INSTRUCTION MANUAL

MODEL 102A TRS ANALYZER

MODEL 501TRS
TOTAL REDUCED SULFUR (TRS) THERMAL CONVERTER

Teledyne Instruments Advanced Pollution Instrumentation

(T-API)

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SAFETY MESSAGES

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

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

General Warning/Caution: Refer to the instructions for details on the specific danger.

Hot Surface Warning

Electrical Shock Hazard

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

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

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

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1.0 WARRANTY

ADVANCED POLLUTION INSTRUMENTATION DIVISION

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-API MANUFACTURED EQUIPMENT

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

GENERAL

Teledyne API warrants each Product manufactured by 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 or discrepancies

1.1.1 Inspection

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 Teledyne API should be notified immediately.

1.1.2 Documentation

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

1.1.3 Shipping Containers

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 instrument model number, serial number, sales order number and purchase order number should be referenced on all claims. Upon receipt of a claim, Teledyne API will advise disposition of the equipment for repair or replacement.

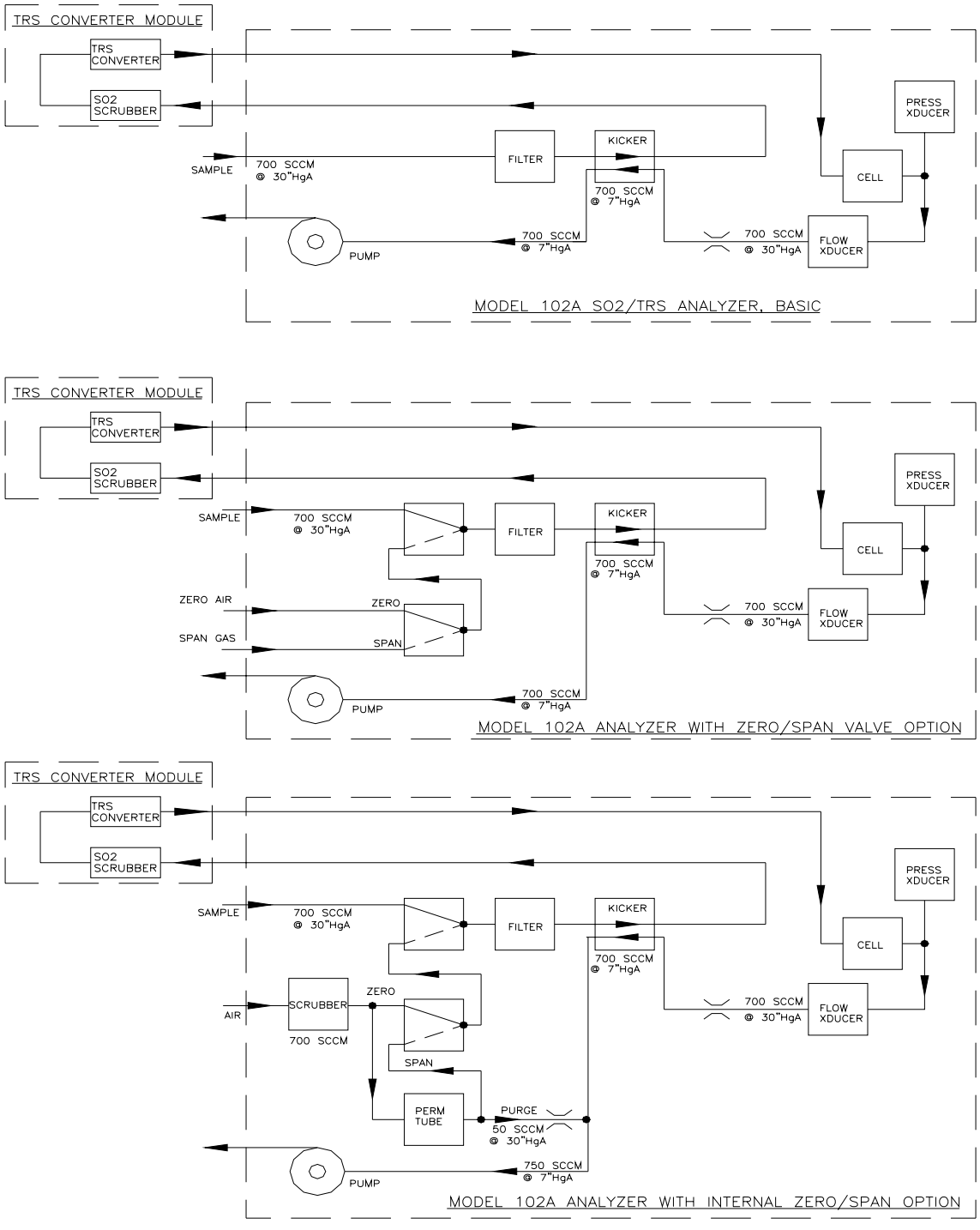
2.0 M102A / M501TRS SYSTEM

The Teledyne API Model 102A / Model 501TRS permits the measurement of Total Reduced Sulfur (TRS).

The M102A fluorescent SO_2 analyzer measures only SO_2, so a means of converting TRS to SO_2 is necessary. The M501TRS Converter thermally oxidizes reduced sulfur compounds to SO2. Using an optional switching valve the Converter can be bypassed, allowing analyzer to measure SO_2.

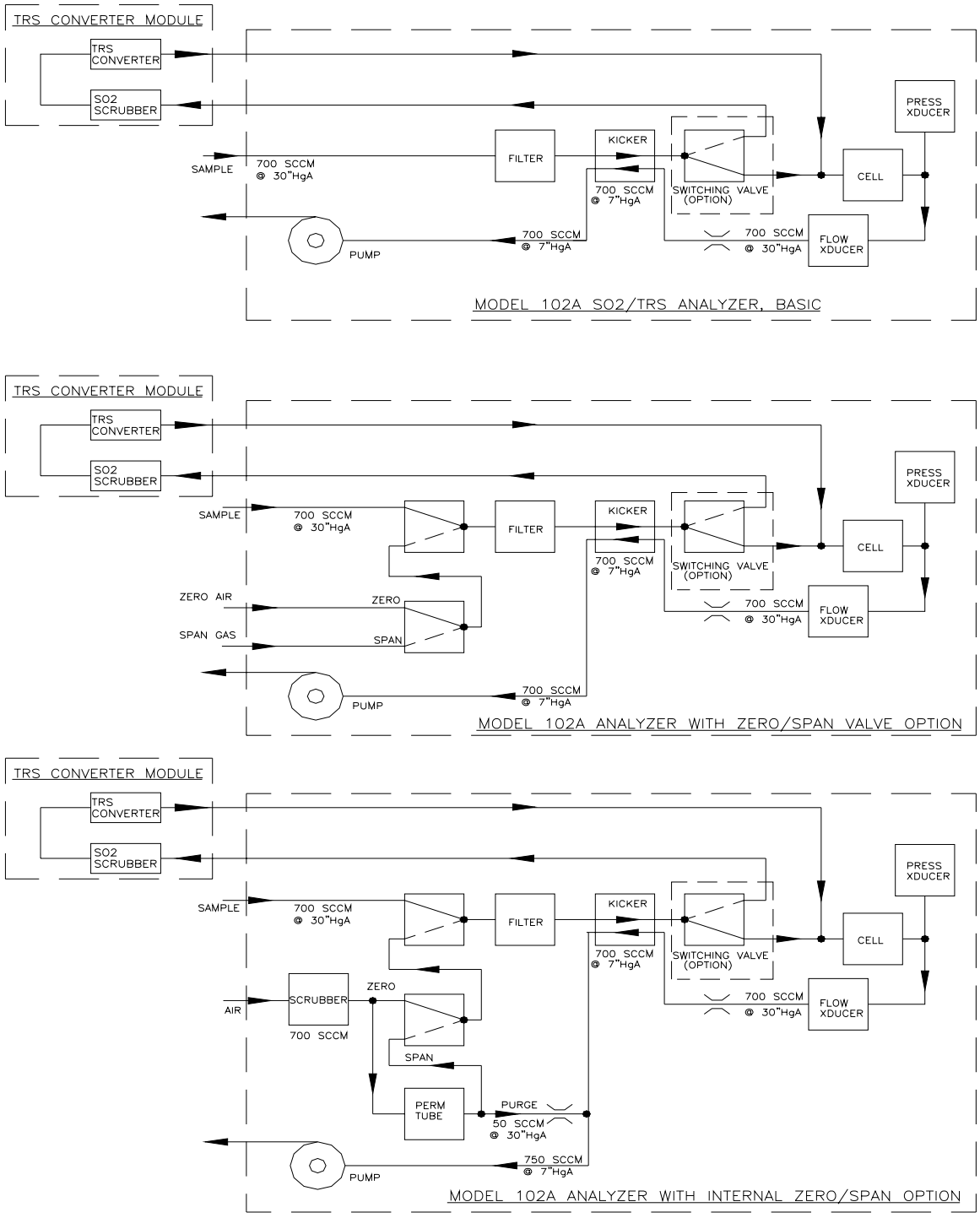
With additional options, the M102A can perform periodic calibrations or calibration checks. Calibration gas can be generated externally using tanks and a diluter, or internally via H2S or SO2 permeation tubes

