filter assembly.
   B. Scroll to select VAC or PRES of the TEST functions.
   D. Check if the pressure readings are close to the current absolute ambient pressure (typical value at sea level is 29.9 Hg-In). Notice that it must be absolute pressure reading. Check if both readings do not differ more than 2% from each other. Replace the pressure/flow sensor board if defective.
   C.
2. Check Flow rate:

   To calibrate the sample flow, proceed as followings:

   A. Scroll to select SAMP FL of the TEST functions.
   B. Using independent flowmeter verify the flow rate into the reaction cell.
   C. If the actual flow differs more than 10% of the displayed flow, proceed flow calibration.

   Flow calibration:

   A. Press SETUP-MORE-DIAG-ENTR. Scroll to select FLOW CALIBRATION - ENTR.
   B. Enter the actual flow value from the independent flow meter and press ENTR.

10.7 Warranty/Repair Questionnaire

Organization:____
Contact:______________________________________ Phone:________________
Address ____

____

Model 300M Serial Number:____
Are there any warning messages? YES ☐ NO ☐
If ***YES***, please list:____

____

Please record the following values:

TEST VALUES		
RANGE	_______	PPM/PPB
CO MEAS @ ZERO	_______	mV
CO REF @ ZERO	_______	mV
MR RATIO @ ZERO	_______	
CO MEAS @ SPAN	_______	mV
CO REF @ SPAN	_______	mV
MR RATIO @ SPAN	_______	
SAMPLE PRESS	_______	IN HG-A
VAC PRESS	_______	IN HG-A
SAMPLE FLOW	_______	SCC/MIN
SAMPLE TEMP	_______	°C
BENCH TEMP	_______	°C
WHEEL TEMP	_______	°C
BOX TEMP	_______	°C
DC POWER SUPPLY	_______	mV
TIME	_______	HH:MM:SS

CALIBRATION VALUES		
CO SPAN SETTING	_______	PPM/PPB
CO SLOPE	_______	
CO OFFSET	_______	

SETUP VALUES		
ELECTRIC TEST	_______	PPM
DARK MEAS	_______	mV
DARK REF	_______	mV

Has the unit been leak checked? YES ☐ NO ☐
What are failure symptoms? ____

____

____

If possible, please include a portion of a strip chart pertaining to the problem. Circle pertinent data.
Do opto-interrupter and detector waveforms match those shown in Figure 10-1 and Figure 10-2?

YES ☐ NO ☐

Thank you for providing this information. Your assistance enables Teledyne API to respond faster to the problem that you are encountering.

Teledyne API Customer Service
Phone: (858) 657-9800 Toll Free:(800) 324-5190 FAX: (858) 657-9816 E-MAIL: api-sales@teledyne.com

11 ROUTINE MAINTENANCE

NOTE

The operations outlined in this chapter are to be performed by qualified maintenance personnel only.

11.1 Model 300M Maintenance Schedule

The following are the recommended periodic maintenance items for the Teledyne API Model 300M CO Analyzer:

Table 11-1: Maintenance Schedule

Date Instrument Received _____________													
Item	**JAN**	**FEB**	**MAR**	**APR**	**MAY**	**JUN**	**JUL**	**AUG**	**SEP**	**OCT**	**NOV**	**DEC**	**Recommended Action**
Particulate filter element													Replace weekly or as needed
Pump diaphragms													Replace every 12 months
Sample flow													Check for proper flow (800cc/min ± 20%) annually
Dark Cal													Perform annually as needed, or after adjusting R7 on Sync-Demod board.
Pneumatic lines													Examine and clean as necessary
Leak Check													Leak Check after maintenance or repair and at least annually
Clean optical bench													As needed

11.2 Replacement of Sample Filter

1. Turn off the analyzer. This will stop the pump and eliminate the possibility of sucking debris into the analyzer while changing the filter element.
2. Open the front panel and remove the transparent filter cover and knurled retaining ring.
3. Remove the Teflon hold-down O-ring.
4. Remove the old filter element and discard.
5. Install a new filter element in the filter cavity. Be careful with the element, it is fragile.
6. Replace the hold-down O-ring (notch up) on top of the filter element.
7. Replace the filter top and re-tighten.
8. Leak check.
9. Turn on the analyzer.

11.3 Leak Checking

There are two methods of leak checking.

