

**MANUAL ADDENDUM**

***MODEL T102***  
***TOTAL REDUCED SULFUR ANALYZER***  
***with***  
***MODEL 501 TRS***  
***THERMAL CONVERTER***

(to be used in conjunction with T101 Operation Manual, PN 07266)

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# ABOUT TELEDYNE ADVANCED POLLUTION INSTRUMENTATION (TAPI)

Teledyne Advanced Pollution Instrumentation, Inc. (TAPI) is a worldwide market leader in the design and manufacture of precision analytical instrumentation used for air quality monitoring, continuous emissions monitoring, and specialty process monitoring applications. Founded in San Diego, California, in 1988, TAPI introduced a complete line of Air Quality Monitoring (AQM) instrumentation, which comply with the United States Environmental Protection Administration (EPA) and international requirements for the measurement of criteria pollutants, including CO, SO<sub>2</sub>, NO<sub>x</sub> and Ozone.

Since 1988 TAPI has combined state-of-the-art technology, proven measuring principles, stringent quality assurance systems and world class after-sales support to deliver the best products and customer satisfaction in the business.

For further information on our company, our complete range of products, and the applications that they serve, please visit [www.teledyne-api.com](http://www.teledyne-api.com) or contact [sales@teledyne-api.com](mailto:sales@teledyne-api.com).

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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; the safety symbols are also located inside the instrument. It is imperative that you pay close attention to these messages, the descriptions of which are 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

**For Technical Assistance regarding the use and maintenance of this instrument or any other Teledyne API product, contact Teledyne API's Technical Support Department:**

**Telephone: 800-324-5190**

**Email: [sda\\_techsupport@teledyne.com](mailto:sda_techsupport@teledyne.com)**

**or access any of the 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!

# WARRANTY

## WARRANTY POLICY (02024 F)

Teledyne Advanced Pollution Instrumentation (TAPI), a business unit of Teledyne Instruments, Inc., provides that:

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

## COVERAGE

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

## NON-TAPI MANUFACTURED EQUIPMENT

Equipment provided but not manufactured by TAPI is warranted and will be repaired to the extent and according to the current terms and conditions of the respective equipment manufacturer's warranty.

## Product Return

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

The complete Terms and Conditions of Sale can be reviewed at [http://www.teledyne-api.com/terms\\_and\\_conditions.asp](http://www.teledyne-api.com/terms_and_conditions.asp)

### CAUTION – Avoid Warranty Invalidation



Failure to comply with proper anti-Electro-Static Discharge (ESD) handling and packing instructions and Return Merchandise Authorization (RMA) procedures when returning parts for repair or calibration may void your warranty. For anti-ESD handling and packing instructions please refer to "Packing Components for Return to Teledyne API's Customer Service" in the *Primer on Electro-Static Discharge* section of this manual, and for RMA procedures please refer to our Website at <http://www.teledyne-api.com> under Customer Support > Return Authorization.

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# ABOUT THIS MANUAL

This T102 Addendum, PN 07267, is comprised of multiple documents as follows.

Part No.	Rev	Name/Description
07267	B	T102 Addendum
05515	B	T102 Menu Trees (inserted as Appendix A in this addendum)
07349	1/7/11	Spare Parts List (located in Appendix B of this addendum)
05517	C	Repair Questionnaire (inserted as Appendix C in this addendum)
03404	L	Assembly Diagram, M501TS Converter
05764	A	Wiring Diagram, M501TS (034040100) (located in Appendix D of this addendum)

## NOTE

Please read this manual in its entirety before making any attempt made to operate the instrument.

# REVISION HISTORY

T102/501 TRS Addendum, PN07267

Date	Rev	DCN	Change Summary
2012 June 11	B	6485	Administrative updates
2011 February 4	A	5975	Initial Release

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# 1. INTRODUCTION

## NOTE

The information contained in this addendum is pertinent to T102 analyzers running software revision G.4. Some or all of the information may not be applicable to previous revision of that software.

This addendum is based on the Model T101 Operators Manual (PN 07266). In most ways the T102 is identical to the T101 in design and operation; therefore most of the basic set up information, operating instructions as well as calibration, maintenance, troubleshooting and repair methods are found in that manual.

This addendum documents only those areas where the T102 is different in design or operating method from the T101.

Specifically:

- Areas where updates and improvements to the Model T10X software have been implemented since the publication date of the T101 Manual - PN 07266.
- **EXTERNAL TRS CONVERSION:** Like the T101, which converts H<sub>2</sub>S to SO<sub>2</sub>, then measures the amount of SO<sub>2</sub> present using a UV fluorescence technique, the T102 converts total reduced sulfur (TRS) gases into SO<sub>2</sub> before measuring the SO<sub>2</sub> using the same UV fluorescence method.

Unlike the T101, which performs the H<sub>2</sub>S → SO<sub>2</sub> conversion internally, the T102 requires an external TRS converter, in this case a TAPI M501-TRS.

Therefore this addendum includes instructions and information regarding:

- Areas of operation and setup of the T102 that depart from the method described by the T101 operator's manual due to the TRS → SO<sub>2</sub> conversion being performed externally.
- The proper setup and operation on the M501-TRS.

## 1.1. Reference Numbering Convention

Unless otherwise specified, chapter, section, figure and table reference numbers referred to within this text are relative to this document.

EXAMPLE: "Figure 2-1" refers to the figure, within this document, labeled as 2-1.

References to chapters, sections, figures and tables in the original document will be labeled as such.

EXAMPLE: "Front Panel Display Figure in Overview of Operating modes section of the T101 Operators Manual (PN 07266)".



## 2. SPECIFICATIONS AND APPROVALS

### 2.1. Specifications

As there are no significant differences between the performance specifications for the T102 and the T101 please refer to in the Specification section of the T101 Manual - PN 07266. However, the AC power specifications for the T102 are as follows:

**T102 AC Power:** 100V – 120V, 60Hz (200W); 220V – 240V, 50Hz (211W)

#### 2.1.1. M501-TRS Specifications

**Table 2-1: Model 501 Basic Unit Specifications**

Minimum Converter Efficiency	H <sub>2</sub> S >95% COS >90% CS <sub>2</sub> >90%
Maximum TS Concentration for specified conversion efficiency	20 ppmv
Sample Flow Rate	650cc/min. ±10% - driven by T102 pneumatic system
Optimum Converter Temperature	850°C (factory setup)
Maximum Converter Temperature	1100°C
Dimensions H x W x D	7" x 17" x 23.5" (178 mm x 432 mm x 597 mm)
Weight	16 lbs (7.3 kg) 26 lbs (11.8 kg) CE version
AC Power Rating	115 V, 50/60 Hz - 400 Watts; 230 V, 50/60 Hz - 575 Watts; CE Version
Internal Alarms	High Alarm Point: 900°C Low Alarm Point: 800°C
Alarm Output Relay	SPST - 1 point: Alarm output is energized should either the temperature controller's high or low internal alarm set points be activated.
Alarm Output Rating	220V AC/30V DC, 1A (resistive load)
Environmental	Installation category (over-voltage category) II; Pollution degree 2
Certifications	IEC 1010-1 / 61010-1:93 (includes A1) + A2:95,
For indoor use at altitudes ≤ 2000m only	

### 2.2. EPA Equivalency Designation

No EPA equivalency standards exist for TRS measurement, however, the T102 analyzer qualifies for EPA equivalency designation as Reference Method Number EQSA-0495-100 per 40 CFR Part 53 when operated under the following conditions:

- Measurement Mode: SO<sub>2</sub> single gas mode.

- Range: Any range from 50 parts per billion (ppb) to 10 parts per million (ppm).
- Ambient temperature range of 5 °C to 40 °C.
- Line voltage range of 105-125 VAC or 220-240 VAC, at 50 or 60 Hz.
- Sample filter: Equipped with PTFE filter element in the internal filter assembly.
- Sample flow of 650 +/- 65 cc/min.
- Vacuum pump (internal or external) capable of 14"Hg Absolute pressure @ 1 slpm or better.
- Software settings:
 

Dynamic span	OFF
Dynamic zero	OFF
Dilution factor	OFF
AutoCal	ON or OFF
Dual range	ON or OFF
Auto-range	ON or OFF
Temp/Pressure compensation	ON

Under the designation, the analyzer may be operated with or without the following optional equipment:

- Rack mount with chassis slides.
- Rack mount without slides, ears only.
- Zero/span valve options.
- Internal zero/span (IZS) option with either:
  - SO<sub>2</sub> permeation tube - 0.4 ppm at 0.7 liter per minute; certified/uncertified.
  - SO<sub>2</sub> permeation tube - 0.8 ppm at 0.7 liter per minute; certified/uncertified. Under the designation, the IZS option cannot be used as the source of calibration.
- 4-20mA isolated analog outputs.
- Status outputs.
- Control inputs.
- RS-232 output.
- Ethernet output.
- Zero air scrubber.
- 4-20mA, isolated output.

## 2.3. CE Mark Compliance

See Section titled *CE Mark Compliance* in the T101 Manual - PN 07266

## 3. GETTING STARTED

### 3.1. Unpacking the T102

Unpack the T102 as per the directions in section titled *Unpacking and Initial Setup* in the T101 Manual - PN 07266.

There are no shipping screws to be removed in the T102.

### 3.2. Unpacking the M501-TRS

There are no shipping screws to be removed in the M501-TRS.

1. Inspect the shipping package for external damage. If damaged, please advise the shipper first, then Teledyne Advanced Pollution Instrumentation (TAPI).
2. Carefully remove the top cover of the converter and check for internal shipping damage.
  - a. Remove the screws fastening the top cover to the unit (four per side).
  - b. Lift the cover straight up.



#### WARNING

**Never disconnect electronic circuit boards, wiring harnesses or electronic subassemblies while the unit is under power.**

3. Inspect the interior of the instrument to make sure all components are in good shape and properly seated.
4. Check the connectors of the various internal wiring harnesses and pneumatic hoses to make sure they are firmly and properly seated.
5. Replace the top cover and fasten with original screws.

#### NOTE

**The M501-TRS will not operate properly with the top cover removed.**  
**The air cooling required to stabilize the temperature of the converter tube is dependent on air flow patterns that only exist with the top cover in place.**  
**Without the top cover in place, the thermal cutout may overheat and shut off the heating element.**

### 3.2.1. M501-TRS Ventilation Clearance

Whether the M501-TRS is set up on a bench or installed into an instrument rack, be sure to leave sufficient ventilation clearance.

AREA	MINIMUM REQUIRED CLEARANCE
Behind the instrument	10 cm / 4 inches
Sides of the instrument	2.5 cm / 1 inch
Above and below the instrument.	2.5 cm / 1 inch

#### NOTE

**If the M501-TRS is installed in an instrument rack or any type of enclosure, make sure that the rack/enclosure itself is adequately ventilated.**

**Failure to provide proper ventilation can result in the ambient temperature exceeding the maximum operating temperature specification for the T102 (40°C)**

### 3.3. Internal Layouts

Figure 3-1 supersedes the *T101* internal chassis layout in the T101 Manual - PN 07266.

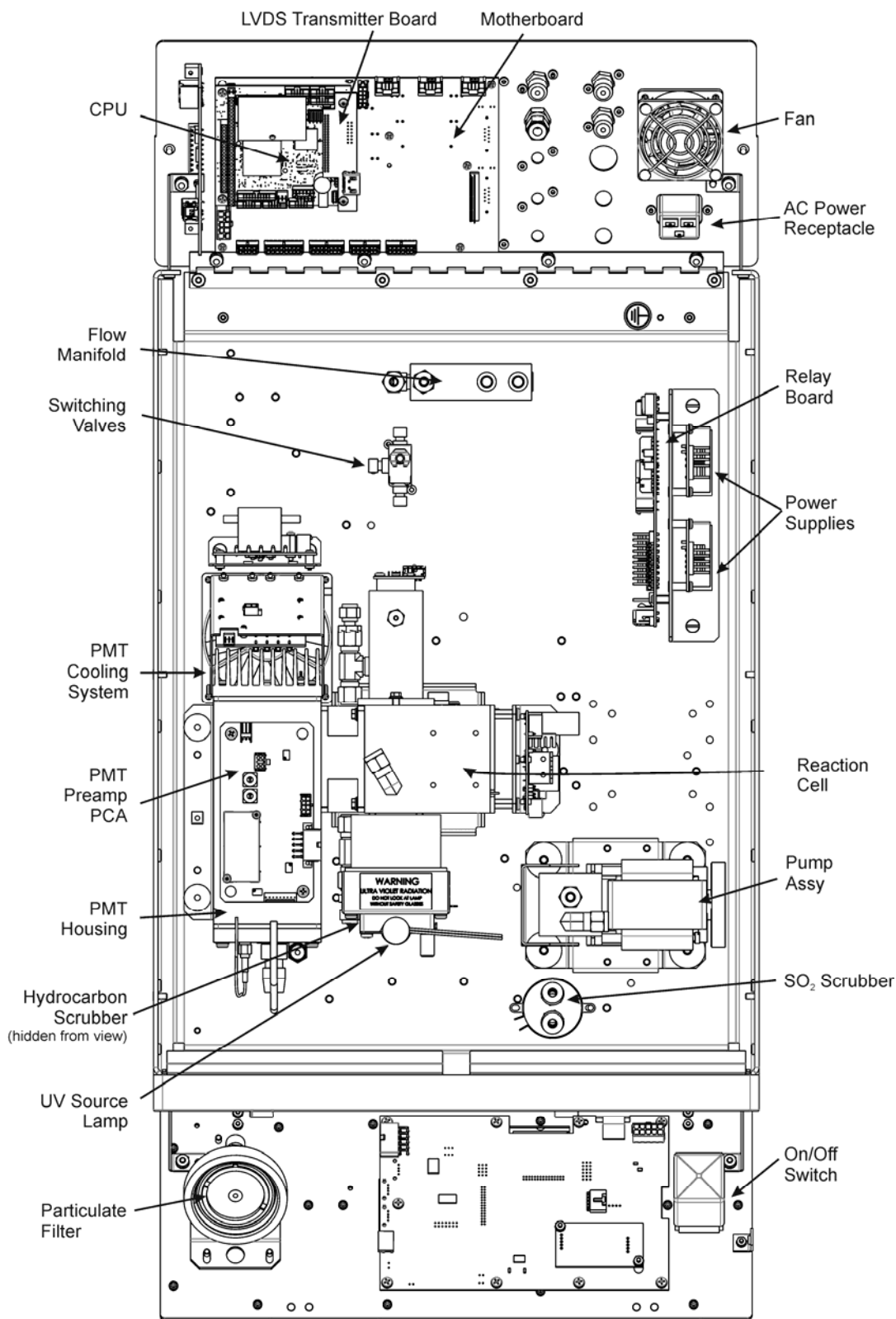


Figure 3-1. T102 Internal Layout

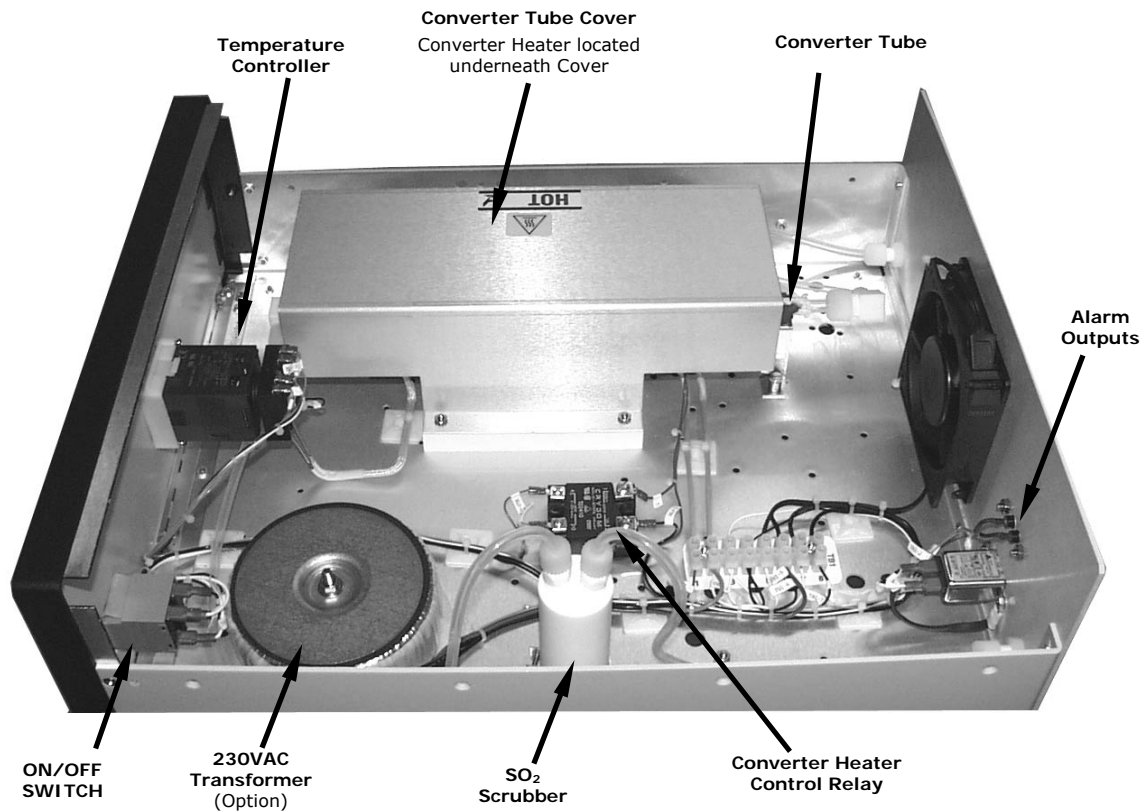


Figure 3-2. M501-TRS Internal Layout

### 3.4. T102 and M501-TRS Internal Pneumatic Flow

Figure 3-3 shows the internal pneumatic flow of the T102 in its Standard configuration. For information on instruments with the various zero/span valve options refer to Section 5.2, Figure 5-1 and Figure 5-2.

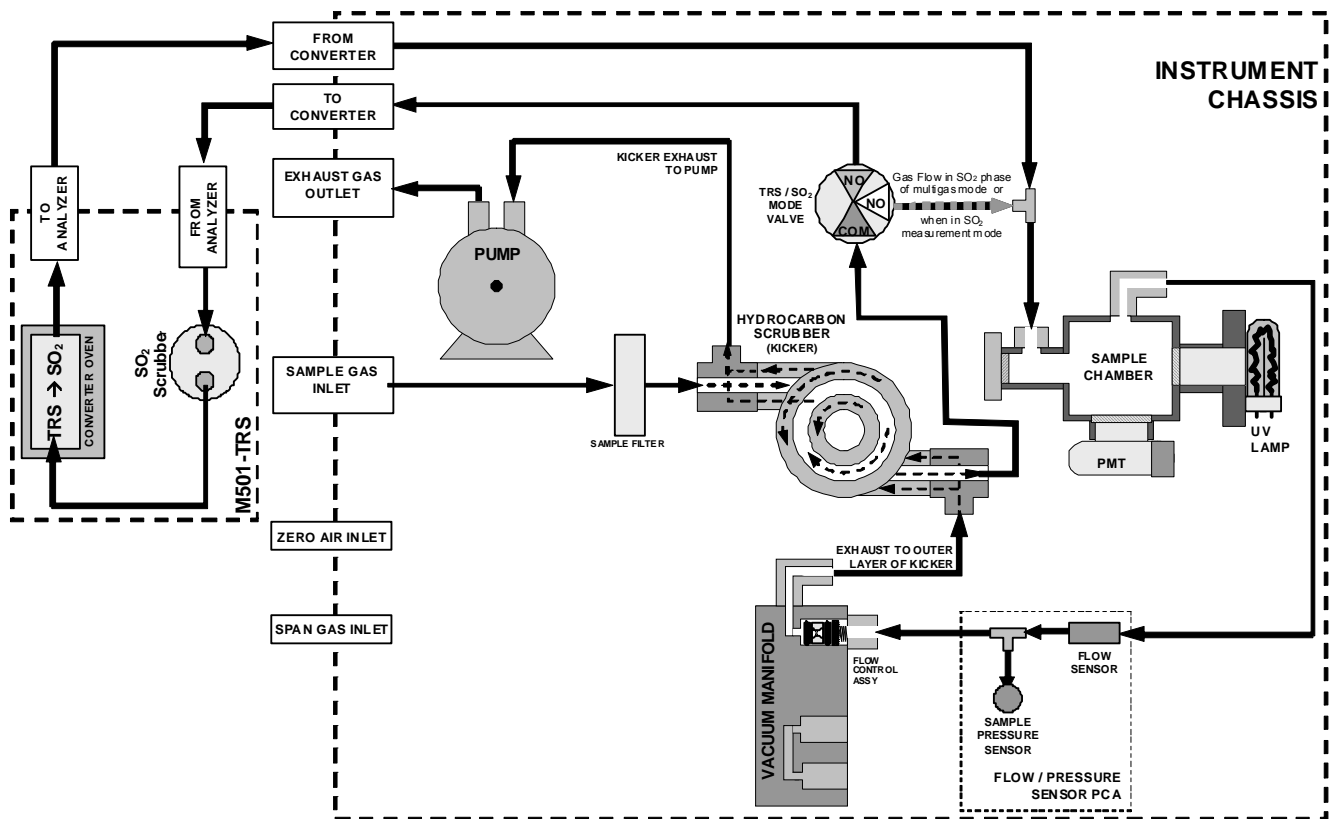


Figure 3-3. Internal Pneumatic Diagram of the T102 Standard Configuration

Table 3-1. TRS – SO<sub>2</sub> Switching Valve Operating Modes

GAS MODE	CONDITION OF TRS –SO <sub>2</sub> SWITCHING VALVE	VALVE PORT CONNECTION (FIG. 5-2)
TRS	Open to SO <sub>2</sub> Scrubber and Molybdenum Converter	COM → NO
SO <sub>2</sub>	Open to directly to Sample Chamber. Bypasses M501-TRS	COM → NC
TRS –SO <sub>2</sub>	Switches between above two states every 10 minutes.	- -

### 3.5. Rear Panel Layout for the T102 & M501-TRS

Figure 3-4 and Figure 3-5 supersede *Rear Panel Layout* in the T101 Manual - PN 07266.

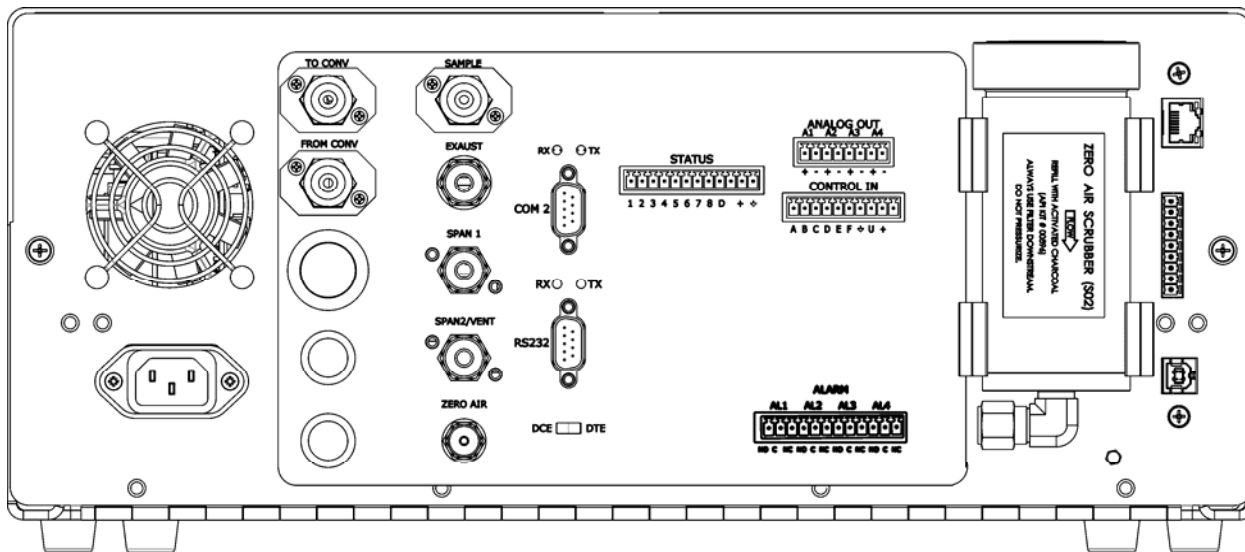


Figure 3-4. T102 Rear Panel (with Zero Air Scrubber attached)

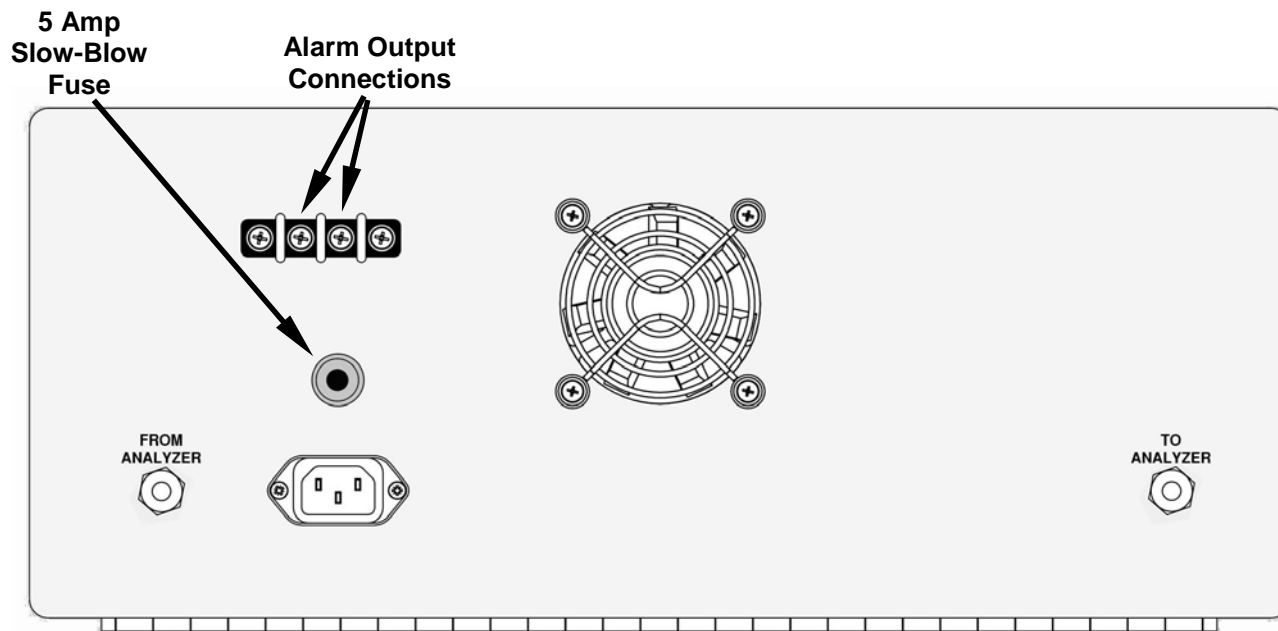


Figure 3-5. M501-TRS Rear Panel Layout



## 3.6. Initial Setup

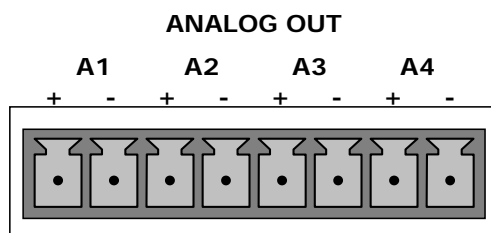
### 3.6.1. Electrical Connections

The electrical connections for the T102 are the same as those described in the *Electrical Connections Section* of the T101 Manual - PN 07266 *except* for the test channel analog output.

