On-Line Transformer Monitor Installation Guide - Model TM1

January 2019

Document ID: 810-1902-03 Rev D

SERVERON®
A QUALITROL Company

www.serveron.com

Information in this document is subject to change without notice. This document is provided to purchasers of Serveron® products for use in the installation, operation and servicing of such products. No other use, nor any reproduction, distribution or the making of any derivatives of this document is authorized, without the express prior written permission of Serveron® Corporation.

Serveron® endeavors to ensure the accuracy and quality of its published materials; however, no warranty, expressed or implied, is provided. Serveron® disclaims any responsibility or liability for any direct or indirect damages resulting from the use of the information in this manual or products described in it. Mention of any product or brand does not constitute an endorsement by Serveron® of that product or brand.

This document was originally composed in English and was subsequently translated into other languages. The fidelity of subsequent translations cannot be guaranteed. In case of conflict between the English version and another language version, the English version takes precedence.

Product Overview

The TM1 is a remotely-deployed transformer monitor which can be safely installed onto an energized or non-energized transformer to detect and measure dissolved hydrogen found in an electrical power transformer‘s insulating oil. The monitor is designed and constructed to operate in environmental conditions in Power Plants, Switchyards or Substations.

The TM1 is directly mounted to an existing valve on the transformer and circulates transformer oil within it to provide a continuous reading of hydrogen in ppm. Data can be viewed with the supplied TM View software or via a customer’s SCADA system (RS485 / RS232) using Modbus or DNP3 protocol and will allow the end user to track the hydrogen ppm levels over time and compare against user-defined caution and alarm settings.

The TM1 monitor includes two 4-20mA inputs for use with an optional moisture sensor. In addition to the inputs, there are three 4-20mA outputs. Also included are three user-programmable relays, as well as relays for service-related conditions and loss-of-power.

The TM1 measures hydrogen (H_2) without cross-interference from other gases. Hydrogen is formed under all known thermal fault conditions in the transformer and is one of the first gases to be generated, making it an excellent early indicator of a broad range of fault types.

Note: The TM1 is designed for use on mineral-oil, FR3 and silicone oils.

The TM1 is designed to be installed and configured by the end-user. Configuration of the monitor’s alarms, settings and options is accomplished using a PC-based TM1 Configuration Utility Tool described in greater depth in the TM1 Operation & Maintenance Guide (**810-1928-01**).

System Description

The TM1 measures hydrogen using a patented, solid-state sensor made of Palladium. The sensor is in direct contact with the transformer oil; neither gas extraction nor membranes are utilized. An electric potential is applied to the palladium sensor. When hydrogen from the oil contacts the sensor, the electrical properties of the palladium sensor change, resulting in a change in the electrical output of the sensor. This electrical change is proportional to the concentration of hydrogen in contact with the sensor and is reported as ppm H_2. Using the ppm results, ROC is calculated and reported in units of ppm/day.

The temperature of the measurement environment is precisely controlled in order to ensure stable readings. The TM1 will make one measurement approximately every 30 minutes. The exact time between measurements is a function of the temperature of the incoming oil. Therefore, the time between measurement results may vary slightly.

TM1 data is stored onboard in non-volatile RAM. At least two years' worth of the most recent data is stored. Once the available memory is full, data is overwritten in a first-in, first-out manner. Several communication options allow for the transfer of data in near real-time, or discrete batch download of data is available via the USB port.

The major components of the TM1 include:

- H_2 Sensor – Palladium sensor selective for H_2 gas
- Oil Circulation System – utilizes a patent-pending design that eliminates the need for a reciprocating or positive-displacement pump. More robust in design, the auger-style TM1 pump is used to provide a representative oil sample at the sensor.
- Heater – provides thermal control of measurement environment
- Electronics – power supply, analog inputs and outputs, alarm relays, system board and communications ports
- Enclosure – IP66 /NEMA 4X rated enclosure with integrated sunshield
- Transformer connections – 1½" NPT valve (can be adapted to other sizes), power and communication wiring glands, bleed port.
- Display – Touch activated. Displays hydrogen level, hydrogen rate of change, alarm status, and service status.

Product Symbols

The following symbols are used throughout the Transformer Monitor or accessories. They are defined by the International Electrotechnical Commission, IEC 878 and IEC 417A. It is important for safety reasons to have an understanding of their representation.

	Voltage Input
	Fuse
	High Voltage
	Caution: Refer to On-Line Transformer Monitor Installation Guide and accompanying documentation.
	Protective Earth (ground)
L1	Connect to mains live conductor (brown)
L2	Connect to mains neutral conductor (blue)
__I__ **O**	The **I** position indicates the power switch is ON The **O** position indicates the power switch is OFF
	This device has been tested and certified by UL to comply with applicable U.S. and Canadian safety standards.

Table 1: Product Symbols

WARNING statements in this manual identify conditions or practices that could result in personal injury.

CAUTION statements in this manual identify conditions or practices that could result in damage to the equipment or other property**.**

NOTE statements provide additional important information.

