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Hydran* M2-X

Transformer Gas Monitoring System

Instruction Manual

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Contents

1 PRELIMINARY INFORMATION

1.1 Safety Warnings In Six Languages

1.1.1 [EN] (in English) WARNINGS:

- All procedures in this manual must be strictly adhered to.
- Any deviation from these could cause irreversible damage to the transformer being monitored and/or the Hydran M2-X, and could lead to property damage, personal injury and/or death.
- Installation and maintenance of the Hydran M2-X must be carried out by qualified personnel only. Please advise station operator prior to maintenance. Working inside the Hydran M2-X may trigger unwanted alarms due to parameter changes, power shutdown, and system rebooting or electrostatic discharge.
    - For a maximum distance of 15 m (50 ft) from the power source, use a 2.08 mm^2 (14-AWG) cable and an overcurrent protection.

1.1.2 [FR] (in French) ATTENTION:

- Toutes les procédures dans ce manuel doivent être observées rigoureusement.
- Tout écart par rapport à celles-ci pourrait causer des dommages irréversibles au transformateur surveillé et/ou au Hydran M2-X, et pourrait entraîner des dommages à la propriété, des blessures corporelles et/ou la mort.
- L'installation et l'entretien du Hydran M2-X doivent être effectués par du personnel qualifié seulement. Veuillez aviser l'opérateur du poste avant l'entretien. Travailler à l'intérieur du Hydran M2-X peut déclencher des alarmes non voulues en raison de changements à des paramètres, d'arrêt de l'alimentation, de remise en marche du système ou de décharge électrostatique.
- Pour une distance maximale de 15 m (50 pi) de la source d'alimentation, utiliser un câble de 2,08 mm^2 (14-AWG) et une protection contre les surintensités.

1.1.3 [ES] (in Spanish) ADVERTENCIA:

- Se debe cumplir estrictamente con todos los procedimientos señalados en este manual.
- Cualquier desviación al respecto puede causar daños irreparables al transformador que está bajo monitoreo y/o al Hydran M2-X, asimismo puede ser causa de daños materiales, lesiones corporales y/o muerte.
- La instalación y mantenimiento del equipo Hydran M2-X se reserva únicamente al personal perfectamente cualificado. Aconseje por favor a operador de la estación

antes del mantenimiento. El trabajo dentro del Hydran M2-X puede accionar alarmas indeseadas debido a los cambios del parámetro, parada de la energía, sistema que reanuda o descarga electrostática.

- Para una distancia máxima de 15 m (50 pies) de la fuente de alimentación, utilice un cable de 2,08 mm^2 (14-AWG) y una protección contra las sobrecargas de corriente.

1.1.4 [DE] (in German) WARNUNG:

- Alle Abläufe in diesem Handbuch müssen strengstens befolgt werden.
- Jede Abweichung davon könnte dem zu überwachenden Transformator und/oder dem Hydran M2-X unwiderrufliche Schäden zufügen, und könnte zu Sachschaden, Personenverletzung und/oder Tod führen.
- Installation und Wartung des Hydran M2-X dürfen daher nur von qualifiziertem Personal durchgeführt werden. Verständigen Sie bitte den Bediener der Schaltanlage vor der Wartung. Das Arbeiten innerhalb des Hydran M2-X kann aufgrund von Parameteränderungen, Spannungsabschaltung, Neubooten des Systems oder elektrostatischer Entladung unerwartete Alarme auslösen.
- Für eine maximale Entfernung von 15 m von der Spannungsquelle, verwenden Sie ein 2,08 mm^2 Kabel (14 AWG) und ein Überstromschutz.

1.1.5 [IT] (in Italian) ATTENZIONE:

- Tutte le procedure del presente manuale dovranno essere eseguite in totale conformità.
- Qualsiasi deviazione dallo stesso manuale potrebbe causare danni irreversibili al trasformatore sotto monitoraggio e/o all' Hydran M2-X, e potrebbe causare danni alla proprietà, lesioni personali e/o alla morte.
- L'installazione e la manutenzione del Hydran M2-X devono essere eseguite solo ed esclusivamente da personale qualificato. Avissare l'operatore della stazione prima di manutenzione. Funzionando all'interno del Hydran M2-X può fare scattare degli alarmi indesiderabili e cambiamenti dei parametri, arresto dell'alimentazione, un "reboot" del sistema o scarico elettrostatico.
- A una distanza massima di 15 m dalla fonte di energia usare un cavo 2.08 mm^2 (14-AWG) e una protezione di sovracorrente.

