



MANUAL ADDENDUM

MODEL T300U ***CO Analyzer with Auto-Reference*** (Addendum to T300/T300M Operation Manual, P/N 06864)

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WARRANTY

See Warranty page in the T300/T300M Manual - P/N 06864.

ABOUT THIS MANUAL

This manual is intended for use in conjunction with the Model T300/T300M Operation Manual, part number 06864. Where operation of the Model T300U diverges from that of the Model T300/T300M, this addendum takes precedence.

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SAFETY MESSAGES

Important safety messages are provided throughout this manual for the purpose of avoiding personal injury or instrument damage. Please read these messages carefully. Each safety message is associated with a safety alert symbol, and are placed throughout this manual and inside the instrument. The symbols with messages are defined as follows:



WARNING: Electrical Shock Hazard



HAZARD: Strong oxidizer



GENERAL WARNING/CAUTION: Read the accompanying message for specific information.



CAUTION: Hot Surface Warning



Do Not Touch: Touching some parts of the instrument without protection or proper tools could result in damage to the part(s) and/or the instrument.



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



Electrical Ground: This symbol inside the instrument marks the central safety grounding point for the instrument.

CAUTION



This instrument should only be used for the purpose and in the manner described in this manual. If you use this instrument in a manner other than that for which it was intended, unpredictable behavior could ensue with possible hazardous consequences.

NEVER use any gas analyzer to sample combustible gas(es)!

Note

Technical Assistance regarding the use and maintenance of the T300/T300M or any other Teledyne API product can be obtained by contacting Teledyne API's Technical Support Department:

Phone: 800-324-5190

Email: api-techsupport@teledyne.com

or by accessing various service options on our website at <http://www.teledyne-api.com/>.

CONSIGNES DE SÉCURITÉ

Des consignes de sécurité importantes sont fournies tout au long du présent manuel dans le but d'éviter des blessures corporelles ou d'endommager les instruments. Veuillez lire attentivement ces consignes. Chaque consigne de sécurité est représentée par un pictogramme d'alerte de sécurité; ces pictogrammes se retrouvent dans ce manuel et à l'intérieur des instruments. Les symboles correspondent aux consignes suivantes :



AVERTISSEMENT : Risque de choc électrique



DANGER : Oxydant puissant



AVERTISSEMENT GÉNÉRAL / MISE EN GARDE : Lire la consigne complémentaire pour des renseignements spécifiques



MISE EN GARDE : Surface chaude



Ne pas toucher : Toucher à certaines parties de l'instrument sans protection ou sans les outils appropriés pourrait entraîner des dommages aux pièces ou à l'instrument.



Pictogramme « technicien » : Toutes les opérations portant ce symbole doivent être effectuées uniquement par du personnel de maintenance qualifié.



Mise à la terre : Ce symbole à l'intérieur de l'instrument détermine le point central de la mise à la terre sécuritaire de l'instrument.

MISE EN GARDE



Cet instrument doit être utilisé aux fins décrites et de la manière décrite dans ce manuel. Si vous utilisez cet instrument d'une autre manière que celle pour laquelle il a été prévu, l'instrument pourrait se comporter de façon imprévisible et entraîner des conséquences dangereuses.

NE JAMAIS utiliser un analyseur de gaz pour échantillonner des gaz combustibles!

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1. INTRODUCTION

This addendum for the Teledyne API Model T300U is a supplement to the T300/T300M manual (P/N 06864) and provides an overview of the instrument operation and specific details regarding those areas where the T300U is different in design or operating method from the T300.

In most ways the T300U is identical to the T300/T300M in design and operation; therefore, most of the basic set up information, operating instructions and calibration, maintenance, troubleshooting and repair methods are the same and can be found in the T300/T300M manual (P/N 06864).

1.1. REFERENCE NUMBERING CONVENTION

Unless otherwise specified, section, figure and table reference numbers referred to within this text are relative to this document. EXAMPLE: “Table 2-1” refers to the table within this document.

Additionally, in the electronic version(s) of this manual references internal to this document will be active links to that section, figure or table.

References to sections, figures and tables in other manuals will be labeled as such and will not be an active link. EXAMPLE: “Figure 6.1 of the T300/T300M Operators Manual (P/N 06864)”.

1.2. T300U OVERVIEW

The Model T300U is a close derivative of the T300/T300M CO Analyzer; however its higher sensitivity requires some changes to its design and operation, which are documented in this addendum.

The primary differences between the T300U and the T300/T300M analyzers are:

- **INTERFERENT REJECTION:** Periodically the sample gas stream is routed through an internal CO scrubber allowing the instrument to make a measurement of the sample gas completely free of CO; the measurement made during this auto-reference period (**A-REF**) is subtracted from the sample concentration measurement. This corrects for instrument drift, ambient temperature changes and changing CO₂ levels in the sample gas.
- **OPERATING METHOD:** An additional operating mode is added allowing the user to manipulate several parameters associated with the **A-REF** measurement cycle.
- **SAMPLE GAS CONDITIONING:** A Nafion[®] drier is used to dry the sample and alleviate any effects from humidity changes in the sample gas.
- **IR OPTICS:** The objective and field mirrors on the optical bench are gold plated. This maximizes their reflectivity and increasing the amount of IR light reaching the detector and improving the optical bench’s signal-to-noise performance.
- **PNEUMATIC OPERATION:** The flow rate is higher. It has a 1.8 LPM nominal flow rate. The flow sensor is rated to 6 LPM.
- **MECHANICAL DESIGN:** The optical bench is placed in a temperature-controlled, convection-heated oven. This dramatically reduces instrument noise and temperature related drift.

1.3. CALIBRATION VALVE OPTIONS FOR THE T300U

The hardware options for the T300x family of analyzers are available in the T300U. For a list and descriptions of these options please see Section 1 of the T300/T300M Operators Manual (P/N 06864).

However, the T300U offers one calibration valve option: Ambient Zero and Ambient Span, except that due to the auto-reference gas path and multi-tube Nafion[®] dryer, this option has a different gas flow in the T300U versus the T300/T300M.

2. SPECIFICATIONS, APPROVALS, AND WARRANTY

2.1. SPECIFICATIONS

Table 2-1: T300U Basic Unit Specifications

| PARAMETER | SPECIFICATION | |
|--|--|---|
| Ranges | Min: 0-100 ppb Full scale Max: 0-100 ppm Full scale (selectable dual ranges and auto ranging supported) | |
| Measurement Units | ppb, ppm, µg/m ³ , mg/m ³ (selectable) | |
| Zero Noise ¹ | ≤ 10 ppb RMS | |
| Span Noise ¹ | < 0.5% of reading RMS above 2.5 ppm ³ | |
| Lower Detectable Limit | < 20 ppb | |
| Zero Drift (24 hours) ² | < 20 ppb | |
| Span Drift (24 hours) ⁴ | < 0.5% of reading above 5ppm | |
| Lag Time ¹ | 10 sec | |
| Rise/Fall Time ¹ | < 60 sec to 95% | |
| Linearity ⁵ | 1% of full scale | |
| Precision ^{1, 5} | 0.5% reading | |
| Sample Flow Rate | 1800 cm ³ /min. ± 20% | |
| AC Power Requirements | Rating 100V-120V~, 60Hz, 3.0 A 220V-240V~, 50/60 Hz, 3.0 A | Typical Power Consumption 165 W 225 W |
| Analog Output Ranges | 10V, 5V, 1V, 0.1V (selectable) | |
| Analog Output Resolution | 1 part in 4096 of selected full-scale voltage | |
| Recorder Offset | ± 10% | |
| Voltage Coefficient | < 0.05 % of reading per V | |
| Standard I/O | 1 Ethernet: 10/100Base-T 2 RS-232 (300 – 115,200 baud) 2 USB front panel device ports 8 opto-isolated digital status outputs 6 opto-isolated digital control inputs (2 defined, 4 spare) 4 analog outputs | |
| Optional I/O | 1 USB com port 1 RS485 8 analog inputs (0-10V, 12-bit) 4 digital alarm outputs Multidrop RS232 3 4-20mA current outputs | |
| Environmental Conditions | Installation Category (Over voltage Category) II Pollution Degree 2 Intended for indoor use only at altitudes ≤ 2000 m | |
| Temperature Range | 5 - 40°C operating | |
| Humidity Range | 0-95% RH, Non-Condensing | |
| Dimensions (HxWxD) | 7" x 17" x 23.5" (178 mm x 432 mm x 597 mm) | |
| Weight | 50 lb (22.7 kg) | |
| Certifications | CE: EN61010-1:90 + A1:92 + A2:95, EN61326 - Class A | |
| ¹ As defined by the USEPA ² At constant temperature and voltage ³ Or 10 ppb, whichever is greater ⁴ Or 20 ppb, whichever is greater ⁵ Above 1 ppm range, otherwise 20 ppb for lower ranges | | |

2.2. EPA METHOD DESIGNATION

Teledyne API's T300U carbon monoxide analyzer is designated as a reference method (RFCA-1093-093) for CO measurement, as defined in 40 CFR Part 53. The official List of Designated Reference and Equivalent Methods is published in the U.S. Federal Register – <http://www3.epa.gov/ttn/amt/criteria.html>.

2.3. APPROVALS AND CERTIFICATIONS

The Teledyne API Model T300/T300M analyzer was tested and certified for Safety and Electromagnetic Compatibility (EMC). This section presents the compliance statements for those requirements and directives.

2.3.1. SAFETY

IEC 61010-1:2001 (3rd Edition), Safety requirements for electrical equipment for measurement, control, and laboratory use.

CE: 2006/95/EC, Low-Voltage Directive

2.3.2. EMC

EN 61326-1 (IEC 61326-1), Class A Emissions/Industrial Immunity

EN 55011 (CISPR 11), Group 1, Class A Emissions

FCC 47 CFR Part 15B, Class A Emissions

CE: 2004/108/EC, Electromagnetic Compatibility Directive

2.3.3. OTHER TYPE CERTIFICATIONS

MCERTS: Sira MC 050068/05

For additional certifications, please contact Technical Support.

3. GETTING STARTED



CAUTION GENERAL SAFETY HAZARD

To avoid personal injury, always use two persons to lift and carry the T300/T300M.

ATTENTION

COULD DAMAGE INSTRUMENT AND VOID WARRANTY

Printed Circuit Assemblies (PCAs) are sensitive to electro-static discharges too small to be felt by the human nervous system. Failure to use ESD protection when working with electronic assemblies will void the instrument warranty. See *A Primer on Electro-Static Discharge* of the T300/300M manual for more information on preventing ESD damage.



CAUTION!

Do not operate this instrument until you've removed dust plugs from **SAMPLE** and **EXHAUST** ports on the rear panel!

Note

Teledyne API recommends that you store shipping containers/materials for future use if/when the instrument should be returned to the factory for repair and/or calibration service. See Warranty section in this manual and shipping procedures on our Website at <http://www.teledyne-api.com> under Customer Support > Return Authorization.

3.1. UNPACKING THE T300U

Unpack and install the T300U per the directions in Sections 3.1 and 3.1.1. of the T300/T300M manual (P/N 06864).

3.2. INSTRUMENT LAYOUT

The front panel of the T300U is identical to that of the T300/T300M (see Figure 3-1 of the T300/T300M Operators Manual, P/N 06864). The Rear Panel is also very similar to that of the T300/T300M (see Figure 3-4 of the T300/T300M Operators Manual, P/N 06864), the only difference being that the instrument's particulate filter is mounted externally on the upper left side of the rear panel rather than internally as on the T300/T300M.

The internal layout of the T300U (Figure 3-1) differs from the T300/T300M due to the need to create a thermally insulated, convection-heated oven in which the optical bench temperature is raised and maintained at a high and very stable temperature. Additionally, there is a multi-tube, high flow Nafion® dryer that removes moisture from the sample gas.

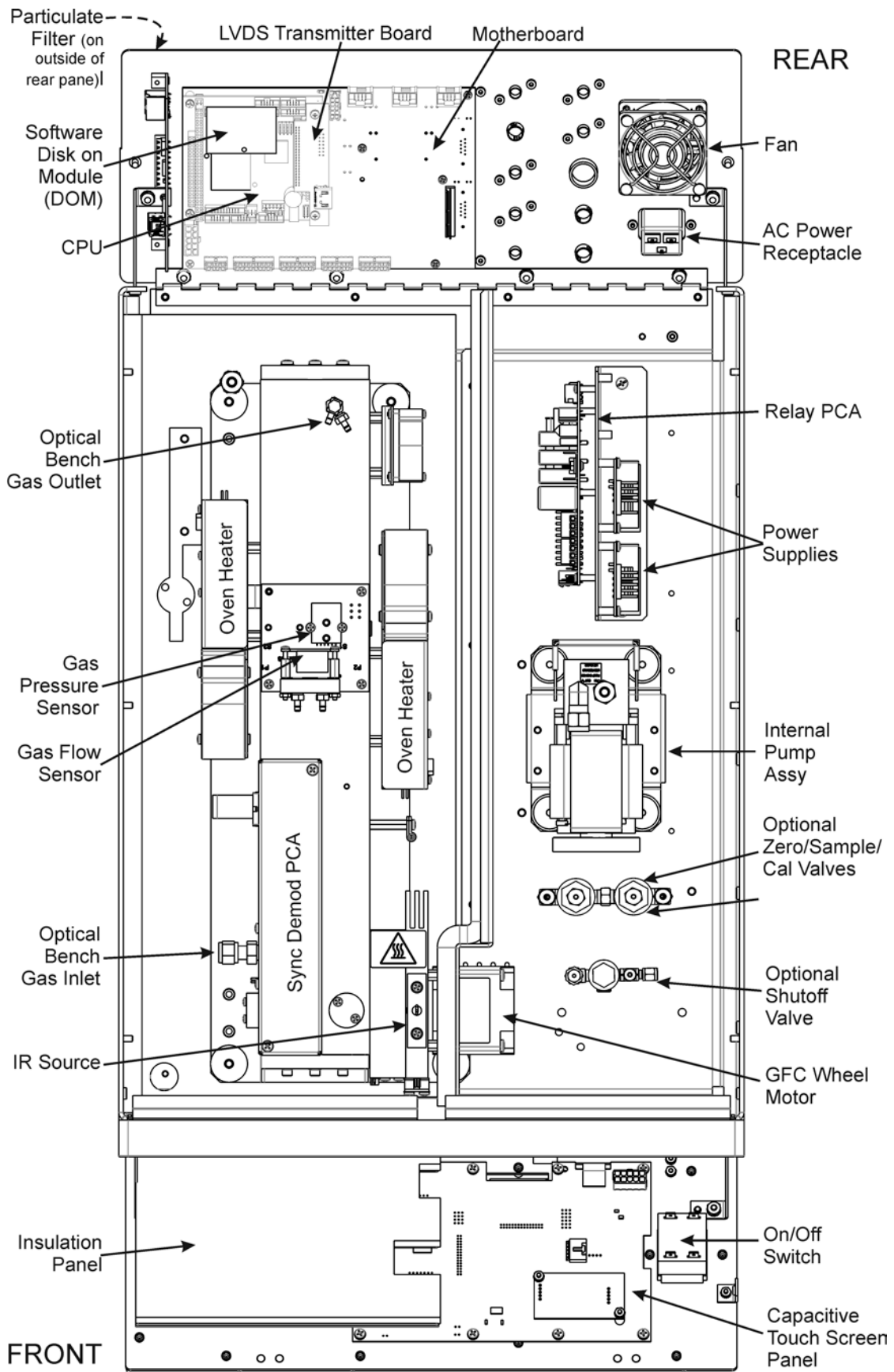


Figure 3-1: T300U Internal Layout

3.3. CONNECTIONS AND SETUP

The information found in Section 3.3 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the exceptions of the Analog and Status Output connections, as described here.

Note

To maintain compliance with EMC standards, it is required that the cable length be no greater than 3 meters for all I/O connections, which include Analog In, Analog Out, Status Out, Control In, Ethernet/LAN, USB, RS-232, and RS-485.

3.3.1. ELECTRICAL CONNECTIONS

The electrical connection instructions in the T300/T300M Operators Manual apply except as differentiated herein.

3.3.1.1. Connecting Analog Outputs

The analog outputs for the T300U are different from those of the T300/T300M. Unlike the T300/T300M which can include options for measuring both O₂ and CO, the T300U is a single gas analyzer (CO) and therefore does not require the fully configurable version of the analog outputs. The following information replaces the Analog Outputs Section of the T300/T300M Operators Manual.

The T300U is equipped with several analog output channels accessible through a connector on the rear panel of the instrument:

- Channels **A1** and **A2** output a signal that is proportional to the CO concentration of the sample gas.
 - The default analog output voltage setting of these channels is 0 to 5 VDC with a reporting range of 0 to 500 ppb.
 - An optional Current Loop output is available for each.
- The output labeled **A4** is special. It can be set by the user to output any one a variety of diagnostic test functions.
 - The default analog output voltage setting of these channels is also 0 to 5 VDC.
 - See Section 4.2.2 for a list of available functions.
 - There is **NO** optional Current Loop output is available for Channel **A4**.

Table 3-1 lists the default settings for each of these channels.

Table 3-1: Analog Output Data Type Default Settings

| PARAMETER | CHANNEL DEFAULT SETTING | | | |
|------------------------|-------------------------|-------|---------------|-----------------|
| | A1 | A2 | A3 | A4 ¹ |
| DATA TYPE ¹ | CONC1 | CONC2 | Not Available | TEST CHANNEL |
| RANGE | 0 – 5 VDC ² | | | |
| OVERRANGE | ON | | | |
| REC OFS | 0 mVDC | | | |
| AUTO CAL. | ON | | | |
| CALIBRATED | NO | | | |
| OUTPUT | ON | | | |

¹ See Table A-6 of T300/T300M Appendix A for definitions of these DAS data types
² Optional current loop outputs are available for analog output channels **A1& A2**.

To access these signals attach a strip chart recorder and/or data-logger to the appropriate analog output connections on the rear panel of the analyzer. Pin-outs for the analog output connector are:

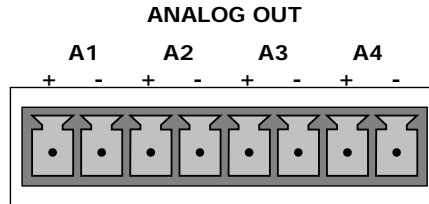


Figure 3-2: T300U Analog Output Connector


Table 3-2: Analog Output Pin Outs

| Pin | Analog Output | Standard Voltage Output | Current Loop Option |
|-----|---------------|-------------------------|---------------------|
| 1 | A1 | V Out | I Out + |
| 2 | | Ground | I Out - |
| 3 | A2 | V Out | I Out + |
| 4 | | Ground | I Out - |
| 5 | A3 | NOT USED | |
| 6 | | | |
| 7 | A4 | V Out | Not Available |
| 8 | | Ground | Not Available |

3.3.2. CONNECTING STATUS OUTPUTS

The information found in Section 3.3.1.5. of the T300/T300M Operators Manual is correct with the following exception:

Table 3-3: Status Output Pin Assignments

| Output # | Status Definition | Condition |
|---|-------------------|--|
| 1 | SYSTEM OK | On if no faults are present. |
| 2 | CONC VALID | On if CO concentration measurement is valid. If the CO concentration measurement is invalid, this bit is OFF. |
| 3 | HIGH RANGE | On if unit is in high range of DUAL or AUTO Range Modes. |
| 4 | ZERO CAL | On whenever the instruments ZERO point is being calibrated. |
| 5 | SPAN CAL | On whenever the instruments SPAN point is being calibrated. |
| 6 | DIAG MODE | On whenever the instrument is in DIAGNOSTIC mode. |
| 7 | A-REF | On whenever the instrument in is A-REF mode. |
| 8 | SPARE | |
| D | EMITTER BUSS | The emitters of the transistors on pins 1-8 are bussed together. |
| + | DC POWER | + 5 VDC |
|  | Digital Ground | The ground level from the analyzer's internal DC Power Supplies. |

3.3.3. PNEUMATICS

The pneumatic flow of the T300U is different from the T300/T300M in two ways:

- The addition of a high-flow multi-tube Nafion® dryer.
- An additional gas path that passes the sample gas through a CO scrubber used during the auto-reference cycle.