#### 3.6.1.1. T102 Analog Output Connections

This section supersedes the *Analog Output Connections* section in the T101 Manual - PN 07266.

Attach a strip chart recorder and/or data-logger to the appropriate contacts of the analog output connector on the rear panel of the analyzer.



**Figure 3-6. Analog Output Connector**

The **A1** and **A2** channels output a signal that is proportional to the SO<sub>2</sub> concentration of the sample gas.

The output, labeled **A3** is special. It can be set by the user (see *Test Channel Output* section in the T101 Manual - PN 07266) to output any one of the parameters accessible through the <TST TST> keys of the units sample display.

Pin-outs for the Analog Output connector at the rear panel of the instrument are:

**Table 3-2. Analog output Pin Outs**

PIN	ANALOG OUTPUT	VOLTAGE OUTPUT	CURRENT LOOP OPTION
1	<b>A1</b>	V Out	I Out +
2		Ground	I Out -
3	<b>A2</b>	V Out	I Out +
4		Ground	I Out -
5	<b>A3</b>	V Out	I Out +
6		Ground	I Out -
7	<b>A4</b>	Not Available	Not Available
8		Not Available	Not Available

- The default analog output voltage setting of the T102 UV Fluorescence SO<sub>2</sub> Analyzer is 0 – 5 VDC with a range of 0 – 500 ppb.
- To change these settings, see *Analog I/O Configuration* and *SETUP – RANGE: Analog Output Reporting Range Configuration* sections, respectively, in the T101 Manual - PN 07266.

### 3.6.1.2. M501-TRS Alarm Output Connections

The rear panel of the M501-TRS includes a terminal strip by which connections can be made to the converter's internal temperature alarm. For information on adjusting this alarm see Section 7.5).

- Connect the input leads of your alarm-sensing device (e.g. datalogger) to the center two pins of the alarm output connector (see).
- Make sure the load does not exceed the rated capacity of the relay.

## 4. PNEUMATIC CONNECTIONS

This section supersedes the information contained in the *Pneumatic Connections* section in the T101 Manual - PN 07266.

### NOTE

To prevent dust from getting into the analyzer, it was shipped with small plugs inserted into each of the pneumatic fittings on the rear panel. Make sure that all dust plugs are removed before attaching exhaust and supply gas lines.



### CAUTION

Sample and calibration gases should only come into contact with PTFE (Teflon) or glass materials. They should not come in contact with FEP or stainless steel materials.

Figure 4-1 and Figure 4-2 show the most common configurations for gas supply and exhaust lines to the Model T102 Analyzer. Figure 4-3, Figure 4-4, and Figure 4-5 show the connections for units with valve options installed.

Please refer to Figure 3-4 and Figure 3-5 for the location of pneumatic connections at the rear panel of the T102 and the M501-TRS instruments.

**Table 4-1. Table 3-3: Inlet / Outlet Connector Labels and Functions**

<b>T102 PNEUMATIC CONNECTERS</b>	
<b>REAR PANEL LABEL</b>	<b>FUNCTION</b>
<b>SAMPLE</b>	Connects the sample gas to the analyzer. When operating the analyzer without zero/span option, this is also the inlet for any calibration gases.
<b>EXHAUST</b>	Exhausts the gas sampled by the analyzer. Connect to an outside area away from people.
<b>SPAN</b>	On units with zero/span/shutoff valve options installed, connect a gas line to the source of calibrated span gas here.
<b>ZERO AIR</b>	On Units with zero/span valve or IZS option installed, this port connects the zero air gas or the zero air cartridge to the analyzer.
<b>TO CONVERTER</b>	Sample gas leaves the T102 to be conditioned by the M501-TRS via this port.
<b>FROM CONVERTER</b>	Sample gas returns to the T102 after being conditioned by the M501-TRS via this port.
<b>M501-TRS PNEUMATIC CONNECTERS</b>	
<b>REAR PANEL LABEL</b>	<b>FUNCTION</b>
<b>FROM ANALYZER</b>	Sample gas enters the M501-TRS from the T102 via this port.
<b>TO ANALYZER</b>	Sample gas leaves the M501-TRS to return to the T102 via this port.

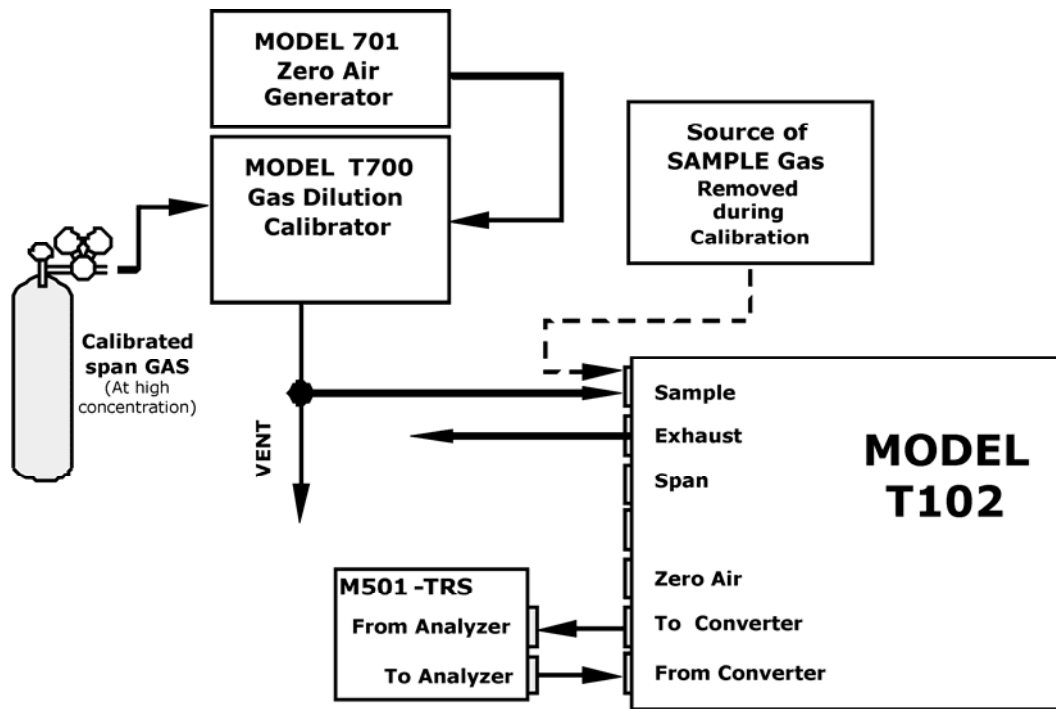


Figure 4-1. Pneumatic Connections—Basic Configuration—Using Gas Dilution Calibrator

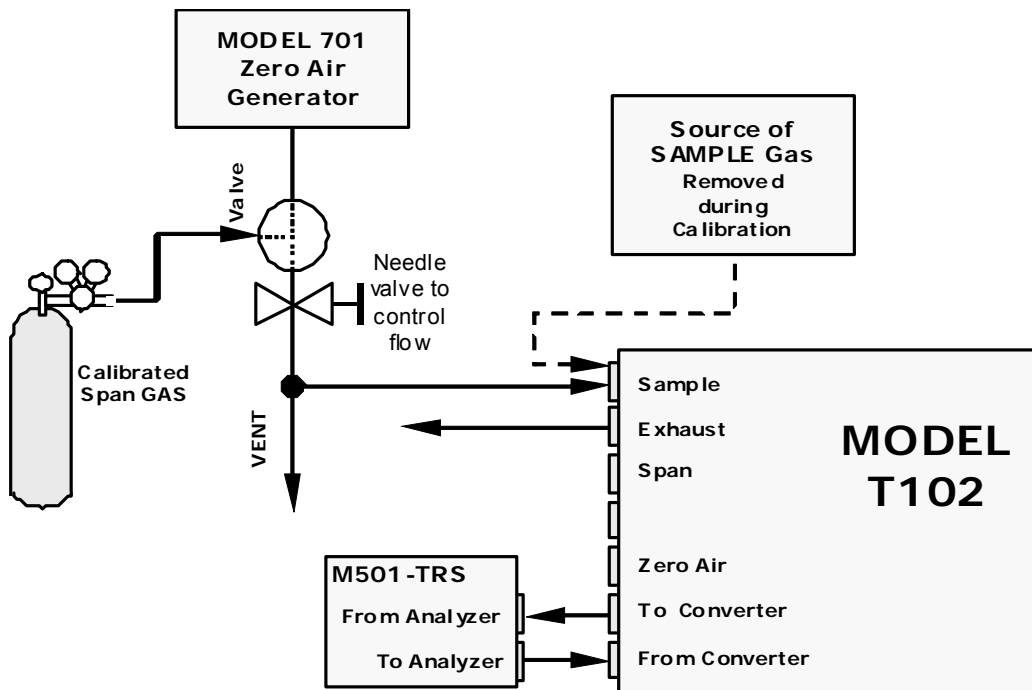


Figure 4-2. Pneumatic Connections—Basic Configuration—Using Bottled Span Gas

1. Attach the 1/4" exhaust line to the exhaust port.

**CAUTION**

**The exhaust from the instrument must be vented outside the immediate area or shelter surrounding the instrument and conform to all safety requirements using a maximum of 10 meters of 1/4" PTFE tubing.**

2. Attach the sample line to the sample inlet port. Ideally, the pressure of the sample gas should be equal to ambient atmospheric pressure.

**NOTE**

**Maximum pressure of any gas at the sample inlet should not exceed 1.5 in-Hg above ambient pressure and ideally should equal ambient atmospheric pressure.**

**In applications where the sample gas is received from a pressurized manifold, a vent must be provided to equalize the sample gas with ambient atmospheric pressure before it enters the analyzer. The vented gas needs to be routed outside the immediate area or shelter surrounding the instrument.**

3. Attach zero air and span gas supply lines as appropriate (see Figure 3-4 and Figure 3-5).

Zero air and span gas inlets should supply their respective gases in excess of the 700 cc<sup>3</sup>/min demand of the analyzer. Supply and vent lines should be of sufficient length and diameter to prevent back diffusion and pressure effects.

For this type of analyzer, zero air and span gas are defined as follows:

**SPAN GAS**

While it is possible to calibrate the T102 using SO<sub>2</sub> as the span calibration gas by setting the analyzer's gas measurement mode to SO<sub>2</sub>, TAPI recommends that H<sub>2</sub>S be used and that calibration operations be carried out with the analyzer's TRS gas measurement mode selected. Please note that verifying converter efficiency requires that the instrument be calibrated on both TRS and SO<sub>2</sub>, and the slope factors compared between the TRS and SO<sub>2</sub> modes.

It is recommended that the H<sub>2</sub>S span gas be equal to 90% of the analyzer's selected reporting range.

O<sub>2</sub> is a quenching agent in fluorescent Sulfur analyzers. If the balance gas is pure nitrogen, then false positive readings will result, both at zero and span. Therefore the user should either use cylinders with zero air as the balance gas, or should use higher concentration cylinders with an N<sub>2</sub> balance, and dilute further with zero air using a calibrator, such as the TAPI M700.

EXAMPLE: If the selected reporting range is 0 ppb → 500 ppb, an appropriate span gas concentration would be 450 ppb H<sub>2</sub>S.

Cylinders of calibrated H<sub>2</sub>S gas traceable to NIST-Standard Reference Material specifications (also referred to as SRM's or EPA protocol calibration gases) are commercially available. Table 3-4 lists specific NIST-SRM reference numbers for various concentrations of H<sub>2</sub>S.

**Table 4-2. NIST-SRM's Available for Traceability of H<sub>2</sub>S & SO<sub>2</sub> Calibration Gases**

NIST-SRM <sup>4</sup>	TYPE	NOMINAL CONCENTRATION
2730	Hydrogen sulfide in N <sub>2</sub>	5000 ppb
2731	Hydrogen sulfide in N <sub>2</sub>	20 ppm

## ZERO AIR

Zero air is similar in chemical composition to the earth's atmosphere but without the gas(es) being measured by the analyzer, in this case total reduced sulfur (TRS). While TRS typically includes Hydrogen sulfide (H<sub>2</sub>S), Dimethyl sulfide (CH<sub>3</sub>)<sub>2</sub>, Dimethyl disulfide (CH<sub>3</sub>)<sub>2</sub>S<sub>2</sub> and Methyl mercaptan (MeSH), CH<sub>4</sub>S many other gases fall into this category as well. Other interferent gases may be present in ambient air as well.

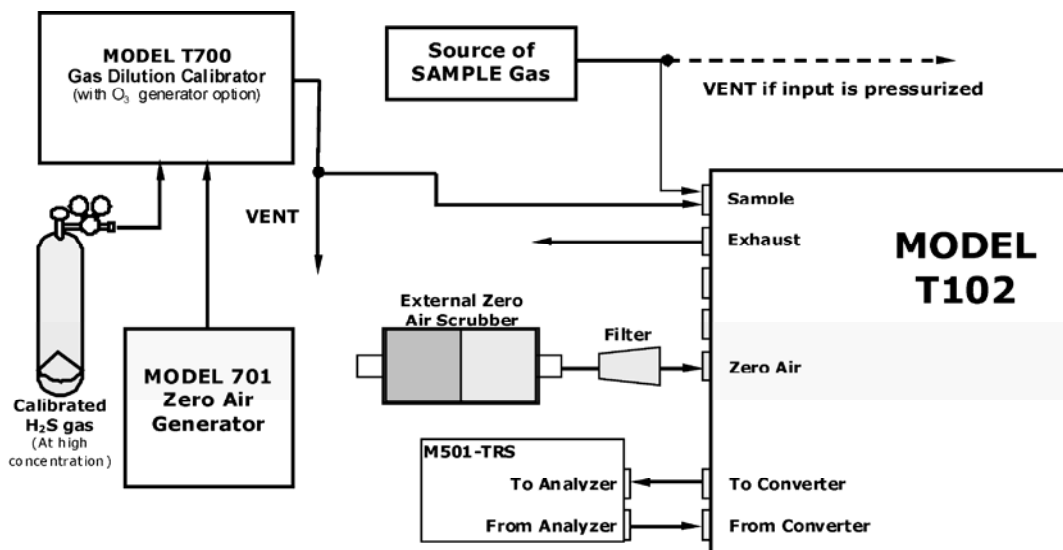
To ensure that high quality zero air is available, a zero air generator such as the TAPI Model 701 should be used.

If your analyzer is equipped with an IZS option, it is capable of creating zero air that is adequate for performing informal calibration checks, but a zero air generator such as the TAPI Model 701 is still recommended for performing formal calibration operations.

Once the appropriate pneumatic connections have been made, check all pneumatic fittings for leaks using a procedure similar to that defined in the *Detailed Pressure Leak Check* section in the T101 Manual - PN 07266.

### 4.1.1.1. Connections with Internal Valve Options Installed

If your analyzer is equipped with either the zero/span valve option (Option 50) or the internal zero/span option (Option 51), the pneumatic connections should be made as shown in Figure 4-3, Figure 4-4, and Figure 4-5.

**Figure 4-3. Basic Pneumatic Connections for Units with Zero/Span Valve Option**

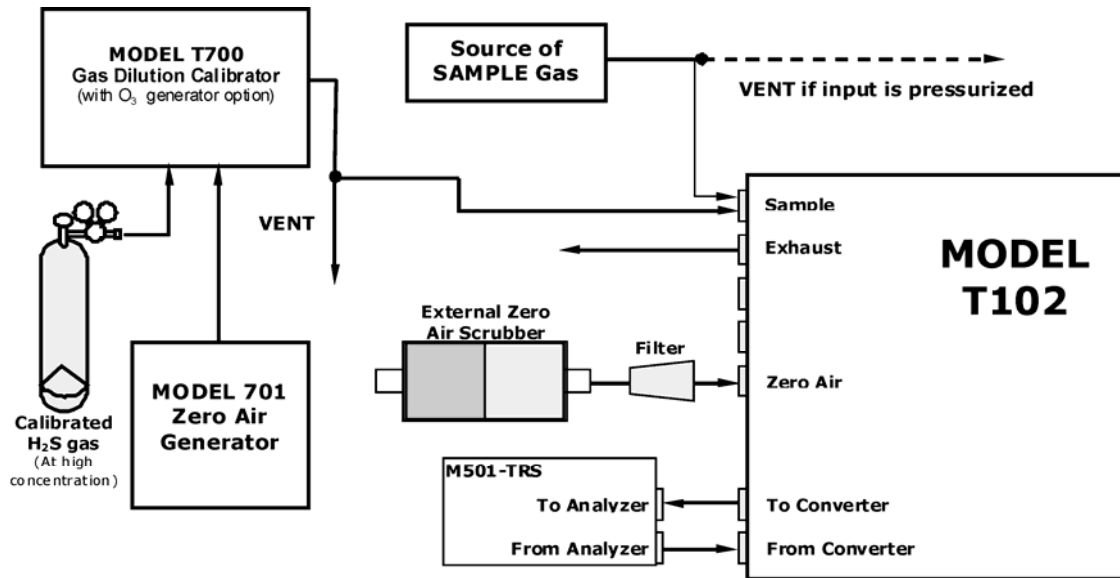


Figure 4-4. Pneumatic Connections for Formal Calibration of Units w/ IZS Valve Option

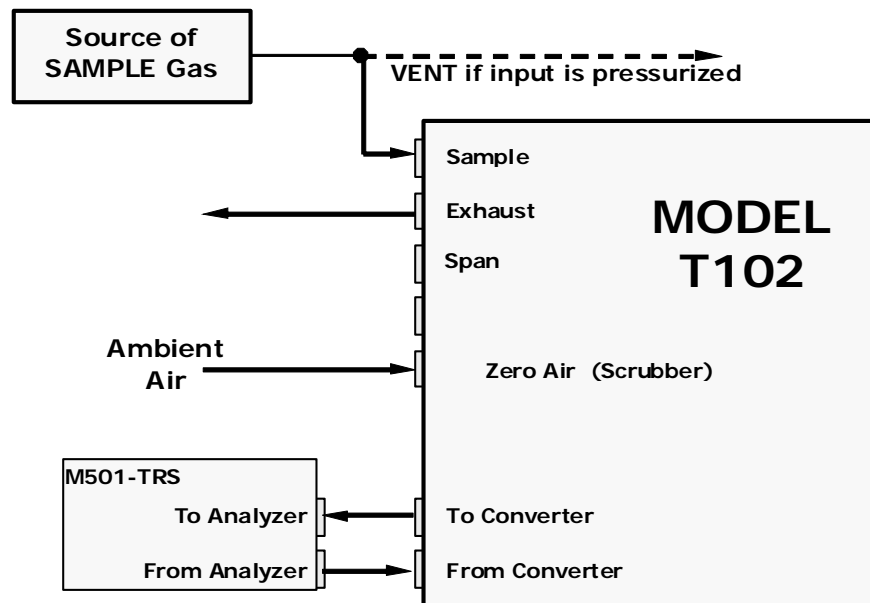


Figure 4-5. Pneumatic Connections for Informal Calibration Checks of Units with IZS Valve Option

**NOTE**

Gas flow must be maintained at all times for units with IZS Options installed. The IZS option requires a permeation tube (customer supplied) which emits H<sub>2</sub>S. Insufficient gas flow can build up H<sub>2</sub>S to levels that will damage the instrument.

Remove the permeation device when taking the analyzer out of operation.

## 4.2. Initial Operation

### 4.2.1. Startup / Warm Up of the T102

Startup procedures and warm up behavior of the T102 are identical to those described in the T101 Manual - PN 07266.

#### Possible Warning Messages at Start-Up

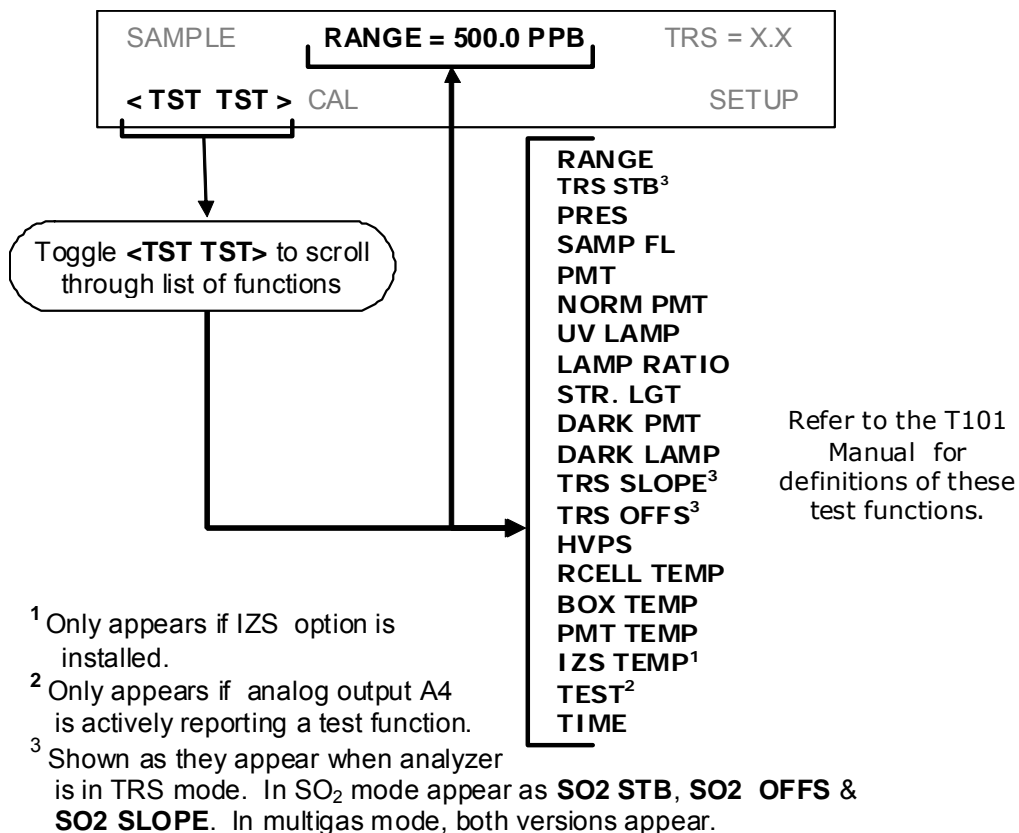
Warning messages for the T102 is the same as the list of warning messages included in Appendix A: *Mode 101E Warnings and Test Measurements* in the T101 Manual - PN 07266 with the exception that there is no **CONV TEMP WARNING** (converter Temperature Warning).

### 4.2.2. Functional Check of the T102

To performing an initial functional check of the T102, follow the steps contained in the *Functional Check* section in the T101 Manual - PN 07266.

#### Test Functions

The following diagram supersedes the diagram found in Step 2 of the *Functional Check* section in the T101 Manual - PN 07266.





### 4.2.3. Startup / Warm Up of the M501-TRS

After electrical and pneumatic connections are made, turn on the instrument and pump power. The exhaust fan should start.

The M501-TRS' temperature controller is preprogrammed at the factory so no special setup operation is required. The temperature controller (see Figure 4-6) should immediately come on in operation mode: the current temperature of the converter oven should the display immediately appear in the display area and the process value (PV) LED should be lit.

It may take as much as 30 minutes for the oven to reach its nominal operating temperature.

During that initial warm up period the high and low alarms and the M501-TRS single alarm output are disabled. Both the internal alarms and the alarm output will be automatically enabled once the converter oven temperature rises above the lower alarm limit.



Figure 4-6. M501-TRS Temperature Controller Startup

### 4.3. Initial Calibration

Initial calibration of the T102 should be performed with:

- Zero air supplied by a zero air generator such as the TAPI Model 701;
- Calibrated H<sub>2</sub>S span gas of the appropriate concentration;
- With external pneumatic connections as described in Figure 4-1 through Figure 4-5 of this addendum, and;
- Using the information and procedure included in the *Initial Calibration* section in the T101 Manual - PN 07266.

No initial calibration of the M501-TRS instrument is required.

#### NOTE

**Once you have completed the above set-up procedures, please fill out the quality questionnaire that was shipped with your unit and return it to TAPI. This information is vital to our efforts in continuously improving our service and our products. Thank you.**

## 5. OPTIONAL HARDWARE AND SOFTWARE

This section includes descriptions of the hardware and software options available for the Model T102 analyzer and M501-TRS converter that are different from or not included in the *Options* section of the T101 Manual - PN 07266. For all other available options see that manual.