Warranty

Serveron warrants its Goods to be free from latent defects in materials or workmanship for **24** months from the date of shipment. Serveron will repair or replace, at Serveron's discretion and without cost to Buyer, any Goods furnished hereunder that are found to contain defects in materials or workmanship during that period. Serveron uses new and reconditioned parts in performing warranty repairs and building replacements. Serveron owns all Goods it has replaced and all parts removed from repaired Goods. It is Buyer's responsibility to return the Goods to Serveron for warranty coverage. This warranty does not cover items damaged in shipment or damages resulting from misuse, neglect, abuse, acts of war or acts of God. Serveron recommends using the provided shipping material and packing inserts for transportation. The TM1 is designed to be mounted and used in normal transformer operation. It is not designed to be mounted or affixed to the transformer or any other device during transportation; doing so is subject to void all and any warranties. Prior to returning any item (whether during the warranty period or out of warranty), Buyer must obtain a Return Material Authorization (RMA) number from Serveron by calling (800) 880-2552 Monday through Friday, 8 am to 5 pm, Pacific Time, or by sending a fax request to (503) 924-3290. Serveron makes no warranties, expressed or implied, other than the warranties expressly stated in this paragraph. All other warranties, expressed or implied, arising by law or otherwise, including, but not limited to, the implied warranties of title, merchantability, non-infringement and fitness for a particular purpose, are expressly disclaimed. Serveron's product operations manuals and product installation guides describe approved accessories, options, operating materials and installation methods. Use of accessories, options, operating materials and installation methods not as described, will void the warranty.

Environmental

The TM1 is designed to operate within the following outdoor conditions:

- Altitude Range -2000 to 15,000 ft. (-610 to 4,572 m)
- Humidity Range 5% to 95%
- Temperature Range -50°C to +55°C
- Oil Inlet Pressure 0 to 100psi
- Oil Inlet Temperature -20°C to +105°C
- Installation Category 1
- Pollution Degree 1

Altitude, humidity, and temperature ranges indicated are considered extended environmental conditions from the minimum ranges required by ICE/UL/CAN 61010-1, Clause 1.4.1.

Items Shipped

Upon receipt of your TM1 Transformer Monitor, it is important to verify the contents of the shipping carton with the packing list. After inspection of the contents, please notify Serveron directly if there are any signs of damage that may have occurred in transit. If possible, please retain the original shipping container and packing materials in the event that it becomes necessary to return the monitor.

Part Number	Description
782-0042-00	TM1 Transformer Monitor
140-0342-00	Uni-tee, 1 ½" NPT Stainless Steel
253-0216-00	Set Screw, ¼-20 3/8"L
250-0258-00	Plug, ½" NPT
250-0259-00	Plug, ¼" NPT
642-0020-00	Quick Clamp
252-0038-00	Lock Nut
254-0117-00	Washer
259-0045-00	Gasket
420-0118-01	Oil Inlet assembly
160-1514-05	USB Flash Drive (Contains all User documentation)
291-0060-00	Disposable Syringe, 20ml
648-0107-00	Tygon Tubing (6 inches)
250-0249-00	Luer Fitting, Male
250-0250-00	Luer Fitting, Female
900-0082-60	Oil Moisture / Temperature Kit (optional)

Table 2: Items Shipped

Monitor Installation

CAUTION: Do not attempt to install your TM1 On-Line Transformer Monitor until you have read and fully understand the procedures outlined in this document.

Installation of the TM1 consists of the following:

- Site preparation
- Mounting the monitor
- Wiring the monitor
- Bleeding air from the monitor
- Configuration

Site Preparation

NOTE: Serveron recommends a **minimum** size of 1" for the transformer oil supply valve and a **minimum** of 6" vertical clearance between the valve centerline and the transformer foundation for proper installation space.

Ensure the following prior to mounting the monitor:

- An adequate valve location for mounting the TM1 monitor has been identified
- Power is present and available at the installation site for the monitor
- Transformer is oil-filled
- All shipped items have been located

Tools / Materials Required

The following tools are required for installation of the TM1 monitor:

- 7/16", ½" and 1 ½" wrenches (or an adjustable wrench)
- 1/8", 3/16"and 3/32" Allen keys (3/16" Allen key used for optional Moisture Kit only)
- Small flat-blade screw driver
- Large flat-blade or Phillips screwdriver
- Teflon tape and pipe-thread sealant
- Wire strippers/cutters
- Container to collect oil during installation
- Pipe wrench

Mounting the Monitor

NOTE: If the desired valve is not 1 ½" NPT, then the appropriate hardware must be installed.

NOTE: Whenever installing or un-installing the monitor, the cover must be installed and secured. The cover only needs to be removed when wiring the monitor, servicing it or connecting to the service port with a USB cable.

1) Ensure the transformer valve is closed and remove any existing plug on the valve. Position a container to collect any oil after removing the plug. Remove any debris from the threads.

2) Wrap the threads of the supplied stainless-steel uni-tee with Teflon tape and apply a thin layer of pipe-thread sealant. Insert the tee into the transformer valve and tighten, ensuring the ½" NPT plug is oriented vertically as shown in (**Fig 1**).

