TELEDYNE
ADVANCED POLLUTION INSTRUMENTATION
A Teledyne Technologies Company

INSTRUCTION MANUAL

MODEL 108E/A
Total Sulfides in CO_2 Analyzer

Addendum to M100E Operation Manual (045150100)
OR
Addendum to M100A Instruction Manual (021640000)

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03940 Rev P
DCN 5588
09 December 2009

ABOUT THIS MANUAL

This manual is an addendum that supplements the M100E or the M100A ammonia analyzers; it includes documents as listed below.

Part No.	Name/Description
05477W	M108E Spare Parts List
04357A	M108E Expendables Kit
06210A	M108A Spare Parts List
0187701B	M108A Expendables Kit

NOTE
We recommend that this manual be read in its entirety before any attempt is made to operate the instrument.

REVISION HISTORY

M108E/A Manual, PN 03940

19 Nov 2009, Rev P, DCN[5588]					
	Document	**Part #**	**To Rev**	**DCN**	**Change Summary**
	This manual in its entirety.	03940	P	5588	Table 2-5 – add details to distinguish among different thermocouples. Update instructions for replacing the thermocouple, to distinguish among thermocouple types. Reformat and make general, non-technical edits throughout for clarity. Insert PNs of embedded documents (Spare Parts and Expendables).
	M108E Spare Parts List	05477	W	5494	Insert most recent released
	M108E Expendables	04357	A	4126	Insert most recent released
	M108A Spare Parts List	06210	A	4880	Replace with most recent released
	M108A Expendables	0187710	B	5588	Replace with most recent released

TABLE OF CONTENTS

TABLE OF CONTENTS III
1 WARRANTY 5
1.1 Claims for Damaged Shipments 6
1.2 Claims for Shipping Discrepancies 6
2 INTRODUCTION 7
2.1 Specifications 7
2.1.1 Analyzer Specifications 7
2.1.2 M501TS Converter Specifications 7
2.2 The M108E or M108A Total Sulfides in CO_2 Analyzer 8
2.3 Configurations 8
2.4 The M501TS – Total Reduced Sulfur Converter 12
2.5 Installation 14
2.6 Operation and Calibration 16
2.6.1 CO_2 Source 16
2.7 TS and Zero Air Scrubbers 16
2.8 M501TS Temperature Controller 17
2.8.1 Changing the Temperature Set Point 17
2.8.2 Adjusting the P-I-D Parameters 18
3 TROUBLESHOOTNG 21
3.1 SO_2 Analyzer Maintenance 23
3.2 Changing the Quartz Tube 25
3.3 Checking the Converter Efficiency 25
3.4 Sample Diluter Maintenance 26
3.5 Thermocouple Replacement 26
4 SPARE PARTS 31
4.1 M108E Spare Parts and Expendables Lists 31
4.2 M108A Spare Parts List and Expendables Kit 34
5 INSTRUMENT TEST & CALIBRATION RECORD 37

List of Figures

FIGURE 2-1. M108E (M108A) BASIC CONFIGURATION 9
FIGURE 2-2. M108E (M108A) WITH IZS/PERMEATION TUBE OPTION 10
FIGURE 2-3. M108E (M108A) WITH M702 CALIBRATOR OPTION 11
FIGURE 2-4. M501TS CONVERTER LAYOUT 13
FIGURE 2-5. M108E (M108A) PNEUMATIC CONNECTIONS 15
FIGURE 3-1. M501TS WIRING DIAGRAM 22
FIGURE 3-2. M501TS WIRING DIAGRAM, 220V SYSTEMS 24
FIGURE 3-3. DILUTER FLOW BLOCK ASSEMBLY 26
FIGURE 3-4. THERMOCOUPLE 27
FIGURE 3-5. QUARTZ TUBE CAVITY FOR THERMOCOUPLE 28
FIGURE 3-6. THERMOCOUPLE INSTALLED 28
FIGURE 3-7. TIE-WRAP HOLD-DOWN LOCATION 29

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List of Tables

TABLE 2-1. M501TS CONVERTER SPECIFICATIONS 7
TABLE 2-2 THERMOCOUPLE TYPE DISTINCTIONS 12
TABLE 2-3. TEMPERATURE CONTROLLER – INITIAL SETTINGS 19
TABLE 2-4. TEMPERATURE CONTROLLER - SECONDARY MENU 20
TABLE 4-1. M108E SPARE PARTS LIST 31
TABLE 4-2. M108E EXPENDABLES KIT, PN 04357A 34
TABLE 4-3. M108A SPARE PARTS LIST 34
TABLE 4-4 M108A EXPENDABLES 36

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1 WARRANTY

ADVANCED POLLUTION INSTRUMENTATION DIVISION (T-API) 02024c

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

COVERAGE

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

NON- TELEDYNE API MANUFACTURED EQUIPMENT

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

GENERAL

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

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

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

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

TERMS AND CONDITIONS

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

1.1 Claims for Damaged Shipments

All instruments should be thoroughly inspected immediately upon receipt. Material in the container should be checked against the enclosed packing list. If the contents are damaged and/or the instrument fails to operate properly, the carrier and API should be notified immediately.

The following documents are necessary to support claims:

- Original freight bill and bill of lading
- Original invoices or photocopy of original invoice
- Copy of the packing list
- Photographs of damaged equipment and container
-

1.2 Claims for Shipping Discrepancies

All containers should be checked against packing list immediately upon receipt. If a shortage occurs, notify the carrier and Teledyne API immediately. Teledyne API will not be responsible for shortages against the packing list unless they are reported immediately.

The following information is necessary to make a claim:

- The instrument model number
- Serial number
- Sales order number or purchase order number

Upon receipt of a claim, Teledyne API will advise disposition of the equipment for repair or replacement.

2 INTRODUCTION

The M108E (or M108A) consists of two major assemblies: a modified M100E (or M100A) SO2 analyzer and an M501TS thermal converter. This manual addendum describes the specifics of the M108E configuration and should be used in conjunction with the M100E Manual (p/n 04515). These specifics also apply to the M108A configuration to be used in conjunction with the M100A Manual (p/n 02164).

2.1 Specifications

2.1.1 Analyzer Specifications

The specifications for the SO_2 analyzer are contained in the M100E (or M100A) manual.

2.1.2 M501TS Converter Specifications

Table 2-1. M501TS Converter Specifications

Specification	Value	Unit
Maximum Flow Rate	1000	cc/min
Nominal Flow Rate (CO2)	625	cc/min
Nominal Flow Rate (Air/N2)	450	cc/min
Maximum TS Concentration for specified conversion efficiency	20	ppmv
Minimum Conversion Efficiency (In CO2 matrix) H_2S COS, CS_2	 98 90	%
Least Discernible Level (LDL)	See M100A Manual	
Operating Converter Temperature	1000	˚ C
Maximum Converter Temperature	1050	˚ C
Power	100-120/220-240 VAC 50/60 Hz, 440 watts	
Weight	24 (11)	lbs. (kg)
Dimensions	7 x 17 x 22 (178 x 432 x 559)	inches (mm)

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2.2 The M108E or M108A Total Sulfides in CO_2 Analyzer

The Teledyne API Model 108E (or Model 108A) Total Sulfides in CO_2 Analyzer, is designed to measure mixed sulfur impurities, collectively referred to as Total Sulfides (TS), in carbon dioxide (CO_2) gas. Since there is no SO_2 scrubber in the system, the instrument reading is the sum of the reduced sulfur compounds and SO_2. The M108E (M108A) consists of a modified M100E (M100A) UV Fluorescence SO_2 Analyzer, with special software, and a M501TS high temperature quartz thermal converter.

The M501TS primarily consists of a heated, temperature-controlled quartz tube. Sulfur compounds are heated to approximately 1000 ˚C as they pass through the quartz tube and are converted to SO_2 in the following manner:

$$TS + O_2 \text{ --> } SO_2$$

Since the gas being analyzed is essentially CO_2, which generally contains no oxygen, there is an assembly to add approximately 6% oxygen to the sample before it passes through the converter. This dilution of the sample gas is corrected for by the software and calibration procedure. The added oxygen allows the sulfur compounds to be oxidized to SO_2 making the M108E (M108A) respond to the total number of sulfur molecules in the sample gas. Any SO_2 present in the sample is unaffected by the converter and adds to the measured concentration. The sample gas then passes to a modified M100E (M100A) analyzer where the SO_2 and converted compounds are analyzed as SO_2.

2.3 Configurations

There are three configurations available: the standard and two with options.

The standard unit consists of:

- modified M100E (M100A) Fluorescent SO_2 Analyzer
- M501TS High Temperature Thermal Converter
- External Span, Internal Zero with High-performance Charcoal Scrubber for Zero.

See Figure 2-1 for the pneumatic diagram, and Section 2.4 for details on operation of the M501TS.

Another configuration consists of the standard unit described above plus an Internal Zero/Span (IZS) Option with H_2S permeation tube. The IZS option uses sample gas (passed through a special, high-performance charcoal scrubber) to dilute H_2S from the perm tube for span calibration checks. See Figure 2-2 for the pneumatic diagram.

The third configuration consists of the standard unit described above plus an external M702 calibrator for blending tanks of H_2S span gas with process CO_2. See Figure 2-3 for the pneumatic diagram.