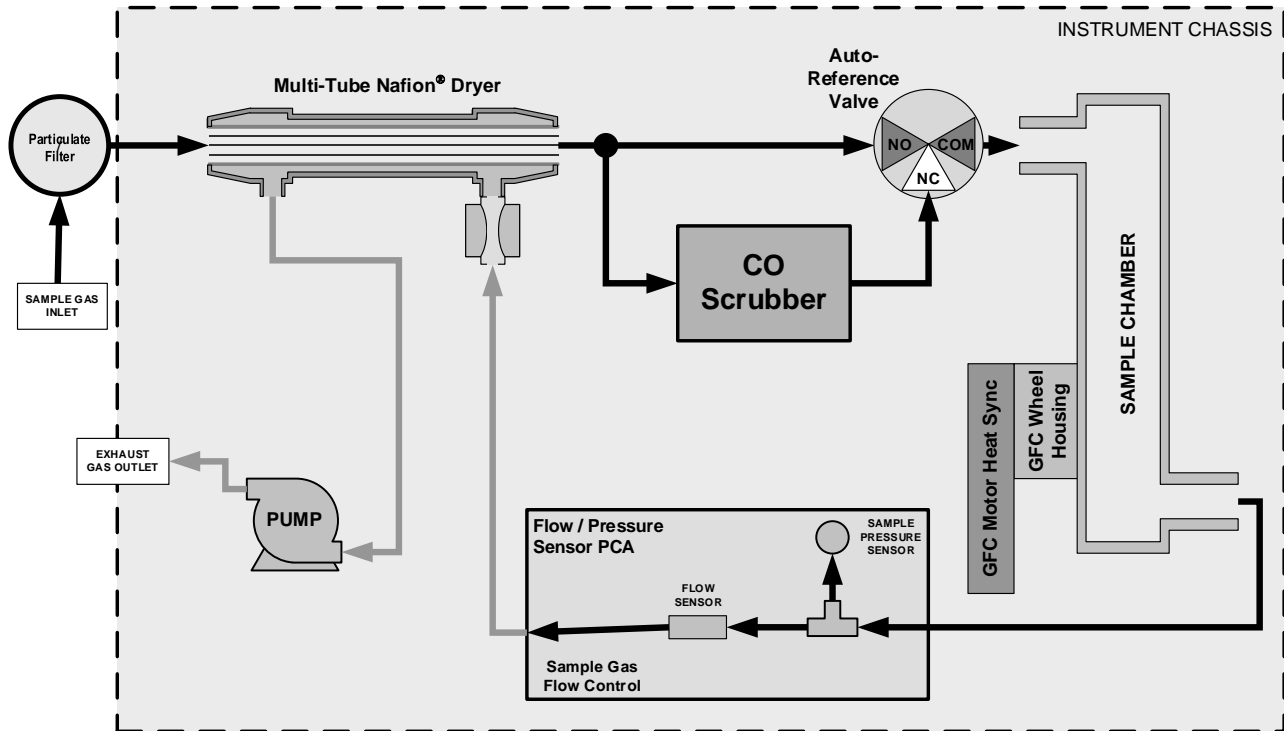


Figure 3-3: T300U Internal Pneumatic Flow – Basic Configuration

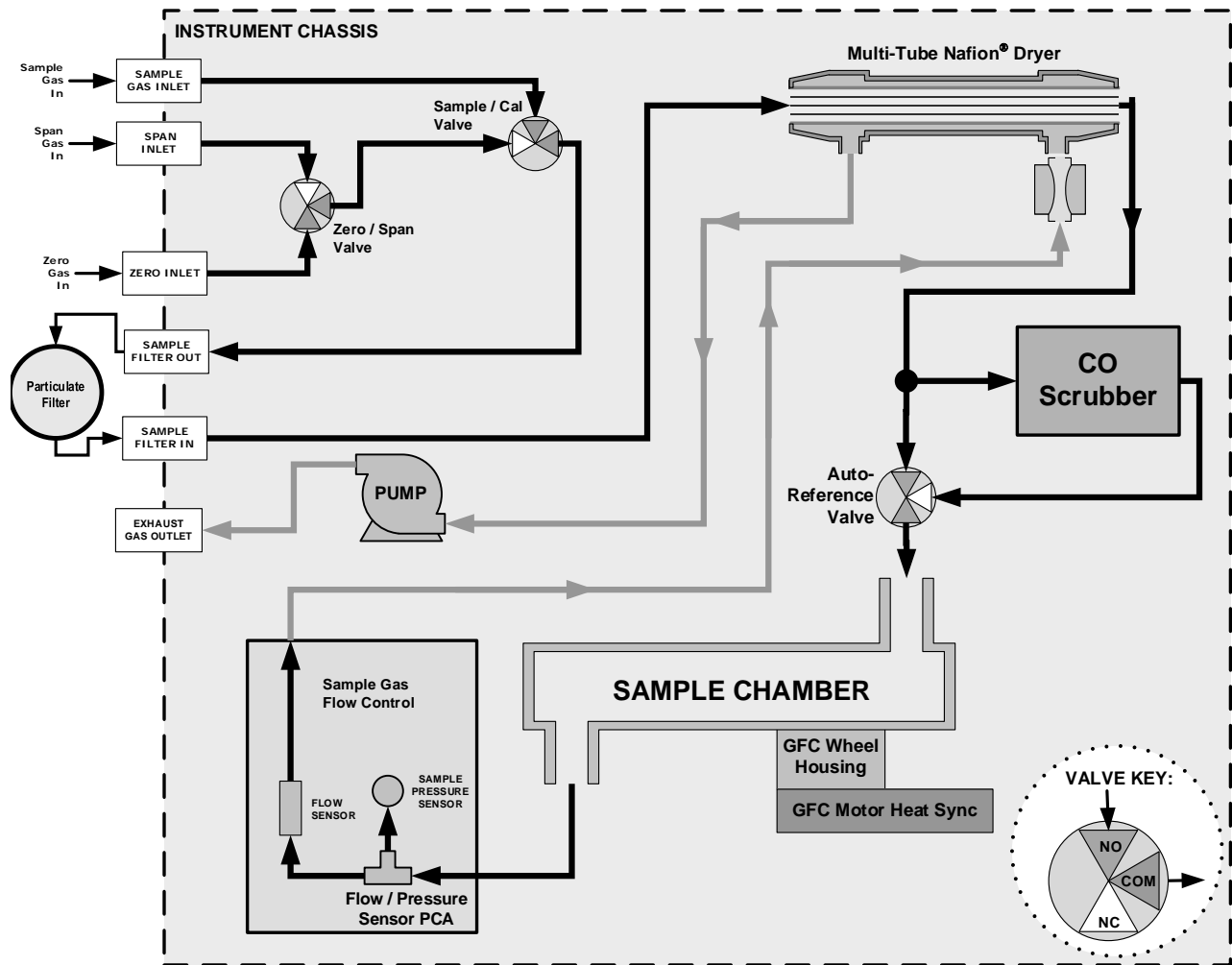


Figure 3-4: T300U Internal Pneumatic Flow – Ambient Zero/Span Valves (OPT 50A)

3.4. STARTUP, FUNCTIONAL CHECKS, AND INITIAL CALIBRATION

IMPORTANT

IMPACT ON READINGS OR DATA

The analyzer's cover must be installed and securely fastened to ensure that the convection oven portion of the internal layout is capable of properly creating and controlling temperatures of the analyzer's optical bench.

3.4.1. STARTUP

The process for starting and warming up the T300U is identical to that described in Section 3.4.1 of the T300/T300M Operators Manual (P/N 06864) except:

- It is best to allow the T300U to operate uninterrupted for at least 2 hours to allow the temperature of all areas of the convection oven area to equalize.

3.4.2. WARNING MESSAGES

The information found in Section 3.4.2 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exceptions (marked by bold print and heavy outline):

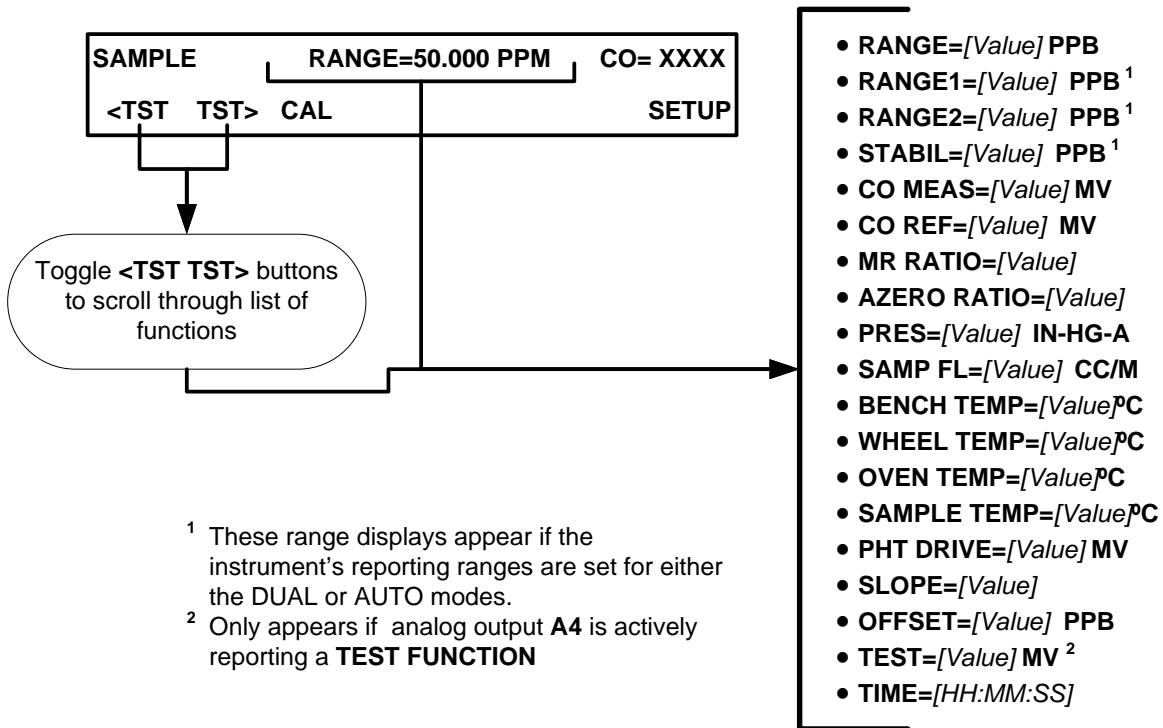
Table 3-4: Possible Warning Messages at Start-Up

| MESSAGE | MEANING |
|---------------------------|---|
| ANALOG CAL WARNING | The instrument's A/D circuitry or one of its analog outputs is not calibrated. |
| AZERO WARN 1.001 | Auto-reference ratio below the specified limits. |
| BENCH TEMP WARNING | Optical bench temperature is outside the specified limits. |
| BOX TEMP2 WARNING | The temperature inside the T300U chassis is outside the specified limits (Replaces BOX TEMP WARNING) |
| CANNOT DYN SPAN | Remote span calibration failed while the dynamic span feature was set to turned on |
| CANNOT DYN ZERO | Remote zero calibration failed while the dynamic zero feature was set to turned on |
| CONFIG INITIALIZED | Configuration was reset to factory defaults or was erased. |
| DATA INITIALIZED | DAS data storage was erased. |
| OVEN TEMP WARNING | The temperature of the insulated convection oven area of the analyzer is outside the specified limits. |
| PHOTO TEMP WARNING | Photometer temperature outside of warning limits. |
| REAR BOARD NOT DET | The CPU is unable to communicate with the motherboard. |
| RELAY BOARD WARN | The firmware is unable to communicate with the relay board. |
| SAMPLE FLOW WARN | The flow rate of the sample gas is outside the specified limits. |
| SAMPLE PRESS WARN | Sample pressure outside of operational parameters. |
| SAMPLE TEMP WARN | The temperature of the sample gas is outside the specified limits. |
| SOURCE WARNING | The IR source may be faulty. |
| SYSTEM RESET | The computer was rebooted. |
| WHEEL TEMP WARNING | The Gas Filter Correlation wheel temperature is outside the specified limits. |

3.4.3. FUNCTIONAL CHECKS

The information found in Section 3.4.3 of the T300/T300M Operators Manual (P/N 06864) regarding performing an initial functional check of the analyzer is applicable to the T300U with the following exception(s).

The Test functions available from the front panel of the T300U are:



3.5. INITIAL CALIBRATION

3.5.1. PRE-CALIBRATION STABILIZATION

Before initially calibrating the T300U it must be allowed to operate for a minimum of 12 hours.

After this stabilization period is complete and just prior to performing the initial calibration, manually initiate an auto-reference measurement by following the instructions in Section 4.4.

3.5.2. BASIC CO CALIBRATION SETUP

Note

The following procedure assumes that the instrument does not have any of the available Zero/Span Valve Options installed.

To perform the following calibration you must have sources for zero air and span gas available for input into the sample port on the back of the analyzer. See Section 3.3.2.1 of the T300/T300M Operators Manual (P/N 06864) for instructions for connecting these gas sources.

Note

All Gas lines should be PTFE (Teflon), FEP, glass, stainless steel or brass.

3.5.2.1. Calibration Gases

The information found in Section 3.3.2.11 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception:

ZERO AIR

Zero air is a gas that is similar in chemical composition to the earth's atmosphere but scrubbed of all components that might affect the analyzer's readings, in this case CO and water vapor.

For the T300U this gas MUST include at least 5% O₂ (required for the proper operation of the analyzer's CO scrubber).

For analyzers without an IZS or external zero air scrubber option, a zero air generator such as the Teledyne Instruments Model 701 can be used.

Note

The zero air generator MUST be equipped with a hydrocarbon (HC) & CO scrubber option. For the Teledyne Instruments M701, this is Option 2B.

3.5.3. BASIC CO CALIBRATION PROCEDURE

The initial calibration should be carried out using the same reporting range set up as used during the analyzer's factory calibration. This will allow you to compare your calibration results to the factory calibration as listed on the *Final Test and Validation Data Sheet*.

Because the T300U's analog output setup differs from that of the T300/T300M and because the T300U could not be modified to include the optional CO₂ or O₂ sensor packages, there are some minor differences in the initial Calibration procedure as described in Section 3.4 of the T300/T300M Operators Manual (P/N 06864).

These differences are:

- STEP 1 - Set Limits:
 - Reporting Range Limit should be set to 50.000 ppm.
- STEP 2 – Dilution Ratio:
 - Ignore this step
- STEP 3 – Set CO Span Gas Concentration
 - The CO span gas concentration should be 40.000 ppm
- STEP 4 – Zero/Span CalibratiOn
 - Set the display to show the **STABILITY** test function.
 - There is no **GAS TO CAL** step because there are no gas options to choose in the T300U.

Ignore Sections 3.4.4.3 and 3.4.4.4 of the T300/T300M Operators Manual (P/N 06864) since they relate to sensor options not available on the T300U.

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4. T300U OPERATING INSTRUCTIONS

4.1. SUMMARY OF SETUP AND OPERATION DIFFERENCES BETWEEN T300U AND T300/T300M ANALYZERS.

For the most part the setup and operation instruction for the T300U are the same as those described in Sections 4, 5, and 6 of the T300/T300M manual (P/N 06864) with the following exceptions:

- There are several additional Test functions related to the optical bench's convection oven and the **A-REF** cycle (see Section 4.2.2).
- There is an additional warning message related to the optical bench's convection oven (see Section 3.4.2)
- There is an additional operating mode, **AREF**, which can be used to force the instrument to make an auto-reference measurement and calculation.
- There are several additional DAS trigger events and parameters (see Appendix A of this addendum).
- The reporting range setup and configuration of the A1 and A2 analog outputs is different (see Section 4.3).
- The optional O₂ and CO₂ sensor packages available for the T300/T300M are not available on the T300U. Ignore all references to these in the T300/T300M Operators Manual (P/N 06864) when operating the T300U.
- The set of available VARS is different (see Section 4.5).
- The set of submenus available under the **DIAG** menu is slightly different (see Section 4.6).
- The set of signals available under the **DIAG → SIGNAL I/O** submenu is different (see Appendix A of this addendum).
- Because of the difference in how the analog output ranges are implemented between the T300/T300M and the T300U, there are some differences in **DIAG → ANALOG I/O CONFIGURATION** submenu (see Section 4.7.1).
- There are no alarm outputs available of the T300U. Ignore Section 5.10 of the T300/T300M Operators Manual (P/N 06864).
- There is an additional **STATUS OUTPUT** related to the **A-REF** cycle (see Section 3.3.2).
- The default Hessen protocol gas ID and status flag list is different from that of the T300/T300M (see Section 4.7.4).

4.2. OPERATING MODES

The information found in Section 4 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s).

The following table supersedes Table 4-1 of the T300/T300M Operators Manual (P/N 06864).

Table 4-1: T300U Operating Modes

| MODE | MEANING |
|-------------------------------|---|
| A-REF | The analyzer is currently recording values for CO MEAS and CO ref, while the sample gas stream is being routed through the CO scrubber of the auto-reference gas path. |
| DIAG | One of the analyzer's diagnostic modes is being utilized. |
| M-P CAL | This is the basic, multi-point calibration mode of the instrument and is activated by pressing the CAL key. |
| SAMPLE | Sampling normally, flashing indicates adaptive filter is on. |
| SAMPLE A | Indicates that unit is in SAMPLE Mode and AUTOCAL feature is activated. |
| SETUP | SETUP mode is being used to configure the analyzer (CO sampling will continue during this process as well as data collection and output). |
| SPAN CAL A¹ | Unit is performing span cal procedure initiated automatically by the analyzer's AUTOCAL feature. |
| SPAN CAL M¹ | Unit is performing span cal procedure initiated manually by the user. |
| SPAN CAL R¹ | Unit is performing span cal procedure initiated remotely via the RS-232, RS-4485 or digital i/o control inputs. |
| ZERO CAL A¹ | Unit is performing zero cal procedure initiated automatically by the analyzer's AUTOCAL feature. |
| ZERO CAL M¹ | Unit is performing zero cal procedure initiated manually by the user. |
| ZERO CAL R¹ | Unit is performing zero cal procedure initiated remotely via the RS-232, RS-4485 or digital I/O control inputs. |

¹ The various **CAL** modes allow calibration of the analyzer. Because of their importance, these modes are described separately in Section 9 of the T300/T300M Operators Manual (P/N 06864).

4.2.1. AUTO-REFERENCE MODE (A-REF)

One of the most significant differences between the T300/T300M and the T300U analyzers is the auto-reference measurement feature. In this mode, the analyzer makes special measurements and calculations that are applied to the CO concentration calculation to dramatically improve interferent rejection as well as compensate for changes in ambient temperature of the sample gas and age related drift of the optical bench components (see Section 8.1.1 for detailed information about how and when this **A-REF** feature occurs).

When in **A-REF** mode, the analyzer:

- Freezes the CO concentration reading displayed on the front panel and output via the analog outputs or COM Ports.
- Displays **AUTO-REF** in the Mode field of the analyzer's front panel (see menu chart, Figure 4-1).
- Sets the **A-REF** status output (pin-7 on the status output connector) to high.

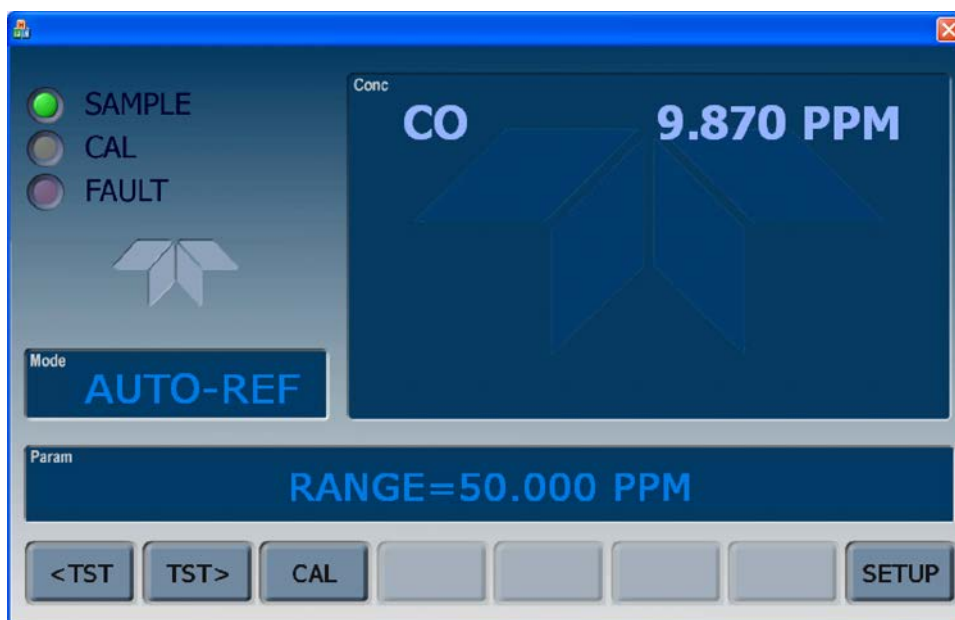


Figure 4-1: Display during A-REF Mode

Note

Initiating a calibration through either the front panel touchscreen, the COM ports or digital control inputs terminates the A-REF mode.

Also, when the instrument is in Calibration Mode, the A-REF mode is suppressed until the instrument exits Calibration Mode.

See Section 4.4 for information about changing the **A-REF** cycle time or manually initiating an auto-reference measurement.

4.2.2. TEST FUNCTIONS

The information found in Section 4.1.1 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the exception that the following table supersedes Table 4-2 of the T300/T300M Operators Manual (P/N 06864).