Figure 1 Pneumatic Diagram



PNEUMATIC DIAGRAM
FIGURE 102A–1 TRS ANALYZER

Figure 2 Pneumatic Diagram



PNEUMATIC DIAGRAM

FIGURE 102A–2 SO2/TRS ANALYZER

2.1 M102A Description

The M102A is similar to a M100A SO2 analyzer. In addition to this manual, a manual for the M100A analyzer(p/n 01472) is included. Section 3.1 of the M100A manual contains specifications for the fluroescent SO2 analyzer, the features and specifications unique to the M102A are listed below.

The M102A fluorescent SO_2 analyzer measures SO2 by the following equations:

$$SO_2 + h\nu_1 \text{ --> } SO_2*$$

$$SO_2* \text{ --> } SO_2 + h\nu_2$$

where $h\nu_1$ is the incident UV energy at 214 nm, and $h\nu_2$ is the resultant fluorescence at 400 nm which is directly proportional to the SO2 concentration in the reaction cell.

The processing and analysis of the sample gas is as follows:

1. Sample gas enters through the "Sample Inlet" port on the M102A rear panel.
2. Particulate matter is removed by the sample filter.
3. Hydrocarbon interferent gasses are removed by a permeation type "hydrocarbon kicker".
4. The sample passes to the M501TRS where SO2 gas is removed by the scrubber.
5. TRS compounds are converted to SO2 by thermal oxidation.
6. The sample returns to the M102A and goes to the sensor assembly, which measures the oxidized TRS compounds as SO2.
7. Leaving the sensor, the sample pressure and flow are measured, then the gas passes through a flow control orifice which determines the overall sample flow rate.
8. The sample, now at low pressure, passes through the outer annulus of the hydrocarbon kicker and then to the sample pump.
9. The pump exhaust is plumbed to the exhaust outlet of the M102A.

The Model 102A pneumatic diagrams are shown in Figures 1 and 2, the M201A mechanical layout is shown in Figure 3 and the M501TRS converter layout is shown in Figure 4.

The M102A is a M100A with following modifications:

