

Process Control Instruments

Model TMO2D-TC Thermal Conductivity Analyzer

User's Manual

910-146A2



GE Panametrics



TM02-TC Thermal Conductivity Transmitter with TMO2D

Warranty

Each instrument manufactured by GE Panametrics is warranted to be free from defects in material and workmanship. Liability under this warranty is limited to restoring the instrument to normal operation or replacing the instrument, at the sole discretion of GE Panametrics. Fuses and batteries are specifically excluded from any liability. This warranty is effective from the date of delivery to the original purchaser. If GE Panametrics determines that the equipment was defective, the warranty period is:

- one year for general electronic failures of the instrument
- one year for mechanical failures of the transducers

If GE Panametrics determines that the equipment was damaged by misuse, improper installation, the use of unauthorized replacement parts, or operating conditions outside the guidelines specified by GE Panametrics, the repairs are not covered under this warranty.

The warranties set forth herein are exclusive and are in lieu of all other warranties whether statutory, express or implied (including warranties or merchantability and fitness for a particular purpose, and warranties arising from course of dealing or usage or trade).

Return Policy

If a GE Panametrics instrument malfunctions within the warranty period, the following procedure must be completed:

1. Notify GE Panametrics, giving full details of the problem, and provide the model number and serial number of the instrument. If the nature of the problem indicates the need for factory service, GE Panametrics will issue a RETURN AUTHORIZATION NUMBER (RAN), and shipping instructions for the return of the instrument to a service center will be provided.
2. If GE Panametrics instructs you to send your instrument to a service center, it must be shipped prepaid to the authorized repair station indicated in the shipping instructions.
3. Upon receipt, GE Panametrics will evaluate the instrument to determine the cause of the malfunction.

Then, one of the following courses of action will then be taken:

- If the damage is covered under the terms of the warranty, the instrument will be repaired at no cost to the owner and returned.
- If GE Panametrics determines that the damage is not covered under the terms of the warranty, or if the warranty has expired, an estimate for the cost of the repairs at standard rates will be provided. Upon receipt of the owner's approval to proceed, the instrument will be repaired and returned.

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Chapter 1

Features and Capabilities

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Overview

This chapter will introduce you to the features and capabilities of the GE Panametrics TMO2D-TC Thermal Conductivity Analyzer. You will find the following topics discussed:

- Introduction — A discussion of the TMO2D-TC Analyzer features and capabilities.
- Theory of Operation — Details on TMO2-TC Transmitter construction and how the measurement is made.
- System Description — A detailed description of the basic TMO2D-TC Analyzer and available options, and sample systems.
- Typical Applications — A brief discussion of industries and applications where the TMO2D-TC can be used, along with two common applications and the required TMO2D-TC configurations.

TMO2D-TC technical specifications can be found in Chapter 6, *Specifications*. Ordering information can be found in Chapter 7, *Ordering Information*.

Introduction

The GE Panametrics TMO2D-TC is an analyzer that measures the thermal conductivity of a binary (or pseudo-binary) gas mixture, determines and displays the concentration of one of the gases in the mixture, and also provides 0/4-20 mA and RS232C outputs and alarm relays for process control requirements. The TMO2D-TC consists of two main components — the TMO2-TC Transmitter and the TMO2D-TC Display.

The TMO2-TC Transmitter offers several unique design features:

- Ultra-stable thermistors and a temperature-controlled measuring cell (55 °C standard, or 70 °C optional) provide excellent zero and span stability, as well as insensitivity to ambient temperature variations.
- The measuring cell design makes it resistant to contamination and essentially flow insensitive. Since it has no moving parts, the transmitter can handle the shock and vibration found in many industrial applications.
- You can select a 2-port version for measurement of zero-based gas mixtures using a sealed reference gas (air), or 4-port version for measurement of zero-suppressed gas mixtures (and some other special calibrations) using a flowing reference gas.

Introduction (cont.)

- The TMO2-TC modular construction means that the unit can be field-calibrated quickly and easily; or the plug-in measuring cell can be replaced with a pre-calibrated spare in minutes.
- The TMO2-TC Transmitter, with weatherproof and explosion-proof packaging, is designed to be installed as close as possible to the process sample point. It can be located up to 2,800 feet (850 meters) from the TMO2D-TC Display using inexpensive, unshielded cable.

The TMO2D-TC Display offers several advanced features:

- The microprocessor-based TMO2D-TC electronics unit features a two-line, backlit LCD display, full keypad, and menu-driven software to provide easy access to a variety of features, including user-selectable gas range, recorder output range, alarm settings, and automatic calibration (Auto Cal).
- Standard 0/4-20 mA output and dual Form C alarm relays, coupled with optional dual isolated 0/4-20 mA outputs and dual relays for Auto Cal, provide excellent flexibility for process control applications.
- Long-term, hands-off performance is provided by Auto Cal. When re calibration is desired, the TMO2D-TC controls solenoid valves in the sample system to bring zero and span gases to the TMO2-TC Transmitter. Then, TMO2D-TC software compares the Auto Cal readings with factory calibration data and makes any necessary corrections -automatically - so manual re calibration requirements can be reduced significantly.
- The TMO2D-TC Display, with bench, rack, panel, weatherproof, and explosion-proof packaging options, can be located adjacent to the TMO2-TC Transmitter, or up to 2,800 feet (850 meters) away using inexpensive, unshielded cable.

Theory of Operation

The TMO2-TC Transmitter measures the concentration of a gas in a binary gas mixture by measuring the thermal conductivity of the sample gas and comparing it to the thermal conductivity of a selected reference gas.

Two ultra-stable, glass-coated thermistors are used: one in contact with the sample gas, and the other in contact with a selected reference gas. The thermistors are mounted so that they are in close proximity to the stainless steel walls of the sample chamber. The entire sensor is heated to 55 °C (or 70 °C) and the thermistors are heated above the sensor temperature using a constant current source. The thermistors lose heat to the walls of the sample chamber at a rate that is proportional to the thermal conductivity of the gas surrounding them. Thus, each thermistor will reach a different equilibrium temperature. The temperature difference between the two thermistors is detected in an electrical bridge circuit. It is amplified and converted to a 4-20 mA output proportional to the concentration of one of the constituents of the binary gas mixture.

Appendix A contains a Table of Relative Thermal Conductivity of Common Gases. Figure 1-1 on the next page shows several of these values graphically. In order to measure 0 to 25% H₂ in N₂, the reference gas would be air (2-port version, sealed reference gas), and, for calibration, the zero gas would be 100% N₂ (i.e., 0 % H₂) and the span gas 25% H₂ (balance N₂). In order to measure 90-100% H₂ in N₂, the reference gas would be 100% H₂ (4-port version, flowing reference gas), the zero gas would be 90% H₂ (balance N₂), and the span gas 100% H₂ (the same as the reference gas).

The TMO2-TC has a polarity adjustment switch which permits the measurement of gases (such as CO₂) with relative thermal conductivity less than the background gas.

Theory of Operation (cont.)

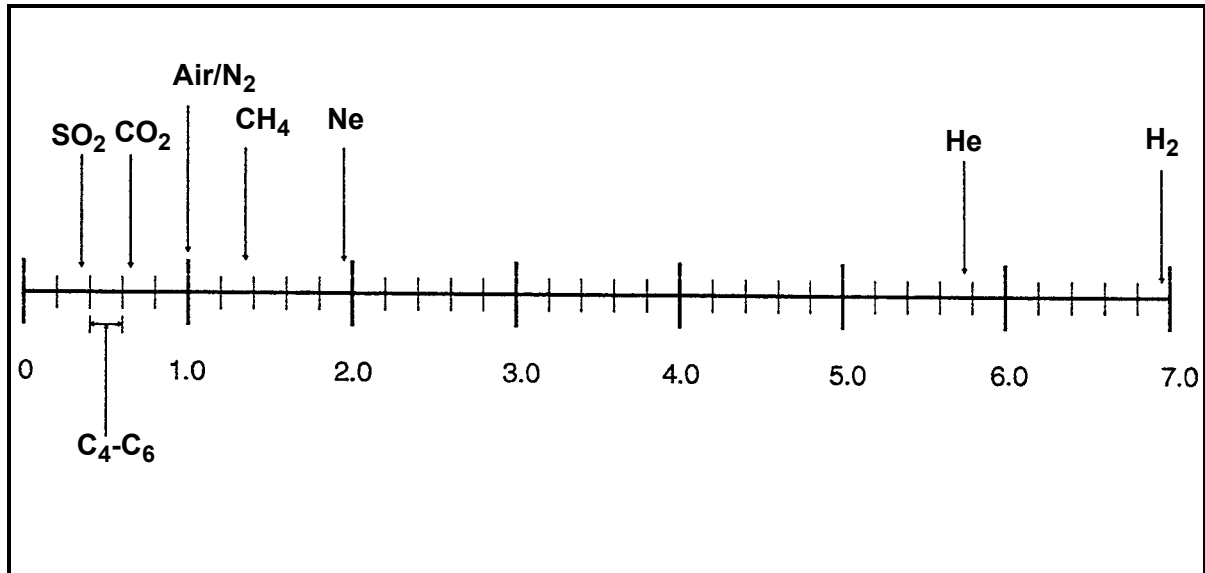


Figure 1-1: Relative Thermal Conductivity of Several Common Gases

System Description

The basic TMO2D-TC measurement system consists of a TMO2-TC Transmitter mounted in a sample system and connected to a TMO2D-TC Display. The sample system is mandatory, and can be provided by GE Panametrics or constructed according to our recommendations. The TMO2D-TC is supplied with a standard 10 ft. (3 m), 3-wire cable for connecting the transmitter to the display module. Lengths up to 2,800 ft. (850 m) are optionally available.

TMO2-TC Transmitter

The TMO2-TC Transmitter is self-contained, consisting of the thermal conductivity sensor and associated electronics. It requires 24 VDC power (1 amp maximum at power-up), which it receives from the TMO2D-TC Display. It provides a 4-20 mA output signal to the display module proportional to the thermal conductivity of the sample gas and to the concentration of one of the gases in the binary mixture.

The TMO2-TC is designed to be installed in a sample system as close as possible to the process sample point. Thus, it is available in two environmental packages — weatherproof (NEMA-4X; IP65) and explosion-proof (Class I, Groups C,D, Div. 1; Cenelec EEx d II C T6) with the addition of flame arrestors to the sample/reference gas inlet and outlet.

Each environmental package is available in a standard 2-port (sealed reference gas) version, or optional 4-port (flowing reference gas) version.

2-Port (Sealed Reference Gas) Version

This standard configuration (see Figure 1-2 below) is used for zero-based ranges with air or nitrogen at atmospheric pressure as the balance or background gas. It utilizes air with desiccant in a factory-sealed chamber as the reference gas. The following standard ranges and gases are provided:

0 to 1%
0 to 2%
0 to 5%
0 to 10%
0 to 25%
0 to 50%
0 to 100%

H₂ in N₂
CO₂ in N₂ (minimum range 0 to 5% CO₂)
CO₂ in Air (minimum range 0 to 5% CO₂)
He in N₂
He in Air

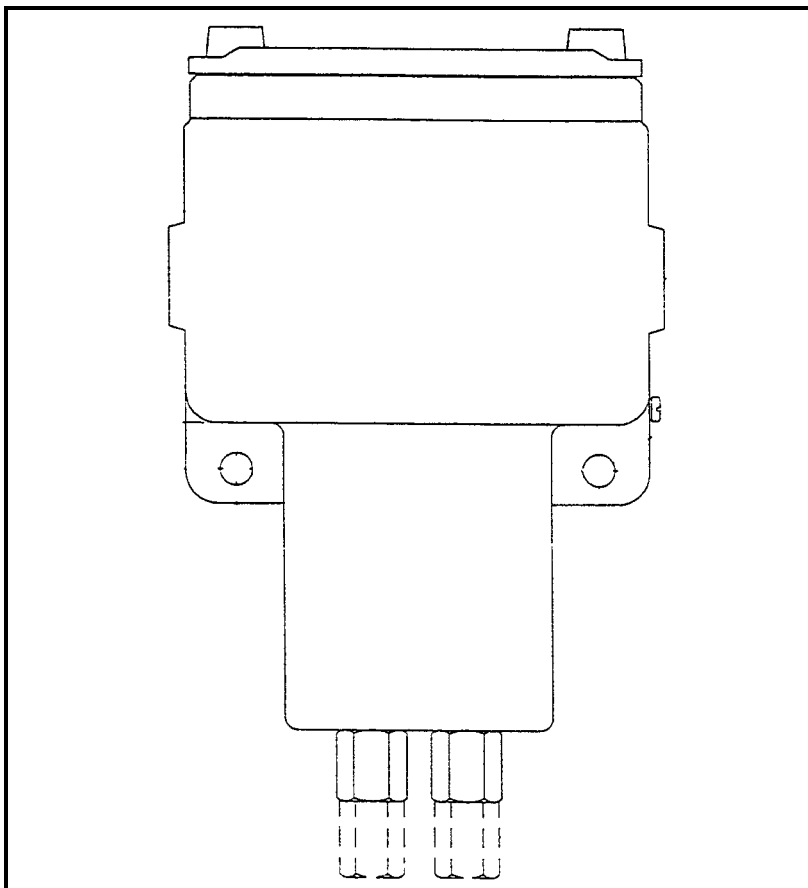


Figure 1-2: 2-Port (Sealed Reference Gas) TMO2-TC

4-Port (Flowing Reference Gas) Version

This optional configuration (see Figure 1-3 on the following page) is used for zero-suppressed ranges and some other special applications. Typically, a flowing reference gas of 100% H₂ or CO₂ is used. The following standard ranges and gases are provided:

90 to 100%

80 to 100%

H₂ in N₂

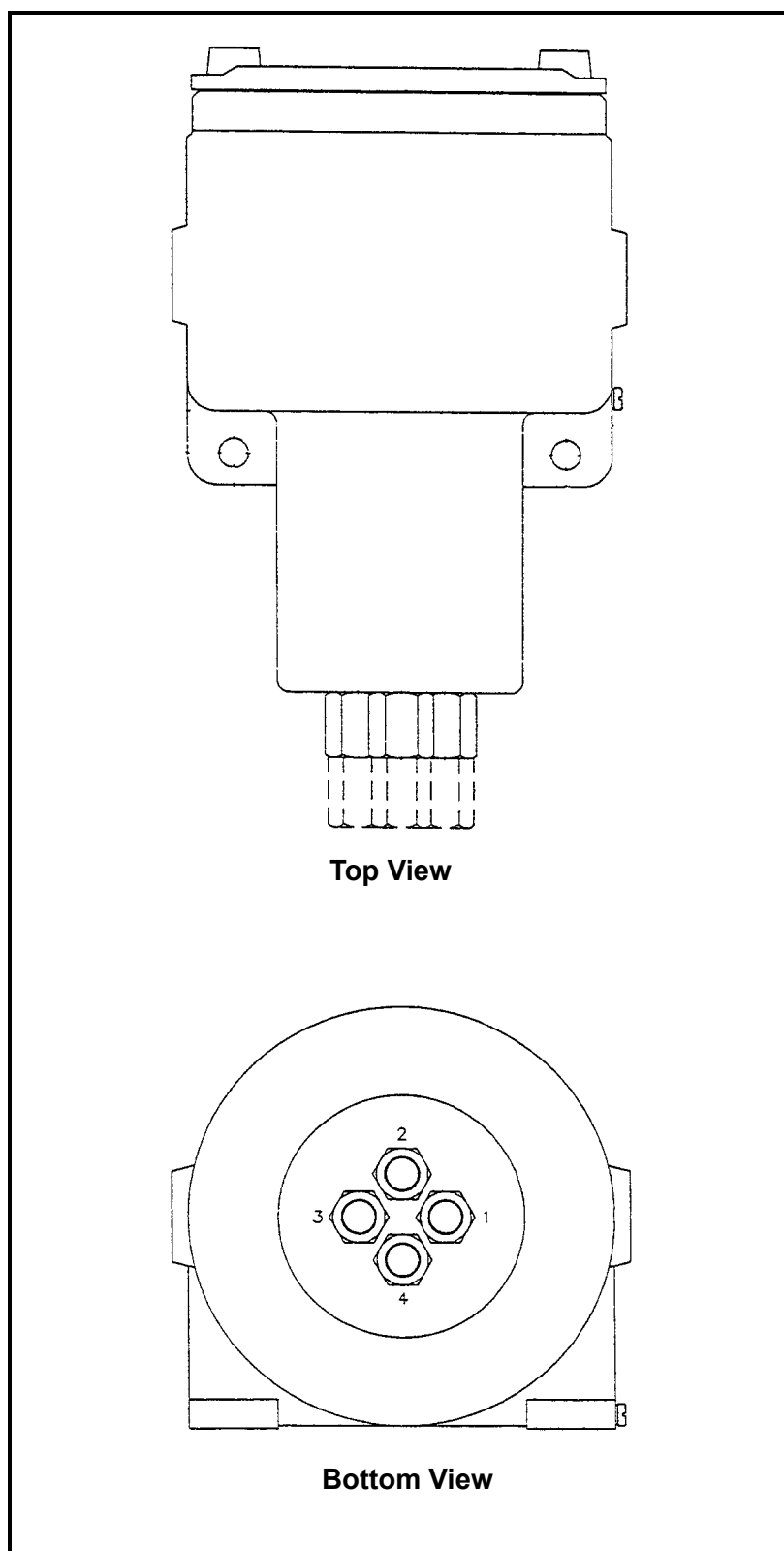
CO₂ in N₂/Air

He in N₂/Air

Note: *For factory calibration pricing on the standard ranges and gases, or for pricing on other zero-suppressed ranges and gases, please consult the factory.*

The TMO2-TC is supplied with a standard measurement cell operating temperature of 55 °C. An optional 70 °C cell operating temperature is available.

Note: *The 70 °C operating temperature should be selected only for high temperature applications, since it will result in reduced sensitivity.*

4-Port (Flowing Reference Gas) Version (cont.)**Figure 1-3: 4-Port (Flowing Reference Gas) TMO2-TC**

Sample System

A sample system is mandatory for use with the TMO2-TC. The design of the sample system will depend on the conditions of the sample gas and the requirements of the application. In general, a sample system must deliver a clean, representative sample to the TMO2-TC at a temperature, pressure, and flow rate that are within acceptable limits. Standard TMO2-TC sample conditions are as follows:

- Less than 50 °C (122 °F) temperature (for 55 °C cell operating temperature)
- Atmospheric pressure
- 0.5 SCFH (250 cc/min) flow rate

GE Panametrics offers sample systems for a wide variety of applications. Three standard sample systems for the TMO2-TC are shown in Chapter 2, *Installation*. For assistance in designing your own sample system, please consult the factory.

TMO2D-TC Display

The TMO2D-TC Display receives a 4-20 mA signal from the TMO2-TC Transmitter proportional to the concentration of one of the gases in the binary mixture (the sample gas). It then displays the concentration (and other information) on a 2-line x 24 character, backlit LCD.

It requires 100/120/220/240 VAC power (35 watts max.), and provides 24 VDC power to the TMO2-TC Transmitter. The standard TMO2D-TC provides a 0/4-20 mA analog output; an RS232C digital output; and dual Form C, SPDT relays for process monitoring and control. Dual isolated 0/4-20 mA outputs and a second pair of relays for Auto Cal are available as options.

The TMO2D-TC can be located adjacent to the TMO2-TC Transmitter or as far as 2,800 ft. (850 m) away. It is provided in bench, rack, panel, weatherproof (NEMA 4X; IP65), or explosion-proof mounting configurations. The standard TMO2D-TC is suitable for use in general purpose areas. A package suitable for use in Class I, Div. 2 hazardous areas is available as an option. This package includes hermetically-sealed alarm relays.

Extra Cable (optional)

GE Panametrics provides a 10 ft. (3 m) length of 3-wire, color-coded cable with each TMO2D-TC to connect the transmitter to the display module. The same cable is available in lengths up to 2,800 ft (850 m). If you are using your own cable, refer to Chapter 2, Table 2-2, *Cable Requirements*, for recommendations.

Typical Applications

The TMO2D-TC can be used in a wide variety of industrial applications where it is necessary to measure the concentration of one component of a binary gas mixture. It can also be used in pseudo-binary gas mixtures where the ratio of concentrations of the background gas components remains constant, and in gaseous mixtures where the thermal conductivity of the gas of interest is significantly different from that of the background gas. Some typical industries and applications include:

- Metals Industry —
H₂ in heat treat furnace atmospheres
- Electric Power Industry —
H₂ in generator cooling systems
- Gas Production Industry —
Purity monitoring of argon, hydrogen, nitrogen, helium
- Chemical Industry —
H₂ in ammonia synthesis gas
H₂ in methanol synthesis gas
H₂ in chlorine plants
- Food Industry —
CO₂ in fermentation processes
Ethylene Oxide (ETO) sterilization
- Steel Industry —
H₂ in blast furnace top gas
- Petroleum Industry —
H₂ in hydrocarbon streams

Two very common applications are as follows:

1. H₂ in N₂ in heat treat furnace atmospheres - Zero-based 0-25% H₂, 2-Port (sealed reference gas, air)
2. H₂ purity in H₂ electricity generator cooling - Zero-suppressed, 80-100% H₂, 4-Port (flowing reference gas, 100% H₂)

For more details on these applications, refer to Appendix B, *Applications*. For details on applications not shown in Appendix B, or if you wish to discuss your own application, please consult the factory.

Chapter 2

Installation

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Overview

This chapter will describe how to mount and wire the TMO2-TC Transmitter and its sample system, and the TMO2D-TC Display. You will find the following topics discussed:

- Introduction — A brief discussion of installation steps.
- Mounting the TMO2-TC Transmitter — How to mount the transmitter in a sample system.
- Mounting the Sample System — Mounting and plumbing a GE Panametrics sample system. Includes drawings of basic 2-Port and 4-Port sample systems, and an automatic 2-Port sample system.
- Mounting the TMO2D-TC Display — How to mount the different TMO2D-TC packaging configurations.
- Wiring the TMO2-TC Transmitter — How to connect the transmitter to the display module.
- Wiring the TMO2D-TC Display — Connecting 100/120/220/240 VAC power, 0/4-20 mA output and alarm relay wiring to the TMO2D-TC.

!WARNING!

TO ENSURE THE SAFE OPERATION OF THE TMO2D-TC, YOU MUST INSTALL AND OPERATE IT AS DESCRIBED IN THIS MANUAL. IN ADDITION, BE SURE TO FOLLOW ALL APPLICABLE SAFETY CODES AND REGULATIONS FOR INSTALLING ELECTRICAL EQUIPMENT IN YOUR AREA.

PROCEDURES SHOULD BE PERFORMED BY TRAINED SERVICE PERSONNEL.

**!ATTENTION EUROPEAN CUSTOMERS!
IN ORDER TO MEET CE MARK REQUIREMENTS,
YOU MUST INSTALL CABLES AS DESCRIBED IN
APPENDIX H.**

Note: *Different versions of the TMO2D-TC display have different PC boards. In Appendix C refer to the appropriate drawings, as follows:*

- *Serial numbers 101 through 749, schematic 700-997 and PCB assembly drawing 703-997.*
- *Serial numbers 750 or greater, schematics 700-1226 and PCB assembly drawing 703-1226.*

Introduction

Installation of the TMO2D-TC analyzer typically consists of five steps:

1. Mounting the TMO2-TC Transmitter in a sample system. (If you purchased your sample system from GE Panametrics, this step has already been done for you.)
2. Mounting, plumbing (and possibly wiring) the sample system.
3. Mounting the TMO2D-TC Display.
4. Making wiring connections between the transmitter and the display module.
5. Making wiring connections to the TMO2D-TC Display for power, outputs, and alarms.

Mounting the TMO2-TC Transmitter

This section applies only if you are mounting the TMO2-TC Transmitter to a sample system that has not been supplied by GE Panametrics.

Your sample system should deliver a clean, representative sample to the TMO2-TC at the proper temperature, pressure and flow rate. This usually means a clean, dry sample (free of solid and liquid particulates) at atmospheric pressure; a temperature no greater than 50 °C (122 °F); and a flow rate of approximately 0.5 SCFH (250 cc/min). Factory calibration of the sensor is at atmospheric pressure and 0.5 SCFH - higher or lower operating pressures may necessitate field-calibration adjustment.

A simple sample system for a 2-Port TMO2-TC might have an inlet and/or outlet flow regulating needle valve; a flow meter; and a pressure gauge, in addition to the TMO2-TC Transmitter.

The TMO2-TC Transmitter should be mounted in the sample system so that it is upright and level to within $\pm 15^\circ$. Also, provide at least 9" of clearance above the top cover of the transmitter to allow access to the transmitter printed circuit board (PCB) for calibration and maintenance. For a 2-Port TMO2-TC, connect the sample system Sample Inlet and Sample Outlet portions to the appropriate TMO2-TC port (see Drawing 712-225 in Appendix C for port location). For a 4-Port system, also connect the Reference Inlet and Reference Outlet portions to the appropriate TMO2-TC port (see Drawing 712-226 in Appendix C for port location).

!WARNING!
FOR EXPLOSION-PROOF UNITS, BE SURE TO
CONFORM TO ALL SAFETY AND ELECTRICAL
CODE REQUIREMENTS.

Mounting the Sample System

You can order a complete sample system, which includes the TMO2-TC Transmitter and all necessary components and sample tubing mounted on a metal panel, from GE Panametrics. Several standard sample systems are available; and custom-designed sample systems can be built to your exact specifications. Following are descriptions of three standard sample systems:

Manual, 2-Port (Sealed Reference Gas) Sample System

Figure 2-1 below shows a basic sample system for a 2-Port (sealed reference gas) TMO2-TC. This sample system consists of inlet needle valves for sample, zero, and span gases; a ball valve; a 2-port TMO2-TC; a pressure gauge; and a flow meter. All components are mounted on a painted steel plate. Other components could be added for filtration (filter/coalescer), pressure control (regulator), or flow control (pump).

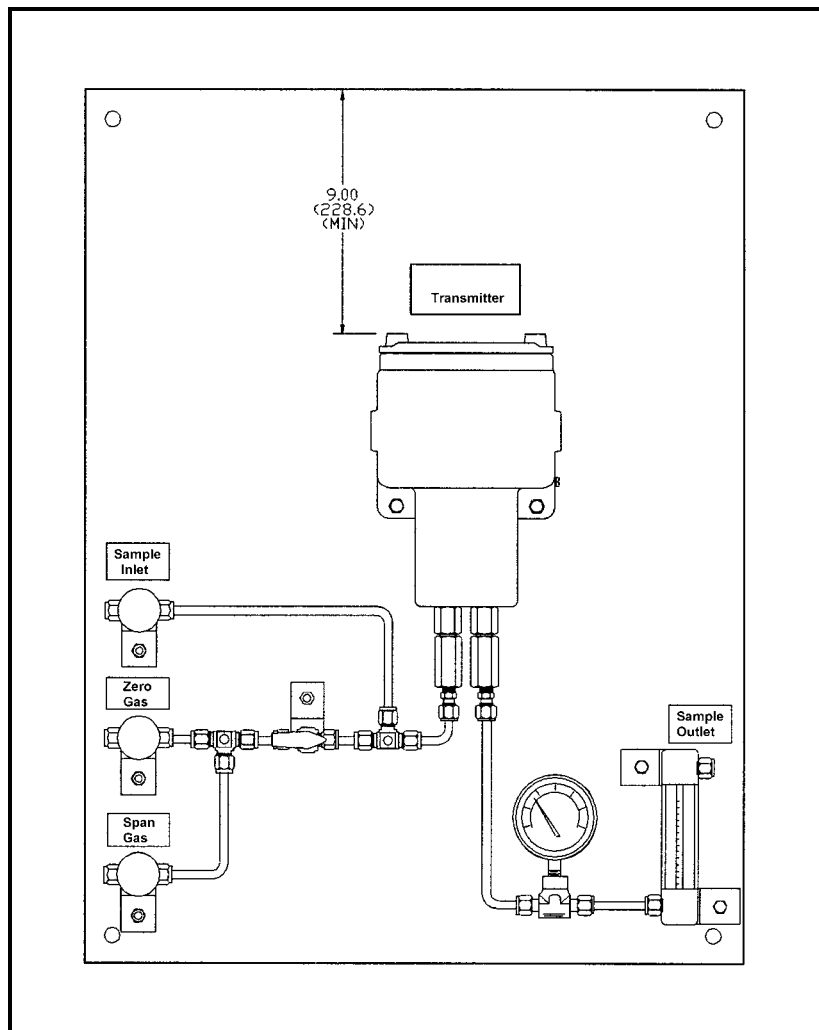


Figure 2-1: Basic Sample System for a 2-Port TMO2-TC

Manual, 4-Port (Flowing Reference Gas) Sample System

Figure 2-2 below shows a basic sample system for a 4-Port (flowing reference gas) TMO2-TC. This sample system consists of inlet needle valves for sample, reference, and calibration gases; a 4-port TMO2-TC; two pressure gauges; and two flow meters. All components are mounted on a painted steel plate. Other components could be added for filtration (filter/coalescer), pressure control (regulator), or flow control (pump).