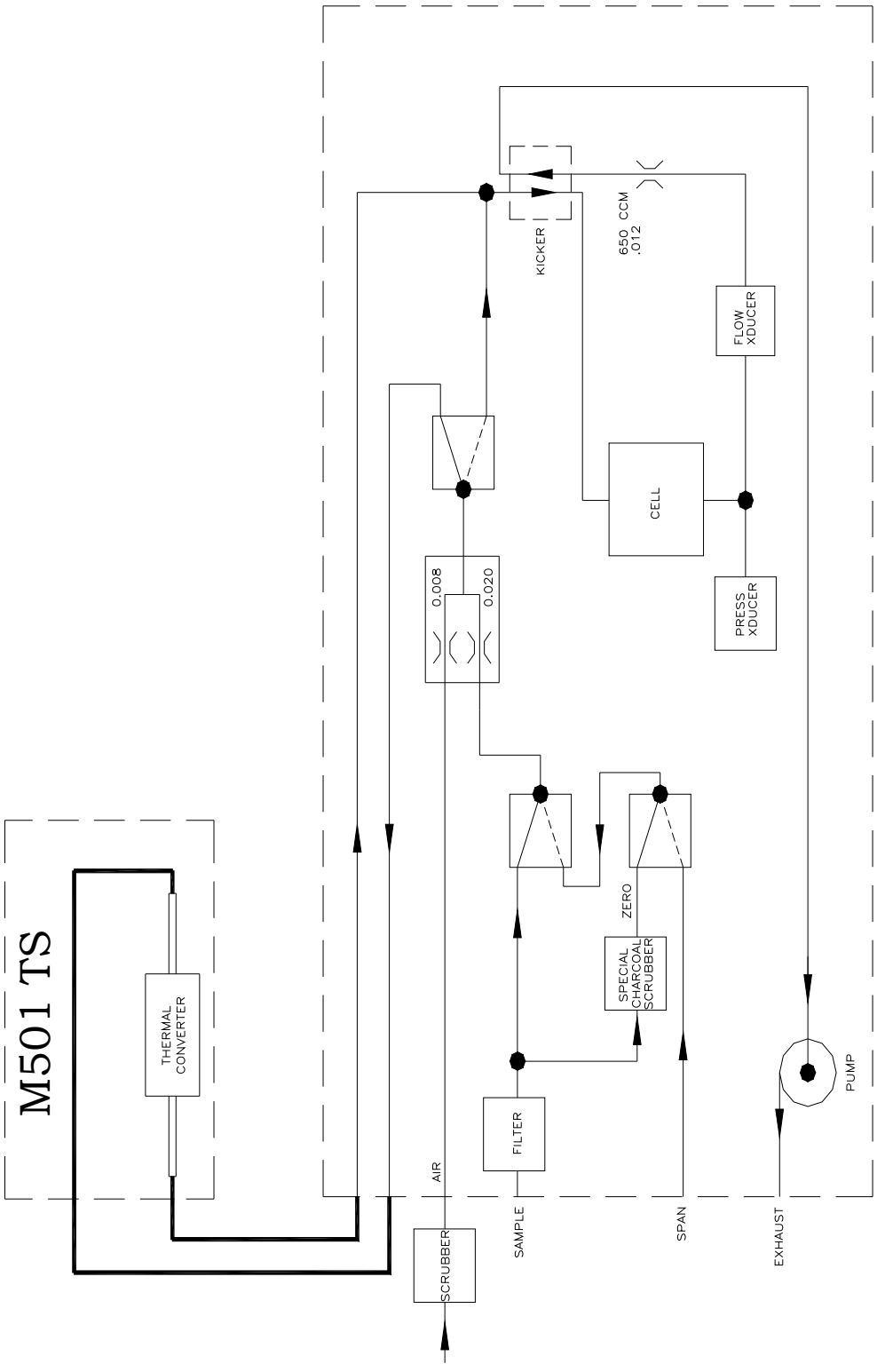


Figure 2-1. M108E (M108A) Basic Configuration

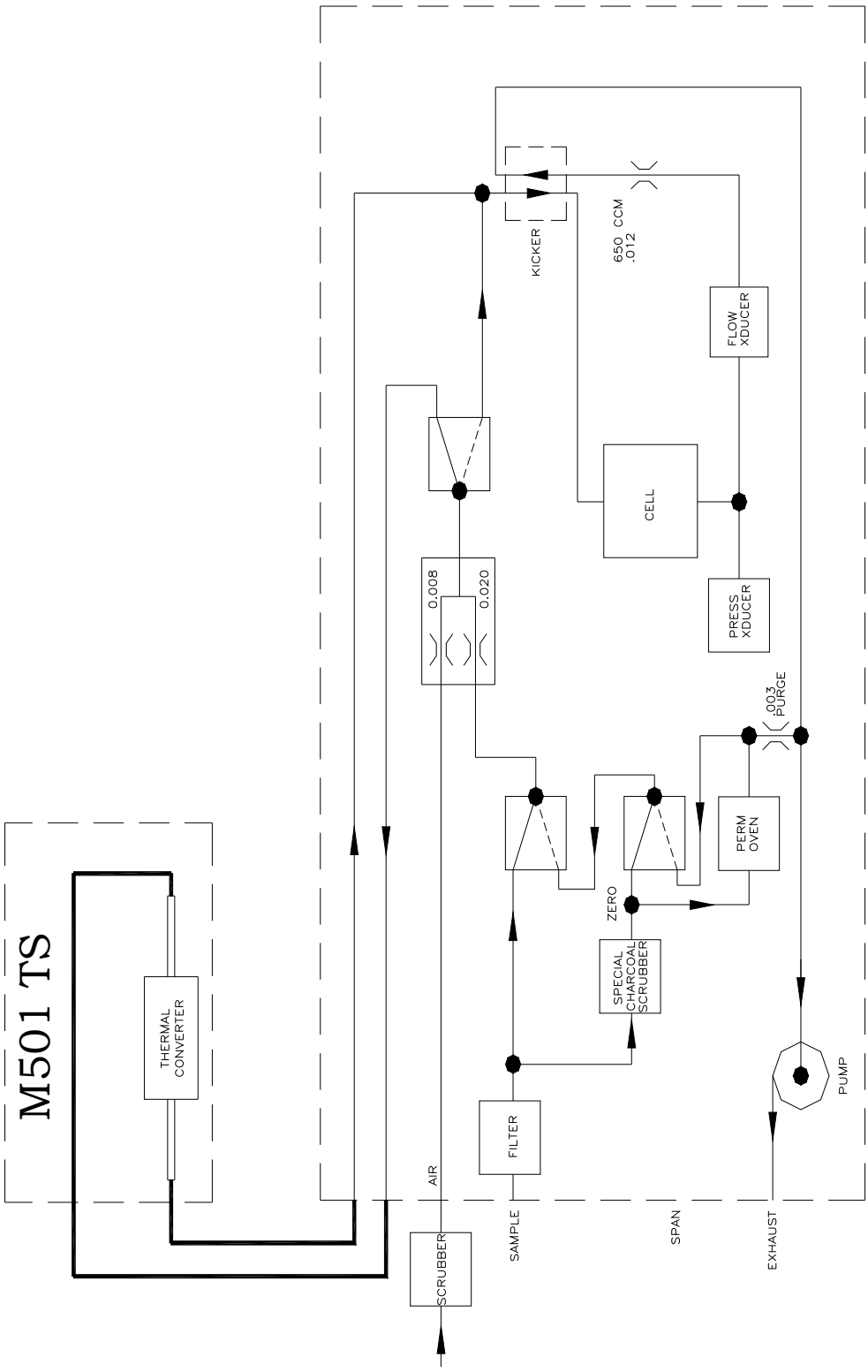


Figure 2-2. M108E (M108A) with IZS/Permeation Tube Option

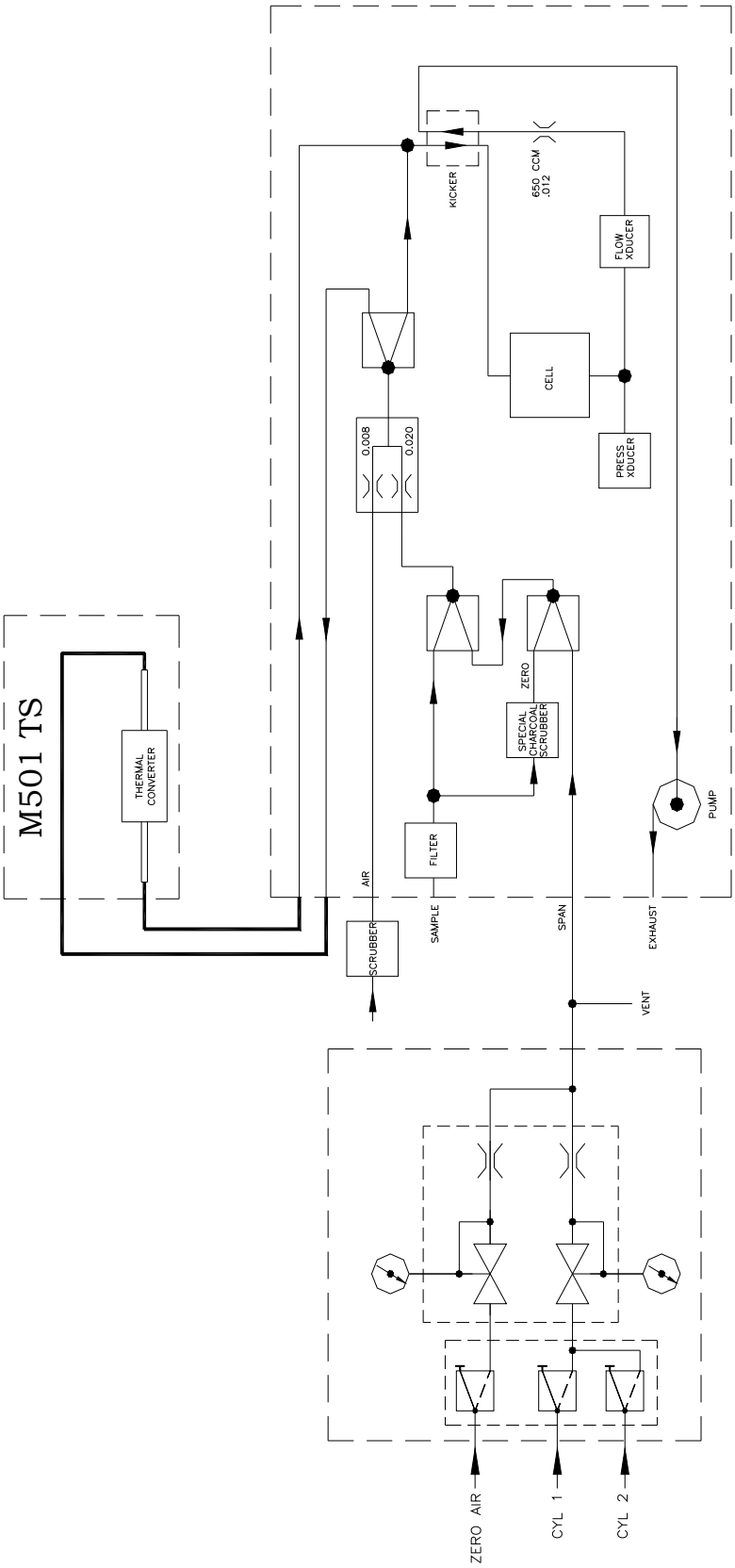


Figure 2-3. M108E (M108A) with M702 Calibrator Option

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2.4 The M501TS – Total Reduced Sulfur Converter

The M501TS oxidizes reduced sulfur compounds to SO_2 in a high temperature quartz oven. A front panel mounted programmable digital temperature controller regulates power to the heater. Power to the heater is switched by a solid state, zero-crossing relay. An over/under-temperature alarm contact closure is located on the rear panel. The alarm set point is adjustable in the temperature controller. The heater temperature is sensed by a Type S (distinguished from other thermocouple types by its wire colors, red and black; see table below) (Platinum-Rhodium) thermocouple probe inserted in the bore alongside the quartz tube. Note: If using a type K or N thermocouple, or if switching to a type S thermocouple, please refer to Sections 2.8 and 3.5 for proper controller configuration.