Figure 1: Tee Orientation

3) Remove the ¼" NPT plug from the tee and apply Teflon tape and pipe-thread sealant to the threads, then re-install in the tee (**Fig 2**). If the optional Moisture Kit will not be installed, remove the ½" NPT plug and apply Teflon tape and pipe-thread sealant to it as well. Then re-install in the tee. If the Moisture Kit will be installed, remove the ½" NPT plug from the tee entirely.

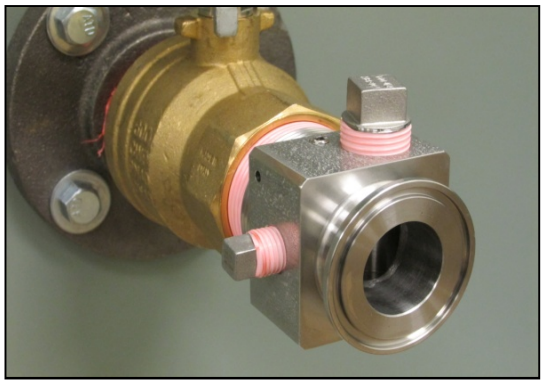


Figure 2: 1/2" and ¼" NPT plug

4) Remove the yellow protective shipping cap and absorbent pad from the end of the TM1. It is normal to see a small amount of oil after removing the cap. Install the **Oil Inlet** assembly into the threaded hole on the back of the TM1 (**Fig 3**) and tighten, but do not over-tighten.

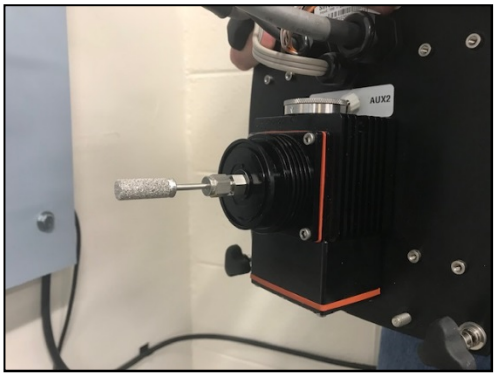


Figure 3: Oil Inlet Assembly

5) Install the black gasket onto the uni-tee, ensuring that it is seated in the groove, as shown (**Fig 4**).

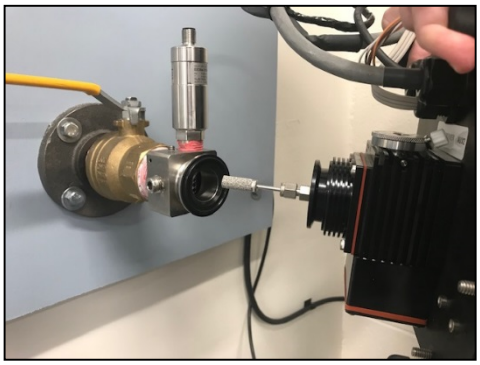


Figure 4: Mounting the Monitor

6) While properly supporting the TM1, position it on the open end of the uni-tee, carefully inserting the tube of the oil inlet assembly into the tee. Make sure the gasket is properly seated between the tee and the TM1. Install the clamp, capturing the uni-tee and the TM1 flanges as shown (**Figs 5 & 6**). Make sure the flat washer is directly under the nut as shown and tighten the nut on the clamp, ensuring that the TM1 is oriented vertically.

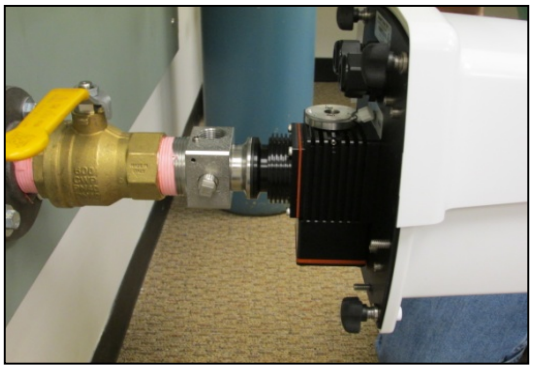


Figure 5: Clamping Flange

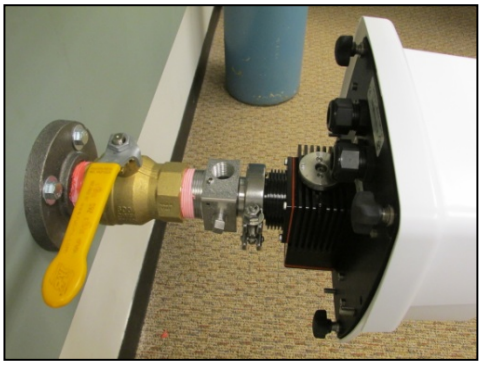


Figure 6: Quick Clamp Installed

7) If installing the optional Moisture Kit, wrap the threads of the moisture probe body with Teflon tape and apply a thin layer of pipe-thread sealant. Insert the fitting into the uni-tee and tighten as shown (**Fig 7**).

Figure 7: Moisture Probe

8) Place a container under the uni-tee. Partially open the transformer valve. Using a 1/8" Allen key, slowly loosen the set-screw until oil exits the bleed hole (**Fig 8**), then tighten the set screw and close the transformer valve.