For assistance with ordering these options please contact the sales department of TAPI at:

**TOLL-FREE: 800-324-5190**  
**TEL: +1 858-657-9800**  
**FAX: +1 858-657-9816**  
**E-MAIL: apisales@teledyne.com**  
**WEB SITE: <http://www.teledyne-api.com>**

### 5.1. Rack Mount Kits (Options 20a, 20b, 21, 22 & 81)

The following table supersedes the table included in *Rack Mount Kits (Option 20a, 20b & 21)* section in the T101 Manual - PN 07266.

OPTION NUMBER	DESCRIPTION
OPT 20A	Rack mount brackets with 26 in. chassis slides.
OPT 20B	Rack mount brackets with 24 in. chassis slides.
OPT 21	Rack mount brackets only
OPT 22	Rack Mount for M501-TRS
OPT 81	Rack Mount for M501-TRS with slides

### 5.2. Calibration Valves Options

#### 5.2.1. Zero/Span Valves (Option 50) & Internal Zero/Span Gas Generator (Option 51)

The description of the construction and operation for the zero span and IZS valve options for the T102 TRS is identical to that information contained in *Calibration Valves Option* section in the T101 Manual - PN 07266.

However, the internal pneumatic flow of the T102 with either of these options installed is different. See:

- Figure 5-1 for an illustration of the T102 internal gas flow with the zero/span valves option
- Figure 5-2 for an illustration of the T102 internal gas flow with the IZS valve option

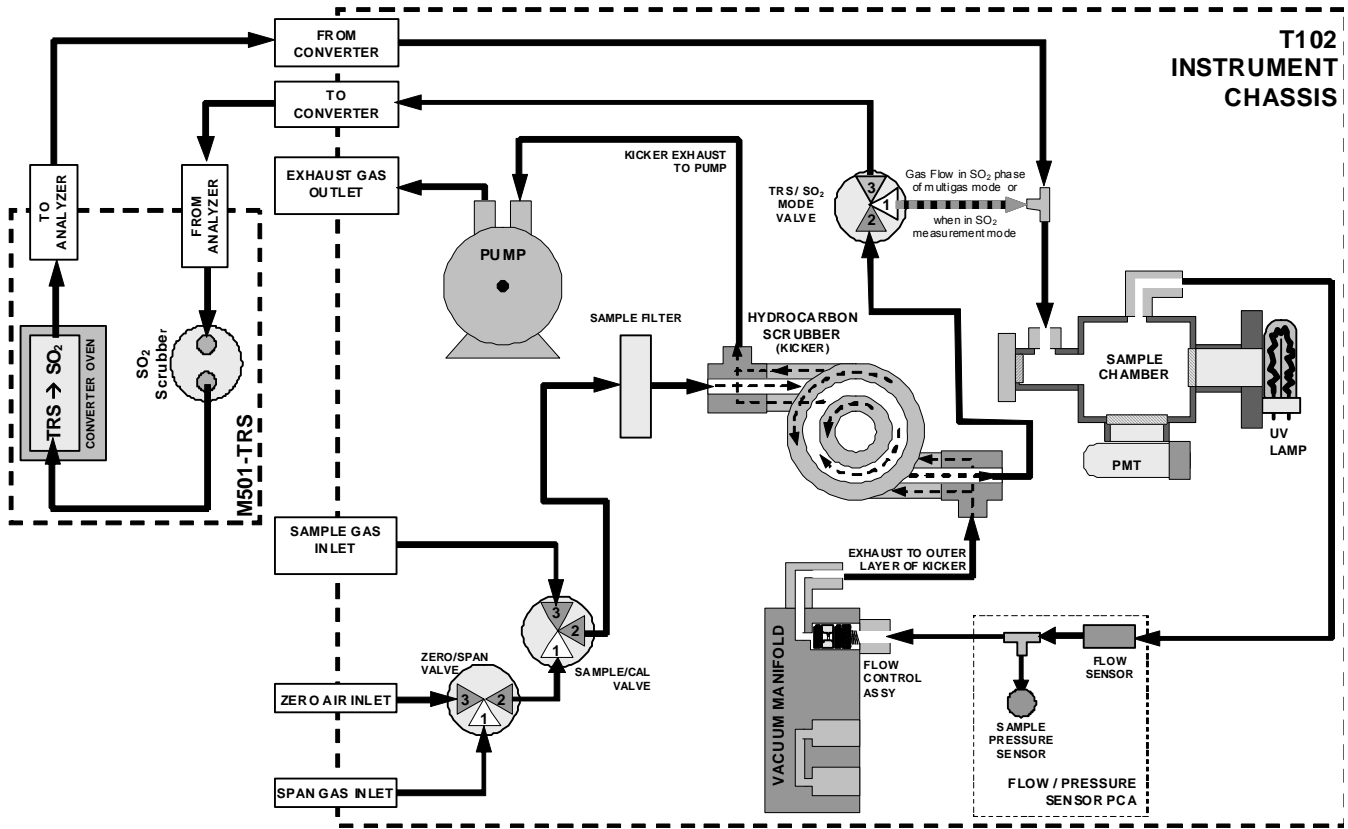


Figure 5-1. Internal Pneumatic Diagram of the T102 With Z/S Option Installed

The following table describes the state of each valve during the analyzer’s various operational modes.

Table 5-1. Zero/Span Valve Operating States

MODE	VALVE	CONDITION	VALVE PORT CONNECTION (FIG. 5-2)
SAMPLE	Sample/Cal	Open to SAMPLE inlet	3 → 2
	Zero/Span	Open to ZERO AIR inlet	3 → 2
ZERO CAL	Sample/Cal	Open to zero/span inlet	1 → 2
	Zero/Span	Open to ZERO AIR inlet	3 → 2
SPAN CAL	Sample/Cal	Open to zero/span inlet	1 → 2
	Zero/Span	Open to SPAN GAS inlet	1 → 2

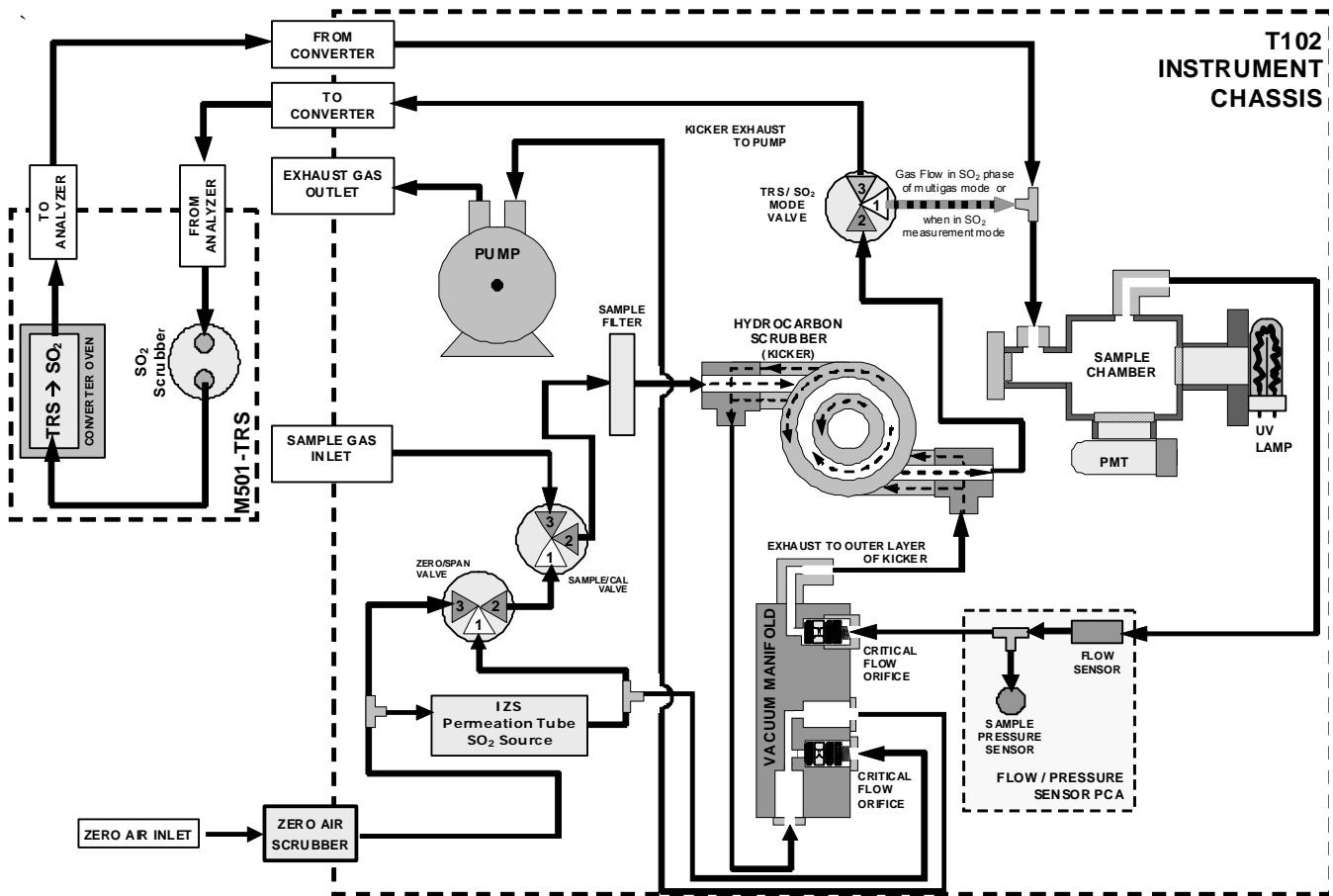


Figure 5-2. Internal Pneumatic Diagram of the T102 with IZS Options Installed

The following table describes the state of each valve during the analyzer’s various operational modes.

Table 5-2. IZS Valve Operating States

MODE	VALVE	CONDITION	VALVE PORT CONNECTIONS
SAMPLE	Sample/Cal	Open to SAMPLE inlet	3 → 2
	Zero/Span	Open to ZERO AIR inlet	3 → 2
ZERO CAL	Sample/Cal	Open to zero/span valve	1 → 2
	Zero/Span	Open to ZERO AIR inlet	3 → 2
SPAN CAL	Sample/Cal	Open to zero/span valve	1 → 2
	Zero/Span	Open to SPAN GAS inlet	1 → 2

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## 6. T102 OPERATING INSTRUCTIONS

### NOTE

For the most part the operation instruction for the T102 are the same as those described in Chapter 6 of the T101 Manual - PN 07266 with the exception that the terms "TRS" & "total reduced sulfur" should be substituted for the terms "H<sub>2</sub>S" & "hydrogen sulfide" unless otherwise stated in this addendum.

### 6.1.1. T102 Analog Output Signals

The information contained in the available *Analog Output Signals* section in the T101 Manual - PN 07266 is correct except that the test channel output is located on analog output **A3** rather than **A4**.

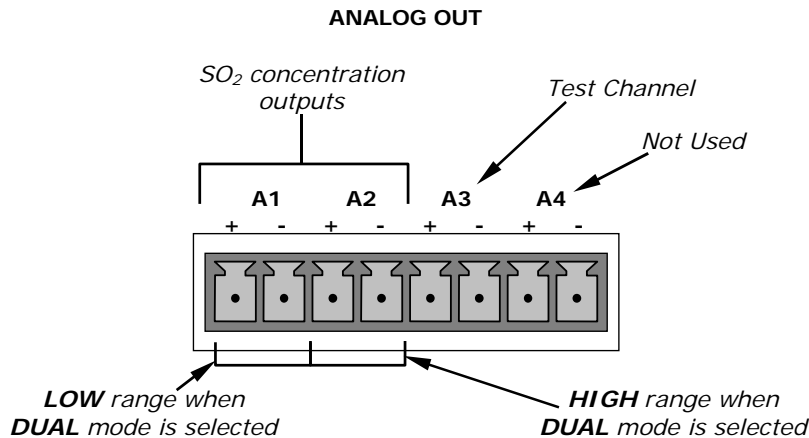


Figure 6-1. Analog Output Connector

### NOTE

On analyzers with the SO<sub>2</sub>-TRS multigas gas measurement option available, the outputs of A1 and A2 correspond to:

<u>Output Channel</u>		<u>SO<sub>2</sub> Mode</u>		<u>SO<sub>2</sub> - TRS Mode</u>		<u>TRS Mode</u>
A1	↔	SO <sub>2</sub>	↔	SO <sub>2</sub>	↔	TRS
A2	↔	SO <sub>2</sub>	↔	TRS	↔	TRS

**As the instrument switches between TRS mode to SO<sub>2</sub> mode , only the reporting range and analog output associated with the gas currently being measured will be active. The reporting range and analog output for the gas not being measured will continue to report the last valid reading.**

The output, labeled **A3** is special. It can be set by the user (see *Test Channel Output* section in the T101 Manual - PN 07266) to output many of the parameters accessible through the <TST TST> buttons of the units Sample Display.

Output **A4** is not available on the Model T102 Analyzer.

## 6.1.2. Setting the T102 Gas Measurement Mode

Setting the gas measurement mode on the T102 is identical to the method described in the *Setting the Gas Measurement* section in the T101 Manual - PN 07266 except that the available measurement modes are as described in the following table:

**Table 6-1. T102 Gas Measurement Modes**

GASMODE	DESCRIPTION
TRS	The sample gas stream is stripped of any ambient SO <sub>2</sub> by a special chemical scrubber, then passed through a catalytic converter that changes the TRS present into SO <sub>2</sub> which is then measured using the UV Fluorescence method
SO <sub>2</sub>	The sample gas stream bypasses the SO <sub>2</sub> Scrubber and catalytic converter allowing the only ambient SO <sub>2</sub> to be measured.
TRS –SO <sub>2</sub>	The switching valve alternates the gas stream between the two paths at regular intervals allowing the instrument to measure both gases.

## 6.2. SETUP – DIAG: Using the Diagnostics Functions

### 6.2.1. T102 Analog I/O Configuration

The following table supersedes the *Analog Output Pin Assignments* table in the *Analog I/O Configuration* section of the T101 Manual - PN 07266

**Table 6-2. Analog Output Pin Assignments**

PIN	ANALOG OUTPUT	VOLTAGE SIGNAL	CURRENT SIGNAL
1	A1	V Out	I Out +
2		Ground	I Out -
3	A2	V Out	I Out +
4		Ground	I Out -
5	A3	V Out	not available
6		Ground	not available
7-8	A3	Not Used	Not Used

See Figure 3-4 for the location of the analog output connector on the instrument's rear panel.



## 6.2.2. T102 Test Channel Output

The following table supersedes the *Test Parameters Available for Analog Output A4* table in the *Test Channel Output* section in the T101 Manual - PN 07266

**Table 6-3. Test Parameters Available for Analog Output A4**

TEST CHANNEL	TEST PARAMETER RANGE <sup>1</sup>
NONE	Test channel is turned off
PMT READING	0-5000 mV
UV READING	0-5000 mV
SAMPLE PRESSURE	0-40 in-Hg-A
SAMPLE FLOW	0-1000 cm <sup>3</sup> /min
RCELL TEMP	0-70° C
CHASSIS TEMP	0-70° C
IZS TEMP	0-70° C
PMT TEMP	0-50° C
CHASSIS TEMP	0-70° C
HVPS VOLTAGE	0-5000 V
<sup>1</sup> This refers to the voltage range of the parameter and not the output signal of the test channel.	

Once a TEST function is selected, the instrument begins to report a signal on the **A36** output and adds **TEST=** to the list of test functions viewable on the display (just before the TIME display).

## 6.3. SETUP – COMM: Setting Up the T102's Communication Ports

### 6.3.1. T102 ID Code

The default ID code for all T102 analyzers is **102**.

To edit the instrument's ID code, see *Analyzer ID* Section of the T101 Manual - PN 07266.

### 6.3.2. T102 Ethernet Host Name

The default name for all TAPI Model T102 analyzers is **T102**.

To change the Ethernet Host Name see *Changing the Analyzer's HOSTNAME* section in the T101 Manual - PN 07266.

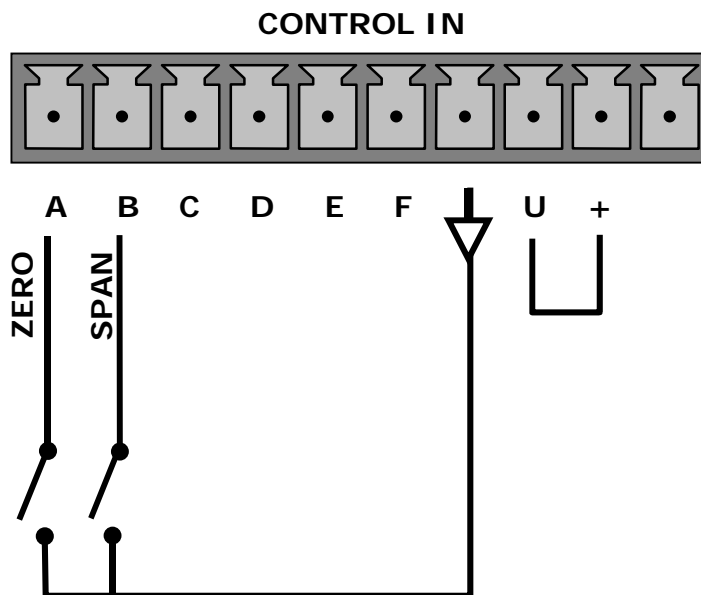
## 6.4. Remote Operation of the Analyzer

### 6.4.1. Control Inputs

The following table and figures supersede the Control Input Pin Assignment table and the figures for Control Inputs with Local 5 V Power Supply and Control Input with External 5 V Power Supply in the *Control Inputs* section in the T101 Manual - PN 07266 respectively.

**Table 6-4. T102 Control Input Pin Assignments**

INPUT	STATUS	CONDITION WHEN ENABLED
A	External Zero Cal	Zero calibration mode is activated. The mode field of the display will read ZERO CAL R.
B	External Span Cal	Span calibration mode is activated. The mode field of the display will read SPAN CAL R.
C, D, E, & F		Unused
⏚	Digital Ground	Provided to ground an external device (e.g., recorder).
U	DC Power For Input Pull Ups	Input for +5 VDC required to activate inputs A - F. This voltage can be taken from an external source or from the "+" pin.
+	Internal +5v Supply	Internal source of +5V which can be used to activate inputs when connected to pin U.



**Figure 6-2. Control Inputs with Local 5 V Power Supply**

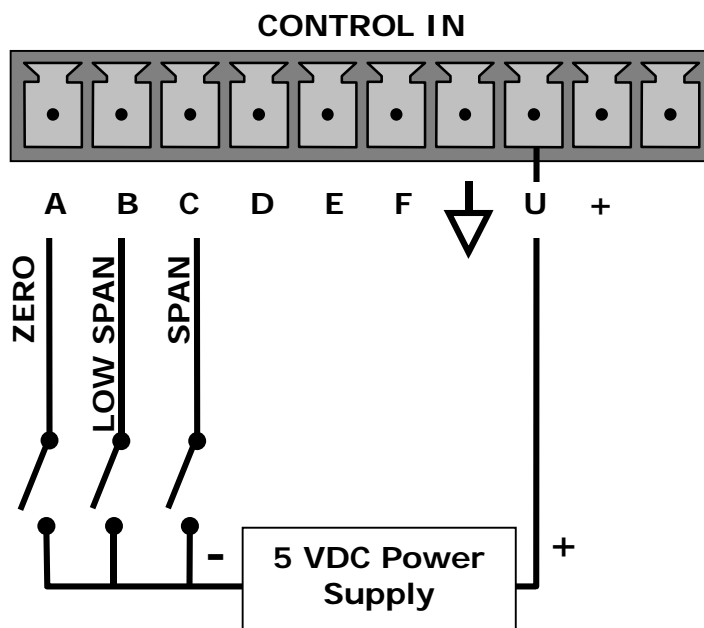


Figure 6-3. Control Inputs with External 5 V Power Supply

## 6.4.2. Using the T102 with a Hessen Protocol Network

### 6.4.2.1. T102 Hessen Protocol Gas ID List.

The default Hessen Gas Id's for all T102 analyzers are:

Table 6-5. T102 Default Hessen Gas ID's

Gas Type	Hessen Gas ID
SO <sub>2</sub>	111
TRS	112

To edit the instrument's ID code, see the *Hessen Protocol Gas ID* section in the T101 Manual - PN 07266.

### 6.4.2.2. Setting Hessen Protocol Status Flags

The following table supersedes the Setting Hessen Protocol Status Flags Table in the T101 Manual - PN 07266 /

**Table 6-6. Default Hessen Status Bit Assignments**

STATUS FLAG NAME	DEFAULT BIT ASSIGNMENT
<b>WARNING FLAGS</b>	
SAMPLE FLOW WARNING	0001
PMT DET WARNING	0002
UV LAMP WARNING	0002
HVPS WARNING	0004
DARK CAL WARNING	0008
RCELL TEMP WARNING	0010
IZS TEMP WARNING	0020
PMT TEMP WARNING	0040
CONV TEMP WARNING	1050
<b>OPERATIONAL FLAGS</b>	
In Manual Calibration Mode	0200
In Zero Calibration Mode	0400
In Span Calibration Mode	0800
<b>UNITS OF MEASURE FLAGS</b>	
UGM	0000
MGM	2000
PPB	4000
PPM	6000
<b>SPARE/UNUSED BITS</b>	0080, 0100, 1000, 8000
<b>UNASSIGNED FLAGS</b>	
Box Temp Warning	Front Panel Warning
Sample Press Warning	Analog Cal Warning
System Reset	Cannot Dyn Zero
Rear Board Not Detected	Cannot Dyn Span
Relay Board Warning	Invalid Conc

## 7. M501-TRS OPERATING INSTRUCTIONS



### CAUTION!

DO NOT OPERATE WITHOUT THE COVER INSTALLED ON THE M501TS CONVERTER. OVEN TEMPERATURE WILL NOT REGULATE PROPERLY WITHOUT THE COVER IN PLACE.

### NOTE:

Changing the Converter temperature from the value preprogrammed at the factory may have undesirable effects on TRS converter's efficiency.

Do not change the factory-preprogrammed value unless absolutely necessary or unless directed to do so by TAPI Technical Support.

### 7.1. Basic M501-TRS Controls

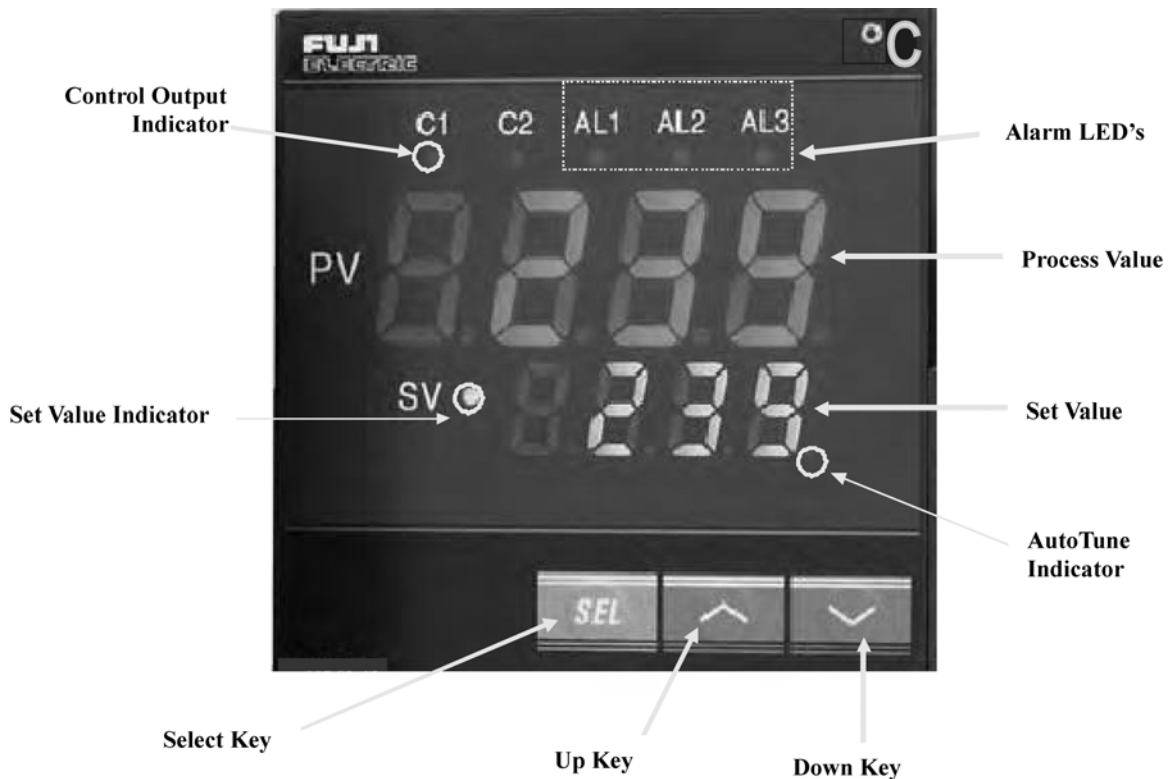


Figure 7-1. M501-TRS Temperature Controls

**Table 7-1. M501-TRS Temperature Controls and Definitions**

<b>NAME</b>	<b>FUNCTION</b>
<b>Process Value</b>	A 4-digit, 7 segment LED display on which the current value of the PV and as well as error codes and programming parameters and data are all displayed.
<b>Set Value</b>	A 4-digit, 7 segment LED display which shows the current value of the SV. It also displays the the parameter settings in parameter setting mode It flickers during Standby Mode.
<b>Select Key</b>	<p>This key is used to switch between the 1<sup>st</sup>, 2<sup>nd</sup> or 3<sup>rd</sup> parameter block. It is sued to switch between the parameter and the data at the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> block.</p> <p>To access the 1<sup>st</sup> parameter block press and hold the select key for 1 sec.</p> <p>To access the 2<sup>nd</sup> parameter block press and hold the select key for 3 sec.</p> <p>To access the 3<sup>rd</sup> parameter block press and hold the select key for 5 sec.</p> <p>To return to the main display after entering a paremeter block press and hold the key for 2 sec.</p> <p>Used to confirm parameter value changes by pressing once.</p>
<b>Set value Indicator</b>	Is lit indicates when a the set value (SV) is displayed.
<b>Up Key</b>	<p>Used to increase the numerical value. The numerical value is increased by pressing the key once. The numerical value keeps oon increasing by pressing the key continuously.</p> <p>Used to search for parameters within the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> blocks.</p>
<b>Down Key</b>	<p>Used to decrease the numerical value. The numerical value is increased by pressing the key once. The numerical value keeps oon increasing by pressing the key continuously.</p> <p>Used to search for parameters within the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> blocks.</p>
<b>Autotune Indicator</b>	The lamp blinks while the PID autotuning or self tuning is being performed.
<b>Control Indicator</b>	Lit when the controller is actively controlling the heater temperature.
<b>Alarm Indicator1 (AL1)</b>	Lit when the PV equals or exceeds the upper alarm limit.
<b>Alarm Indicator2 (AL2)</b>	Lit when the PV equals or falls below the lower alarm limit.