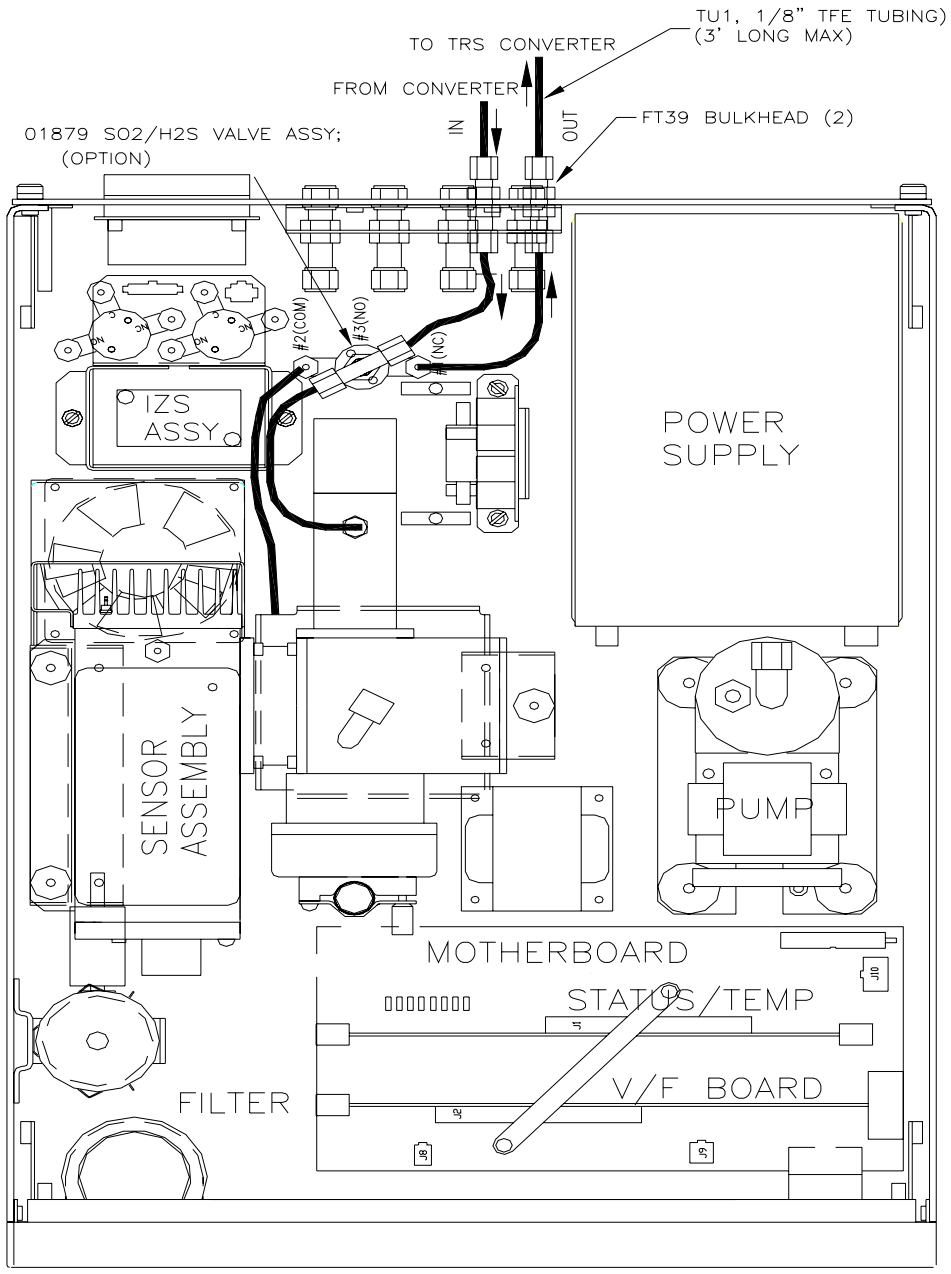
1. The M501NH Thermal TRS converter.
2. An added switching stainless steel valve (optional) to allow TRS and SO2 measurement.
3. Model 102A software.
4. This M102A / M501TRS manual.

2.1.1 IZS Permeation Tube Options

The M102A can be ordered with the IZS option. With this option it is possible to do calibrations or calibration checks on either SO2 or H2S depending on the choice of permeation tube types.

If the optional switching valve (Option 82) is installed, then user can use either SO_2 or H_2S permeation tube source for the calibration check. If the option 82 is not purchased, then user must use the H_2S perm tube only. See M100A manual Section 6.5 for additional information regarding the permeation tube.

Figure 3 - M102A TRS Analyzer Layout



2.1.2 M102A Operating Modes

There are 3 operating modes, which can be selected from the front panel keyboard:

1. TRS only
2. SO2 only
3. TRS/SO2 switching

Availability of operating modes depends on which options are ordered.

2.2 M501TRS Features and Specifications

2.2.1 M501TRS Checkout Sheet

CHECKOUT SHEET

INPUT VOLTAGE_____VAC

HERTZ_____50 / 60 Hz

TEMPERATURE SET-POINT_____ C (1050C MAX)

TEST FLOW_____CCM

H_2S IN_____PPM

H_2S RESPONSE_____PPM

FINAL CONTROLLER SETTINGS, AFTER AUTOTUNING COMPLETE;

SV _____	P-n1_____
P _____	P-n2_____
i _____	P-dF_____
d _____	P-SL_____
7C _____	P-SU_____
HYS_____	P-Ab_____
5rr _____	P-An_____
A7 _____	P-dP_____
LoC_____	P-48_____
	r5 _____
	PUOF _____
	SUOF _____
	P-F _____

2.2.2 Description

The essential components of the Model 501TRS are the SO2 scrubber, and a heated quartz tube.