The quartz tube carrying the sample mixture runs through the core of the heater and is heated by radiation from electrical heating elements at the heater bore surface. See Figure 2-4 for a layout view of the converter.

Table 2-2 Thermocouple Type Distinctions

Thermocouple Type	Indicated by Wire Color
S	red and black
K	red and yellow
N	red and orange



WARNING !
ENSURE PROPER LINE VOLTAGE IS SELECTED PRIOR TO PLUGGING UNIT INTO POWER SOURCE.



CAUTION!
THE QUARTZ TUBE AND HEATER ARE VERY HOT
DO NOT TOUCH



CAUTION!
ENSURE THAT YOU SELECT THE CORRECT SETTING (see Table 2-4) FOR THE THERMOCOUPLE TYPE THAT YOU HAVE!

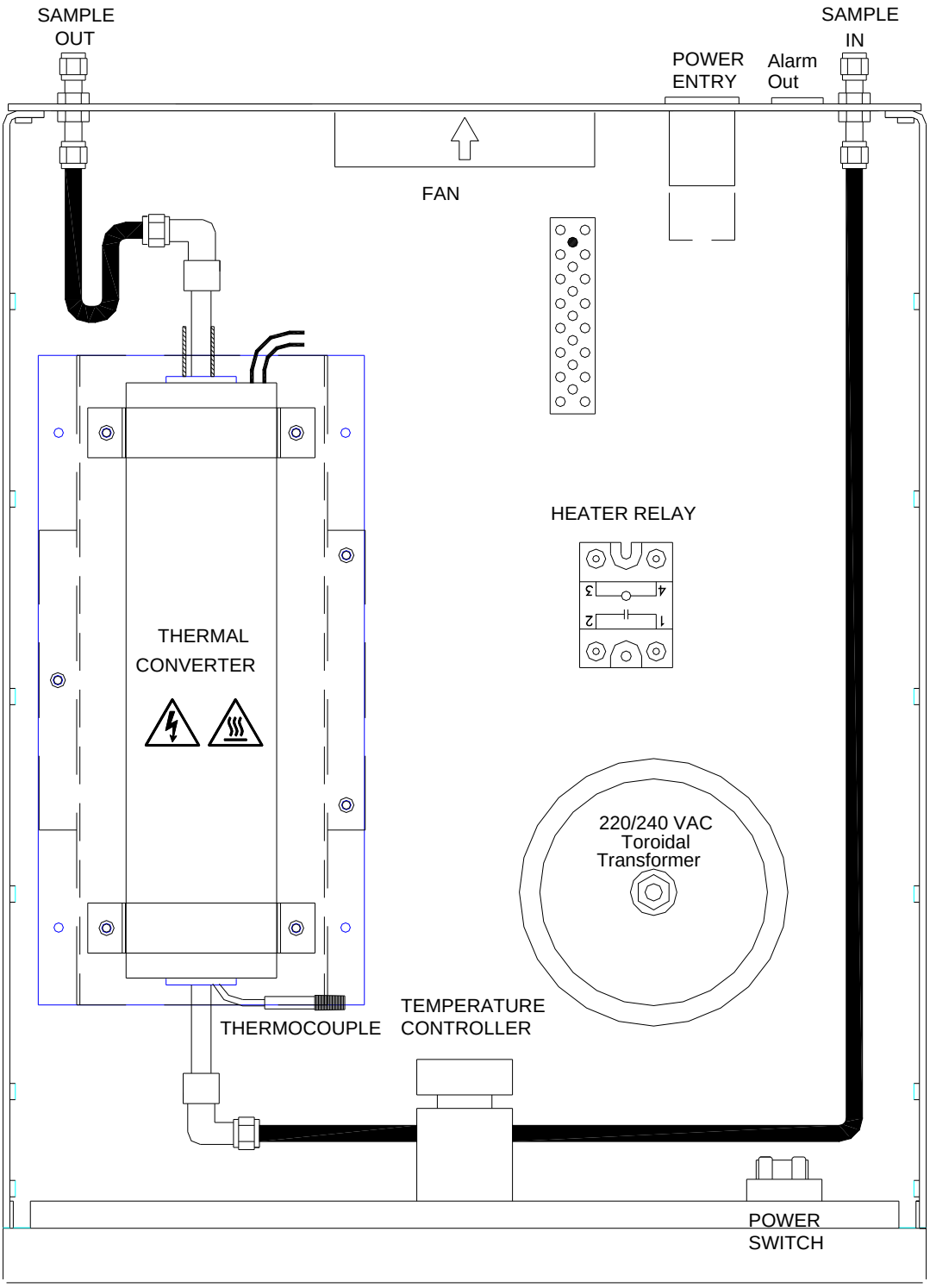


Figure 2-4. M501TS Converter Layout

2.5 Installation

The M108E or M108A consists of two chassis. There is a power cord for each that should be plugged into the correct AC mains receptacle. See the tag on the rear panel of each chassis for the voltage and frequency configuration. The power connection must be made with an approved three-wire-grounded power cord.

The pneumatic connections are shown in Figure 2-5 .

- Connection to the TS analyzer must be made with Teflon tubing.
- Connect the sample inlet to the labeled fitting.
- The sample exhaust must be routed to a well-ventilated area away from the air inlet for the zero air scrubber on the rear panel.



CAUTION !
DO NOT BLOCK THE SIDE AND BACK VENTILATION OF THE M501TS CONVERTER

The overall pneumatic diagrams of the Model 108E (108A) are shown in Figure 2-1, Figure 2-2 , and Figure 2-3.



CAUTION !
DO NOT OPERATE WITHOUT THE COVER OF THE M501TS CONVERTER INSTALLED

OVEN TEMPERATURE WILL NOT REGULATE PROPERLY WITHOUT THE COVER IN PLACE

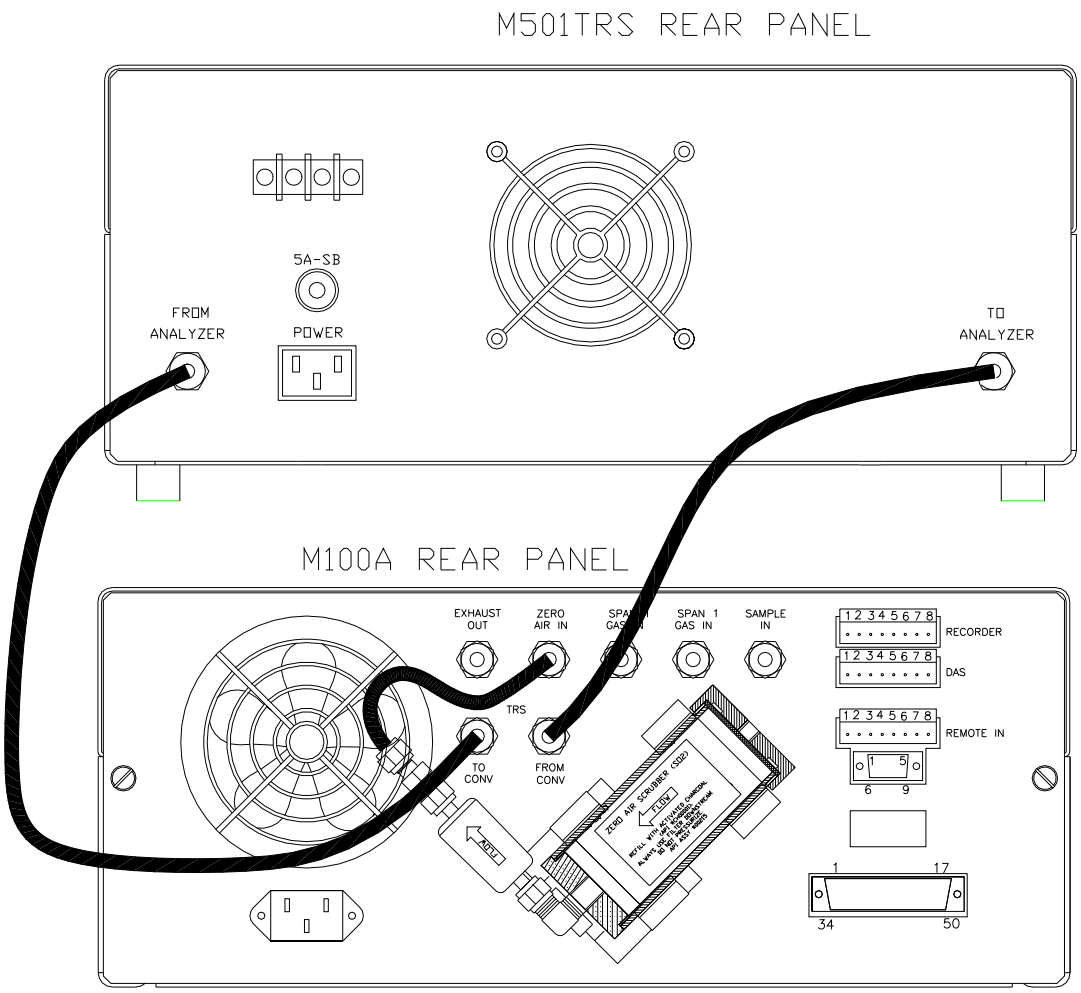


Figure 2-5. M108E (M108A) Pneumatic Connections

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2.6 Operation and Calibration

Refer to the M100E or to the M100A manual (as applicable) for the overall operation of the SO_2 analyzer. This unit has some unique operating characteristics and calibration procedures detailed below.