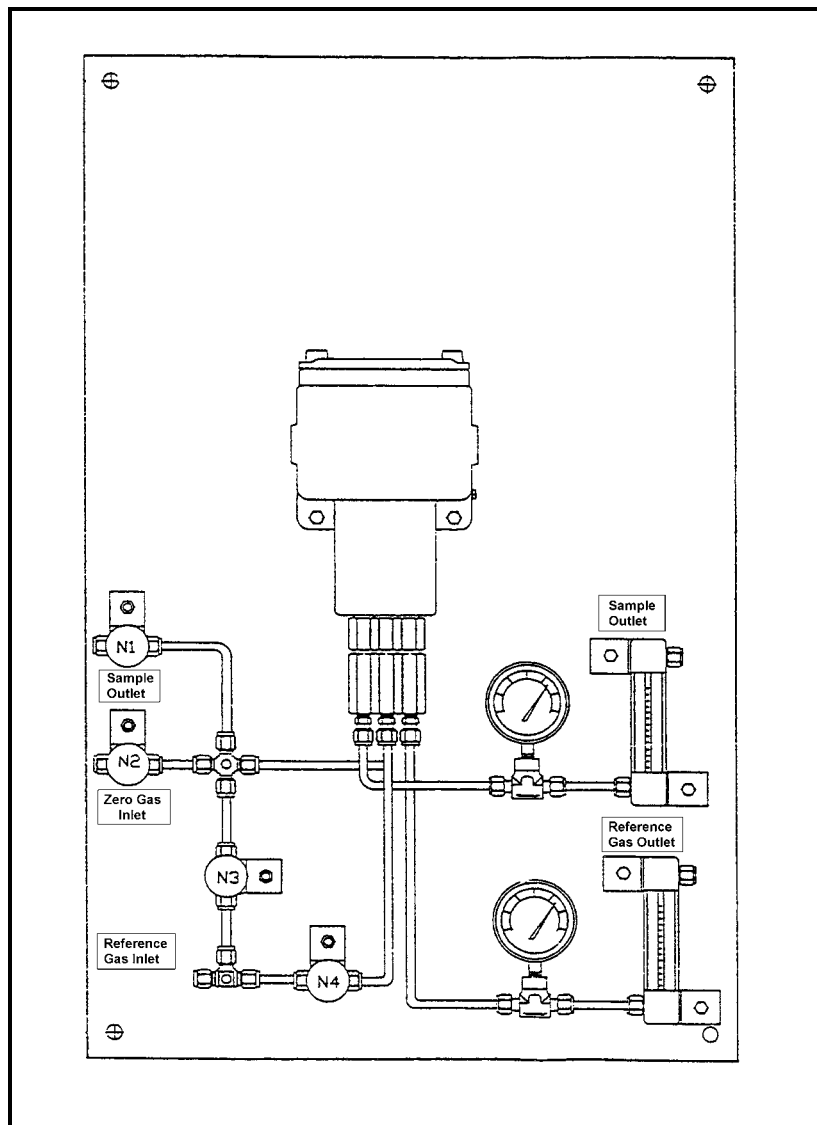
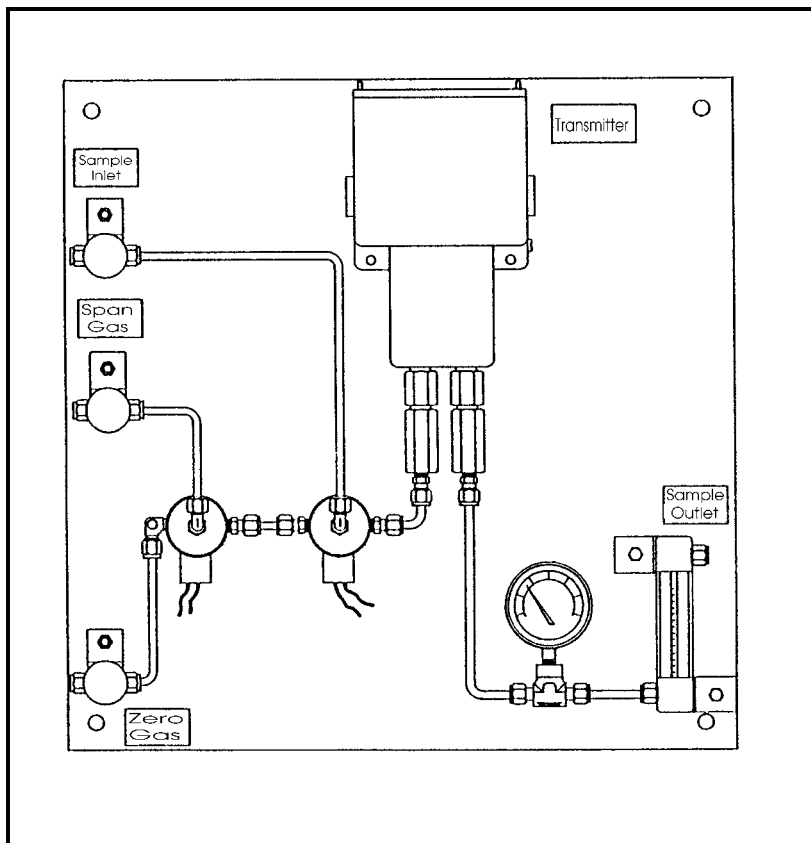


Figure 2-2: Basic Sample System for a 4-Port TMO2-TC

Automatic, 2-Port (Sealed Reference Gas) Sample System

Figure 2-3 below shows an automatic sample system for a 2-Port (sealed reference gas) TMO2-TC. This sample system requires the Auto Cal option on the TMO2D-TC Display. It consists of inlet needle valves for sample, zero, span, and optional calibration gases; two electrically-actuated solenoid valves for gas selection; a 2-Port TMO2-TC; a pressure gauge; a flowmeter; a regulating needle valve; and a sample pump. All components are mounted on a painted steel plate. Other components could be added for filtration (filter/coalescer), or pressure control (regulator).



**Figure 2-3: Automatic Sample System
for a 2-Port TMO2-TC**

Automatic, 2-Port
(Sealed Reference Gas)
Sample System (cont.)

When used in conjunction with the TMO2D-TC Display with the Auto Cal option, the above sample system allows automatic switching of sample, zero, and span gases during calibration. Refer to Appendix B, *Applications*, for details on sample systems designed by GE Panametrics for specific applications.

Mount the sample system as close as possible to the process sample point. Once the sample system is mounted, connect all inlet and outlet lines via the fittings on the sample system (1/4" compression). The sample line leading from the process to the sample system should be of 1/4" stainless steel tubing, and as short as possible in order to insure a representative sample.

Mounting the TMO2D-TC Display

The TMO2D-TC Display is available in five mounting configurations: bench, rack, panel, weatherproof, and explosion-proof. See Appendix C, *Outline and Installation Drawings*, for dimensional drawings for each configuration, as well as rack/panel cutout dimensions.

No special mounting requirements are needed for the TMO2D-TC Display.

!WARNING!
FOR EXPLOSION-PROOF AND CLASS I, DIV. 2
UNITS, BE SURE TO CONFORM TO ALL SAFETY
AND ELECTRICAL CODE REQUIREMENTS.

!WARNING!
TO ENSURE THE SAFE OPERATION OF THE
TMO2D-TC, YOU MUST INSTALL AND OPERATE IT
AS DESCRIBED IN THIS MANUAL. IN ADDITION, BE
SURE TO FOLLOW ALL APPLICABLE SAFETY
CODES AND REGULATIONS FOR INSTALLING
ELECTRICAL EQUIPMENT IN YOUR AREA.

PROCEDURES SHOULD BE PERFORMED BY
TRAINED SERVICE PERSONNEL.

Wiring the TMO2-TC Transmitter

Caution!

Always bring power to the TMO2-TC immediately after installation, especially when it is mounted outdoors or in a humid area.

This section describes how to wire the TMO2-TC Transmitter to the TMO2D-TC Display. First, the transmitter enclosure must be grounded. This can be done using an external ground screw on the TMO2-TC, or, if required, an internal ground screw located below the transmitter PCB. See Figure 2-4 below for the location of both ground screws.

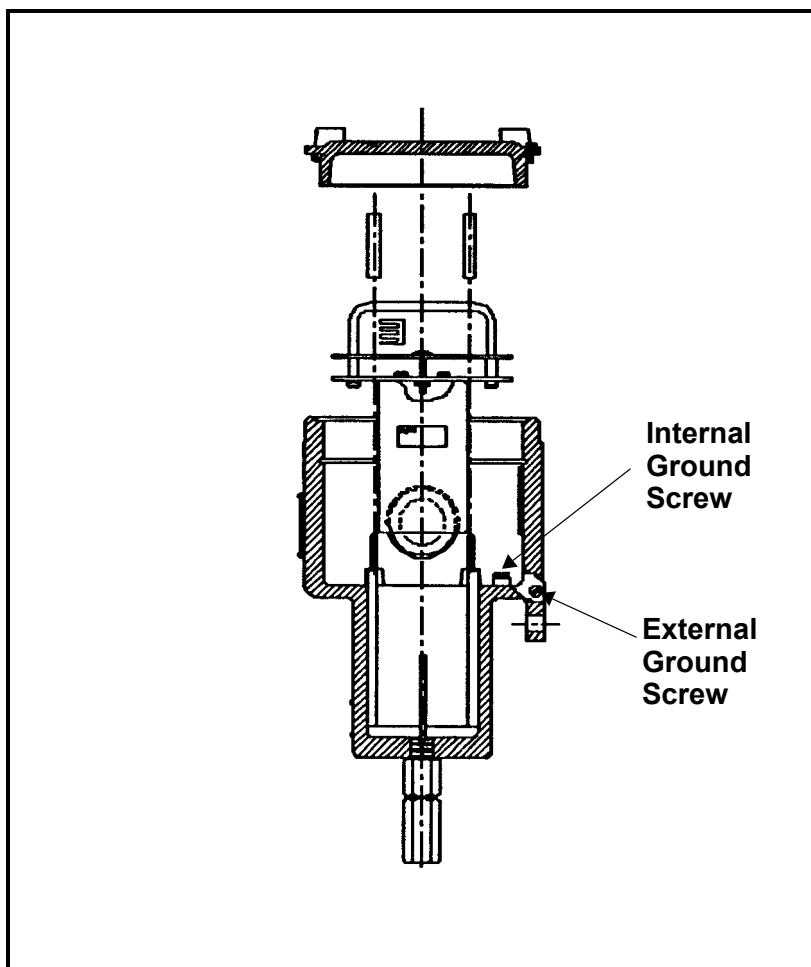


Figure 2-4: Location of Ground Screws



= Protective Conductor Terminal

Wiring the TMO2-TC Transmitter (cont.)

Wiring connections to the TMO2-TC Transmitter are made to terminal block TB1, which is accessed by removing the TMO2-TC cover. See Figure 2-5 below for the location and pin designations for TB1. Also refer to Appendix C, *Outline and Installation Drawings*.

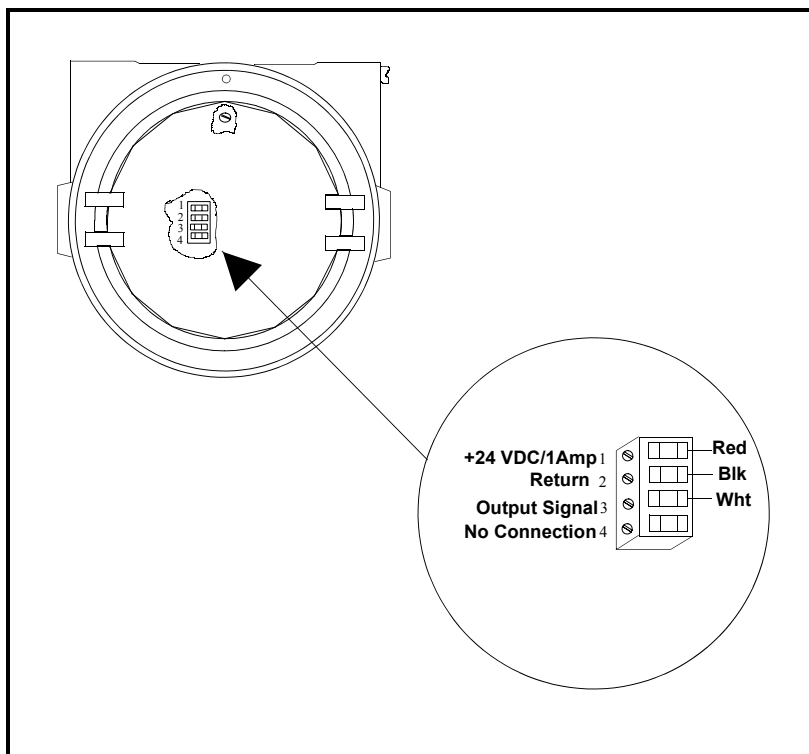


Figure 2-5: TMO2-TC Wiring Connections

Wiring connections to the TMO2D-TC Display are made to the terminal block labeled OXYGEN CELL at the rear of the TMO2D-TC. See Figure 2-6 on the following page for the location of the OXYGEN CELL terminal block.

Caution!

Do not make any connections to unassigned or unused terminals.

Wiring the TMO2-TC Transmitter (cont.)

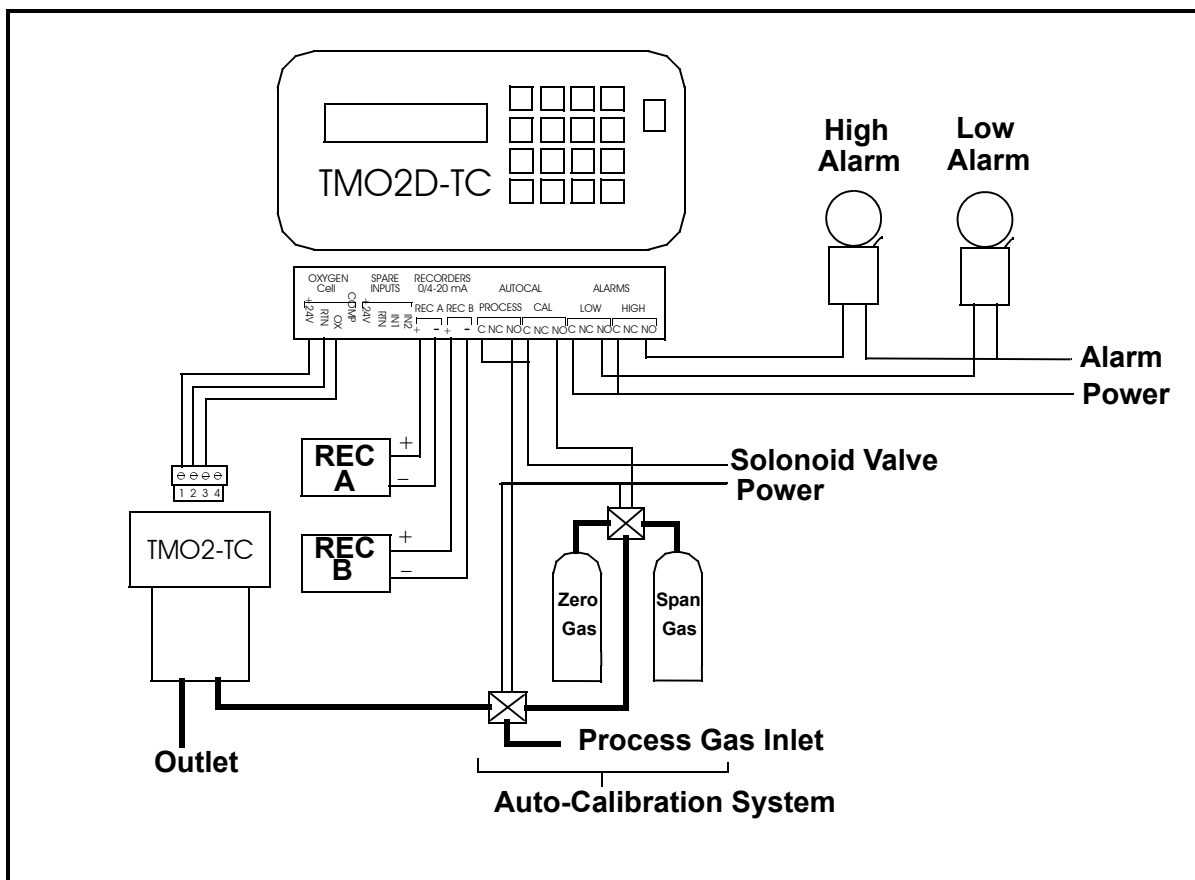


Figure 2-6: TMO2D-TC Wiring Connections

Wiring the TMO2-TC Transmitter (cont.)

Table 2-2 below shows the transmitter to display module wiring connections using the standard GE Panametrics TMO2D-TC cable. This cable can be used for distances up to 2,800 ft (850 m). If you are using your own cable, refer to Table 2-2 for cable requirements.

Table 2-1: Cable Requirements

Max Cable Length		Cable Size	
Feet	Meters	AWG	Sq. Millimeters
450	130	22	0.35
700	200	20	0.6
1,050	320	18	1.0
1,700	500	16	1.2
2,800	850	14	2.0
4,000	1,200	12	3.0

Use the following steps to make the proper connections:

1. Route the cable into the transmitter through one of the 3/4" conduit holes.

!WARNING!

BE SURE TO PLUG UP THE UNUSED CONDUIT HOLE ON THE SIDE OF THE TRANSMITTER IN ORDER TO MAINTAIN THE APPROPRIATE WEATHERPROOF OR EXPLOSION-PROOF RATING.

2. Unplug TB1 by carefully pulling it directly up without bending the pins attached to the PCB.
3. Loosen the TB1 side screws and insert the colored wires into the corresponding openings on top of TB1. See Table 2-1 above for color-coded pin designations.

!WARNING!

BE SURE THAT +24 VDC (RED WIRE) IS CONNECTED TO TERMINAL TB1-1. CONNECTING +24 VDC POWER TO ANY OTHER TERMINAL WILL DAMAGE THE TMO2-TC PCB, REQUIRING FACTORY REPAIR.

**Wiring the TMO2-TC
Transmitter (cont.)****Table 2-2: Transmitter Power and Output Connections**

Wire	Color	Gage	Transmitter TB1	Display
+24 VDC	Red	14 AWG	Pin 1	+24V
Return	Black	14 AWG	Pin 2	RTN
Signal	White	22 AWG	Pin 3	OX

4. Tighten the side screws, and carefully plug TB1 back onto the PCB.
5. Connect the other end of the cable in a similar manner to the OXYGEN CELL terminal block located on the rear panel of the TMO2D-TC Display. See Table 2-1 on the previous page for color-coded pin designations.

Wiring the TMO2D-TC Display

Figure 2-6 on page 2-9 shows possible output wiring connections between the TMO2D-TC Display and recorders, alarms, and automatic sample systems. Note that the standard TMO2D-TC has a single, non-isolated 0/4-20 mA output (RCDR A) and dual Form C SPDT alarm relays (ALARMS). Dual isolated 0/4-20 mA outputs (RCDR A/RCDR B) and dual auto calibration (Auto Cal) relays are optional.

The alarm relays can be wired in a “fail-safe” configuration that will allow a contact closure when the H₂ level falls below a certain point or rises above a certain point, or when a power failure occurs. For example, to have a contact closure when the H₂ level falls below 1% or rises above 5%, or in the event of a power failure, do the following:

TMO2D-TC Alarm	Wire	Program	For Use As
LOW	COM/NC	5% H ₂	HIGH
HIGH	COM/NC	1% H ₂	LOW

Note: See Chapter 4, Programming the TMO2D-TC, The Alarms Menu, for information on programming the alarm set points.

When the LOW alarm is wired and programmed as above, a loss of power or an H₂ reading greater than 5% causes a contact closure that can be used as a HIGH or “fail-safe” alarm.

When the HIGH alarm is wired and programmed as above, a loss of power or an H₂ reading less than 1% causes a contact closure that can be used as a LOW or “fail-safe” alarm.

**!ATTENTION EUROPEAN CUSTOMERS!
IN ORDER TO MEET CE MARK REQUIREMENTS,
YOU MUST SHIELD AND GROUND ELECTRICAL
CABLES AS DESCRIBED IN APPENDIX H.**

**!WARNING!
TO ENSURE THE SAFE OPERATION OF THE
TMO2D-TC, YOU MUST INSTALL AND OPERATE IT
AS DESCRIBED IN THIS MANUAL. IN ADDITION, BE
SURE TO FOLLOW ALL APPLICABLE SAFETY
CODES AND REGULATIONS FOR INSTALLING
ELECTRICAL EQUIPMENT IN YOUR AREA.**

**PROCEDURES SHOULD BE PERFORMED BY
TRAINED SERVICE PERSONNEL.**

Wiring the TMO2D-TC Display (cont.)

The TMO2D-TC also has a bi-directional, industry standard RS232C serial port, which can be connected to a terminal or PC that supports the RS232C protocol. Figure 2-7 below shows the wiring pin designations. The 25-pin, male D connector is located at the right on the rear of the TMO2D-TC Display.

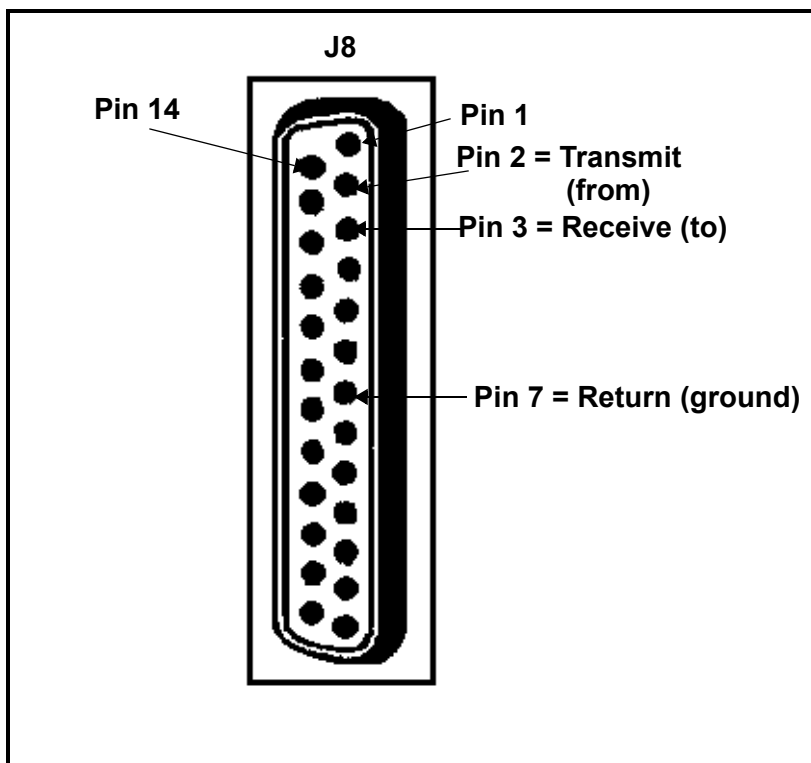


Figure 2-7: RS232C Wiring Connections

Wiring the TMO2D-TC Display (cont.)

The TMO2D-TC Display is connected to 100/120/220/240 VAC power using the supplied power cord.

Caution!

The interconnecting wiring between the TMO2-TC Transmitter and TMO2D-TC Display must be completed before powering up.

Note: *The power cord is the main disconnect device.*

Note:  = Protective Conductor Terminal

IMPORTANT: *To comply with the European Low Voltage Directive, you must install a switch or circuit breaker on the input power line. For greatest safety, locate the circuit breaker or switch near the unit that the line serves.*

Chapter 3

Operation

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Overview

This chapter provides information on operating the TMO2D-TC analyzer. You will find the following topics discussed:

- Introduction — A brief discussion of operational considerations.
- Powering Up the TMO2D-TC Analyzer — How to start the TMO2D-TC.
- Establishing a Flow of Sample Gas — Basic sample gas considerations.
- Operating the TMO2D-TC Display — A description of the TMO2D-TC LCD display and keypad.

Introduction

The TMO2D-TC operation consists of only three steps:

1. Supplying power to the analyzer and turning it on.
2. Establishing a flow of sample gas through the system.
3. Operating the display module.

If you have not already done so, please read Chapter 2, *Installation*, for details on mounting and wiring the TMO2-TC Transmitter, the sample system, and the TMO2D-TC Display.

Powering Up the TMO2D-TC Analyzer

The TMO2D-TC Display has a power switch located at the top right of the front panel. It will begin operation as soon as it is turned to the ON position.

Note: *The power cord is the main disconnect device.*

Note: *If your TMO2D-TC was supplied in a weatherproof enclosure or was modified for use in Class I, Div. 2 hazardous areas, the power switch will be inoperative. The TMO2D-TC will begin operating as soon as it is connected to a 100/120/220/240 VAC power source.*

The TMO2D-TC Display will provide 24 VDC power to the TMO2-TC Transmitter. Because the transmitter is controlled at a constant 55°C (131°F) operating temperature, allow 30 minutes for the unit to warm up and reach temperature stability. During this time, you can establish a sample gas flow through the sample system.

IMPORTANT: *To comply with the European Low Voltage Directive, you must install a switch or circuit breaker on the input power line. For greatest safety, locate the circuit breaker or switch near the unit that the line serves.*

Powering Up the TMO2D-TC Analyzer (cont.)

When the display module is first turned on, it will show the firmware version installed. For example:

GE Panametrics TMO2D STD.00X.X

Next it will do some internal testing:

GE Panametrics Testing RAM ... Passed.

The above sequence should take about 10 seconds. The display module then begins taking measurements from the transmitter, and the LCD displays the gas concentration, the time, and the Alarm status. Allow the transmitter 30 minutes to warm up before accepting data from the TMO2D-TC.

Establishing a Flow of Sample Gas

Open the necessary valves to establish a sample gas flow of 0.5 SCFH (250 cc/min) at atmospheric pressure. Make sure that nothing obstructs the flow of sample gas, thereby causing a pressure build-up in the sensing chamber. For proper operation, the TMO2-TC Transmitter should be vented to atmosphere.

Note: *Unless otherwise specified, the TMO2-TC is factory calibrated at atmospheric pressure and 0.5 SCFH (250 cc/min) and should therefore be operated at atmospheric pressure. Operating the TMO2-TC at any other pressure will necessitate a field calibration at that pressure in order to maintain accuracy. See Chapter 5, Calibration.*

If you are using the 4-Port (flowing reference gas) configuration, open the necessary valves to establish a reference gas flow of 0.5 SCFH (250 cc/min) at atmospheric pressure. Note that you can use a reference gas flow as low as 5 cc/min in order to conserve gas.

Operating the TMO2D-TC Display

The TMO2D-TC Display has a 2-line x 24 character backlit Liquid Crystal Display (LCD) screen, and a 16-key keypad (see Figure 3-1). After displaying the firmware version and testing RAM, the display module enters Operate Mode.

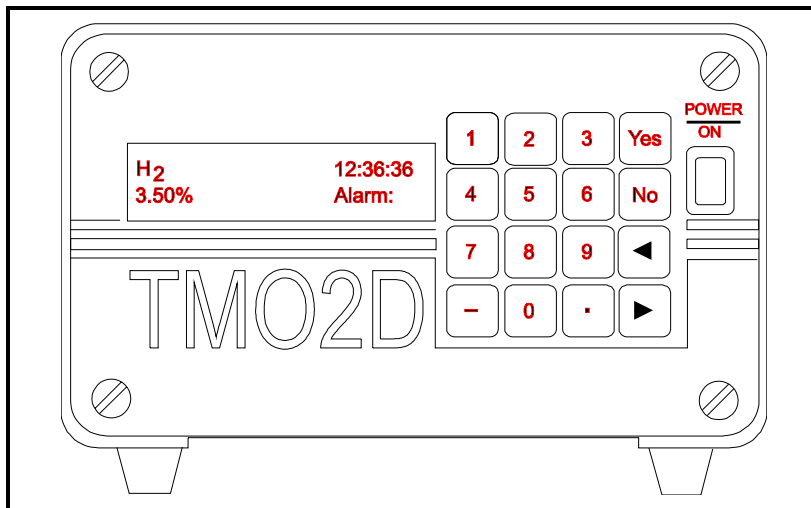


Figure 3-1: TMO2D-TC Display and Keypad

LCD Display

In Operate Mode, the left side of the top line of the LCD shows the name of the gas being measured (e.g., H₂, N₂, SO₂, CO₂). It was set at the factory according to initial specifications. If you should need to change the name of the gas, refer to Appendix E, *Special Programming*. This manual will refer to the gas being measured as H₂. The left side of the bottom line shows the gas concentration in % (see Figure 3-1 above).

The right side of the top line is a clock. When the TMO2D-TC is powered up, this clock will start from 00:00:00. The current time (and date) can be entered in Programming Mode (see Chapter 4, *Programming the TMO2D-TC*). However, if power to the TMO2D-TC is interrupted, the clock will be reset to 00:00:00.

The right side of the bottom line displays the alarm status. The word “Alarm:” is displayed. If the HIGH alarm is activated, an “H” will be displayed in reverse lettering. If the LOW alarm is activated, an “L” will be displayed.

Keypad

Except for the No key, which is used to enter Programming Mode, the keypad does not function in Operate Mode. Pressing any other key will activate the display backlight.

Chapter 4

Programming

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Overview

This chapter provides information on programming the TMO2D-TC Display using either the 16-key keypad or the RS232C serial port. You will find the following topics discussed:

- Introduction — A brief overview of the TMO2D-TC user program.
- Key Functions — Keypad key functions and their RS232C equivalents when in Programming Mode.
- Entering Programming Mode — How to enter Programming Mode from Operate Mode in order to access the user program.
- Menu Navigation — How to navigate the TMO2D-TC menu structure.
- The Main Menu — A description of the Main menu functions.
- The Setup Menu — A description of the Setup menu functions.
- The Recorders Menu — A description of the Recorders menu functions.
- The Alarms Menu — A description of the Alarms menu functions.
- The Tests Menu — A description of the Tests menu functions.
- The Calibration Menu — A description of the Calibration menu functions.

Introduction

The TMO2D-TC Display contains an interactive, user-friendly program that allows the user to customize the TMO2D-TC to their application and change operating parameters as desired. The program is accessed through the TMO2D-TC keypad and LCD display, or the RS232C serial port using an ASCII terminal or PC.

Data entered into the TMO2D-TC by the user overrides any previously entered data, and is retained in memory for several years, even if power to the TMO2D-TC is interrupted.

Note: *The time in the TMO2D-TC is reset to 00:00:00 if power is interrupted. The date information is retained if power is interrupted, but may be incorrect if power is not restored immediately. Both date and time should be re-entered in the event of power interruption.*

!WARNING!
**IF THE CABLE CONNECTING THE TMO2D-TC
DISPLAY TO THE TMO2-TC TRANSMITTER IS
DISCONNECTED WHILE THE TMO2D-TC IS
POWERED UP, DATA MAY BE LOST. ALWAYS
REMOVE POWER FROM THE DISPLAY MODULE
BEFORE DISCONNECTING THE TMO2D-TC TO
TMO2-TC CABLE.**

Key Functions

When the TMO2D-TC is in Operate Mode, it will ignore all keys except the No key. On receipt of a No, the LCD will display **Enter Code:**, and await the user program entry code, 1 2 3. During code entry, the TMO2D-TC continues to update the data display, alarm status, and recorder output.

If the correct code is entered, the TMO2D-TC switches to Programming Mode. While it is in Programming Mode, data collection is suspended, and alarm status and recorder outputs are held at their current values.

In Programming Mode, the keypad keys are divided into three groups: Yes/No, Selector, and Data Entry:

Yes/No: The Yes key is used to select a displayed menu option or to confirm a numeric entry. The No key is used to scroll forward to the next menu option or to clear a numeric entry.