The Converter permits measurement of TRS concentrations up to 20,000 ppb. TRS is oxidized by flowing the sample gas through a quartz tube heated to ~1000°C.

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

The oxidation process requires that >10% oxygen to be present in the sample stream. The efficiency of the conversion is > 95% with H2S. The only consumable is the SO_2 scrubber media.

See Figure 4 for a plan view of the M501TRS.

The AC power to the heater is controlled by a programmable PID controller and solid state relay.

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

The heater temperature is sensed by a Type-K thermocouple probe inserted in the bore alongside the QUARTZ tube.

WARNING
THE HEATER AND QUARTZ TUBE ARE VERY HOT.
DO NOT TOUCH

Figure 4 - M501TRS Converter Layout

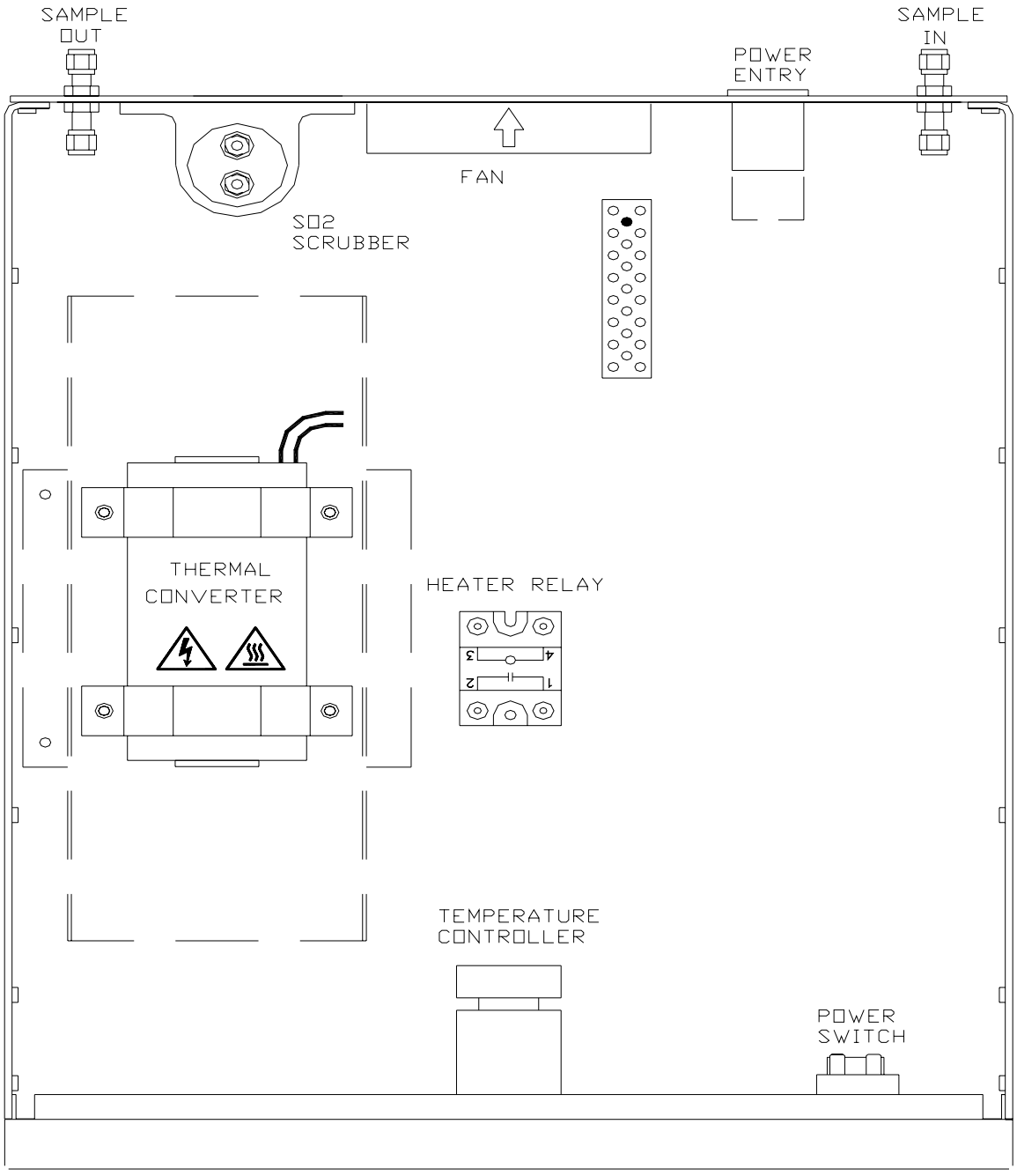


FIGURE 102A-4 M501TRS CONVERTER

2.2.3 M501TRS Specifications

FLOW RATE: 1000 cc/min MAX

TRS CONCENTRATION: 20 ppm MAX

SO_2 CONCENTRATION: 10 ppm MAX

TEMPERATURE SETPOINT: 970°C ± 10%

LOW ALARM SETPOINT: 800°C

HIGH ALARM SETPOINT: 999 °C

CONVERSION EFFICIENCY: ⩾95% for hydrogen sulfide (H_2S)

POWER REQUIREMENT; 115/230 VAC, 50/60 Hz. 450 WATTS

SIZE: 7" (178 mm) HIGH,
17" (432 mm) WIDE,
22" (559 mm) DEEP.

WEIGHT; 18 LBS (8 Kg) STANDARD.

2.2.4 SO2 Scrubber

The SO2 scrubber is mounted at the rear of the TRS converter chassis and contains a room-temperature scrubber material. See Figure 3 for component location. The scrubber removes SO2 from the sample stream by selective adsorption.

The chemical reaction that removes the SO2 requires some water vapor (humidity) to be present in the sample gas. It has been demonstrated that if the sample gas is cooled to below minus 40°C, there is not enough water vapor present for the scrubber to work. If your sample gas is below this temperature the sample should be heated and humidified to above this dew point before it is input into the TRS converter. If there is concern about sample gas humidity and scrubber operation we suggest you contact the Teledyne API factory.