The basic purpose of this instrument is to analyze CO_2 sample gas for sulfur containing impurities. Typically the impurities should be at low levels; therefore it is especially important that the zero calibration of the analyzer is done accurately so that even small levels of impurities can be detected.

2.6.1 CO_2 Source

A source of CO_2 that is free of sulfides is required for accurate zero calibration of the instrument. If the 'zero gas' used to zero the instrument is contaminated, the process gas will read artificially low, sometimes even showing a negative TS concentration. Standard CO_2 bottles can have unacceptably high levels of sulfur compounds in them. Beverage grade CO_2 should be used as a diluent as well as the 'zero gas' source for calibration of the M108E (M108A).

Since CO_2 strongly quenches the SO_2 fluorescence reaction, the instrument sensitivity will be greatly reduced when using CO_2 as the balance gas. Therefore it is imperative that the M108E (M108A) be calibrated using CO_2 as the balance gas when it will be measuring TS in a gas matrix that is primarily CO_2.

CO_2 liquefies when compressed, and sulfur compounds do not stay dissolved in liquid CO_2. Therefore it is not practical to use compressed gas bottles of H_2S in CO_2 for calibration purposes. TAPI strongly recommends that H_2S in N_2 bottles be used for calibration of the M108E (M108A), and that a calibrator be used to mix zero gas (CO_2) into the cal gas stream, making the final calibration gas mostly CO2.

2.7 TS and Zero Air Scrubbers

There are two charcoal scrubbers in the analyzer chassis of the M108E (M108A). The scrubber canister on the outside of the rear panel of the analyzer is a standard charcoal scrubber that supplies zero air for the diluter assembly. The second scrubber is located inside the analyzer behind the sample filter. This scrubber uses a specially impregnated charcoal (TAPI Part# CH_52) which is especially effective in scrubbing TS gasses. This filter is used to scrub TS from the inlet sample gas for use in zero calibrating the analyzer.

2.8 M501TS Temperature Controller

A front panel-mounted programmable controller maintains the heater temperature. The “Fuji Electric PXZ Series Operation Manual” is included with the documentation for this instrument. The controller has been set up at the factory. Should further adjustments be necessary, set-up instructions are briefly stated in Section 2.8.1.

To view the actual temperature, PV – Present Value, or the set point value, SV – Set-point Value, press the PV/SV button in the lower left corner of the controller.

2.8.1 Changing the Temperature Set Point

The temperature can be adjusted to temperatures other than 1000 ºC. However, TAPI recommends that the converter always be left at the nominal temperature of 1000 ºC. The converter has not been tested for conversion efficiency or reliability at other temperatures, and TAPI does not guarantee warranty support or that the converter will meet published specifications if the operating temperature is changed. To adjust the operating temperature:

1. Select **SV** with the PV/SV button,

2. Select the Set-Point value at approximately 1000 ^{o}C by pressing the "up-arrow" under the digit you want to change, (the digit will flash).

NOTE:
DO NOT SET THE TEMPERATURE HIGHER THAN 1050^{O}C

3. Press the "up-arrow" under the digit or the "down-arrow" at the left to scroll the digit to the desired value.

4. Repeat for each digit.

5. Press the ENTER button.

6. Select **PV** with the PV/SV button to observe the actual temperature. Allow temperature to equilibrate for a minimum of 30 to 45 minutes.

2.8.2 Adjusting the P-I-D Parameters

In the event that the control parameters must be changed or in the event that a new controller is installed, it must be reprogrammed to suit the thermal characteristics of the instrument. It is recommended that the Auto Tune function be used to set the control functions if reprogramming is necessary.

The following table is a guide to the approximate values for setting the parameters that will produce the initial settings for the auto-tune function. Below is a summary of the auto-tune procedure, refer to the Fuji Manual for more detailed information.

2.8.2.1 Auto-Tune

To perform the Auto Tune function:

1. Set the SV to the desired temperature.
2. Set the parameter A7 to 1.
3. Press ENTER.

The controller will begin the auto-tune process, which takes several minutes. The decimal point at the lower right of the display will blink, indicating the controller is auto-tuning. During the process, the temperature may oscillate $\pm 100^{o}C$ or more. When the process is completed, the decimal point will stop blinking.

NOTE:
It is normal for the ceramic heating element to emit a red glow at the operating temperature.

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Table 2-3 includes typical values for a converter set up for operation on 115V/60Hz. The P, I and d values may be different for individual converters and AC mains voltages, and will vary somewhat after auto-tuning.

Table 2-3. Temperature Controller – Initial Settings

PRESS	DISPLAY	INITIAL VALUE
SEL	**P** PROP BAND	UP/DOWN SET TO “11”
SEL	**I** INTEGRAL	SET TO “10”
SEL	**d** DERIVATIVE TIME	SET TO “7.7”
SEL	**AL** LOW ALARM SETPOINT	SET TO “50” (ºC BELOW FINAL SETVALUE)
SEL	**AH** HIGH ALARM SETPOINT	SET TO “50” (ºC ABOVE FINAL SETVALUE)
SEL	**7C** CYCLE TIME	SET TO “2”
SEL	**HYS** HYSTERESIS	SET TO “3”
SEL	**A7** AUTOTUNE	SET TO “0” (OFF)
SEL	**LOC** LOCK	“0” (OPEN) “1” (LOCKED) “2” (SV ONLY OPEN)

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Table 2-4 shows a Secondary Menu of parameters that set more basic parameters of the controller, these include the thermocouple type, the temperature units etc.
Do not use any setting for the thermocouple Type other than as described for "**p n2**" in the following table:

Table 2-4. Temperature Controller - Secondary Menu

PRESS	DISPLAY	PARAMETER VALUE
SEL	HOLD TILL **p-n1**	SET TO "0"
SEL	**p-n2*** *** Set only to the value stated in the next column.**	Type S thermocouple (red & black wires): SET TO "6" In the rare event that you have a different thermocouple: Type K, red and yellow wires, SET TO "3"_ Type N, red and orange wires, SET TO "12". CAREFULLY FOLLOW THE INSTALLATION INSTRUCTIONS PROVIDED IN SECTION 3.5 OF THIS MANUAL.
SEL	**p-dF** DIGITAL FILTER	SET TO "5"
SEL	**P-SL** LOWER LIMIT	SET TO "32" (32C)
SEL	**P-SU** UPPER LIMIT	SET TO "1050" (1050C)
SEL	**P-AL** ALARM TYPE2	SET TO "10"
SEL	**P-AH** ALARM TYPE 1	SET TO "10"
SEL	**P-An** HYTERESIS	SET TO "3"
SEL	**P-dP** DECIMAL LOCATION	SET TO "0"
SEL	**PVOF** PROCESS OFFSET	LEAVE AT "0"
SEL	**SVOF** SET POINT OFFSET	LEAVE AT "0"
SEL	**P-F**	SET TO "ºC" (CENTIGRADE)
SEL	**FUZZY** FUZZY LOGIC	SET TO "ON"

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3 TROUBLESHOOTNG

NO POWER: Plugged in?
Switched on?
Circuit breaker Tripped?

NOT HEATING: PV/SV switch to PV. Is it heating?
PV/SV switch to SV. Set point correct?
Socket in place on back of temperature controller?
Check M501TS wiring diagram Figure 3.1
Thermocouple has failed? 'UUUU' shown on front panel of 501TS. Also, check thermocouple resistance.

TS ANALYZER UNSTABLE: Leak-check.
(Pressurize and see if pressure falls.
Use soap bubble to find leak.)

EFFICIENCY <90%: Leaking? Leak-check.
Plugged? Compare flow through and bypassing converter.
Flow too high?
Set-point temperature optimized?
Span gas correct?
Contaminated? Check inside of Teflon tubing.

CONVERTER TEMP UNSTABLE: Perform Auto-Tune procedure in Section 2.8.2.1.