1.1.6 [SV] (in Swedish) VARNING:

- Alla procedurer i manualen måste följas noggrant.

- Varje avvikelse från dessa procedurer kan orsaka oåterkalleliga skador på den övervakade transformatorn och/eller på Hydran M2-X samt leda till egendomsförlust, personskada och/eller livsfara.
- Installation och underhåll av Hydran M2-X måste utföras av behörig personal. Råd var god posterar operatören före underhåll. Funktionsduglig insida Hydran M2-X kan starta oönskade parameterändringar för larm tack vare, driver avstängning, systemomstart eller elektrostatisk urladdning.
- För ett maximalt avstånd på 15 m från kraftuttaget, använd 2,08 mm^2 kabel (14-AWG) och ett överströmsskydd.

1.2 Safety Symbols Description

Description of safety symbols used on the Hydran M2-X device:

Refer to the Instruction Manual to prevent injury or damage to equipment.

Hazardous voltages may be present.

Protective earth connection.

Description of safety messages used in this Instruction Manual:

CAUTION — ***A procedure, practice, or condition that could cause equipment damage or permanent loss of data, if not adhered to.***

WARNING — ***A procedure, practice, or condition that could cause bodily injury or death, if not adhered to.***

1.3 Preface

This manual provides a complete reference for the Hydran M2-X, which is a unique, continuous, on-line monitor of combustible gases and moisture in dielectric oils.

The information in this manual may be used by:

- Purchaser or specifier
- Installation planner
- Operator
- Commissioning manager
- Person responsible for collecting the readings
- Maintenance technician
- Troubleshooting technician

WARNING

- ***All procedures in this manual must be strictly adhered to. Any deviation from these may cause irreversible damage to the transformer being monitored and/or the Hydran M2-X, and may lead to property damage, personal injury and/or death.***
- ***Installation and maintenance of the Hydran M2-X must be carried out by qualified personnel only.***

This manual is not a tutorial on combustible gases or water in dielectric oil. It is assumed that the reader is already familiar with these subjects. However, forms of water in oil are summarized in Section 3.1.2.

To simplify the text, the following expressions are used:

- "Supervisory control and data acquisition" (SCADA) is used to identify the numerous devices (control panel, alarm panel, retransmission unit, display, terminal, data recorder, external detection device, etc.) on which can be connected the Hydran M2-X.
- "Sensor" refers to the cylindrical brass assembly that encases the gas detector and humidity sensor.

This manual is written for the 0–2,000 ppm operating range only. This range is the one used by most Hydran M2-X's. Should your Hydran M2-X(s) use a different operating range, please convert the values (in doubt, contact the General Electric Customer Service; the coordinates can be found at the bottom of page 2).

To help the reader, a Table of Contents is at the beginning of the manual, along with a Glossary in Appendix M at the end of the manual.

The names of menus, options, parameters, etc., shown on the Hydran M2-X's display are displayed in bold characters; for example: the **Main Menu**. The Hydran M2-X's menus and options are sorted according to a tree structure; to indicate the path from

the **Main Menu** to a submenu, an option or a parameter, the symbol "**>**" is used to separate each level ("branch" of the tree). In the example **Setup > Reading Setup > Gas Reading Setup,** these steps must be followed to navigate from the **Main Menu** to the **Gas Reading Setup** options:

1. From the **Main Menu**, select **Setup**.
2. From Setup, select Reading Setup.
3. From Reading Setup, select Gas Reading Setup.

The *Hydran M2-X Instruction Manual* (this manual), the *Hydran M2-X Installation Guide* are located in PDF format in the **English/Manuals** folder of the Hydran M2-X installation CD. Hard copies of each manual can be purchased from General Electric.

1.4 Standard GE Warranty

The products covered by this manual and manufactured by GE ("Products") are warranted to be free from defects in material, workmanship and title at the time of delivery. Any components of a Product or other products manufactured by persons other than GE carry only the warranty provided by the manufacturers thereof and GE gives no warranty on behalf of the manufacturers of such products.