The SO2 scrubber material is consumed as it removes SO2. If the expected concentrations of SO2 are very high, the lifetime of the scrubber will be short. The expected life of the scrubber is approximately 1000 ppm-hours. To check the efficiency of the scrubber, periodically sample SO2 span gas, of 100 ppb (for example), the Analyzer response should be less than 2 ppb.

3.0 TRS SYSTEM INSTALLATION

3.1 Pneumatic and Power Connections

Connect the M501TRS "TO ANALYZER" to the M102A "FROM TRS" fitting.
Connect the M501TRS "FROM ANALYZER" to the M102A "TO TRS" fitting.

Connect the M102A "SAMPLE INLET" fitting using Teflon or stainless steel tubing to the desired sample gas at ambient pressure.

If the appropriate option was ordered, connect the "ZERO IN" port to zero gas at ambient pressure. Connect the "SPAN IN" port to span gas at ambient pressure.

Connect both the M102A and M501TRS to suitable line power of the correct voltage frequency and power handling capability. The power connection must be made by an approved three-wire-grounded power cord. Do not defeat the grounding terminal on the power plug.

Connect the analog outputs on the M102A rear panel per the following table.

Analog Output Pin Assignments

PIN No	ASSIGNMENT
1	+ SO2
2	- SO2
3	+ TRS
4	- TRS
5	
6	
7	+ TEST CHANNEL
8	- TEST CHANNEL

BE SURE THAT THE VENTILATION SLOTS IN THE SIDES
AND THE FAN AT THE REAR OF THE ANALYZER
ARE UNOBSTRUCTED.

WARNING

THE CERAMIC HEATING ELEMENT
AND THE QUARTZ TUBE
ARE VERY HOT

The overall pneumatic diagram of the M102A / M501TRS System is shown in Figure 2.4.

3.2 Calibration

The M102A is calibrated as follows:

Note: Refer to Section 7 of the M100A manual for general information on calibration.

Note: This example uses a value of 400 ppb SO2 and 400 ppb H2S for span gas concentrations, other values may be used.