Table 4-2: Test Functions Defined

| Parameter | Display Title | Units | Meaning |
|--------------------------------------|------------------------------|----------------------|---|
| RANGE -- RANGE1 RANGE2 | RANGE | PPB, PPM UGM, MGM | The full-scale limit at which the output range of the analyzer's Analog Outputs is currently set. <ul style="list-style-type: none"> THIS IS NOT the Physical Range of the instrument. See Section 4.3.2 for more information. If DUAL or AUTO Range modes have been selected, two RANGE functions will appear, one for each range. |
| Stability | STABIL | PPB, PPM UGM, MGM | Standard deviation of CO concentration readings. Data points are recorded every ten seconds using the last 25 data points. This function can be reset to show O ₂ or CO ₂ stability in instruments with those sensor options installed. |
| CO Measure | MEAS | MV | The demodulated, peak IR detector output during the measure portion of the GFC Wheel cycle. |
| CO Reference | REF | MV | The demodulated, peak IR detector output during the reference portion of the GFC wheel cycle. |
| Measurement / Reference Ratio | MR Ratio | - | The result of CO MEAS divided by CO REF based on readings taken during the normal sample measurement portion of the A-REF cycle. This ratio is the primary value used to compute CO concentration. The value displayed is not linearized. |
| Auto-Reference Ratio | AZERO RATIO | - | The result of CO MEAS divided by CO REF based on readings taken during the zero-reference portion of the A-REF cycle. This ratio is the used to compute a reference correction factor for computing the CO concentration. The value displayed is not linearized. |
| Sample Pressure | PRES | In-Hg-A | The absolute pressure of the Sample gas as measured by a pressure sensor. |
| Sample Flow | SAMPLE FL | cm ³ /min | Sample mass flow rate as measured by the flow rate sensor in the sample gas stream, |
| Sample Temperature | SAMP TEMP | °C | The temperature of the gas inside the sample chamber. |
| Bench Temperature | BENCH TEMP | °C | Optical bench temperature. |
| Wheel Temperature | WHEEL TEMP | °C | GFC wheel temperature. |
| Box Temperature | BOX TEMP | °C | The temperature inside the analyzer chassis. |
| Oven Temperature | OVEN TEMP² | °C | The current temperature of the circulating air inside the T300U's convection oven area. |
| Photo-detector Temp. Control Voltage | PHT DRIVE | mV | The drive voltage being supplied to the thermoelectric coolers of the IR photo-detector by the sync/demod Board. |
| Slope | SLOPE | - | The sensitivity of the instrument as calculated during the last calibration activity. The SLOPE parameter is used to set the span calibration point of the analyzer. |
| Offset | OFFSET | - | The overall offset of the instrument as calculated during the last calibration activity. The OFFSET parameter is used to set the zero point of the analyzer response. |
| Test Channel Output | TEST | mV | The raw voltage being output on the analyzer's A4 analog output. Only appears when the test channel is assigned a function. |
| Current Time | TIME | - | The current time. This is used to create a time stamp on DAS readings, and by the AUTOCAL feature to trigger calibration events. |

4.3. SETUP → RNGE: ANALOG OUTPUT REPORTING RANGE CONFIGURATION

4.3.1. PHYSICAL RANGE VERSUS ANALOG OUTPUT REPORTING RANGES

Functionally, the T300U analyzer has one hardware “physical range” that is capable of determining CO concentrations between 0 ppb and 100,000 ppb. This architecture improves reliability and accuracy by avoiding the need for extra, switchable, gain-amplification circuitry. Once properly calibrated, the analyzer’s front panel will accurately report concentrations along the entire span of its physical range. T300U analyzer’s physical range can create data resolution problems for most analog recording devices. For example, in an application where the expected concentration of CO is typically less than 1000 ppb, the full scale of expected values is only 1% of the instrument’s 100,000 ppb physical range. Unmodified, the corresponding output signal would also be recorded across only 1% of the range of the recording device.

The T300U solves this problem by allowing the user to select a scaled reporting range for the analog outputs that only includes that portion of the physical range relevant to the specific application.

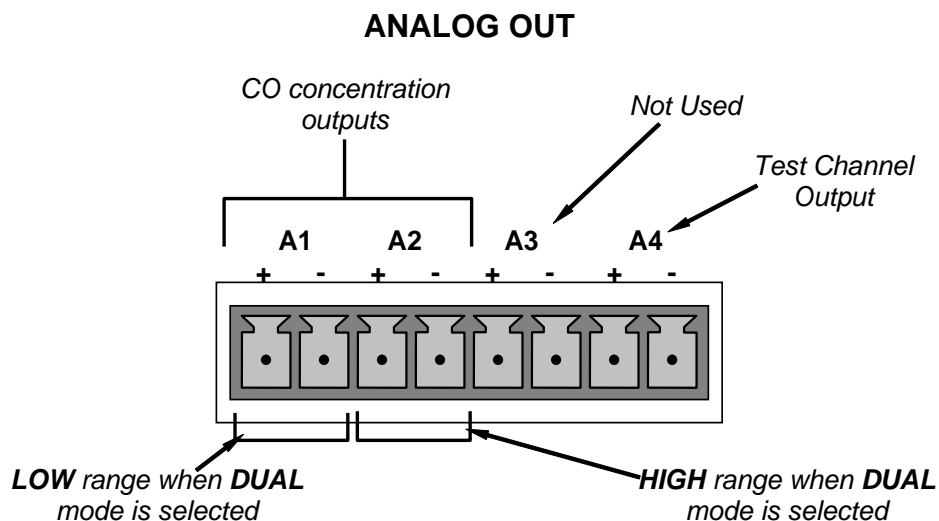
Note

Only the reporting range of the analog outputs is scaled.

Both the DAS values stored in the CPU’s memory and the concentration values reported on the front panel are unaffected by the settings chosen for the reporting range(s) of the instrument.

4.3.2. ANALOG OUTPUT RANGES FOR CO CONCENTRATION

The analyzer has two active analog output signals related to CO concentration that are accessible through a connector on the rear panel.



The **A1** and **A2** channels output a signal that is proportional to the CO concentration of the sample gas. They can be configured:

- With independent reporting ranges reporting a “single” output signal (**SNGL** Mode, see Section 4.3.3).
- Be to operate completely independently (**DUAL** mode, see Section 4.3.4). In this mode the user can set the measure span and signal scale of each output in a variety of combinations (but not the units of measure).

EXAMPLE:

A1 OUTPUT: Output Signal = 0-5 VDC representing 0-1000 ppb concentration values

A2 OUTPUT: Output Signal = 0-10 VDC representing 0-500 ppb concentration values.

- Or to automatically switch between the two ranges dynamically as the concentration value fluctuates (**AUTO** modes, see Section 4.3.5).

Both the **A1** and **A2** outputs can be:

- Configured full scale outputs of: 0 - 0.1 VDC; 0 - 1VDC; 0 - 5VDC or; 0 - 10VDC.
- Equipped with optional 0-20 mA DC current loop drivers and configured for any current output within that range (e.g. 0-20, 2-20, 4-20, etc.).

The user may also add a signal offset independently to each output (see Section 4.7.1) to match the electronic input requirements of the recorder or data logger to which the output is connected.

DEFAULT SETTINGS

The default setting for these the reporting ranges of the analog output channels **A1** and **A2** are:

- SNGL mode
- 0 to 500.0 ppb
- 0 to 5 VDC

Reporting range span may be viewed via the front panel by viewing the **RANGE** test function. If the **DUAL** or **AUTO** modes are selected, the **RANGE** test function will be replaced by two separate functions, **RANGE1** & **RANGE2**. Reporting range status is also available as output via the external digital I/O status bits.

Note

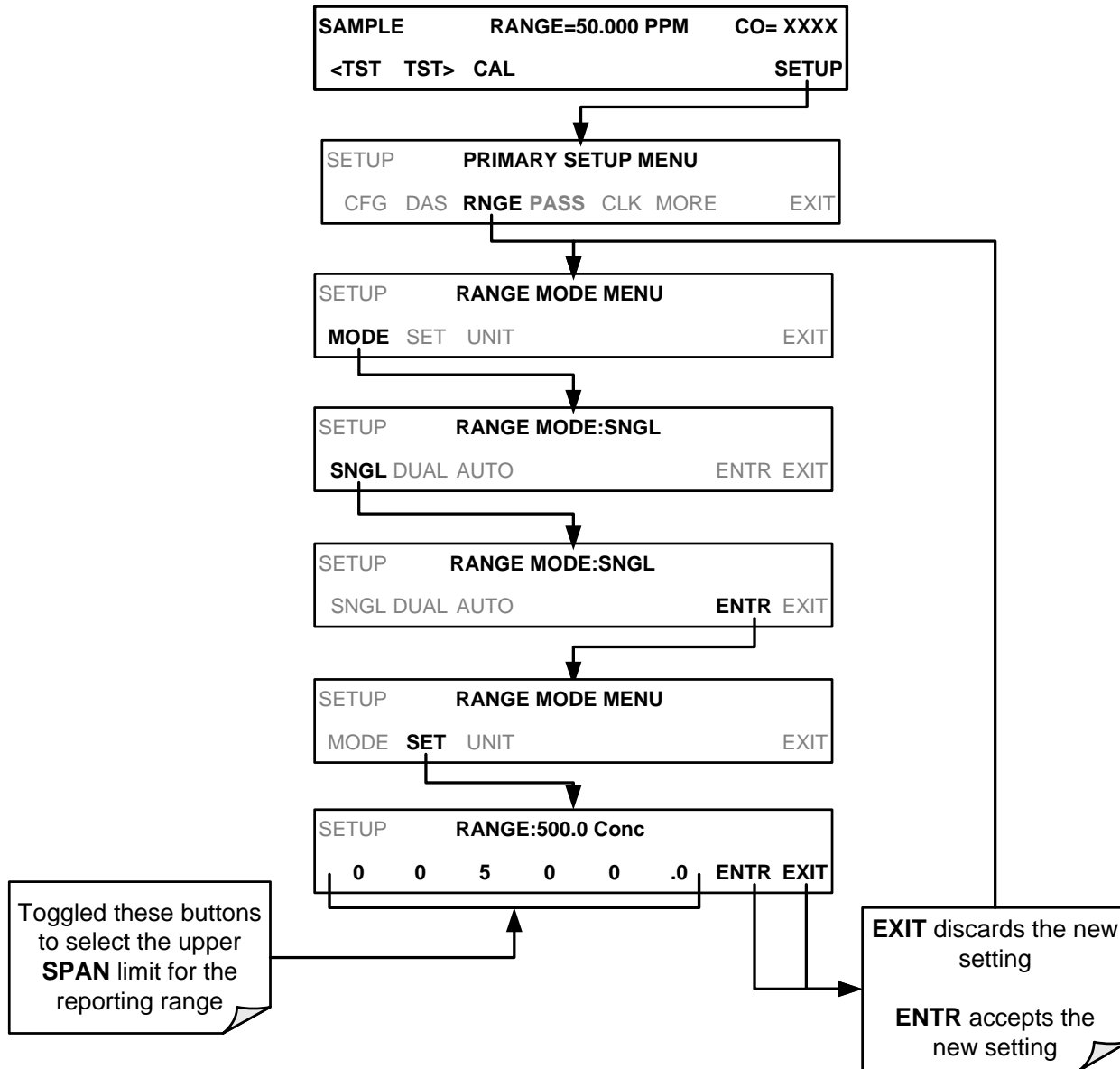
Upper span limit setting for the individual range modes are shared. Resetting the span limit in one mode also resets the span limit for the corresponding range in the other modes as follows:

| | | | | |
|--------------------|---|--------------------|---|--------------------|
| <u>SNGL</u> | | <u>DUAL</u> | | <u>AUTO</u> |
| Range | ↔ | Range1 (Low) | ↔ | Low Range |
| | | Range2 (Hi) | ↔ | High Range |

4.3.3. RNGE → MODE → SNGL: CONFIGURING THE T300U ANALYZER FOR SINGLE RANGE MODE

The single range mode sets a single maximum range for the both the A1 and A2 analog outputs. If the single range is selected both outputs are slaved together and will represent the same reporting range span (e.g. 0-50 ppm), however, their electronic signal levels may be configured for different ranges (e.g. 0-10 VDC vs. 0-0.1 VDC).

This Reporting range can be set to any value between 0.1 ppb and 10,000 ppb. To select **SINGLE** range mode and set the upper limit of the reporting range, press:



Note

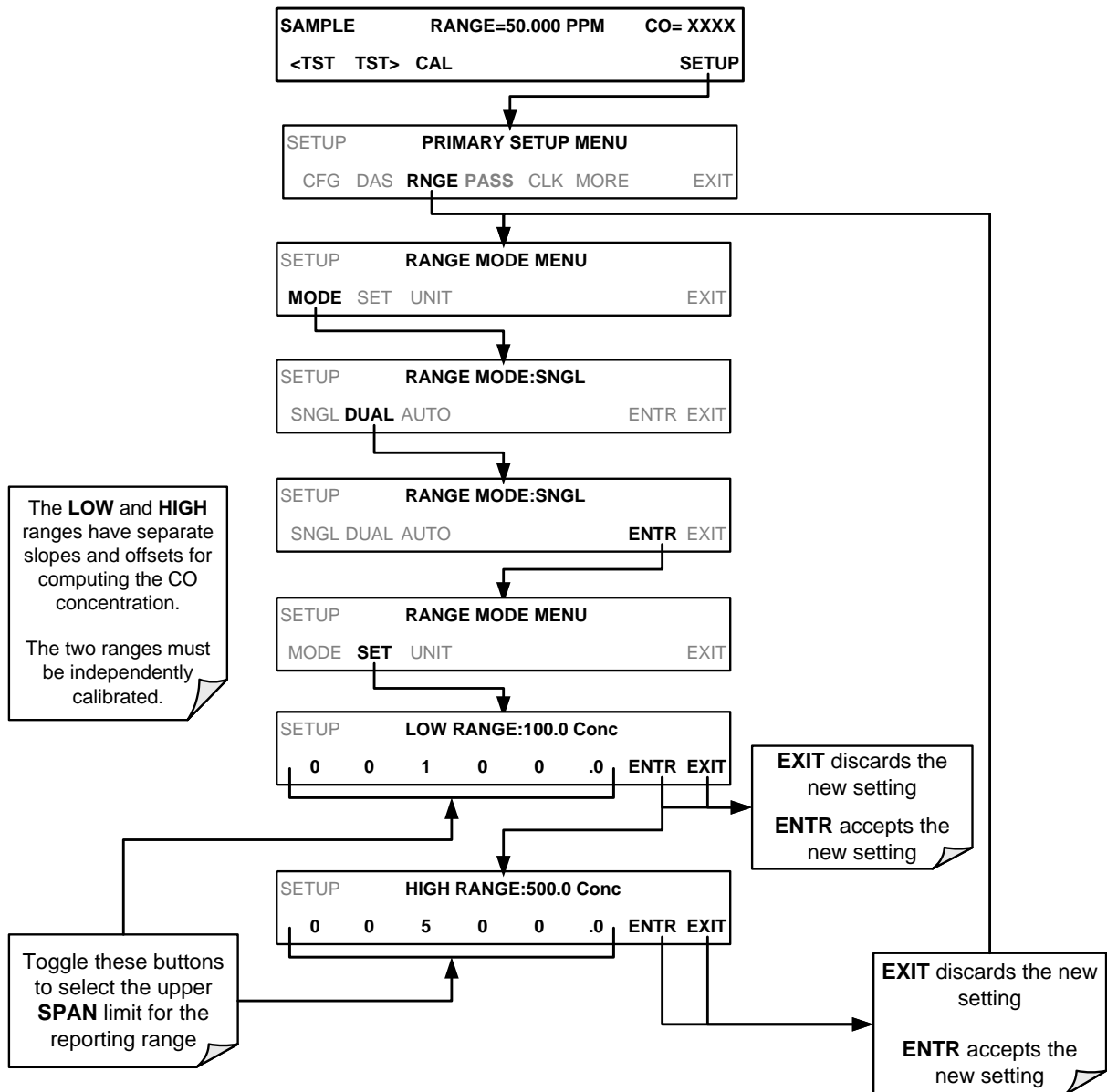
 This is the default reporting range mode for the analyzer.

4.3.4. RNGE → MODE → DUAL: CONFIGURING THE T300U ANALYZER FOR DUAL RANGE MODE

DUAL range mode allows the **A1** and **A2** outputs to be configured with separate reporting range spans as well as separate electronic signal levels. The analyzer software calls these two ranges **LOW** and **HI**.

- The **LOW** range setting corresponds with the analog output labeled **A1** on the rear panel of the instrument and is viewable via the test function **RANGE 1**.
- The **HIGH** range setting corresponds with the **A2** output and is viewable via the test function **RANGE 2**.
- While the software labels these two ranges as **LOW** and **HI**, when in **DUAL** mode their upper limits need not conform to that convention. The upper span limit of the **LOW/RANGE1** can be a higher number than that of **HI/RANGE 2**

To set the ranges press:



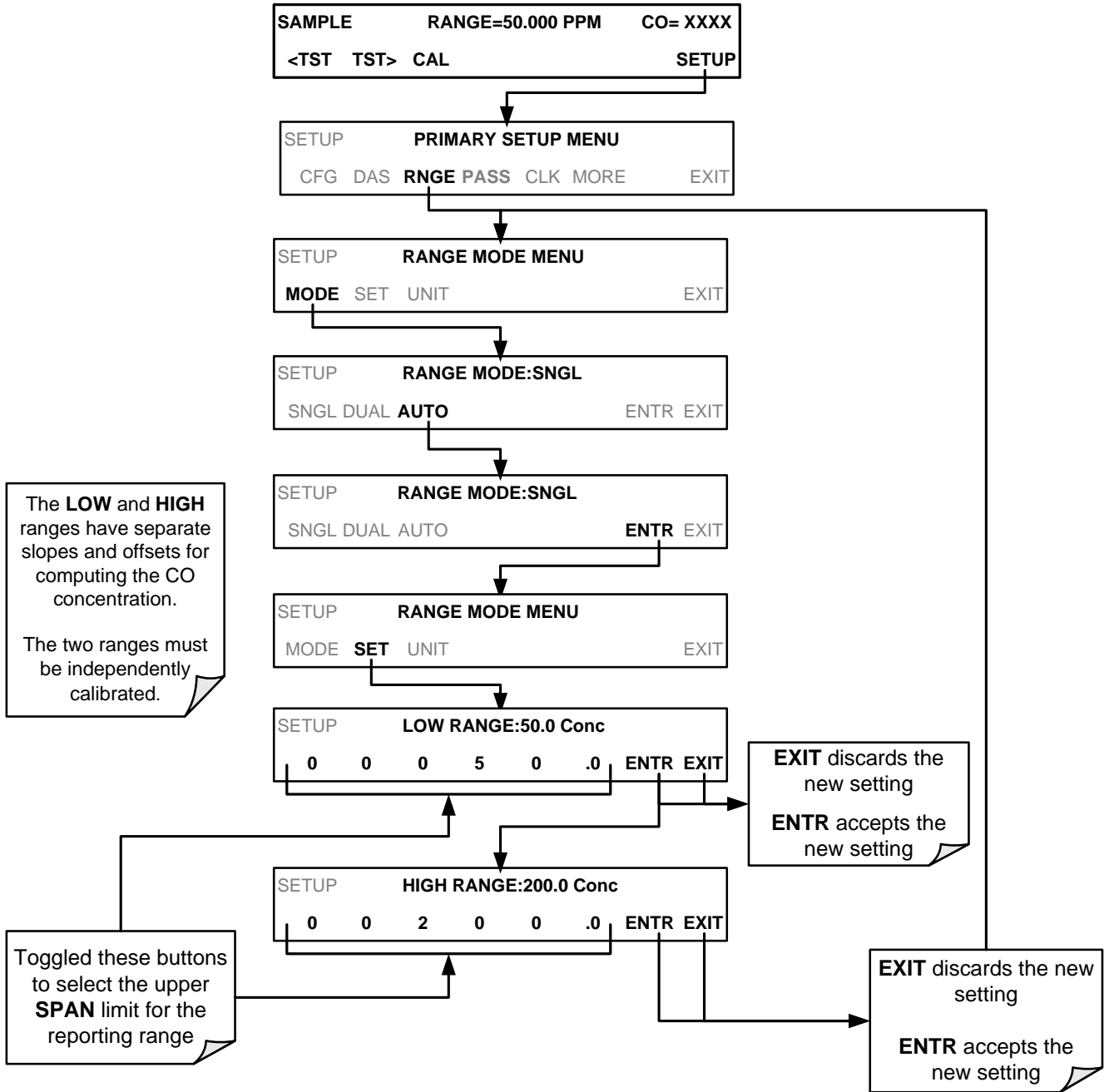
4.3.5. RANGE → MODE → AUTO: CONFIGURING THE T300U ANALYZER FOR AUTO RANGE MODE

AUTO range mode gives the analyzer the ability to output data via a **LOW** range (displayed on the front panel as **RANGE1**) and **HIGH** range (displayed on the front panel as **RANGE2**) on a single analog output.

When the **AUTO** range mode is selected, the analyzer automatically switches back and forth between user-selected **LOW** & **HIGH** ranges depending on the level of the CO concentration.

- The unit will move from **LOW** range to **HIGH** range when the CO concentration exceeds to 98% of the LOW range span limit.
- The unit will return from **HIGH** range back to **LOW** range once the CO concentration falls below 75% of the **LOW** range span limit.