Selector: The Left and Right Arrow keys are used as selector keys. The Left Arrow key is used to step backward through a displayed list of menu options, or as a back-space (erase) key during numeric entry. The Right Arrow key is used to step forward through a displayed list of menu options. It is equivalent to the No key.

Data Entry: The 0-9, -, and . keys are used to enter numeric values.

All keypad and most display operations can be performed remotely on the RS232C serial port using a terminal or PC that supports the RS232C protocol. Table 4-1 on the next page provides a list of keypad keys (left column) and their ASCII (center column) and terminal/PC (right column) equivalents.

Key Functions (cont.)**Table 4-1: TMO2D-TC RS232C Serial Port
Corresponding Keys**

TMO2D-TC Keypad	ASCII	Terminal/PC Keys
0	030	0
1	031	1
2	032	2
3	033	3
4	034	4
5	035	5
6	036	6
7	037	7
8	038	8
9	039	9
-	02D	-
.	02E	.
Y	00D	ENTER_
N	01B	ESCAPE
←	008	BACKSPACE
→	020	SPACE BAR

Entering Programming Mode

When the TMO2D-TC is turned on, it enters Operate Mode (after approx. 10 seconds). In order to enter data into the user program or to check previously entered values, the TMO2D-TC must be switched to Programming Mode. To enter Programming Mode:

1. Press the No key.
2. The top line of the display will show **Enter Code:**
3. Key in the code 1 2 3, pressing each key slowly and firmly. The display will show an * after each digit is entered.

Note: *If an incorrect code is entered, or a non-numeric (Yes/No or Arrow) key is pressed, or the keys are pressed too quickly, the TMO2D-TC will return to Operate Mode, and the user must press No again to re-enter the code.*

4. The display will now show:

MAIN MENU Setup?

5. The TMO2D-TC is now in Programming Mode, ready for user input.

Menu Navigation

When a menu item is being displayed, the first line of the LCD shows the title of the current menu in capital letters. The second line shows the current menu option followed by a question mark. Press Yes to select a displayed option, No or Right Arrow to move on to the next option, or Left Arrow to move back to the previous option.

Note: *The menu options are circular — skipping over the last option in the list returns to the first option.*

The Main Menu

The Main menu consists of six submenus: Setup, Recorders, Alarms, Tests, Calibration, and Resume. Selecting Resume returns the TMO2D-TC to Operate Mode. Refer to Appendix D, *Menu Flow Diagrams*, for a flow diagram of the Main menu.

The Setup Menu

The Setup menu consists of seven options: Set Time, Set Date, Set Backlight, Set Display, Set Communications, Set Error Handling, and Done. These options allow the user to change basic operating parameters. Selecting Done returns the TMO2D-TC to the Main menu. Refer to Appendix D, *Menu Flow Diagrams*, for a flow diagram of the Setup menu.

Set Time

Set Time sets the current time in 24-hour format. For example, to enter 1:15 PM (13.15 in 24-hour time):

MAIN MENU Setup?

Press Yes to enter the Setup menu.

SETUP MENU Set Time?

Press Yes to set the time.

Enter 24 hour time: HH.MM [XX.XX]: 13.15

Use the Data Entry keys to enter 13.15 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

SETUP MENU Set Time?

Press No to move to the next option on the Setup menu.

Set Date

Set Date sets the current date in USA (month, day, year) format. For example, to enter August 12, 1994:

SETUP MENU
Set Date?

Press Yes to set the date.

Enter Date (MM.DD.YY):
XX.XX.XX]: 08.12.94

Use the Data Entry keys to enter 08.12.94 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

SETUP MENU
Set Date?

Press No to move to the next option on the Setup menu.

Set Backlight

The LCD contains an electro-luminescent (EL) panel to enhance the readability of the screen in dim light. EL panels have a finite life span, dimming with use. To maintain the life of the EL backlight, the TMO2D-TC will automatically turn the backlight off after a predetermined time period. The backlight time-out period can be set from 0 (never on) to 60 minutes. The default is 3 minutes. For example, to enter a time-out of 10 minutes:

SETUP MENU
Set Backlight?

Press Yes to set the backlight time-out period.

SETUP MENU
Remain ON (min) [XX]: 10

Use the Data Entry keys to enter 10 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

SETUP MENU
Set Backlight?

Press No to move to the next option on the Setup menu.

Set Display

This option is not applicable to the TMO2D-TC and should not be used.

SETUP MENU
Set Display?

Press No to move to the next option on the Setup menu.

Set Communications

The Set Communications menu consists of three options: Set Baud Rate, Set Update Rate, and Done. These options allow the user to change RS232C communications parameters. Selecting Done returns the TMO2D-TC to the Setup menu. Refer to Appendix D, *Menu Flow Diagrams*, for a flow diagram of the Set Communications menu.

Set Baud Rate

The TMO2D-TC supports communications rates of 9600, 4800, 2400, 1200, and 300 baud. The default setting is 9600 baud, Word size is fixed at 8 bits, 1 stop bit, NO parity.

Note: *The use of 300 baud greatly limits the computation speed of the TMO2D-TC, and is not recommended. It is provided solely for compatibility with older equipment.*

SETUP MENU Set Communications?

Press Yes to enter the Set Communications menu.

SET COMMUNICATIONS Set Baud Rate?

Press Yes to set the baud rate.

SELECT BAUD RATE 9600 baud?

Use the No or Arrow keys to scroll through the choices (9600, 4800, 2400, 1200, 300). Press Yes to select the desired baud rate and exit to the Set Communications submenu.

Note: *The baud rate can also be changed via a terminal/PC connected to the RS232C port; however, this practice is not recommended. Since the TMO2D-TC will immediately change to the new baud rate, the display and keyboard operation will not be correct until the baud rate of the terminal/PC is changed to match the new baud rate set in the TMO2D-TC.*

Set Update Rate

This option is used to change the interval at which data is sent to the RS232C serial port. The data update rate can be set from 0 (no data sent) to 300 seconds. The default rate is 1 second. For example, to set an update rate of 180 seconds:

SETUP MENU Set Update Rate?

Press Yes to set the update rate.

SET COMMUNICATIONS Data Interval [XXX]: 180
--

Use the Data Entry keys to enter 180 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

SET COMMUNICATIONS Set Update Rate?
--

Press No to move to the next option on the SET COMMUNICATIONS submenu.

SET COMMUNICATIONS Done?

Press Yes to exit to the Setup menu.

SETUP MENU Set Communications?

Press No to move to the next option on the Setup menu.

Set Error Handling

The Set Error Handling option is used to program the LCD, output(s), and alarms to respond to an invalid H₂ measurement (under-range or over-range) that occurs when the TMO2D-TC is in Operate mode. An invalid measurement occurs if the H₂ reading is 1 mA or less, or 24 mA or greater.

Note: *Error handling for an invalid H₂ measurement is independent of error handling for Auto Cal (see “Auto Cal Parameters” in the Calibration menu). If both error conditions occur simultaneously, error handling for the invalid H₂ measurement will take precedence.*

Follow the steps below to enable Error Handling, set the LCD, and select the output and alarm responses:

SETUP MENU Set Error Handling?	Press Yes to select the Set Error Handling option.
-----------------------------------	--

Enable Error Handling: [YES] no	Press the No or the Arrow keys to select YES. Press Yes to confirm.
---	---

Note: *If you select NO and press Yes to confirm, you will be immediately returned to the Setup menu.*

SYSTEM ERROR EFFECTS Set Display Response?	Press Yes to set the LCD response.
---	------------------------------------

Display System Error? yes [NO]	Press the No or the Arrow keys to select your choice. Press Yes to confirm.
--	---

SYSTEM ERROR EFFECTS Set Display Response?	Press No to move to the next option on the System Error Effects menu.
---	---

SYSTEM ERROR EFFECTS Set Alarm Response?	Press Yes to set the alarm response.
---	--------------------------------------

Set Error Handling (cont.)

Select Alarm Effect?
No Effect?

Use the No or Arrow keys to scroll through the choices and press Yes at your choice.

Select Alarm Effect?
Trip High?

Select Alarm Effect?
Trip Low?

Select Alarm Effect?
Trip Both?

SYSTEM ERROR EFFECTS
Set Alarm Response?

Press No to move to the next option on the System Error Effects menu.

SYSTEM ERROR EFFECTS
Set Recorder Response?

Press Yes to set the recorder output(s) response.

Select Recorder Effect?
No Effect?

Use the No or Arrow keys to scroll through the choices and press Yes at your choice.

Select Recorder Effect?
Force High?

Select Recorder Effect?
Force Low?

Select Recorder Effect?
Hold Last Value?

SYSTEM ERROR EFFECTS
Set Recorder Response?

Press No to move to the next option on the System Error Effects menu.

SYSTEM ERROR EFFECTS
Done?

Press Yes to return to the Setup menu.

Set Error Handling (cont.)

SETUP MENU Set Error Handling?

Press No to move to the next option on the Setup menu.

SETUP MENU Done?

Press Yes to return to the Main menu.

MAIN MENU Setup?

Press No to move to the next option on the Main menu.

The Recorders Menu

The Recorders menu is used to scale the 0/4-20 mA analog output(s). Selecting A allows the user to scale the first analog output. Selecting B allows the user to scale the second analog output (if one is present). Selecting Done returns the TMO2D-TC to the Main menu. Refer to Appendix D, *Menu Flow Diagrams*, for a flow diagram of the Recorders menu.

The TMO2D-TC provides a choice of one non-isolated 0/4-20 mA output, or two isolated 0/4-20 mA outputs. Both recorder options can be set for a 0-20 mA or 4-20 mA response, and can be scaled anywhere within the range of the transmitter.

Note: *The TMO2D-TC user program will accept settings for two outputs, A and B. However, if the TMO2D-TC has been purchased with only a single, non-isolated 0/4-20 mA output, only recorder A is effective.*

Use the steps in the following example to set up recorders A and B. We will set recorder A for a 4-20 mA output, with 4 mA equal to 0% H₂ and 20 mA equal to 100% H₂.

MAIN MENU Setup?	Press No or Right Arrow until Recorders? appears.
MAIN MENU Recorders?	Press Yes to enter the Recorders menu.
Select Recorder to set: [A] B done	Press No or the Arrow keys to select A. Press Yes to confirm the entry.
Rcd A Output (mA): 0-20 [4-20]	Press No or the Arrow keys to select 4-20. Press Yes to confirm the entry.
Recorder A 4 mA Value %H ₂ [XX.XX]: 0.00	Use the Data Entry keys to enter 0.00 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.
Recorder A 20 mA Value %H ₂ [XXX.XX]: 100.00	Use the Data Entry keys to enter 100.00 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

The Recorders Menu (cont.)

Select Recorder to set:
[A] B done

MAIN MENU
Recorders?

Recorder B is scaled in the same manner. After Recorder B is scaled, use the No or Arrow keys to select DONE. Press Yes to return to the Main menu.

Press No to move to the next option on the Main menu.

The Alarms Menu

The TMO2D-TC is provided with two single-pole double throw (SPDT), Form C alarm relays for use in activating alarm devices. See Chapter 6, *Specifications*, for details on relay specifications, and Chapter 2, *Installation*, for wiring recommendations. Both relays provide a normally-open (NO) and a normally-closed (NC) set of contacts. The alarms are addressed as HIGH or LOW. The HIGH alarm relay will change state when the current reading becomes greater than or equal to the HIGH alarm set point. The LOW alarm relay will change state when the current reading becomes less than or equal to the LOW alarm set point. Refer to Appendix D, *Menu Flow Diagrams*, for a flow diagram of the Alarms option.

Use the steps in the following example to set the HIGH and LOW alarm relays. We will set the HIGH alarm relay to 75% H₂, and the LOW alarm relay to 25% H₂.

MAIN MENU Setup?	Press No or Right Arrow until Alarms? appears.
MAIN MENU Alarms?	Press Yes to enter the Alarms menu.
Select Alarm to set: [HIGH] low done	Press No or the Arrow keys to select HIGH. Press Yes to confirm the entry.
Enter Alarm Setpoint: High %H ₂ [XX.XX]:	Use the Data Entry keys to enter 75.00 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.
Select Alarm to set: [HIGH] low done	Press No or the Arrow keys to select LOW. Press Yes to confirm the entry.
Enter Alarm Setpoint: Low %H ₂ [XX.XX]:	Use the Data Entry keys to enter 25.00 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.
Select Alarm to set: high [LOW] done	Press No or the Arrow keys to select DONE. Press Yes to return to the Main menu.
MAIN MENU Alarms?	Press No to move to the next option on the Main menu.

The Tests Menu

The Tests menu consists of four options: DVM Test, Recorder Calibrate, Alarms Test, and Done. These options allow the user to perform operational tests on the analog outputs and alarm relays, and to directly measure the raw signal from the TMO2-TC Transmitter. Selecting Done returns the TMO2D-TC to the Main menu. Refer to Appendix D, *Menu Flow Diagrams*, for a flow diagram of the Tests menu.

DVM Test

The DVM test allows the TMO2D-TC to operate as a simple, digital voltmeter to measure, in milliamps, the signal being received from the TMO2-TC Transmitter. The TMO2D-TC is updated approximately twenty times per second, facilitating connection and calibration of the TMO2-TC Transmitter.

Follow the steps below to test the input signal from the TMO2-TC Transmitter:

MAIN MENU Setup?	Press No or Right Arrow until Tests? appears.
MAIN MENU Tests?	Press Yes to enter the Tests menu.
TESTS DVM Test?	Press Yes to enter the DVM test option.
Select DVM Input: [GAS] comp done	Press No or the Arrow keys to select GAS. Press Yes to confirm.

Note: *The COMP option is not applicable to the TMO2D-TC, and should not be used. If you select COMP by mistake, you should see:*

H ₂ DVM TEST 0.00 mA	Press any key to exit.
------------------------------------	------------------------

The Tests Menu (cont.)

H₂ DVM TEST
XX.XX mA

The X's represent the mA signal from the TMO2-TC Transmitter, which will update continuously. Press any key to exit.

Select DVM Input:
[GAS] comp done

Press No or the Arrow keys to select DONE. Press Yes to exit to the Tests menu.

TESTS
DVM Test?

Press No to move to the next option on the Tests menu.

Recorder Calibrate

The Recorder Calibrate test allows a selected % gas composition to be output to the recording device to facilitate adjustment of the device's zero and span.

For example, to enter a %H₂ of 36.39 to be output to recorder A:

TESTS
Recorder Calibrate?

Press Yes to enter the Recorder Calibrate option.

Select Recorder to test:
[A] B done

Press No or the Arrow keys to select A. Press Yes to confirm the entry.

Set Recorder A to:
%H₂ [XX.XX]: 36.39

Use the Data Entry keys to enter 36.39 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

Select Recorder to test:
[A] B done

Recorder B (if present) is tested in the same manner. After you are done, press No or the Arrow keys to select DONE. Press Yes to exit to the Tests menu.

TESTS
Recorder Calibrate?

Press No to move to the next option on the Tests menu.

Alarms Test

The Alarms test enables you to trip and reset the alarm relays using the keypad, in order to test the operation of external alarm devices and circuits. For example, to test the HIGH alarm relay:

TESTS Alarms Test?	Press Yes to enter the Alarms test option.
-----------------------	--

Select Alarm to test: [HIGH] low done	Press No or the Arrow keys to select HIGH. Press Yes to confirm the entry.
--	--

Turn High Alarm: [ON] off done	Press No or the Arrow keys to select ON. Press Yes to confirm.
-----------------------------------	--

Note: Upon selecting the ON option and pressing Yes, the HIGH alarm relay will turn on, and the brackets will automatically move to OFF.

Turn High Alarm: on [OFF] done	Press Yes to turn the HIGH alarm off.
-----------------------------------	---------------------------------------

Note: Upon selecting the OFF option and pressing Yes, the HIGH alarm relay will turn off and the brackets will automatically move to ON.

Turn High Alarm: [ON] off done	Press No or the Arrow keys to select DONE. Press Yes to exit.
-----------------------------------	---

Select Alarm to test: [HIGH] low done	The LOW alarm is tested in the same manner. After you are done, press No or the Arrow keys to select DONE. Press Yes to exit to the Tests menu.
--	---

TESTS Alarms Test?	Press No to move to the next option on the Tests menu.
-----------------------	--

TESTS Done?	Press Yes to return to the Main menu.
----------------	---------------------------------------

MAIN MENU Tests?	Press No to move to the next option on the Main menu.
---------------------	---

The Calibration Menu

The Calibration menu consists of three options: Auto Cal Parameters, Edit Calibration Data, and Done. These options allow the user to perform automatic zero and span calibration of the TMO2D-TC, and to enter measurement parameters and calibration data. Selecting Done returns the TMO2D-TC to the Main menu. Refer to Appendix D, *Menu Flow Diagrams*, for a flow diagram of the Calibration menu.

Auto Cal Parameters

The TMO2D-TC can be programmed to perform an automatic calibration procedure (Auto Cal) at specified time intervals ranging from minutes to months. By performing measurements on two calibration gases (zero and span), the TMO2D-TC can automatically correct for changes in the response of the TMO2-TC Transmitter without operator intervention. Auto Cal does not physically recalibrate the TMO2-TC Transmitter, but instead creates a drift curve to the TMO2-TC calibration data that is stored in memory in the TMO2D-TC Display. Refer to Chapter 5, *Calibration*, for details on manually calibrating the TMO2-TC Transmitter.

Note: *Auto Cal requires the CAL option to be ordered with the TMO2D-TC. It also requires a sample system with electrically-actuated solenoid valves, and zero and span gases for use during Auto Cal. See Figure 2-3 for a description of a suitable sample system. If you do not presently have the Auto Cal option or the proper sample system, please consult GE Panametrics for assistance.*

!WARNING!
**USING THE AUTO CAL PROCEDURE WITHOUT
THE OPTIONS DESCRIBED ABOVE WILL
PRODUCE AN ERRONEOUS CALIBRATION AND
PREVENT PROPER OPERATION
OF THE TMO2D-TC.**

At a user-specified time interval, the TMO2D-TC activates a solenoid valve on the sample system. This isolates the transmitter from the process stream, and connects it instead to the span calibration gas. After a programmable equilibration time, to allow the span gas to completely replace the process gas, measurements are taken of the span calibration gas. The TMO2D-TC then activates a second solenoid valve to connect to the zero calibration gas. After equilibration, measurements are taken of the zero calibration gas. The TMO2D-TC then reconnects the transmitter to the process stream. A final settling time takes place while the process gas completely replaces the zero gas.

The Calibration Menu (cont.)

Once settling has been completed, if no error has occurred, the TMO2D-TC calculates the amount of drift from the TMO2-TC Transmitter calibration, and creates a drift curve that is applied to the transmitter calibration data for future measurements. The transmitter calibration data is not changed.

If the Auto Cal measurements were out of range, the data is disregarded, and the TMO2D-TC uses the drift curve already stored in memory. If Auto Cal Error Handling is enabled, the display, analog output, and alarms will respond to the out-of-range Auto Cal as programmed.

MAIN MENU Setup?

Press No or Right Arrow until Calibration? appears.

MAIN MENU Calibration?

Press Yes to enter the Calibration menu.

CALIBRATION MENU Auto Cal Parameters?
--

Press Yes to enter the Auto Cal parameters option only if you have the proper equipment. See Note and **WARNING** above. Otherwise, press No or the Arrow keys to move to the next option on the Calibration menu.

Enable AutoCal: [YES] no

Press the No or the Arrow keys to select YES. Press Yes to confirm.

Note: *If you select NO and press Yes to confirm, Auto Cal will be disabled and you will be immediately returned to the Calibration Menu.*

The Auto Calibration menu consists of nine options: Set Time Interval, Set Zero Gas, Set Span Gas, Set Settling Time, Set Error Handling, Perform AutoCal, Zero AutoCal, View Drift Curve, and Done. These options allow the user to control all aspects of the Auto Cal operation. Selecting Done returns the TMO2D-TC to the Calibration menu. Refer to Appendix D, *Menu Flow Diagrams*, for a flow diagram of the Auto Calibration menu.

Set Time Interval

The Set Time Interval option is used to set the time interval between successive Auto Cal's. This interval can be specified in either hours or days.

Hours can be entered fractionally (e.g., 90 minutes = 1.5 hours) up to a maximum of 24. An interval of 0 hours prevents Auto Cal from occurring.

If a non-zero number of days is entered, the TMO2D-TC will prompt for the time of day when Auto Cal should occur. Fractional days are not allowed. Days can range from 0 to 99.

!WARNING!

IF YOU PROGRAM THE TMO2D-TC TO PERFORM AN AUTO CAL AT A CERTAIN TIME BUT THE TMO2D-TC TIME IS INCORRECT DUE TO A POWER LOSS, THE TMO2D-TC WILL PERFORM THE AUTO CAL AT THE WRONG TIME. MAKE SURE THAT THE TMO2D-TC TIME IS SET CORRECTLY (SEE SETUP MENU).

For example, to set the time interval to 12 hours:

AUTO CALIBRATION MENU
Set Time Interval?

Press Yes to select the Set Time Interval option.

Select AutoCal Interval:
[HOURS] days

Press the No or the Arrow keys to select HOURS. Press Yes to confirm.

Auto-Cal Interval
Hours [XX.XX]: 12.00

Use the Data Entry keys to enter 12.00 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes to exit.

AUTO CALIBRATION MENU
Set Time Interval?

Press No to move to the next option on the Auto Calibration menu.

For another example, to set the time interval to 3 days, to occur at 1:45 PM:

AUTO CALIBRATION MENU
Set Time Interval?

Press Yes to select the Set Time Interval option.

Set Time Interval (cont.)

Select AutoCal Interval:
hours [DAYS]

Press the No or the Arrow keys to select DAYS. Press Yes to confirm.

Auto-Cal Interval
Days [XX]: 3

Use the Data Entry keys to enter 3 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

AutoCal at Time:
HH.MM [XX.XX]: 13.45

Use the Data Entry keys to enter 13.45 -1:45 PM in 24-hour notation (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

AUTO CALIBRATION MENU
Set Time Interval?

Press No to move to the next option on the Auto Calibration menu.

Set Zero Gas

The Set Zero Gas option is used to enter the zero gas concentration and equilibration time. The default concentration is 0%. After entering the zero gas concentration, the TMO2D-TC will prompt for the equilibration time for the zero gas. The equilibration time should allow for the distance that the zero gas must travel from source to TMO2-TC Transmitter, the flow rate, and the equilibration time of the transmitter itself.

Note: *For a successful Auto Cal to be performed, the equilibration time should be a minimum of 3 minutes. The maximum equilibration time is 30 minutes. For testing purposes, the equilibration time can be as low as 10 seconds.*

For example, to set the zero gas to 0% H₂ with a equilibration time of 3 minutes:

AUTO CALIBRATION MENU
Set Zero Gas?

Press Yes to select the Set Zero Gas option.

Zero Gas
%H₂ [XX.XX]: 0.00

Use the Data Entry keys to enter 0.00 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

Zero Gas ON for
MM.SS [XX.XX]: 3

Use the Data Entry keys to enter 3 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

AUTO CALIBRATION MENU
Set Zero Gas?

Press No to move to the next option on the Auto Calibration menu.

Set Span Gas

The Set Span Gas option is used to enter the span gas concentration and equilibration time. The default concentration is 10.00%. After entering the span gas concentration, the TMO2D-TC will prompt for the equilibration time for the span gas. The equilibration time should allow for the distance that the span gas must travel from source to TMO2-TC Transmitter, the flow rate, and the equilibration time of the transmitter itself.

Note: *For a successful Auto Cal to be performed, the equilibration time should be a minimum of 3 minutes. The maximum equilibration time is 30 minutes. For testing purposes, the equilibration time can be as low as 10 seconds.*

For example, to set the span gas to 100% H₂ with a equilibration time of 3 minutes:

AUTO CALIBRATION MENU Set Span Gas?
--

Press Yes to select the Set Span Gas option.

Span Gas %H ₂ [XX.XX]: 0.00

Use the Data Entry keys to enter 100.00 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

SpanGas ON for MM.SS [XX.XX]: 3

Use the Data Entry keys to enter 3 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

AUTO CALIBRATION MENU Set Span Gas?
--

Press No to move to the next option on the Auto Calibration menu.

Use the Data Entry keys to enter 100.0 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

Set Settling Time

The Set Settling Time option is used to enter the amount of time the process gas should remain on before the TMO2D-TC resumes taking measurements. The settling time should allow for the distance that the process gas must travel from source to TMO2-TC Transmitter, the flow rate, and the settling time of the transmitter itself.

Note: *For a successful Auto Cal to be performed, the settling time should be a minimum of 3 minutes. The maximum settling time is 30 minutes. For testing purposes, the settling time can be as low as 10 seconds.*

Note: *The display, output, and alarms are not updated during the settling period.*

For example, to set the settling time to 3 minutes:

AUTO CALIBRATION MENU
Set Settling Time?

Press Yes to select the Set Settling Time option.

Settling Time:
MM.SS [XX.XX]: 3

Use the Data Entry keys to enter 3 (the X's represent the previous entry). Press Yes to confirm the entry; then press Yes again to exit.

AUTO CALIBRATION MENU
Set Settling Time?

Press No to move to the next option on the Auto Calibration menu.

Set Error Handling

The Set Error Handling option is used to program the LCD, output(s), and alarms to respond to any invalid measurement that occurs during Auto Cal. An invalid measurement would occur if the zero gas reading was 1 mA or less, or the span gas reading was 24 mA or greater, or either reading differed from the previous value by 1.6 mA or more. If an invalid measurement does occur during Auto Cal, it may be time to manually recalibrate the TMO2-TC Transmitter. See Chapter 5, *Calibration*, for details.

Note: *Error handling for Auto Cal is independent of error handling for an invalid H₂ measurement. If both error conditions occur simultaneously, error handling for the invalid H₂ measurement will take precedence.*

Follow the steps below to enable Error Handling, set the LCD, and select the output and alarm responses:

AUTO CALIBRATION MENU Set Error Handling?
--

Press Yes to select the Set Error Handling option.

Enable Error Handling: [YES] no

Press the No or the Arrow keys to select YES. Press Yes to confirm.

Note: *If you select NO and press Yes to confirm, you will be immediately returned to the Auto Calibration menu.*

SYSTEM ERROR EFFECTS Set Display Response?

Press Yes to set the LCD response.

Display System Error? yes [NO]
--

Press the No or the Arrow keys to select your choice. Press Yes to confirm.

Auto Cal ERROR EFFECTS Set Display Response?

Press No to move to the next option on the Auto Cal Error Effects menu.

Auto Cal ERROR EFFECTS Set Alarm Response?

Press Yes to set the alarm response.

Set Error Handling (cont.)

Select Alarm Effect?
No Effect?

Use the No or Arrow keys to scroll through the choices. Press Yes at your choice.

Select Alarm Effect?
Trip High?

Select Alarm Effect?
Trip Low?

Select Alarm Effect?
Trip Both?

AUTOCAL ERROR EFFECTS
Set Alarm Response?

Press No to move to the next option on the Auto Cal Error Effects menu.

AUTOCAL ERROR EFFECTS
Set Recorder Response?

Press Yes to set the recorder output(s) response.

Select Recorder Effect?
No Effect?

Use the No or Arrow keys to scroll through the choices. Press Yes at your choice.

Select Recorder Effect?
Force High?

Select Recorder Effect?
Force Low?

Select Recorder Effect?
Hold Last Value?

AUTOCAL ERROR EFFECTS
Set Recorder Response?

Press No to move to the next option on the Auto Cal Error Effects menu.

AUTOCAL ERROR EFFECTS
Done?

Press Yes to return to the Auto Calibration menu.

AUTO CALIBRATION MENU
Set Error Handling?

Press No to move to the next option on the Auto Calibration menu.

Perform AutoCal

The Perform AutoCal option is used to manually activate the Auto Cal procedure without waiting for the specified Auto Cal interval.

When an Auto Cal is performed, either by pressing Yes at the Perform AutoCal? prompt or when the specified time arrives, the following sequence occurs:

1. The top line of the LCD changes to “*Auto Cal in Progress*.” At this point the Process/Cal relay changes to the Cal state, and the Zero/Span relay changes to the Span state.
2. The bottom line of the LCD changes to “Span Gas is ON” and displays the equilibration time, which begins counting down to zero.

Note: *The Auto Cal can be interrupted at this point by pressing No. The LCD will prompt “Abort AutoCal?”. Press No to resume the countdown. Press Yes to return the LCD to the state it was in prior to the AutoCal.*

3. When the equilibration time reaches zero, the LCD will read “Measuring ...” and count down the measurement cycles. At the end of the measurement, the Zero/Span relay changes to the Zero state.
4. The bottom line of the LCD changes to “Zero Gas is ON” and displays the equilibration time, which begins counting down to zero.
5. When the equilibration time reaches zero, the LCD reads “Measuring ...” and counts down the measurement cycles.
6. At the end of the measurement, the Process/Cal relay changes to the Process state and the LCD displays the settling time, which begins counting down to zero.
7. When the settling time reaches zero, the LCD reads “Working ...” as it performs the drift curve fitting functions.

Perform AutoCal

To set Auto Cal to begin automatically, refer to *The Calibration Menu* on page 4-19. To manually activate the Auto Cal procedure:

AUTO CALIBRATION MENU Perform AutoCal?	Press Yes to activate Auto Cal.
Auto Cal in Progress Span Gas is ON XX.XX	The X's represent the countdown for span gas equilibration time. When the countdown reaches zero:
Auto Cal in Progress Measuring ... XX	The X's represent the countdown for span gas measuring time. When the countdown reaches zero:
Auto Cal in Progress Zero Gas is ON XX.XX	The X's represent the countdown for zero gas equilibration time. When the countdown reaches zero:
Auto Cal in Progress Measuring ... XX	The X's represent the countdown for zero gas measuring time. When the countdown reaches zero:
Auto Cal in Progress Settling ... XX.XX	The X's represent the countdown for process gas settling time. When the countdown reaches zero:
Working ...	The TMO2D-TC applies the Auto Cal results to the original calibration data, and creates a drift curve. It then returns to the prompt:
AUTO CALIBRATION MENU Perform AutoCal?	Press No to move to the next option on the Auto Calibration menu.

Zero Autocal

The Zero AutoCal option is used to reset the Auto Cal drift curve to the original calibration data. This should be done after performing a manual calibration of the TMO2-TC Transmitter (see Chapter 5, *Calibration*).