11.3.1 Using a Leak Checker

Turn the power off. Disconnect the fittings from the pump and bypass the pump. Connect the leak checker to the sample inlet of the Model 300M. Cap the exhaust of the analyzer. Set the leak checker to pressure mode.

CAUTION

Do not exceed 15 PSI of pressure.

Leave the checker on until 15 PSI is achieved. Close the valve and ensure the pressure remains at 15 PSI for at least 5 minutes. If pressure drops more than 1 PSI in 5 minutes, there is a leak and it must be repaired.

If there is a leak present, pressurize the Model 300M to 15 PSI and put soap bubble solution on pneumatic assemblies until the leak is found.

> **Caution**
>
> **Be careful using the bubble solution. If there is no internal pressure, the solution may enter and contaminate the cell.**
>
> **Do not attempt to use the bubble solution while the unit is under vacuum. This may cause damage to the analyzer.**
>
> **Use only bubbles, not liquid.**

11.3.2 Leak Self Test

If only a Model 300M is available, the following alternate method for leak checking can be used. The power must be on and the pump must be in-line. Disconnect the power from the pump. Check for the sample flow. If the sample flow does not read zero, record the reading. Re-connect the power to the pump. Cap the sample inlet. Check if the sample flow goes down to zero. If not, check the sample flow exceeds the prerecorded value when the pump was disconnected. If the sample flow is above zero or higher than the prerecorded value, the unit has the leak.

INTENTIONALLY BLANK

12 SPARE PARTS LISTS

12.1 Spare parts for CE Mark units

Note: Use of replacement parts other than those supplied by Teledyne API may result in non-compliance with European Standard EN 61010-1.

PART NO.	DESCRIPTION
00015	POWER SUPPLY BOARD
00276-0804	CPU BOARD
00329	THERMISTOR ASSY (885-071600)
00329-12	THERMISTOR ASSY: WHEEL
00329-11	THERMISTOR ASSY: BENCH
026220300	ASSY FLOW SENSOR
00514-03	V/F BOARD
00551-14	POWER SUPPLY MODULE (EU) - 230V/50Hz
00551-18	POWER SUPPLY MODULE (UK) - 230V/50Hz
00611-04	ASSY, STRIP HEATER
00611-05	ASSY, HEATER, WHEEL
01930	SAMPLE FILTER ASSY
00690-00	PADS
01930	KEYBOARD
00728	NEW DISPLAY
00798	SYNC DEMODULATOR BOARD
0261803	ASSY, OPTICAL BENCH
00953	PREAMP/DETECTOR ASSEMBLY
00956-0001	GAS FILTER WHEEL
00969	FILTER, TFE, 47 MM, QTY 100
00969-01	FILTER, TFE, 47 MM, QTY 25
00982	ASSY, SYNCHRONOUS MOTOR
00987	OPTO INTERRUPTER ASSEMBLY
01037	CO/CO2 CONVERTER ASSEMBLY
04033	INSTRUCTION MANUAL FOR 300M
02607	FIELD MIRROR
01079	INPUT MIRROR
01080	OUTPUT MIRROR
01581	SOURCE ASSEMBLY (WITH ADAPTOR)
02606	OBJECTIVE MIRROR
01916-01	REAR PANEL BOARD, CE
01930	KEYBOARD, CE
01934-02	ASSY, SAMPLE THERMISTOR
CB004	FUSE, 3 AG 3 AMP 250V
CH024	CATALYST, CO/CO2 CONVERTER (1 OZ)
00793	FAN

FL001	SINTERED FILTER (002-024900)
HW020	SPRING, FLOW CONTROL
HW036	TFE THREAD TAPE (48 FT)
HW037	TIE, CABLE
OP009	WINDOW, SAPPHIRE
OR030	O-RING, 2-141 V
OR034	O-RING, INPUT/OUTPUT MIRROR/DETECTOR
OR039	O-RING, WINDOW
PU020	PUMP, 115V 50/60 Hz
PU022	PUMP REBUILD KIT, KNF MODEL #NO5ATI
SW006	OVERHEAT SW, CELL
02471	TUBING: 6', 1/8" CLR (TU1)
02472	TUBING: 6', 1/8" BLK (TU2)
02475	TUBING: 6', 1/4" TYGON (TU9)
VA002	SOLENOID, SS, 3-WAY, 24V
VA004	SOLENOID, SS, 2-WAY, 24V