To set the ranges press:



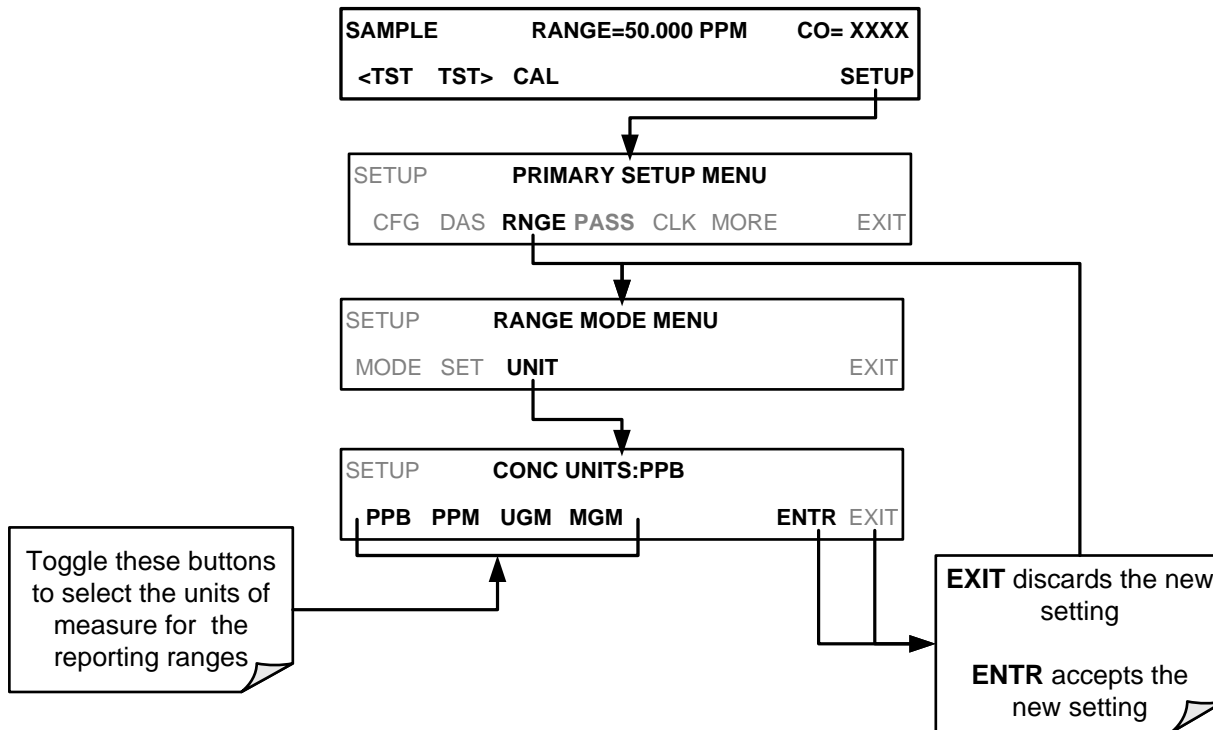
IMPORTANT

IMPACT ON READINGS OR DATA

Avoid accidentally setting the LOW range (RANGE 1) of the instrument with a higher span limit than the HIGH range (RANGE 2). This will cause the unit to stay in the low reporting range perpetually and defeat the function of the AUTO range mode.

4.3.6. SETUP → RNGE → UNIT: SETTING THE REPORTING RANGE UNIT TYPE

The T300U can display concentrations in ppb, ppm, ug/m³, mg/m³ units. Changing units affects all of the COM port values, and all of the display values for all reporting ranges. To change the units of measure press:



Note Concentrations displayed in mg/m³ and ug/m³ use 0°C, 760 mmHg for Standard Temperature and Pressure (STP). Consult your local regulations for the STP used by your agency.

Note Once the units of measurement have been changed, the unit **MUST** be recalibrated, as the “expected span values” previously in effect will no longer be valid. Simply entering new expected span values without running the entire calibration routine is not sufficient.

The following equations give approximate conversions between volume/volume units and weight/volume units:

$$\text{CO ppb} \times 1.25 = \text{CO ug/m}^3$$

$$\text{CO ppm} \times 1.25 = \text{CO mg/m}^3$$

4.4. SETUP → MORE → AREF: CONFIGURING AND PERFORMING AUTO-REFERENCE MEASUREMENTS

4.4.1. ADJUSTING THE A-REF MODE CYCLE TIME

The auto-reference measurement feature is initiated by the T300U at regular intervals (see Section 8.1.1). It is triggered by the timer feature of the analyzers ACAL system, which uses the instrument's internal clock.

All T300U analyzers are shipped from the factory the **ACAL** system enabled (even on instruments without calibration valve options installed) and the first **ACAL** sequence already programmed and activated with the **DELTA TIME** parameter set for 4 hours (for a more detailed discussion of the ACAL system see Section 9.4 of the T300/T300M Operators Manual).

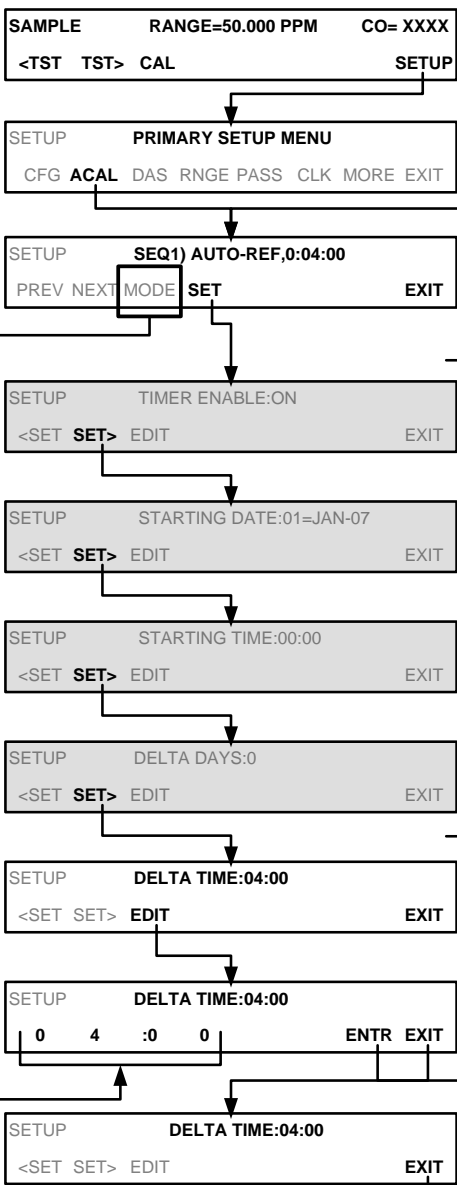
This interval time can be changed to fit the specific application in which the T300U is being used. To change the A-REF interval, press:

NOTE
DO NOT change the **MODE**.
 Changing to mode to anything other than **AUTO-REF** will disable the **A-REF** feature and seriously compromise the accuracy of the T300U's CO measurements

NOTE
DO NOT change any of the settings. Altering these setting may disable the **A-REF** feature and seriously compromise the accuracy of the T300U's CO measurements

Toggle these buttons to change the **A-REF** start interval.

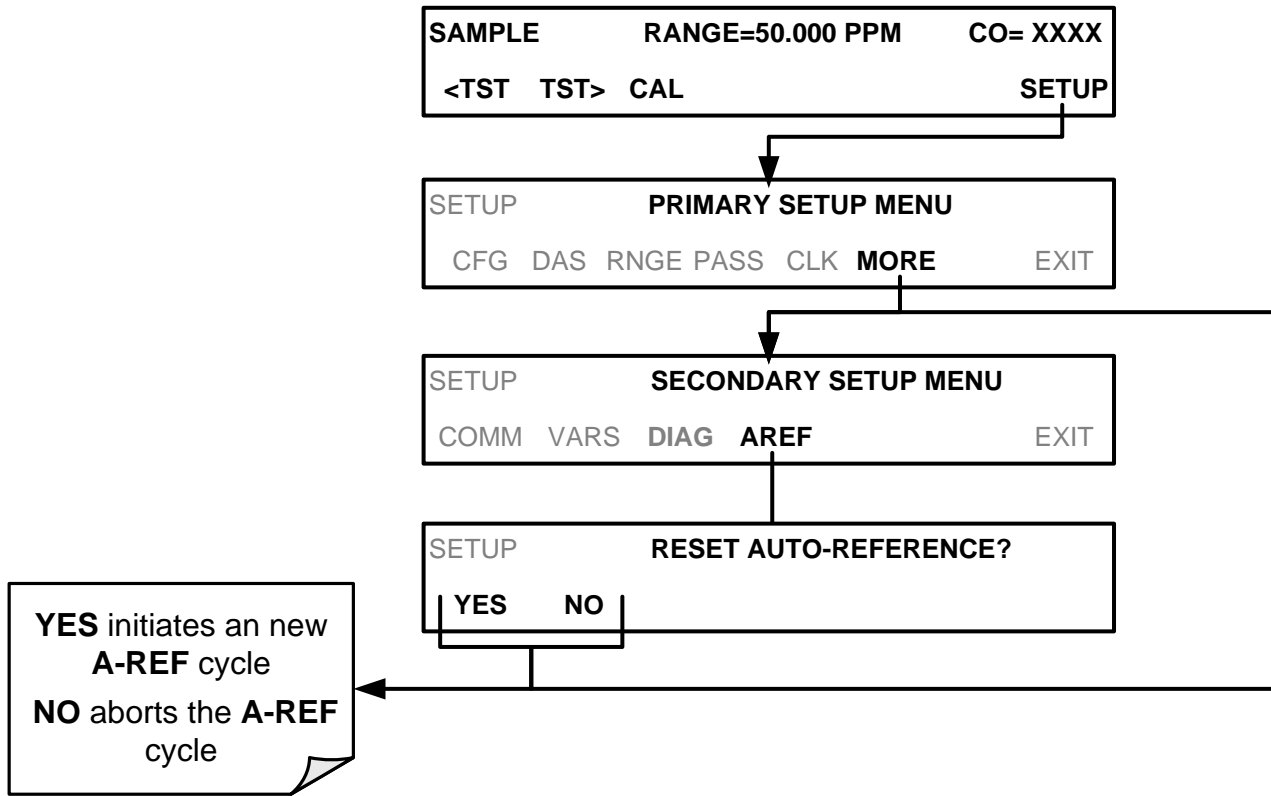
EXIT discards the new setting
ENTR accepts the new setting



4.4.2. FORCING AN AUTO-REFERENCE MEASUREMENT

Sometimes it is advisable to perform an auto-reference measurement at other times such as just before calibrating the analyzer.

To manually start an auto-reference measurement cycle, press:



4.5. SETUP → MORE → VARS: VARIABLES SETUP AND DEFINITION

The information found in Section 5.8 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s):

- There is no **STABIL_GAS** variable available under the **VARS** menu of the T300U.
- The following table supersedes Table 5-3 of the T300/T300M Operators Manual (P/N 06864).

Table 4-3: T300U VARS Menu

| NO. | VARIABLE | DESCRIPTION | ALLOWED VALUES |
|-----|-----------------------|---|--|
| 0 | DAS_HOLD_OFF | Changes the internal data acquisition system (DAS) hold-off time, which is the duration when data are not stored in the DAS because the software considers the data to be questionable. That is the case during warm-up or just after the instrument returns from one of its calibration modes to SAMPLE mode. DAS_HOLD_OFF can be disabled entirely in each DAS channel. | Can be between 0.5 and 20 minutes Default=15 min. |
| 1 | CONC_PRECISION | Allows the user to set the number of significant digits to the right of the decimal point display of concentration and stability values. | AUTO, 1, 2, 3, 4 Default=AUTO |
| 2 | DYN_ZERO | Dynamic zero automatically adjusts offset and slope of the CO response when performing a zero point calibration during an AutoCal (Section 7). | ON/OFF |
| 3 | DYN_SPAN | Dynamic span automatically adjusts slope and slope of the CO response when performing a zero point calibration during an AutoCal (Section 7). Note that the DYN_ZERO and DYN_SPAN features are not allowed for applications requiring EPA equivalency. | ON/OFF |
| 4 | CLOCK_ADJ | Adjusts the speed of the analyzer's clock. Choose the + sign if the clock is too slow, choose the - sign if the clock is too fast. | -60 to +60 s/day |

4.6. SETUP → MORE → DIAG: DIAGNOSTICS FUNCTIONS

The information found in Section 5.9 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s):

- There is no **DISPLAY SEQUENCE CONFIGURATION** submenu available under the **DIAG** menu of the T300U.
- The following table supersedes Table 5-4 of the T300/T300M Operators Manual (P/N 06864).

Table 4-4: T300U Diagnostic (DIAG) Submenus

| DIAGNOSTIC FUNCTION AND MEANING | Front Panel Mode Indicator | |
|---|----------------------------|-----------------------|
| SIGNAL I/O: Allows observation of all digital and analog signals in the instrument. Allows certain digital signals such as valves and heaters to be toggled ON and OFF . | DIAG I/O | See T300/T300M Manual |
| ANALOG OUTPUT: When entered, the analyzer performs an analog output step test. This can be used to calibrate a chart recorder or to test the analog output accuracy. | DIAG AOUT | See T300/T300M Manual |
| ANALOG I/O CONFIGURATION: This submenu allows the user to configure the analyzer's four analog output channels, including choosing what parameter will be output on each channel. Instructions that appear here allow adjustment and calibration the voltage signals associated with each output as well as calibration of the analog to digital converter circuitry on the motherboard. | DIAG AIO | 4.7.1 |
| ELECTRIC TEST: The analyzer is performing an electric test. This test simulates IR detector signal in a known manner so that the proper functioning of the sync/demod board can be verified. | DIAG OPTIC | See T300/T300M Manual |
| DARK CALIBRATION: The analyzer is performing a dark calibration procedure. This procedure measures and stores the inherent dc offset of the sync/demod board electronics. | DIAG ELEC | See T300/T300M Manual |
| PRESSURE CALIBRATION: The analyzer records the current output of the sample gas pressure sensor. This value is used by the CPU to compensate the CO concentration. | DIAG PCAL | See T300/T300M Manual |
| FLOW CALIBRATION: This function is used to calibrate the gas flow output signals of sample gas and ozone supply. These settings are retained when exiting DIAG . | DIAG FCAL | See T300/T300M Manual |

4.7. ANALOG OUTPUT CONFIGURATION

4.7.1. ANALOG I/O CONFIGURATION

Because the manner in which the analog outputs are implemented differs between the T300/T300M and the T300U, there are significant differences in the manner in which the ANALOG I/O are manipulated.

This section replaces Section 5.9.3 of the T300/T300M Operators Manual (P/N 06864).

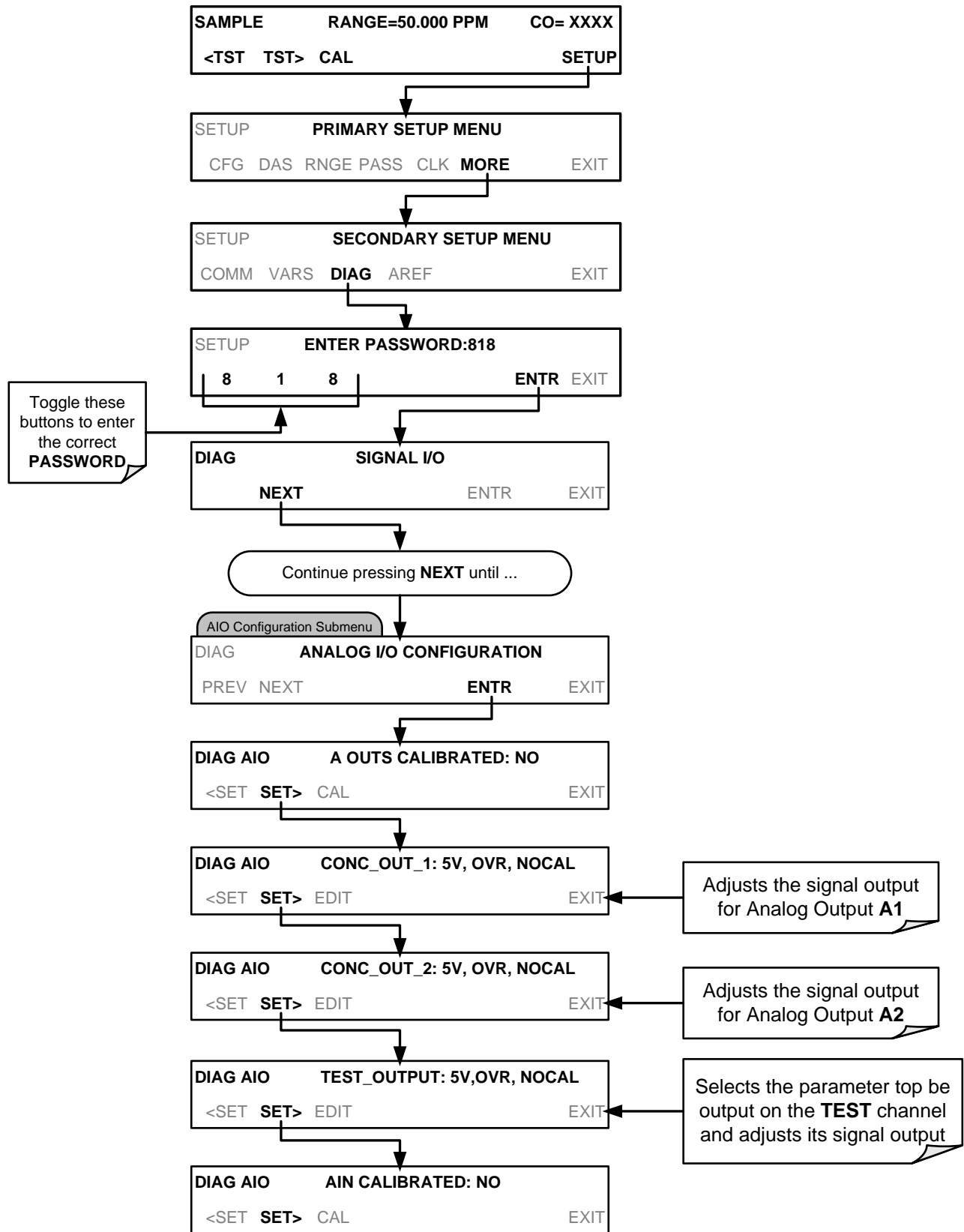
Table 4-5: DIAG - Analog I/O Functions

| SUB MENU | FUNCTION |
|--|--|
| AOUT CALIBRATED | Initiates a calibration of the A1 , A2 and A4 analog output channels that determines the slope and offset inherent in the circuitry of each output. These values are stored in the and applied to the output signals by the CPU automatically |
| CONC_OUT_1¹ | Sets the basic electronic configuration of the A1 output. There are four options: <ul style="list-style-type: none"> • RANGE: Selects the signal type (voltage or current loop) and level of the output • A1 OFS: Allows them input of a DC offset to let the user manually adjust the output level • AUTO CAL: Enables / Disables the AOUT CALIBRATION Feature • CALIBRATED: Performs the same calibration as AOUT CALIBRATED, but on this one channel only. |
| CONC_OUT_2¹ | Sets the basic electronic configuration of the A2 output. There are three options: <ul style="list-style-type: none"> • RANGE: Selects the signal type (voltage or current loop) and level of the output • A2 OFS: Allows them input of a DC offset to let the user manually adjust the output level • AUTO CAL: Enables / Disables the AOUT CALIBRATION Feature • CALIBRATED: Performs the same calibration as AOUT CALIBRATED, but on this one channel only. |
| TEST OUTPUT¹ | Sets the basic electronic configuration of the A4 output. There are three options: <ul style="list-style-type: none"> • RANGE: Selects the signal type (voltage or current loop) and level of the output • A4 OFS: Allows them input of a DC offset to let the user manually adjust the output level • AUTO CAL: Enables / Disables the AOUT CALIBRATION Feature • CALIBRATED: Performs the same calibration as AOUT CALIBRATED, but on this one channel only. |
| AIN CALIBRATED | Initiates a calibration of the A-to-D Converter circuit located on the Mother Board. |
| ¹ Changes to RANGE or REC_OFS require recalibration of this output. | |

To configure the analyzer's three analog outputs, set the electronic signal type of each channel and calibrate the outputs by:

1. Selecting an output type (voltage or current, if an optional current output driver has been installed) and the signal level that matches the input requirements of the recording device attached to the channel.
2. Determining if the over-range feature is needed and turn it on or off accordingly.
3. Considering if a Voltage scale is in use: a bipolar recorder offset may be added to the signal if required.
4. Choosing a Test Channel parameter to be output on the channel.
5. Calibrating the output channel. This can be done automatically or manually for each channel.

To access the analog I/O configuration sub menu, press:



4.7.2. ANALOG OUTPUT CALIBRATION

This section corresponds to Section 5.9.3.2 of the T300/T300M Operators Manual (P/N 06864).

ANALOG OUPUT calibration needs to be carried out on first startup of the analyzer (performed in the factory as part of the configuration process) or whenever re-calibration is required. The analog outputs can be calibrated automatically, either as a group or individually, or adjusted manually.

During automatic calibration, the analyzer tells the output circuitry to generate a zero mV signal and high-scale point signal (usually about 90% of chosen analog signal scale) then measures actual signal of the output. Any error at zero or high-scale is corrected with a slope and offset.

In its default state, the analyzer is configured for automatic calibration of all channels, which is useful for clearing any analog calibration warnings associated with channels that will not be used or connected to any input or recording device, e.g., datalogger. However, manual calibration should be used for the 0.1V range or in cases where the outputs must be closely matched to the characteristics of the recording device. Manual calibration requires the AUTOCAL feature to be disabled. Automatic group calibration can be performed via the AOUTS CALIBRATION command, or by the DIAG>ANALOG I/O CONFIGURATION menu and pressing the CAL button within each of the output submenus (e.g. **CONC_OUT_1**, **CONC_OUT_2** or **TEST_OUTPUT**).