## 7.2. To Display The Current Temperature

If the **Process Value** is displaying a numerical value, the process value is currently being displayed.

If it is not being displayed press the select key for 2 seconds.

## 7.3. To Manually Adjust the Converter Oven Temperature



### CAUTION !

**DO NOT SET THE TEMPERATURE HIGHER THAN 1050 °C**

4. Set the main display to show the current value of the set variable by pressing the PV/SV mode key.
5. To set each digit:
  - c. Press the up-arrow under that digit once. The digit will flash.
  - d. To increment that digit press and hold the UP key until the appropriate number is displayed.
  - e. To decrement that digit press and hold the DOWN key until the appropriate number is displayed.
  - f. To increment/decrement the 1000's digit it is necessary to adjust increment/decrement the 100's digit up and down. Each time the 100's digit passes "0" the 1000s digit will increment or decrement correspondingly. See EXAMPLE table below.
6. Once the desired value is reached, press the ENT key to store the new set value
7. Return the main display to process mode by pressing the PV/SV mode button once.

EXAMPLE to change the set value from 950 to equal 1050.

ACTION	RESULT
Press the PV/SV mode key	The SV indicator will lit up and the display will show 950.
Press the 10's UP key once	The 10's digit will begin to blink
Press the DOWN key	The 10's digit will decrement from "5". Release the DOWN key when the 10's digit reads "5".
Press the 100's UP Key once	The 100's digit will begin to blink
Press and hold the 100's UP key	The 100's digit will increment from "9". When it passes "0" the 1000's digit will increment to "1". Release the 100's UP key.
--	The Display should now read "1050"
Press the ENTER key	The new set value is recorded
Press the PV/SV mode key	The current level of the process value will be displayed.

## 7.4. Autotune the Temperature Controller

The M501-TRS controller includes an auto tune feature which allows the controller to find and set optimum values for various process control parameters so that the controller can establish and maintain the converter oven at the temperature set value in the most stable and efficient manner.

### NOTE

**Before initiating the autotune feature make sure that the converter temperature oven has reached a stable, constant temperature.**

### 7.4.1. Initiating the Autotune Process

1. Press the SELECT key once. The main display will show **P**
2. Use the SELECT , DOWN or 100's UP key to scroll through the primary menu parameters until the display shows **AT** (AT =Autotune).
3. Press the DATA key once. The display will show **0** (zero = Off).
4. Press the 1's UP key once. The display will show **1** (1 = autotune based on set point value).
5. Press the ENTER key to begin the autotune process. A blinking decimal point will appear at the bottom right-hand corner of the main display.
6. Wait until the blinking light stops. This may take up to 30 minutes.
7. The autotune process is finished. The autotune parameter value will automatically reset to zero (off).
8. Press the PV/SV mode key to return to operational mode.

### Note

**The P-I-D parameters calculated by autotuning will be retained even if the power is lost. However, if the power is turned off during the auto-tuning process, you must restart autotuning.**



## 7.4.2. Aborting the Autotune Process

1. Press the DATA key once. The display will show **1** (1).
2. Press the 1's UP key once. The **1** will begin blinking
3. Press the DOWN key once. The display will show **0** (zero).
4. Press the ENTER key once.
5. Press the PV/SV mode key to return to operational mode.

### Note

**Auto-tuning MUST to be repeated if there is a significant change in the set value.**

**If the temperature begins to oscillate excessively around the set value, it may be necessary to repeat the autotune procedure.**

## 7.5. M501TRS Alarm Relay Adjustment

To set the High and Low Alarm points:

1. Press the SELECT key once. The main display will show **P**
2. Use the SELECT , DOWN or 100's UP key to scroll through the primary menu parameters until the display shows either **AL** (AL = Alarm Low) or **AH** (AH = High Alarm).
3. Press the DATA key once. The current value of the alarm limit will be displayed.
4. To set each digit:
  - a. Press the up-arrow under that digit once. The digit will flash.
  - b. To increment that digit, press and hold the digit until the appropriate number is displayed.
  - c. To decrement that digit press and hold the DOWN key until the appropriate number is displayed.
  - d. To increment/decrement the 1000's digit it is necessary to adjust increment/decrement the 100's digit up and down. Each time the 100's digit passes "0" the 1000s digit will increment or decrement correspondingly.
5. Once the desired value is reached, press the ENT key to store the new set value
6. Press the PV/SV mode key to return to operational mode.

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## 8. CALIBRATION PROCEDURES

### 8.1. T102 Calibration

Calibration of the T102 should be performed according to the procedures described in the *Calibration Procedures* and *EPA Protocol Calibration* Chapters in the T101 Manual - PN 07266.

**NOTE**

**It is recommended that the T102 be calibrated in TRS gas measurement mode using H<sub>2</sub>S as a span gas.**

If you are using the T102 for US-EPA controlled monitoring of SO<sub>2</sub>, see the EPA Protocol Calibration Chapter in the T101 Manual (PN 07266) for information on the EPA calibration protocol.

### 8.2. M501-TRS Calibration

The M501-TRS converter does not require field calibration.

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# 9. INSTRUMENT MAINTENANCE

The following table supersedes the T101 Preventative Maintenance Table in the *Maintenance Schedule* section in the T101 Manual - PN 07266.

**Table 8-1. T102 Preventive Maintenance Schedule**

ITEM	ACTION	FREQUENCY	CAL CHECK	T101 MANUAL SECTION	DATE PERFORMED					
M501 SO2 scrubber	Replace scrubber material	As required	Yes	9.1.1.3 of this addendum						
<sup>1</sup> Particulate filter	Change particle filter	Weekly	No	9.3.1						
Verify test functions	Review and evaluate	Weekly	No	Appendix C						
Zero/span check	Evaluate offset and slope	Weekly	--	7.3, 7.6, 7.9						
<sup>1</sup> Zero/span calibration	Zero and span calibration	Every 3 months	--	7.2, 7.4, 7.5, 7.7, 7.8						
<sup>1</sup> External zero air scrubber (option)	Exchange chemical	Every 3 months	No	9.3.4						
<sup>1</sup> Perform flow check	Check Flow	Every 6 Months	No	11.5.2						
<sup>1</sup> Sample chamber optics	Clean windows and filters	Annually or as necessary	Yes	9.3.6						
<sup>1</sup> Critical flow orifice & sintered filters	Replace	Annually	Yes	9.3.7						
Internal IZS Permeation Tube	Replace	Annually	YES	9.3.2						
Perform pneumatic leak check	Verify Leak Tight	Annually or after repairs involving pneumatics	Yes	11.5.1						
<sup>2</sup> Pump diaphragm	Replace	Every 2 years, or as necessary	Yes	See instruction in diaphragm kit						
PMT sensor hardware calibration	Low-level hardware calibration	On PMT/ preamp changes if $0.7 < \text{SLOPE}$ or $\text{SLOPE} > 1.3$	Yes	11.5.4						
Desiccant bags	Replace	Any time sensor assy inspection plate is opened (reference Section 11.5.3)								

<sup>1</sup> These Items are required to maintain full warranty, all other items are strongly recommended.

<sup>2</sup> A pump rebuild kit is available from TAPI Technical Support including all instructions and required parts (see Appendix B for part numbers).



## 9.1. Additional and Updated Maintenance Procedures

The following procedures need to be performed regularly as part of the standard maintenance of the Model T102.

### 9.1.1. Maintaining the SO<sub>2</sub> Scrubber

**This section supersedes the *Changing the SO<sub>2</sub> Scrubber Material* section in the T101 Manual - PN 07266.**

Unlike the T101 which includes an internal scrubber to remove SO<sub>2</sub> from the sample gas before the H<sub>2</sub>S → SO<sub>2</sub> conversion takes place, the T102 relies on the SO<sub>2</sub> scrubber of the M501-TRS to perform the same function.

The SO<sub>2</sub> scrubber of your M501-TRS utilizes a consumable compound to absorb SO<sub>2</sub> from the sample gas before the TRS is converted to SO<sub>2</sub>. This material must be replaced periodically in order for the analyzer to continue measuring TRS accurately and reliability.

This material is capable of efficiently scrubbing SO<sub>2</sub> for up to 1000 ppm-hours. This means that if the SO<sub>2</sub> content of the sample gas is typically around 100 ppb, the scrubber will function for approximately 10,000 hours, a little over 13 months. If, however, the typical ambient SO<sub>2</sub> level of the sample gas is 250 ppb, the scrubber would only last for approximately 4000 hours or about 5 ½ months.

#### 9.1.1.1. Predicting When to Replace the SO<sub>2</sub> Scrubber

To determine how long the SO<sub>2</sub> scrubber will operate efficiently:

1. Measure the amount of SO<sub>2</sub> in the sample gas.
  - If your T102 has the multigas measurement options activated, this can be done by following instructions found in the *Setting the Gas Measurement Mode* section in the T101 Manual (PN 07266) and selecting **MEASURE MODE = SO<sub>2</sub>**.
  - Let the analyzer operate for 30 minutes, then note the SO<sub>2</sub> concentration.
2. Divide 1 000 by the SO<sub>2</sub> concentration.

EXAMPLE: If the SO<sub>2</sub> concentration is 125 ppb:

Operational hours= 1000 ppm/hr ÷ 0.125 ppm

Operational hours= 100 000 ppb/hr ÷ 125 ppb

Operational hours= 8000 hrs

### 9.1.1.2. Checking the Function of the SO<sub>2</sub> Scrubber

To check to see if your SO<sub>2</sub> scrubber is operating properly perform the following test:

1. Set the analyzer for TRS gas measurement mode (see *Setting the Gas Measurement Mode* section in the T101 Manual - PN 07266).
2. Set the reporting range to range of 1000 PPB (see Sections 6.7.4, 6.7.5 and 6.7.6 of the T101 Manual - PN 07266).
3. Introduce a gas mixture into the sample gas stream that includes 500 PPB of SO<sub>2</sub>.

An increase of more than 10 PPB in the TRS reading is an indication that the efficiency of the scrubber is decreasing to the point that the absorbing material should be replaced.

### 9.1.1.3. Changing the SO<sub>2</sub> Scrubber Material

1. Input zero air for 5 minutes
2. Turn off the M501-TRS
3. Locates the SO<sub>2</sub> scrubber cartridge on the right side of the converter: It looks like a big white cylinder (See Figure 3-2 of this addendum).
4. Undo the two 1/4 inch fittings on the top of the scrubber
5. Remove the two screws holding the scrubber to the instrument chassis and remove the scrubber
6. Take the two Teflon fittings off the instrument.
7. Empty the SO<sub>2</sub> scrubbing material into a hazmat bin.
8. Fill each side of the scrubber with new SO<sub>2</sub> scrubber material until it is 1/2 inch from the bottom of the thread lines (about 1 inch from the top of the scrubber), do not fill it too high or the fitting will compact the material, causing a restriction in the gas flow.
9. Remove the Teflon tape from both of the removed fittings, and wrap them with new Teflon tape.
10. Install both fittings back onto the scrubber.
11. Put the scrubber back into the analyzer and replace the two screws on the bottom.
12. Screw the two 1/4" fittings back onto the top of the scrubber (either fitting can fit the inlet or the outlet). Return analyzer to normal operation



## 10. THEORY OF OPERATION

The T102 is a modified T101 which, when used in conjunction with a M501-TRS determines the concentration of total reduced sulfur (TRS), in a sample gas drawn through the instrument. In most ways the theory of operation of the T102 & M501-TRS system is identical to the T101 theory of operation as described in the *Theory of Operation* Chapter in the T101 Manual - PN 07266.

This section describes those areas where differences between the T102 and the T101 exist as well as updated information made available since the publication date of the T101 Manual - PN 07266.

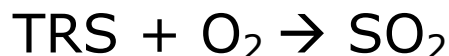
### 10.1. Measurement Principle

**This section supersedes the *Measurement Principle* section in the T101 Manual - PN 07266**

#### 10.1.1. TRS Conversion

The T102 TRS analyzer is basically an SO<sub>2</sub> analyzer with a TRS → SO<sub>2</sub> converter (the M501-TRS) inserted into the gas stream before the sample gas enters the sample chamber.

The M501-TRS, receives sample gas from the T102 after it has been passed through a particulate filter and has been scrubbed of hydrocarbon interferences. Once inside the M501-TRS the sample gas is scrubbed of all naturally occurring SO<sub>2</sub>, then passed through a special quartz converter which heats the gas to a very high temperature causing it to react with the O<sub>2</sub> present in the sample gas creating SO<sub>2</sub> in the following manner .



**Equation 10-1**

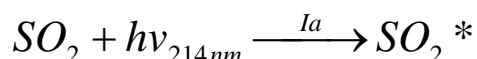
For TRS compounds, the converter is most efficient when it operates at 850°C, converting >95% of the TRS into SO<sub>2</sub>. The converter temperature is viewable via the front panel of the M501-TRS

When the converter is operating at peak efficiency there is a nearly 1:1 relationship between the amount of TRS entering the converter and the amount of SO<sub>2</sub> leaving it. Therefore, by measuring the amount of SO<sub>2</sub> in the gas after it leaves the converter, the amount of TRS originally present on the sample gas can be directly inferred.

### 10.1.2. SO<sub>2</sub> Ultraviolet Fluorescence

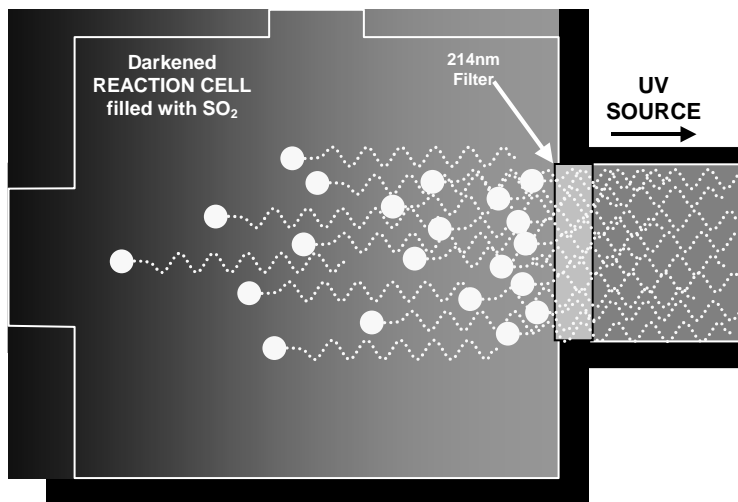
The physical principle upon which the T102's measurement method is based is the fluorescence that occurs when sulfur dioxide (SO<sub>2</sub>) is changed to an excited state (SO<sub>2</sub><sup>\*</sup>) by ultraviolet light with wavelengths in the range of 190 nm-230 nm. This reaction is a two-step process.

The first stage (Equation 9-2) occurs when SO<sub>2</sub> molecules are struck by photons (**hν**) of the appropriate ultraviolet wavelength. (In the case of the Model T102, a band pass filter between the source of the UV light and the affected gas limits the wavelength of the light to approximately 214 nm). The SO<sub>2</sub> absorbs some of energy from the UV light causing one of the electrons of each of the affected SO<sub>2</sub> molecules to move to a higher energy orbital state.



**Equation 10-2**

The amount of SO<sub>2</sub> converted to SO<sub>2</sub><sup>\*</sup> in the sample chamber is dependent on the average intensity of the UV light (**Ia**) and not its peak intensity because the intensity of UV light is not constant in every part of the sample chamber. Some of the photons are absorbed by the SO<sub>2</sub> as the light travels through the sample gas.



**Figure 10-1. UV Absorption in the T102 Reaction Cell**

The equation for defining the average intensity of the UV light (**Ia**) is:

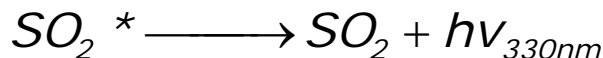
$$Ia = I_0 [1 - \exp(-ax(SO_2))] ]$$

**Equation 10-3**

Where:

- I<sub>0</sub>** = Intensity of the excitation UV light.
- a** = The absorption coefficient of SO<sub>2</sub> (a constant).
- SO<sub>2</sub>** = Concentration of SO<sub>2</sub> in the sample chamber.
- x** = The distance between the UV source and the SO<sub>2</sub> molecule(s) being affected (path length).

The second stage of this reaction occurs after the SO<sub>2</sub> reaches its excited state (SO<sub>2</sub>\*). Because the system will seek the lowest available stable energy state, the SO<sub>2</sub>\* molecule quickly returns to its ground state (Equation 10-3) by giving off the excess energy in the form of a photon (*hν*). The wavelength of this fluoresced light is also in the ultraviolet band but at a longer (lower energy) wavelength centered at 330nm.



Equation 10-4

The amount of detectable UV (*F*) given off by the decay of the SO<sub>2</sub>\* is affected by the rate at which this reaction occurs (*k*).

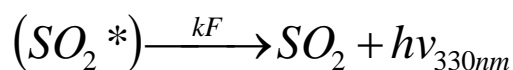
$$F = k(SO_2^*)$$

Equation 10-5

Where:

- F* = the amount of fluorescent light given off.  
*k* = The rate at which the SO<sub>2</sub>\* decays into SO<sub>2</sub>.  
 SO<sub>2</sub>\* = Amount of excited state SO<sub>2</sub> in the sample chamber.

Therefore:



Equation 10-6

Furthermore, the function (*k*) is affected by the temperature of the gas. The warmer the gas, the faster the individual molecules decay back into their ground state and the more photons of UV light are given off per unit of time.

Given that the absorption rate (*a*) of SO<sub>2</sub> is constant, the amount of fluorescence (*F*) is a result of:

- The amount of SO<sub>2</sub>\* created which is affected by the variable factors from equation 10-2 above: concentration of SO<sub>2</sub>; intensity of UV light (*I<sub>0</sub>*); path length of the UV light (*x*) and;
- The amount of fluorescent light created which is affected by the variable factors from equation 10-5: the amount of SO<sub>2</sub>\* present and the rate of decay (*k*) which changes based on the temperature of the gas.

The amount of fluorescent light emitted (*F*) is directly related to the concentration of the SO<sub>2</sub> in the Sample Chamber, when:

- the intensity of the light (*I<sub>0</sub>*) is known
- the path length of excitation light is short (*x*)
- the temperature of the gas is known and compensated for so that the rate of SO<sub>2</sub>\*decay is constant (*k*)
- there are no interfering conditions present (such as interfering gases or stray light)

The Teledyne API UV Fluorescence SO<sub>2</sub> Analyzer is specifically designed to create these circumstances.

- The light path is very short (**x**).
- A reference detector measures the intensity of the available excitation UV light and is used to remove effects of lamp drift (**I<sub>o</sub>**).
- The temperature of the sample gas is measured and controlled via heaters attached to the sample chamber so that the rate of decay (**k**) is constant.
- A special hydrocarbon scrubber removes the most common interfering gases from the sample gas.
- And finally, the design of the sample chamber reduces the effects of stray light via its optical geometry and spectral filtering.

The net result is that any variation in UV fluorescence can be directly attributed to changes in the concentration of SO<sub>2</sub> in the sample gas.

## 10.2. The UV Light Path

The following information is in addition to that contained in the *UV Light Path* section in the T101 Manual - PN 07266.

### 10.2.1. UV Lamp Shutter & PMT Offset

Inherent in the operation of both the reference detector and the PMT are minor electronic offsets. The degree of offset differs from detector to detector and from PMT to PMT and can change over time as these components age.

To account for these offsets the T102 includes a shutter, located between the UV Lamp and the source filter, that periodically cuts off the UV light from the sample chamber. This happens every 30 minutes. The analyzer records the outputs of both the reference detector and the PMT during this dark period and factors them into the SO<sub>2</sub> concentration calculation.

- The reference detector offset is stored as and viewable via the front panel as the test function **DRK LMP**.
- The PMT offset is stored as and viewable via the front panel as the test function **DRK PMT**

## 10.3. Pneumatic Operation

### 10.3.1. Sample gas Flow

See Figures 3-4, 4-1 and 4-2 for depictions of the internal pneumatic flow of both the T102 & the M501-TRS.

### 10.3.2. M501 SO<sub>2</sub> Scrubber

In order to ensure that no ambient SO<sub>2</sub> interferes with the analyzer's TRS measurement the sample gas stream is passed through a chemical scrubber that removes SO<sub>2</sub> from the sample stream before it is passed through the M501-TRS converter oven.

The SO<sub>2</sub> scrubber is a Teflon encased, stand-alone unit containing a room-temperature catalyst tube mounted in the right side of the converter case (see Figure 3.2).

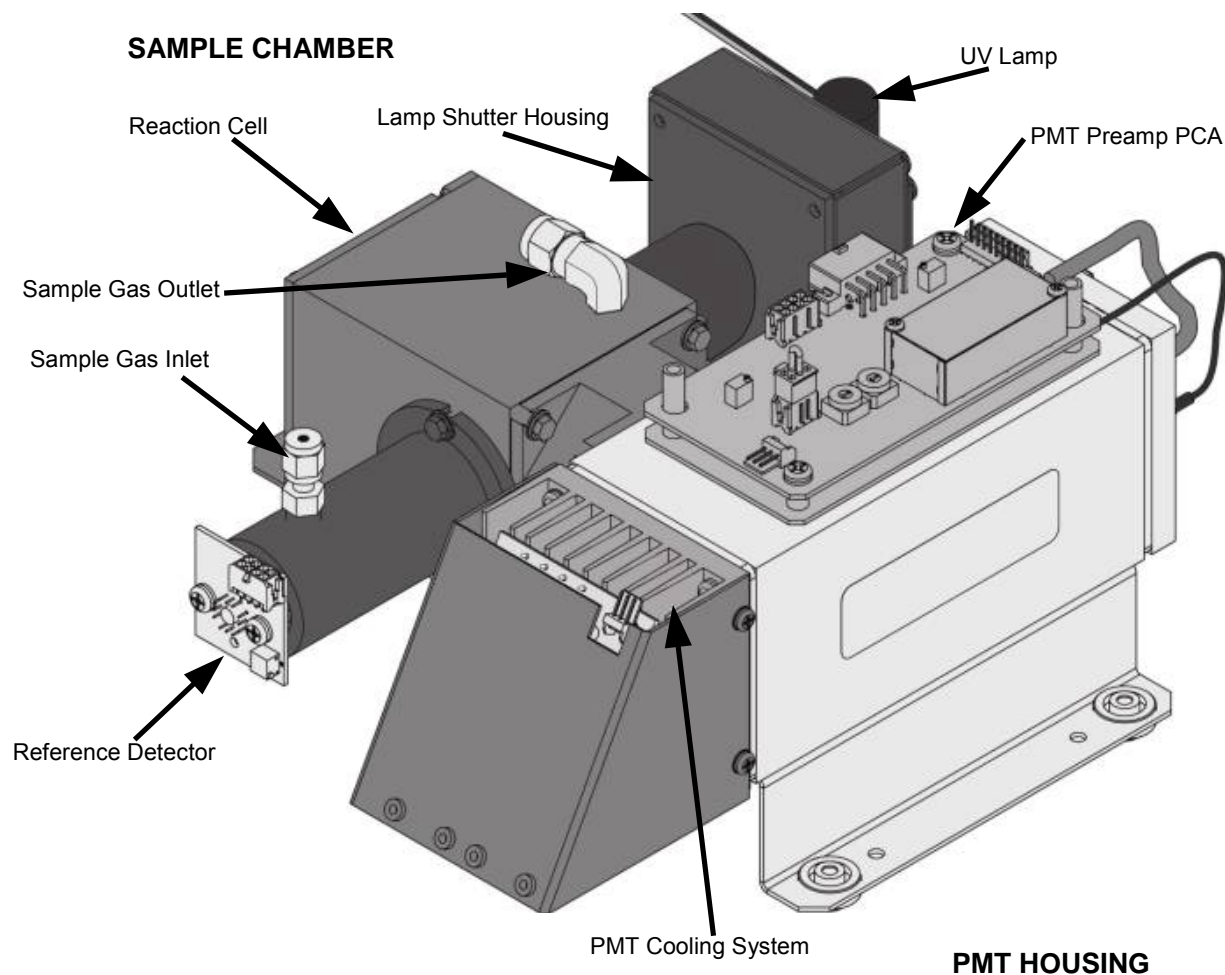
The SO<sub>2</sub> scrubber material is consumed as it removes SO<sub>2</sub>. If the expected concentrations of SO<sub>2</sub> are very high, the lifetime of the scrubber will be short. The expected life of the scrubber is approximately 1000 ppm-hours. See Section 8.1.1.3 for information on when and how to replace the SO<sub>2</sub> scrubber material)

## 10.4. Electronic Operation

### 10.4.1. Sensor Module

This Section replaces the *Sensor Module and Sample Chamber* section in the T101 Manual - PN 07266.