AUTO CALIBRATION MENU
Zero AutoCal?

Press Yes to select the Zero Autocal option.

Zero AutoCal?
[YES] no

Press the No or the Arrow keys to select YES. Press Yes to confirm.

Note: *If you select NO and press Yes to confirm, you will be immediately returned to the Auto Calibration menu.*

Working ...

After the TMO2D-TC resets the Auto Cal drift curve, you will be returned to the Auto Calibration menu.

AUTO CALIBRATION MENU
Zero AutoCal?

Press No to move to the next option on the Auto Calibration menu.

View Drift Curve

The View Drift Curve option is used to view the Auto Cal drift curve.

AUTO CALIBRATION MENU
View Drift Curve?

Press Yes to view the drift curve.

Note: *If the TMO2-TC Transmitter is uncalibrated, or if the TMO2D-TC has not undergone Auto Cal previously (no calibration data has been previously entered), there will not be any points in the drift curve, and the LCD will display:*

No Points in Curve.
Press YES to proceed ...

Press Yes to return to the Auto Calibration Menu.

Drift Values:
XX.XX %H₂, XX.XX mA

Press Yes to scroll through the drift curve values. After the last value, press Yes to exit.

AUTO CALIBRATION MENU
View Drift Curve?

Press No to move to the next option on the Auto Calibration Menu.

View Drift Curve (cont.)

AUTO CALIBRATION MENU
Done?

Press Yes to return to the
Calibration menu.

CALIBRATION MENU
Auto Cal Parameters?

Press No to move to the next
option on the Calibration menu.

Edit Calibration Data

The Edit Calibration Data option is used to view or change calibration data entered at the factory or by the user in the field. It contains two options: Enable Compensation and Set System Response.

Enable Compensation is not applicable to the TMO2D-TC. It should always be disabled.

Set System Response is used to provide damped or normal response from the TMO2D-TC. Damped response is the natural response of the TMO2-TC Transmitter (see Chapter 6, *Specifications*). Normal response is software-enhanced response for faster performance under certain conditions. The System Response option should normally be set to damped. If you desire faster response, please consult the factory before switching to normal response.

Edit Calibration Data allows the user to view or change calibration (grid) data points entered at the factory or by the user during a field calibration. The TMO2D-TC uses the calibration data points, along with the drift curve calculated from the Auto Cal procedure (if you have the Auto Cal option), to compensate the raw signal received from the TMO2-TC Transmitter. If you want to check the calibration data points entered at the factory, refer to the TMO2D-TC Calibration Sheet supplied with your unit (see Appendix G for a sample TMO2D-TC calibration sheet).

If the Calibration Sheet contains more than 2 data points, they have already been entered into the TMO2D-TC at the factory. You can generate new calibration data points in the field by using the TMO2D-TC in DVM mode (refer to *Tests Menu/DVM Test* on page 4-16), and by using the same gases and gas concentrations that were used during the factory calibration (refer to the TMO2D-TC Calibration Sheet supplied with your unit).

For example, to enter new calibration (grid) data points:

CALIBRATION MENU Edit Calibration Data?
--

Press Yes.

Enable Compensation yes [NO]

Press No or the Arrow keys to select NO. Press Yes to confirm.

Set System Response: normal [DAMPED]

Press No or the Arrow keys to select DAMPED. Press Yes to confirm.

Edit Calibration Data (cont.)

CALIBRATION MENU
Enter Grid Data?

Press Yes only if you want to view or change the grid data points. If you press No, you will see:

CALIBRATE
Done?

Press Yes to return to the Calibration menu.

H₂ GRID ENTRY
of Points [X]:

Use the Data Entry keys to enter the number of data points (the X represents the previous entry). Press Yes to confirm the entry.

Note: *If X=0, the TMO2D-TC does not contain any grid data points. You can also enter 0 here to nullify the existing data points already in memory. You would do this before calibrating the TMO2-TC Transmitter.*

Note: *If you only wish to view the grid data points, just press Yes continuously until you are returned to:*

CALIBRATION MENU
Enter Grid Data?

Press No and then Yes to return to the Calibration menu.

H₂ GRID ENTRY
of Points [Y]:

Press Yes to exit (the Y represents the value you entered).

Point # 1
%H₂ [XX.XX]:

Use the Data Entry keys to enter the % value for Point #1 (the X's represent the previous entry). Press Yes to confirm the entry.

Note: *The % gas concentrations must be in ascending order.*

Point # 1
%H₂ [YY.YY]:

Press Yes to exit (YY.YY represents the value you entered).

Edit Calibration Data (cont.)

Enter % gas concentrations for the remaining points in the same manner. When you are done, the TMO2D-TC will briefly display

Working ..., followed by:

YY.YY %H₂
H₂ mA [XX.XX]:

Use the Data Entry keys to enter the corresponding mA values for the given % gas concentration (the X's represent the previous entry). Press Yes to confirm the entry.

YY.YY %H₂
H₂ mA [YY.YY]:

Press Yes to exit (YY.YY represents the value you entered).

Enter mA values for the remaining points in the same manner. When you are done, the TMO2D-TC will briefly display **Working ...**, followed by:

CALIBRATE
Enter Grid Data?

Press No to move to the next option on the Calibrate menu.

CALIBRATE
Done?

Press Yes to return to the Calibration menu.

CALIBRATION MENU
Edit Calibration Data?

Press No to move to the next option on the Calibration menu.

CALIBRATION MENU
Done?

Press Yes to return to the Main menu.

MAIN MENU
Calibration?

Press No to move to the next option on the Main menu.

MAIN MENU
Resume?

Press Yes to return the TMO2D-TC to Operate Mode, or No or the Arrow keys to continue in Programming Mode.

Chapter 5

Calibration

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Overview

This chapter provides information on calibrating the TMO2-TC Transmitter in the field using zero, span, and reference gases. You will find the following topics discussed:

- Introduction — General considerations for calibration at the factory and in the field. Also, information on how the TMO2D-TC “Edit Calibration Data” and “Auto Cal” routines enhance the TMO2-TC Transmitter calibration.
- Required Equipment and Materials — What you will need before you begin calibrating.
- Preparing the Transmitter for Calibration — Getting the TMO2-TC ready and locating the adjustment pots.
- 2-Port (Sealed Reference Gas) Calibration — How to calibrate the 2-Port version using zero and span gases.
- 4-Port (Flowing Reference Gas) Calibration — How to calibrate the 4-Port version using zero, span, and reference gases.
- Checking/Changing Switch and Jumper Settings — Locating the switches, along with a list of switch and jumper settings for various applications.

!WARNING!

TO ENSURE THE SAFE OPERATION OF THE TMO2D-TC, YOU MUST INSTALL AND OPERATE IT AS DESCRIBED IN THIS MANUAL. IN ADDITION, BE SURE TO FOLLOW ALL APPLICABLE SAFETY CODES AND REGULATIONS FOR INSTALLING ELECTRICAL EQUIPMENT IN YOUR AREA.

PROCEDURES SHOULD BE PERFORMED BY TRAINED SERVICE PERSONNEL.

Introduction

The TMO2-TC Transmitter was calibrated at GE Panametrics for the range and gas mixture specified at the time of purchase. The following standard ranges and gases are provided:

0 to 1%
0 to 2%
0 to 5%
0 to 10%
0 to 25%
0 to 50%
0 to 100%

H₂ in N₂
CO₂ in N₂ (minimum range 0 to 5% CO₂)
CO₂ in Air (minimum range 0 to 5% CO₂)
He in N₂
He in Air

Introduction (cont.)

In addition, calibrations are performed for special ranges and gases.

When the TMO2-TC Transmitter was calibrated at the factory, the actual calibration data points (if there were more than two) were entered into the TMO2D-TC software to enhance the calibration. Calibration data points generated in the field can also be entered into the TMO2D-TC. Refer to Chapter 4, *Programming*, for details on "Edit Calibration Data".

Factory calibration can be further enhanced by using the Auto Cal option. If you have the Auto Cal option with your TMO2D-TC Display (and the proper sample system), the TMO2D-TC will automatically calibrate itself with zero and span gases at a preset time interval. The TMO2D-TC uses the new calibration data to create a drift curve that compensates the original calibration data of the TMO2-TC Transmitter. Refer to Chapter 4, *Programming*, for details on Auto Cal Parameters.

When taking a reading, the TMO2D-TC uses the entered data points (Edit Calibration Data) and drift curve (Auto Cal Parameters) to modify the TMO2-TC Transmitter calibration data.

The TMO2D-TC without the Auto Cal option will need to be recalibrated every 2 to 6 months, depending on the application. The exact calibration interval will depend on such factors as components of the binary gas mixture, desired accuracy, range, and the cleanliness of the sample gas. Please refer to the discussion of sensitivity in "Checking/Changing Switch and Jumper Settings" on page 5-9.

If your TMO2D-TC has the Auto Cal option, but you are getting invalid measurements after running Auto Cal, or it has been a long time since the TMO2-TC Transmitter was calibrated, you will want to proceed with a manual calibration of the TMO2-TC Transmitter. If you decide to perform a manual calibration, make sure that you first reset your Auto Cal drift curve to the original calibration data and delete any data points entered into the TMO2D-TC. Refer to Chapter 4, *Programming*, and the "AutoCal Parameters" and "Edit Calibration Data" routines for details.

You can recalibrate the TMO2-TC for the same range and binary gas mixture as the previous calibration using just the zero and span adjustments. If you want to calibrate the TMO2-TC for a different range or for a different binary gas mixture, you must first check (and possibly change) several internal switches. See "Checking/Changing Switch and Jumper Settings" in this chapter.

Caution!

The calibration procedure described in this section requires the use of specialized apparatus, and should be performed only by properly trained personnel.

**Required Equipment
and Materials**

You will need the following equipment and materials:

- 3 1/2 digit multimeter
- Zero gas
- Span gas
- Reference gas (4-Port version - reference gas is usually the same as span gas)
- Sample system or individual components (e.g., flow meter, needle valve, pressure regulator) for connecting zero and span gases and controlling pressure and flow rates.

Note: *The accuracy of the calibration will only be as good as the accuracy of the zero and span gases used.*

!WARNING!
**IF YOU WILL BE WORKING IN A HAZARDOUS
AREA, FOLLOW THE APPROPRIATE GUIDELINES
BEFORE AND DURING CALIBRATION. AVOID
EXPLOSIVE GAS MIXTURES.**

Preparing the Transmitter for Calibration

Proceed with the following steps before connecting and adjusting the zero, span, and reference gases.

1. Allow 30 minutes after power is turned on for the TMO2-TC to reach temperature stability.
2. Loosen the set screw that locks the TMO2-TC cover in place, and unscrew the cover (see Figure 5-1 below).

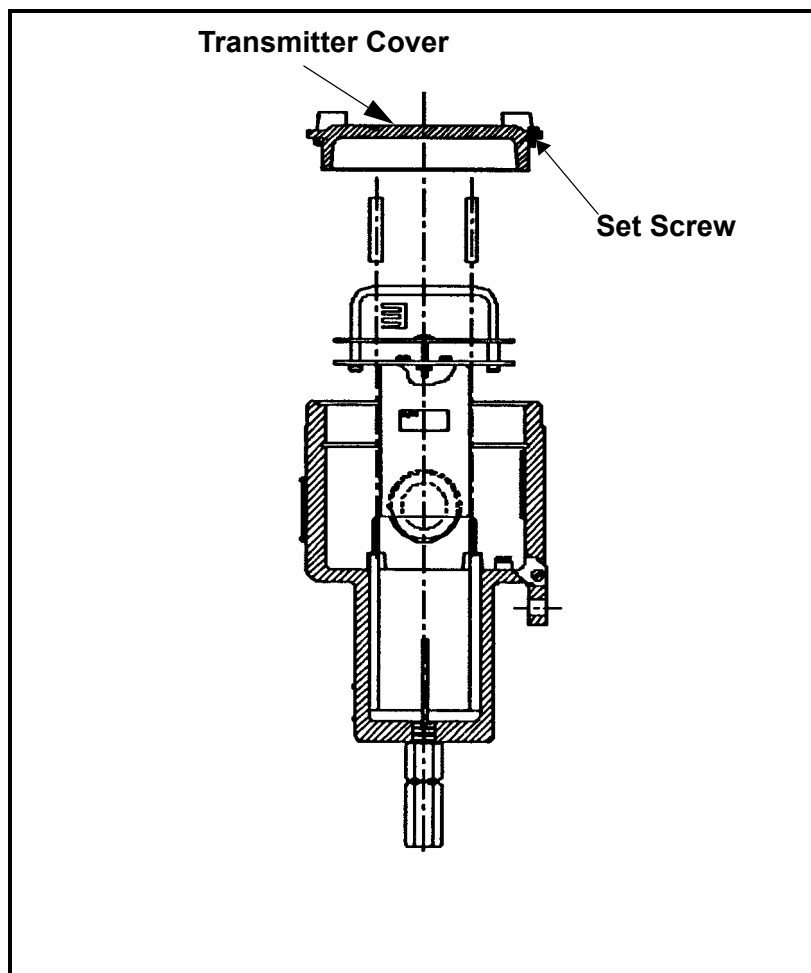


Figure 5-1: Transmitter Cover and Set Screw

Preparing the Transmitter for Calibration (cont.)

- You will see the TMO2-TC PCB #703-1095 located directly below the cover. Locate the adjustment pots R20 (Zero Adjustment) and R41 (Gain Adjustment) using Figure 5-2 below as a guide.

Note: This calibration procedure applies to PCB #703-1095 only. If your TMO2-TC is equipped with PCB #703-1036 or PCB #703-867, refer to Appendix F, Calibration Procedure and Adjustment Locations for Older Versions.

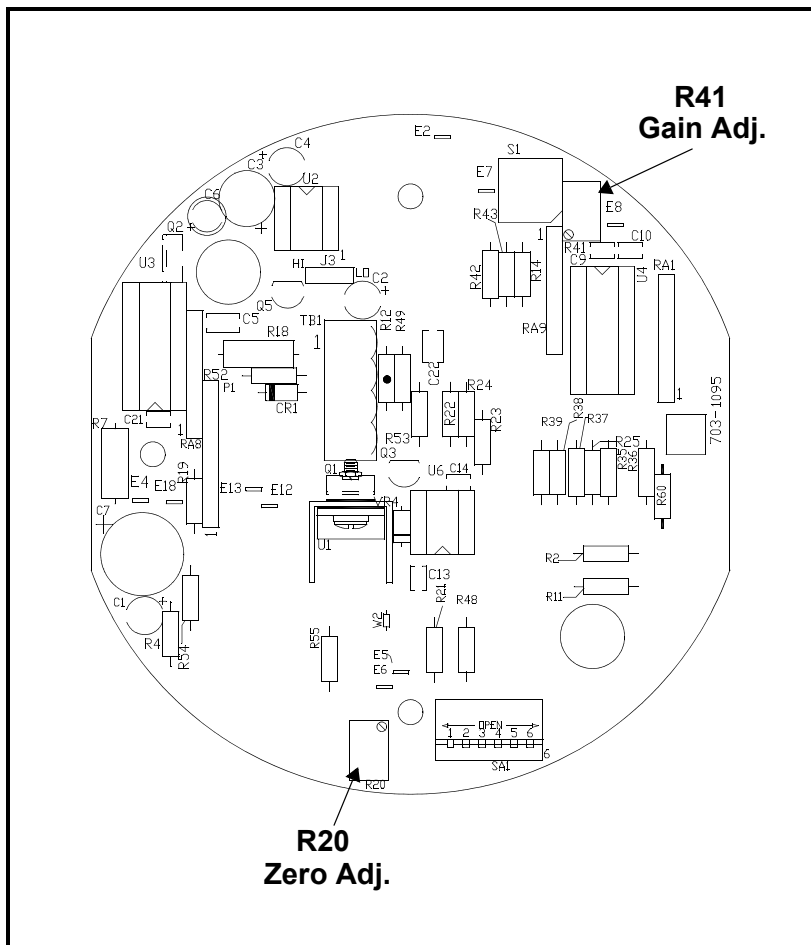


Figure 5-2: PCB 703-1095 Calibration Potentiometer Locations

2-Port (Sealed Reference Gas) Calibration

1. Connect the current lead of the multimeter to TB1, Pin 3, and the return lead to TB1, Pin 2. Note that TB1 can be unplugged from the PCB for easy connections. See Figure 5-3 below for the location of TB1.

Note: The current (mA) measurement cannot be made in parallel with any other resistance. If another wire is connected to TB1, Pin 3, disconnect that wire prior to connecting the multimeter.

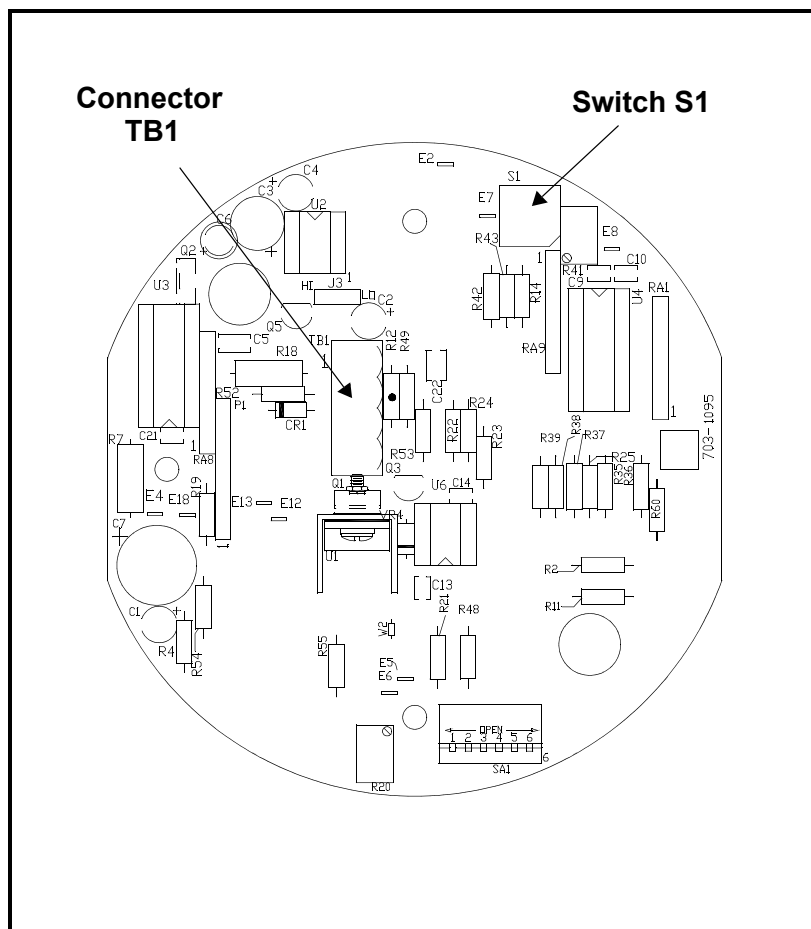


Figure 5-3: TB1 and S1 Locations on PCB 703-1095

**2-Port (Sealed
Reference Gas)
Calibration (cont.)**

2. Set the multimeter to read 0-20 mA.
3. Connect the TMO2-TC Sample Inlet to the zero gas via the Zero Gas Inlet on the sample system or other gas control system.
4. Establish a flow of 0.5 SCFH (250 cc/min) of zero gas at 0.0 psig to the TMO2-TC.
5. Adjust R20 until the multimeter reads 4.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.
6. Connect the TMO2-TC Sample Inlet to the span gas via the Span Gas Inlet on the sample system or other gas control system.
7. Establish a flow of 0.5 SCFH (250 cc/min) of span gas at 0.0 psig to the TMO2-TC.
8. Adjust R41 (clockwise provides increased gain) until the multimeter reads 20.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.

Note: *If R41 does not provide enough gain, you can adjust switch S1 (Coarse gain adjustment rotary switch) on PCB #703-1095 clockwise. See Figure 5-3 on the previous page for the location of S1.*

9. Repeat Steps 3 through 8 until there is no change in settings. R20 and R41 are interdependent; adjustment of one pot will affect the set point of the other pot.

4-Port (Flowing Reference Gas) Calibration

1. Connect the current lead of the multimeter to TB1, Pin 3, and the return lead to TB1, Pin 2. Note that TB1 can be unplugged from the PCB for easy connections. See Figure 5-3 on page 5-6 for the location of TB1.

Note: *The current (mA) measurement cannot be made in parallel with any other resistance. If another wire is connected to TB1, Pin 3, disconnect that wire prior to connecting the multimeter.*

2. Set the multimeter to read 0-20 mA.
3. Connect the TMO2-TC Reference Inlet to the reference (span) gas via the Reference Gas Inlet on the sample system or other gas control system.
4. Establish a flow of 0.5 SCFH (250 cc/min) of reference (span) gas at 0.0 psig to the TMO2-TC Reference Inlet. Note that you can establish a flow as low as 5 cc/min in order to conserve gas.
5. Connect the TMO2-TC Sample Inlet to the zero gas via the Zero Gas Inlet on the sample system or other gas control system.
6. Establish a flow of 0.5 SCFH (250 cc/min) of zero gas at 0.0 psig to the TMO2-TC Sample Inlet.
7. Adjust R20 until the multimeter reads 4.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.
8. Connect the TMO2-TC Sample Inlet to the span gas via the Span Gas Inlet on the sample system or other gas control system.
9. Establish a flow of 0.5 SCFH (250 cc/min) of span gas at 0.0 psig to the TMO2-TC Sample Inlet.
10. Adjust R41 (clockwise provides increased gain) until the multimeter reads 20.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.

Note: *If R41 does not provide enough gain, you can adjust switch S1 (coarse gain adjustment rotary switch) on PCB #703-1095 clockwise. See Figure 5-3 on page 5-6 for the location of S1.*

11. Repeat Steps 5 through 10 until there is no change in settings. R20 and R41 are interdependent; adjustment of one pot will affect the set point of the other pot.

Checking/Changing Switch and Jumper Settings

The TMO2-TC PCB #703-1095 contains two switches, SA1 and S1, and one jumper, J3, which have been preset at the factory for your application (see Figure 5-4 below for location). PCB #703-1096, located below PCB #703-1095, contains two jumpers, labeled S1, which are also preset at the factory for your application (see Figure 5-5 on page 5-11 for location). If you are recalibrating the TMO2-TC for the same range and binary gas mixture as the previous calibration, you do not need to change the settings of these switches and jumpers. If you like, you can verify the settings of these switches and jumpers against the TMO2D-TC Calibration Sheet supplied by GE Panametrics at the time of purchase. A typical Calibration Sheet can be found in Appendix G, *Sample TMO2D-TC Calibration Sheet*. If you are changing the range or binary gas mixture, you may have to change switch and jumper settings before you calibrate for zero and span.

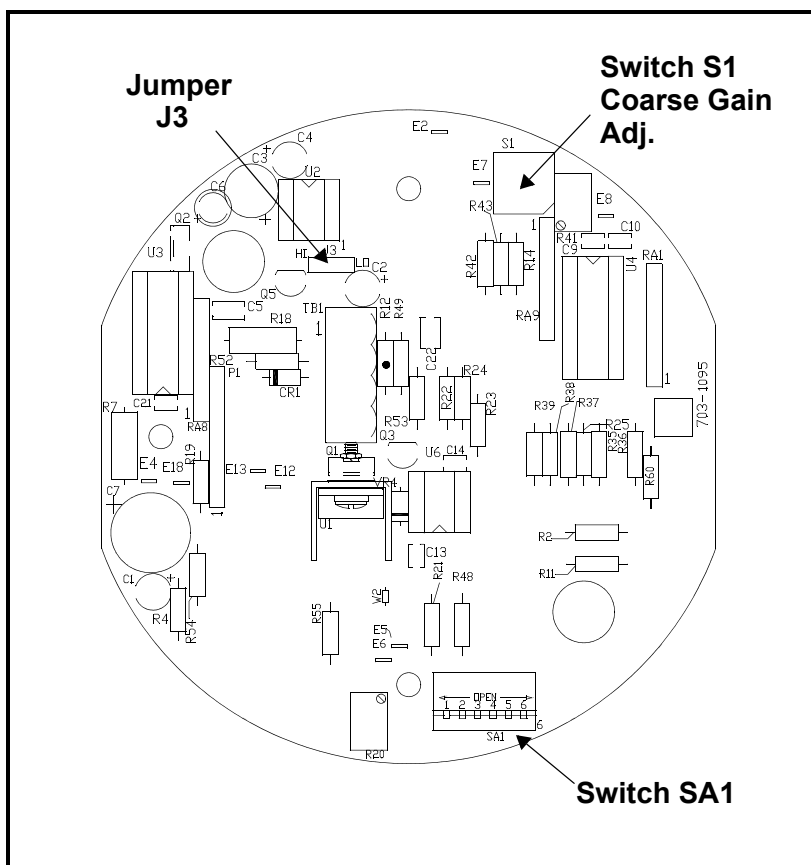


Figure 5-4: PCB 703-1095 Switch and Jumper Locations

**Checking/Changing
Switch and Jumper
Settings (cont.)**

A brief description of SA1, S1 (on PCB # 703-1095), J3, and the S1 jumpers (on PCB #703-1096) follows:

SA1 Gain adjustment dip switch (PCB #703-1095)

SA1 serves as a coarse gain adjustment, and is preset at the factory according to your application. See Table 5-1 on page 5-12 for standard SA1 switch settings.

S1 Coarse gain adjustment rotary switch (PCB #703-1095)

S1 also serves as a coarse gain adjustment, and is set at the factory during the initial calibration. It is advanced if R41 does not provide enough gain. Note that position 0 is never used.

J3 Bridge voltage adjustment jumper (PCB #703-1095)

Jumper J3 is used to select between high or low bridge voltage, and is preset at the factory according to your application. Low voltage (LO) is used for most applications. High voltage (HI) is used for applications with a hydrogen or helium concentration of more than 90%. See Table 5-1 on page 5-12 for standard J3 jumper settings.

S1 Polarity adjustment jumpers (PCB #703-1096)

These jumpers are preset at the factory according to your application. They are set to “+” if the thermal conductivity of the gas being measured is greater than the thermal conductivity of the secondary gas (e.g., H₂ in CO₂). They are set to “-” if the thermal conductivity of the gas being measured is less than the thermal conductivity of the secondary gas (e.g., CO₂ in air). The jumpers do not normally need to be checked or changed unless you are changing to or from a measured gas of CO₂ or SO₂. See Table 5-1 on page 5-12 for standard S1 jumper settings.

Note: *Do not confuse these jumpers with the coarse gain adjustment rotary switch S1 on PCB # 703-1095.*

Checking/Changing Switch and Jumper Settings (cont.)

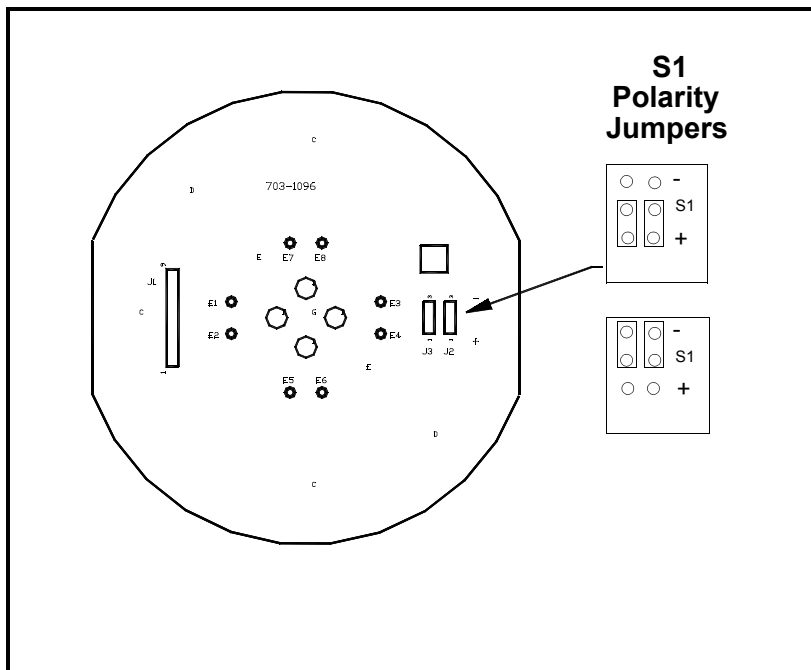


Figure 5-5: PCB 703-1096 S1 Jumper Locations

Table 5-1 on the next page shows switch settings for SA1, J3, and the S1 jumpers (PCB 703-1096) for a variety of standard applications. If you do not see your range and/or binary gas mixture listed, please consult the factory.

Table 5-1 also classifies applications based upon Sensitivity Class: Ultra (U), High (H), Medium (M), and Low (L). Generally, as the applications range in sensitivity from Low to Ultra, the TMO2-TC bridge voltage differential decreases. For example, 0 to 100% H₂ in N₂ (Low) might have 1,200 mV available, while 0 to 1% H₂ in N₂ (Ultra) might have only 12 mV available. If you are changing range or binary gas mixture and your new application is in a higher Sensitivity Class (e.g. Low - Ultra), you may have to calibrate the TMO2-TC more frequently in order to maintain its accuracy. Conversely, if you are changing from an Ultra to a Medium application, you may find that you can recalibrate less frequently.