MANUAL CALIBRATION OF ANALOG OUTPUTS CONFIGURED FOR CURRENT LOOP RANGES

The information found in Section 5.9.3.7 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception:

- The current output option can only be installed on outputs **A1** and **A2** of the T300U

4.7.3. SELECTING A TEST CHANNEL FUNCTION FOR OUTPUT A4

This section replaces Section 5.9.8.1 of the T300/T300M Operators Manual (P/N 06864)

The Test Functions available to be reported on analog output **A4** are:

Table 4-6: Test Channels Functions Available on the T300U's Analog Output

| TEST CHANNEL | DESCRIPTION | ZERO | FULL SCALE |
|-----------------|--|------------------------|---------------------------|
| NONE | TEST CHANNEL IS TURNED OFF | | |
| CO MEASURE | The raw output of the optical bench's IR detector during the measure phase of the m/r cycle | 0 mV | 5000 mV* |
| CO REFERENCE | The raw output of the optical bench's IR detector during the reference phase of the m/r cycle | 0 mV | 5000 mV* |
| SAMPLE PRESSURE | The pressure of gas in the optical bench's sample chamber | 0 "Hg | 40 "Hg-In-A |
| SAMPLE FLOW | The gas flow rate through the optical bench's sample chamber | 0 cm ³ /min | 6000 cm ³ /min |
| SAMPLE TEMP | The temperature of gas in the optical bench's sample chamber | 0 °C | 70 °C |
| BENCH TEMP | The temperature of optical bench's itself | 0 °C | 70 °C |
| WHEEL TEMP | The temperature of GFC wheel | 0 °C | 70 °C |
| OVEN TEMP | The temperature of the circulating air inside the convection oven section of the T300U's interior. | 0 °C | 70 °C |
| PHT DRIVE | The drive voltage being supplied to the thermoelectric coolers of the IR photo-detector by the sync/demod board. | 0 mV | 5000 mV |
| TEMP4 | SPARE | | |

Once a function is selected, the instrument not only begins to output a signal on the analog output, but also adds **TEST** to the list of Test Functions viewable via the Front Panel Display.

4.7.4. HESSEN PROTOCOL

The information found in Section 6.7.2 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s):

- There is only one default gas type programmed into the T300U, as follows:

Table 4-7: T300U Hessen GAS ID List

| GAS DEFAULT | HESSEN GAS ID |
|-------------|---------------|
| CO | 310 |

- The list of Hessen status flags for the T300U is different from that of the T300/T300M. The following table replaces Table 6-6 of the T300/T300M Operators Manual (P/N 06864).

Table 4-8: Default Hessen Status Bit Assignments

| STATUS FLAG NAME | DEFAULT BIT ASSIGNMENT |
|--|------------------------|
| WARNING FLAGS | |
| SAMPLE FLOW WARNING | 0001 |
| BENCH TEMP WARNING | 0002 |
| SOURCE WARNING | 0004 |
| BOX TEMP WARNING | 0008 |
| WHEEL TEMP WARNING | 0010 |
| SAMPLE TEMP WARNING | 0020 |
| SAMPLE PRESSURE WARNING | 0040 |
| INVALID CONC (The Instrument's Front Panel Display Will Show The Concentration As "XXXX") | 0080 |
| OPERATIONAL FLAGS | |
| In Manual Calibration Mode | 0200 |
| In Zero Calibration Mode | 0400 |
| In Span Calibration Mode | 0800 |
| UNITS OF MEASURE FLAGS | |
| UGM | 0000 |
| MGM | 2000 |
| PPB | 4000 |
| PPM | 6000 |
| SPARE/UNUSED BITS | 100, 1000, 8000 |
| UNASSIGNED FLAGS (0000) | |
| AZERO WARN | RELAY BOARD WARNING |
| OVEN TEMP WARNING | ANALOG CAL WARNING |
| MP CAL | CANNOT DYN ZERO |
| PHOTO TEMP WARNING | CANNOT DYN SPAN |
| SYSTEM RESET | INVALID CONC |
| REAR BOARD NOT DETECTED | |

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5. CALIBRATION PROCEDURES

Calibration of the T300U should be performed according to the procedures described in Sections 9 & 10 of the T300/T300M Manual - P/N 06864 with the following notes and exceptions:

- Delivering span and zero gases for the higher resolution the T300U can be difficult. Attention must be paid to the quality of the gasses, the level of contaminants in the gases as well as the history and conditioning of the gas delivery components.
- The analyzer must be continually operating with an adequate flow of sample gas, for 2 hours prior to performing a calibration (12 hours is recommended for the initial calibration).
- NOTE: DO NOT calibrate the analyzer if it has been turned off or if no sample gas has been flowing through it within the last 2 hours.
- After this stabilization period is complete and just prior to performing the initial calibration, force the instrument to perform an auto-reference measurement by following the instructions in Section 4.4.2 .

5.1. REQUIRED EQUIPMENT, SUPPLIES AND EXPENDABLES

- Gas lines to and from the analyzer should be PTFE or FEP Teflon, glass, stainless steel or brass only.
- Zero-air source (defined in Section 9.1.1.1 of the T300/T300M Operators Manual).
 - Zero air must include at least 5% O₂ (required for the proper operation of the CO scrubber).
 - If a zero air generator such as the Teledyne Instruments M701 is used, it **MUST** be equipped with a hydrocarbon (HC) & CO scrubber option. For the Teledyne Instruments M701, this is Option 2B.
- Span gas source (defined in Section 9.1.1.3 of the T300/T300M Operators Manual).
- A recording device such as a strip-chart recorder and/or data logger (optional). Data recording device should be capable of bi-polar operation so that negative readings can be recorded.
- For electronic documentation, the internal data acquisition system can be used.

Note

If any problems occur while performing the following calibration procedures, refer to Section 11 of this manual for troubleshooting tips

5.2. MANUAL CALIBRATION

The information found in Section 9.2 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s).

- Zero/Span Calibration
 - Set the display to show the **STABILITY** test function (same as the **CO STB** function mentioned in the T300/T300M operator's manual).
 - There is no **GAS TO CAL** step because the T300U cannot be modified to include the O₂ and CO₂ sensor packages.

5.2.1. MANUAL CALIBRATION CHECKS

The information found in Section 9.2.2 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s).

- Set the display to show the **STABILITY** test function.

5.2.2. MANUAL CALIBRATION WITH ZERO/SPAN VALVES

The information found in Section 9.3 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s).

- Set the display to show the **STABILITY** test function.
- There is no **GAS TO CAL** step.

5.2.3. MANUAL CALIBRATION CHECKS WITH ZERO/SPAN VALVES

The information found in Section 9.3.2 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s).

- Set the display to show the **STABILITY** test function.
- There is no **GAS TO CAL** step.

5.2.4. CALIBRATION WITH REMOTE CONTACT CLOSURES

The information found in Section 9.3.3.3 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s).

Note

It is required that the analyzer be forced to perform an auto-reference measurement just prior to calibration, however this cannot be forced via the analyzer's digital control inputs.

The A-REF measurement can only be initiated using either the instrument's front pane interface or via Teledyne Instruments' APICOM emulator software.

5.2.5. AUTOMATIC ZERO/SPAN CAL/CHECK (AUTOCAL)

The information found in Section 9.4 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s).

- The following table replaces Table 9-2 of the T300/T300M Operators Manual (P/N 06864).

Table 5-1: AUTOCAL Modes

| MODE NAME | ACTION |
|------------------|--|
| DISABLED | Disables the Sequence |
| ZERO | Causes the Sequence to perform a zero calibration/check |
| ZERO-SPAN | Causes the Sequence to perform a zero and span concentration calibration/check |
| SPAN | Causes the Sequence to perform a span concentration calibration/check |
| AUTO-REF | Causes the analyzer to perform an auto-reference measurement. |

5.2.6. CO CALIBRATION QUALITY

The information found in Section 9.5 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U.

5.2.7. CALIBRATION OF OPTIONAL SENSORS

There are no optional sensors in the T300U.

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6. EPA PROTOCOL CALIBRATION

The information found in Section 10 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U.

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7. INSTRUMENT MAINTENANCE

The information found in Section 11 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s):

- The oven temperature should be tracked along with the other parameters listed on Table 11-2 of the T300/T300M Operators Manual (see Table 7-1 below).

7.1. PERFORMING AN AUTO-REFERENCE MEASUREMENT AFTER MAINTENANCE

It is very important to manually initiate an **A-REF** measurement whenever any maintenance is performed on the T300U, particularly if that maintenance involves:

- Opening the top cover or the front panel while the instrument is making **A-REF** measurements.
- Opening the top cover or the front panel at any time when the next ACAL scheduled **A-REF** measurement cycle is < 2 hours away.
- Turning off the analyzer at any time when the next ACAL scheduled **A-REF** measurement cycle is < 2 hours away.

This should be done no sooner than 2 hours after the T300U has been operating with the front panel / top cover properly closed and sealed. Once this manual A-REF measurement is performed; the analyzer will discard any erroneous A-REF ratios that may have been recorded before the instrument's oven temperature had a chance to re-stabilize.

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Table 7-1: T300U Test Function Record

| FUNCTION | OPERATING MODE* | DATE RECORDED | | | | | | | | | | | |
|-----------|----------------------|---------------|--|--|--|--|--|--|--|--|--|--|--|
| | | | | | | | | | | | | | |
| STABILITY | ZERO CAL | | | | | | | | | | | | |
| CO MEAS | ZERO CAL | | | | | | | | | | | | |
| MR RATIO | ZERO CAL | | | | | | | | | | | | |
| | SPAN CAL | | | | | | | | | | | | |
| PRES | SAMPLE | | | | | | | | | | | | |
| PHT DRIVE | SAMPLE AFTER WARM-UP | | | | | | | | | | | | |
| SLOPE | SPAN CAL | | | | | | | | | | | | |
| OFFSET | ZERO CAL | | | | | | | | | | | | |
| OVEN TEMP | SAMPLE | | | | | | | | | | | | |

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8. PRINCIPLES OF OPERATION

8.1. MEASUREMENT METHOD

The information found in Section 13.1 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following addition. It is recommended that you read that section before continuing.

8.1.1. AUTO-REFERENCE (A-REF) RATIO

The higher resolution of the T300U makes it more susceptible than the T300/T300M to the effects of a variety of environmental conditions such as:

- Drift related to the age of the optical bench components (e.g. the IR lamp, the IR detector, etc.)
- Variations in the temperature of the sample gas (affecting its density).
- Interferents, specifically CO₂ and H₂O.

The T300U accounts for these issues by adding an additional component to the CO concentration calculation call the Auto-reference ratio.

This ratio is arrived at in the same manner as the measure/reference ratio (described in Section 13.2.1.2 of the T300/T300M Operators Manual) with the difference that that during the measurements that are to calculate the **A-REF** ratio, the gas stream is switched to pass through a scrubber that completely removes all CO from the sample gas. Therefore the measured difference between **CO MEAS** and **CO REF** represents the exact state of the sample gas and the optical bench's sensors without CO present.

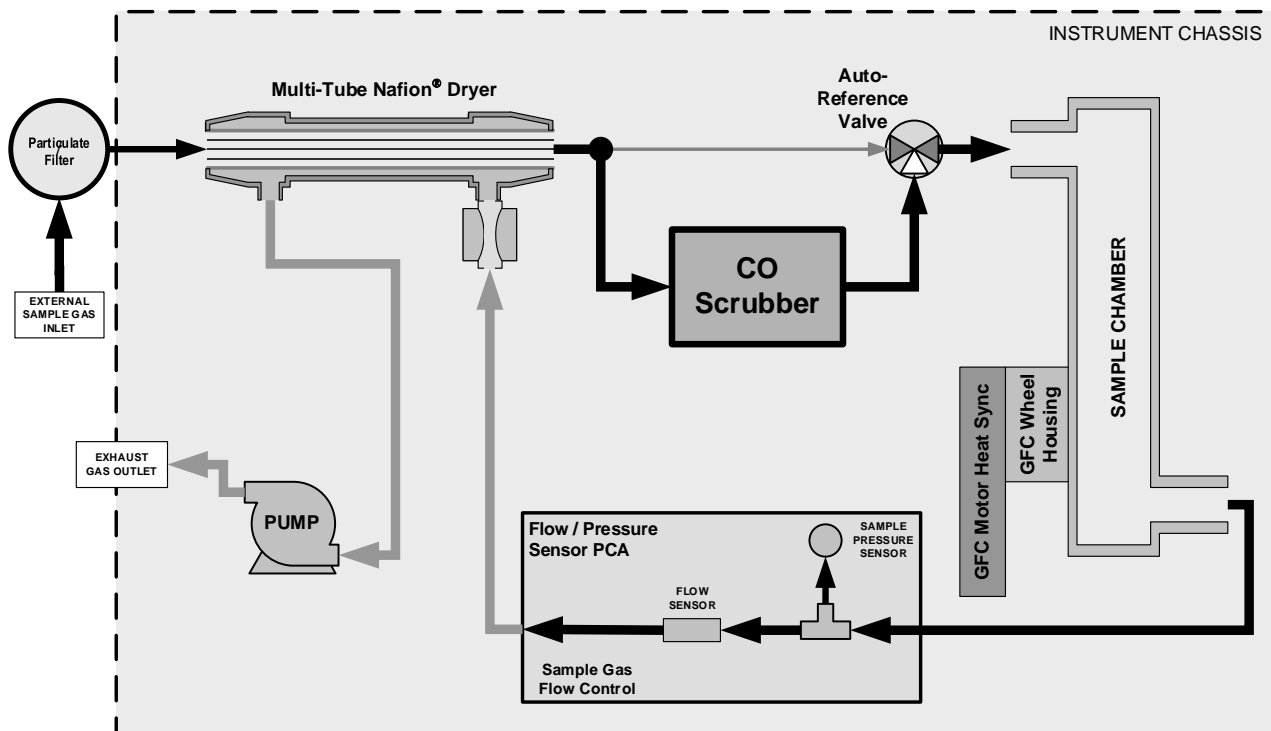


Figure 8-1: T300U Gas Flow during Auto-Reference Measurements

The analyzer averages the last five **A-REF** ratios and multiplies this average by a constant and the result is included in the final CO calculation as a positive or negative offset.

Whenever an **A-REF** is manually initiated either by using the **AREF** submenu via the front panel (see Section 4.4.2) or by activating pin-7 of the instrument's digital control input connector, all previously stored A-REF ratios are erased and the new ratio inserted. This allows the user to correct for a bad A-REF reading (e.g. the oven temperature during the A-REF cycle was too high/low)

The auto-reference measurement takes approximately 15 minutes. To ensure that the sample chamber of the optical bench is properly purged when switching between the sample and auto-reference measurements and vice-versa, each auto-reference cycle includes a 3 minute dwell period before and after the actual measurements are made. This cycle is restarted every 4 hours by an ACAL sequence, programmed at the factory (see Section 4.4).

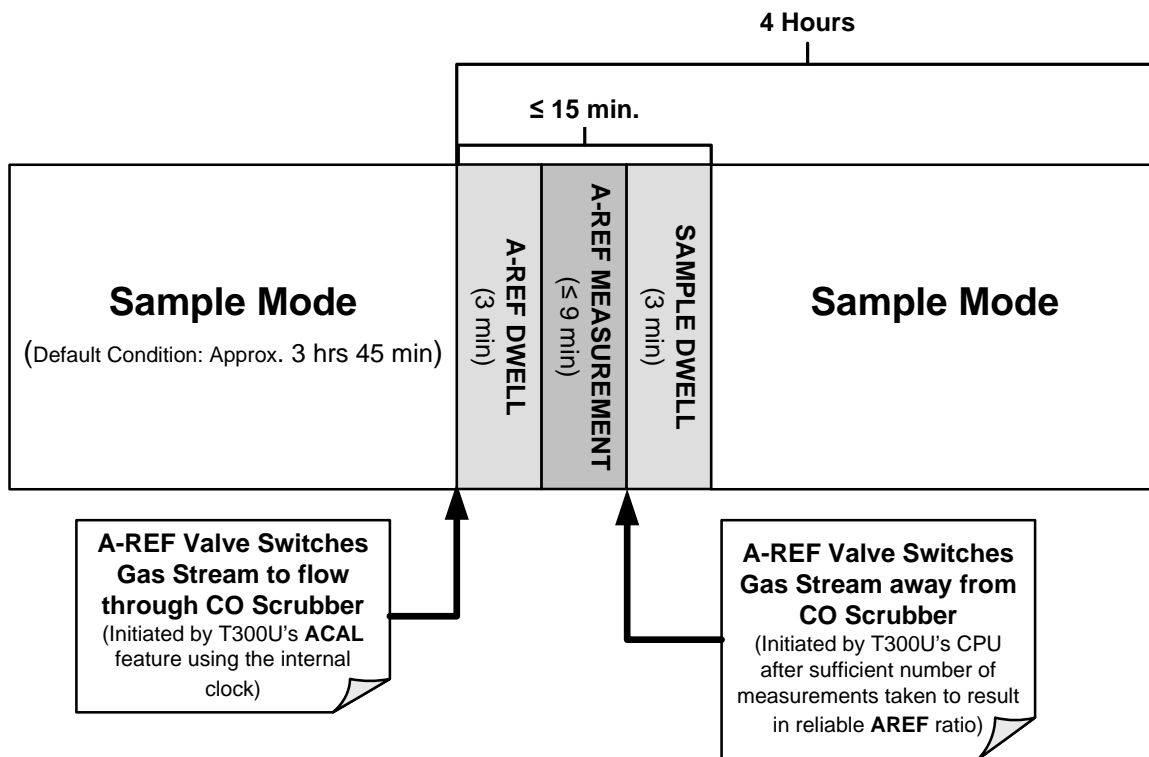


Figure 8-2: Auto-Reference Measurement Cycle

8.2. PNEUMATIC OPERATION

With the exceptions to the difference discussed on other portions of this addendum regarding the **A-REF** CO scrubber and the Nafion® dryer, the pneumatic operation is the same as that described in Section 13.3 of the T300/T300M Operators Manual (P/N 06864).

8.2.1. THE A-REF CARBON MONOXIDE SCRUBBER

A special CO scrubber is used to remove all of the CO from the gas stream when the instrument is performing an auto-reference measurement. The scrubber contains a substance that catalyses a chemical reaction converting any CO in the gas stream to CO₂.

Note

To operate properly, the gas flowing through the scrubber must contain at least 5% O₂.

This includes calibration gases such as zero air and span gas.

8.2.2. THE A-REF VALVE ASSEMBLY

The auto-reference valve assembly is located next to the optical bench, at the rear of the analyzer between the Nafion[®] dryer and the outer wall of the instrument (see Figure 3-1). The following table describes the state of each valve during the analyzer's various operational modes (see Figure 8-1).

Table 8-1: Auto-Reference Valve Operating States

| Mode | Valve State | VALVE PORT CONNECTIONS |
|---------------------------------|---|------------------------|
| SAMPLE (Normal State) | Gas stream from Nafion [®] Dryer & SAMPLE inlet | 3 → 2 |
| A-REF DWELL | Gas stream from CO scrubber | 1 → 2 |
| A-REF MEASUREMENT | Gas stream from CO scrubber | 1 → 2 |
| SAMPLE DWELL | Gas stream from Nafion [®] Dryer & SAMPLE inlet | 3 → 2 |

8.2.3. THE NAFION[®] DRYER.

Normal room air contains a certain amount of water vapor. While H₂O is a very low-level interferent for IR absorption (in the same range as CO) it can cause enough interference to affect the high-resolution measurements of the T300U.

To account for this the T300U has a special dryer added to the gas stream. The dryer consists of a bundle of parallel tubes of Nafion[®], a co-polymer similar to Teflon[®] that absorbs water very well but not other chemicals. The multiple tube design of this dryer creates a large reactive surface without causing a restriction in the higher gas flow rate required by the T300U that a long single tube style dryer would.

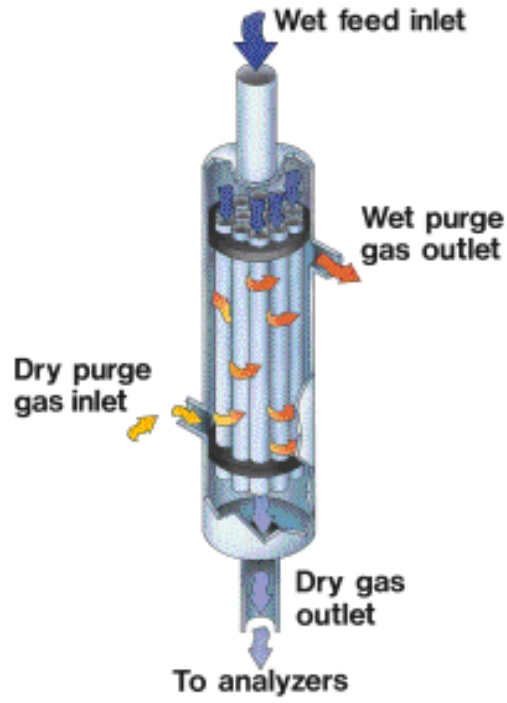


Figure 8-3: Semi-Permeable Membrane Drying Process

The dryer consists of a bundle of 0.030" O.D. Nafion® tubes housed within a single large tube shell. Sample gas flows within the Nafion tubes while water vapor absorbs into the tubular membrane walls and is removed. Moisture permeating the tubing is carried away by a dry purge gas within the shell that flows countercurrent to the sample gas.

This process is called per-evaporation and is driven by the humidity gradient between the inner and outer tubes as well as the flow rates and pressure difference between inner and outer tubing. Unlike micro-porous membrane permeation, which transfers water through a relatively slow diffusion process, per-evaporation is a simple kinetic reaction. Therefore, the drying process occurs quickly, typically within milliseconds.

The first step in this process is a chemical reaction between the molecules of the Nafion® material and water, other chemical components of the gases to be dried are usually unaffected. The chemical reaction is based on hydrogen bonds between the water molecule and the Nafion material. Other small polar gases that are capable of hydrogen bonds can be absorbed this way, too, such as ammonia (NH₃) and some low molecular amines. The gas of interest to the T300U, CO, does not get absorbed and passes through the dryer unaltered.

To provide a dry purge gas for the outer side of the Nafion tube, the T300U returns some of the dried air from the inner tube to the outer tube (see Figure 3-3).

When the analyzer is first started, or if the instrument is turned on after having been off for more than 30 minutes, the humidity gradient between the inner and outer tubes is not very large and the dryer's efficiency is low at first but improves as this cycle reduces the moisture in the sample gas and settles at a minimum humidity.