Electronically, the T102 sensor module is a group of components that: create the UV light that initiates the fluorescence reaction between SO<sub>2</sub> and O<sub>3</sub>; sense the intensity of that fluorescence and generate various electronic signals needed by the analyzer to determine the SO<sub>2</sub> concentration of the sample gas (see Section 9.1) and sense and control key environmental conditions such as the temperature of the sample gas and the PMT.



**Figure 10-2. T102 Sensor Module**

These components are divided into two significant subassemblies. The sample chamber and the PMT assembly.

- Figure 9-3 shows an exploded view of the sample chamber assembly
- Figure 9-5 shows an exploded view of the PMT Assembly

### 10.4.1.1. Sample Chamber

The main electronic components of the sample chamber are the reference detector (see the *Reference Detector* section in the T101 Manual - PN 07266); the UV Lamp (see the *UV source Lamp* section in the T101 Manual - PN 07266) and its electronically operated shutter (see Section 10.2.1 of this addendum); and the sample chamber heating circuit,

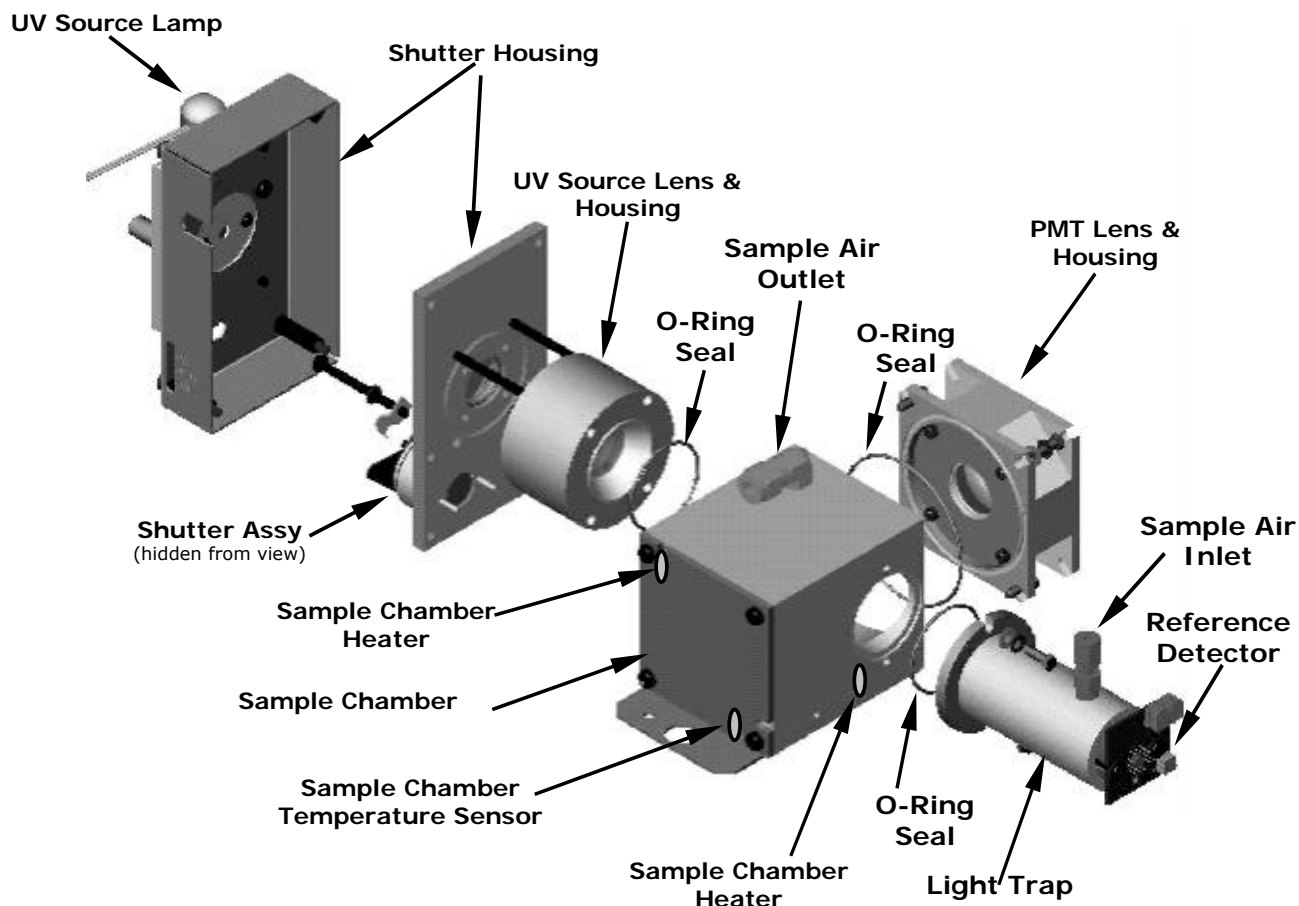


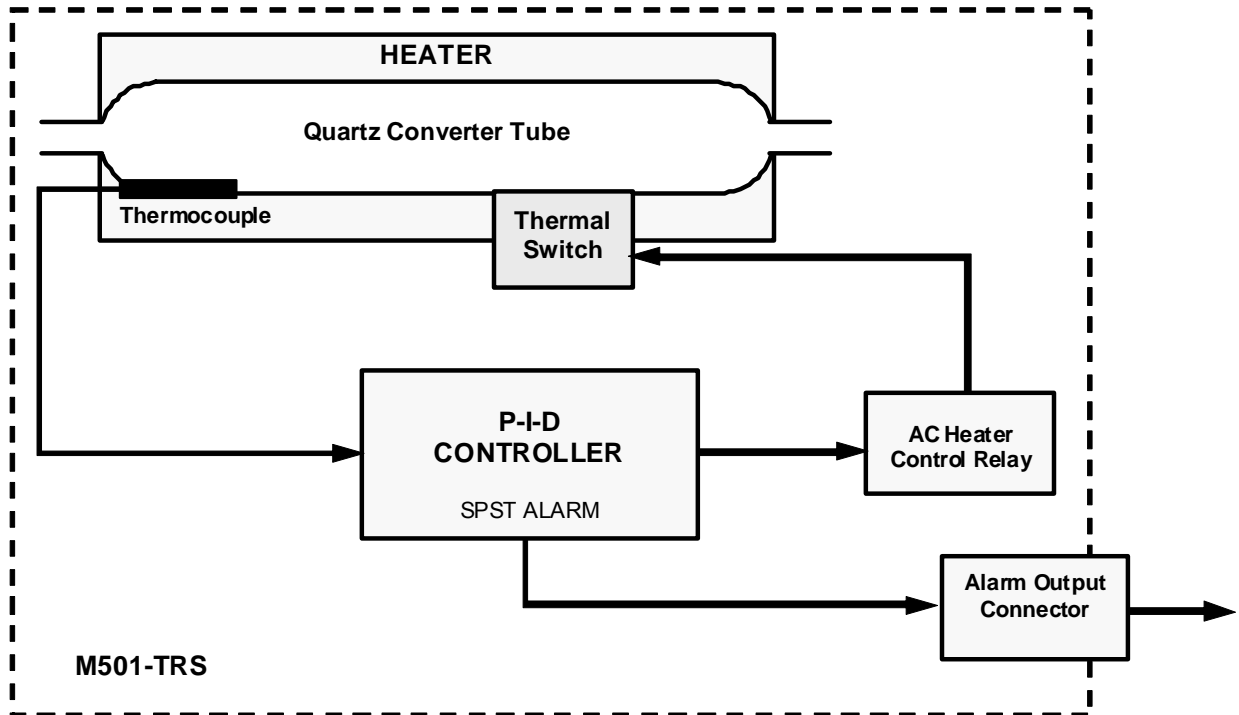
Figure 10-3. T102 Sample Chamber

### 10.4.1.2. Sample Chamber Heating Circuit

In order to reduce temperature effects, the sample chamber is maintained at a constant 50°C, just above the high end of the instrument's operation temperature range. Two AC heaters, one embedded into the top of the sample chamber, the other embedded directly below the reference detector's light trap, provide the heat source. These heaters operate off of the instrument's main AC power and are controlled by the CPU through a power relay on the relay board. A thermistor, also embedded in the bottom of the sample chamber, reports the cell's temperature to the CPU through the thermistor interface circuitry of the motherboard.

## 10.4.2. M501-TRS Electronics

Electronically the M501-TRS is a simple device. The nucleus of the instrument is a programmable, P-I-D temperature controller that manages the temperature of the instrument's AC powered converter oven based on analog input from the thermocouple attached to the converter's chamber.



**Figure 10-4. M501-TRS Electronic Block Diagram**

The P-I-D controller determines the differences between the actual temperature (called the Process Value or PV) of the oven, compares it to the target temperature (called the Set Point or SV) and changes the percentage of time the heater is turned on versus the time it is turned off accordingly. The higher the proportion of ON-time versus OFF-time the faster the oven is heated. For instance, if the PV is much lower than the SV the P-I-D will keep the heater turned on 100% of the time resulting in a relatively rapid increase in the temperature of the oven. As the PV approaches the same temperature as the SV the ON cycles get shorter compared to the OFF cycles.

The M501-TRS's P-I-D controller includes sophisticated software that allows the controller to track the rate change in temperature of the oven compared to the percentage of heater ON-time and predict the proportion needed to reach and maintain the proper oven temperature with a minimal amount of overshoot or fluctuation.

### 10.4.2.1. Thermal Switch

While the M501-TRS's P-I-D Controller includes many safeguards that prevent runaway heating of the converter oven, as an additional safety backup the M501-TRS includes a heat sensitive switch which automatically interrupts power to the heater before the oven temperature reaches critical levels.



### 10.4.2.2. Temperature Alarms and Alarm Output

The M501-TRS' controller has two user settable alarm points: High Alarm and Low Alarm. A single SPST alarm output is triggered should the PV rise above the set level of the high alarm point or fall below the level of the low alarm point.


The relay is normally open, and the contact closes in the alarm condition. The relay contacts are isolated (dry) SPST, 220VAC / 30 VDC 1 Amp, resistive load. This alarm output is available via a connector on the rear panel of the M501-TRS.


The M501-TRS temperature controller is programmed to hold off activation of either alarm until after the process value rises above the lower limit for the first time after power up.

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# 11. TROUBLESHOOTING and REPAIR

This section includes various troubleshooting and repair information supplemental to that in the Troubleshooting and Repair section of the T101 manual (PN 07266).

	<p style="text-align: center;"><b>CAUTION</b></p> <p>The operations outlined in this section must be performed by qualified maintenance personnel only.</p> <p>Please read the Troubleshooting and Repair section of the T101 Manual (PN 07266) before attempting the following trouble shooting or repair procedures</p>
---	---

	<p style="text-align: center;"><b>WARNING</b></p> <p>Risk of electrical shock. Some operations need to be carried out with the analyzer open and running. Exercise caution to avoid electrical shocks and electrostatic or mechanical damage to the analyzer. Do not drop tools into the analyzer or leave those after your procedures. Do not shorten or touch electric connections with metallic tools while operating inside the analyzer. Use common sense when operating inside a running analyzer.</p>
---	--

## 11.1.1. Fault Diagnosis with Warning Messages

### 11.1.1.1. T102 Warning Messages

The warning messages for the T102 are identical to those included in the *Fault Diagnosis with Warning Messages* section in the T101 Manual (PN 07266) except that there is no **CONV TEMP WARNING**.

### 11.1.1.2. M501-TRS Error Codes

The following error codes may appear on the temperature controller display of the M501-TRS

**Table 11-1. Test Functions - Possible Causes for Out-Of-Range Values**

ERROR MESSAGE	CAUSE	NOTES
UUUU	Thermocouple burnt out or wiring between Thermocouple and Temperature Controller is open. The controller process value exceeds the upper input range set point by 5% of full scale.	Controller will automatically turn off the converter heater and allow the TRS converter to cool down.  <ul style="list-style-type: none"> <li>• Check the thermocouple for shorts or opens.</li> <li>• Check the condition of the wiring between the thermocouple and the controller.</li> </ul>
LLLL	When the controller process value is below the lower input range set point by 5% of full scale.	
Err	When either the Upper or lower limit of the input range is set improperly (e.g. Upper limit is set to lower value than lower limit).	Controller will turn off heating element until error is corrected.
FAL7	Undefined fault in controller	<b>Turn off M501-TRS. Call TAPI Technical Support.</b>

### 11.1.2. Fault Diagnosis with Test Functions

The Following table supersedes the Test Functions-Possible Causes for Out-of-Range Values Table in the *Fault Diagnosis with Test Functions* section in the T101 Manual - PN 07266.

**Table 11-2. Test Functions - Possible Causes for Out-Of-Range Values**

TEST FUNCTION	NOMINAL VALUE(S)	POSSIBLE CAUSE(S)
STABIL	≤1 ppb with zero air	Faults that cause high stability values are: pneumatic leak; low or very unstable UV lamp output; light leak; faulty HVPS; defective preamp board; aging PMT; PMT recently exposed to room light; dirty/contaminated reaction cell.
SAMPLE FL	650 cm <sup>3</sup> /min ± 10%	Faults can be caused by: clogged critical flow orifice; pneumatic leak; faulty flow sensor; sample line flow restriction.
PMT	-20 TO 150 mV with zero air	High or noisy readings could be due to: calibration error; pneumatic leak; light leak (improper assembly); aging UV filter; low UV reference output; PMT recently exposed to room light; light leak in reaction cell; reaction cell contaminated; HVPS problem.  <i>It takes 24-48 hours for a PMT exposed to ambient light levels to return to normal functioning.</i>
NORM PMT	- -	Noisy Norm PMT value (assuming unchanging SO <sub>2</sub> concentration of sample gas): Calibration error; HVPS problem; PMT problem; UV reference problem; UV lamp problem.
UV LAMP	2000 -4000 mV	This is the instantaneous reading of the UV lamp intensity. Low UV lamp intensity could be due to: aging UV lamp; UV lamp position out of alignment; faulty lamp transformer; aging or faulty UV detector; dirty optical components.  Intensity lower than 600 mV will cause <b>UV LAMP WARNING</b> .
LAMP RATIO	30 TO 120%	The current output of the UV reference detector divided by the reading stored in the CPU's memory from the last time a UV Lamp calibration was performed. Out of range lamp ratio could be due to: malfunctioning UV lamp; UV lamp position out of alignment; faulty lamp transformer; aging or faulty UV detector; dirty optical components; pin holes or scratches in the UV optical filters; light leaks.
STR LGT	40-100 ppb	High stray light could be caused by: aging UV filter; contaminated reaction cell; light leak; pneumatic leak.
DRK PMT	-50 - +200 mV	High dark PMT reading could be due to: light leak; shutter not closing completely; high pmt temperature; high electronic offset.
DRK LMP	-50 - +200 mV	High dark UV detector could be caused by: light leak; shutter not closing completely; high electronic offset.

TEST FUNCTION	NOMINAL VALUE(S)	POSSIBLE CAUSE(S)
HVPS	≈ 400 V to 900 V	Incorrect HVPS reading could be caused by; HVPS broken; preamp board circuit problems.
RCELL TEMP	50°C ± 1°C	Incorrect temperature reading could be caused by: malfunctioning heater; relay board communication (I <sup>1</sup> C bus); relay burnt out
BOX TEMP	ambient + ~ 5°C	Incorrect temperature reading could be caused by: Environment out of temperature operating range; broken thermistor; runaway heater
PMT TEMP	7°C ± 2°C constant	Incorrect temperature reading could be caused by: TEC cooling circuit broken; High chassis temperature; 12V power supply
IZS TEMP (OPTION)	50°C ± 1°C	Malfunctioning heater; relay board communication (I <sup>1</sup> C bus); relay burnt out
PRESS	ambient ± 2 IN-HG-A	Incorrect SAMPLE pressure could be due to: pneumatic leak; malfunctioning valve; malfunctioning pump; clogged flow orifices; sample inlet overpressure; faulty pressure sensor
SLOPE	1.0 ± 0.3	Slope out of range could be due to: poor calibration quality; span gas concentration incorrect; leaks; UV Lamp output decay.
OFFSET	< 250 mV	High offset could be due to: incorrect span gas concentration/contaminated zero air/leak; low-level calibration off; light leak; aging UV filter; contaminated reaction cell; pneumatic leak.
TIME OF DAY	Current time	Incorrect Time could be caused by: Internal clock drifting; move across time zones; daylight savings time?

## 11.2. M501-TRS Troubleshooting

### 11.2.1. TRS Converter Not Heating:

Problems with heating the If the TRS converter oven can have several causes.

- The “UUUU” error code shown on the M501-TRS temperature controller display indicating a problem with the thermocouple
  - Check the resistance across the thermocouple leads for opens or shorts.
  - Check to make sure that the thermocouple leads are securely connected to the wiring block at the back of the controller.
  - Make sure that the wiring block/socket is correctly plugged onto socket on the back of the controller.
- The set point for the process value is set incorrectly.
  - Check the set value; if it is incorrect, reset it.
- The controller is not in operational mode.
  - Press the PV/SV switch to return it to operation mode.
- The heater is malfunctioning.

**CAUTION**

**Make sure the M501-TRS is turned off and no AC power is being supplied to the heater before proceeding.**

- Check the resistance across the heater coil. It should be approximately 16.5 ohms.
- Check the wiring between the heater and the power supply.
- Check to make sure the M501-TRS cooling fan is operating properly and that the instrument is properly ventilated. Poor ventilation can cause the M501-TRS' thermal switch to turn off the converter to prevent overheating.
- Check to make sure that the thermal switch and heater control relay are operating properly.

## 11.3. Other Performance Problems

### 11.3.1. Excessive noise

In addition to the causes listed in the *Excessive noise* section in the T101 Manual (PN 07266), an excessively noisy TRS measurement can be caused by hysteresis or fluctuations in the temperature of the TRS converter oven in the M501-TRS. If this is the case, perform the autotune procedure described in Section 7.4. of this addendum.

## 11.4. Subsystem Checkout

In addition to the information contained in the *Subsystem Checkout* section in the T101 Manual - PN 07266, the following diagnostic procedures are useful for troubleshooting and diagnosing problems with your T102 and M501-TRS.

### 11.4.1. Checking the Efficiency of the M501-TRS SO<sub>2</sub> Scrubber

See Section 9.1.1.2 of this addendum

### 11.4.2. Checking the Efficiency of the M501-TRS TRS → SO<sub>2</sub> Converter

To check to see if your TRS → SO<sub>2</sub> converter is operating properly:

1. Set the analyzer to TRS measurement mode (see the *Setting the Gas Measurement* section in the T101 Manual - PN 07266).
2. Bypass the scrubber inside the M501-TRS.
  - a. Unscrew the pneumatic fittings from the scrubber.
  - b. Connect them with a stainless steel or Teflon<sup>®</sup> union.

3. Supply a gas with a known concentration of SO<sub>2</sub> to the sample gas inlet of the analyzer.
4. Wait until the analyzer's output concentration measurement stabilizes. This can be determined by setting the analyzer's display to show the **TRS STB** test function (see the *Test Functions* section in the T101 Manual - PN 07266). **TRS STB** should be **0.5 ppb** or less before proceeding.
5. Record the stable SO<sub>2</sub> concentration (although the concentration is labeled TRS, we are measuring SO<sub>2</sub>).
6. Supply a gas with a concentration of H<sub>2</sub>S equal to that of the SO<sub>2</sub> gas used in steps 2 through 5 above, to the sample gas inlet of the analyzer.
7. Wait until the analyzer's output concentration measurement stabilizes. This can be determined by setting the analyzer's display to show the **TRS STB** test function (see Section 6.2.1 of the T101 manual). **TRS STB** should be **0.5 ppb** or less before proceeding.
8. Record the stable TRS concentration.
9. Divide the TRS concentration by the SO<sub>2</sub> concentration.

EXAMPLE: If the SO<sub>2</sub> and TRS concentration of the two test gases used is 500 ppb:

Measured SO <sub>2</sub> concentration	=	499.1 ppb
Measured TRS concentration	=	490.3 ppb
Converter Efficiency	=	490.3 ÷ 499.1
Converter Efficiency	=	0.982 (98.2%)

10. If TRS → SO<sub>2</sub> converter efficiency is below 90% check for one of the following possible causes:
- **Pneumatic leak**
    - Perform a leak check (with the M501-TRS connected) as described in the *Detailed Pressure Leak Check* section in the T101 Manual - PN 07266.
  - **Plugged or constricted pneumatic flow**
    - Perform a sample flow check as described in the *Performing a Sample Flow Check* section in the T101 Manual - PN 07266. This tests the entire system
    - Disconnect the gas feed line from the **FROM ANALYZER** port of the M501-TRS. Attach the flow meter to the port and repeat the test. Isolates the portions of the pneumatic system down stream from the TRS → SO<sub>2</sub> switching valve but includes the M501-TRS in the flow test.
    - Attach the flow meter to the **FROM CONVERTER** port at the back of the T102. Retest. This bypasses M501-TRS during the flow test.
  - **Improper Set point temperature**
    - Call Teledyne API's Technical Support for advice.
  - **Incorrect/wrong concentration Span Gas used in efficiency test**
    - Independently verify the concentration of the span gas.
  - **Contaminants in the converter chamber, pneumatic lines**
    - Sometimes contaminants such as tiny particles of scrubber material from the M501-TRS' SO<sub>2</sub> scrubber can get into the converter tube and react with the TRS → SO<sub>2</sub> conversion process. This can occur if the filter material inside the scrubber lets any particulates through.
    - Call TAPI Technical Support for instructions on cleaning the converter tube and M501-TRS pneumatic lines.

## 11.5. Additional Repair Procedures

The following repair procedures are in addition to those listed in the *Repair Procedures* section in the T101 Manual - PN 07266,



## 11.5.1. UV Lamp Adjustment and/or Replacement

There are three ways in which ambient conditions can affect the UV Lamp output and therefore the accuracy of the TRS concentration measurement: lamp power supply failing, lamp aging, and lamp positioning.

### Lamp Power Supply Failing

If the UV lamp power supply begins to fail, it can cause the UV lamp value to decrease in its output. Ensure the Lamp driver board has a Yellow Dot on the board. If it doesn't, contact TAPI Technical Support for a replacement board.

### Lamp Aging

Over a period of months, the UV energy will show a downward trend, usually 30% - 50% in the first 90 days, and then a slower rate, until the end of useful life of the lamp. Periodically running the UV lamp calibration routine (see the *Lamp Calibration* section in the T101 Manual - PN 07266) will compensate for this until the lamp output becomes too low to function at all, 2-3 years nominally.

### Lamp Positioning

The UV output level of the lamp is not even across the entire length of the lamp. Some portions of the lamp shine slightly more brightly than others. At the factory the position of the UV lamp is adjusted to optimize the amount of UV light shining through the UV filter/lens and into the reaction cell. Changes to the physical alignment of the lamp can affect the analyzer's ability to accurately measure SO<sub>2</sub>.

### 11.5.1.1. Adjusting the UV Lamp (*Peaking the Lamp*)



**CAUTION:**  
**ALWAYS wear UV-Protective, Safety Glasses when working with the UV Lamp Assembly**

1. Set the analyzer display to show the signal I/O function, **UVLAMP\_SIGNAL** (see the *Using the Diagnostic Signal I/O Function* section in the T101 Manual - PN 07266). **UVLAMP\_SIGNAL** is function 35.
2. Slightly loosen the large brass thumbscrew located on the shutter housing (see Figure 11-1) so that the lamp can be moved.
3. While watching the **UVLAMP\_SIGNAL** reading, slowly rotate the lamp or move it back and forth vertically until the **UVLAMP\_SIGNAL** reading is at its maximum.

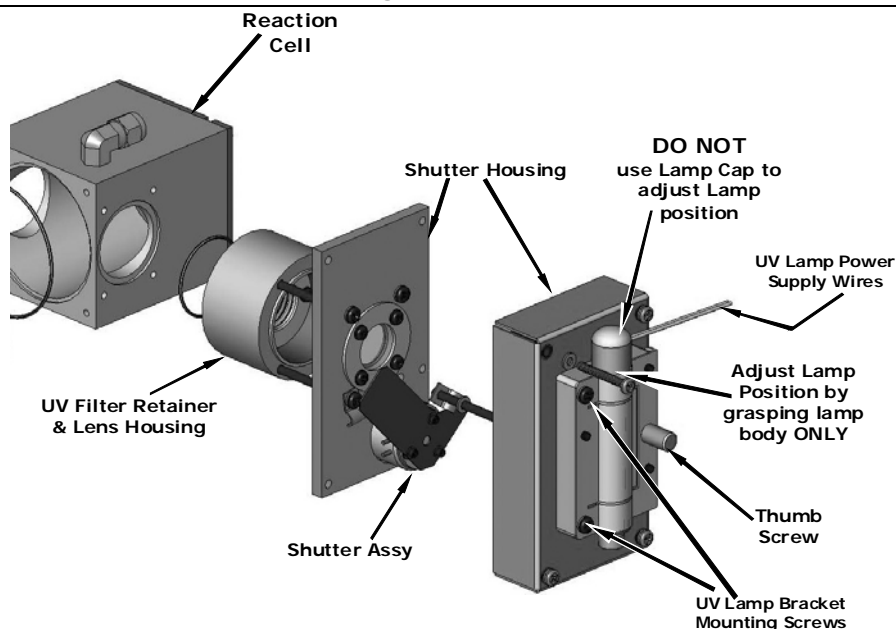
**NOTE:**  
**DO NOT grasp the UV lamp by its cap when changing its position (see Figure 11-1). Always grasp the main body of the lamp.**

Ideally, the reading should be 3500mV±200mV.

- If **UVLAMP\_SIGNAL** is lower than 600mV, replace the lamp.
- If **UVLAMP\_SIGNAL** is greater than 3800 mV, adjust the pot on the UV reference board down until the output reads 3500 mV, and then continue to peak the lamp.

- Finger tighten the thumbscrew.

**NOTE:**  
**DO NOT over-tighten the thumbscrew.**



**Figure 11-1. Shutter Assembly - Exploded View**

### 11.5.1.2. Replacing the UV Lamp

- Turn off the analyzer.
- Disconnect the UV lamp from its power supply.  
You can find the power supply connector by following the two UV Lamp power supply wires from the lamp to the power supply.
- Loosen, but do not remove the two UV lamp bracket screws, and the large brass thumbscrew located on the shutter housing (see Figure 10-1) so that the lamp can be moved.