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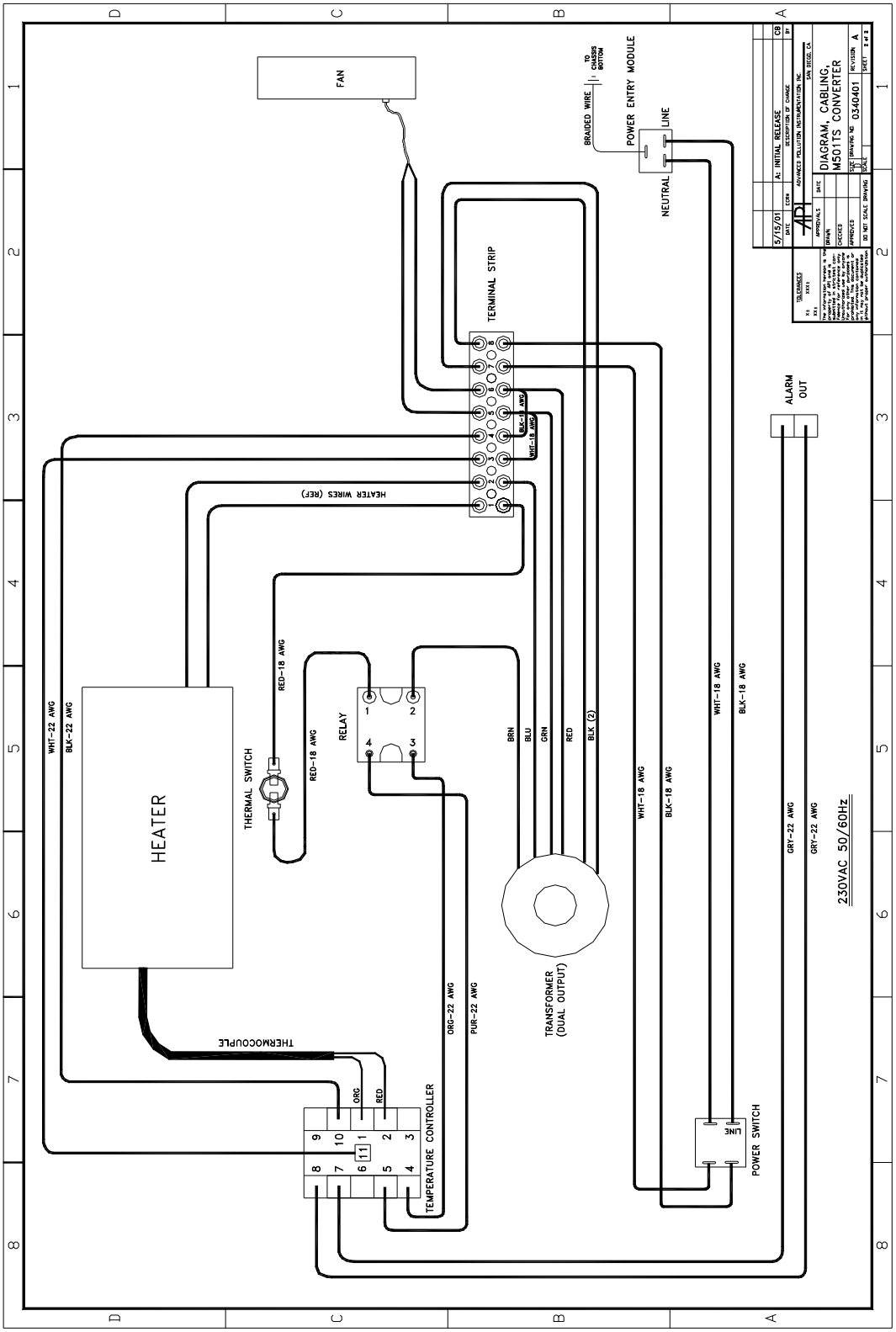


Figure 3-1. M501TS Wiring Diagram

3.1 SO_2 Analyzer Maintenance

Maintenance of the SO_2 analyzer is covered in the Maintenance section of its respective manual. Unlike the M100E (M100A), the M108E (M108A) has one standard charcoal scrubber on the rear panel of the SO_2 analyzer instrument chassis, and another special charcoal scrubber inside the chassis. The zero calibration (and thus the overall accuracy of the instrument) is dependent on high quality zero air. **Make sure that the charcoal is replaced at the 3-month interval suggested in the M100E (M100A) maintenance schedule. Also be sure not to mix charcoal between the inner and outer scrubber canisters, they are different materials.**

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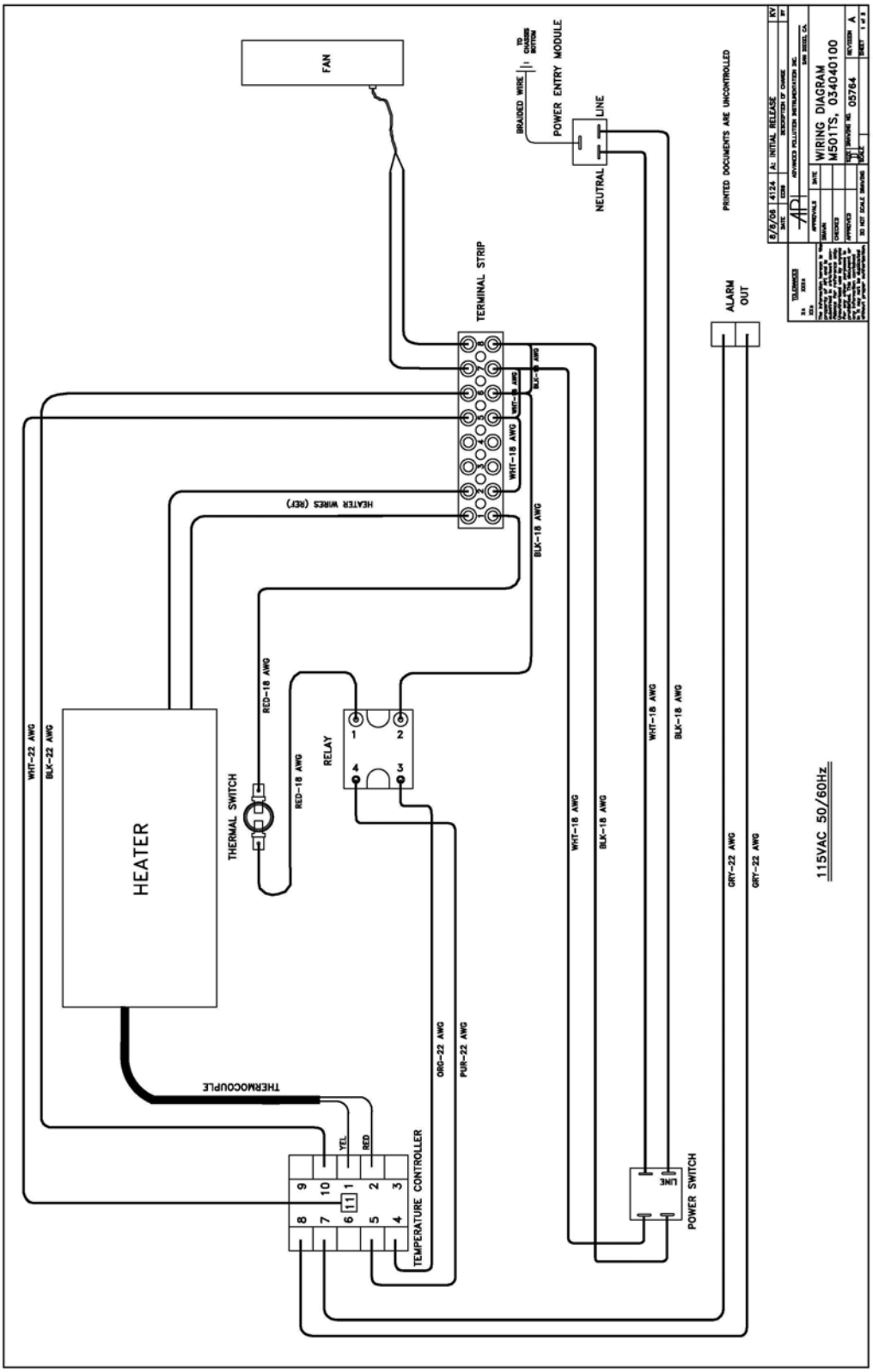


Figure 3-2. M501TS Wiring Diagram, 220V Systems

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3.2 Changing the Quartz Tube

1. Turn off M501TS and allow it to cool to room temperature (~2 hours).
2. See Figure 2.4. – M501TS Layout
3. Remove the screws from the top inside of the front panel and fold panel downward.
4. Loosen front and rear fittings at each end of the tube.
5. Carefully slide the tube out of the heater – the ceramic bushings at each end of the heater are very fragile.
6. Slide the new tube into the heater, and re-connect the fittings.
7. Leak check the unit.
8. Replace the thermocouple making sure that it is fully inserted into the indentation in the body of the quartz tube.
9. Check the converter efficiency. See Section 4.3

3.3 Checking the Converter Efficiency

After maintenance it is good practice to check the converter efficiency. To check the converter efficiency, perform the following procedure:

1. Produce a calibration gas of 400 ppb H_2S in CO_2 at a flow greater than the demand of the instrument; vent the excess gas out of the room.
   - When using a calibrator or gas blender to generate H_2S span gas (either permeation tube or tank) with CO_2 gas as the diluent, please remember that rotameters and mass flow controllers are calibrated with air or nitrogen. Using them with CO_2 will produce large calibration errors (as large as 30% or more), since CO_2 gas has considerably different characteristics. Contact the manufacturer of your mass flow measurement/control device for instructions on how to use it to measure CO_2 flow. Or use a flowmeter such as a soap bubble, or BIOS – DryCal flowmeter that measures volume flow
2. Allow the M108E (M108A) to stabilize at span for at least 30 minutes.
3. Check the converter efficiency by adjusting the converter's temperature controller set point:
   - Starting at the converters normal set-point of 1000 ^oC, lower the set-point temperature of the Converter in 5 ^oC increments (allowing 10 minutes minimum settling time between increments) until a drop of approximately 5% of Full Scale is observed. Note the Thermal Converter temperature at this point.
   - Verify that the converter efficiency does not drop by 5% until the temperature has dropped by at least 40 ^oC,
   - Return the temperature set point to 1000 ^oC.

3.4 Sample Diluter Maintenance

The sample diluter is used to inject a small amount of ambient air into the sample stream to provide oxygen for the converter. The diluter is located on the inside rear panel of the SO_2 analyzer. It consists of a stainless steel block and 2 orifices to control the amount of sample and air that is blended.

There should be no periodic maintenance required on this assembly, but a diagram is included in case rebuilding of this assembly is required. The assembly is shown in Figure 3.3.