The dryer used in the T300U is capable of adequately drying ambient air to a dew point of $\leq -6^{\circ}\text{C}$ (~4000 ppm residual H₂O) at the flow rate of the analyzer.

8.3. ELECTRONIC OPERATION

8.3.1. OVERVIEW

The information found in Section 13.4 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s):

- This figure replaces Figure 13-9 of the T300/T300M Operators Manual.

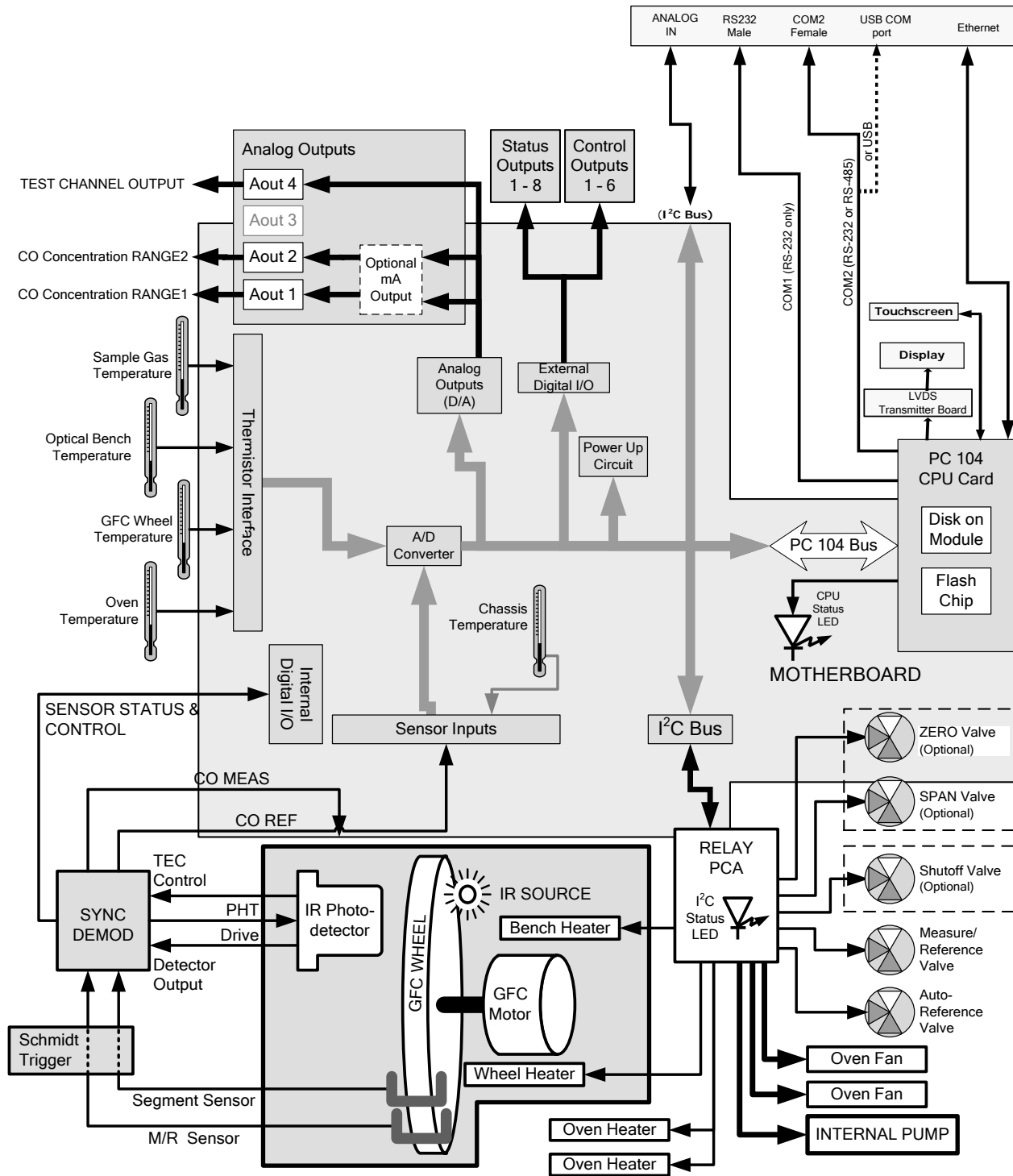


Figure 8-4: T300U Electronic Overview Block Diagram

8.3.2. THE RELAY PCA

The information found in Section 13.4.4 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s):

8.3.2.1. Temperature Control of the Convection Oven

The information found in Section 13.4.4.1 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s):

- There are two heaters attached to either side of the optical bench (see Figure 3-1) that radiate heat into the insulated, oven area of the analyzer. Each heater has a fan attached to it that circulates the heated air throughout the oven airspace.
- The CPU senses the temperature level from different places inside the oven area and determines the overall temperature of the oven. Eventually, all of the components within the oven area will stabilize at the same temperature. This usually takes about 24 hours after the instrument is turned **ON**.
- A separate fan blows directly on the A-to-D conversion circuitry of the motherboard to more keep it at the same temperature as the oven airspace in order to eliminate any temperature-coefficient related offset.

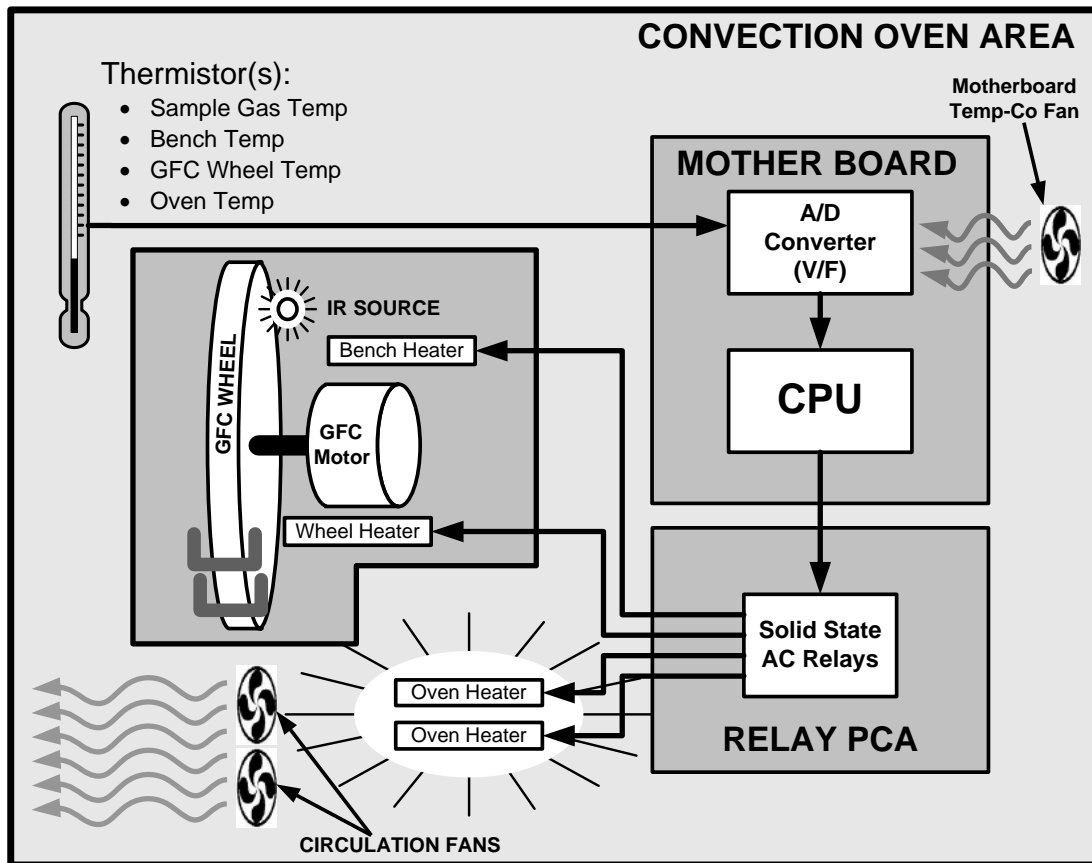


Figure 8-5: T300U Heating Control Block Diagram

8.3.2.2. Oven Heater AC Power Configuration

The two main heaters for the convection oven area of the T300U are AC heaters. A jumper, located in line on the power connection between the relay PCA and the heaters, set the heaters in one of two configurations:

- In parallel for 115 VAC operation, or;
- In series for 230 VAC operation.

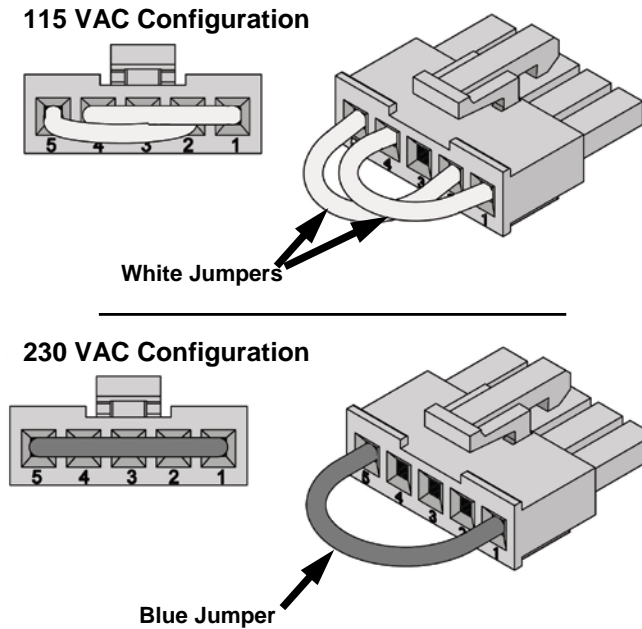


Figure 8-6: T300U Oven Heater Configuration Jumpers

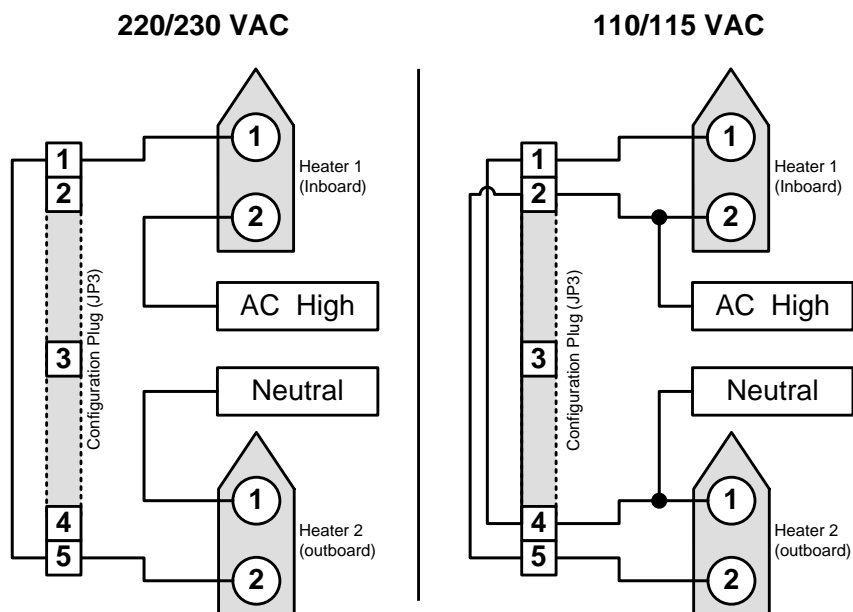


Figure 8-7: T300U Oven Heater Configuration Circuit

8.3.2.3. Status LEDs

This information replaces that found in Sections 13.4.4.5 of the T300/T300M Operators Manual.

- Eight LEDs, described in Table 8-2 are located on the analyzer's relay board to show the current status on the various control functions performed by the relay board (see Figure 13-15 of the T300/T300M Operators Manual).

Table 8-2: Relay Board Status LED's

| LED | COLOR | FUNCTION | STATUS WHEN LIT | STATUS WHEN DARK |
|-----------|---------------|-----------------------------|---|-------------------------------|
| D1 | RED | Watchdog Circuit | Cycles On/Off Every 3 Seconds under direct control of the analyzer's CPU. | |
| D2 | YELLOW | Wheel Heater | HEATING | NOT HEATING |
| D3 | YELLOW | Bench Heater | HEATING | NOT HEATING |
| D4 | YELLOW | Oven Heaters | HEATING | NOT HEATING |
| D5 | GREEN | Sample/Cal Gas Valve Option | Valve Open to CAL GAS FLOW | Valve Open to SAMPLE GAS FLOW |
| D6 | GREEN | Zero/Span Gas Valve Option | Valve Open to SPAN GAS FLOW | Valve Open to ZERO GAS FLOW |
| D7 | GREEN | Shutoff Valve Option | Valve Open to CAL GAS FLOW | Valve CLOSED to CAL GAS FLOW |
| D8 | GREEN | IR SOURCE | Source ON | Source OFF |

8.3.3. MOTHERBOARD

The information found in Section 13.4.5 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following additions:

8.3.3.1. A to D Conversion

Because the T300U has much higher resolution and sensitivity than the T300/T300M, the possibility that temperature-coefficient related drift could occur in the 10.3.3.1. A to D conversion circuitry if there were a significant difference in temperature between the converter and the surrounding airspace. To prevent this, a fan direct heated air directly onto the A to D converter area of the motherboard to ensure that it is as close as possible to the current temperature of the oven area.

8.3.3.2. Sensor Inputs

OVEN TEMPERATURE SENSOR

A thermistor is located in the center of the insulated oven area (see Figure 3-1). It measures the analyzer's inside temperature. This information is stored by the CPU and can be viewed by the user for troubleshooting purposes via the front panel display by selecting the test function **OVEN TEMP** or reported via the instruments **TEST CHANNEL** analog output (A4) by setting the output function also named **OVEN TEMP**.

8.3.4. POWER DISTRIBUTION

The information found in Section 13.4.7 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception(s):

- The following figure replaces Figure 13-16 of the T300/T300M Operators Manual (P/N 06864).

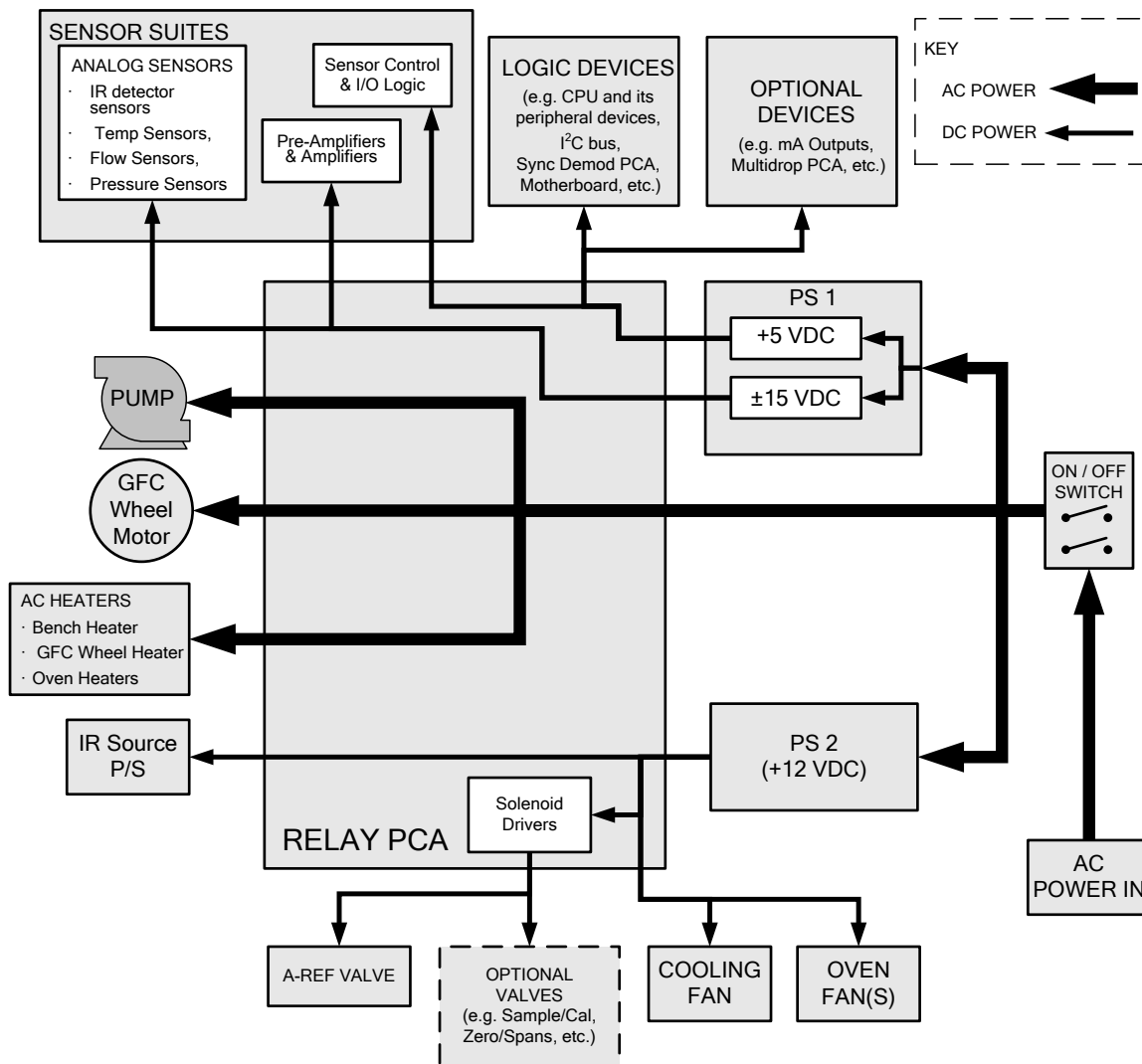




Figure 8-8: T300U Distribution Block Diagram

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9. TROUBLESHOOTING & SERVICE

9.1. GENERAL NOTES

| | |
|---|---|
|  | <p style="text-align: center;">CAUTION</p> <p>THE OPERATIONS PRESENTED IN THIS SECTION MUST BE PERFORMED BY QUALIFIED MAINTENANCE PERSONNEL ONLY.</p> <p>PLEASE READ SECTION 14 OF THE T300/T300M MANUAL (P/N 06864) BEFORE ATTEMPTING THE FOLLOWING TROUBLESHOOTING OR SERVICE PROCEDURES</p> |
|---|---|

| | |
|---|--|
|  | <p style="text-align: center;">WARNING - RISK OF ELECTRICAL SHOCK.</p> <p>SOME OPERATIONS NEED TO BE CARRIED OUT WITH THE ANALYZER OPEN AND RUNNING.</p> <p>EXERCISE CAUTION TO AVOID ELECTRICAL SHOCKS AND ELECTROSTATIC OR MECHANICAL DAMAGE TO THE ANALYZER.</p> <p>DO NOT DROP TOOLS INTO THE ANALYZER OR LEAVE THOSE AFTER YOUR PROCEDURES.</p> <p>DO NOT SHORTEN OR TOUCH ELECTRIC CONNECTIONS WITH METALLIC TOOLS WHILE OPERATING INSIDE THE ANALYZER.</p> <p>USE COMMON SENSE WHEN OPERATING INSIDE A RUNNING ANALYZER.</p> |
|---|--|

The information found in Section 12 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the exceptions below.

| | |
|---|--|
|  | <p style="text-align: center;">CAUTION</p> <p>ALWAYS ALLOW THE T300U TO OPERATE FOR AT LEAST 24 HOURS AFTER ALL REPAIRS HAVE BEEN FINISHED AND THE INSTRUMENT'S CASE IS CLOSED.</p> <p>AT THE END OF THIS 24-HOUR STABILIZATION PERIOD MANUALLY INITIATE AN A-REF MEASUREMENT (SEE SECTION 4.4.2)</p> |
|---|--|

9.2. FAULT DIAGNOSIS WITH WARNING MESSAGES

The following Table replaces Table 13-1 of the T300/T300M Operators Manual.