1. Attach a calibrator to the sample gas port of the M102A.

2. Set the calibrator to deliver zero gas to the analyzer. After stabilization, set the instrument zero point.

3. Set the calibrator to deliver 400 ppb SO2. Bypass the M501TRS converter at the rear panel of the M201A. Allow the instrument to sample span gas, after stabilization, set the instrument span point for SO2 gas.

4. Now check the scrubber efficiency. Re-connect the M501TRS converter. The SO2 scrubber in the Converter should now be removing all 400 ppb of the SO2 gas. The instrument front panel should read 0 ± 4 ppb.

5. Set the calibrator to deliver 400 ppb H2S. After stabiliaztion, H2S concentration value should be read 380 to 400 ppb H2S (95 – 100 % conversion efficiency). NOTE: Be sure to allow for calibrator dilution and span gas tank calibration errors when assessing the conversion efficiency.

NOTE: If the efficiency is less than 95% from step 5 above, you can adjust the temperature of he converter. The general rules are: 1. Adjust the converter in 10^{o}C steps up or down. 2. Do not deviate more than 10% from the temperature set at the factory.

NOTE: Increasing the Converter temperature may have the undesirable side effect of increasing the conversion efficiency of other sulfur compounds that are not supposed to be measured.

3.3 M102A Software and Setup

The operation of the M102A is similar to the M100A. Refer to the accompanying M100A manual for more information. The M102A software allows the selection of 3 operating modes:

SO2 only
TRS only
SO2 - TRS switching mode (with Option 82)

To select the measurement mode;
Press SETUP-MORE-VARS,
Press ENTR for the password 818 (refer to the M100A manual Section 5.3.9).
Press NEXT until MEAS_MODE is shown.

To change the mode,
Press EDIT,
enter one of the following setting numbers;

MEAS_MODE Setup Variable Settings	
Value	**Description**
400	Measures SO2 only.
401 (default)	Alternately measures SO2 and TRS. Calibration check initiated by automatic timers or contact closures expects using SO2 span gas.
402	Measures TRS only.
403	Alternately measures SO2 and TRS. Calibration check initiated by automatic timers or contact closures expects using TRS span gas.

For example, if switching SO2/TRS mode is selected and SO2 span gas will be used for calibration, then set 401 for the MEAS_MODE above**.** The SO2/TRS switching is disabled during the calibration.

Range modes:

Single Range Mode
In this mode all the measured gases use the same range.

Independent Range Mode
In this mode, SO_2 and TRS can have a different range.

Auto-RangeMode
In this mode, both SO2 and TRS share the same range, and the range automatically changes between a low and a high range, depending on the concentration.

To select the Range Mode, press SETUP-RNGE-MODE, then press press MODE, then select the desired range mode. After finishing, press EXIT to return to SAMPLE mode.

3.4 M501TRS Converter Temperature

The temperature is maintained by a front panel-mounted programmable controller. The controller uses a PID algorithm to maintain the temperature and has AutoTune capabilities.

NOTE: Changing the Converter temperature may have the undesirable side effect of changing the conversion efficiency of other sulfur compounds that are not supposed to be measured.

To display the current temperature:

Press the PV/SV button. This button toggles between the PV – present value and SV – setpoint value. LED's along the left side of the display indicate which temperature is being displayed.

The initial control parameters have been set at the factory, see specifications in Section 2.3.3. Depending on the measurement environment, further adjustments may be necessary.

To adjust the temperature, follow these steps:

1. Select SV with the PV/SV button,

2. With the Set-Point value displayed, press the up-arrow under the digit you want to change, (the digit will flash),

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 the other two digits,

5. Press the ENT button.

If the temperature is oscillating excessively around the setpoint, it may be necessary to repeat the AutoTune procedure.

To AutoTune the PID controller:

1. Allow temperature to equilibrate for a minimum of 30 to 45 minutes.

2. Scroll display to the AT parameter.

3. Press DATA, scroll up arrow to 1, press ENT.

4. When the decimal goes off, the process is complete. During the AutoTuning process the decimal point will blink, indicating progress. During the AutoTune cycle the temperature may overshoot/undershoot 100°C.

After temperature adjustments, the instrument calibration should be rechecked.