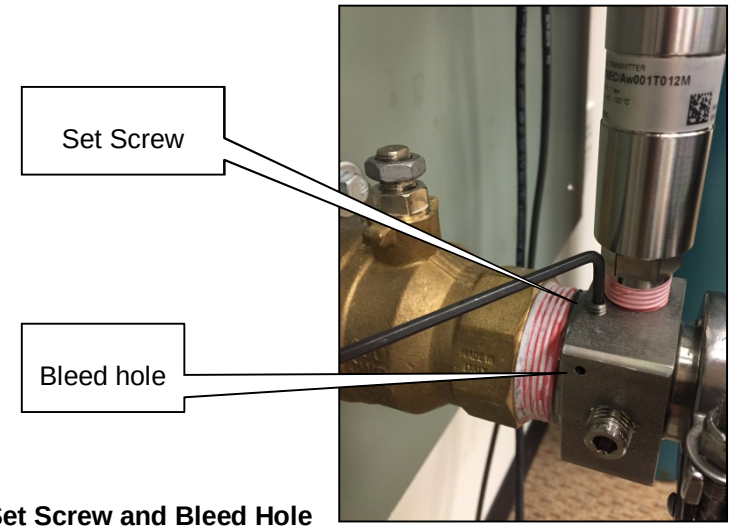


Figure 8: Set Screw and Bleed Hole

9) Insert the green connector of the supplied signal cable to the top of the moisture probe body. The connector is keyed, so it will align correctly in the probe connector (**Fig 9**).

Figure 9: Moisture Probe Signal Connector

Wiring Terminations

The following section outlines the wiring terminations for power, I/O, and relays

Power

Input: 100 to 240VAC, 50/60Hz
Power: 120VAC - Max 0.5A, nominal 0.1A @ 25°C
240VAC – Max 0.25A, nominal 0.05A @ 25C

NOTE: A switch or circuit breaker should be installed in close proximity to the equipment, easily accessible by an operator and be clearly marked as identifying its use. The equipment is to be installed in accordance with local and national electrical codes and installed by a licensed electrical installer. Remove the 4 thumb-screws (or socket-head screws) securing the cover of the TM1.

1. Determine the power source for the TM1 (e.g. 120VAC, 240VAC.). Make sure the power is locked out at the source.
2. Insert the power cable through the small center gland fitting and connect as follows:

NOTE: Recommended minimum torque for the power connector terminal is **5 in-lbs**.

Terminal Conmnections	120VAc	240VAC
Earth GND	GRN/YLW	GRN/YLW
L1	BRN or BLK - Line	RED
L2	BLUE or WHT - Neutral	BLK

Table 3: Power Terminations

3. Tighten the gland fitting to provide a secure weather-tight seal.
4. Source power should remain off until all wiring service has been completed.

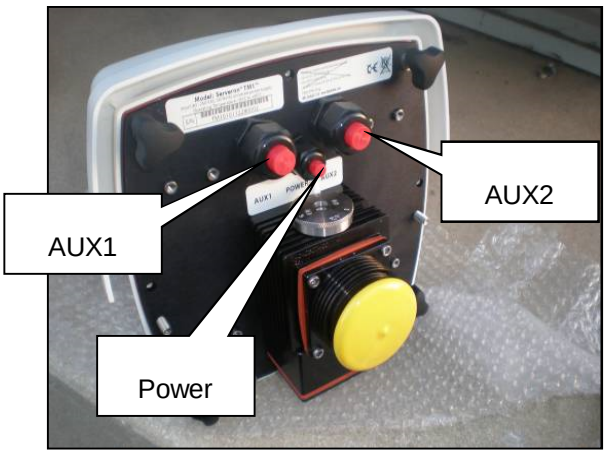


Figure 10: Cable Locations

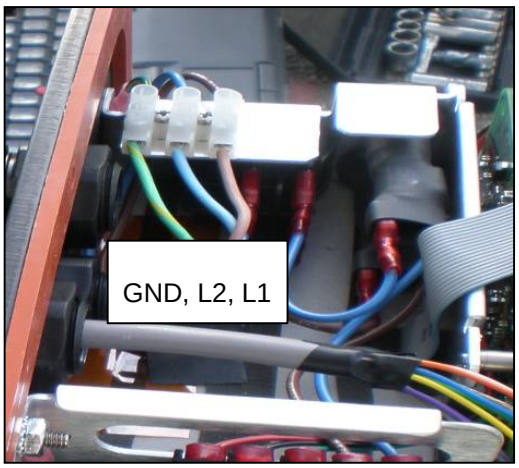


Figure 11: Power Terminals

NOTE: Gland Fitting Information –

Large Gland (AUX1 and AUX2) – Accepts a multi-conductor cable with **0.31”** to **0.63” OD**

Hole size is **0.850”**

Small Gland (Power) – Accepts a multi-conductor cable with **0.2”** to **0.47” OD**