Table 9-1: Warning Messages - Indicated Failures

| WARNING MESSAGE | FAULT CONDITION | POSSIBLE CAUSES |
|---------------------------|---|--|
| BENCH TEMP WARNING | The optical bench temp is controlled at 48 ± 2 °C. | Bad bench heater Bad bench temperature sensor Bad relay controlling the bench heater Entire relay board is malfunctioning |
| BOX TEMP WARNING | Box Temp is < 5 °C or > 48 °C. | NOTE: For T300U's operating for at least 2 hours, the box temperature typically should be the same as the oven temperature (46°C). Stopped motherboard stabilization fan Stopped oven heater fan (there are two) Failed oven heater (s) Failed oven fan(s) Failed oven temperature sensor Failed relay controlling the one of the oven heaters Failed relay board |
| CANNOT DYN SPAN | Dynamic Span operation failed | Measured concentration value is too high or low. Concentration slope value to high or too low |
| CANNOT DYN ZERO | Dynamic Zero operation failed | Measured concentration value is too high. Concentration offset value to high. |
| CONFIG INITIALIZED | Configuration and Calibration data reset to original Factory state. | Failed disk on module User erased data |
| DATA INITIALIZED | Data Storage in DAS was erased | Failed disk on module User cleared data |
| PHOTO TEMP WARNING | PHT DRIVE is >4800 mVDC | Failed IR photo-detector Failed sync/demod board IR photo-detector improperly attached to the sample chamber Bench temp too high. |
| OVEN TEMP WARNING | The temperature of the insulated convection oven area of the analyzer is outside of the specified limits. | Oven temperature outside of specified range Failed oven heater (s) Failed oven fan(s) Failed oven temperature sensor Relay controlling the one of the oven heater Failed relay board |
| REAR BOARD NOT DET | Motherboard not detected on power up. | Warning only appears on serial I/O com port(s) Front panel display will be frozen, blank or will not respond. Massive failure of motherboard |
| RELAY BOARD WARN | The CPU cannot communicate with the Relay Board. | I ² C buss failure Failed relay board Loose connectors/wiring |
| SAMPLE FLOW WARN | Sample flow rate is <1400 cm ³ /min or > 2200 cm ³ /min. | Failed sample pump Blocked sample inlet/gas line Dirty particulate filter Leak downstream of critical flow orifice Failed flow sensor/circuitry |

| WARNING MESSAGE | FAULT CONDITION | POSSIBLE CAUSES |
|---------------------------|---|---|
| SAMPLE PRES WARN | Sample Pressure is <10 in-Hg or > 35 in-Hg Normally 29.92 in-Hg at sea level decreasing at 1 in-Hg per 1000 ft of altitude (with no flow – pump disconnected). | If sample pressure is < 10 in-hg: <ul style="list-style-type: none"> o Blocked particulate filter o Blocked sample inlet/gas line o Failed pressure sensor/circuitry If sample pressure is > 35 in-hg: <ul style="list-style-type: none"> o Pressurized sample gas. Install vent o Blocked vent line on pressurized sample/zero/span gas supply o Bad pressure sensor/circuitry |
| SAMPLE TEMP WARN | Sample temperature is < 10°C or > 100°C. | Ambient temperature outside of specified range Failed bench heater Failed bench temperature sensor Relay controlling the bench heater Failed relay board |
| SOURCE WARNING | Occurs when CO Ref is <1250 mVDC or >4950 mVDC. Either of these conditions will result in an invalid M/R ratio. | GFC wheel stopped Failed sync/demod board If status LED's on the sync/demod board <u>ARE</u> flashing, the cause is most likely a failed: <ul style="list-style-type: none"> o IR source o Relay board o IR photo-detector |
| SYSTEM RESET | The computer has rebooted. | This message occurs at power on. If you have not cycled the power on your instrument: <ul style="list-style-type: none"> o Failed +5 VDC power, o Fatal error caused software to restart o Loose connector/wiring |
| WHEEL TEMP WARNING | The filter wheel temperature is outside specified limites. (The wheel temperature is typically controlled at 62 ± 2 °C). | Blocked cooling vents below GFC Assembly. (Make sure that adequate clear space beneath the analyzer). Analyzer's top cover removed Wheel heater Wheel temperature sensor Relay controlling the wheel heater Entire relay board |

9.2.1. FAULT DIAGNOSIS WITH TEST FUNCTIONS

The following table supersedes Table 12.2 of the T300/T300M Operators Manual (P/N 06864).

Table 9-2: Test Functions - Indicated Failures

| TEST FUNCTIONS (As Displayed) | INDICATED FAILURE(S) |
|----------------------------------|---|
| TIME | Time of day clock is too fast or slow To adjust, see Section 5.6 of the T300/T300M Operators Manual (P/N 06864). Battery in clock chip on CPU board may be dead. |
| RANGE | Incorrectly configured measurement range(s) could cause response problems with a Data logger or chart recorder attached to one of the analog output. If the Range selected is too small, the recording device will over range. If the Range is too big, the device will show minimal or no apparent change in readings. |
| STABIL | Indicates noise level of instrument or CO concentration of sample gas (See Section 12.4.2 of the T300/T300M Operators Manual for causes). |
| CO MEAS & CO REF | If the value displayed is too high the IR Source has become brighter. Adjust the variable gain potentiometer on the sync/demod board (See Section 12.5.7.1 of the T300/T300M Operators Manual) If the value displayed is too low or constantly changing and the CO REF is OK: <ul style="list-style-type: none"> o Failed multiplexer on the mother board o Failed sync/demod board o Loose connector or wiring on sync/demod board If the value displayed is too low or constantly changing and the CO REF is <u>BAD</u> : <ul style="list-style-type: none"> o GFC wheel stopped or rotation is too slow o Failed sync/demod board IR source o Failed IR source o Failed relay board o Failed I²C bus o Failed IR photo-detector |
| MR RATIO | When the analyzer is sampling zero air and the ratio is too low: <ul style="list-style-type: none"> o The reference cell of the GFC wheel is contaminated or leaking. o The alignment between the GFC wheel and the segment sensor, the M/R sensor or both is incorrect. o Failed sync/demod board When the analyzer is sampling zero air and the ratio is too high: <ul style="list-style-type: none"> o Zero air is contaminated o Failed IR photo-detector |
| PRES | See Table 9-1 for SAMPLE PRES WARN |
| SAMPLE FL | Check for gas flow problems. (See Section 12.2 of the T300/T300M Operators Manual) |
| SAMPLE TEMP | SAMPLE TEMP should be close to BENCH TEMP. Temperatures outside of the specified range or oscillating temperatures are cause for concern |
| BENCH TEMP | Bench temp control improves instrument noise, stability and drift. Temperatures outside of the specified range or oscillating temperatures are cause for concern. See Table 9-1 for BENCH TEMP WARNING |
| WHEEL TEMP | Wheel temp control improves instrument noise, stability and drift. Outside of set point or oscillating temperatures are causes for concern. See Table 9-1 for WHEEL TEMP WARNING |
| BOX TEMP | If the box temperature is out of range: <ul style="list-style-type: none"> o Check the motherboard stabilization fan (see Figure 3-1). o See Table 9-1 for BOX TEMP WARNING. |
| OVEN TEMP | If the oven is temperature is out of range, check both of the oven heater fans in the power supply module. Areas to the side and rear of instrument should allow adequate ventilation. <ul style="list-style-type: none"> o Check the both of the oven fans (see Figure 3-1). o Check both of the oven heaters. See Table 9-1 for OVEN TEMP WARNING . |

| TEST FUNCTIONS (As Displayed) | INDICATED FAILURE(S) |
|---|---|
| PHT DRIVE | <p>If this drive voltage is out of range it may indicate one of several problems:</p> <ul style="list-style-type: none"> - A poor mechanical connection between the various components in inside the detector housing - An electronic failure of the IR Photo-Detector's built-in cooling circuitry, or; - A temperature problem inside the analyzer chassis. In this case other temperature warnings would also be active such as OVEN TEMP WARNING, BENCH TEMP WARNING or BOX TEMP WARNING. |
| SLOPE | <p>Values outside range indicate</p> <ul style="list-style-type: none"> Contamination of the zero air or span gas supply Instrument is miscalibrated Blocked gas flow Contaminated or leaking GFC wheel (either chamber) Faulty IR photo-detector Faulty sample faulty IR photo-detector pressure sensor (P1) or circuitry Invalid M/R ratio (see above) Bad/incorrect span gas concentration due. |
| OFFSET | <p>Values outside range indicate</p> <ul style="list-style-type: none"> Contamination of the zero air supply Contaminated or leaking GFC wheel (either chamber) Faulty IR photo-detector |

9.2.2. RELAY BOARD STATUS LEDs

The information found in Section 12.1.4.3 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception:

- The following table replaces Table 12-5 of the T300/T300M Operators Manual.

Table 9-3: Relay Board Status LED Failure Indications

| LED | FUNCTION | SIGNAL I/O PARAMETER | | DIAGNOSTIC TECHNIQUE |
|----------------------|-----------------------------|----------------------|------------------|--|
| | | ACTIVATED BY | VIEW RESULT | |
| D2 Yellow | WHEEL HEATER | WHEEL_HEATER | WHEEL_TEMP | Voltage displayed should change. If not: Failed Heater Faulty Temperature Sensor Failed AC Relay Faulty Connectors/Wiring |
| D3 Yellow | BENCH HEATER | BENCH_HEATER | BENCH_TEMP | Voltage displayed should change. If not: Failed Heater Faulty Temperature Sensor Failed AC Relay Faulty Connectors/Wiring |
| D4 Yellow | OVEN HEATERS | OVEN_HEATER | OVEN_TEMP | Voltage displayed should change. If not: Failed Oven Heater(s) Failed Oven Fans(s) Faulty Oven Temperature Sensor Failed AC Relay Faulty Connectors/Wiring |
| D5 Green | SAMPLE/CAL GAS VALVE OPTION | CAL_VALVE | N/A | Sample/Cal Valve should audibly change states. If not: Failed Valve Failed Relay Drive IC on Relay Board Failed Relay Board Faulty +12 VDC Supply (PS2) Faulty Connectors/Wiring |
| D6 Green | ZERO/SPAN GAS VALVE OPTION | SPAN_VALVE | N/A | Zero/Span Valve should audibly change states. If not: Failed Valve Failed Relay Drive IC on Relay Board Failed Relay Board Faulty +12 VDC Supply (PS2) Faulty Connectors/Wiring |
| D7 Green | SHUTOFF VALVE OPTION | SHUTOFF_VALVE | N/A | Shutoff Valve should audibly change states. If not: Failed Valve Failed Relay Drive IC on Relay Board Failed Relay Board Faulty +12 VDC Supply (PS2) Faulty Connectors/Wiring |
| D8 Green | IR SOURCE | IR_SOURCE | CO_MEASURE | Voltage displayed should change. If not: Failed IR Source Faulty +12 VDC Supply (PS2) Failed Relay Board Failed IR Photo-Detector Failed Sync/Demod Board Faulty Connectors/Wiring |

9.3. GAS FLOW PROBLEMS

Along with the information found in Section 12.2 of the T300/T300M Operators Manual (P/N 06864), also be aware that problems with the flow of gas through the Nafion® dryer could also be a cause of pressure or flow problems through the T300U. Poor gas flow or leaks related to the dryer can also cause it to not dry the sample gas efficiently allowing extra H₂O to interfere with the analyzer's CO measurements.

In addition to the checks described in the T300/T300M Operators Manual

- Check for blockages in the dryer.
- Check for leakage in and around the dryer and its fixtures (both the wet gas stream and the purge gas inlets/outlets).

If it becomes necessary to replace the Nafion® dryer, contact Teledyne Instruments' Customer Service (see Section 9.6) for parts and instructions.

9.4. OTHER PERFORMANCE PROBLEMS

The information found in Section 12.4 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following addition.

9.4.1. UNEXPLAINED DRIFT

Because the T300U makes higher resolution CO measurements than the T300/T300M, subtle issues with certain subsystems that would be unimportant for the T300/T300M can affect its accuracy. The most common of these are:

- Temperature Coefficient issues related to the motherboard's A-to-D converter
- Age related changes to some of the optical bench components (e.g. the mirrors, the IR source, the IR detector, etc.)
- Ambient changes in the condition of the instrument or the sample gas.

If a drift problem exists and calibrating the instruments zero and span points does not correct the problem or there is no obvious component failure, perform the following operations in order:

1. Let the analyzer run uninterrupted for at least 24 hours.
 - This will ensure that the entire oven area and all of the components therein have reached an equal and stable temperature.
2. Perform an Internal A-to-D Converter calibration (see Section 5.9.3.10 of the T300/T300M Operators Manual).
 - This should solve any issues related to the A/D converter.
3. Perform a Dark Calibration of the Optical Bench (see Section 9.6.1 of the T300/T300M Operators Manual).
 - This should account for any issues related to changes in the optical bench components.
4. Manually initiate an **A-REF** cycle (see Section 4.4.2).
 - This should account for any issues related to changes in the ambient conditions of the sample gas.

9.5. SUBSYSTEM CHECKOUT

9.5.1. RELAY BOARD

The information found in Section 12.5.6 of the T300/T300M Operators Manual (P/N 06864) is applicable to the T300U with the following exception:

- The following table replaces Table 12-8 of the T300/T300M Operators Manual.

Table 9-4: Relay Board Control Devices

| FUNCTION | CONTROL DEVICE | IN SOCKET |
|--------------------|----------------|------------|
| Wheel Heater | K1 | Yes |
| Bench Heater | K2 | Yes |
| OVEN HEATER | K3 | YES |
| IZS Valves | U4 | Yes |
| IR Source Drive | U5 | No |

9.5.2. MOTHERBOARD

9.5.2.1. A/D Functions

The T300U makes higher resolution CO measurements than the T300/T300M means that it is susceptible to temperature coefficient issues related to the motherboard’s A-to-D converter that could occur if the temperature of the motherboard differs significantly from that of the rest of the analyzer’s oven area.

- Compare the values of the **BOX TEMP & OVEN TEMP** test functions. If they are significantly different check the function of the:
 - Oven heaters.
 - The oven heater fans.
 - The motherboard stabilization fan.
 - The relays controlling the oven heaters.
 - No abnormal blockages to airflow inside the oven area exist.

9.6. TECHNICAL ASSISTANCE

If this addendum and its trouble-shooting / repair sections do not solve your problems, technical assistance may be obtained from:

Teledyne API
Technical Support
9970 Carroll Canyon Rd
San Diego, CA 92131-1106

Phone: +1 858 657 9800 or 1-800 324 5190

Fax: +1 858 657 9816

Email: api-techsupport@teledyne.com.

Before you contact Technical Support, fill out the Product Warranty Repair/Questionnaire on our website at <http://www.teledyne-api.com> under Service & Support.

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APPENDIX A – T300U/M300EU Version Specific Software Menu Trees (05924B DCN5871)

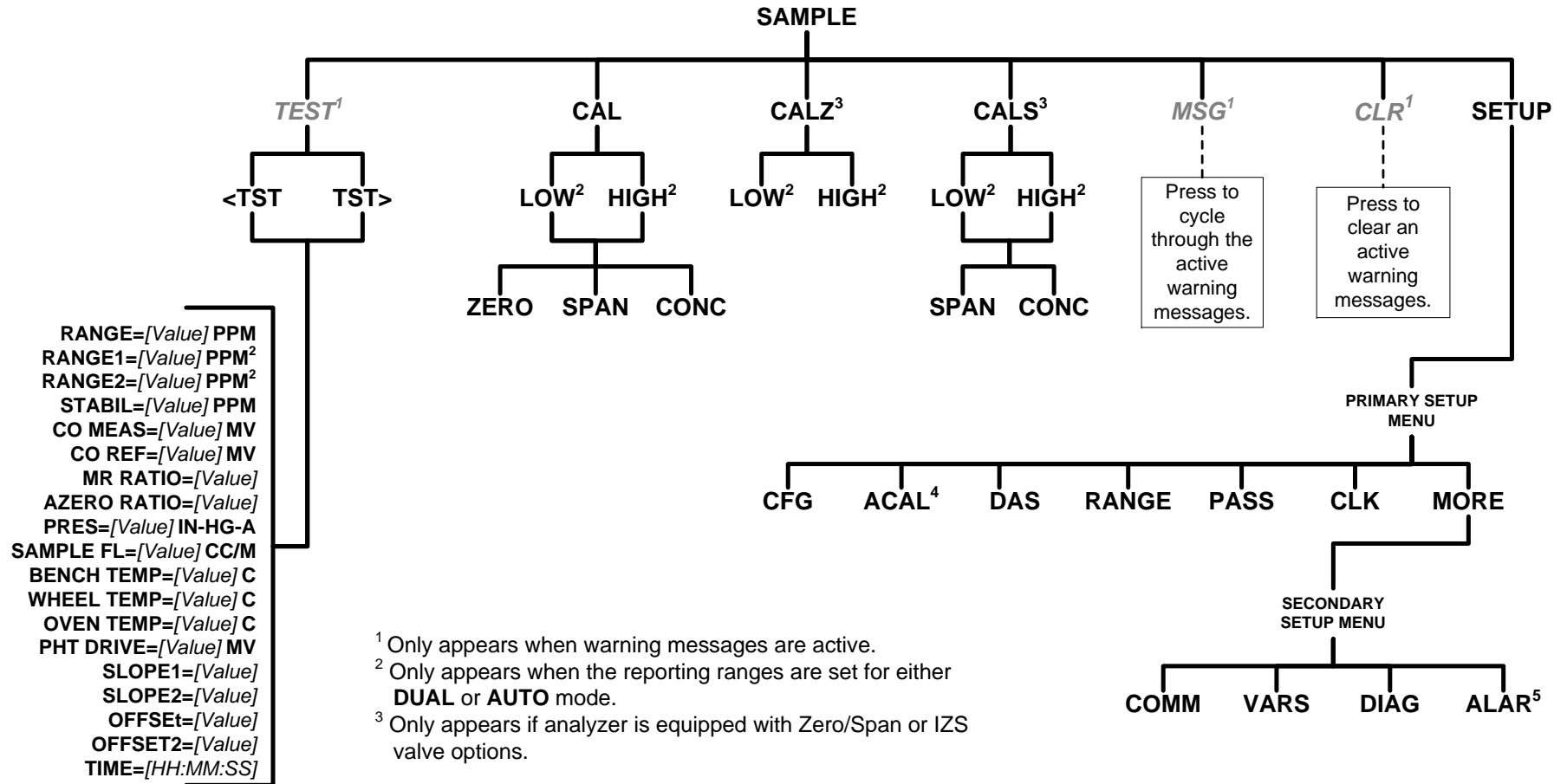
This Appendix to the T300U and M300EU Addenda contains only the software menu trees unique to the T300U and the M300EU models. For the additional software documentation, please refer to Appendix A in the related operation manual:

- T300U - T300/T300M operation manual, PN 06864
- M300EU - M300E/EM operation manual, PN 04288

Please note that in those appendices not all variables or parameters apply to the T300U or M300EU, such as the O₂ or CO₂ options, which are not available in these units.

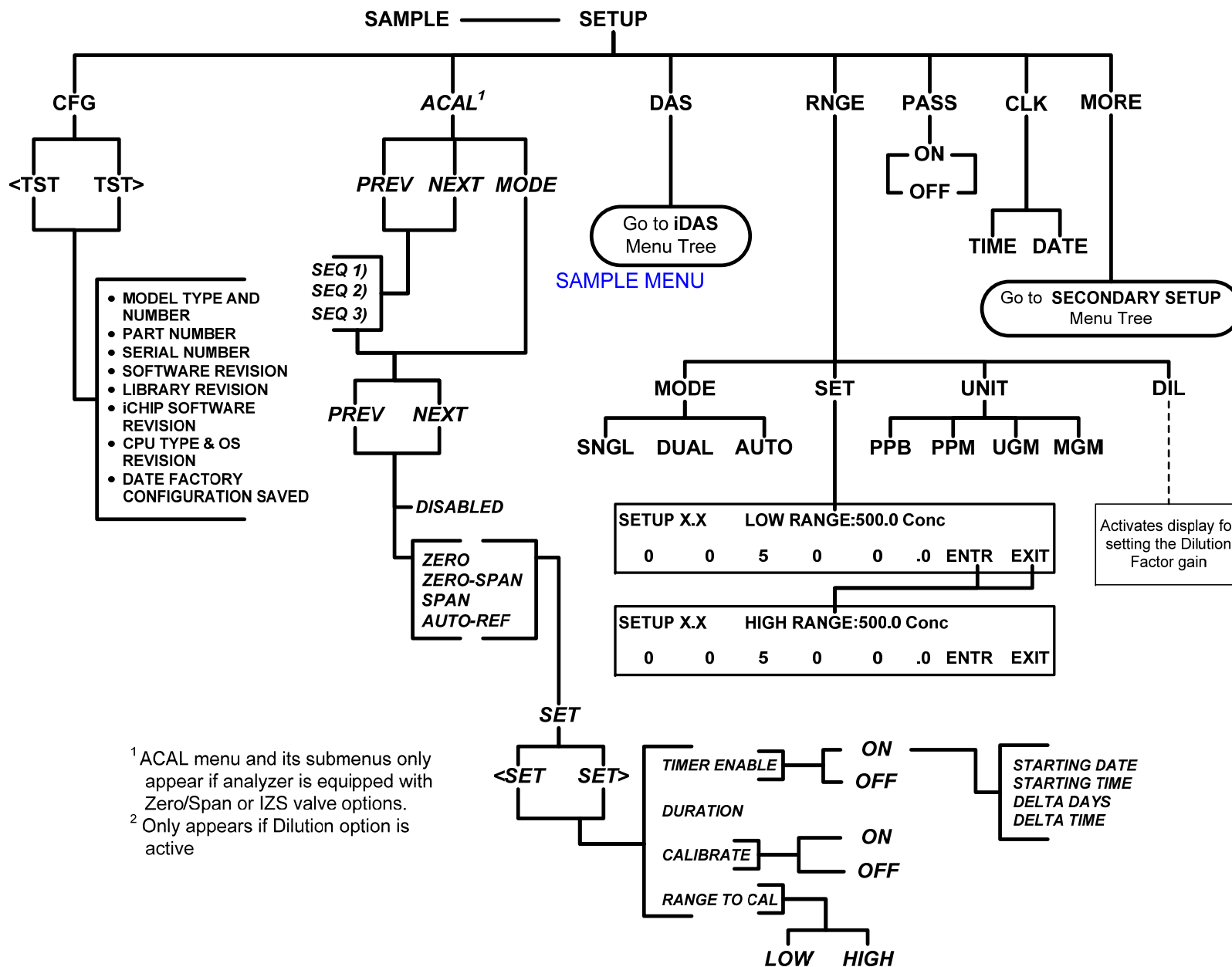
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APPENDIX A: T300U, M300EU Software Menu Trees, Revision L.8



- ¹ Only appears when warning messages are active.
- ² Only appears when the reporting ranges are set for either **DUAL** or **AUTO** mode.
- ³ Only appears if analyzer is equipped with Zero/Span or IZS valve options.