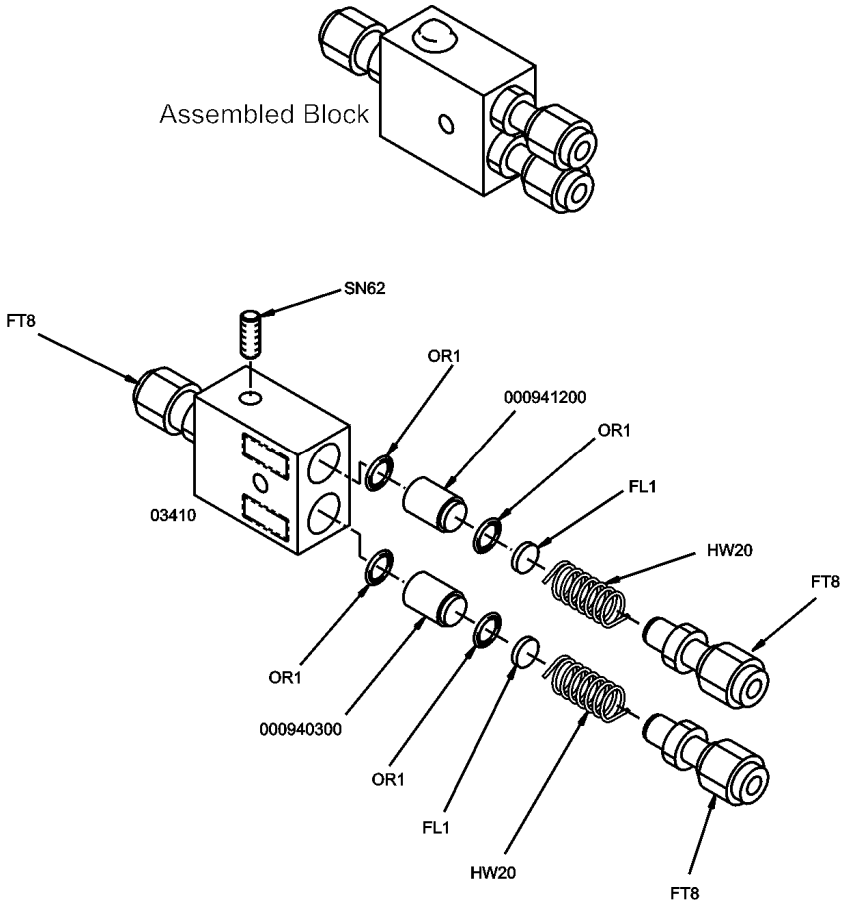


Figure 3-3. Diluter Flow Block Assembly

3.5 Thermocouple Replacement

Continuous operation at 1000 ºC will eventually degrade the performance of the thermocouple used to sense the temperature of the quartz oven. The following instructions describe how to install a new thermocouple into the Converter Heater Block. This is a replacement thermocouple (KIT000255). Teledyne API recommends updating any older thermocouples with the new version. The

following instructions provide the necessary information to remove the existing thermocouple and replace it with the new one supplied in Kit 255.

You will need the following tools:

- Nutdriver, $^{5}/_{16}$
- Nutdriver, $^{11}/_{32}$
- Diagonal Cutter
- Philips head Screwdriver #2

You must obtain the following replacement parts kit from T-API:

- KIT000255 (AKIT, Retrofit, M501TS, TC Type S RPLCMN)

Once you have the right tools and parts, replace the thermocouple as follows:

1. Ensure power is removed from the M501TS Converter. If the Converter has been operational you will need to wait for 2 hours for the Converter oven to cool before continuing with the replacement of the thermocouple.
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 inner cover protecting 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.

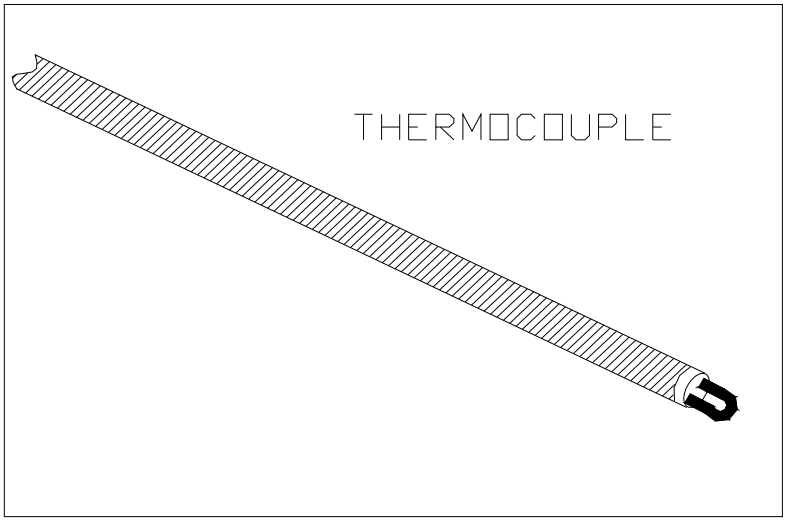


Figure 3-4. Thermocouple

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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 fat part of the quartz tube. This is where the thermocouple you are installing will reside. Refer to Figure 3-5.

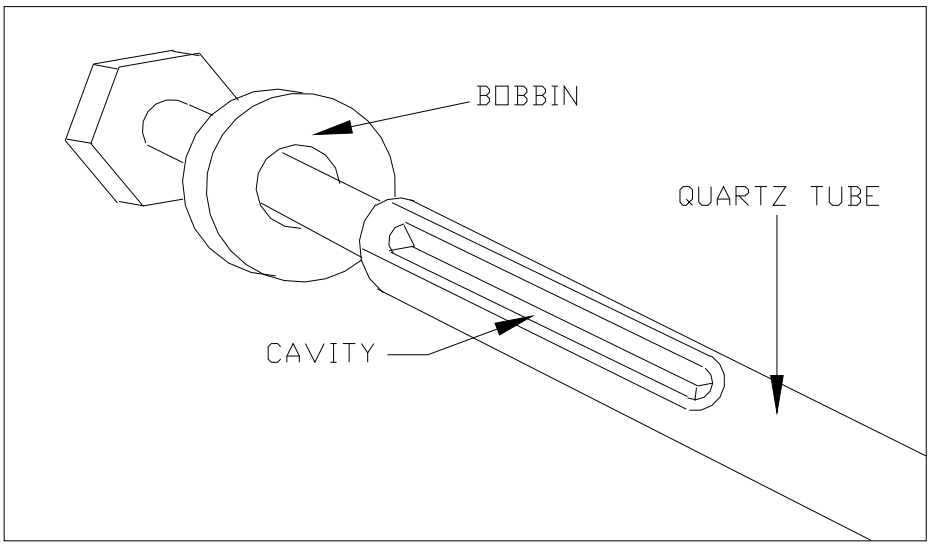


Figure 3-5. Quartz Tube Cavity for Thermocouple

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. The thermocouple should now be properly seated in the cavity of the quartz tube. Refer to Figure 3-6

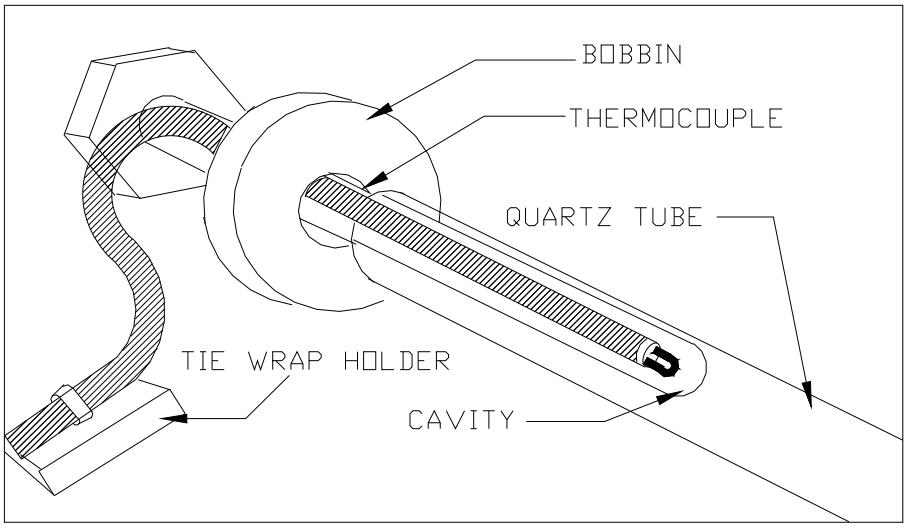


Figure 3-6. Thermocouple Installed

14. 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 the teflon fitting is tightened.
15. 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 the Figure 3-7.

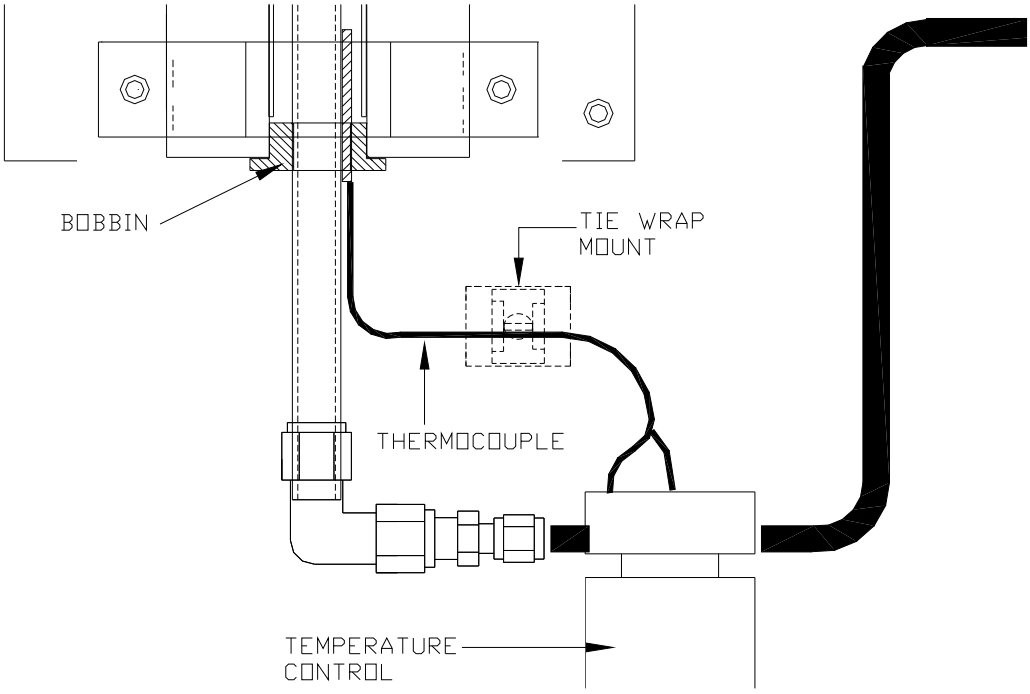


Figure 3-7. Tie-Wrap Hold-Down Location

16. Form the Thermocouple wire so that it rests in the cavity with little movement.
17. Connect the (2) 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 T-API Sales or call Customer Service).
18. 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.
19. Install the inner cover of the Heater Block and secure with the (3) nuts. Close the Front Panel and secure with the (4) nuts. Install the top cover on the Converter chassis.
20. 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.
21. Check the Temp Controller to be sure that it knows which type of Thermocouple it has in it. Follow the directions in Section 2.8.2 of this

document, paying particular attention to the settings in Table 2-5 to be sure that the temp controller is set properly.