Hole size is **0.690”**

I/O Connections

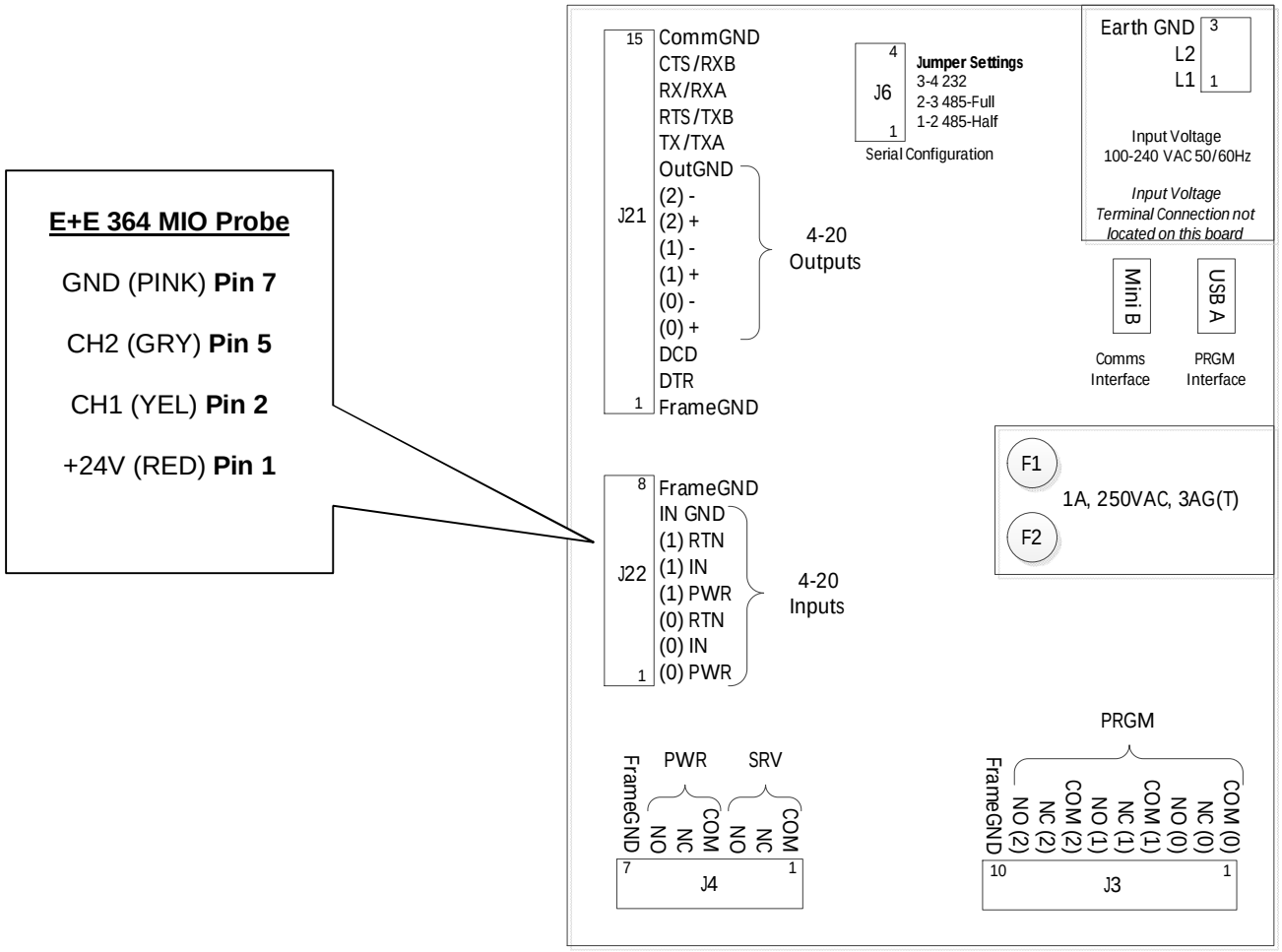
1) Refer to the figure below to identify the various wiring connectors.

NOTE: IO cable must be shielded and grounded

2) The wiring connections specific to the cable coming from the optional Oil Moisture/Temperature probe are shown below.

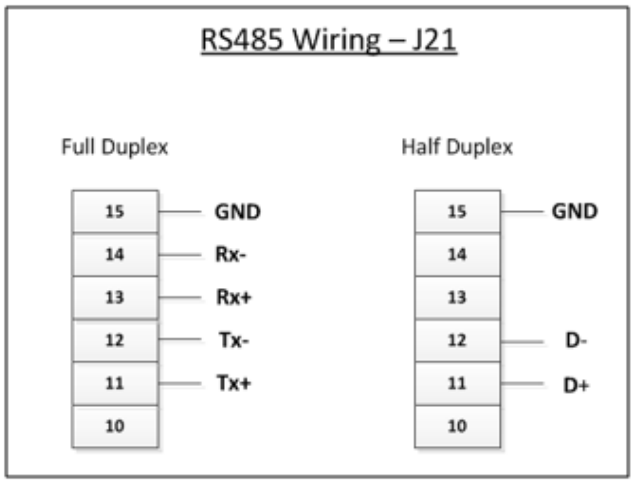
3) Terminate any additional wiring (alarm/service relays, 4-20mA inputs/outputs) per the diagram below, which is also located on the inside of the TM1 cover.