Table 5-1: TMO2-TC Switch and Jumper Settings for Common Applications

Application	Switch SA1				J3	S1 Pol. (703-1096)	Sensitivity
	1	2	3	4, 5, 6			
0 to 5000 PPM H ₂ /He in N ₂ or Air	Off	Off	Off	Off		+	Ultra (U)
0 to 1% H ₂ /He in N ₂ or Air						+	
0 to 5% CO ₂ in N ₂ or Air						-	
0 to 10% CO ₂ in N ₂ or Air						-	
95 to 100% CO ₂ in N ₂ or Air						-	
0 to 5% SO ₂ in N ₂ or Air						-	
0 to 2% H ₂ /He in N ₂ or Air	Off	Off	On	Off		+	High (H)
0 to 15% CO ₂ in N ₂ or Air						-	
0 to 20% CO ₂ in N ₂ or Air						-	
0 to 30% CO ₂ in N ₂ or Air						-	
80 to 100% CO ₂ in N ₂ or Air						-	
0 to 10% SO ₂ in N ₂ or Air						-	
0 to 5% H ₂ /He in N ₂ or Air	On	On	Off	Off		+	Medium (M)
0 to 10% H ₂ /He in N ₂ or Air						+	
90 to 100% H ₂ /He in N ₂ or Air					Hi	+	
95 to 100% H ₂ /He in N or Air					Hi	+	
0 to 20% SO ₂ in N ₂ or Air						-	
0 to 30% SO ₂ in N ₂ or Air						-	
0 to 15% H ₂ /He in N ₂ or Air	On	On	On	Off		+	Low (L)
0 to 20% H ₂ /He in N ₂ or Air						+	
0 to 30% H ₂ /He in N ₂ or Air						+	
0 to 100% H ₂ /He in N ₂ or Air					Hi	+	
0 to 100% CO ₂ in N ₂ or Air						-	
20 to 50% in N ₂ or Air						+	
80 to 100% H ₂ /He in N ₂ or Air					Hi	+	

!WARNING!
AVOID EXPLOSIVE GAS MIXTURES

Chapter 6

Specifications

TMO2-TC Transmitter Specifications6-1

TMO2D-TC Display Specifications6-3

TMO2-TC Transmitter Specifications

Performance

Accuracy:

±1% of span (with TMO2D-TC Display)

Linearity:

±1% of span (with TMO2D-TC Display)

Repeatability:

±0.2% of span (short term)

Stability:

Zero: ±0.5% of span per week

Span: ±0.5% of span per week

Response Time:

20 seconds for 90% of step change

Measurement Ranges (typical):

0 to 1%

0 to 2%

0 to 5%

0 to 10%

0 to 25%

0 to 50%

0 to 100%

80 to 100%

90 to 100%

Measurement Gases (typical):

H₂ in N₂

He in N₂ or Air

CO₂ in N₂ or Air

SO₂ in Air

Ambient Temperature Effect:

±0.05% of span per °C

Required Sample Flow Rate:

0.1 to 4.0 SCFH (50 to 2000 cc/min), 0.5 SCFH (250 cc/min) nominal

Sample Flow Rate Effect:

0.5% of span (for flow range of 0.1 to 4.0 SCFH (50 to 2,000 cc/min))

Performance (cont.)	Required Reference Flow Rate: 0.01 to 4.0 SCFH (5 to 2000 cc/min), 0.5 SCFH (250 cc/min) nominal Line Voltage Effect: 0.02% of span (for normal variations)
Functional	Analog Output: 4-20 mA, 600 ohm max. Power: 24 VDC $\pm$2 VDC, 1 amp max. Cable: 10 ft. (3 m), 3-wire; lengths up to 2,800 ft. (850 m) available Operating Temperature: <i>Standard:</i> +55 °C (+131°F) <i>Optional:</i> +70 °C (+158°F) Ambient Temperature Range: <i>Standard:</i> -10 to +50 °C (+14 to +122 °F) <i>Optional:</i> -10 to +65 °C (+14 to +149 °F)
Physical	Sensor Wetted Materials: 316 SS, glass, PVC, Viton (standard) Dimensions: <i>Weatherproof Unit:</i> 9.54" (H) x 5.70" (DIA) (242 x 145 mm) <i>Explosion-proof Unit:</i> 10.48" (H) x 5.70" (DIA) (266 x 145 mm) Weight: 9.5 lbs (4.3 kg) Environmental: <i>Weatherproof:</i> NEMA-4X; IP65 <i>Explosion-proof:</i> Class 1, Groups A, B, C and D, Div. 1; Cenelec EEx d IIC T6 -ISSEP Cert. #90C.103.882
Accessories	T(XX)N3 - 3-wire cable (XX specifies length). Lengths up to 2,800 ft. (850 m) available.

TMO2D-TC Display Specifications

Performance

Accuracy:

$\pm 0.1\%$ of span (electronics only)

Ambient Temperature Effect:

$\pm 0.01\%$ of full scale per $^{\circ}\text{C}$

Functional

Analog Output:

Standard: Single, isolated 0/4-20 mA, 500 ohm max., field programmable

Optional: Dual, isolated 0/4-20 mA, 500 ohm max., field programmable

Alarm Relays:

1 fault alarm and 2 programmable high/low alarms:

2 Form C SPDT Relays	<u>Standard</u>	<u>Hermetically Sealed</u>
	2.5 A @ 240 VAC	
	3 A @ 115 VAC	0.3 A @ 115 VAC
	3 A @ 30 VDC	2 A @ 28 VDC

Standard and hermetically-sealed designs are available for the high/low alarms, set to trip at any level within the range of the instrument, programmable from the front panel. (The fault alarm is the same type as the high/low alarms.)

Note: *To maintain Low Voltage Directive Compliance, EN Standard EN61010, the following rating applies:
2 A @ 28 VDC.*

Digital Output:

RS232C serial port

Display:

2-line x 24 character backlit LCD

Analog Input:

4 to 20 mA from TMO2-TC Transmitter

Power:

100/120/220/240 VAC $\pm 10\%$, 50/60 Hz, 35 watts max., provides 24 VDC, 1 A max. to TMO2-TC Transmitter

Fuses:

110/120 VAC: 0.5 A, Slo-Blo.

220/240 VAC: 0.25 A, Slo-Blo.

Temperature:

Operating: 0 to $+50^{\circ}\text{C}$ ($+32$ to $+122^{\circ}\text{F}$)

Storage: -20 to $+70^{\circ}\text{C}$ (-4 to $+158^{\circ}\text{F}$)

Physical**Dimensions:**

Rack Mount: 5.25" (H) x 19" (W) x 9.25" (D)
(133 x 483 x 235 mm)

Bench Mount: 5.25" (H) x 9" (W) x 9.25" (D)
(133 x 229 x 235 mm)

Panel Mount: 5.25" (H) x 9" (W) x 9.25" (D)
(133 x 229 x 235 mm)

Weatherproof, fiberglass: 11.25" (H) x 9.38" (W) x 4.38" (D)
(286 x 238 x 111 mm)

Weatherproof, stainless steel: Consult factory

Explosion-proof: Consult factory

Weight:

Rack Mount: 5.4 lbs (2.4 kg)

Bench Mount: 7.4 lbs (3.4 kg)

Panel Mount: 4.7 lbs (2.1 kg)

Weatherproof, fiberglass: 6.5 lbs (3.0 kg)

Weatherproof, stainless steel: Consult factory

Explosion-proof: Consult factory

Environmental:

Rack, Bench, Panel Mount: General-purpose

Weatherproof, fiberglass: NEMA-4X; IP65

Weatherproof, stainless steel: Consult factory

Explosion-proof: Consult factory

European Compliance:

This unit complies with EMC Directive 89/336/EEC and 73/23/EEC Low Voltage Directive. (Installation Category II, Pollution Degree II.)

Chapter 7

Ordering Information

TMO2-TC Thermal Conductivity Transmitter

A	B	C	D
TMO2-TC	-		2
	-		

B- Measuring Cell Package (Requires 24 VDC, 1 A Power Supply)

- 1- Weatherproof enclosure, 2-Port (Sealed Reference Gas)
- 2- Explosion-proof enclosure, 2-Port (Sealed Reference Gas)
- 3- Weatherproof enclosure, 4-Port (Flowing Reference Gas)**
- 4- Explosion-proof enclosure, 4-Port (Flowing Reference Gas)**
- X- Without enclosure, 2-Port (Sealed Reference Gas)
- Y- Without enclosure, 4-Port (Flowing Reference Gas)**

C- Output*

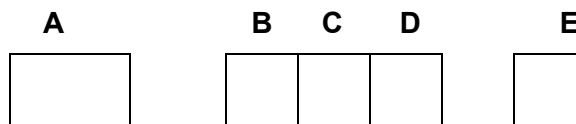
2- 4 to 20 mA

D- Constant Operating Temperature

- 1- 55°C (131°F), standard, for -10 to 50°C (14 to 122°F) ambient
- 2- 70°C (158°F), for -10 to 65°C (14 to 149°F) ambient

*Refer to Calibration Specification below. Binary gas composition must total 100%.

**Suppressed-zero and some other special calibrations require the 4-Port (Flowing Reference Gas) version.

TMO2D-TC Display**B - Display Package**

- 1) Rack Mount
- 2) Bench Mount
- 3) Panel Mount
- 4) Weatherproof fiberglass (NEMA 4X)
- 5) Explosion-proof*
- 6) Weatherproof, stainless steel, NEMA 4X/CE

C - Power

- 1) 100 VAC, 50/60 Hz
- 2) 120 VAC, 50/60 Hz
- 3) 220 VAC, 50/60 Hz
- 4) 240 VAC, 50/60 Hz

D - Output

- 1) Single, isolated 0/4-20 mA (standard)
- 2) Dual, isolated 0/4-20 mA

E - Alarm Relays

- 1) 2 alarm relays (standard)
- 2) 2 alarm relays, hermetically-sealed, for Class I, Div. 2
- 3) 4 alarm relays
- 4) 4 alarm relays, hermetically-sealed,
for Class I, Div. 2

*For delivery consult factory

**Dual, automatic calibration relays (Auto Cal)

TMO2-TC Calibration Specification

A		B	C
TC-CAL	-		

B- Cell Range

- 1- 0 to 1%
- 2- 0 to 2%
- 3- 0 to 5%
- 4- 0 to 10%
- 5- 0 to 25%
- 6- 0 to 50%
- 7- 0 to 100%
- 8- 90 to 100%*
- 9- 80 to 100%*
- S- Special*

C-Standard Gases

- 1- H₂ in N₂
- 2- CO₂ in N₂ (minimum range 0 to 5% CO₂)
- 3- CO₂ in Air (minimum range 0 to 5% CO₂)
- 4- He in N₂
- 5- He in air
- S- Special

Note: *Binary gas composition must total 100%.*

*Suppressed-zero and some other special calibrations require the 4-Port (Flowing Reference Gas) version. Reference gas flow is the same as 100% span gas and can be as low as 10 cc/min.

Appendix A

Relative Thermal Conductivity of Common Gases

Thermal Conductivity of Common Gases

Gas	Temperature		F.S. mV**
	0°C (32°F)	100°C (212°F)	
Air, N ₂ /O ₂	1.000	1.000	
Hydrogen, H ₂	6.968	6.803	1200
Helium, He	5.97	5.53	1000
Nitrogen, N ₂	1.000	0.989	
Oxygen, O ₂	1.018	1.028	
Neon, Ne	1.90	1.84	
Argon, Ar	0.677	0.665	-120
Chlorine, Cl ₂	0.323	0.340	
Carbon Monoxide, CO	0.962	0.958	
Carbon Dioxide, CO ₂	0.603	0.704	-120
Nitric Oxide, NO	0.980	0.978	
Sulfur Dioxide, SO ₂	0.350	0.381	
Hydrogen Sulfide, H ₂ S	0.538	0.562	
Carbon Disulfide, CS ₂	0.285	0.300	
Ammonia, NH ₃	0.897	1.04	
Water Vapor, H ₂ O	0.755	0.771	
Methane, CH ₄	1.25	1.45	
Ethane, C ₂ H ₆	0.750	0.970	
Propane, C ₃ H ₈	0.615	0.832	
n-Butane, C ₄ H ₁₀	0.552	0.744	
Isobutane, C ₄ H ₁₀	0.569	0.776	
n-Pentane, C ₅ H ₁₂	0.535	0.702	
Isopentane, C ₅ H ₁₂	0.515	0.702	
n-Hexane, C ₆ H ₁₄	0.508	0.662	
n-Heptane, C ₇ H ₁₆	0.399	0.582	
Cyclohexane, C ₆ H ₁₂	0.375	0.576	
Ethylene, C ₂ H ₄	0.720	0.980	
Propylene, C ₃ H ₆	0.626	0.879	
Acetylene, C ₂ H ₂	0.777	0.900	
1,3 Butadiene, C ₄ H ₆	0.441	0.642	
Nitrous Oxide, N ₂ O	0.633	0.762	
Ethylene Oxide, C ₂ H ₄ O	0.469	0.620	
Ethyl Alcohol, C ₂ H ₅ OH	0.590	0.685	
Isopropyl Alcohol*, C ₃ H ₇ OH	0.492	0.644	
Acetone, C ₃ H ₆ O	0.406	0.557	
Methyl Chloride, CH ₃ Cl	0.377	0.530	
Ethyl Chloride, C ₂ H ₅ Cl	0.391	0.540	
Vinyl Chloride, C ₂ H ₃ Cl	0.443	0.551	
Freon-11, CCl ₃ F	0.286	0.368	
Freon-12, CCl ₂ F ₂	0.344	0.442	
Freon-22, CHClF ₂	0.388	0.474	
Freon-113, C ₂ Cl ₃ F ₃	0.277	0.369	
Hydrogen Chloride, HCl	0.520	0.517	
Hydrogen Fluoride, HF	0.654	0.959	
*Consult GE Panametrics	**Full Scale Millivolts		

Appendix B

Applications

H₂ in N₂ in Heat Treat Furnace Atmospheres B-1

H₂ Purity in H₂ Electricity Generator Cooling B-7

H₂ in N₂ in Heat Treat Furnace Atmospheres

The TMO2-TC can be used to measure the concentration of hydrogen (H₂) in nitrogen (N₂) in a heat treat furnace atmosphere.

Problem

Mixtures of H₂ and N₂ are used as controlled atmospheres in the heat treating of metals. These mixtures are well-defined and need to be maintained in order to assure product quality and consistency. Dissociated ammonia is one such atmosphere. Here, ammonia is broken down into free N₂ and H₂ in a 25 to 75% mixture.

Equipment

A typical instrumentation package includes a 2-Port (Sealed Reference Gas - air) TMO2-TC Transmitter with a 4-20 mA range of 0 to 25 % H₂ mounted in a sample system similar to the one shown in Figure B-1 below. A display package is often specified.

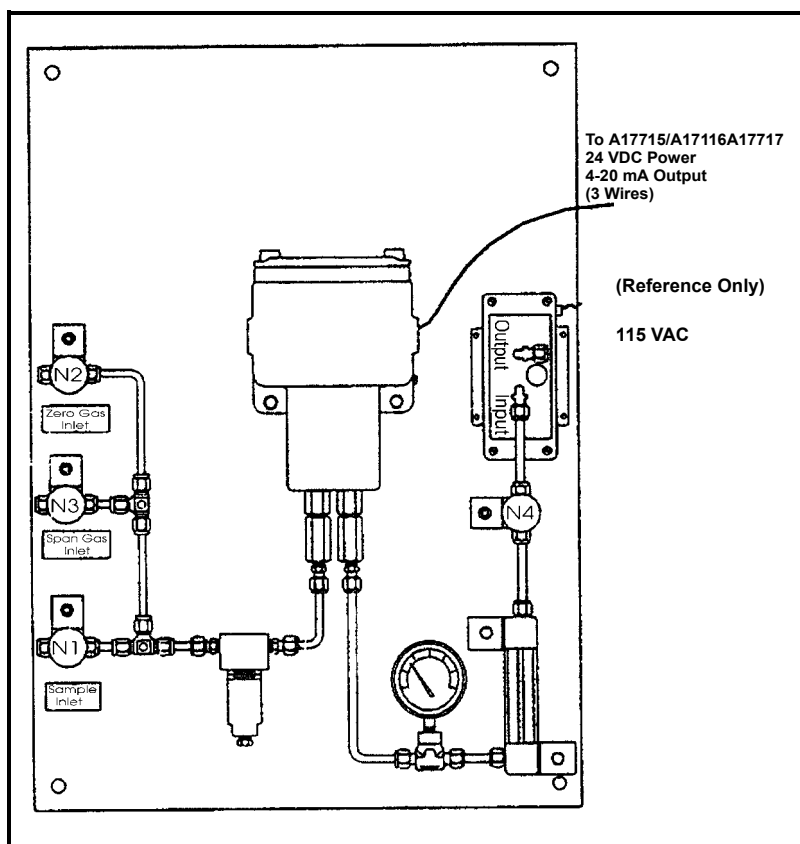


Figure B-1: Sample System - H₂ in N₂ in Heat Treat Furnace Atmospheres

Equipment (cont.)

The sample system consists of needle valves for selection/isolation of sample, zero, and span gases, a needle valve for flow control, a filter/coalescer, a 2-Port TMO2-TC, a pressure gauge, a flowmeter, and a sample pump. All components are mounted on a painted steel plate.

The TMO2D display package is typically used. A GE Panametrics moisture analyzer display package can be used when the H₂ measurement is to be made in conjunction with a moisture measurement.

Basic Operating Procedure

The H₂ content is continuously monitored at the inlet, hot zone, and/or effluent of the furnace. A sample gas flow rate of 0.5 SCFH (250 cc/min) is established. The sample system should be located in an area cooler than 50 °C, and the tubing leading to the sample system should be at least 5 ft long to insure proper cooling of the sample gas.

For this application, the required calibration gases are as follows:

- Zero gas - N₂ (99.95+ % purity)
- Span gas - 10.0 or 25.0 % H₂ in N₂, or H₂ (99.95+ % purity)

A typical TMO2-TC Calibration Data Sheet is shown in Figure B-2 on page B-3.

Basic Operating
Procedure (cont.)

**TMO2-TC CALIBRATION SHEET
THERMAL CONDUCTIVITY TRANSMITTER**

Serial Number TC-102
Part Number TMO2-TC-22-2
Range, % 0 to 25% H₂
Output 4 to 20 mA
PC Board 703-1095
Work Order: PCI 90403
Calibration Date: February 18, 1994

Point	%H ₂ *	H ₂ , mA
1	0.00	4.00
2	25.00	20.00

*Calibration is with Hydrogen (H₂) in Nitrogen (N₂)

TMO2-TC Switch Settings:

703-1095 PCB

S1: 3 Gain

J3: LO Power

SA1 -1: ON (ON=DOWN-CLOSED)

-2: ON

-3: ON

-4: OFF

-5: OFF

-6: OFF

703-1096 PCB

S1: + Polarity

Figure B-2: TMO2-TC Calibration Data Sheet

Permanent Installation Continuous monitoring of the furnace atmosphere H₂ content using the GE Panametrics TMO2-TC assures a high degree of quality control in the manufacturing process.

Specifications

Typical Ranges

0 to 10 % H₂ in N₂

0 to 25 % H₂ in N₂

0 to 100 % H₂ in N₂

Operating Conditions

Pressure: Ambient

Temperature: +540 to +1,370 °C (+1,000 to +2,500 °F)

Detailed Operating Procedure

The following procedure details the start-up, operation, and calibration of the 2-port (Sealed Reference Gas) TMO2-TC sample system for heat treat furnace applications shown in Figure B-1 on page B-1.

Needle valves on the sample system drawing have been tagged N1 through N4. The function of each valve is as follows:

- N1 Selects/Isolates the process sample gas.
- N2 Selects/Isolates the calibration zero gas.
- N3 Selects/Isolates the calibration span gas.
- N4 Controls the flow of the selected gas.

Detailed Operating Procedure (cont.)

Startup

- S1.** Mount the sample system in an enclosed area heated to a temperature above 0°C.
- S2.** Make sure that all needle valves are fully closed.
- S3.** Run 1/4" tubing from the process to N1 (SAMPLE INLET).

Note: *If the process is at a high pressure, a pressure regulator should be placed before this valve.*

Caution!

The TMO2-TC is calibrated and intended for use at atmospheric pressure. Higher pressures will lead to inaccurate readings, may result in damage to the instrument, and/or may pose a safety concern.

- S4.** Run 1/4" tubing from the pressure regulator on the cylinder containing the calibration zero gas to N2 (ZERO GAS INLET).
- S5.** Run 1/4" tubing from the pressure regulator on the cylinder containing the calibration span gas to N3 (SPAN GAS INLET).
- S6.** No pressure restrictions should be placed on the pump outlet. Any tubing on the outlet should be at least 1/4" in diameter, and preferably 1/2".
- S7.** Leak test all sample system fittings, as well as those leading to the sample system.
- S8.** Bring 24 VDC to the TMO2-TC. Refer to Chapter 2, *Installation*. Allow 1 hour before proceeding.
- S9.** Bring 115 VAC to the sample pump.
- S10.** Open N4 one turn.
- S11.** Fully open N1.
- S12.** Adjust N4 until the flowmeter reads mid-scale. The pressure gauge should read 0 psig.

Once the system has come to equilibrium, the sample system should be checked periodically to insure that there is gas flow through the flow meter.

Detailed Operating Procedure (cont.)

Calibration

Refer to Chapter 4, *Calibration*, for the complete TMO2-TC calibration procedure. The procedures below are only a supplement to that procedure. These procedures show the valve configurations necessary to bring the calibration gases to the TMO2-TC.

Zero Gas Calibration:

C1. Fully close N1.

C2. Fully open N2.

C3. Adjust N4 until the flowmeter reads mid-scale. The pressure gauge should read 0 psig.

Allow enough time for the tubing to be cleared of the sample gas before making any adjustments to the transmitter.

Span Gas Calibration:

C4. Fully close N2 (or N1).

C5. Fully open N3.

C6. Adjust N4 until the flowmeter reads mid-scale. The pressure gauge should read 0 psig.

Allow enough time for the tubing to be cleared of the zero (or sample) gas before making any adjustments to the transmitter.

Returning to Standard Operation:

C7. Fully close N3 (or N2).

C8. Fully open N1.

C9. Adjust N4 until the flowmeter reads mid-scale. The pressure gauge should read 0 psig.

Once the system has come to equilibrium, the sample system should be checked periodically to insure that there is flow through the flow meter.

H₂ Purity in H₂ Electricity Generator Cooling

The TMO2-TC can be used to measure the purity of hydrogen (H₂) in hydrogen-cooled electricity generators used in the power industry.

Problem

H₂ is used as a cooling media in electricity generators because of its high thermal conductivity. If air leaks into the H₂, the mixture can become explosive.

Equipment

A typical instrumentation package includes a 4-Port (Flowing Reference Gas - hydrogen), explosion-proof TMO2-TC Transmitter with a 4-20 mA range of 80 to 100% H₂ mounted in a sample system similar to the one shown in Figure B-3 below. A display package is often specified.

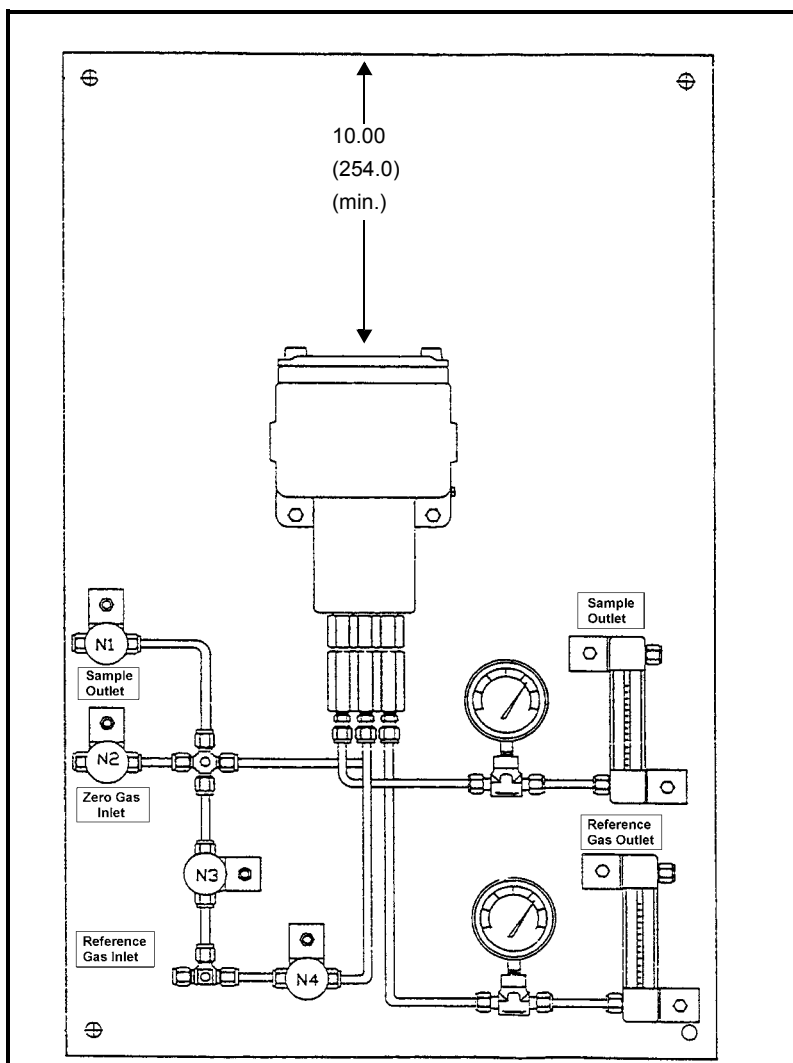


Figure B-3: Sample System -- H₂ Purity in H₂ Electricity Generator Cooling

Equipment (cont.)

The sample system consists of inlet needle valves for sample, zero, span, and reference gases; a 4-Port explosion-proof TMO2-TC; two pressure gauges; and two flowmeters. All components are mounted on a painted steel plate. A pump may be needed to draw a sample through the sample system.

The TMO2D display package is typically used. A GE Panametrics moisture analyzer display package can be used when the H₂ measurement is to be made in conjunction with a moisture measurement.

Basic Operating Procedure

The H₂ purity is continuously monitored at the generator. A sample gas flow of 0.5 SCFH (250 cc/min) is established. A hydrogen reference gas flow of 0.4 SCFH (200 cc/min) is sufficient for proper operation. The sample system should be located in an area cooler than 50 °C, and the tubing leading to the sample system should be at least 5 ft long to insure proper cooling of the sample gas.

For this application the required calibration gases are as follows:

- Zero gas - 80.0% H₂ in N₂
- Span gas - H₂ (99.95+ % purity)
- Reference gas - Same as span gas

A typical TMO2-TC Calibration Data Sheet is shown in Figure B-4 on page B-9.

TMO2-TC CALIBRATION SHEET
THERMAL CONDUCTIVITY TRANSMITTER
TMO2-TC Transmitter

Serial Number	TC-135
Part Number	TMO2-TC-42-1
Range, %	80 to 100% H ₂ in N ₂
Output	4 to 20 mA
PC Board	703-1095
Work Order:	PCI 94445
Calibration Date:	September 1, 1994

Point	%H ₂ *	H ₂ , mA
1	80.00	4.00
2	90.00	11.62
3	100.0	20.00

*Calibration is with Hydrogen (H₂) in Nitrogen (N₂)

TMO2-TC Switch Settings:

703-1095 PCB

S1: 8 Gain

J3: HI Power

SA1 -1: ON (ON=DOWN=CLOSED)

-2: ON

-3: ON

-4: OFF

-5: OFF

-6: OFF

703-1096 PCB

S1: + Polarity

Figure B-4: TMO2-TC Calibration Data Sheet

How Previously Handled	The system (generator) was leak checked periodically. If a leak occurred between checks, an explosion could occur. Moisture analyzers were also used for continuous analysis, since the presence of moisture in the H ₂ is indirect evidence of an air leak.
Permanent Installation	Continuous monitoring of the generator H ₂ purity using the GE Panametrics TMO2-TC provides increased safety. A low H ₂ reading alerts plant personnel to a potential safety problem and allows them to locate the leak and correct the problem.
Specifications	Range 80 to 100 % H₂ in N₂ Operating Conditions <i>Pressure:</i> 0.5 to 75 psig <i>Temperature:</i> +30 to +50 °C (+86 to +122 °F)
Detailed Operating Procedure	The following procedure details the start-up, operation, and calibration of the 4-port (Flowing Reference Gas) TMO2-TC sample system for hydrogen purity applications shown in Figure B-3 on page B-7. Needle valves on the sample system drawing have been tagged N1 through N4. The function of each valve is as follows: • N1 Controls the flow of the process sample gas. • N2 Controls the flow of the calibration zero gas. • N3 Controls the flow of the calibration span gas. • N4 Controls the flow of the reference gas.

Detailed Operating Procedure (cont.)

Startup

- S1.** Mount the sample system in an enclosed area heated to a temperature above 0 °C.
- S2.** Make sure that all needle valves are fully closed.
- S3.** Run 1/4" tubing from the process to N1 (SAMPLE INLET).

Note: *If the process is at a high pressure, a pressure regulator should be placed before this valve.*

Caution!

The TMO2-TC is calibrated and intended for use at atmospheric pressure. Higher pressures will lead to inaccurate readings, may result in damage to the instrument, and/or may pose a safety concern.

- S4.** Run 1/4" tubing from the pressure regulator on the cylinder containing the calibration zero gas to N2 (ZERO GAS INLET).
- S5.** Run 1/4" tubing from the pressure regulator on the cylinder containing the calibration span gas/reference gas to N4 (REFERENCE GAS INLET).
- S6.** No pressure restrictions should be placed on the flowmeter outlets. Any tubing on the outlets should be at least 1/4-in. in diameter, and preferably 1/2 in.
- S7.** Leak test all sample system fittings, as well as those leading to the sample system.
- S8.** Bring 24 VDC to the TMO2-TC. Refer to Chapter 2, *Installation*. Allow 1 hour before proceeding.
- S9.** Slowly open N1 until the sample outlet flowmeter reads mid-scale. The pressure gauge at the sample outlet should read 0 psig.
- S10.** Slowly open N4 until the reference gas outlet flowmeter reads mid-scale. The pressure gauge at the reference gas outlet should read 0 psig.

Once the system has come to equilibrium, the sample system should be checked periodically to insure that there is gas flow through both flow meters.

Detailed Operating Procedure (cont.)

Calibration

Refer to Chapter 4, *Calibration*, for the complete TMO2-TC calibration procedure. The procedures below are only a supplement to that procedure. These procedures show the valve configurations necessary to bring the calibration gases to the TMO2-TC.

Zero Gas Calibration:

C1. Fully close N1 and/or N3.

C2. Slowly open N2 until the sample outlet flowmeter reads mid-scale. The pressure gauge at the sample outlet should read 0 psig.

Note: *If N3 was closed in this step and if the flow in the reference gas outlet flowmeter increased when N3 was closed, adjust N4 to bring the flow to mid-scale.*

Allow enough time for the tubing to be cleared of the sample gas or calibration span gas before making any adjustments to the transmitter.

Span Gas Calibration:

C3. Fully close N1 and/or N2.

C4. Slowly open N3 until the sample outlet flowmeter reads mid-scale. The pressure gauge at the sample outlet should read 0 psig.

Note: *If the flow in the reference gas outlet flowmeter decreased when N3 was opened, adjust N4 to bring the flow to mid-scale.*

Returning to Standard Operation:

C5. Fully close N2 and/or N3.