22. After the Converter comes to the regulated temperature, perform the Auto Tune function (see Section 2.8.2.1) to tune the Temperature Controller to the new thermocouple. .
23. After the Auto-Tune process is completed, verify that the “process” temperature is indicating that the desired temperature is stable and being regulated.

The converter is now ready for operation.

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4 SPARE PARTS

This section presents the Spare Parts Lists for the M108E and for the M108A. For M100E or M100A Spare Parts or Expendables, please refer to the respective manual. Also, please refer to our Website or call Sales for more recent updates to these lists.

Please note that the internal scrubber cartridge takes a special scrubber material. TAPI's standard Sox scrubber material is not appropriate for use in the internal scrubber assembly. The external scrubber does take standard scrubber material.

4.1 M108E Spare Parts and Expendables Lists

Please check the Teledyne API website or Sales for the most recent updates to the lists.

Table 4-1. M108E Spare Parts List

M108E Spare Parts List, PN 05477W	
Part Number	**Description**
000940100	ORIFICE, 3 MIL, IZS
000940300	ORIFICE, 20 MIL, SAMPLE DILUTION
000940400	CD, ORIFICE, .004 BLUE
000940800	ORIFICE, 12MIL, RXCELL
000941200	ORIFICE, 8 MIL, AIR DILUTION
002690000	LENS, UV LENS
002700000	LENS, PMT
002720000	FILTER, PMT OPTICAL, 330 NM
003290000	ASSY, THERMISTOR
005960000	AKIT, EXP, 6LBS ACT CHARCOAL (2 BT=1)
009690000	KIT, TFE FILTER ELEMENTS, 5 UM (100)
009690100	KIT, TFE FILTER ELEMENTS, 5 UM (30)
011630000	HVPS INSULATOR GASKET (KB)
012720100	OPTION, NOx OPTICAL FILTER, M100A/E *
013140000	ASSY, COOLER FAN
013210000	ASSY, VACUUM MANIFOLD
013390000	ASSY, KICKER
013400000	PMT, SO2
013420000	ASSY, ROTARY SOLENOID
013570000	ASSY, THERMISTOR (COOLER)
014080100	ASSY, HVPS
014400100	ZERO AIR SCRUBBER
014750000	KIT, EXPENDABLES, IZS
016290000	WINDOW, SAMPLE FILTER
016300700	ASSY, SAMPLE FILTER, 47 MM
029580000	ASSY, CONVERTER XFMR, 230V/115V

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M108E Spare Parts List, PN 05477W	
Part Number	**Description**
037100000	TUBE, CONVERTER
037310000	ASSY, DILUTION FLOW CONTROL
037340100	ASSY, ZERO AIR SCRUBBER, TRS
037860000	ORING, TFE RETAINER, SAMPLE FILTER
040010000	ASSY, FAN, REAR PANEL
040030100	PCA, FLOW/PRESSURE
040031100	OXYGENATOR FLOW SENSOR ASSEMBLY
041620100	ASSY, SO2 SENSOR
041710000	ASSY, CPU, CONFIGURATION, "E" SERIES * (USE WITH DOC 053180100)
041800400	PCA, PMT PREAMP, VR, M100E
042410200	ASSY, PUMP, INT, E SERIES
042580000	PCA, KEYBOARD, E SERIES
042900100	PROGRAMMED FLASH, E SERIES
043420000	ASSY, HEATER/THERM, O2 SEN, "E" SERIES
043570000	AKIT, EXPENDABLES, M100E
043880100	DOC, w/SOFTWARE, M100E*
043940000	PCA, INTERFACE, ETHERNET
045150100	MANUAL, OPERATION, M100E
045230200	PCA, RELAY CARD, E SERIES
046250000	ASSY, RXCELL HEATER/FUSE, M100E
046260000	ASSY, THERMISTOR, RXCELL
048620200	PCA, SERIAL INTERFACE, w/ MD, E SERIES (USE WITH ACROSSER CPU 041710000)
049310100	PCA, TEC CONTROL, E SERIES
050610100	CONFIGURATION PLUGS, 115V/60Hz
050610200	CONFIGURATION PLUGS, 115V/50Hz
050610300	CONFIGURATION PLUGS, 220-240V/50Hz
050610400	CONFIGURATION PLUGS, 220-240V/60Hz
050610500	CONFIGURATION PLUGS, 100V/50Hz
050610600	CONFIGURATION PLUGS, 100V/60Hz
050630100	PCA, M100E UV REFERENCE DETECTOR
052660000	ASSY, HEATER/THERMISTOR (IZS)
053180100	MANUAL, OPERATION, M108E
055100200	ASSY, OPTION, PUMP, 240V *
055560000	ASSY, VALVE, VA59 W/DIODE, 5" LEADS
058021100	PCA, E-SERIES MOTHERBD, GEN 5-ICOP (ACCEPTS ACROSSER OR ICOP CPU)
059220000	THERMOCOUPLE, TYPE S, ALUMINA SHEATH
061930000	PCA, UV LAMP DRIVER, GEN-2 *
062420200	PCA, SER INTRFACE, ICOP CPU, E- (OPTION) (USE WITH ICOP CPU 062870000)
062870000	CPU, PC-104, VSX-6150E, ICOP *(KB) (MUST USE WITH 058021100 MB)

M108E Spare Parts List, PN 05477W	
Part Number	**Description**
063500100	DOM, w/SOFTWARE, M108E * (USE WITH ICOP CPU 062870000)
CN0000458	CONNECTOR, REAR PANEL, 12 PIN
CN0000520	CONNECTOR, REAR PANEL, 10 PIN
CP0000017	CONTROLLER, CONVERTER TEMPERATURE
DS0000025	DISPLAY, E SERIES
FL0000001	FILTER, SS
FL0000003	FILTER, DFU (KB)
FM0000004	FLOWMETER
HE0000007	HEATER, CONVERTER
HW0000005	FOOT, CHASSIS
HW0000020	SPRING
HW0000030	ISOLATOR, M100/M200 A/E/H/U
HW0000031	FERRULE, SHOCKMOUNT
HW0000036	TFE TAPE, 1/4" (48 FT/ROLL)
HW0000101	ISOLATOR
HW0000416	COVER, CRYDOM RELAYS, RL9, 19 & 20
HW0000453	SUPPORT, CIRCUIT BD, 3/16" ICOP
KIT000093	KIT, 214NM FILTER REPLACEMENT
KIT000095	KIT, COOLER REPLACEMENT
KIT000219	KIT, 4-20MA CURRENT OUTPUT (E SERIES)
KIT000236	KIT, UV LAMP, w/E-A ADAPTER (BIR)
KIT000253	ASSY & TEST, SPARE PS37, E SERIES
KIT000254	ASSY & TEST, SPARE PS38, E SERIES
KIT000255	AKIT, RETROFIT, M501TS, TC TYPE S RPLCMN
OP0000031	WINDOW, QUARTZ, REFERENCE DETECTOR
OR0000001	ORING, FLOW CONTROL/IZS
OR0000004	ORING, OPTIC/CELL, CELL/TRAP
OR0000006	ORING, CELL/PMT
OR0000007	ORING, PMT/BARREL/CELL
OR0000015	ORING, PMT FILTER
OR0000016	ORING, UV LENS
OR0000025	ORING, ZERO AIR SCRUBBER
OR0000027	ORING, COLD BLOCK/PMT HOUSING & HEATSINK
OR0000039	ORING, QUARTZ WINDOW/REFERENCE DETECTOR
OR0000046	ORING, PERMEATION OVEN
OR0000083	ORING, PMT SIGNAL &OPTIC LED
OR0000084	ORING, UV FILTER
OR0000094	ORING, SAMPLE FILTER
PU0000022	KIT, PUMP REBUILD
RL0000015	RELAY
RL0000020	RELAY, CONVERTER
SW0000040	SWITCH, CONVERTER POWER
SW0000051	SWITCH, ANALYZER POWER
SW0000058	SWITCH, THERMAL/450 DEG F

M108E Spare Parts List, PN 05477W	
Part Number	**Description**
SW0000059	PRESSURE SENSOR, 0-15 PSIA, ALL SEN
WR0000008	POWER CORD, 10A

Table 4-2. M108E Expendables Kit, PN 04357A

M108E Expendables Kit, PN 04357A	
Part Number	**Description**
009690100	KIT, TFE FILTER ELEMENTS, 47MM, 5UM (30)
018080000	AKIT, DESSICANT BAGGIES (12)
FL0000001	FILTER, SS
HW0000020	SPRING
NOTE01-23	SERVICE NOTE, HOW TO REBUILD THE KNF PUMP
OR0000001	ORING, SAMPLE FLOW
PU0000022	REBUILD KIT, FOR PU20 & 04084