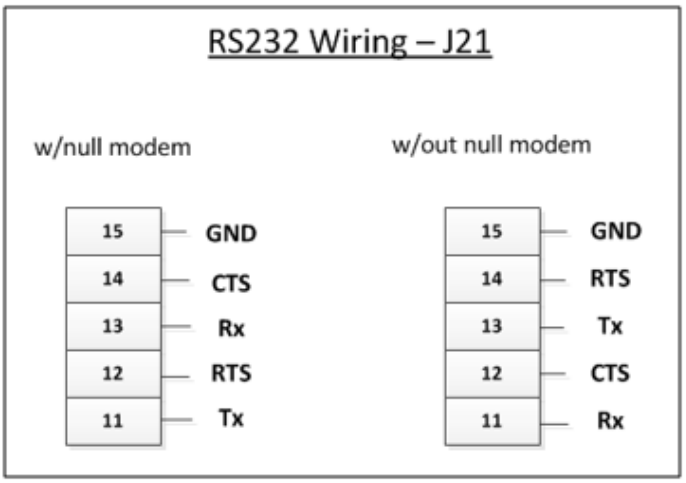
Figure 12: Connection Details



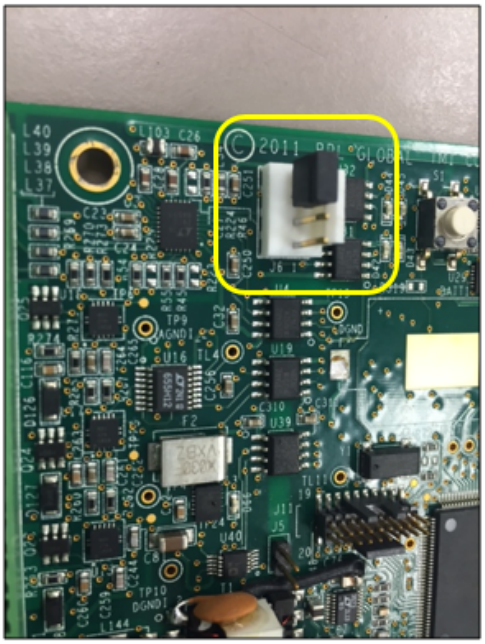
RS485 / RS232 Wiring

Connections for RS485 / 232 serial communications are terminated on **J21,** as indicated below.





The jumper on **J6** must be positioned properly, depending on the type of serial communications desired



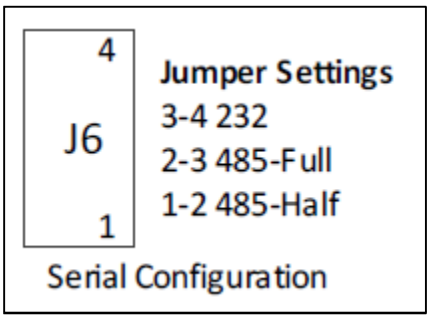


Figure 13: J6 Jumper setting

4-20mA Output Wiring

4-20 Output	AUX Channel	Cover Label Reference	Config Manual Reference
H2 PPM	3	CH0	CH1
H2 ROC	4	CH1	CH2
Moisture PPM	5	CH2	CH3

Table 4: 4-20mA Outputs

NOTE: The 4-20mA outputs require a 24VDC power source for their operation, which is not supplied by the TM1, unless the optional 24V 4-20mA Output PS Module (900-0184-00) is purchased.