GE warrants the Products seven (7) years from date of initial GE shipment, on the condition that the product has been fully field commissioned by a date no later than 3 years after initial GE shipment, failing which the warranty shall expire 3 years after initial GE shipment .[1]

Software is warranted for ninety (90) days from delivery. GE represents and warrants that any software and firmware covered by this manual is free from functional deficiencies. If any functional deficiencies are discovered and are reported to GE within the Warranty Period, GE agrees to use due diligence to correct such deficiencies within 30 days after receipt of such notification. Upon receiving such notice, GE may lend telephone support or patches. If the reported deficiencies cannot be eliminated within 30 days, the Buyer may request, and GE shall then furnish, monthly status reports to the Buyer regarding the progress of GE's efforts to correct such functional deficiencies.

If Products covered by this manual do not meet the above warranties during the applicable Warranty Period, the Buyer shall promptly notify GE in writing but not later than 30 days and make the Products available promptly for correction. GE shall thereupon correct any defect by, at its option, repairing the defective Products or making available necessary replacement parts.

[1] The referenced paragraph covers the standard warranty period for Hydran M2-X devices. All other elements of warranty and all other terms and conditions shall be governed under the relevant contract of sale between GE and its direct customer. Specifically, in GE's terms and conditions "Form EM104 (Global) Grid Solutions 28Oct2015" the warranty periods stated in Clause 5.2 for "Products" shall be replaced by the above statement All other elements of Clause 5.2 and all other elements of "Form EM104 (Global) Grid Solutions 28Oct2015" shall remain unaffected.

Any failure which is the basis for a warranty claim shall not be cause for extension of the duration of the applicable Warranty Period. GE shall not be responsible for removal or replacement of systems, structures or other parts of the Buyer's facility. If a defect in Products or part thereof cannot be corrected by GE's reasonable efforts, the parties shall negotiate an equitable adjustment in price with respect to such Products or part thereof. All decontamination work necessary for the correction of defects shall be performed by the Buyer at the Buyer's expense. The condition of any tests shall be mutually agreed upon and GE shall be notified of and may be represented at all tests that may be made.

GE does not warrant Products or any repaired or replacement parts against normal wear and tear, including that due to environment or operation, including excessive operation at peak capability, frequent starting, type of fuel, detrimental air inlet conditions, or erosion, corrosion or material deposits from fluids, or which have been involved in an accident. The warranties and remedies set forth herein are further conditioned upon:

- Proper storage, installation, operation and maintenance of the Buyer's equipment and conformance with the instruction manuals (including revisions thereto) provided by GE and/or its subcontractors, as applicable.
- Repair or modification pursuant to GE's instructions or approval.

The Buyer shall keep proper records of operation and maintenance during the applicable Warranty Period. These records shall be kept in the form of log sheets and copies shall be submitted to GE upon its request in connection with a warranty claim by the Buyer. GE does not warrant any products or services of others designated by the Buyer where such products or services are not normally supplied by GE.

The preceding paragraphs set forth the exclusive remedies for all claims based on failure of or defect in Products covered by this manual, whether the failure or defect arises before or during the applicable Warranty Period and whether a claim, however instituted, is based on contract, indemnity, warranty, tort (including negligence) or civil liability, strict liability or otherwise. The foregoing warranties are exclusive and are in lieu of all other warranties and guarantees whether written, oral, implied or statutory. NO IMPLIED STATUTORY WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE SHALL APPLY.

2 GENERAL WARNINGS

WARNING

Mishandling of the Hydran M2-X sensor (such as a perforation or scratch on the membrane or subjecting the sensor to paint or solvent) voids the warranty.

1. *Do not remove the plastic cap* from the sensor's threaded extremity until the sensor is installed on the valve (see Figure 2-1). This cap protects the threads and the sensor from debris and sharp objects. If the sensor is unmounted, place immediately the cap onto its threads.

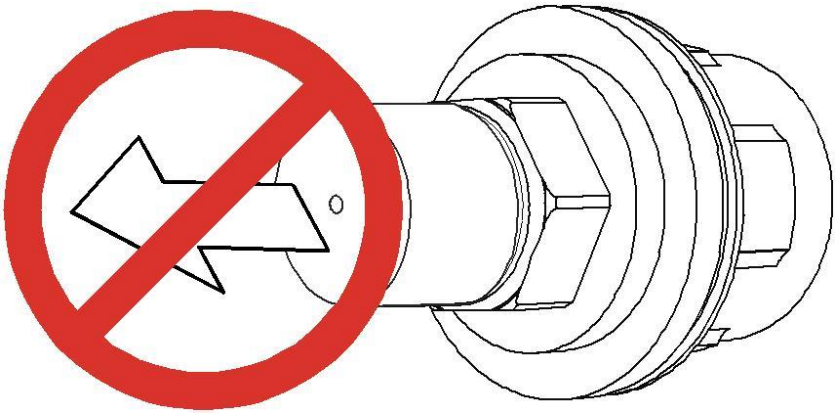


Figure 2-1: Plastic Cap Must Remain in Place Until the Sensor Is Installed on the Valve