4.2 M108A Spare Parts List and Expendables Kit

Table 4-3. M108A Spare Parts List

M108A Spare Parts List, PN 06210A	
Part Number	**Description**
000270000	RETAINER, LENS, PMT (KB)
000940100	CD, ORIFICE, .003 GREEN
000940300	CD, ORIFICE, .020 VIOLET
000940800	CD, ORIFICE, .012 (NO PAINT)
000941200	CD, ORIFICE, .008, RED/NONE
002690000	CD, LENS, PL-CON (KB)
002700000	CD, LENS, BI-CON (KB)
002720000	CD, FILTER, 330NM (KB)
002760900	ASSY, CPU, 512K PROM/SW, M100A, CE
003290000	THERMISTOR, BASIC (VENDOR ASSY)
003370000	ASSY, 2 HEATER/ THERMISTOR, LONG
004021300	PCA, SENSOR BOARD, M108A
004840000	ASSY, UV TRANSFORMER 60HZ
004840100	ASSY, UV TRANSFORMER 50HZ
005140200	PCA, V/F CARD (TESTED) *
005960000	AKIT, EXPEND, 6LBS ACT CHARCOAL
006900000	RETAINER PAD CHARCOAL, SMALL, 1-3/4"
007040000	PCA, KEYBD DISPLAY, A, M700/M552/M450H
007280000	ASSY, DISPLAY (DS25) FOR "A" SERIES
009690200	AKIT, TFE FLTR ELEMENT, 47MM, 1UM (100)
009690300	AKIT, TFE FLTR ELEMENT, 47MM, 1UM (30)
010860300	PCA, STATUS/TEMP M100A, WO/TC
011140100	PCA, REAR PANEL CONNECTOR (NON-CE)
011390000	ASSY, PSM,M100A/M200A, 115V/60HZ
011630000	HVPS INSULATOR GASKET (KB)

M108A Spare Parts List, PN 06210A	
Part Number	**Description**
012360000	ASSY, FAN, "A" PSM
012480000	PCA, MOTHERBOARD, M100A
013110200	PCA, REF. DETECTOR PREAMP w/OP12, M100A
013140100	ASSY, COOLER FAN, M100A
013390000	ASSY, KICKER, M100A/E
013400000	CD, PMT, SO2, M100A/E (KB)
013420000	ASSY, ROTARY SOLENOID, M100A/E/U/H
014080100	ASSY, HVPS, SOX/NOX
018080000	AKIT, DESSICANT BAGGIES, (12) (B/F)
019300000	PCA, KEYBOARD DISPLAY (CE) OPTIONS
021070100	PCA, PREAMP, M100A
021640000	MANUAL, OPERATORS, M100A, AMX
022220000	PCA, PWR SUPPLY SWITCH BD, CE (SUBASSY)
022300000	PCA, DC POWER SUPPLY, CE, (SUBASSY)
022740000	ASSY, XFMR, MULTITAP, 115V (SUBASSY)
022740100	ASSY, XFMR MULTITAP 220/230/240V CE(SUB)
025730000	ASSY, HEATSINK/COOLER, M100A, M200A
029580000	ASSY, XFMR, 230V/115V 400VA, M501
033900000	MANUAL, M102A TRS SYSTEM
035320100	PCA, SINGLE RS232 M100A/200A/300/400
037100000	TUBE, CONVERTER
037320000	ASSY, SWITCHING VALVE
039400000	MANUAL, OPERATORS, M108A/E
039620100	AKIT, EXP KIT, IMPREG CHARCOAL, TS,
044500000	ASSY, Z/S VALVE, M100A
049310200	PCA, TEC DRIVER, PMT, M100/200, A SERIES
056910000	PCA, LAMP SUPPLY O3 GEN
057970100	ASSY, HEATER/THERM, 03 GEN, 108A
059220000	THERMOCOUPLE, TYPE S, ALUMINA SHEATH
CP0000017	CONTROLLER, TEMP, W/PG-11 (CN329)
FL0000001	FILTER, SS
FL0000003	FILTER, DFU
FM0000004	FLOWMETER (KB)
HE0000007	CERAMIC HEATER, 220W@60V M501XX
HE0000017	HTR, 12W/120V (50W/240V), CE AP (KB)
HE0000018	HEATER, 50W / 120V, CE APPROVE (KB)
HW0000020	SPRING
HW0000030	ISOLATOR, M100/M200 A/E/H/U
HW0000031	FERRULE, SHOCKMOUNT
HW0000101	ISOLATOR
HW0000416	COVER, CRYDOM RELAYS, RL9, 19 & 20
KIT000003	RETROFIT, 4-20MA ISOLATED, 100A/200A/300
KIT000013	RETROFIT, M100A AMX CE
KIT000021	REPLACEMENT PWR SW BD, 'A', M100A/200A
KIT000024	RETROFIT ADAPTER FOR VA33, M100A (OBS)
KIT000029	REPLACEMENT, 47MM SAMPLE FILTER TFE RING
KIT000034	REPLACEMENT, INTERNAL PUMP, PU20, "A"
KIT000045	RETROFIT, ZERO/SPAN VALVES, M100A
KIT000093	REPLACEMENT KIT, 214NM FLTR (03187)

M108A Spare Parts List, PN 06210A	
Part Number	**Description**
KIT000236	KIT, UV LAMP (SPARE) (B-I) w/E-A ADAPTER
OP0000012	PHOTOTUBE, IZS, R1228, ALT P/N OP1
OR0000001	ORING, 2-006VT
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
OR0000046	ORING, 2-019V
OR0000048	ORING, 2-112S
OR0000077	ORING, 2-018V
OR0000083	ORING, 105M, 1MM W X 5 MM ID, VITON
OR0000084	ORING, 2-020V
OR0000094	ORING, 2-228V, 50 DURO VITON
PS0000010	PWR SUPPLY, SWITCHING, 15V, ASTEC
RL0000020	SSRT RELAY, TD2410, CE MARK
SW0000006	SWITCH, THERMAL, 60 C
SW0000008	PRESSURE TRANSDUCER (KB)
SW0000040	PWR SWITCH/CIR BREAK, VDE CE (KB)
SW0000051	SWITCH, POWER CIRC BREAK VDE/CE, w/RG(KB
SW0000058	SWITCH, THERMAL/450 DEG F
VA0000007	VALVE, 3-WAY SS, 12VDC (KB)
VA0000030	VALVE, METERING, B, 1/4, B-SS4
VA0000059	VALVE, 3-WAY, 12VDC (KB) *
WR0000008	POWER CORD, 10A, 6'

Table 4-4 M108A Expendables

M108A Expendables Kit, PN 18770100B	
Part Number	**Description**
005960000	AKIT, EXPEND, 6LBS ACT CHARCOAL
006900000	RETAINER PAD CHARCOAL, SMALL, 1-3/4"
009690100	AKIT, TFE FLTR, 47MM, (FL6) (30)
039620100	AKIT, EXP KIT, IMPREG CHARCOAL, TS,
FL0000001	FILTER, SS
FL0000003	FILTER, DFU (KB)
HW0000020	SPRING
OR0000001	ORING, 2-006VT *

5 INSTRUMENT TEST & CALIBRATION RECORD

Table 5.1 - Final Test and Calibration Values

TEST Values	Observed Value	Units	Nominal Range	Ref. Sect. M100A Manual
RANGE		PPB	50 - 20,000	5.3.4
STABIL		PPB	0.0 - 2	5.2.1,9.1.1, Table 9.1, 9.2.5
PRESS		" HG	24 - 35	9.1.1, 9.3.6, Table 9.1
SAMP FL		CC / MIN	500 - 700 w/CO_2	9.2.2, 9.3.6, Table 9.1
PMT		MV	0 - 5000	9.4.1
UV LAMP		MV	3500 - 4000	9.4.2
STR. LGT		PPB	< 60	Table 9.1
DRK PMT		MV	< 50	9.4.3, Table 9.1
DRK LMP		MV	< 50	Table 9.1
SLOPE			1.0+/-.3	7.10
OFFSET		MV	< 100	7.10
HVPS		V	400 - 900 constant	9.3.10
DCPS		MV	2500 +/- 200	9.3.5
RCELL TEMP		^{o}C	50 +/- 1	9.3.7
BOX TEMP		^{o}C	8-50	9.3.4.1
PMT TEMP		^{o}C	7.9 +/- 1	9.3.9
IZS TEMP		^{o}C	50 +/-.3	9.5.4
Electric Test				
PMT Volts		MV	1000 +/-200	9.1.3.2
TS Conc.		PPB	500 +/- 100	9.1.3.2
Optic Test				
PMT Volts		MV	1000 +/- 200	9.1.3.3
TS Conch		PPB	500 +/- 100	9.1.3.3

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Table 5.1 – Continued (Values w/ CO_2 where applicable)

Span and Cal Values				
Parameter	**Observed Value**	**Units**	**Nominal Range**	**Ref. Sect. M100A Manual**
TS Span Conc.		PPB	20 - 20,000	Table 7.3
TS Slope			1.0 +/- .3	7.10
TS Offset		MV	< 100	7.10
Noise at Zero (rms)		PPB	< 0.2	Table 9.1
Noise at Span (rms)		PPB	< 0.5	Table 9.1
PMT at Zero (SO_2/CO_2)		MV		
PMT at Span (SO_2/CO_2)		MV		
Measured Flows				
Parameter	**Observed Value**	**Units**	**Nominal Range**	**Ref. Sect. M100A Manual**
Sample Flow w/ CO_2		cc/min	500 - 700	9.2.2, 9.3.6, Figure 9.6
Sample Flow w/Air		cc/min	400 - 600	9.2.2, 9.3.6, Figure 9.6
Sample Press w/CO_2		" HG	24 - 27	
IZS Purge Flow		cc/min	50 +/- 10	6.3
H_2S Conversion Efficiency	Expected = _____ PPB		Actual = _____ PPB	Efficiency = _____ % (100 ± 2%)

Factory Installed Options	**Option Installed**
Power Voltage/Frequency	
Rack Mount, w/ Slides	
Rack Mount, w/ Ears Only	
Internal Zero/Span - IZS	
Permeation Tube (Output Specification)	
4-20 MA Current Loop Output	
External Pump	

PROM Rev #: _____ M108TS S/N: _____

M501TS S/N: _____

Date: _____ Technician: _____

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