1. Calibrate the SO_2 analyzer by sampling a known SO_2 source. Bypass the M501TRS for this operation.

10. Sample an air/H_2S mixture and allow the SO_2 analyzer to stabilize.

11. Without changing the flow rate, lower the set-point temperature in 5C increments allowing 10 minutes minimum between increments until a drop of approximately 1% Full Scale is observed. Note the Thermal Converter temperature. Increase the set-point temperature in 5C increments allowing 10 minutes minimum between increments until a drop of approximately 1% Full Scale is observed. Note the Thermal Converter temperature. Set the set-point value to fall midway between the low and high temperatures.

No further adjustments must be made as long as the flow rate through the analyzer is not changed.

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

3.3.1 M501TRS Alarm Relay Adjustment

There is an over/under temperature alarm relay on the rear panel of the M501TRS. 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, maximum values.

Set the alarm points as follows. With the M501TRS powered up:

1. Press SEL
2. Scroll to AL (Low Alarm setpoint)

3. Press DATA
4. Press the UP/DOWN arrow keys until the desired value is displayed
5. Press ENT
6. Scroll to AH (High Alarm setpoint)
7. Press DATA
8. Press the UP/DOWN arrow keys until the desired value is displayed
9. Press ENT
10. Press PV/SV

3.3.2 Temperature Controller Programming guide

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

In the event that the control parameters are changed or in the event that a new controller is installed, it must be reprogrammed to suit the thermal characteristics of the instrument.

PROGRAMMING GUIDE

PRESS	DISPLAY	ACTION
SEL	P PROP BAND	UP/DOWN SET TO 7.7
SEL	i INTEGRAL	SET TO 45
SEL	d DERIVATIVE TIME	SET TO 8.7
SEL	AL LOW ALARM SETPOINT	SET TO 50C BELOW FINAL SETPOINT
SEL	AH HIHG ALARM SETPOINT	SET TO 50C ABOVE FINAL SETPOINT
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

NOTE: Refer to FUJI PXZ Series Manual for more information.

SECONDARY MENU (Fixed characteristics of the temperature controller).

PRESS	DISPLAY	ACTION
SEL HOLD TILL p-n1		SET TO 0
SEL HOLD TILL p-n2		SET TO 3 = TYPE K THERMOCOUPLE
SEL	p-dF DIGINAL FILTER	SET TO 5
SEL	P-SL LOWER LIMIT	DEFAULT = 32
SEL	P-SU UPPER LIMIT	SET TO 1050 (1050C)
SEL	P-AL ALARM TYPE2	SET TO 0
SEL	P-AH ALARM TYPE 1	SET TO 0
SEL	P-An HYTERESIS	NONE
SEL	P-dP PROGRAMMABLE DECIMAL	SET TO 0
SEL	PVOF PROCESS OFFSET	LEAVE AT 0
SEL	SVOF SET POINT OFFSET	LEAVE AT 0
SEL	P-F	SET TO 0 (0= CENTIGRADE) (1 = FAHRENHEIT)
SEL	FUZZY FUZZY LOGIC	SET TO ON

NOTE: Refer to FUJI PXZ Series Manual for more information.

4.0 TROUBLESHOOTING

NO POWER	Plugged in? Switched on? Circuit breaker OK?
NOT HEATING	PV/SV switch to PV. Is it heating? PV/SV switch to SV. Set point correct? Socket in place on back of controller?
SO_2 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? (1000 ccm or less) Too cool? Increase temperature, 1050C MAX. Span gas correct? Contaminated? Check inside of Teflon tubing.

NOTE:

FOR SERVICE/REPLACEMENT OF THE QUARTZ TUBE, THE COVER MUST BE REMOVED AND THE FRONT PANEL MOUNTING NUTS MUST BE REMOVED FROM THE INSIDE. THE FRONT FANEL CAN THEN BE ROTATED DOWN ON ITS HINGES TO ACCESS THE QUARTZ TUBE.

5.0 SPARE PARTS

TELEDYNE API NUMBER	DESCRIPTION
CP17	TEMPERATURE CONTROLLER
RL20	RELAY
FA6	FAN
HE7	HEATER
TH003	THERMOCOUPLE PROBE
02271	TUBE, QUARTZ, 10mm OD
02978	TRANSFORMER
FT77	REDUCER (1/4”X1/8”)
03395	ELBOW UNION (10mmX1/4”)
03396	TERMOSTAT
CH17	SO_2 SCRUBBER MEDIA