Note: *If N3 was closed in this step and if the flow in the reference gas outlet flowmeter increased when N3 was closed, adjust N4 to bring the reference gas flow to mid-scale.*

C6. Slowly open N1 until the sample outlet flowmeter reads mid-scale. The pressure gauge at the sample outlet should read 0 psig.

Once the system has come to equilibrium, the sample system should be checked periodically to insure that there is flow through both flowmeters.

Appendix C

Installation and Maintenance Drawings

TMO2-TC (Sealed Ref.) Outline and Installation (Dwg. #712-225)	C-1
TMO2-TC (Flowing Ref.) Outline and Installation (Dwg. #712-226)	C-2
TMO2D-TC Weatherproof Dimensions (Dwg. #701-030)	C-3
TMO2D Panel Mount Outline and Dimensions (Dwg. #712-222)	C-4
Oxygen Analyzer Display PCB Assembly (Dwg. #703-1226)	C-5
Oxygen Analyzer Display PCB Schematic (Dwg. #700-1226, sh. 1)	C-6
Oxygen Analyzer Display PCB Schematic (Dwg. #700-1226, sh. 2)	C-7
Oxygen Analyzer Display PCB Schematic (Dwg. 700-1226, sh. 3)	C-8
TMO2D-TC Bench and Rack Mount Dimensions (Dwg. #421-255)	C-9
Thermal Conductivity Analyzer PCB Schematic (Dwg. 700-1095)	C-10
Oxygen Analyzer Display PCB Schematic (Dwg. #700-997, sh. 1)	C-11
Oxygen Analyzer Display PCB Schematic (Dwg. 700-997, sh. 2)	C-12
Oxygen Analyzer Display PCB Schematic (Dwg. #700-997, sh. 3)	C-13
Thermal Conductivity Analyzer PCB Assembly (Dwg. #703-1095)	C-14
Oxygen Analyzer Display PCB Assembly (Dwg. 703-997)	C-15
I/O PCB Assembly (Dwg. 703-1096)	C-16

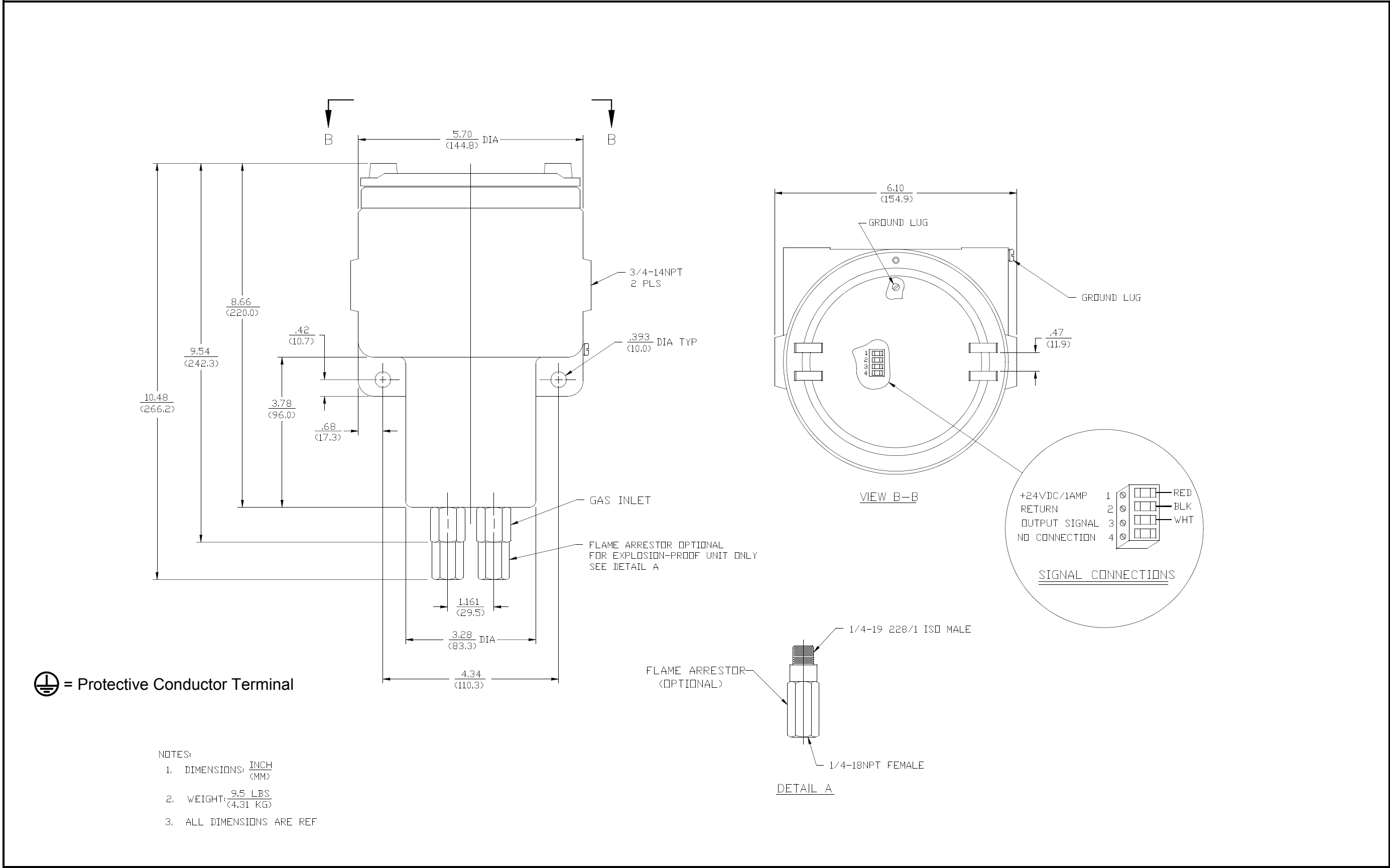


Figure C-1: TMO2-TC (Sealed Ref.) Outline and Installation (Dwg. #712-225)

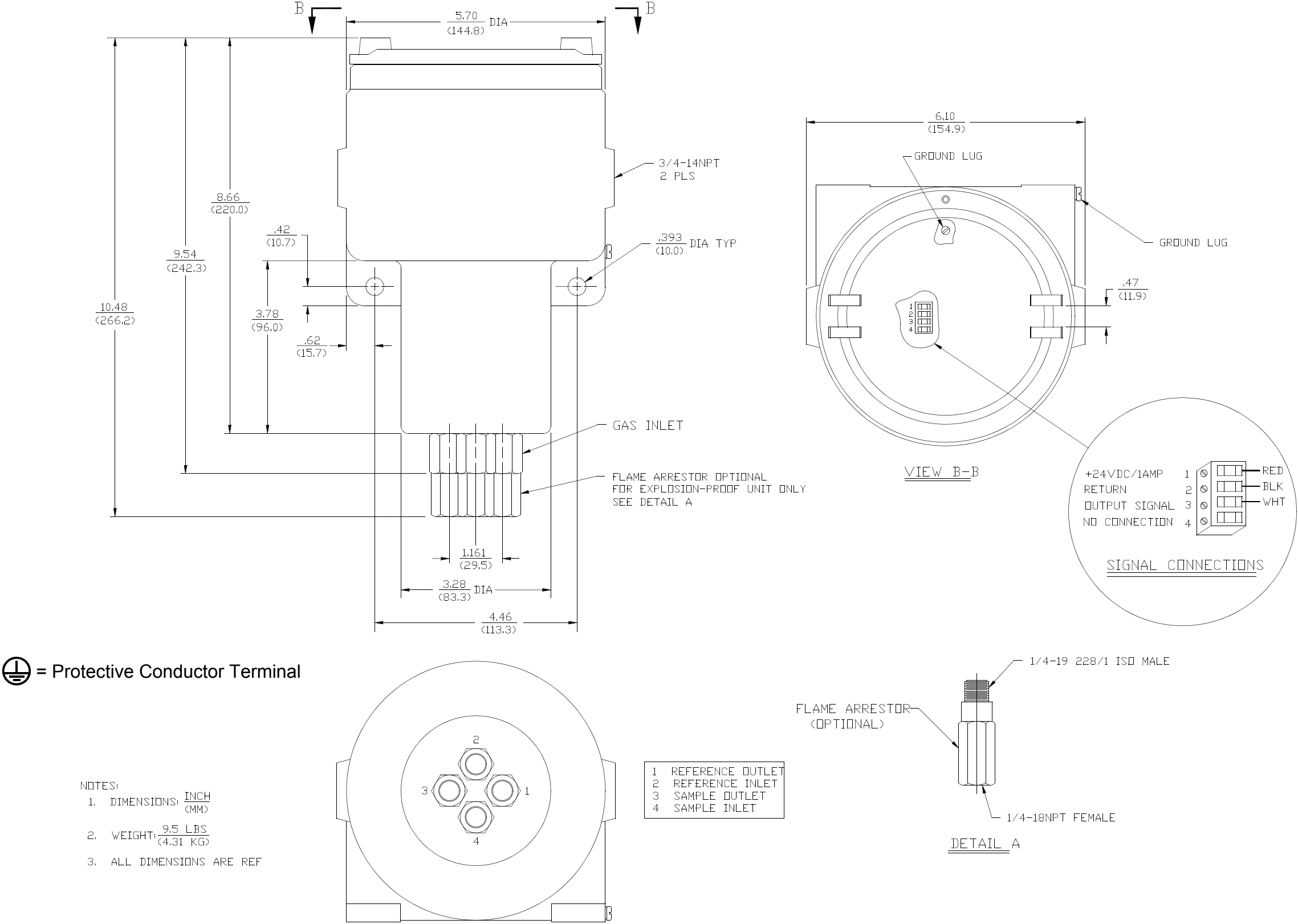


Figure C-2: TMO2-TC (Flowing Ref.) Outline and Installation (Dwg. #712-226)

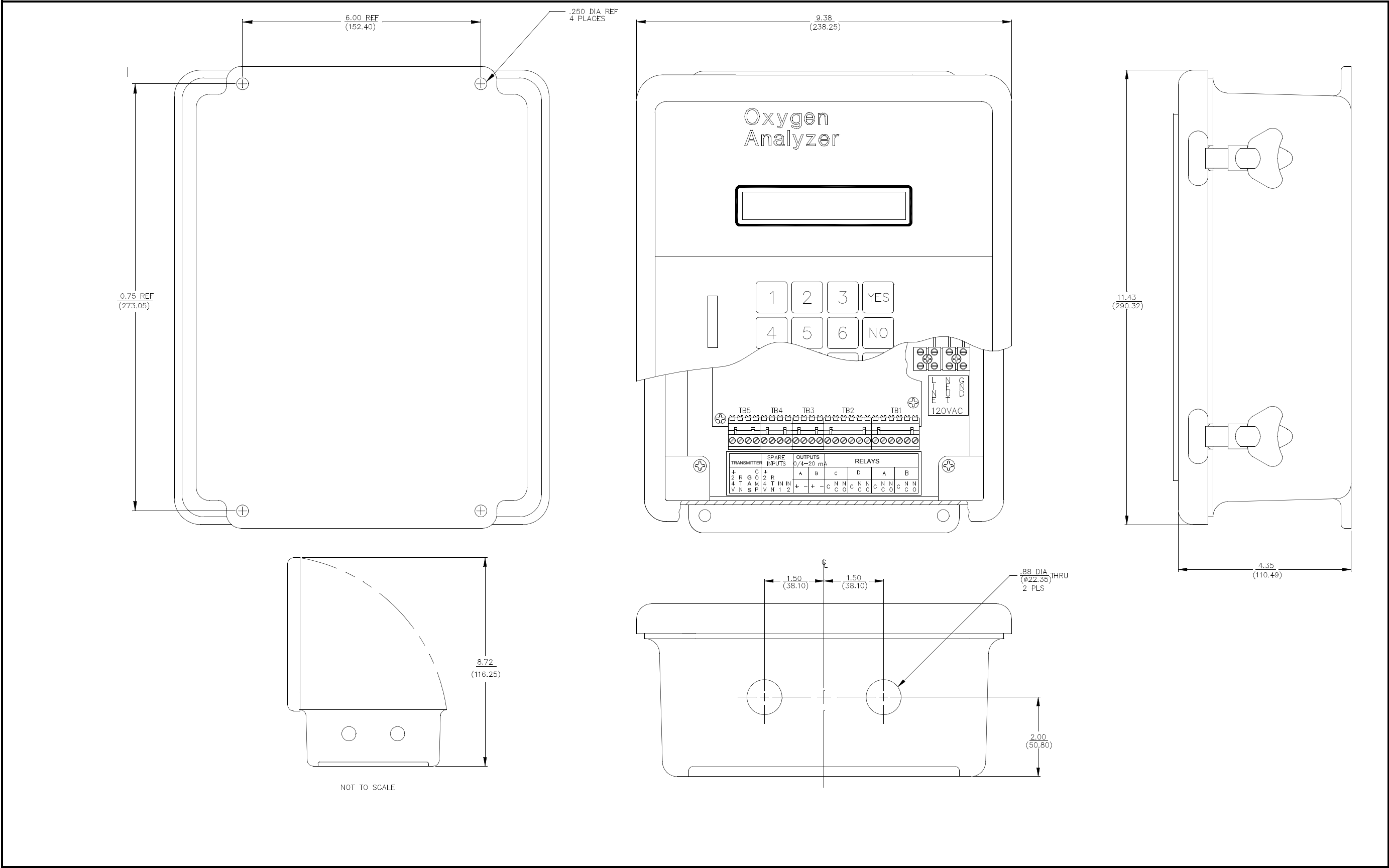


Figure C-3: TMO2D-TC Weatherproof Dimensions (Dwg. #701-030)

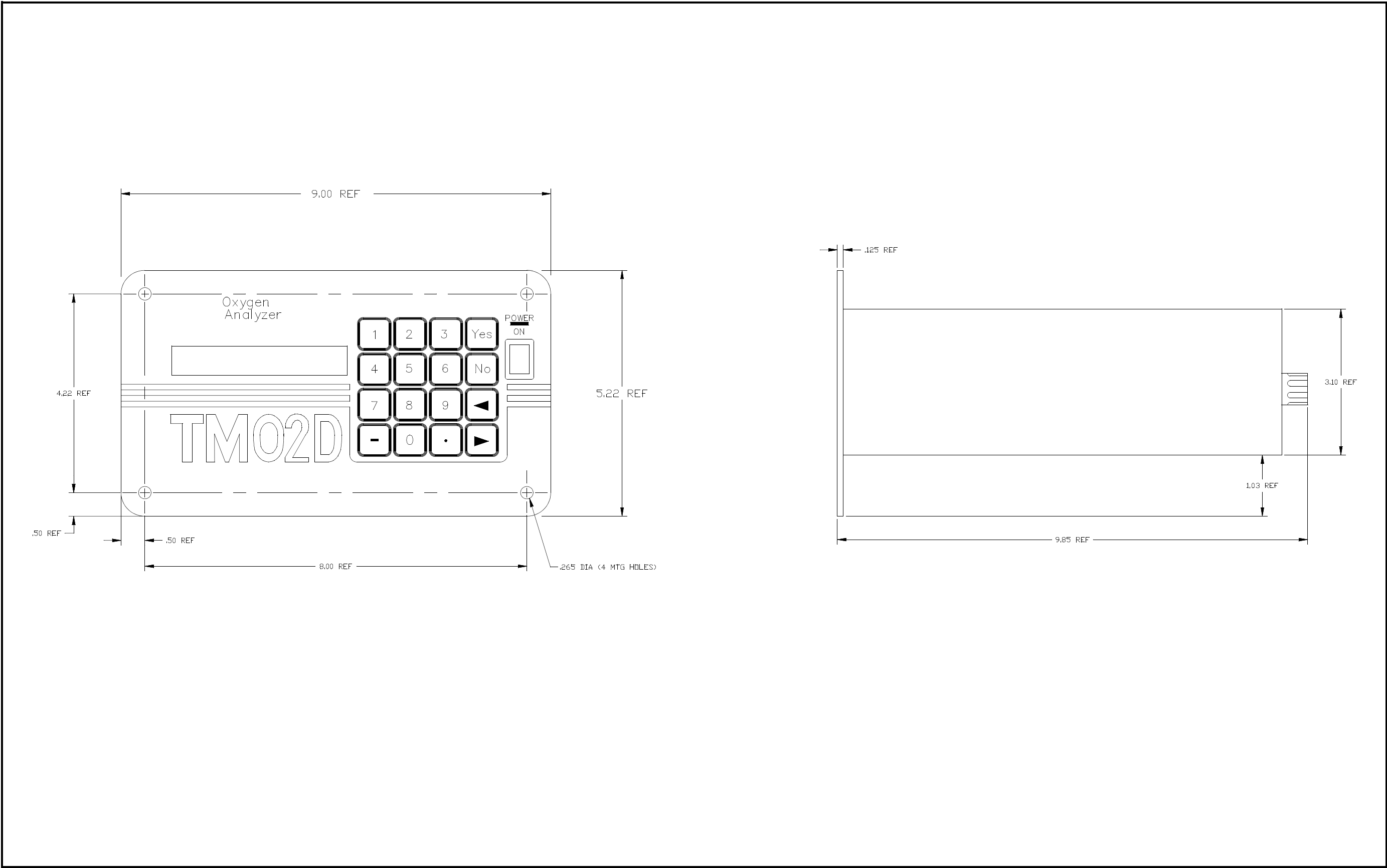


Figure C-4: TMO2D Panel Mount Outline and Dimensions (Dwg. #712-222)

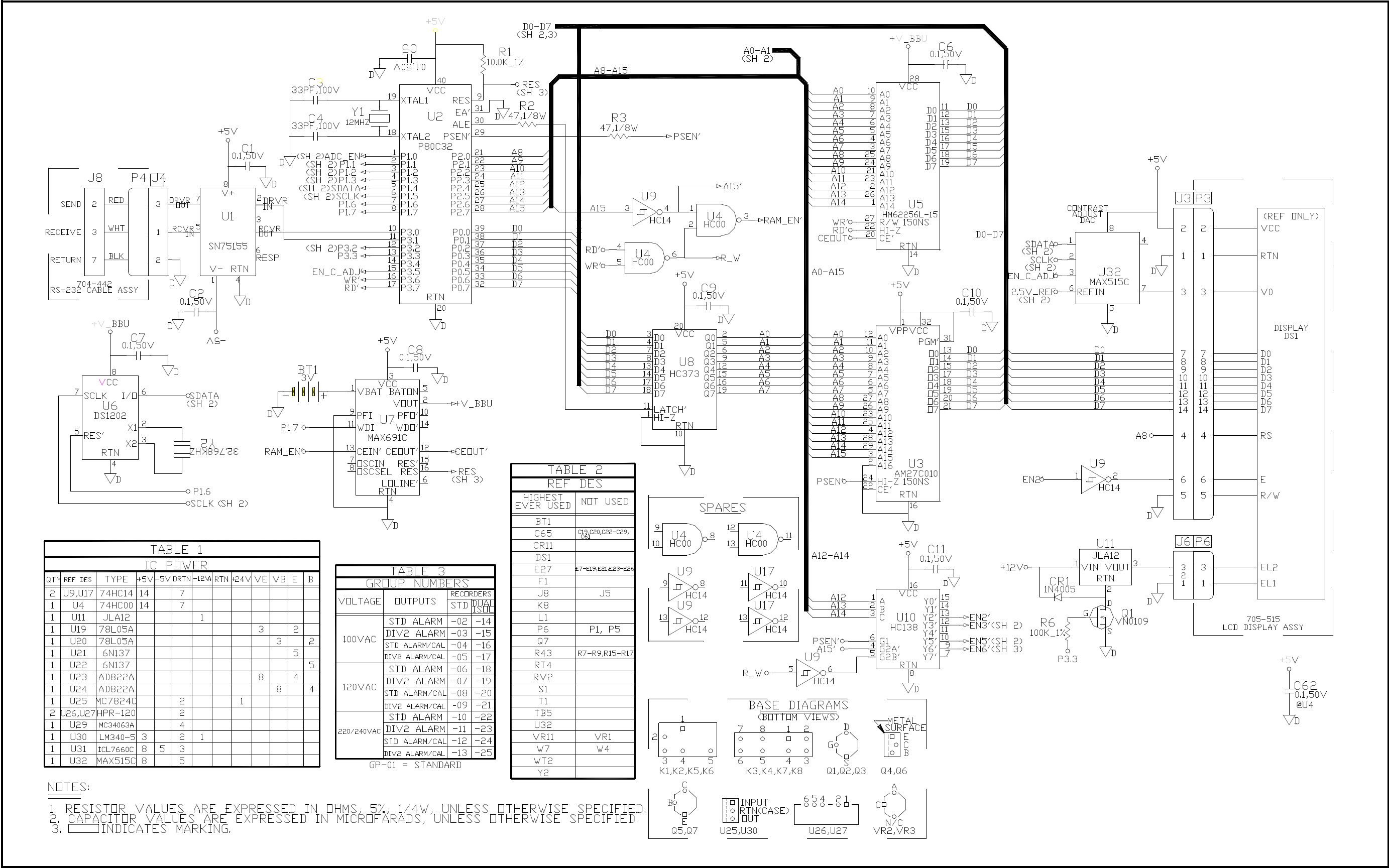


Figure C-6: Oxygen Analyzer Display PCB Schematic (Dwg. #700-1226, sh. 1)

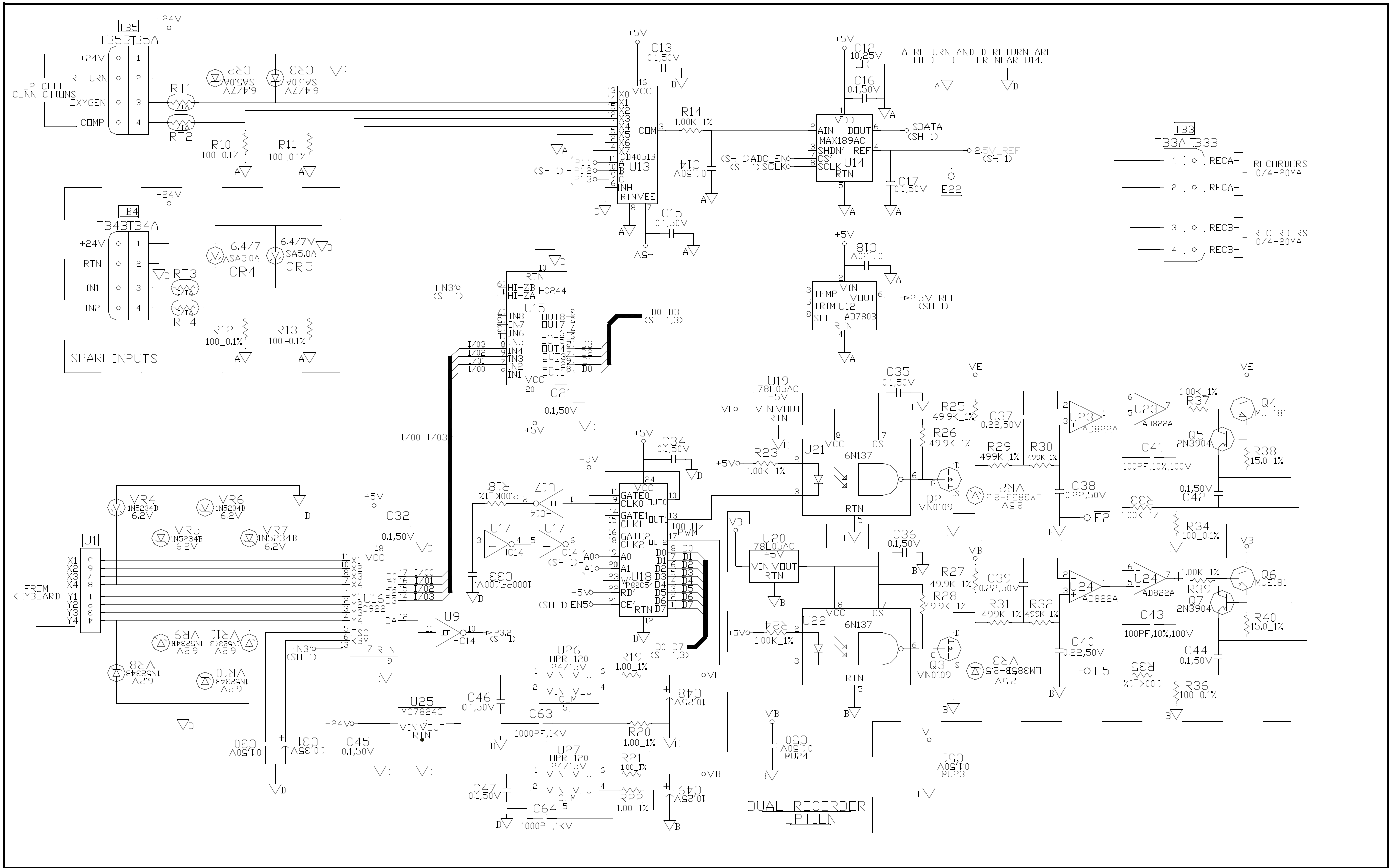
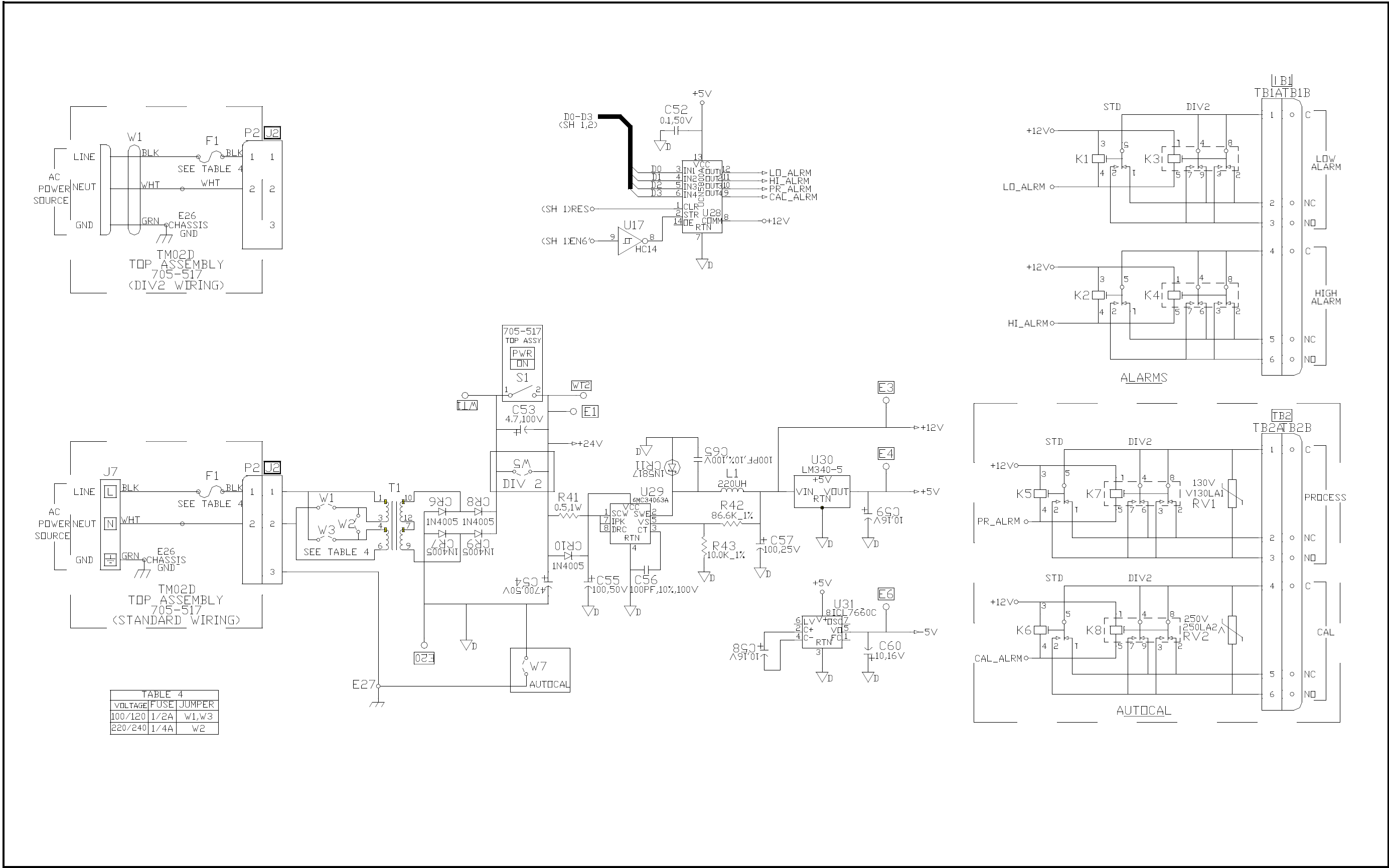


Figure C-7: Oxygen Analyzer Display PCB Schematic (Dwg. #700-1226, sh. 2)