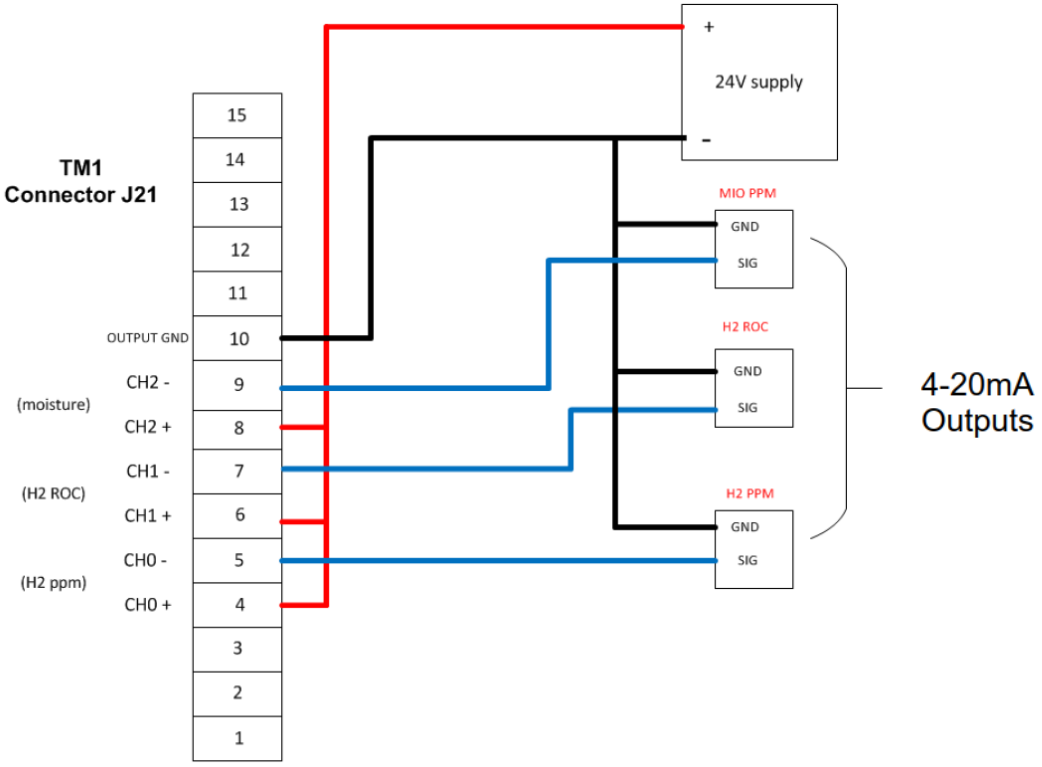


Figure 14: 4-20mA Output Wiring

Once the wiring is completed, the 4-20mA outputs must be configured in the TM1 monitor, using the TM1 Configuration Utility, which is included on the supplied USB flash drive. For instructions on the use of the Utility, refer to the TM1 Configuration Utility User Manual in the **Help** menu within the software.

Relays

There are five dry-contact relays which can be wired for normally-open (NO) or normally-closed (NC) configuration. The relays are defined as follows:

PRGM-0 H2 ppm alarm

PRGM-1 H2 ROC alarm

PRGM-2 Moisture ppm alarm

SVC Service Events

PWR Loss of Power

NOTE: The relay contact ratings for resistive loads are:

Max switched Power 100W or 600VA

Max switched Current 3A

Max switched Voltage 150VDC or 300VAC

Bleeding Air from the Monitor

1) Open the transformer valve fully and inspect for any oil leaks. Power-on the TM1 with the black toggle switch. Using a 3/32" Allen key, remove the two cap screws located on the top of the bleed selector on either side of the screw in the center as shown (**Fig 15**).

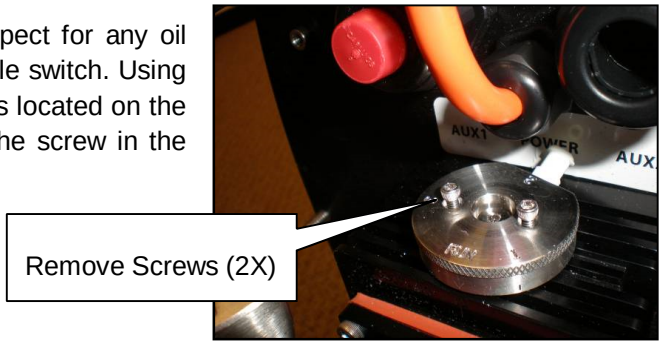


Figure 15: Bleed Selector Screws

2) Rotate the bleed selector clockwise to position **2**, exposing the Luer fitting. Unscrew the white cap from Luer fitting (**Fig 16**). Connect the supplied Tygon tube to the supplied syringe. Secure the other connector on the end of the tube onto the Luer fitting (**Fig 17**). Return the bleed selector to position **1**.

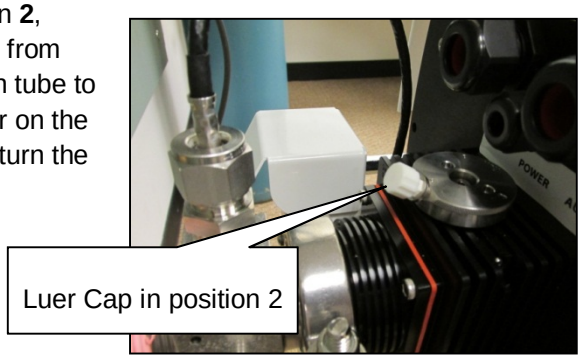


Figure 16: Luer Fitting Cap

3) Draw the syringe plunger back to remove air and draw bubble-free oil into it. Rotate the bleed selector clockwise and repeat for the other two positions, pulling air and then oil out of each port. Remove the syringe from the Luer fitting, replace the Luer cap and rotate the bleed selector counter-clockwise to the **Run** position (**Fig 15**).

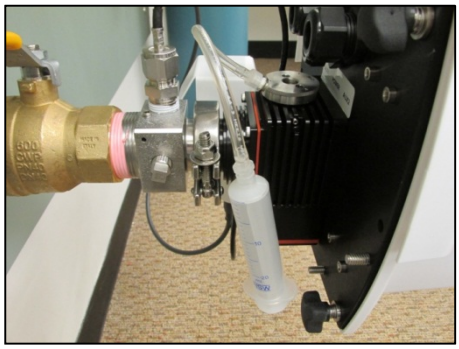


Figure 17: Syringe Attachment

4) Reinstall the two cap screws that were removed previously. Make sure that the screws are securely tightened and that the center screw is tight.

5) Replace the monitor cover and secure the four thumb-screws (or socket-head screws).

6) The TM1 installation is now complete. Please refer to the TM1 Operation & Maintenance Guide (**810-1928-01**) for further instruction on these topics.

Monitor Configuration and Dimensions

Monitor Configuration

The TM1 can be configured with the TM Configuration Utility Tool pre-loaded on the USB flash drive included with the monitor's accessories. To get started, refer to the User's guide, which can be found under the **Help** tab.