12.2 Model 300M Expendables kit

PART NO.	DESCRIPTION
009600400	300M 47 mm Filter Expendables Kit - KNF Pump Model #NO5ATI
Includes:	
009690100	Filter, TFE, 47 mm 5 um, Qty. 25
FL0000001	Sintered Filter (002-024900)
HW0000020	Spring, Flow Control
OR0000001	O-Ring, Flow Control
PU0000022	Pump Rebuild Kit, KNF Model #NO5ATI

12.3 Model 300M Spare parts kit (for one unit)

PART NO.	DESCRIPTION
037620000	300M Spares Kit for 1 Unit
Includes:	
015810000	Source Assembly (with Adapter)
KIT000109	Replacement, Opto Sensor

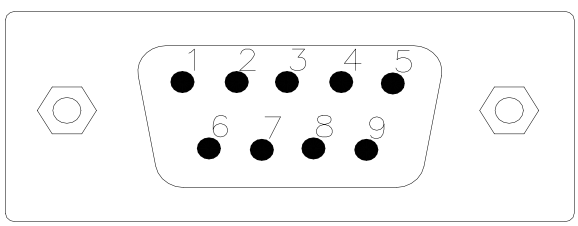
12.4 Model 300M Level 1 parts kit (for ten units)

PART NO.	DESCRIPTION
037610000	300M Level 1 Spare Parts Kit (for 10 units)
Includes:	
000941000	Orifice, 13 mil 800 cc, Rx Cell
007930000	Assembly, Fan, PSM (FA0000004 ASSY)
009530000	Pre-amplifier/Detector Assembly
009820000	Motor, Synchronous
015810000	Source Assembly (with Adapter)
019340200	Thermistor Assembly: Sample TEE
KIT000109	Replacement, Opto Sensor

APPENDIX A Tips on connecting the Teledyne API analyzer RS-232 interface

Teledyne API analyzers use the RS-232 communications protocol to allow the instrument to be connected to a variety of computer-based equipment. RS-232 has been used for many years and as equipment has become more advanced, connections between various types of hardware have become increasingly difficult. Generally, every manufacturer observes the signal and timing requirements of the protocol very carefully. Problems arise when trying to specify connectors, and wiring diagrams that attach the analyzer to various devices.

The problem centers around two areas. First is the physical incompatibility of connectors. Second is the wiring of the connectors. This Note will attempt to provide some guidelines for connecting the Teledyne API analyzers to a variety of other equipment



Pin	Signal
1	Not Used
2	Transmit Data
3	Receive Data
4	Not Used
5	Signal Ground
6	Not Used
7	Data Set Ready (DSR)
8	Request to Send (RTS)
9	Not Used

RS-232 PIN ASSIGNMENTS
FIGURE A.1

Connectors:

There are a wide variety of connectors and cables that are specified to operate with the RS-232 protocol. This is because electronics have decreased in size over the years and connectors have been downsized to match the electronics.

Cables & Adapters come in 4 general types

1. Cables - cables are provided in various lengths from 6 to 50 feet. In most cases they have a male connector at one end and a female at the other. Variations on this are ones that provide both a cable and adapter. For example the cable provided with our analyzer adapts a female DB-9 to a male DB-25 connector. Most cables do not contain a Null modem.

2. Gender changers - convert a male connector to a female connector or vice versa. They do so WITHOUT changing the pin-to-pin wiring.

3. Adapters - these change from one type plug (DB-9) to another type plug (DB-25). They do so WITHOUT changing the wiring.

4. Null modems - here the connector changes the internal wiring so that DTE devices can become DCE or vice versa. The main internal change is swapping pin 2 and 3 so that data is transmitted and received on opposite pins.

NOTE

NULL MODEMS CAN ALSO COMBINE GENDER CHANGER OR ADAPTER FEATURES IN THE DESIGN. WHEN MAKING UP AN ADAPTER CABLE BE CAREFUL TO NOTE WHAT YOU ARE USING, ESPECIALLY WITH COMBINATION NULL MODEM-ADAPTER CONNECTORS.