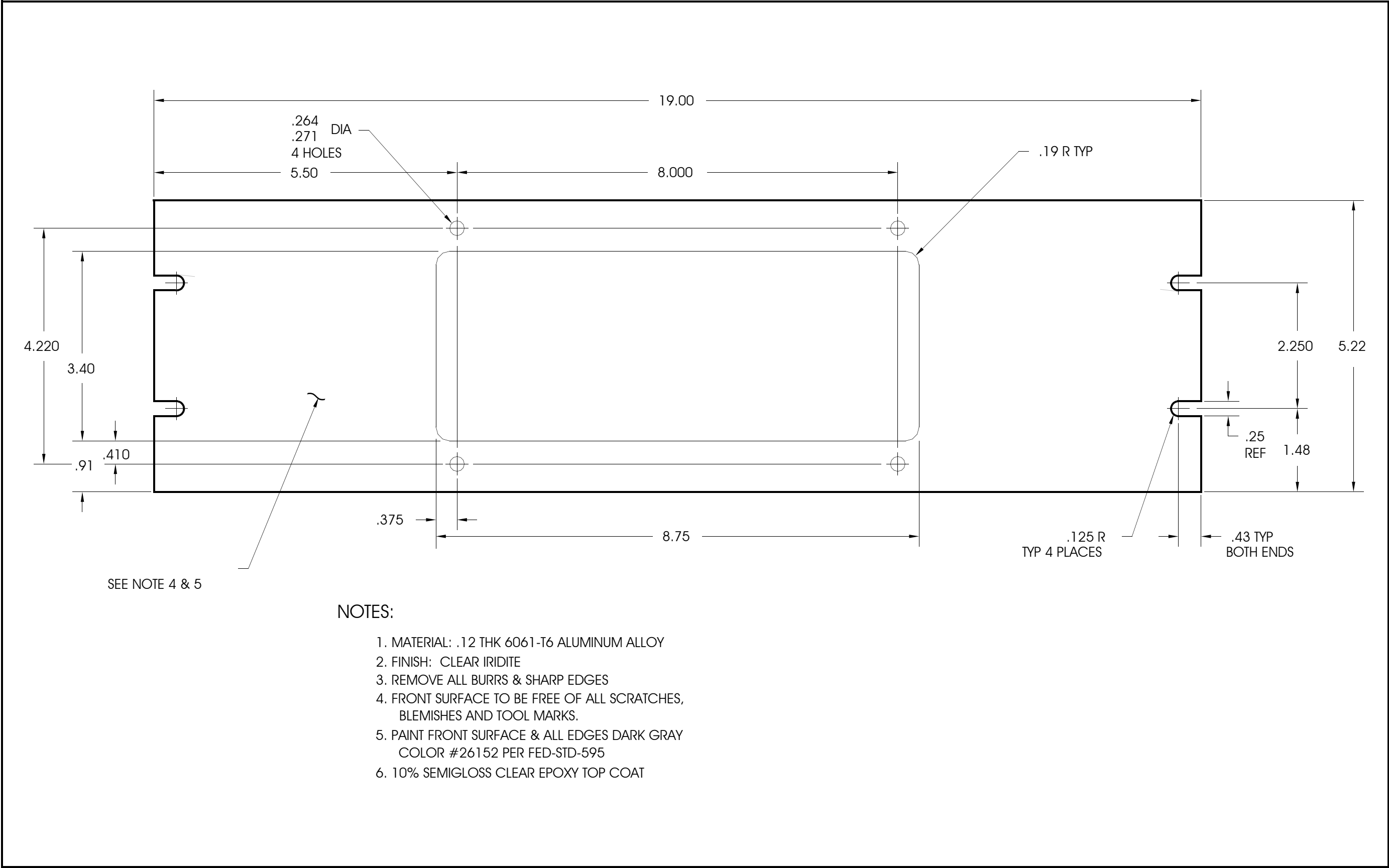


Figure C-9: TMO2D-TC Bench and Rack Mount Dimensions (Dwg. #421-255)

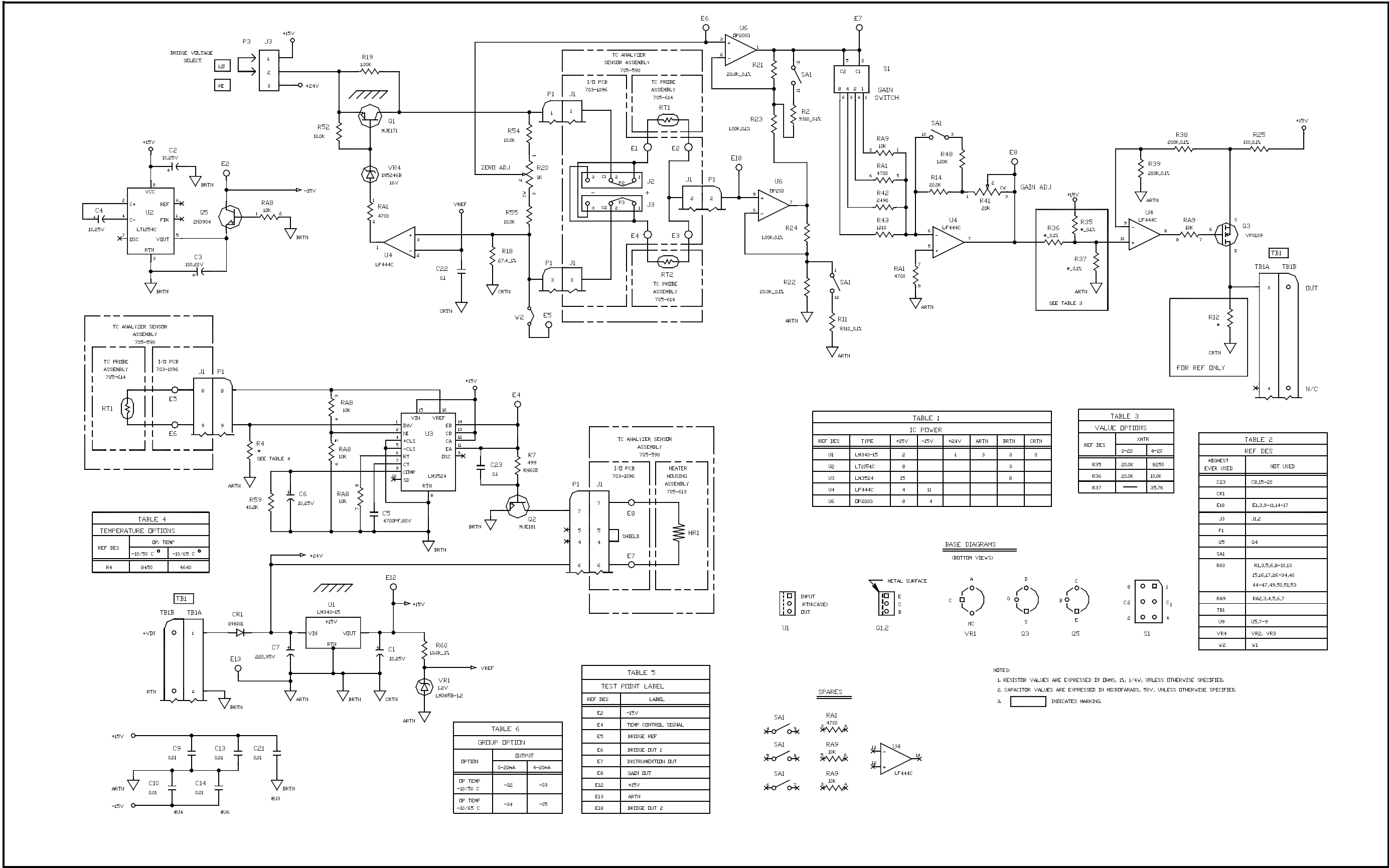
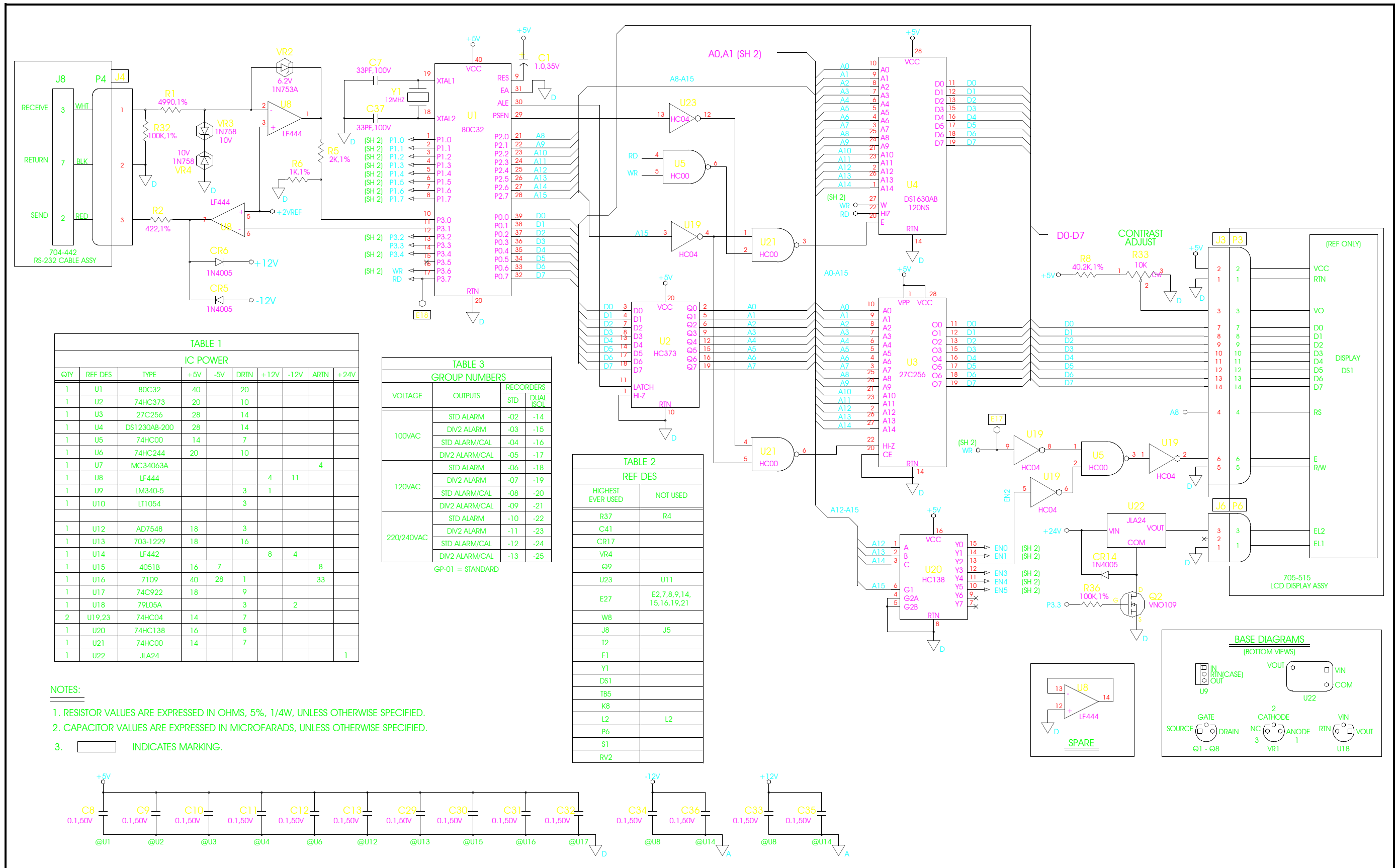


Figure C-10: Thermal Conductivity Analyzer PCB Schematic (Dwg. 700-1095)



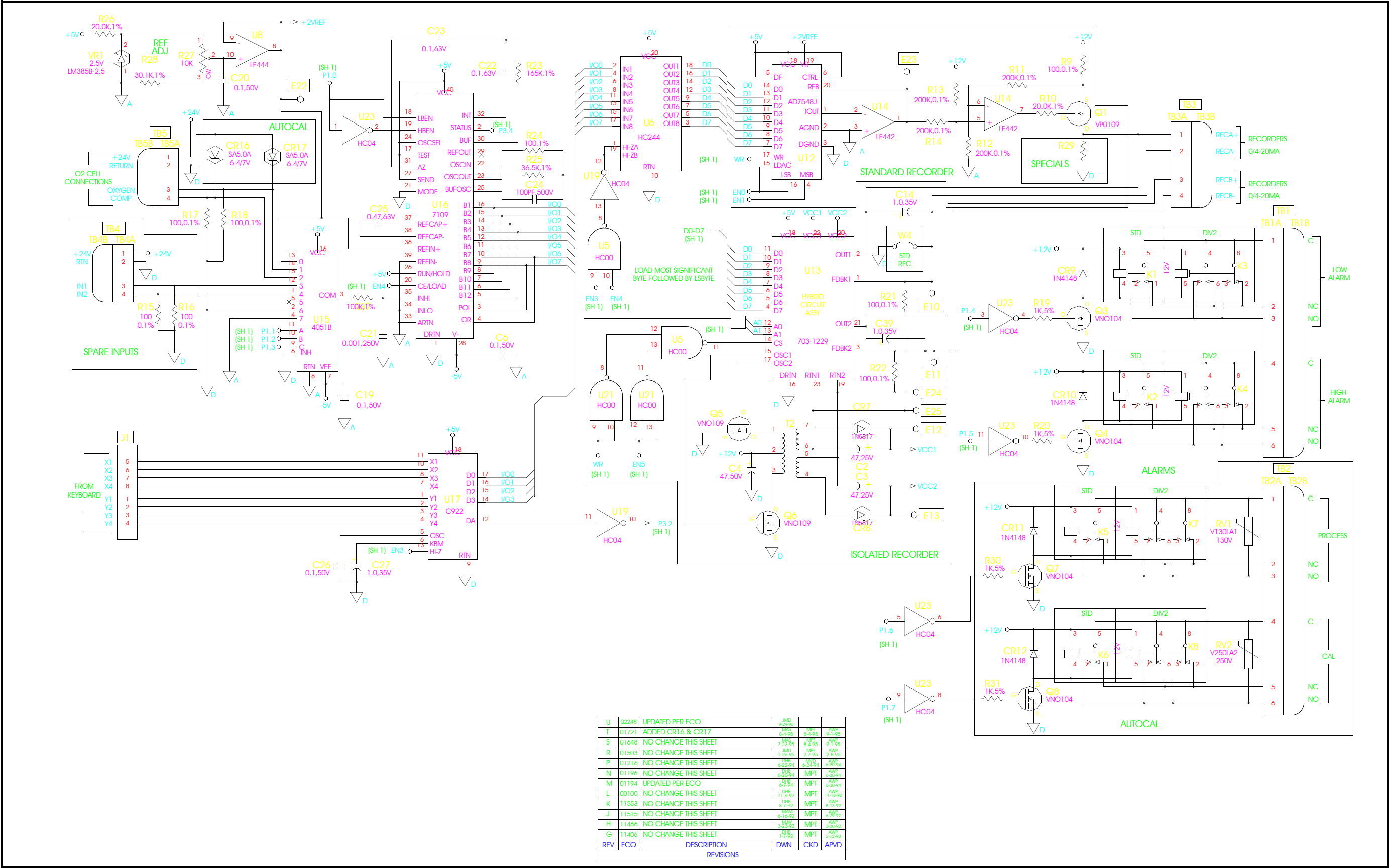


Figure C-12: Oxygen Analyzer Display PCB Schematic (Dwg. 700-997, sh. 2)

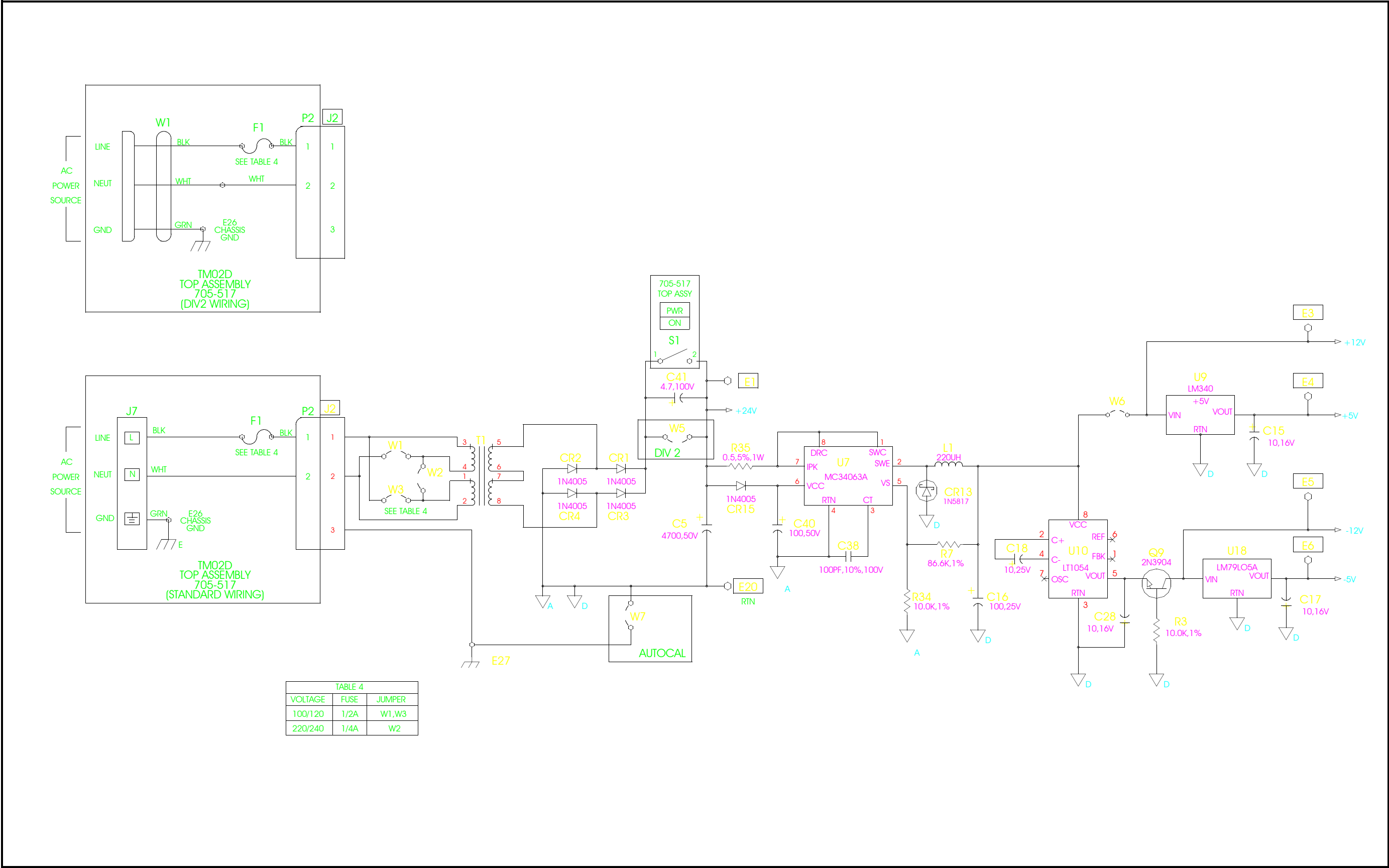


Figure C-13: Oxygen Analyzer Display PCB Schematic (Dwg. #700-997, sh. 3)

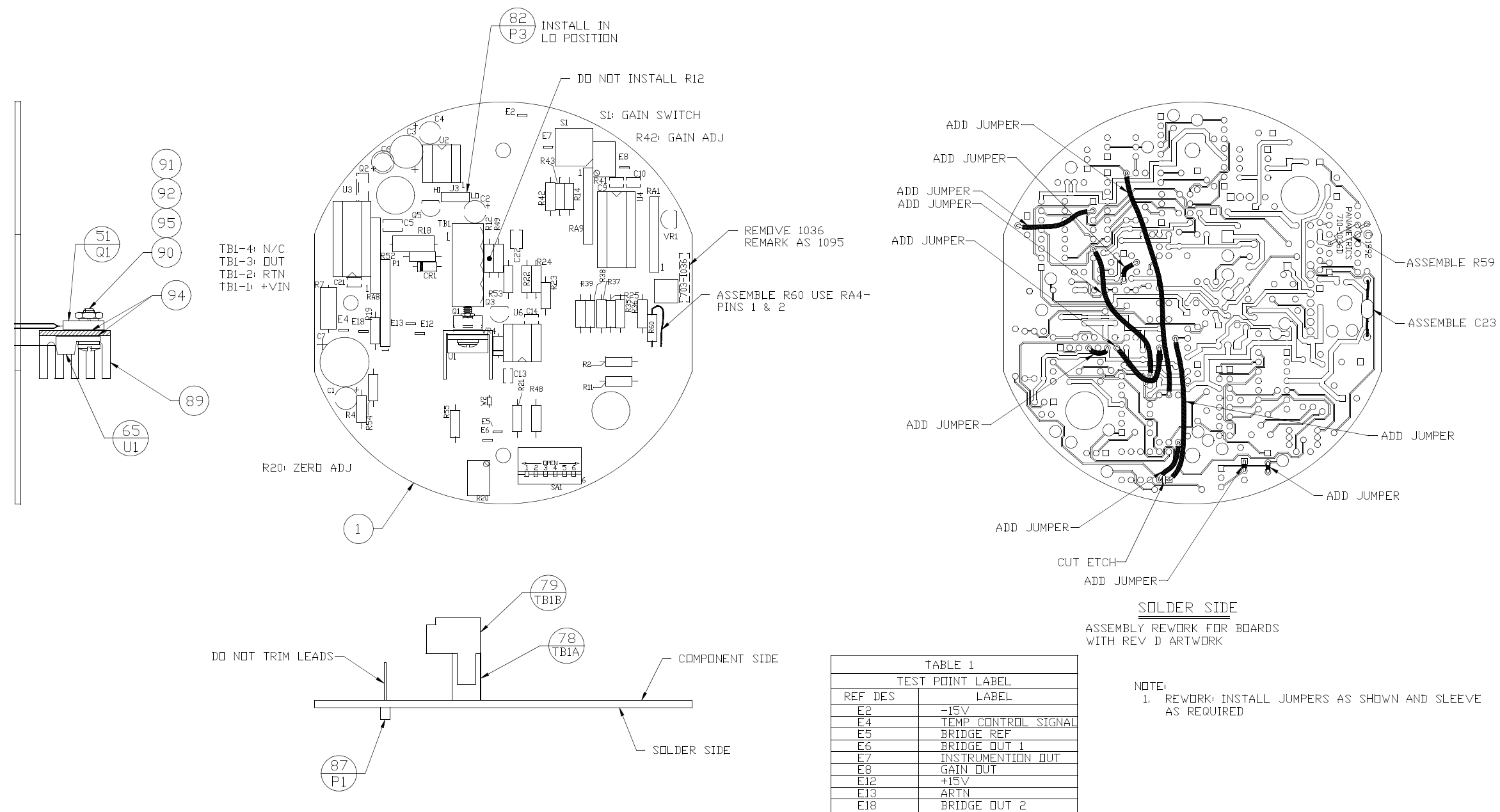


Figure C-14: Thermal Conductivity Analyzer PCB Assembly (Dwg. #703-1095)



C-15

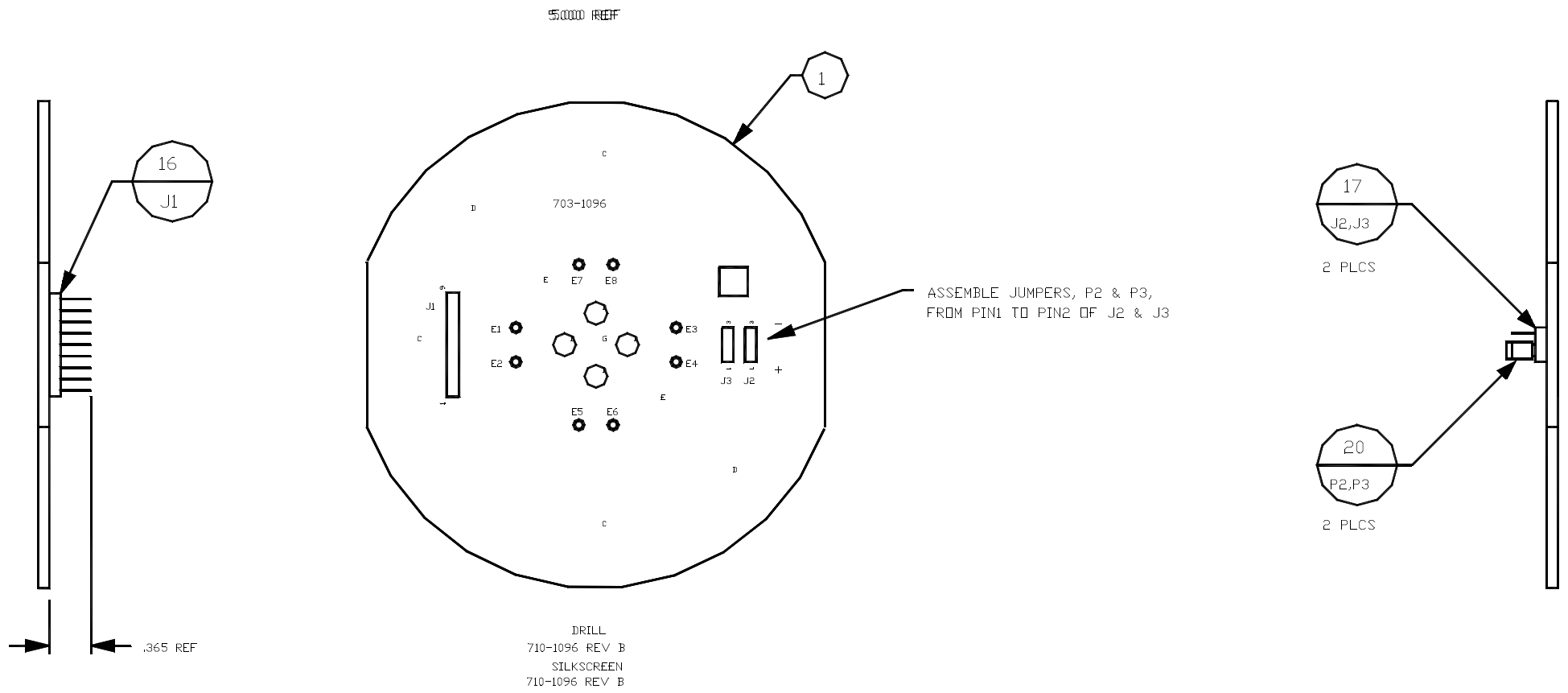


Figure C-16: I/O PCB Assembly (Dwg. 703-1096)

Appendix D

Menu Flow Diagrams

Programming Flow Diagram, Part 1 D-1

Programming Flow Diagram, Part 2 D-2



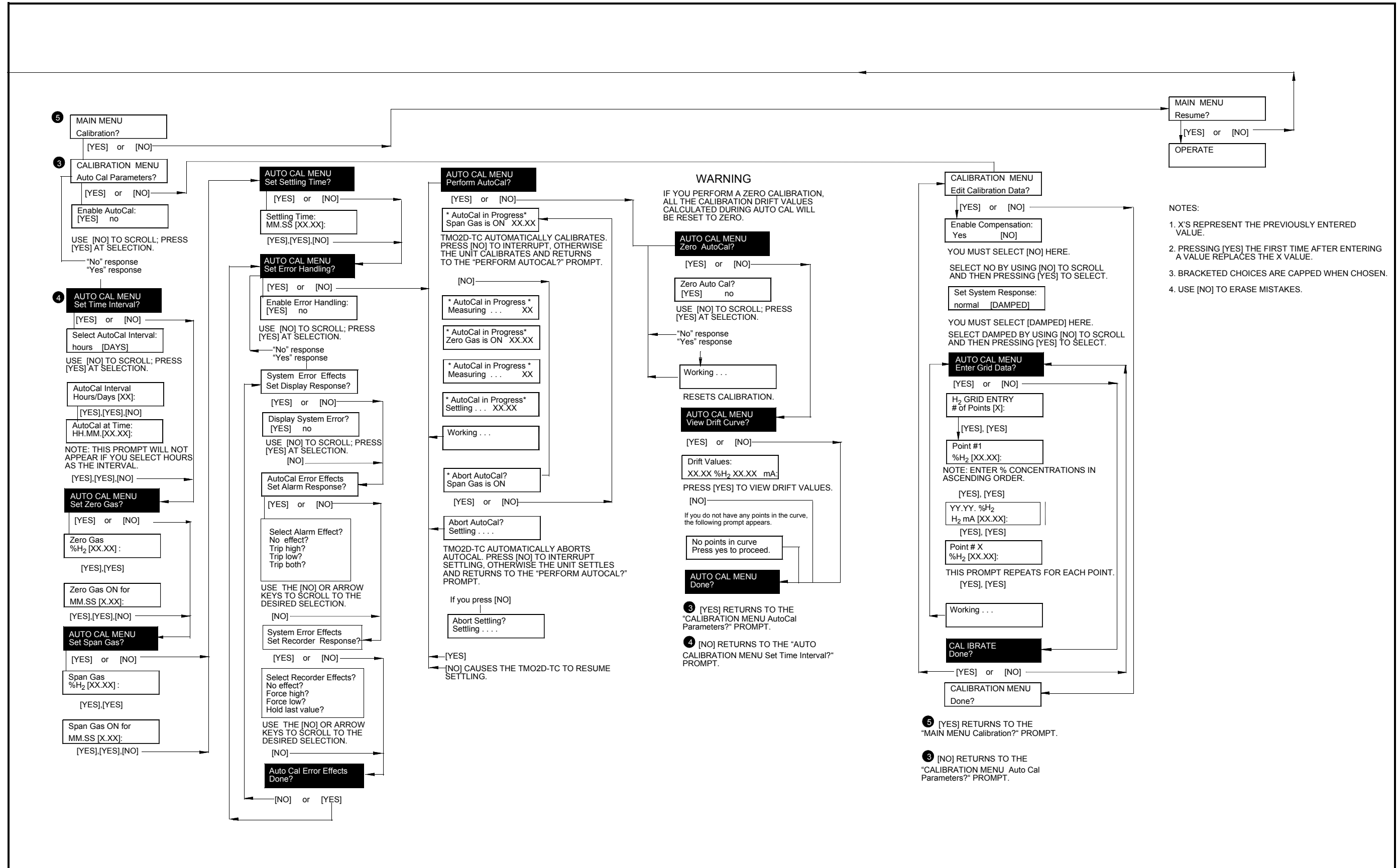


Figure D-2: Programming Flow Diagram, Part 2

Appendix E

Special Programming

Overview	E-1
Entering the Hidden Menu.....	E-1
Erase RAM	E-5

Overview

Special Programming on the TMO2D-TC consists of the Hidden Menu and Erase RAM routines.

The Hidden menu contains functions and routines that are normally not used by the customer. It also contains functions that apply to other types of sensors that can be used with the TMO2D-TC Display (e.g., GE Panametrics' thermoparamagnetic oxygen sensor). Therefore, it is not accessible to the user through the normal entry to Programming Mode.

However, the TMO2D-TC user may need to access one of the functions on the Hidden menu. The three functions the user may need to access are Select Gas, LabCal Recorders and Manual Offset.

Select Gas enables the user to select which gas name will be displayed during Operate Mode and Programming Mode. This was set for you at the factory during the original calibration. If you decide to use the TMO2D-TC to measure a different gas from the original, and the gas appears on the Select Gas list, you may want to access the Hidden menu to change the gas. This is for your convenience only, as the gas name will have no effect on the measurement values. This manual assumes that the gas being measured is H₂.

The LabCal Recorders function lets the users calibrate the 4-20-mA recorder outputs. Lastly, the Manual Offset function adds an offset to the displayed percent oxygen reading. You should not enter an offset value unless instructed to do so by the factory.