Shipping Dimensions

TM1 Monitor and Accessories:

Shipping Weight: 15lbs (6.8 kgs)
Shipping Dimensions: 15 in L x 15 in W x 12 in H (38.1 cm L x 38.1 cm W x 30.5 cm H)

TM1 Monitor and Accessories w/ Moisture Option

Shipping Weight: 20lbs (9.1 kgs)
Shipping Dimensions: 18 in L x 15 in W x 16 in H (45.7 cm L x 38.1 cm W x 40.6 cm H)

Monitor Dimensions

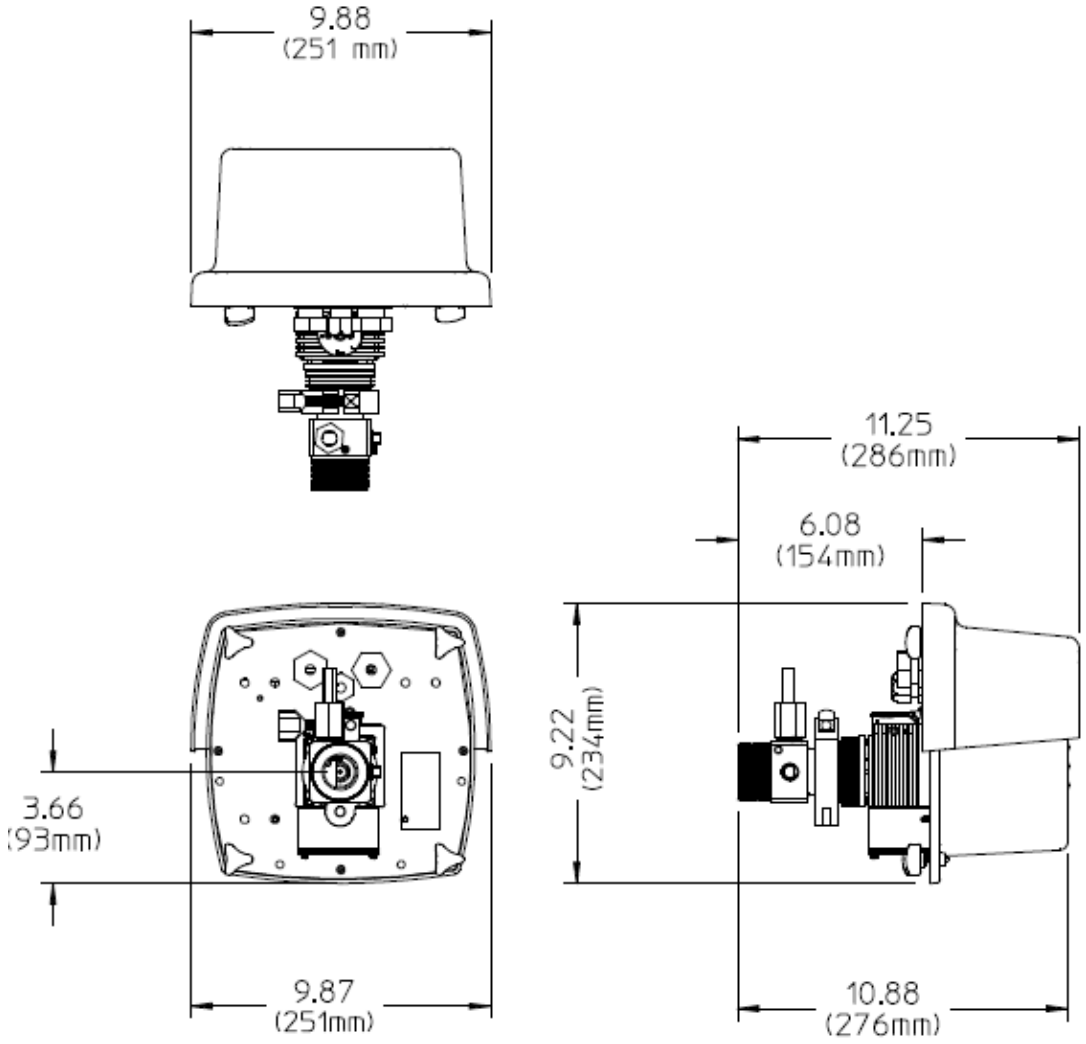


Figure 18: Monitor Dimensions

Serveron® Field Services

Serveron provides on-site commissioning, start-up and comprehensive maintenance contracts to all customers worldwide. To further improve reliability, an extended warranty is available on selected products commissioned by Serveron.

Serveron® Educational Services

Serveron professional training (designed to achieve hands-on performance-based objectives) prepares operations, maintenance, and engineering personnel to install, test, configure, operate and maintain Serveron products.

Serveron® Accelerated Delivery

Serveron provides accelerated delivery on many products and services including replacements, spare parts and repairs.

About Serveron®

Serveron transformer condition assessment and management tools are critical to utilities in improving grid reliability while optimizing the management and economics of their asset base. We are a leader in on-line DGA monitoring of power transformers with solutions across the entire power transformer fleet. Serveron is a QUALITROL Company.