2. *Do not touch the membrane located inside the threaded extremity of the sensor with a finger or an object* (see Figure 2-2). The membrane is easily impaired; impairing the membrane damages the sensor permanently, thus voiding the warranty.

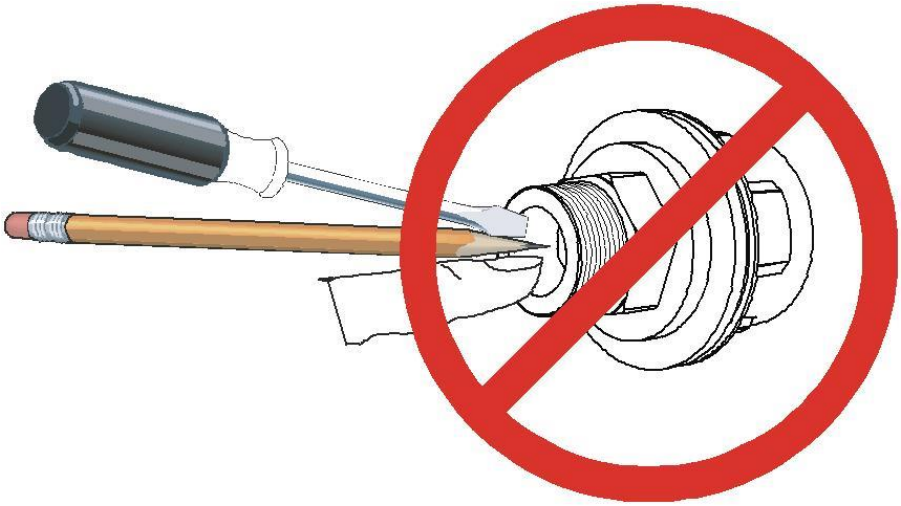


Figure 2-2: Do Not Touch the Sensor's Membrane with a Finger or an Object

3. Do not block the sensor's breathing hole or puncture the breathing hole's membrane (see Figure 2-3). Located above the sensor's connector, this opening provides oxygen to the gas detector (inside the sensor). Blocking this opening or puncturing its membrane damages the sensor permanently, thus voiding the warranty

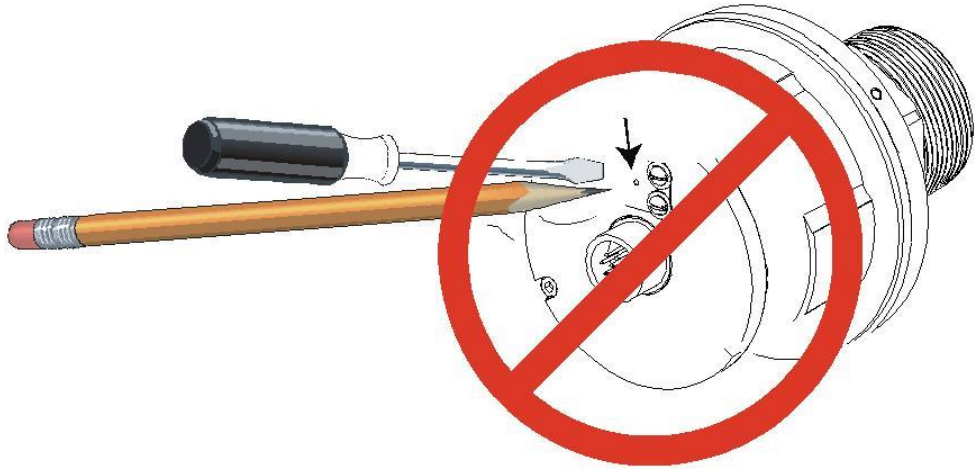


Figure 2-3: Do Not Block the Sensor's Breathing Hole or Puncture the Breathing Hole's Membrane

4. *Install the Hydran M2-X horizontally; not at an angle, vertically or horizontally using an elbow* (see Figure 2-4). For details pertaining to the positioning of Hydran M2-X's, see Section 5.3.3.