Entering the Hidden Menu

To access the Hidden menu from Operate Mode:

1. Press the No key.
2. The top line of the display will show **Enter Code:**
3. Key in the code 3 6 9, pressing each key slowly and firmly. The display will show an * after each digit is entered.

Note: *If an incorrect code is entered, or a non-numeric (Yes/No or Arrow) key is pressed, or the keys are pressed too quickly, the TMO2D-TC will return to Operate Mode, and the user must press No again to re-enter the code.*

Entering the Hidden Menu (cont.)

4. The display will now show:

HIDDEN MENU
 Select Gas?

The TMO2D-TC is now in Programming Mode, Hidden menu, ready for user input.

The Hidden menu contains eight options — Select Gas, Select Background, Select Tracking, Select Tertiary, Response Parameters, LabCal Recorders, Manual Offset, and Resume. The only options you should access are Select Gas, LabCal Recorders and Manual Offset — all other options are not applicable to the TMO2D-TC and should not be accessed. Use the following sections to check or change the settings in these three options.

Select Gas

Use the following procedure to change the gas display.

HIDDEN MENU
 Select Gas?

Press Yes to access the Select Gas option.

Select Input Gas
 %H2?

Press No or the Arrow keys to scroll through the choices. These are %H₂, %N₂, %SO₂, %CO₂, and %O₂ (the %O₂ choice is not applicable to the TMO2D-TC). When the proper gas name is displayed, press Yes.

HIDDEN MENU
 Select Gas?

Press the Left Arrow key to move to the previous option on the Hidden menu or the No key to advance. To exit press the NO key until Resume? appears; then press Yes.

LabCal Recorders

Use the following procedure to calibrate the recorders.

HIDDEN MENU
LabCal Recorders?

Once you enter the Hidden Menu, press the No key until the LabCal Recorders option appears; then press Yes.

Recorder to LabCal:
[A] B done

Press No or one of the Arrow keys to select A. Press Yes to confirm the entry.

Recorder A 20 mA Output
Enter mA (20.00):

Enter the desired mA value for the high value of the recorder range. Press Yes to enter; then press Yes again to confirm the entry.

Recorder A 4 mA Output
Enter mA [4.00]:

Enter the desired mA value for the low value of the recorder range. Press Yes to enter; then press Yes again to confirm the entry.

Recorder to LabCal:
[A] B done

Repeat this procedure for recorder B. When you are done, press No or the Arrow keys to select Done; then press Yes.

HIDDEN MENU
LabCal Recorders?

Press the Left Arrow key to move to the previous option on the Hidden menu or the No key to advance. To exit, press the NO key until Resume? appears; then press Yes.

Manual Offset

Use the following procedure to enter a manual offset.

Caution!

You should not enter a manual offset
unless instructed to do so by the factory.

HIDDEN MENU
Manual Offset?

Once you enter the Hidden Menu, press the No key until the Manual Offset option appears; then press Yes.

HIDDEN MENU
% Offset: [0.00]

Enter the percent value of manual offset and press Yes. Press Yes again to confirm the entry.

HIDDEN MENU
Manual Offset?

Press the Left Arrow key to move to the previous option on the Hidden menu or the No key to advance. To exit press the NO key until Resume? appears; then press Yes.

Erase RAM

!WARNING!
**THE ERASE RAM OPTION WILL DELETE ALL
USER-ENTERED DATA IN THE TMO2D-TC
MEMORY.**

To access Erase RAM from Operate Mode:

1. Press the No key.
2. The top line of the display will show **Enter Code:**
3. Key in the code 9 5 1, pressing each key slowly and firmly. The display will show an * after each digit is entered.

Note: *If you enter an incorrect code, press a non-numeric (Yes/No or Arrow) key, or press the keys too quickly, the TMO2D-TC will return to Operate Mode, and you must press No again to re-enter the code.*

4. The display will now show the following:

WARNING: Erase RAM? yes [NO]

Press No or the Arrow keys to select your choice. Press Yes to confirm.

5. The TMO2D-TC will return to Operate Mode.

Note: *You can also reset the RAM by powering up the TMO2D-TC while pressing the 1 key at the same time.*

Appendix F

Calibration Procedure and Adjustment Locations for Older Versions

Calibration Procedure for PCB #703-1036F-1

Calibration Procedure for PCB #703-867F-7

Calibration Procedure for PCB #703-1036

Use the following procedures to do the following:

- calibrate a 2-Port (Sealed Reference Gas) transmitter
- calibrate a 4-Port (Flowing Reference Gas) transmitter
- check/change switch and jumper settings

2-Port (Sealed Reference Gas) Calibration

1. Connect the current lead of the multimeter to TB1, Pin 3, and the return lead to TB1, Pin 2. Note that TB1 can be unplugged from the PCB for easy connections. See Figure F-1 on page F-3 for the location of TB1 and all adjustment pots.

Note: *The current (mA) measurement cannot be made in parallel with any other resistance. If another wire is connected to TB1, Pin 3, disconnect that wire prior to connecting the multimeter.*

2. Set the multimeter to read 0-20 mA.
3. Connect the TMO2-TC Sample Inlet to the zero gas via the Zero Gas Inlet on the sample system or other gas control system.
4. Establish a flow of 0.5 SCFH (250 cc/min) of zero gas at 0.0 psig to the TMO2-TC.
5. Adjust R20 until the multimeter reads 4.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.

Note: *R44 and R29 are used for very coarse zero adjustments; however, they have been preset at the factory and do not require field adjustment.*

6. Connect the TMO2-TC Sample Inlet to the span gas via the Span Gas Inlet on the sample system or other gas control system.
7. Establish a flow of 0.5 SCFH (250 cc/min) of span gas at 0.0 psig to the TMO2-TC.

2-Port (Sealed
Reference Gas)
Calibration (cont.)

8. Adjust R41 (clockwise provides increased gain) until the multimeter reads $20.00 \text{ mA} \pm 0.08 \text{ mA}$. Allow 2-5 minutes for the reading to settle.

Note: *If R41 does not provide enough gain, you can adjust switch S1 (coarse gain adjustment rotary switch) on PCB #703-1036 clockwise. R27 and R28 are used for very coarse gain adjustments; however, they have been preset at the factory and do not require field adjustment.*

9. Repeat Steps 3 through 8 until there is no change in settings. R20 and R41 are interdependent; adjustment of one pot will affect the set point of the other pot.

2-Port (Sealed
Reference Gas)
Calibration (cont.)

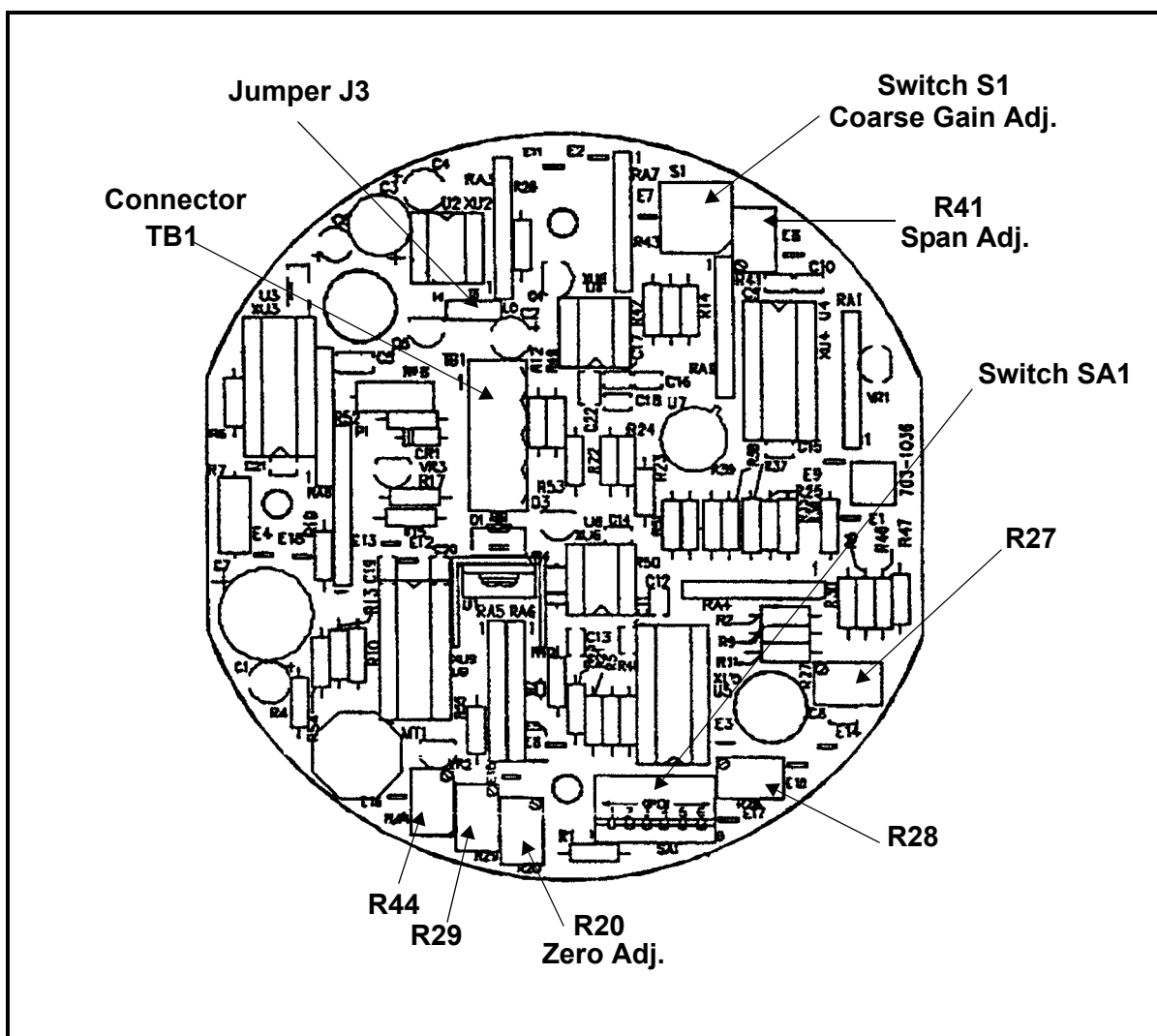


Figure F-1: PCB 703-1036 Calibration Potentiometer and Switch Locations

4-Port (Flowing Reference Gas) Calibration

1. Connect the current lead of the multimeter to TB1, Pin 3, and the return lead to TB1, Pin 2. Note that TB1 can be unplugged from the PCB for easy connections. See Figure F-1 on the previous page for the location of TB1 and all adjustment pots.

Note: *The current (mA) measurement cannot be made in parallel with any other resistance. If another wire is connected to TB1, Pin 3, disconnect that wire prior to connecting the multimeter.*

2. Set the multimeter to read 0-20 mA.
3. Connect the TMO2-TC Reference Inlet to the reference (span) gas via the Reference Gas Inlet on the sample system or other gas control system.
4. Establish a flow of 0.5 SCFH (250 cc/min) of reference (span) gas at 0.0 psig to the TMO2-TC Reference Inlet. Note that you can establish a flow as low as 5 cc/min in order to conserve gas.
5. Connect the TMO2-TC Sample Inlet to the zero gas via the Zero Gas Inlet on the sample system or other gas control system.
6. Establish a flow of 0.5 SCFH (250 cc/min) of zero gas at 0.0 psig to the TMO2-TC Sample Inlet.
7. Adjust R20 until the multimeter reads 4.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.

Note: *R44 and R29 are used for very coarse zero adjustments; however, they have been preset at the factory and do not require field adjustment.*

8. Connect the TMO2-TC Sample Inlet to the span gas via the Span Gas Inlet on the sample system or other gas control system.
9. Establish a flow of 0.5 SCFH (250 cc/min) of span gas at 0.0 psig to the TMO2-TC Sample Inlet.

4-Port (Flowing
Reference Gas)
Calibration (cont.)

10. Adjust R41 (clockwise provides increased gain) until the multimeter reads 20.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.

Note: *If R41 does not provide enough gain, you can adjust switch S1 (Coarse gain adjustment rotary switch) on PCB #703-1036 clockwise. R27 and R28 are used for very coarse gain adjustments; however, they have been preset at the factory and do not require field adjustment.*

11. Repeat Steps 5 through 10 until there is no change in settings. R20 and R41 are interdependent; adjustment of one pot will affect the set point of the other pot.

Checking/Changing Switch and Jumper Settings

The TMO2-TC PCB #703-1036 contains two switches, SA1 and S1, and one jumper, J3, which have been preset at the factory for your application (see Figure F-1). If you are recalibrating the TMO2-TC for the same range and binary gas mixture as the previous calibration, you do not need to change the settings of these switches. If you are changing the range or binary gas mixture, you may have to change switch and jumper settings before you calibrate for zero and span. A brief description of SA1, S1, and J3 follows:

- SA1** Gain adjustment dip switch -
SA1 serves as a coarse gain adjustment, and is preset at the factory according to your application.
- S1** Coarse gain adjustment rotary switch -
S1 also serves as a coarse gain adjustment, and is set at the factory during the initial calibration. It is advanced if R41 does not provide enough gain. Note that position 0 is never used.
- J3** Bridge voltage adjustment jumper -
Jumper J3 is used to select between high or low bridge voltage, and is preset at the factory according to your application. Low voltage (LO) should be used for most applications. High voltage (HI) is used for applications with an H₂ or helium concentration of more than 90%.

The Calibration Data Sheet supplied with your TMO2-TC shows SA1, S1, and J3 switch settings for your original application. If you want to change range and/or binary gas mixture from the original application, please consult the factory.

Calibration Procedure for PCB #703-867

Use the following procedures to do the following:

- calibrate a 2-Port (Sealed Reference Gas) transmitter
- calibrate a 4-Port (Flowing Reference Gas) transmitter

2-Port (Sealed Reference Gas) Calibration

1. Connect the current lead of the multimeter to TB1, Pin 3, and the return lead to TB1, Pin 2. Note that TB1 can be unplugged from the PCB for easy connections. See Figure F-2 on the next page for the location of TB1 and all adjustment pots.

Note: *The current (mA) measurement cannot be made in parallel with any other resistance. If another wire is connected to TB1, Pin 3, disconnect that wire prior to connecting the multimeter.*

2. Set the multimeter to read 0-20 mA.
3. Connect the TMO2-TC Sample Inlet to the zero gas via the Zero Gas Inlet on the sample system or other gas control system.
4. Establish a flow of 0.5 SCFH (250 cc/min) of zero gas at 0.0 psig to the TMO2-TC.
5. Adjust R20 until the multimeter reads 4.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.
6. Connect the TMO2-TC Sample Inlet to the span gas via the Span Gas Inlet on the sample system or other gas control system.
7. Establish a flow of 0.5 SCFH (250 cc/min) of span gas at 0.0 psig to the TMO2-TC.
8. Adjust R41 (clockwise provides increased gain) until the multimeter reads 20.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.

Note: *R27 and R28 are used for very coarse gain adjustments; however, they have been preset at the factory and do not require field adjustment.*

9. Repeat Steps 3 through 8 until there is no change in settings. R20 and R41 are interdependent; adjustment of one pot will affect the set point of the other pot.

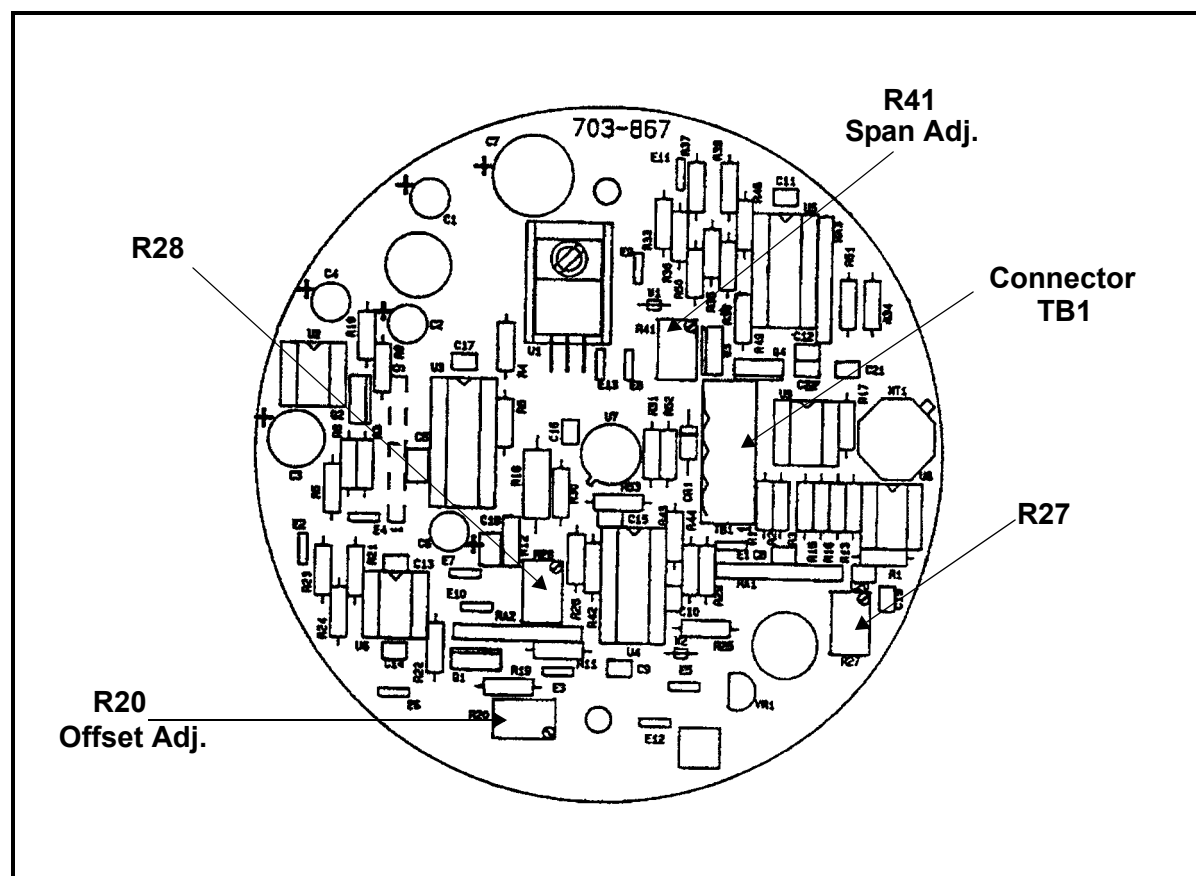


Figure F-2: PCB 703-867 Calibration Potentiometer Locations

4-Port (Flowing Reference Gas) Calibration

1. Connect the current lead of the multimeter to TB1, Pin 3, and the return lead to TB1, Pin 2. Note that TB1 can be unplugged from the PCB for easy connections. See Figure F-2 on the previous page for the location of TB1 and all adjustment pots.

Note: *The current (mA) measurement cannot be made in parallel with any other resistance. If another wire is connected to TB1, Pin 3, disconnect that wire prior to connecting the multimeter.*

2. Set the multimeter to read 0-20 mA.
3. Connect the TMO2-TC Reference Inlet to the reference (span) gas via the Reference Gas Inlet on the sample system or other gas control system.
4. Establish a flow of 0.5 SCFH (250 cc/min) of reference (span) gas at 0.0 psig to the TMO2-TC Reference Inlet. Note that you can establish a flow as low as 5 cc/min in order to conserve gas.
5. Connect the TMO2-TC Sample Inlet to the zero gas via the Zero Gas Inlet on the sample system or other gas control system.
6. Establish a flow of 0.5 SCFH (250 cc/min) of zero gas at 0.0 psig to the TMO2-TC Sample Inlet.
7. Adjust R20 until the multimeter reads 4.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.
8. Connect the TMO2-TC Sample Inlet to the span gas via the Span Gas Inlet on the sample system or other gas control system.
9. Establish a flow of 0.5 SCFH (250 cc/min) of span gas at 0.0 psig to the TMO2-TC Sample Inlet.
10. Adjust R41 (clockwise provides increased gain) until the multimeter reads 20.00 mA $\pm$ 0.08 mA. Allow 2-5 minutes for the reading to settle.

Note: *R27 and R28 are used for very coarse gain adjustments; however, they have been preset at the factory and do not require field adjustment.*

11. Repeat Steps 5 through 10 until there is no change in settings. R20 and R41 are interdependent; adjustment of one pot will affect the set point of the other pot.

Appendix G

Sample TMO2D-TC Calibration Sheet

**TMO2D-TC CALIBRATION SHEET
THERMAL CONDUCTIVITY ANALYZER**

	TMO2-TC Transmitter	TMO2D-TC Display
Serial Number	TC-115	D-365
Part Number	TMO2-TC-12-1	TMO2D-331-1
Range, %	0 to 15% H ₂	0 to 15% H ₂
Output	4 to 20 mA	4 to 20 mA
PC Board	703-1095	
Work Order	PCI 91364	
Calibration Date:	May 4, 1995	

Point	%H ₂ *	H ₂ , mA
1	0.00	4.00
2	7.50	12.17
3	15.00	20.00

*Calibration is with Hydrogen (H₂) in Nitrogen (N₂)

TMO2-TC Switch Settings:

703-1095 PCB

S1: 2 Gain

J3: LO Power (15 V)

SA1 -1: ON (ON=DOWN=CLOSED)

-2: ON

-3: ON

-4: OFF

-5: OFF

-6: OFF

703-1096 PCB

S1: +Polarity

Appendix H

Installation Instructions for CE Mark Compliance

Installation Instructions for CE Mark Compliance

NOTICE

CE MARK COMPLIANCE IS REQUIRED ONLY FOR
UNITS USED IN EEC COUNTRIES

For CE Mark compliance, you must shield and ground the electrical connections as shown in Table H-1 below.

Note: *If you make the modifications as discussed in this appendix, your unit will comply with the EMC Directive 89/336/EEC.*

Table H-1: Wiring Modifications for CE Compliance

Connection	Termination Modification
Power	1. When connecting power, select the cable entry closest to the chassis ground. 2. Connect the power ground to the nearest chassis ground using the shortest run of wire possible. Grounding lugs are provided in the TMO2D-TC enclosure.
Input/Output	1. Use shielded cable to interconnect system enclosures. 2. Connect the shields to the nearest chassis ground using the shortest run of wire possible. Grounding lugs are provided in the TMO2D-TC enclosure.

After you make all the necessary electrical connections, seal unused cable entry holes with standard conduit plugs or equivalent.

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GE Panametrics

**DECLARATION
OF
CONFORMITY**

We,

**GE Panametrics
Shannon Industrial Estate
Shannon, Co. Clare
Ireland**

declare under our sole responsibility that the

**XMO2 Oxygen Transmitter
XMTC Thermal Conductivity Analyzer
TMO2-TC Thermal Conductivity Analyzer
TMO2 Oxygen Transmitter**

to which this declaration relates, are in conformity with the following standards:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation

following the provisions of the 89/336/EEC EMC Directive.

The units listed above and any ancillary sample handling systems supplied with them do not bear CE marking for the Pressure Equipment Directive, as they are supplied in accordance with Article 3, Section 3 (sound engineering practices and codes of good workmanship) of the Pressure Equipment Directive 97/23/EC for DN<25.

Shannon - June 1, 2002

Mr. James Gibson
GENERAL MANAGER





GE Panametrics

**DECLARATION
DE
CONFORMITE**

Nous,

**GE Panametrics
Shannon Industrial Estate
Shannon, Co. Clare
Ireland**

déclarons sous notre propre responsabilité que les

**XMO2 Oxygen Transmitter
XMTC Thermal Conductivity Analyzer
TMO2-TC Thermal Conductivity Analyzer
TMO2 Oxygen Transmitter**

relatif à cette déclaration, sont en conformité avec les documents suivants:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation

suivant les règles de la Directive de Compatibilité Electromagnétique 89/336/EEC.

Les matériels listés ci-dessus ainsi que les systèmes d'échantillonnages pouvant être livrés avec, ne portent pas le marquage CE de la directive des équipements sous pression, car ils sont fournis en accord avec la directive 97/23/EC des équipements sous pression pour les DN<25, Article 3, section 3 qui concerne les pratiques et les codes de bonne fabrication pour l'ingénierie du son.

Shannon - June 1, 2002

Mr. James Gibson
DIRECTEUR GÉNÉRAL





GE Panametrics

**KONFORMITÄTS-
ERKLÄRUNG**

Wir,

**GE Panametrics
Shannon Industrial Estate
Shannon, Co. Clare
Ireland**

erklären, in alleiniger Verantwortung, daß die Produkte

**XMO2 Oxygen Transmitter
XMTC Thermal Conductivity Analyzer
TMO2-TC Thermal Conductivity Analyzer
TMO2 Oxygen Transmitter**

folgende Normen erfüllen:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation

gemäß den Europäischen Richtlinien, Niederspannungsrichtlinie Nr.: 73/23/EWG.

Die oben aufgeführten Geräte und zugehörige, mitgelieferte Handhabungssysteme tragen keine CE-Kennzeichnung gemäß der Druckgeräte-Richtlinie, da sie in Übereinstimmung mit Artikel 3, Absatz 3 (gute Ingenieurpraxis) der Druckgeräte-Richtlinie 97/23/EG für DN<25 geliefert werden.

Shannon - June 1, 2002

Mr. James Gibson
GENERALDIREKTOR





GE Panametrics

ATEX COMPLIANCE

We,

**GE Panametrics
221 Crescent Street, Suite 1
Waltham, MA 02453
U.S.A.**

as the manufacturer, declare under our sole responsibility that the product

TMO2-TC Thermal Conductivity Analyzer

to which this document relates, in accordance with the provisions of ATEX Directive 94/9/EC Annex II, meets the following specifications:

CE 1180  **II 2 GD EEx d IIC T6 or T5 (-40°C to +65°C)
ISSeP02ATEX022 T80°C IP66**

Furthermore, the following additional requirements and specifications apply to the product:

- Having been designed in accordance with EN 50014, EN 50018, and EN 50281, the product meets the fault tolerance requirements of electrical apparatus for category “d”.
- The product is an electrical apparatus and must be installed in the hazardous area in accordance with the requirements of the EC Type Examination Certificate. The installation must be carried out in accordance with all appropriate international, national and local standard codes and practices and site regulations for flameproof apparatus and in accordance with the instructions contained in the manual. Access to the circuitry must not be made during operation.
- Only trained, competent personnel may install, operate and maintain the equipment.
- The product has been designed so that the protection afforded will not be reduced due to the effects of corrosion of materials, electrical conductivity, impact strength, aging resistance or the effects of temperature variations.
- The product cannot be repaired by the user; it must be replaced by an equivalent certified product. Repairs should only be carried out by the manufacturer or by an approved repairer.
- The product must not be subjected to mechanical or thermal stresses in excess of those permitted in the certification documentation and the instruction manual.
- The product contains no exposed parts which produce surface temperature infrared, electromagnetic ionizing, or non-electrical dangers.





GE Panametrics

**DECLARATION
OF
CONFORMITY**

We,

**GE Panametrics
Shannon Industrial Estate
Shannon, Co. Clare
Ireland**

declare under our sole responsibility that the

**CGA351 Clean Gas Analyzer
CGA350GP Clean Gas Analyzer
CGA350X Clean Gas Analyzer
CGA350D Display Unit
TMO2D Display and Control Unit**

to which this declaration relates, are in conformity with the following standards:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
- EN 61010-1:1993 + A2:1995, Overvoltage Category II, Pollution Degree 2

following the provisions of the 89/336/EEC EMC Directive and the 73/23/EEC Low Voltage Directive.

The units listed above and any sensors and ancillary sample handling systems supplied with them do not bear CE marking for the Pressure Equipment Directive, as they are supplied in accordance with Article 3, Section 3 (sound engineering practices and codes of good workmanship) of the Pressure Equipment Directive 97/23/EC for DN<25.

Shannon - June 1, 2002

Mr. James Gibson
GENERAL MANAGER





GE Panametrics

**DECLARATION
DE
CONFORMITE**

Nous,

**GE Panametrics
Shannon Industrial Estate
Shannon, Co. Clare
Ireland**

déclarons sous notre propre responsabilité que les

**CGA351 Clean Gas Analyzer
CGA350GP Clean Gas Analyzer
CGA350X Clean Gas Analyzer
CGA350D Display Unit
TMO2D Display and Control Unit**

relatif à cette déclaration, sont en conformité avec les documents suivants:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
- EN 61010-1:1993 + A2:1995, Overvoltage Category II, Pollution Degree 2

suivant les règles de la Directive de Compatibilité Electromagnétique 89/336/EEC et de la Directive Basse Tension 73/23/EEC.

Les matériels listés ci-dessus, ainsi que les capteurs et les systèmes d'échantillonnages pouvant être livrés avec ne portent pas le marquage CE de la directive des équipements sous pression, car ils sont fournis en accord avec la directive 97/23/EC des équipements sous pression pour les DN<25, Article 3, section 3 qui concerne les pratiques et les codes de bonne fabrication pour l'ingénierie du son.

Shannon - June 1, 2002

Mr. James Gibson
DIRECTEUR GÉNÉRAL





GE Panametrics

**KONFORMITÄTS-
ERKLÄRUNG**

Wir,

**GE Panametrics
Shannon Industrial Estate
Shannon, Co. Clare
Ireland**

erklären, in alleiniger Verantwortung, daß die Produkte

**CGA351 Clean Gas Analyzer
CGA350GP Clean Gas Analyzer
CGA350X Clean Gas Analyzer
CGA350D Display Unit
TMO2D Display and Control Unit**

folgende Normen erfüllen:

- EN 61326:1998, Class A, Annex A, Continuous Unmonitored Operation
- EN 61010-1:1993 + A2:1995, Overvoltage Category II, Pollution Degree 2

gemäß den Europäischen Richtlinien, Niederspannungsrichtlinie Nr.: 73/23/EWG und EMV-Richtlinie Nr.: 89/336/EWG.

Die oben aufgeführten Geräte und zugehörige, mitgelieferte Sensoren und Handhabungssysteme tragen keine CE-Kennzeichnung gemäß der Druckgeräte-Richtlinie, da sie in Übereinstimmung mit Artikel 3, Absatz 3 (gute Ingenieurpraxis) der Druckgeräte-Richtlinie 97/23/EG für DN<25 geliefert werden.

Shannon - June 1, 2002

Mr. James Gibson
GENERALDIREKTOR





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