**NOTE:**  
**DO NOT grasp the UV lamp by its cap when changing its position (see Figure 10-1). Always grasp the main body of the lamp.**

- Remove the UV Lamp by pulling it straight up.
- Insert the new UV lamp into the bracket.
- Tighten the two UV lamp bracket screws, but leave the brass thumb screw un-tightened.
- Connect the new UV lamp to the power supply.
- Turn the instrument on and perform the UV adjustment procedure as defined in Section 11.5.1.1 of this addendum
- Finger tighten the thumbscrew.

**NOTE:**  
**DO NOT over-tighten the thumbscrew.**

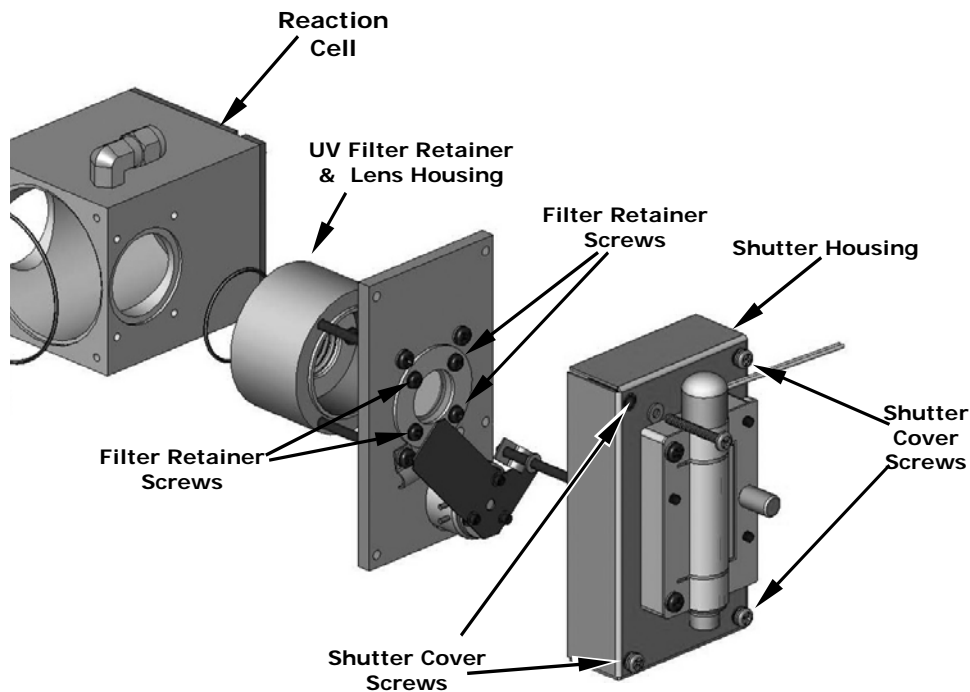
10. Perform a lamp calibration procedure (see the Lamp Calibration Section in T101 Manual - PN 07266) and a zero point and span point calibration (see the Calibration Procedures section in the T101 Manual - PN 07266).

### 11.5.2. Replacing the UV Filter/Lens

**NOTE:**

**Be careful not to leave thumbprints on the interior of the sample chamber. The various oils that make up fingerprints fluoresce brightly under UV light and will significantly affect the accuracy of the analyzer's SO<sub>2</sub> measurement)**

1. Turn off the instrument's power and remove the power cord from the instrument.
2. Unplug the J4 connector from the motherboard to allow tool access.
3. Remove 4 screws from the shutter cover (see Figure 11-2) and remove the cover.
4. Remove 4 screws from the UV filter retainer (see Figure 11-2).

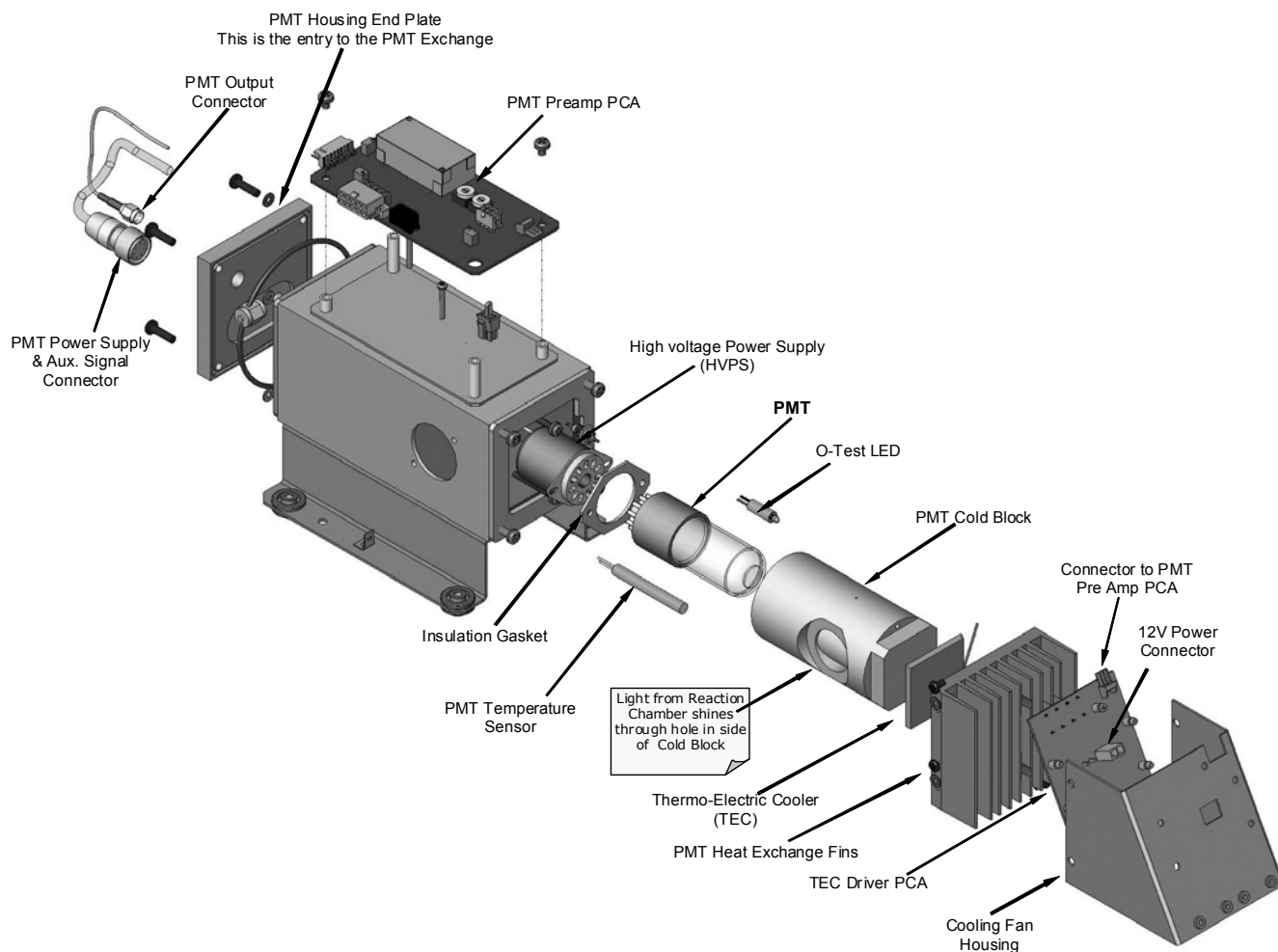


**Figure 11-2. Disassembling the Shutter Assembly**

5. Carefully remove the UV filter.

6. Install the UV filter. Handle carefully and never touch the filter's surface. The UV filter's wider ( ring ) side should be facing out. Install the UV filter retainer and tighten screws.
7. Install the shutter cover and minifit connector. Tighten 4 screws.
8. Re-plug J4 connector into the motherboard.

### 11.5.3. Replacing the PMT, HVPS or TEC



**Figure 11-3. PMT Assembly - Exploded View**

The PMT should last for the lifetime of the analyzer. However, in some cases, the high voltage power supply (HVPS) or the thermo-electric cooler (TEC) may fail.

#### NOTE

**Any time that the black PMT housing end plate cover for the Sensor Assembly is removed, always replace the 5 desiccant bags inside the housing.**

To replace the PMT, the HVPS or the TEC:

1. Power down the analyzer, disconnect the power cord, remove the cover and disconnect all pneumatic and electrical connections from the sensor assembly.
2. Remove the entire sensor module assembly from the analyzer.
3. Remove the reaction cell assembly.
4. Remove the two connectors (PMT Output Connector and the PMT Power Supply and Aux. Connector) on the PMT housing end plate facing towards the front panel.
5. Remove the end plate itself (4 screws with plastic washers).
6. Remove and discard all of the desiccant bags inside the PMT housing end plate.
7. Along with the plate, slide out the OPTIC TEST (O-Test) LED and the thermistor (PMT Temperature Sensor).

The thermistor will be coated with a white, thermal conducting paste. Do not contaminate the inside of the housing or the PMT tube with this paste.

8. Unscrew the PMT assembly. It is held to the cold block by two plastic screws.

Because the threads of the plastic screws are easily damaged it is highly recommended to use new screws when reassembling the unit.

9. Carefully take out the assembly consisting of the HVPS, the insulation gasket and the PMT.
10. Change the PMT or the HVPS or both, clean the PMT glass tube with a clean, anti-static wipe and do not touch it after cleaning.
11. If the cold block or TEC is to be changed disconnect the TEC driver board from the preamplifier board.
  - a. Remove the cooler fan duct (4 screws on its side) including the driver board.
  - b. Disconnect the driver board from the TEC and set the sub-assembly aside.
  - c. Remove the end plate with the cooling fins (4 screws) and slide out the PMT cold block assembly, which contains the TEC.
  - d. Unscrew the TEC from the cooling fins and the cold block and replace it with a new unit.
12. Re-assemble the TEC subassembly in reverse order.

**CAUTION**

**The thermo-electric cooler needs to be mounted flat to the heat sink. If there is any significant gap, the TEC might burn out. Make sure to apply heat sink paste before mounting it and tighten the screws evenly and cross-wise.**

- a. Make sure to use thermal pads between the TEC and the cooling fins as well as between the TEC and the cold block.
  - b. Align the side opening in the cold block with the hole in the PMT housing where the sample chamber attaches.
  - c. Evenly tighten the long mounting screws for good thermal conductivity.
13. Re-insert the TEC subassembly. Make sure that the O-ring is placed properly and the assembly is tightened evenly.
  14. Insert the LED and thermistor into the cold block.
  15. Re-insert the PMT/HVPS subassembly.
    - Ensure to include the gasket between HVPS and PMT.
    - Use new plastic screws to mount the PMT assembly on the PMT cold block.

**NOTE**

Use extreme care to not cross-thread the screws or they will break off in the cold block assembly.

16. Insert the new desiccant bags.
17. Carefully replace the end plate.

Make sure that the O-ring is properly in place. Improperly placed O-rings will cause leaks, which – in turn – cause moisture to condense on the inside of the cooler causing the HVPS to short out.
18. Reconnect the cables and the reaction cell.

Be sure to tighten these screws evenly.
19. Replace the sensor assembly into the chassis and fasten with four screws and washers.
20. Reconnect all electrical and pneumatic connections, leak check the system and power up the analyzer. Verify the basic operation of the analyzer using the ETEST and OTEST features (see the *Optic Test* and *Electrical Test* sections in the T101 Manual - PN 07266) or by measuring calibrated zero and span gases.
21. Perform a PMT Hardware calibration (see the *Factory Cal (PMT Sensor, Hardware Calibration)* section in the T101 Manual - PN 07266)

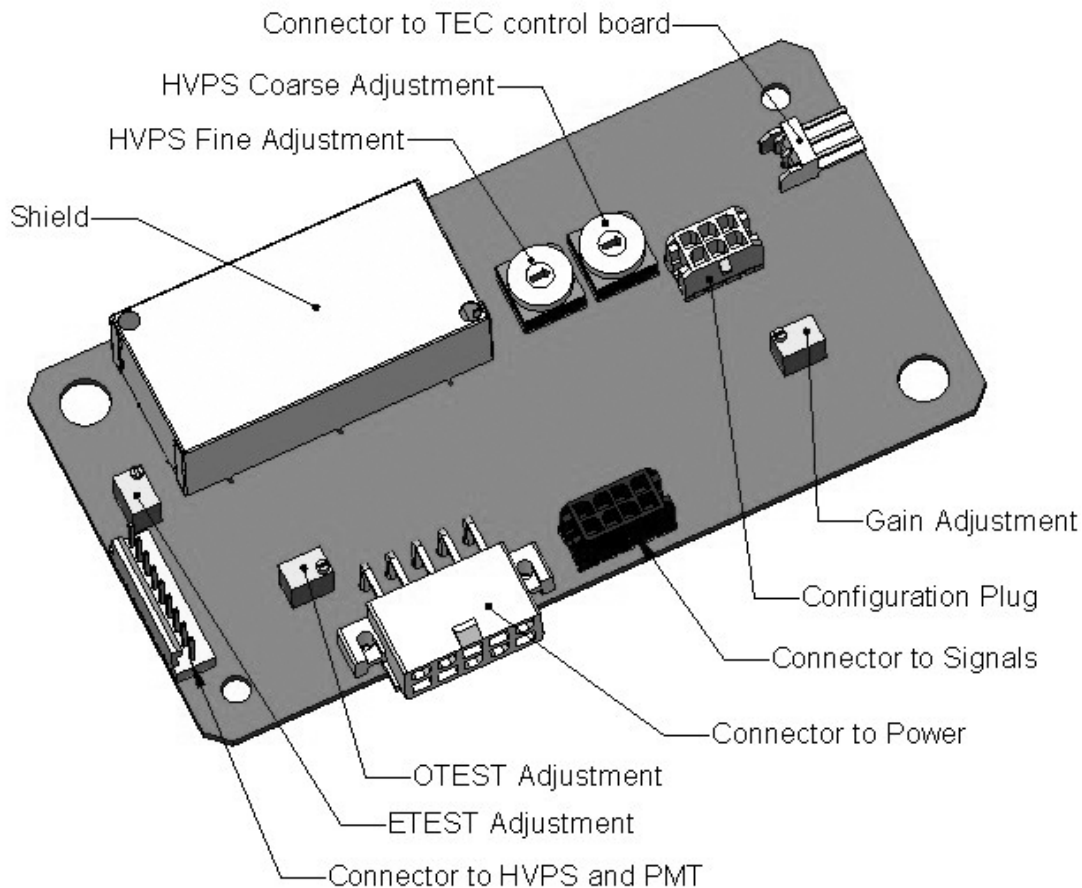
22. Perform a zero point and span calibration (see the *Calibration Procedures* section in the T101 Manual - PN 07266)

#### 11.5.4. T102 PMT Hardware Calibration (FACTORY CAL)

This procedure supersedes the one contained in the *Factory Cal (PMT Sensor, Hardware Calibration)* section in the T101 Manual - PN 07266.

The sensor module hardware calibration adjusts the slope of the PMT output when the Instruments slope and offset values are outside of the acceptable range and all other more obvious causes for this problem have been eliminated.

1. Set the instrument reporting range to **SNGL** and 500 ppb (see the *Single Range Mode (SNGL)* section in the T101 Manual - PN 07266)
2. Perform a full zero-point calibration using zero air (see the *Calibration Procedures* section in the T101 Manual - PN 07266).
3. Let the instrument stabilize by allowing it to run for one hour.
4. Adjust the UV Lamp. (See Section 11.5.1.1 of this addendum)
5. Perform a **LAMP CALIBRATION** procedure (see the *Lamp Calibration* section in the T101 Manual - PN 07266).
6. Locate the Preamp board (see Figure 3-1).
7. Locate the following components on the Preamp board (see Figure 11-4):
  - HVPS coarse adjustment switch (Range 0-9, then A-F)
  - HVPS fine adjustment switch (Range 0-9, then A-F)
  - Gain adjustment potentiometer (Full scale is 10 to 12 turns).



**Figure 11-4. Pre-Amplifier Board Layout**

8. Set the HVPS coarse adjustment to its minimum setting (0).
9. Set the HVPS fine adjustment switch to its maximum setting (F).
10. Turn the gain adjustment potentiometer clockwise to its maximum setting.
11. Set the front panel display to show **TRS STB** (press SAMPLE, TEST, <TST TST>. See Menu Tree in Appendix A of this manual)
12. Feed 400 ppb span gas into the analyzer.

**NOTE**

**If a reporting range other than 500 ppb is used in this procedure:**

**Use a span gas equal to 80% of the reporting range and adjust the PMT to a target NORM PMT value of twice the ppb value of the span gas.**

**EXAMPLE**

**If the reporting range is 800 ppb:**

**Use 640 ppb span gas.**

**Adjust the PMT until NORM PMT equals  $1280 \text{ mV} \pm 10 \text{ mV}$**

13. Wait until the **STB** value is below 0.5 ppb,



14. Scroll to the **NORM PMT** value.
15. Set the HVPS coarse adjustment switch to the lowest setting that will give you more than 1000 mV NORM PMT signal.  
The coarse adjustment typically increments the **NORM PMT** signal in 100-300 mV steps.
16. Adjust the HVPS fine adjustment such that the **NORM PMT** value is at or just above 800 mV.

**NOTE**

**Do not overload the PMT by setting both adjustment switches to their maximum setting. This can cause permanent damage to the PMT.**

17. Continue adjusting the both the coarse and fine switches until **NORM PMT** is as close to 800 mV as possible.
18. Adjust the gain adjustment potentiometer until the NORM PMT value is 800 mV  $\pm$ 10 mV.
19. Perform span and zero-point calibrations (see *Calibration Procedures* section in the T101 Manual - PN 07266) to normalize the sensor response to its new PMT sensitivity.
20. Review the slope and offset values, and compare them to the values in Calibration Data Quality Evaluation Table in the *Calibration Quality* section in the T101 Manual - PN 07266.

## 11.5.5. Replacing the TRS Converter Heating Tube



### CAUTION

**THE CONVERTER TUBE AND HEATER ARE VERY HOT  
DO NOT TOUCH WHILE THE M501-TRS IS OPERATING NOR  
UNTIL IT HAS COOLED TO ROOM TEMPERATURE AFTER  
POWERING OFF THE M501-TRS.**

1. Turn off and remove all power to the M501-TRS
2. Allow it to cool to room temperature before continuing with this replacement procedure. This may take 30 minutes or more.
3. Remove the instrument's top cover (see Section 3.2 of this addendum)
4. Remove the four nuts holding the converter cover in place.
5. Carefully lift the converter cover away.
6. Loosen front and rear pneumatic fittings at each end of the tube and remove the gas lines from the converter tube.
7. Remove the front ceramic bobbin from the converter tube. The thermocouple assembly will come with it.

### NOTE:

#### **Be Careful!**

**The ceramic bobbins at each end of the heater assembly are fragile.**

8. Slide a new tube into the heater coil assembly.
9. Make sure that the thermocouple is slid through its notch on the center hole of the front converter bobbin and properly seated in the corresponding indentation in the body of the quartz heater tube.
10. Reattach the front bobbin onto the converter tube.
11. Reattach the gas lines and retighten the pneumatic fittings.
12. Reassemble the converter cover and reattach the M501-TRS top cover.

### NOTE

**The M501-TRS will not operate properly with the top cover removed.  
The air cooling required to stabilize the temperature of the converter tube is  
dependent on air flow patterns that only exist with the top cover in place.  
Without the top cover in place, the thermal cutout may overheat, and shut the  
heating element off.**

13. Restart the M501-TRS.
14. Check the converter efficiency. See Section 11.4.2 of this addendum.

## 11.5.6. Replacing the Thermocouple

Continuous operation at high temperatures will eventually degrade the performance of the thermocouple used to sense the temperature of the quartz oven. The following instructions provide the necessary information to remove the existing thermocouple from the Converter Heater Block and install the replacement thermocouple supplied in KIT000255 (AKIT, Retrofit, M501TS, TC Type S RPLCMN), which you must obtain from TAPI.

**NOTE:**

**The Type S thermocouple has a red wire and a black wire. If you have any other wire colors, please call Sales for the correct part.**

To get started, you will need the following tools:

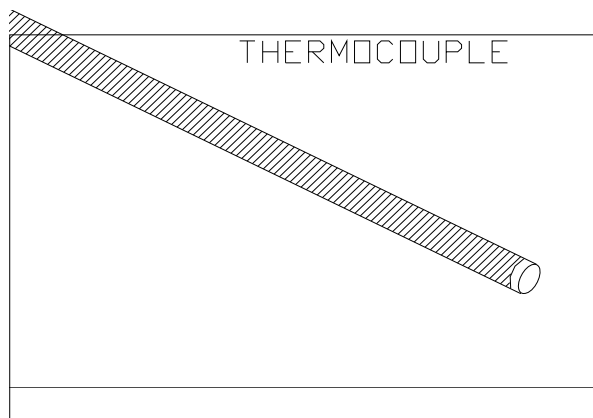
- Nutdriver, 5/16
- Nutdriver, 11/32
- Diagonal Cutter
- Philips head Screwdriver #2

**CAUTION**



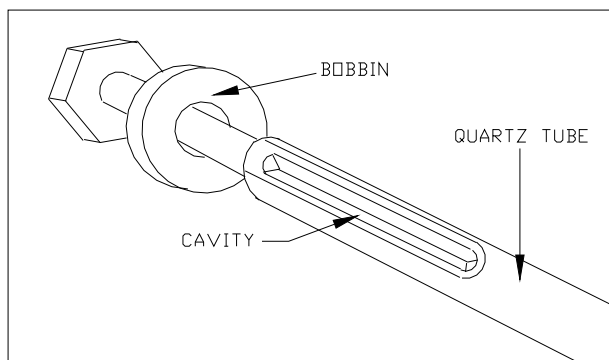
**THE CONVERTER TUBE AND HEATER ARE VERY HOT  
DO NOT TOUCH WHILE THE M501-TRS IS OPERATING NOR UNTIL  
IT HAS COOLED TO ROOM TEMPERATURE AFTER POWERING OFF  
THE M501-TRS.**

1. Turn off and remove all power to the M501TS Converter and allow it to cool to room temperature before continuing with this replacement procedure. This may take 30 minutes or more.
2. Remove the cover from the Converter chassis.
3. Unscrew the (4) nuts that secure the front panel to the chassis. They are located just behind the Front Panel along the top.
4. Lower the Front Panel to gain easier access to the end of the quartz tube.
5. Unscrew the (3) nuts that secure the Heater cover that protects the Heater Block and quartz tube. Remove this cover.
6. Cut the tie-wrap that secures the thermocouple to the fitting at the end of the quartz tube.
7. Loosen the Teflon fitting at the end of the quartz tube taking care not to put any stress on the tube and slide the fitting off the tube.
8. Remove the thermocouple.
9. Disconnect the thermocouple wires from the Temperature Controller.



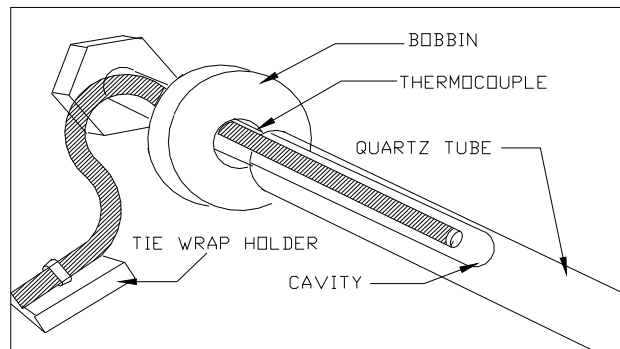
**Figure 11-5. Thermocouple**

10. In preparation for installing the new thermocouple, look into the end of the Heater Block. You will see that there is an indentation (cavity) in the wide part of the quartz tube. This is where the thermocouple you are installing will reside. Refer to Figure 11-6.



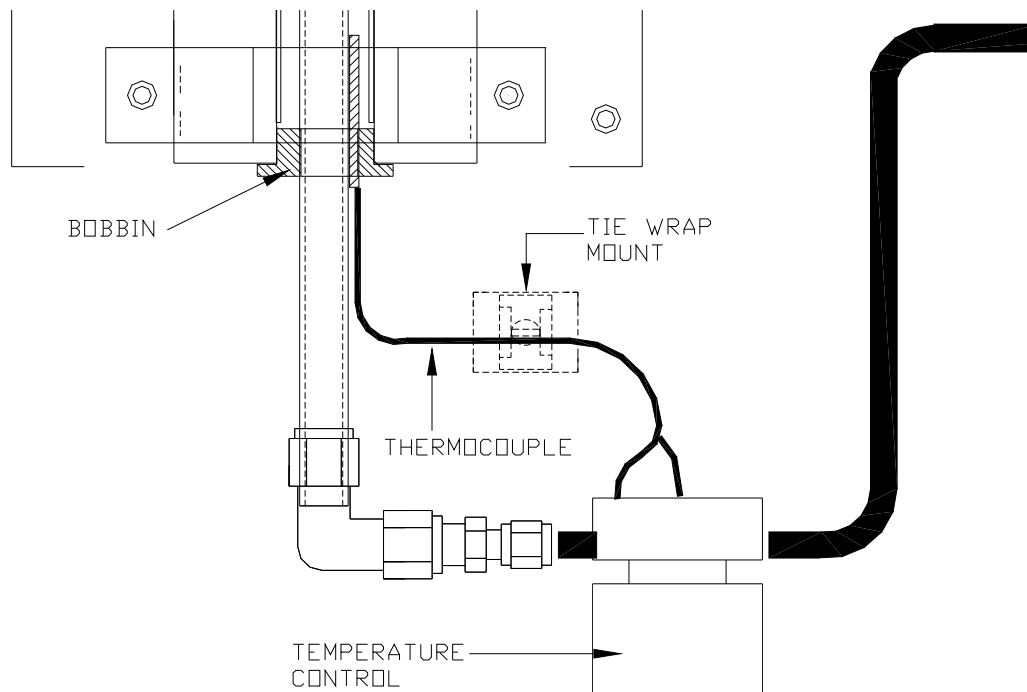
**Figure 11-6. Cavity for Thermocouple**

11. The thermocouple should slide into the Heater Block and into the indentation of the quartz.
12. Align the thermocouple with this cavity and carefully push the thermocouple all the way into the cavity until it comes to a stop, which is the end of the cavity of the quartz tube.
13. Assure the thermocouple is seated flat. If it is not, the quartz tube will have to be replaced (Part #03710000).
14. The thermocouple should now be properly seated in the cavity of the quartz tube. Refer to Figure 11-7.