Figure 2-4: Do Not Install the Hydran M2-X at an Angle, Vertically or Using an Elbow

5. *Do not install the Hydran M2-X on elbows or fitting boxes* (see Figure 2-5). Elbows may cause turbulence that can affect the accuracy of gas level readings.

Figure 2-5: Do Not Install the Hydran M2-X on an Elbow or a Fitting Box

6. *Do not install the Hydran M2-X on the inlet side of the radiator pump* (see Figure 2-6).

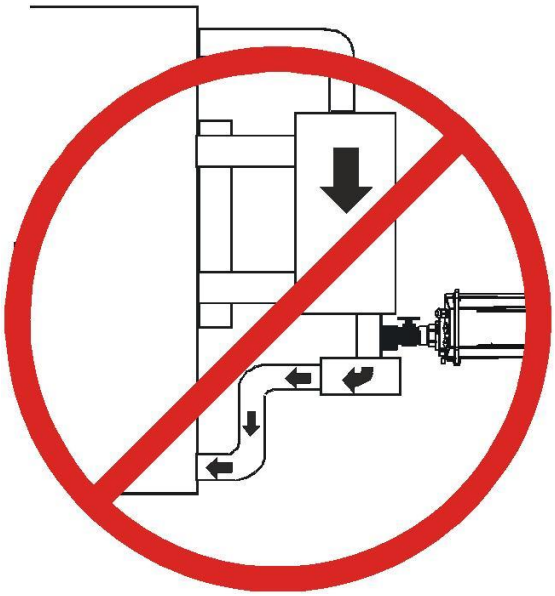


Figure 2-6: Do Not Install the Hydran M2-X on the Inlet Side of the Radiator Pump

7. *Do not subject the Hydran M2-X or its sensor to high-pressure water streams* (see Figure 2-7). High-pressure streams used to clean transformers may cause serious damage.

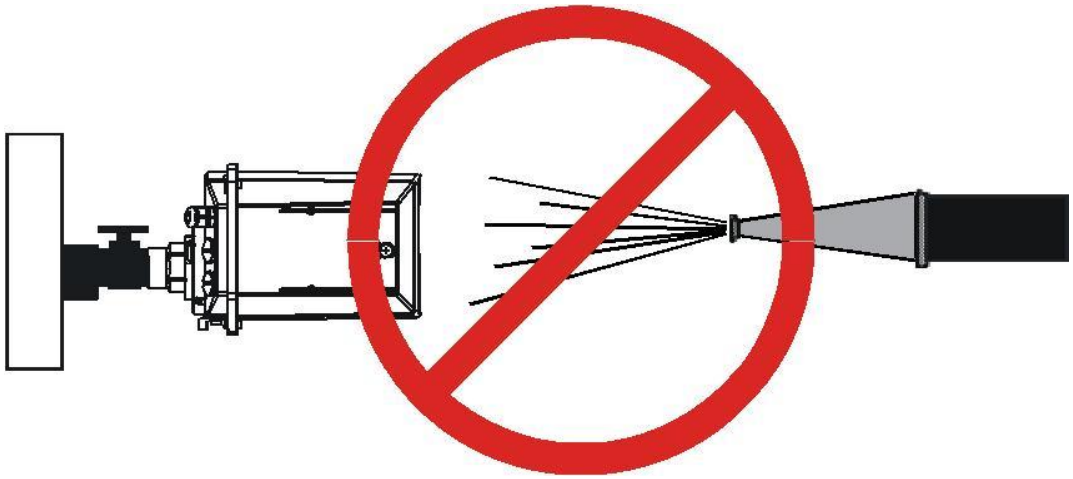


Figure 2-7: Do Not Subject the Hydran M2-X or Its Sensor to High-Pressure Water Streams

8. *Do not paint the sensor* (see Figure 2-8). Paint fumes block the sensor's breathing hole. Blocking this opening damages the sensor permanently, thus voiding the warranty.

Figure 2-8: Do Not Paint the Sensor or Clean It with Any Solvent

9. *Do not use hydrocarbon-based volatile compounds near the sensor; do not clean the sensor with any solvent or other products* (see Figure 2-8). The volatile fumes of these compounds can deteriorate sensor performances. Products to avoid include: paint,

liquid Teflon, close vehicle exhaust, spray can, black pitch, thinner, RTV (Room Temperature Vulcanization; silicon-based mastic) and solvent.