Wiring:

The RS-232 is a point-to-point protocol and as such it specifies a two different wiring schemes depending on if you are originating the transmission or receiving the transmission. In the original spec, modems communicated with terminals and were wired as "Data Communications Equipment" or DCE. Terminals or printers received data from modems and thus were wired as "Data Terminal Equipment" or DTE. As technology has progressed it has become more ambiguous who was DCE and DTE. Teledyne API analyzers are wired as DTE (i.e. like a printer). As can be seen, this presents difficulties if you a hook
a printer to the instrument that is likewise wired as a printer. To help understand the different problems - 3 examples as shown below:

Example 1: Connecting the Teledyne API analyzer to an IBM-PC AT compatible computer.

In this case the PC is wired as DCE and the analyzer is wired as DTE therefore a null modem is not needed. The wiring is "straight through" i.e. pin 1 to pin 1, pin 2 to pin 2, etc. Therefore all you have to do here is adapt the connector on the analyzer (male DB-9) to whatever is on the PC. Make sure none of the adapters have null modems in them.

Example 2: Connecting the Teledyne API analyzer to a serial printer.

In this case both the analyzer and the printer are wired as DTE so a "Null Modem" will have to be inserted in the line to change the wiring to make the analyzer look like a modem (i.e. DCE). Make sure in using your adapters that ONLY ONE null modem connector is used. Null modems can be purchased in DB-9 and DB-25 connectors at each end.

Example 3: Connecting the Teledyne API analyzer to a modem.

The modem is configured as Data Communications Equipment (DCE), and may have additional signal requirements to enable transmission. See modem troubleshooting section below.

> **NOTE**
>
> **MODEMS ARE ESPECIALLY DIFFICULT BECAUSE THEY MAY HAVE PINS THAT NEED TO BE AT CERTAIN EIA RS-232 LEVELS BEFORE THE MODEM WILL TRANSMIT DATA. THE MOST COMMON REQUIREMENT IS THE READY TO SEND (RTS) SIGNAL MUST BE AT LOGIC HIGH (+5V TO +15V) BEFORE THE MODEM WILL TRANSMIT.**
> **THE TELEDYNE API ANALYZER SETS PIN 8 (RTS) TO 10 VOLTS TO ENABLE MODEM TRANSMISSION.**

Troubleshooting the modem connection:

First: Disconnect the RS-232 cable from the analyzer and verify (use a DVM) that you are getting a signal on Pin 2 of the RS232 port on the analyzer. The signal will be between -5V and -15V with respect to signal ground (pin 5). If not, there is a problem with the CPU board or the cable. This is the transmit (TD) signal out of the analyzer. This should then be connected to TD input on the modem, normally Pin 2. If the analyzer is equipped with a DTE/DCE switch, you may need to change its setting so the signal is on Pin 2.

Second: Go to the cable connected to the modem/terminal and verify (use a DVM) that you are getting a -5V to -15V signal on Pin 3 of the cable. This pin should be connected to Pin 3 of the Teledyne API analyzer.

Third: (for modems) Check that the voltage level on Pin 8 of the analyzer is between +5V and +15V. This pin should be connected (through the cable) to Pin 4 of the modem.

Now set the baud rate of the analyzer to the speed required by the modem and it should work. If you are still experiencing problems, a cable adapter may be needed. Please contact the factory for assistance.

APPENDIX B Electrical drawing index

Drawing Number	Title
00015	Assembly, DC Power Supply PCA
00016	Schematic, DC Power Supply PCA
00514	Assembly, A/D - I/O Card PCA
00515	Schematic, A/D - I/O Card PCA
0053202	Assembly, Power Supply Module PCA
0053302	Schematic, Power Supply Module PCA
00551	Wiring Diagram, Power Supply Module
00798	Assembly, Sync Demodulator
00799	Schematic, Sync Demodulator
00866	Assembly, Mother Board
00867	Schematic, Mother Board
00874	Assembly, Pre-Amp/Bias
00875	Schematic, Pre-Amp/Bias
01916	Assembly, Rear Panel PCA (CE Mark Units Only)
01917	Schematic, Rear Panel PCA (CE Mark Units Only)
01930	Assembly, Keyboard PCA (CE Mark Units Only)
01931	Schematic, Keyboard PCA (CE Mark Units Only)
03757	Interconnect Diagram (CE Mark Units)
03758	Interconnect Diagram (Domestic)