**Figure 11-7. Thermocouple Installed**

15. Reconnect the Teflon fitting that was removed earlier from the end of the quartz tube. Take care not to put any stress on the quartz tube as you tighten Teflon fitting.
16. Clean the chassis where the Tie-Wrap Hold-Down will be placed (alcohol is recommended), and place the Tie-Wrap Hold-Down as shown in Figure 11-8.



**Figure 11-8. Tie-Wrap Hold-Down Location**

17. Form the Thermocouple wire so that it rests in the cavity with little movement.
18. Connect the two wires of the thermocouple to the Temperature Controller. The Black wire should be connected to Pin 1 and the Red wire should be connected to Pin 2. (If the wires are of any other color, STOP. Get the correct part from TAPI Sales or call Technical Support).
19. At this point, all connections have been made, both electrically and pneumatically. A leak check should be performed on the Converter to

- verify that all connections are leak free. If a leak is detected, the leak should be resolved before continuing.
20. Install the inner cover of the Heater Block and secure with the three nuts. Close the Front Panel and secure with the four nuts. Install the top cover on the Converter chassis.
  21. The Converter is now ready for the application of power. You will be looking for an indication from the temperature controller that it is functioning correctly and driving the heater to the desired "set" temperature. Apply power now.
  22. Check the Temp Controller to be sure that it knows which type of Thermocouple it has in it. Follow the directions in Section 7.3 of this manual to be sure that the temp controller is set properly.
  23. After the Converter comes to the regulated temperature, perform the Auto Tune function (see Section 7.4) to tune the Temperature Controller to the new thermocouple. .
  24. After the Auto-Tune process is completed, verify that the "process" temperature is indicating that the desired temperature is stable and being regulated.
  25. The converter is now ready for operation.

## 11.6. Manually Programming the M501-TRS Temperature Controller

### NOTE

**The temperature controller has been programmed at the factory and should not be altered, (except for temperature set point).**

**DO NOT manually alter the PID parameters of the M501-TRS temperature Controller unless directed to do so by TAPI Technical Support personnel.**

In the event that the temperature controller of the M501-TRS must be replaced, some initial programming is required to set the control functions if reprogramming is necessary. The tables in the following section define the approximate initial values for various processes control parameters. Once they are set, perform an autotune procedure as defined in Section 7.4 of this addendum

## 11.6.1. Temperature Controller Primary Menu Parameters

### NOTE

Tables 10-3 and 10-4 show the typical primary P-I-D parameter values for operation on 115V/60Hz with a set value of 850°C.

The P, I and d values may be different for other AC main voltages (call TAPI Technical Support), and will vary somewhat after auto-tuning.

To set these parameters:

1. Open the appropriate menu
  - a. Press the SELECT key once to access the primary menu parameters. The main display will show **P**.
  - b. Press and Hold the SELECT key for 3 seconds to access the primary menu parameters. The main display will show **P-n I**.
2. Use the SELECT, DOWN or 100's UP key to scroll through the primary menu parameters until the appropriate parameter is displayed (see Table 10-3 or Table 10-4).
3. Press the DATA key once. The current value of the parameter will be displayed.
4. To set each digit:
  - a. Press the up-arrow under that digit once. The digit will flash.
  - b. To increment that digit, press and hold the digit until the appropriate number is displayed.
  - c. To decrement that digit press and hold the DOWN key until the appropriate number is displayed.
  - d. To increment/decrement the 1000's digit it is necessary to adjust increment/decrement the 100's digit up and down. Each time the 100's digit passes "0" the 1000s digit will increment or decrement correspondingly.
5. Once the desired value is reached, press the ENT key to store the new set Parameter value.
6. Press the PV/SV mode key to return to operational mode.

**Table 11-3. Temperature Controller – Primary Parameter Settings**

DISPLAY	PARAMETER NAME	SET TO	COMMENTS
<b>P</b>	Proportional Band	<b>11</b>	Sets the bandwidth of the proportional control function to $\pm 11\%$ of full scale
<b>I</b>	Integral time	<b>10</b>	Sets the reaction time for the proportional control function to 10 seconds.
<b>d</b>	Derivative Time	<b>7.7</b>	Sets the reaction time for the derivative control function (which reduces overshoot) to 7.7 seconds.
<b>AL</b>	Low Alarm Limit	<b>950</b>	Sets the low alarm point to 950°C
<b>AH</b>	High Alarm Limit	<b>1050</b>	Sets the high alarm point to 1050°C
<b>TC</b>	Cycle Time	<b>2</b>	Sets the cycle time (which is divided proportionally between On and Off) for 2 seconds. EXAMPLE: for a duty cycle of 25% with a Cycle time of 2 seconds, the controller will turn the heater on for 0.5 seconds every 2 seconds
<b>HYS</b>	Hysteresis	<b>3</b>	Sets the bandwidth of the area around the set point where the controller will not try to change the process value (thereby inducing unnecessary fluctuations) to 3 % of full scale.
<b>AT</b>	Autotune	<b>0 (OFF)</b>	Autotune is OFF
<b>LoC</b>	Parameter Lock	Can be either <b>0</b> <b>1</b> <b>2</b>	All parameters are changeable All parameters are locked The set value can be changed but all other parameters are locked
Ignore any other parameters that may appear.			



**Table 11-4. Temperature Controller – Secondary Parameter Settings**

DISPLAY	PARAMETER NAME	SET TO	COMMENTS
<b>P-n1</b>	OFF	<b>0</b>	Sets the controller to reverse action (hotter temperatures = less heating; lower temperatures = more heating) and turns off the heater should the thermocouple input fail.
<b>P-n2</b>	Input type	(Refer to COMMENTS, this row)	You may have one of three thermocouple Types; the wire colors distinguish which one you have: red & black (Type S): set to 6 red & yellow (Type K): set to 3 red & orange (Type N): set to 12 If replacing the thermocouple, carefully follow the instructions provided in Section 11.5.6.
<b>P-dF</b>	Digital Filter	<b>5</b>	Sets the response time of the digital noise filter to 5 sec.
<b>P-SL</b>	Lower input range limit	<b>40</b>	Sets the lower end of the controller full scale bandwidth to 40°C
<b>P-SU</b>	Upper input range limit	<b>1100</b>	Sets the upper end of the controller full scale bandwidth to 1100°C
<b>P-AL</b>	High Alarm Type	<b>10</b>	Sets the High alarm point to trigger when the process value exceeds the high alarm set point only after the process value rises above the lower limit for the first time after power up
<b>P-AH</b>	Low Alarm Type	<b>10</b>	Sets the Low alarm point to trigger when the process value exceeds the high alarm set point only after the process value rises above the lower limit for the first time after power up
<b>P-An</b>	Alarm Hysteresis	<b>3</b>	Sets the hysteresis bandwidth for both alarm points to 3% of full scale.
<b>P-dP</b>	Decimal Point	<b>0</b>	Sets the decimal point for PV & SV readings to NONE
<b>PUOF</b>	Process variable Offset	<b>0</b>	OFF
<b>SUOF</b>	Set variable Offset	<b>0</b>	OFF
<b>P-F</b>	Celsius/Fahrenheit	<b>C</b>	Sets controller to perform function on Celsius temperature scale.
<b>FUS4</b>	Fuzzy Logic	<b>ON</b>	Turns on the controllers advanced fuzz logic feature which further reduces overshoot and fluctuations.

Ignore any other parameters that may appear.

## 11.7. Technical Assistance

If this addendum and its trouble-shooting / repair sections do not solve your problems, technical assistance may be obtained from TAPI, Technical Support, 9970 Carroll Canyon Road, San Diego, CA 92131-1106. Phone: +1 858 657 9800 or 1-800 324 5190. Fax: +1 858 657 9816. Email: [sda\\_techsupport@teledyne.com](mailto:sda_techsupport@teledyne.com).

Before you contact Technical Support, fill out the problem report form in Appendix C, which is also available online for electronic submission at <http://www.teledyne-api.com/forms/index.asp>.



## **APPENDIX A - Version Specific Software Documentation**

### **APPENDIX A-1: Model 102E Software Menu Trees, Version C.5**

#### **NOTE**

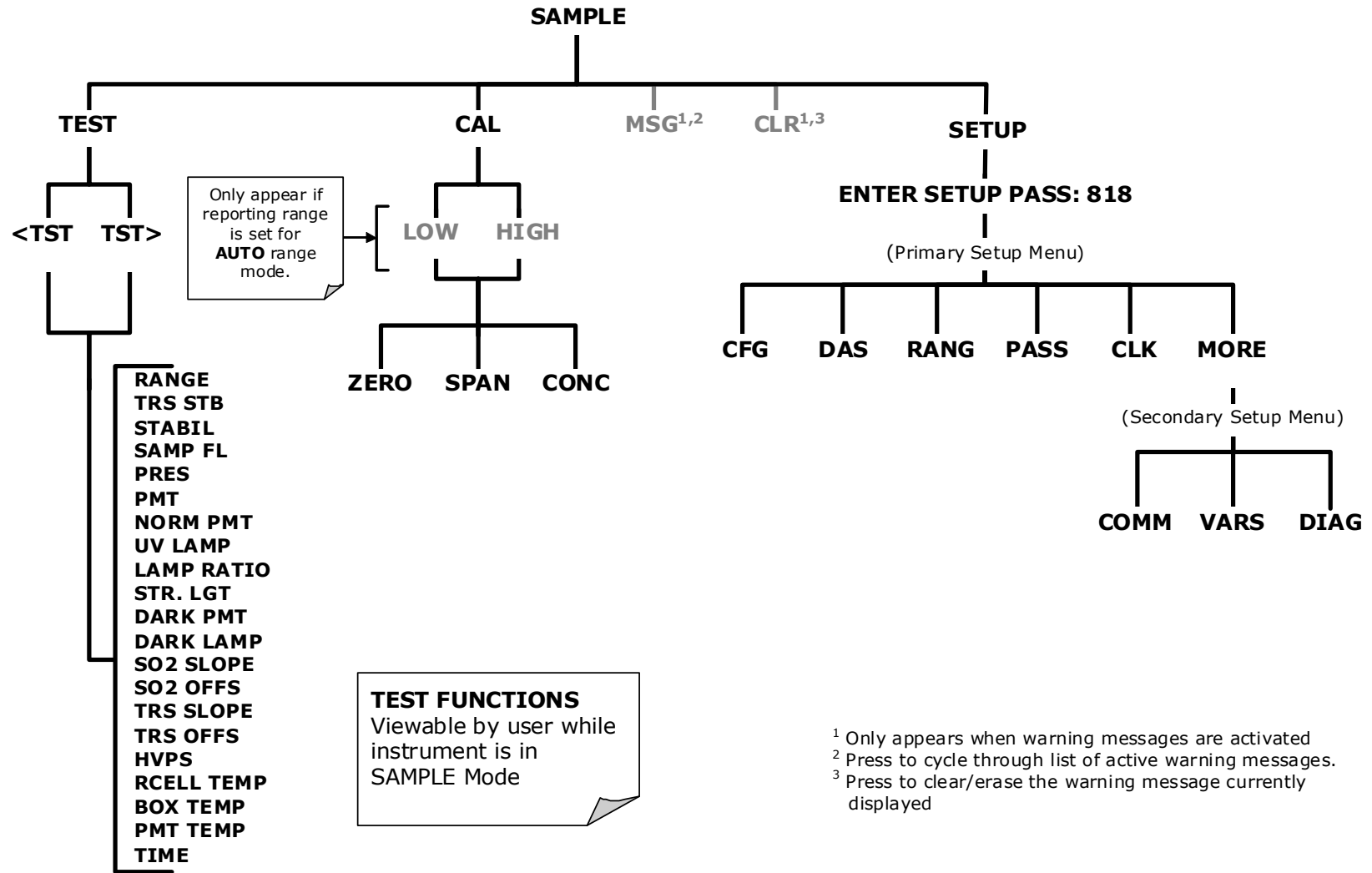
**The menu tree structure for the M102E is identical to that of the M101E, with minor variations for the following menu trees which are included in this appendix:**

Basic Sample Display Menu  
Sample Display Menu for Units with Z/S Valve or IZS Option installed  
HESSEN Submenu  
DIAG Submenu

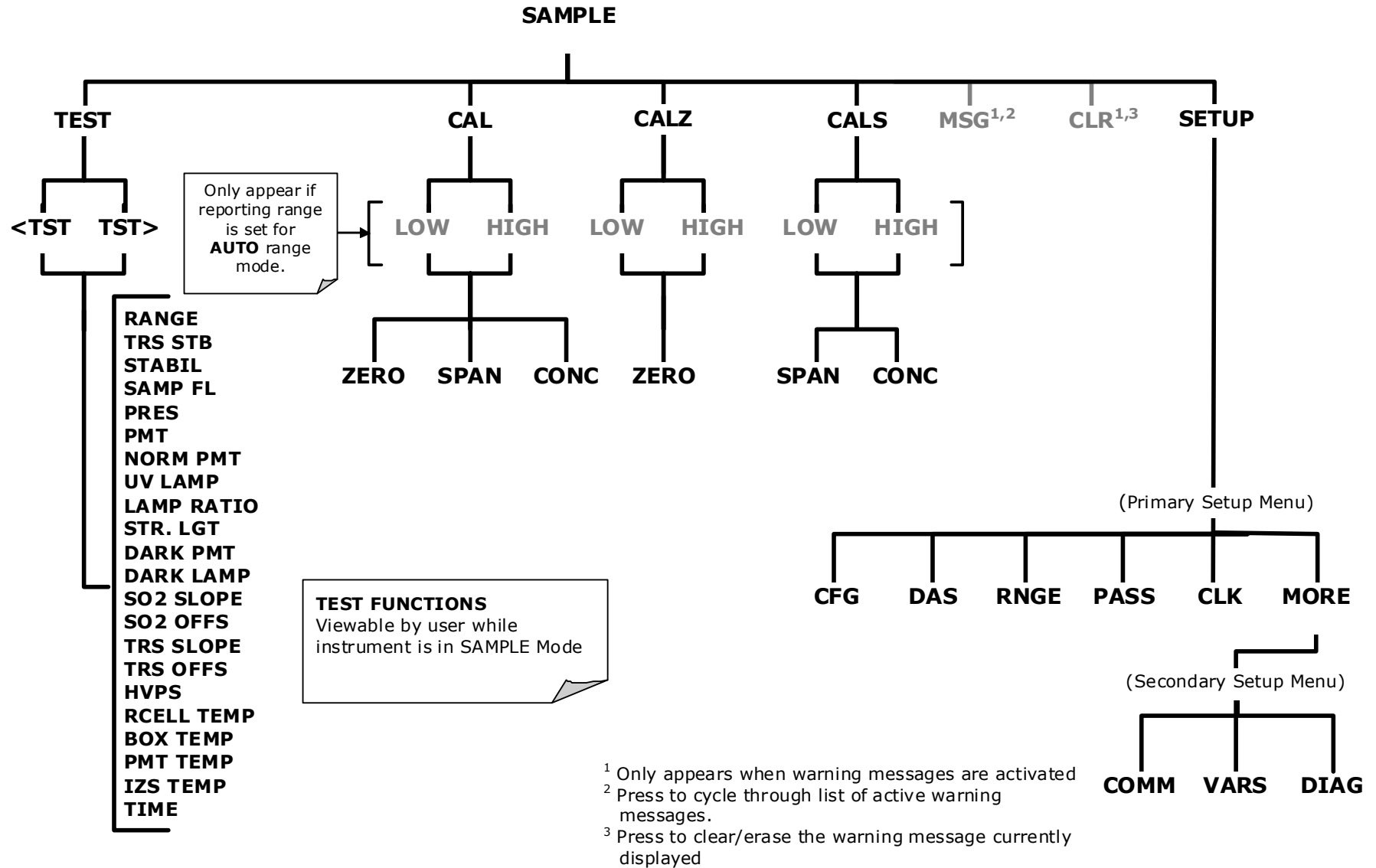
**The remaining menu trees and all related tables can be found in Appendix A of the T101 or 101E Manuals.**



**APPENDIX A-1: M102E Software Menu Trees, Revision A.2**



**Figure A-1: Basic Sample Display Menu**



**Figure A-2: Sample Display Menu - Units with Z/S Valve or IZS Option installed**

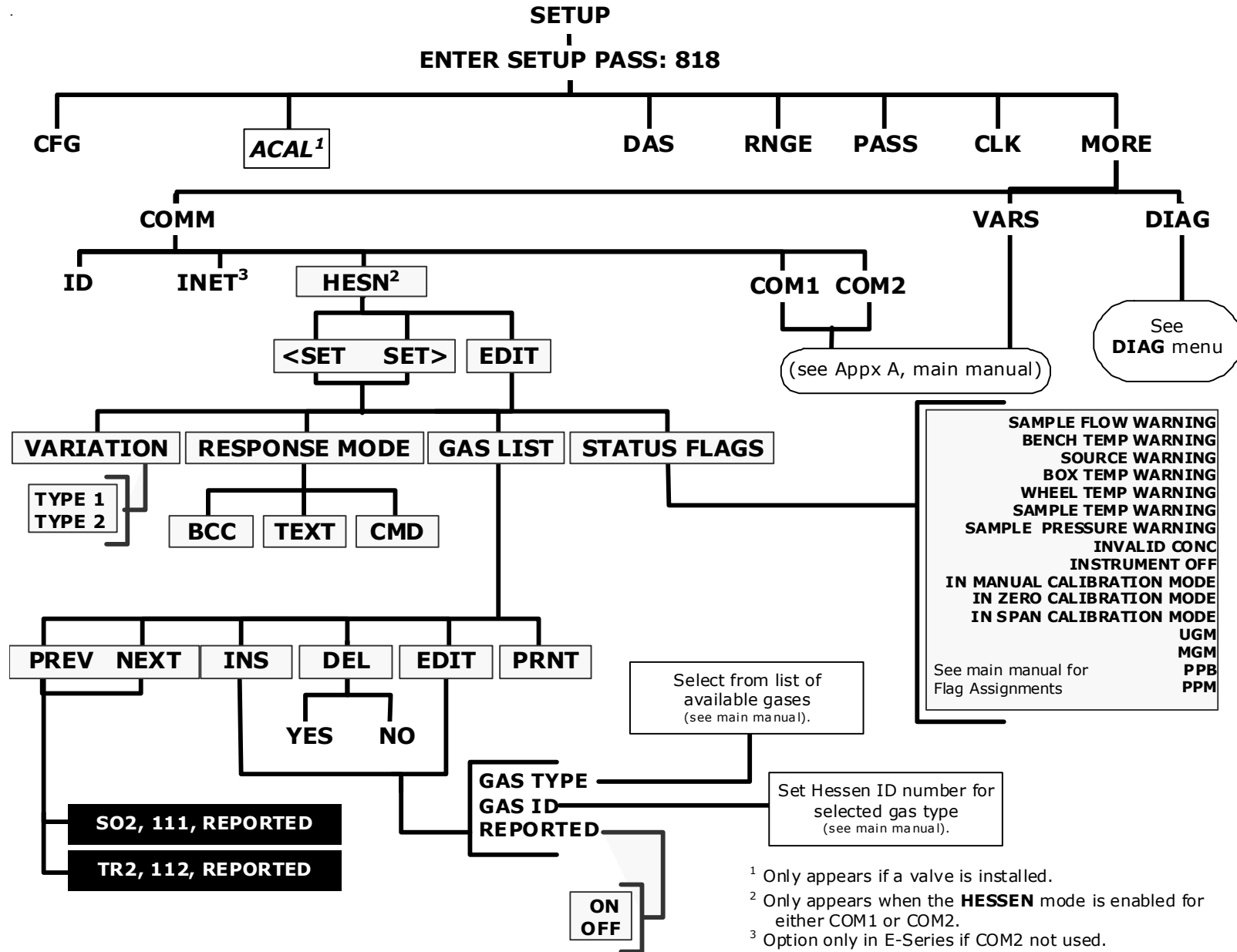
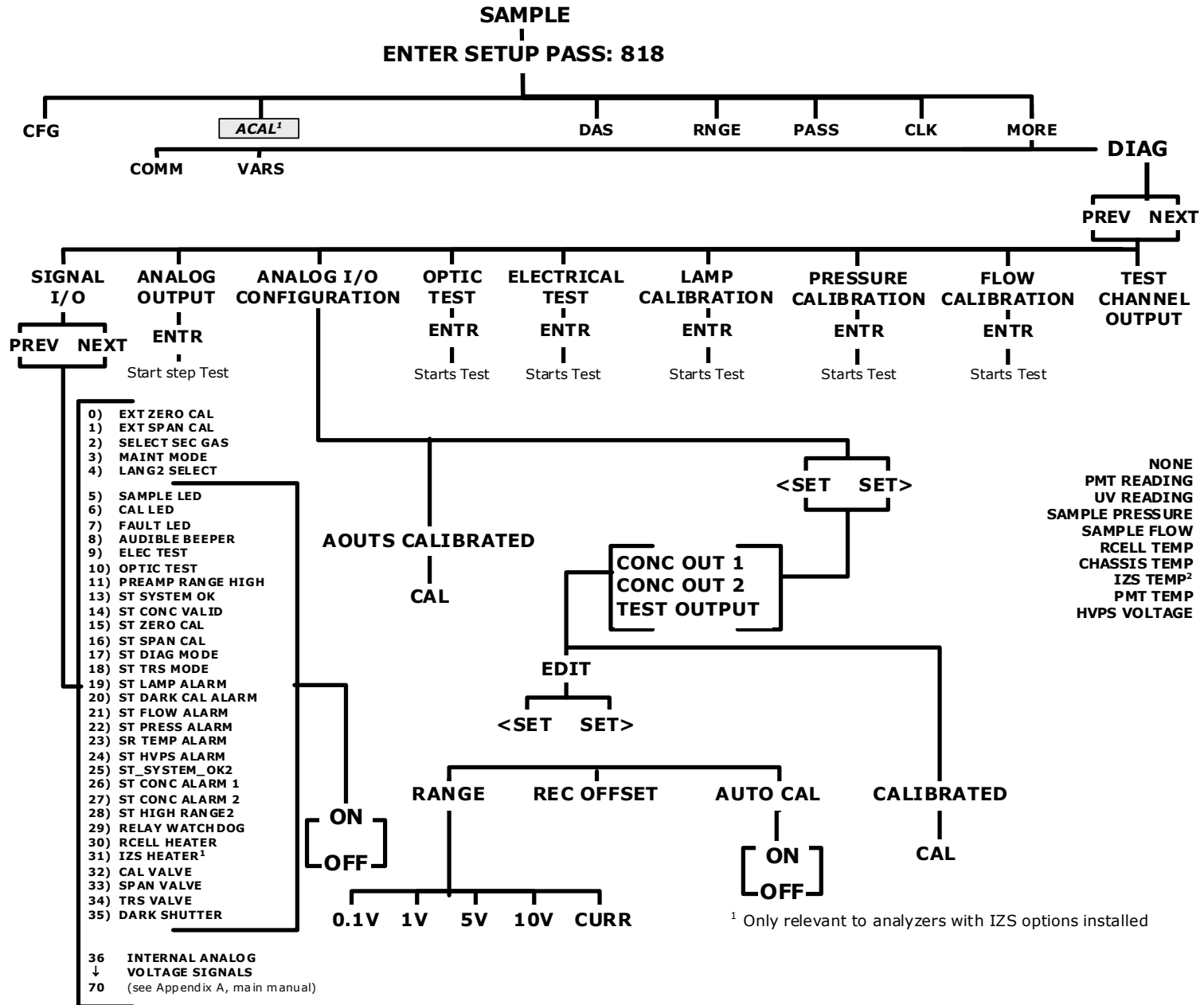


Figure A-3: Secondary Setup Menu - HESSEN Submenu



**Figure A-4: Secondary Setup Menu (DIAG)**



## APPENDIX B - Spare Parts

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**Note** Use of replacement parts other than those supplied by Teledyne Advanced Pollution Instrumentation (TAPI) may result in non-compliance with European standard EN 61010-1.

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**Note** Due to the dynamic nature of part numbers, please refer to the TAPI Website at <http://www.teledyne-api.com> or call Customer Service at 800-324-5190 for more recent updates to part numbers.