10. *Do not use galvanized fittings to install the sensor*. Galvanized fittings (pipes, reducing bushing, rings, etc.) may react with the oil, consequently resulting in higher readings of gas level. Similarly, do not use galvanized fittings on transformer valves used for oil sampling.

11. *Do not separate the Hydran M2-X's from their respective sensor*. The Hydran M2-X is set at the factory for a specific sensor. To verify if the sensor and Hydran M2-X are paired correctly, consult the serial numbers indicated on the shipping box and/or the Test Certificate and Data Sheet (for an example, see Figure 4-12). The sensor's serial number is located below the sensor connector (see Figure 3-7); the Hydran M2-X's serial number is located on its back (external side of the heater plate).

WARNING

Turn off the electric power at the fuse box or service panel before making any electrical connections, and ensure a proper ground connection is made before connecting line voltage. Failure to do so can result in property damage, personal injury and/or death.

12. *The surface of the base plate can be hot*. Heating for the dynamic oil sampling system (Section 3.5) is achieved using heating resistors mounted on the internal side of the base plate.

3 INTRODUCTION TO THE HYDRAN M2-X

3.1 Overview

The Hydran M2-X is an intelligent, on-line monitoring system that measures the level of combustible gases and moisture in dielectric oil for the evaluation of dangerous conditions, bubbling temperature and aging rate, and for the early detection of incipient faults in transformers (or any other oil-filled electrical equipment).

The Hydran M2-X consists of a Type NEMA 4X enclosure (Figure 3-1) easily installed on one of the valves of the equipment to be monitored.

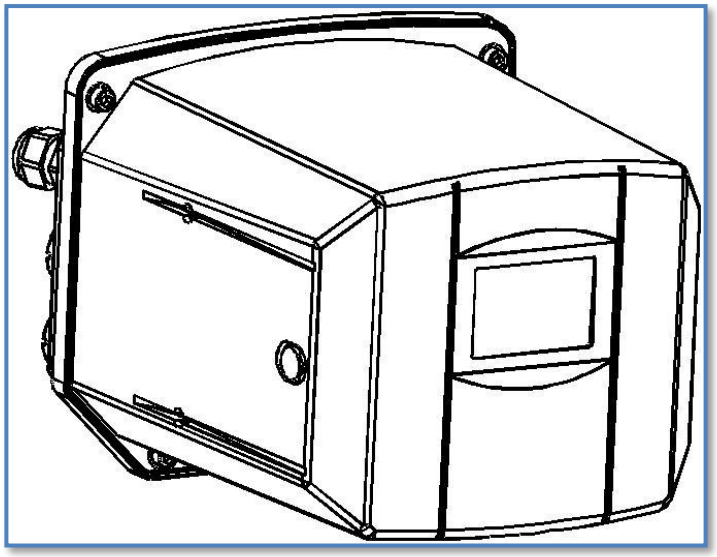


Figure 3-1: Hydran M2-X's Enclosure

The Hydran M2-X's user interface (Figure 3-2) consists of an eight-key membrane keypad and a 128 x 64 pixels, backlit liquid crystal display (LCD) to use the Hydran M2-X as a stand-alone unit. For more information on the user interface, see Chapter 4.

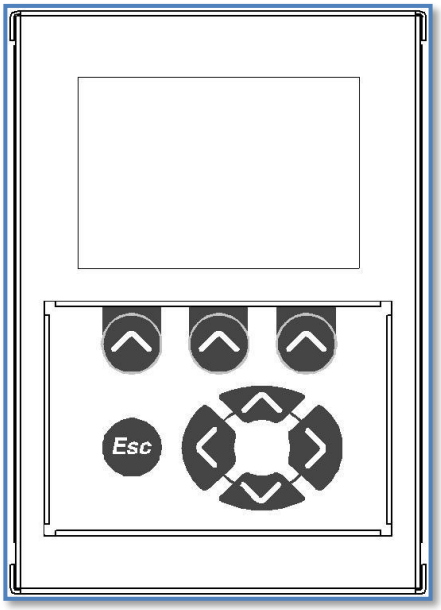


Figure 3-2: User Interface of the Hydran M2-X

Note: Although the Hydran M2-X's user interface can be used to perform all required tasks (some of the set-up functions can be performed only from the user interface), it is recommended to connect (using an RS-232 link) the Hydran M2-X to a laptop computer running the Perception software. This software provides an easier and friendlier environment to perform the same tasks.