Figure A-1: Basic Sample Display Menu



¹ ACAL menu and its submenus only appear if analyzer is equipped with Zero/Span or IZS valve options.
² Only appears if Dilution option is active

Figure A-2: Primary Setup Menu (Except DAS)

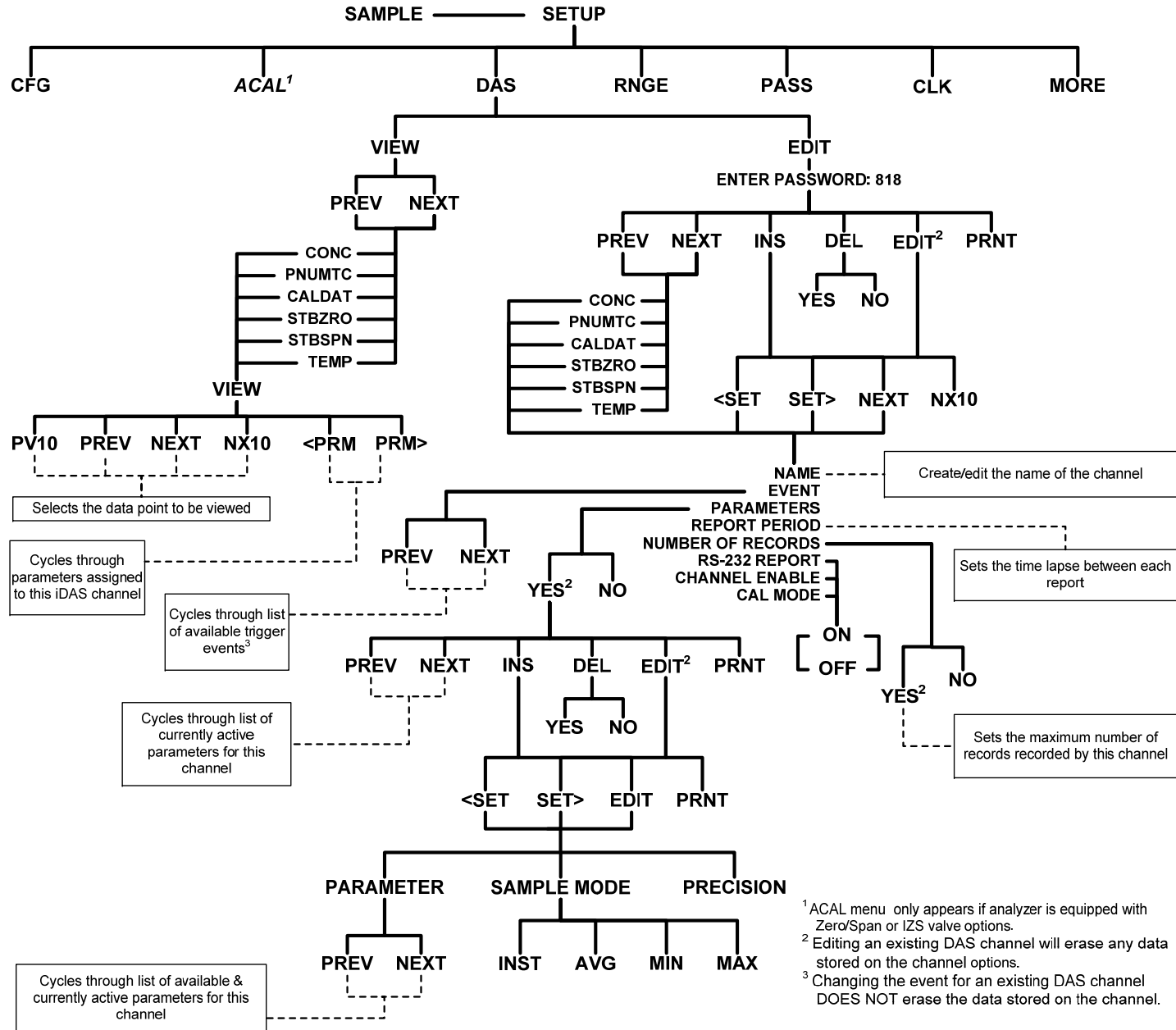
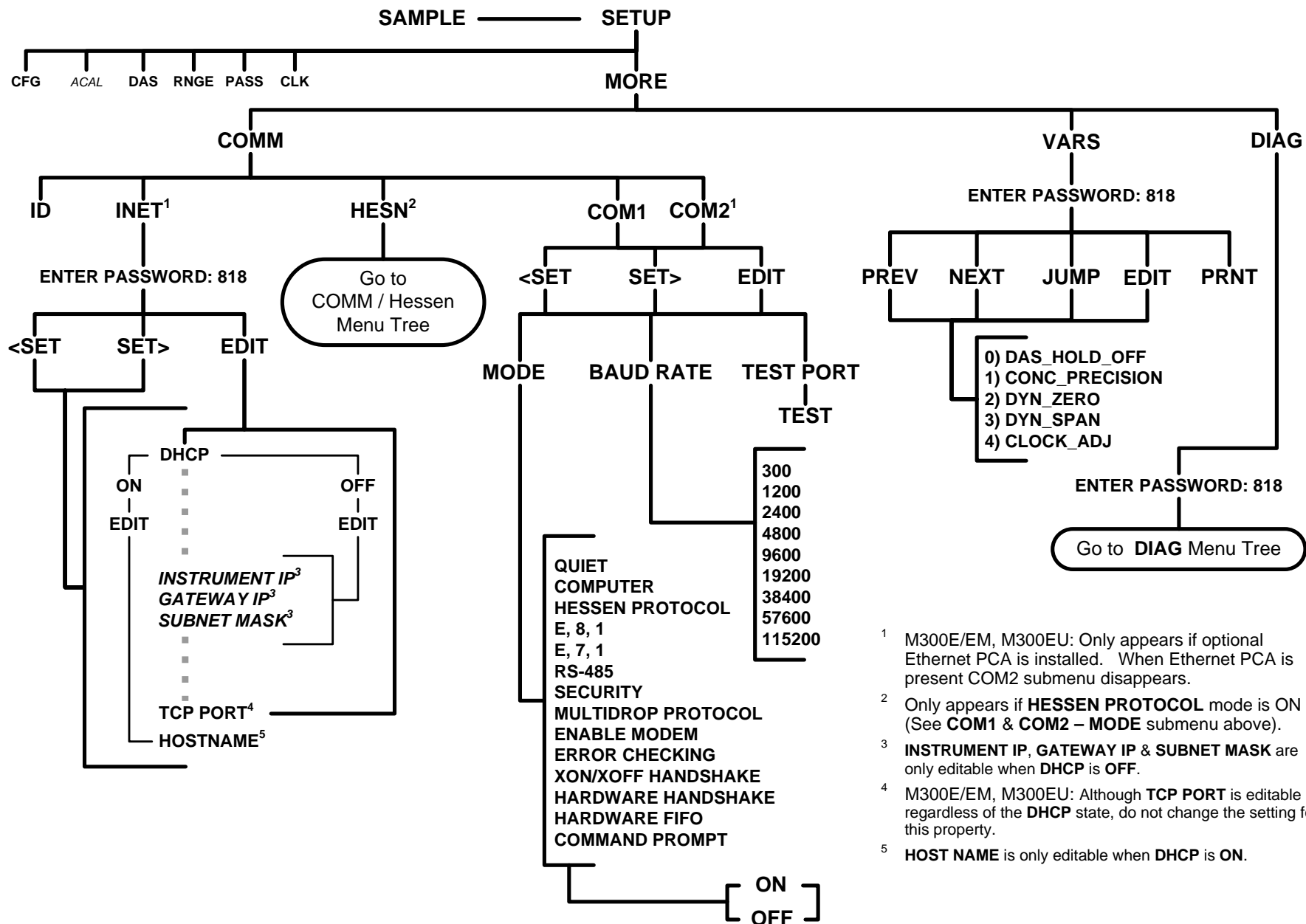


Figure A-3: Primary Setup Menu → DAS Submenu



¹ M300E/EM, M300EU: Only appears if optional Ethernet PCA is installed. When Ethernet PCA is present COM2 submenu disappears.

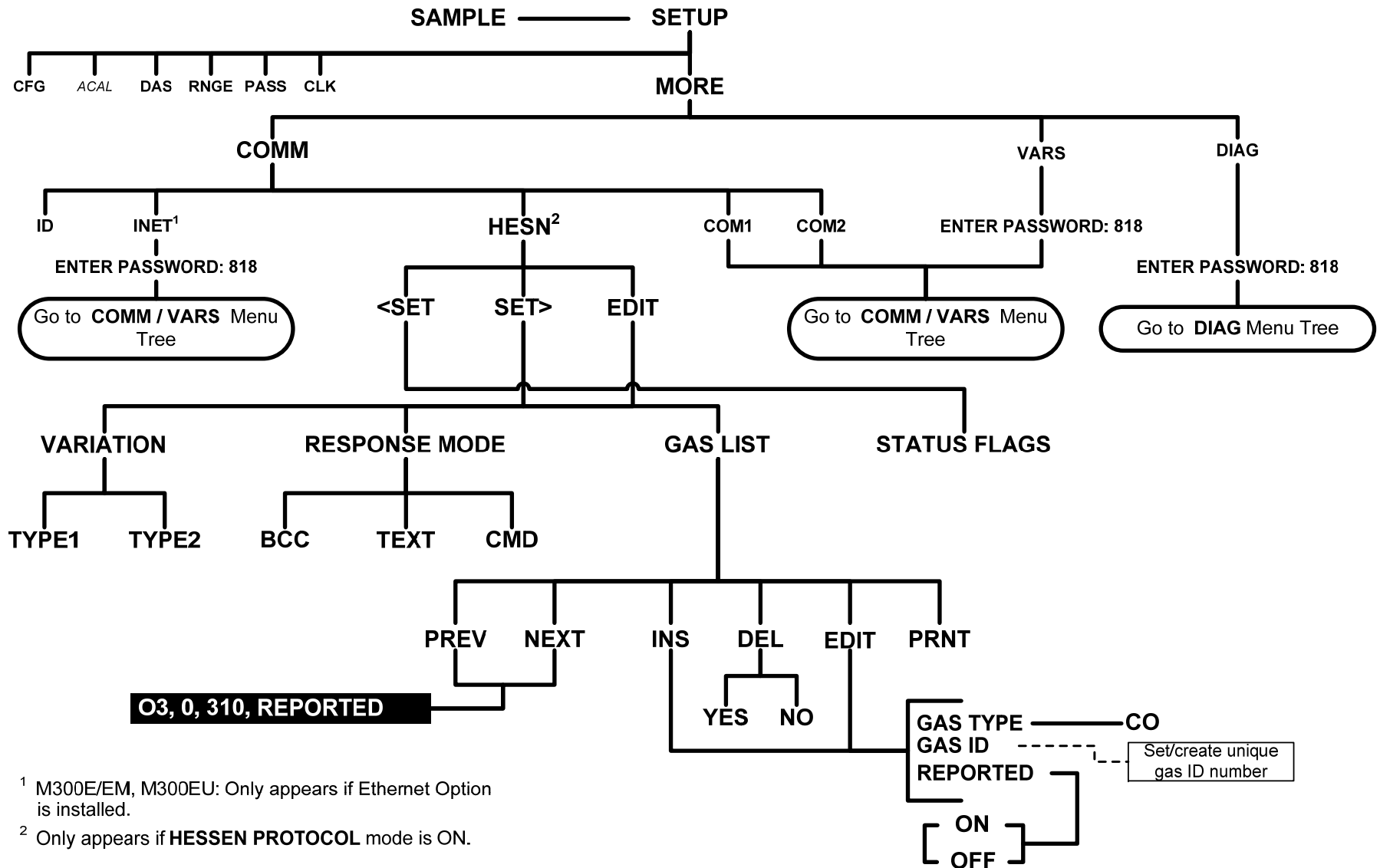
² Only appears if **HESSEN PROTOCOL** mode is ON (See **COM1 & COM2 – MODE** submenu above).

³ **INSTRUMENT IP, GATEWAY IP & SUBNET MASK** are only editable when **DHCP** is OFF.

⁴ M300E/EM, M300EU: Although **TCP PORT** is editable regardless of the **DHCP** state, do not change the setting for this property.

⁵ **HOST NAME** is only editable when **DHCP** is ON.

Figure A-4: Secondary Setup Menu → COMM and VARS Submenus



¹ M300E/EM, M300EU: Only appears if Ethernet Option is installed.

² Only appears if HESSEN PROTOCOL mode is ON.

Figure A-5: Secondary Setup Menu → Hessen Protocol Submenu

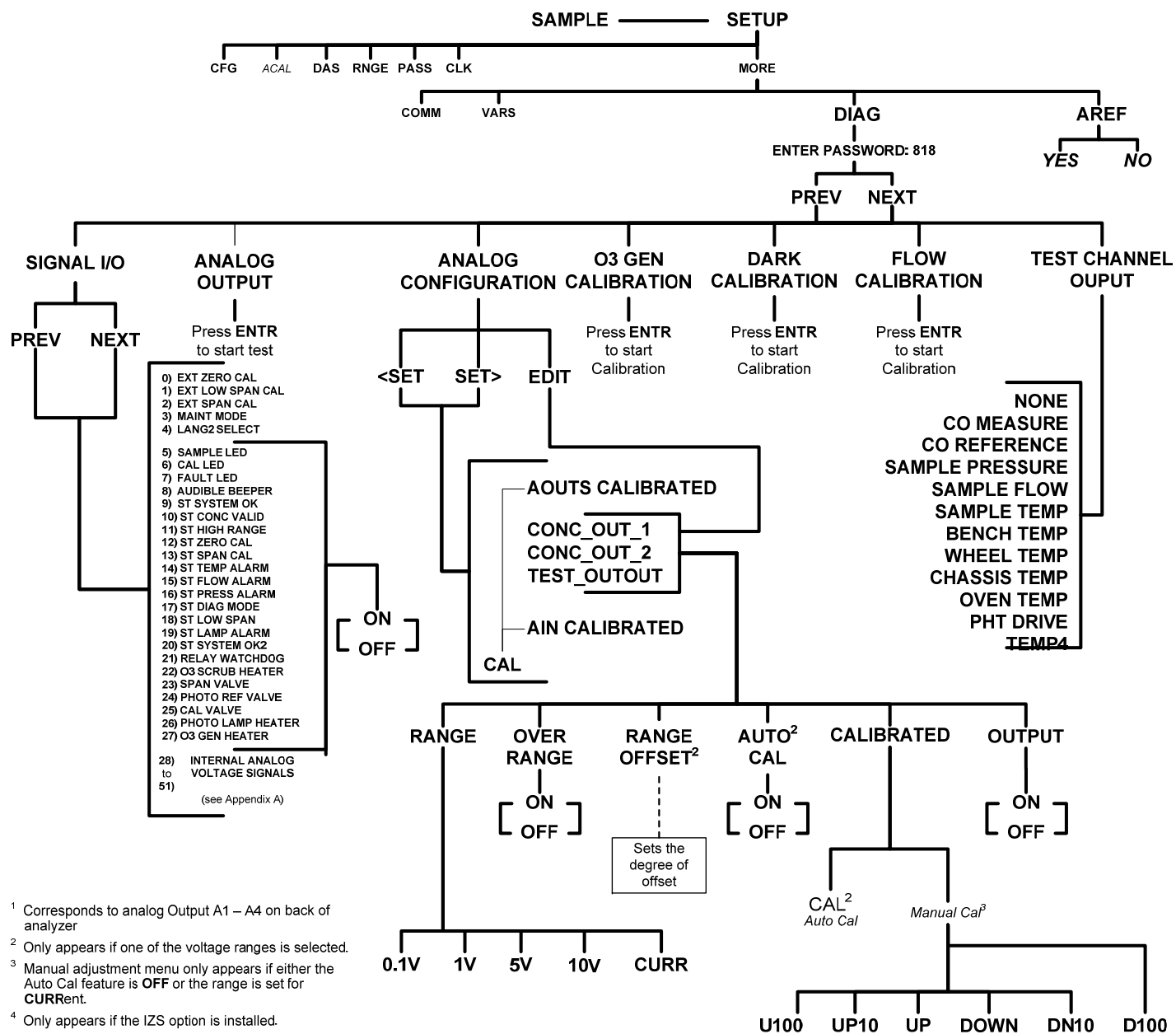
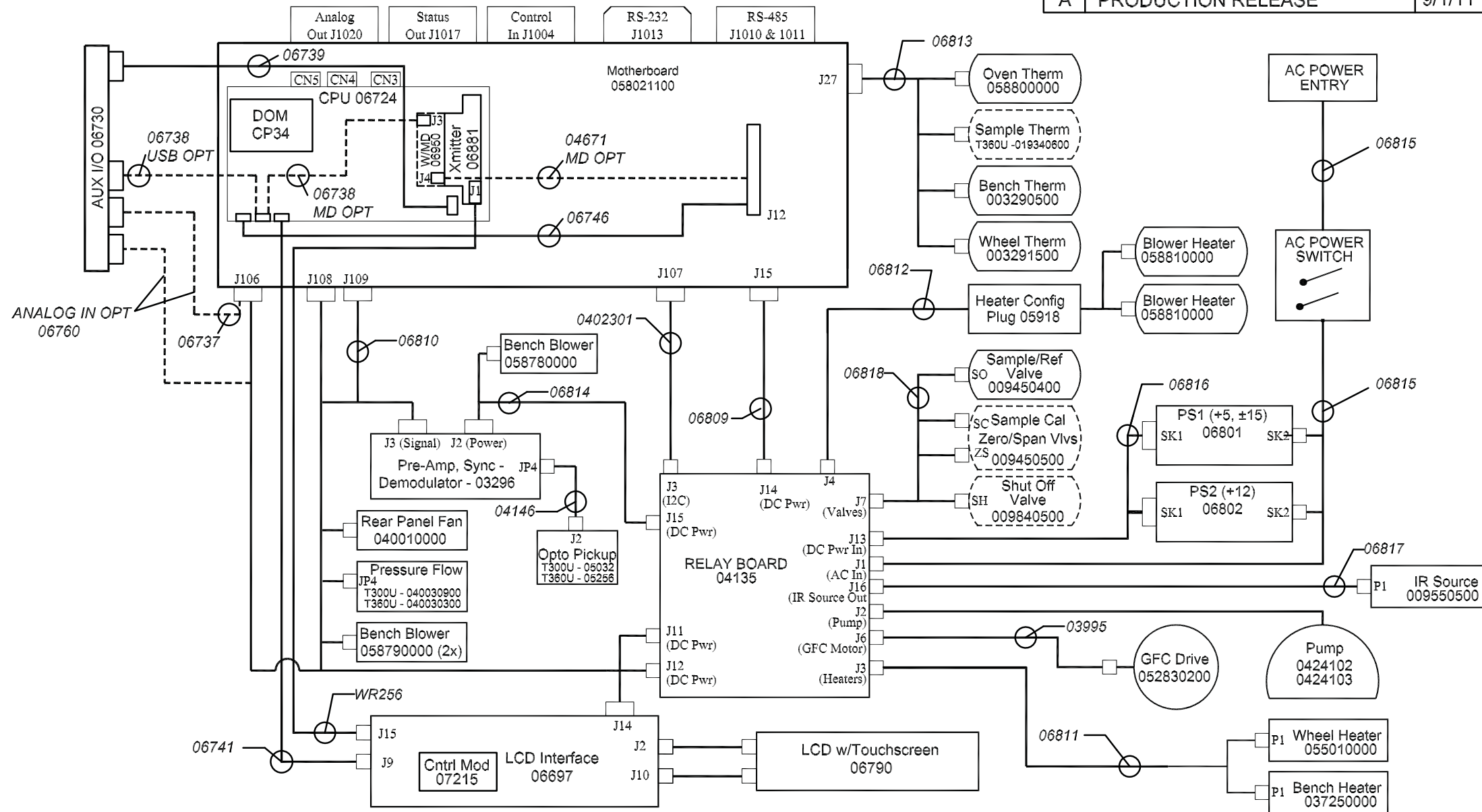


Figure A-6: DIAG Menu

Appendix B - Interconnect Diagram

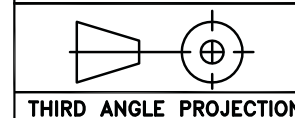
| REVISIONS | | | | |
|-----------|--------------------|--------|------|----------|
| REV | DESCRIPTION | DATE | DCN | APPROVED |
| A | PRODUCTION RELEASE | 9/1/11 | 6229 | BW |



KEY:

1. All part numbers in *Italic* identify cables that are referred to in the accompanying document 073640100.
2. All items in Dashed boxes are optional.

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| | | |
|---|---------------|----------|
| UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES | | |
| TOLERANCES ARE: | | |
| FRACTIONS | DECIMALS | ANGULAR |
| ± 1/32 | ± 0.03 [0.76] | ± 0° 30' |
| DO NOT SCALE DRAWING | | |
| TREATMENT | NA | |
| FINISH | △ | |
| SIMILAR TO | | |

| | |
|--------------|-------|
| CONTRACT: NA | |
| APPROVALS | DATE |
| DRAWN KV | 11/10 |
| CHECK | |
| CCB | |
| ISSUED | |

| | | | |
|--|---------------|----------|-----|
| TELEDYNE Advanced Pollution Instrumentation A Teledyne Technologies Company | | | |
| TITLE INTERCONNECT DRAWING | | | |
| T300U, T360U | | | |
| SIZE | CAGE CODE NO. | DWG. NO. | REV |
| B | 1JZF4 | 07364 | A |
| SCALE | FILE | SHEET | |
| DNS | 07364 | 1 OF 1 | |

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