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# T102 Spare Parts List

(reference 07349, 01/07/2011)

PARTNUMBER	DESCRIPTION
000940100	CD, ORIFICE, .003 GREEN
000940400	CD, ORIFICE, .004 BLUE
000940800	CD, ORIFICE, .012 (NO PAINT)
002690000	CD, LENS, PL-CON (KB)
002700000	CD, LENS, BI-CON (KB)
002720000	CD, FILTER, 330NM (KB)
003290000	THERMISTOR, BASIC (VENDOR ASSY)(KB)
005960000	AKIT, EXP, 6LBS ACT CHARCOAL (2 BT=1)
009690000	AKIT, TFE FLTR ELEM (FL6 100=1) 47mm
009690100	AKIT, TFE FLTR ELEM (FL6, 30=1) 47mm
011630000	HVPS INSULATOR GASKET (KB)
012720100	OPTION, NOx OPTICAL FILTER *
013140000	ASSY, COOLER FAN (NOX/SOX)
013210000	ASSY, VACUUM MANIFOLD
013390000	ASSY, KICKER
013400000	CD, PMT, SO2, (KB)
013420000	ASSY, ROTARY SOLENOID
013570000	THERMISTOR HOUSING ASSY SOX/NOX(KB)
014080100	ASSY, HVPS, SOX/NOX
014400100	OPTION, ZERO AIR SCRUBBER
014750000	AKIT, EXP KIT, IZS
016290000	WINDOW, SAMPLE FILTER, 47MM (KB)
016300700	ASSY, SAMPLE FILTER, 47MM, ANG BKT
029580000	ASSY, XFMR, 230V/115V 400VA
035710000	ASSY, SCRUBBER
037100000	TUBE, CONVERTER (KB)
037860000	ORING, TEFLON, RETAINING RING, 47MM (KB)
040010000	ASSY, FAN REAR PANEL
040030100	PCA, PRESS SENSORS (1X), w/FM4
041620100	ASSY, SO2 SENSOR (KB)
041800400	PCA, PMT PREAMP, VR
042410200	ASSY, PUMP, INT, SOX/O3/IR *
043570000	AKIT, EXPENDABLES
045230200	PCA, RELAY CARD
046250000	ASSY, RXCELL HEATER/FUSE
046260000	ASSY, THERMISTOR, RXCELL (KB)
048830000	AKIT, EXP KIT, EXHAUST CLNSR, SILCA GEL
049310100	PCA,TEC DRIVER,PMT,(KB)
050510200	PUMP, INT, 115/240V * (KB)
050610100	OPTION, 100-120V/60Hz (KB)
050610200	OPTION, 100-120V/50Hz (KB)
050610300	OPTION, 220-240V/50Hz, (KB)
050610400	OPTION, 220-240V/60Hz (KB)
050630100	PCA, REF DET w/OP20, DUAL OUT
052660000	ASSY, HEATER/THERM, IZS
055100200	ASSY, OPTION, PUMP, 240V *
055560000	ASSY, VALVE, VA59 W/DIODE, 5" LEADS
058021100	PCA, MOTHERBD, GEN 5-ICOP
059220000	THERMOCOUPLE, TYPE S, ALUMINA SHEATH

# T102 Spare Parts List

(reference 07349, 01/07/2011)

PARTNUMBER	DESCRIPTION
061930000	PCA, UV LAMP DRIVER, GEN-2 43mA *
066970000	PCA, INTRF. LCD TOUCH SCRNB, F/P
067240000	CPU, PC-104, VSX-6154E, ICOP *
067300000	PCA, AUX-I/O BD, ETHERNET, ANALOG & USB
067300100	PCA, AUX-I/O BOARD, ETHERNET
067300200	PCA, AUX-I/O BOARD, ETHERNET & USB
067900000	LCD MODULE, W/TOUCHSCREEN(KB)
068220100	DOM, w/SOFTWARE, STD, T100 *
068810000	PCA, LVDS TRANSMITTER BOARD
069500000	PCA, SERIAL & VIDEO INTERFACE BOARD
072150000	ASSY. TOUCHSCREEN CONTROL MODULE
072660000	MANUAL, T101, OPERATORS
072670000	MANUAL,T102, ADDENDUM TO T101
073500100	DOM, w/SOFTWARE, STD, T102 *
CN0000073	POWER ENTRY, 120/60 (KB)
CN0000458	PLUG, 12, MC 1.5/12-ST-3.81 (KB)
CN0000520	PLUG, 10, MC 1.5/10-ST-3.81 (KB)
CP0000035	CONTROLLER, TEMP, FUJI, PXR
FL0000001	FILTER, SS (KB)
FL0000003	FILTER, DFU (KB)
FM0000004	FLOWMETER (KB)
HE0000007	CERAMIC HEATER, 220W@60V
HW0000005	FOOT
HW0000020	SPRING
HW0000030	ISOLATOR
HW0000031	FERRULE, SHOCKMOUNT
HW0000036	TFE TAPE, 1/4" (48 FT/ROLL)
HW0000101	ISOLATOR
HW0000453	SUPPORT, CIRCUIT BD, 3/16" ICOP
HW0000685	LATCH, MAGNETIC, FRONT PANEL
KIT000093	AKIT, REPLCMNT(3187)214NM FLTR (BF)
KIT000095	AKIT, REPLACEMENT COOLER
KIT000207	KIT, RELAY RETROFIT
KIT000213	KIT, RETROFIT, M501TS, TC TYPE N RPLCMNT
KIT000219	AKIT, 4-20MA CURRENT OUTPUT
KIT000236	KIT, UV LAMP, w/ADAPTER (BIR)
KIT000253	ASSY & TEST, SPARE PS37
KIT000254	ASSY & TEST, SPARE PS38
KIT000255	AKIT, RETROFIT, M501TS, TC TYPE S RPLCMN
KIT000261	AKIT, SOX SCRUBBER MATERIAL (CH17), 1oz
OP0000031	WINDOW, QUARTZ, 1/2"DIA, .063" THICK (KB)
OR0000001	ORING, 2-006VT *(KB)
OR0000004	ORING, 2-029V
OR0000006	ORING, 2-038V
OR0000007	ORING, 2-039V
OR0000015	ORING, 2-117V
OR0000016	ORING, 2-120V
OR0000025	ORING, 2-133V
OR0000027	ORING, 2-042V
OR0000039	ORING, 2-012V
OR0000046	ORING, 2-019V

## T102 Spare Parts List

(reference 07349, 01/07/2011)

PARTNUMBER	DESCRIPTION
OR0000083	ORING, 105M, 1MM W X 5 MM ID, VITON
OR0000084	ORING, 2-020V
OR0000094	ORING, 2-228V, 50 DURO VITON(KB)
PU0000022	REBUILD KIT, FOR PU20 & 04241 (KB)
RL0000015	RELAY, DPDT, (KB)
RL0000020	SSRT RELAY, TD2410, CE MARK
SW0000025	SWITCH, POWER, CIRC BREAK, VDE/CE *(KB)
SW0000040	PWR SWITCH/CIR BRK, VDE CE (KB)
SW0000058	SWITCH, THERMAL/450 DEG F(KB)
SW0000059	PRESSURE SENSOR, 0-15 PSIA, ALL SEN
WR0000008	POWER CORD, 10A(KB)

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**Appendix C**  
**Warranty/Repair Questionnaire**  
**T102, M102E, M501 TRS**  
 (05517C DCN5798)



**TELEDYNE**  
 ADVANCED POLLUTION INSTRUMENTATION  
 A Teledyne Technologies Company

Company: \_\_\_\_\_ Contact Name: \_\_\_\_\_

Phone Number: \_\_\_\_\_ Fax Number: \_\_\_\_\_ Email: \_\_\_\_\_

Site Address: \_\_\_\_\_

Can we connect to the instrument? If so, provide IP address or modem #: \_\_\_\_\_

Model Serial Number: \_\_\_\_\_ Firmware revision: \_\_\_\_\_

The serial number can be found on the back of the instrument, the firmware revision is displayed in the upper left corner of the display when pressing SETUP on the front panel (Example: C.3).

1. List all front panel error/warning messages: \_\_\_\_\_

2. Please complete the following table: (Depending on options installed, not all test parameters shown below may be available in your instrument)

PARAMETER	RECORDED VALUE	ACCEPTABLE VALUE	PARAMETER	RECORDED VALUE	ACCEPTABLE VALUE
<b>RANGE</b>	ppb/ppm	50 ppb - 20 ppm	<b>SO2 SLOPE</b>		1.0 ± 0.3
<b>SO2 STB</b>	ppb	≤ 1 ppb with zero air	<b>SO2 OFFS</b>	mV	< 250
<b>TRS STB</b>	ppb	≤ 1 ppb with zero air	<b>TRS SLOPE</b>		1.0 ± 0.3
<b>SAMP FL</b>	cm <sup>3</sup> /min	500 ± 50	<b>TRS OFFS</b>	mV	< 250
<b>PRES</b>	IN-HG-A	~5" < ambient	<b>HVPS</b>	V	400-900
<b>PMT signal with zero air</b>	mV	-20 to 150	<b>RCELL TEMP</b>	°C	50 ± 1
<b>PMT signal at span gas conc</b>	mV ppb/ppm	0-5000 0-20 000 ppb	<b>BOX TEMP</b>	°C	Ambient + ~5
<b>NORM PMT at span gas conc</b>	mV ppb/ppm	0-5000 0-20 000 ppb	<b>PMT TEMP</b>	°C	7 ± 2
<b>UV LAMP</b>	mV	1000 to 4800	<b>IZS TEMP</b>	°C	50 ± 3
<b>UV LAMP RATIO</b>	%	30-120%	<b>ETEST (DIAG menu)</b>	mV	2000 ± 1000
<b>STR. LGT</b>	ppm	≤ 100 ppb/ zero air	<b>OTEST (DIAG menu)</b>	mV	2000 ± 1000
<b>DARK PMT</b>	mV	-50 to 200	<b>TRS CONV TEMP*</b>	°C	800-1000 constant
<b>DARK LAMP</b>	mV	-50 to 200	*on converter assy		

3. Has the analyzer been checked for leaks? Yes  No  For proper flows? Yes  No

4. What are the failure symptoms? \_\_\_\_\_  
 \_\_\_\_\_ Continue on back if necessary

5. Which tests have you done trying to solve the problem? \_\_\_\_\_  
 \_\_\_\_\_ Continue on back if necessary

6. If possible, fax a portion of a strip chart or email a data file to Technical Support.

TECHNICAL SUPPORT CONTACT INFORMATION: 9970 Carroll Canyon Road, 92131-1106  
 PHONE: +1 858 657 9800 or 1-800 324 5190 FAX: +1 858 657 9816  
 EMAIL: sda\_techsupport@teledyne.com





## **APPENDIX D – Wire List and Electronic Schematics**

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# 03404XXX, M501 TRS CONVERTER

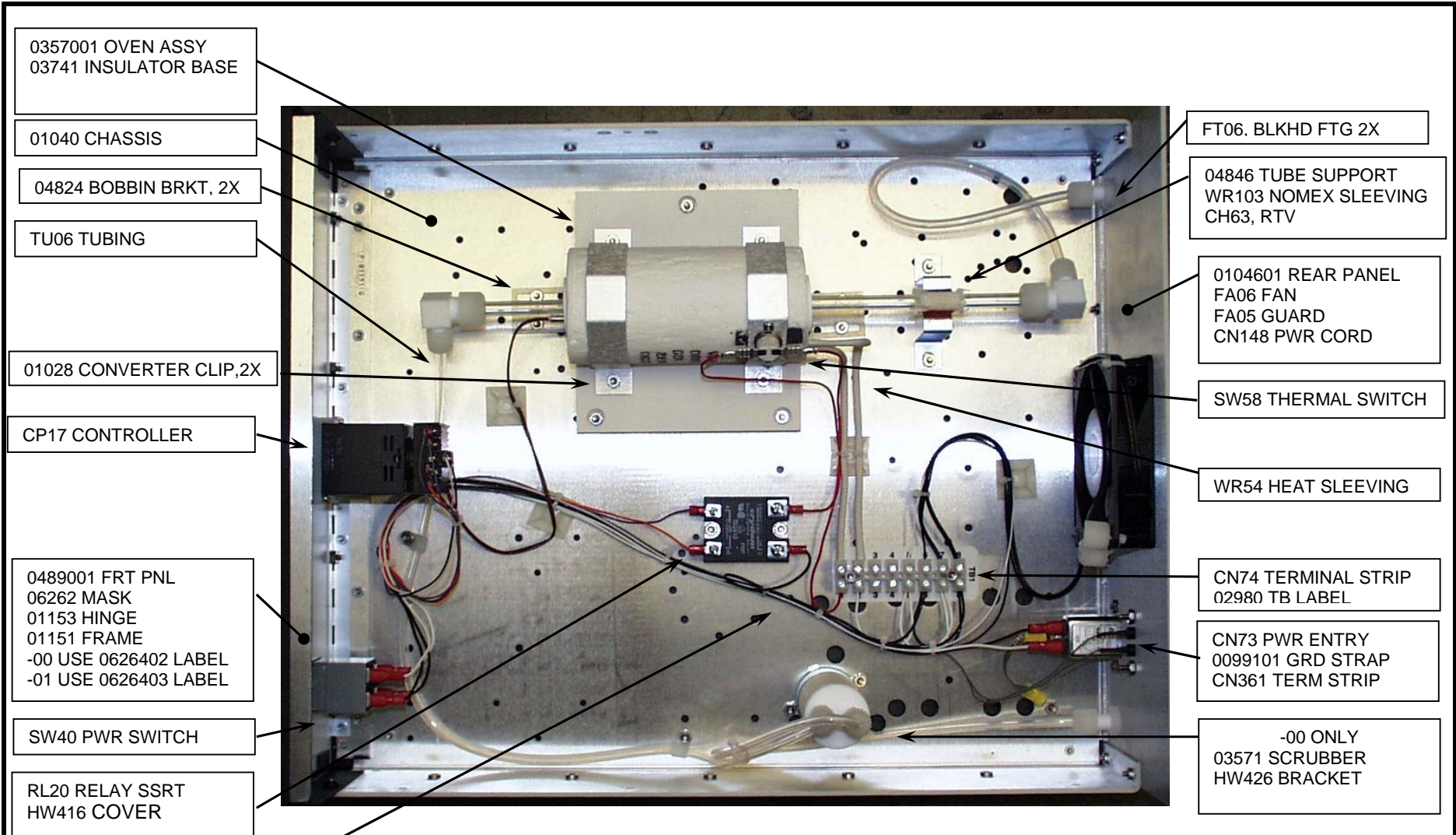
Revision History				
Rev.	Date	DCN	Description	APP
A	5/15/01		Production Release	CB
B	6/16/03	2735	Removed 70V xfmr tap	KV
J	3/24/06	3951	Bumped Drawing Rev match BOM Rev	KV
K	9/22/06	4189	Added Relay Cover & wiring Diagrams	KV
L	9/18/08	5119	Chg'd Power Switch, Merge -00 & -01 Assembly Drawings	KV

Version Table	
Version	Description
0000	M501, TRS, HI TEMP CONVERTER (KB)
0100	M501TS, TOTAL SULFIDES CONVERTER

Option Table	
Number	Description
025170000	FOREIGN POWER
028120000	CE MARK

ASSY, HI-TEMP CONVERTER 501TS/TRS			
<b>Drawn By</b>	KV.	<b>Document</b>	03404
<b>Approved</b>		<b>Revision</b>	L
<b>Created</b>	10/5/05	<b>Date</b>	9/18/08
<b>Page</b>	1	<b>of</b>	3

PRINTED DOCUMENTS ARE UNCONTROLLED



0357001 OVEN ASSY  
03741 INSULATOR BASE

01040 CHASSIS

04824 BOBBIN BRKT, 2X

TU06 TUBING

01028 CONVERTER CLIP, 2X

CP17 CONTROLLER

0489001 FRT PNL  
06262 MASK  
01153 HINGE  
01151 FRAME  
-00 USE 0626402 LABEL  
-01 USE 0626403 LABEL

SW40 PWR SWITCH

RL20 RELAY SSRT  
HW416 COVER

04697 HARNESS

05764 WIRING DIAGRAM

FT06. BLKHD FTG 2X

04846 TUBE SUPPORT  
WR103 NOMEX SLEEVING  
CH63, RTV

0104601 REAR PANEL  
FA06 FAN  
FA05 GUARD  
CN148 PWR CORD

SW58 THERMAL SWITCH

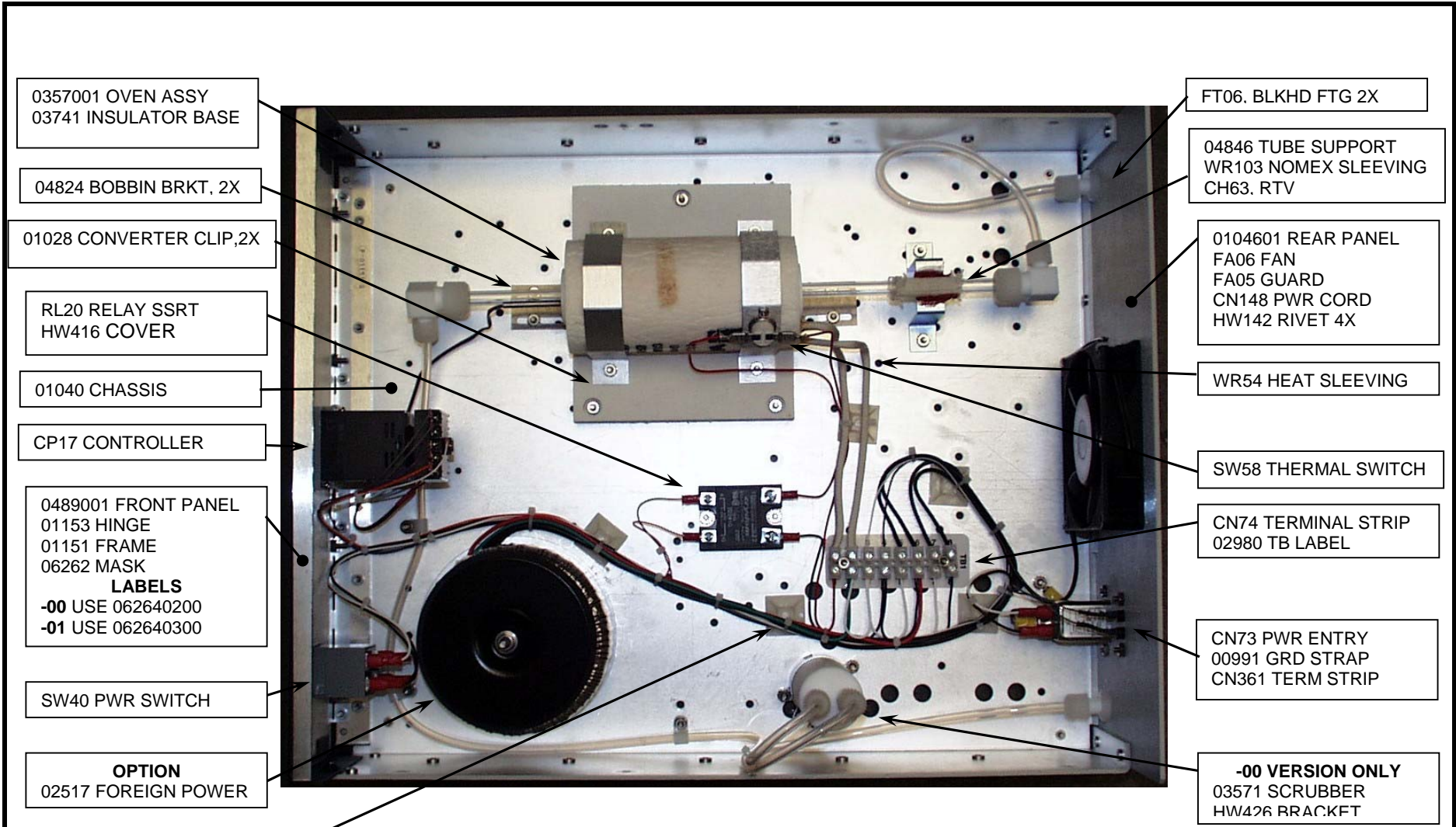
WR54 HEAT SLEEVING

CN74 TERMINAL STRIP  
02980 TB LABEL

CN73 PWR ENTRY  
0099101 GRD STRAP  
CN361 TERM STRIP

-00 ONLY  
03571 SCRUBBER  
HW426 BRACKET

PREPARED BY: K. Valecko	Date: 3/06	Teledyne Instruments, API 9970 Carroll Canyon Road San Diego, California 92131-1106	PRINTED DOCUMENTS ARE UNCONTROLLED
PRODUCT ENGINEER:	Date:		
MANUFACTURING ENGINEER:	Date:	<b>ASSY, HI TEMP CONVERTER</b> <b>M501TRS/TS, 115V</b>	
DOCUMENT CONTROL:	Date:		
File No. 03404.doc	<b>Page 2 of 3</b>	Document Number: <b>03404</b>	REV <b>L</b>



0357001 OVEN ASSY  
03741 INSULATOR BASE

04824 BOBBIN BRKT, 2X

01028 CONVERTER CLIP, 2X

RL20 RELAY SSRT  
HW416 COVER

01040 CHASSIS

CP17 CONTROLLER

0489001 FRONT PANEL  
01153 HINGE  
01151 FRAME  
06262 MASK  
**LABELS**  
-00 USE 062640200  
-01 USE 062640300

SW40 PWR SWITCH

**OPTION**  
02517 FOREIGN POWER

04697 HARNESS

05764 WIRING DIAGRAM

FT06. BLKHD FTG 2X

04846 TUBE SUPPORT  
WR103 NOMEX SLEEVING  
CH63. RTV

0104601 REAR PANEL  
FA06 FAN  
FA05 GUARD  
CN148 PWR CORD  
HW142 RIVET 4X

WR54 HEAT SLEEVING

SW58 THERMAL SWITCH

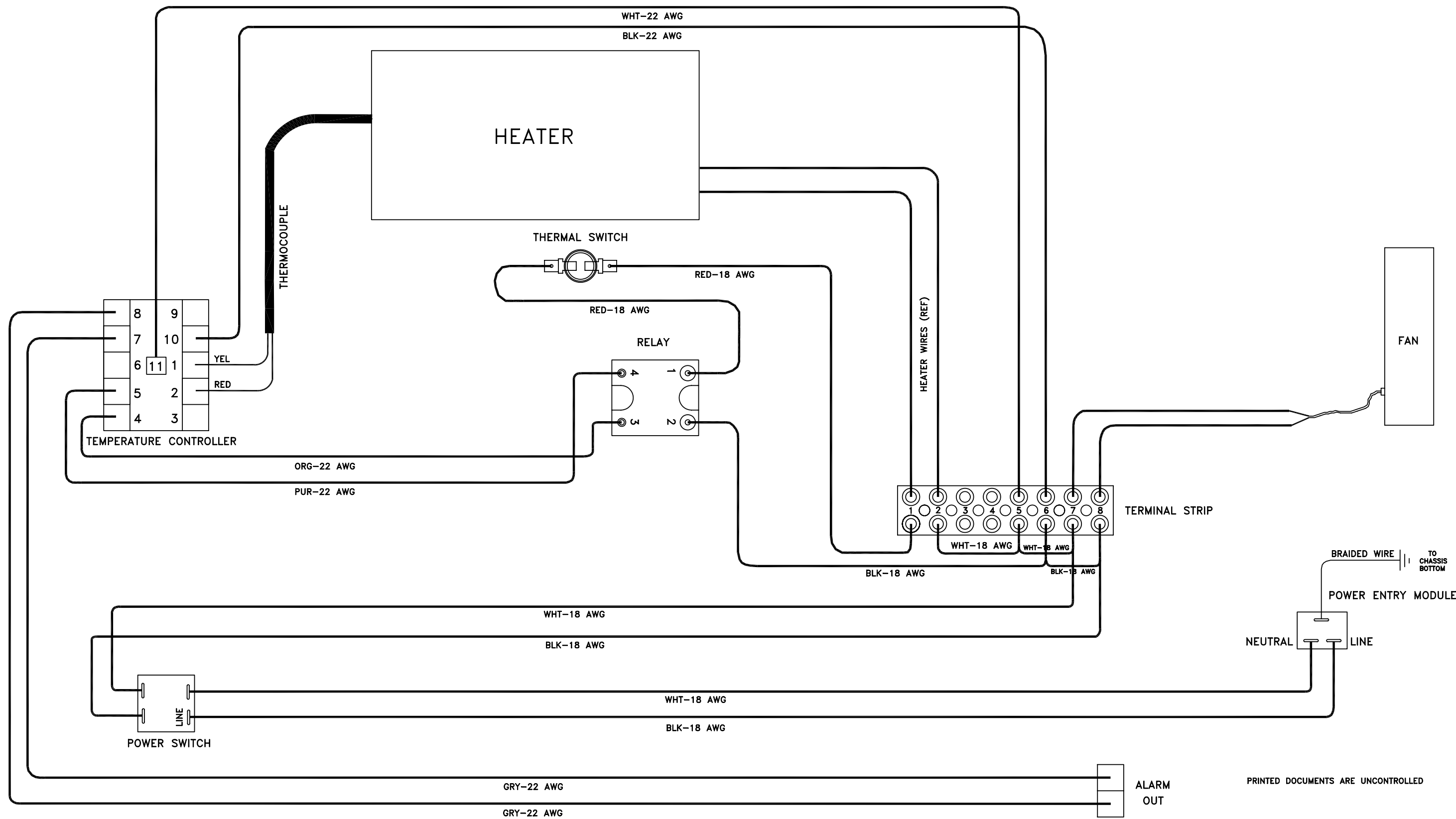
CN74 TERMINAL STRIP  
02980 TB LABEL

CN73 PWR ENTRY  
00991 GRD STRAP  
CN361 TERM STRIP

**-00 VERSION ONLY**  
03571 SCRUBBER  
HW426 BRACKET

PREPARED BY: K. Valecko	Date: 3/06
PRODUCT ENGINEER:	Date:
MANUFACTURING ENGINEER:	Date:
DOCUMENT CONTROL:	Date:
File No. 03404.doc	<b>Page 3 of 3</b>

Teledyne Instruments, API 9970 Carroll Canyon Road San Diego, California 92131-1106	PRINTED DOCUMENTS ARE UNCONTROLLED
<b>ASSY, HI TEMP CONVERTER M501TRS/TS, 230V</b>	
Document Number: <b>03404</b>	REV <b>L</b>



115VAC 50/60Hz

PRINTED DOCUMENTS ARE UNCONTROLLED

8/8/06		4124	A: INITIAL RELEASE		KV
DATE	ECR#	DESCRIPTION OF CHANGE			BY
API		ADVANCED POLLUTION INSTRUMENTATION INC. SAN DIEGO, CA.			
APPROVALS	DATE	WIRING DIAGRAM M501TS, 034040100			
DRAWN		SIZE	DRAWING NDL	REVISION	A
CHECKED		D	05764		
APPROVED		SCALE		SHEET	1 of 2
DO NOT SCALE DRAWING					