3.1.1 Gas Detection

The Hydran M2-X's sensor is equipped with a gas detector that is sensitive to the four gases that are the primary indicators of incipient faults in oil-filled electrical equipment:

- Hydrogen (H_2)
- Carbon monoxide (CO)
- Ethylene (C_2H_4)
- Acetylene (C_2H_2)

Note: The gas detector measures a composite value of the above dissolved gases in oil.

For information on how to compare the Hydran M2-X's gas level reading with a DGA, see Section 10.4.2.

3.1.2 Moisture Detection

The Hydran M2-X's sensor is equipped with a thin-film capacitive sensor that measures the moisture in oil. Water exists in oil in four forms:

- *Dissolved*: Water dissolved in oil and available to move from the oil to the air or to the solid insulation in the transformer to reach equilibrium.

- *Bound*: Water chemically bonded to polar molecules such as by-products of oxidation, and to synthetic anti-oxidants. Although this water is not readily available to move in and out of the oil, it will to some extent.

- *Oversaturated*: This water in a free state is present in the oil in a concentra-tion exceeding the solubility of water in oil and is, in effect, saturating the oil.
- Water bonded to cellulose and metal particles in suspension in oil.

The conventional Karl Fischer titration method measures the total water content in oil in ppm (the sum of all four forms of water in oil). The moisture sensor provides essentially the measurement of water dissolved in the oil.

3.1.3 Optional I/O Interfaces

Up to four optional I/O interfaces can be installed. Available types are:

- 4–20 mA analog input
- 4–20 mA analog output

Any combination is allowed. For more information, see item 3 on page 28.

3.1.4 Backward Compatibility with Hydran Products

General Electric's Hydran products line also includes the Hydran 201T*i* Intelligent Transmitter (H201T*i*) and the Hydran 201C*i* Controllers, a generic term that encompasses the three Hydran Controllers:

- Hydran 201C*i*-C Communications Controller (H201C*i*-C)
- Hydran 201C*i*-1 One-Channel Controller (H201C*i*-1)
- Hydran 201Ci-4 Four-Channel Controller (H201Ci-4)

The H201T*i* and Hydran Controllers can be combined in various ways to form a Hydran 201*i* System. To summarize, a Hydran 201*i* System is either a H201T*i* used alone or the combination of at least one H201T*i* and a Hydran 201C*i* Controller. The Hydran 201R Model *i* is a specific configuration of Hydran 201*i* System, which consists of one H201T*i* linked to a H201C*i*-1.

The Hydran M2-X also includes controller functions. The Hydran M2-X is designed to be compatible with the communication features of the three Hydran 201C *i* Controllers. A Hydran M2-X can therefore replace a H201T*i* in any Hydran 201*i* System and communicate with the Perception software using a laptop computer.

Note: The H201Ci -1 and H201Ci-4 can only display the gas level reading of the Hydran M2-X, not the humidity level. They are also limited to two alarm levels: gas High and High-High (Alarm 1 and Alarm 2 of the Hydran M2-X).

3.1.5 Possible Configurations

The Hydran M2-X can be used in three configurations:

- As a stand-alone unit (using its keypad and display, or the Perception software running on a laptop computer).
- In a network of up to 32 Hydran M2-X's. Network communications are performed through an isolated RS-485 link. Networking is described in Chapter 6.
- As a replacement for a Hydran 201T*i* in any Hydran 201*i* System.

3.1.6 Other Features

- Several adjustable alarm conditions relative to gas detection, moisture detection, analog inputs and system faults.
- Six history files (automatic recording of data): Short Term, Long Term, Events, Alarms, Service and Sensor card.
- Semimonthly, automatic sensor test and state report.
- Dynamic oil sampling, a pumpless sampling system using thermal convection cycles.
- Terminal blocks to connect the following items:
  - ac power supply.
  - Five alarm contacts (four are configurable, and one is assigned to system fault alarm conditions).
  - TDM signal for backward compatibility with Hydran 201C*i* controllers (gas reading).
  - Optional I/O interfaces.
  - Input and output for RS-485 network link.
- An RS-232 connector for local communications with the Perception software.
- An extremely high immunity to electrical surges, radio-frequency interferences and electrostatic discharges.
- A very wide temperature range for all-weather outdoor operation.
- Accessories are also available (see Appendix L : Other Products and Accessories)

For more details, see Appendix A : Technical Specifications.

3.2 External Components

For detailed information on the dimensions of the Hydran M2-X's enclosure, see Section A.2.1.

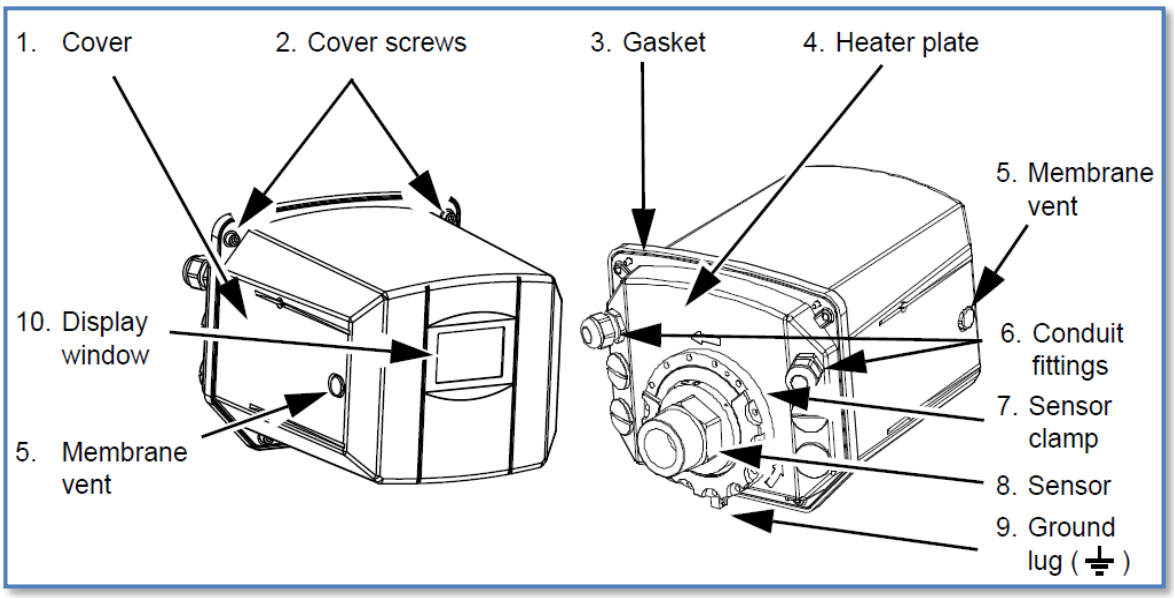


Figure 3-3: External Pats of the Hydran M2-X

The enclosure is composed of the following parts (see Figure 3-3):

1. **Cover**: The cover provides mechanical and weather protections for the sensor and electronic card cage (see Figure 3-4).
2. **Cover screws**: Four screws maintain the cover in place. The cover can be easily removed to access the electronic card cage.
3. **Gasket**: This gasket renders the joining of the cover and heater plate impermeable to water.
4. **Heater plate**: The heater plate accommodates the dynamic oil sampling. The dynamic oil sampling system is carefully controlled to generate oil convection and ensure accurate gas readings. For details, see Section 3.5.

CAUTION

The surface of the base plate can be hot. Heating for the dynamic oil sampling system (see Section 3.5) is achieved using heating resistors mounted on the internal side of the base plate.

5. **Membrane vent**: Air penetrates through the watertight membrane vent and inside the Hydran M2-X. The gas detector requires air to function properly.
6. **Conduit fittings**: Up to six watertight, non-conducting conduit fittings can be mounted on the heater plate. They are used to install standard, watertight, flexible (recommended) or rigid steel conduits. The conduit fittings are made of non-conducting material (plastic) to prevent problems caused by ground loops through the conduits (for example, if the transformer tank is grounded at a single point and monitored continuously for tank-to-ground currents).

CAUTION

All metallic conduits or cable shields must be connected to the ground at one point.

7. **Sensor clamp**: To secure the sensor.
8. **Sensor**: See Section 3.4.
9. **Ground lug**: To ground the Hydran M2-X.

WARNING ***The enclosure must be grounded***

10. **Display window**: The cover has a window to see the display. The display, along with the keypad, is located on the front of the electronic card cage. To access the display and keypad, the cover must be removed. For more information on the display and keypad, see Chapter 4.

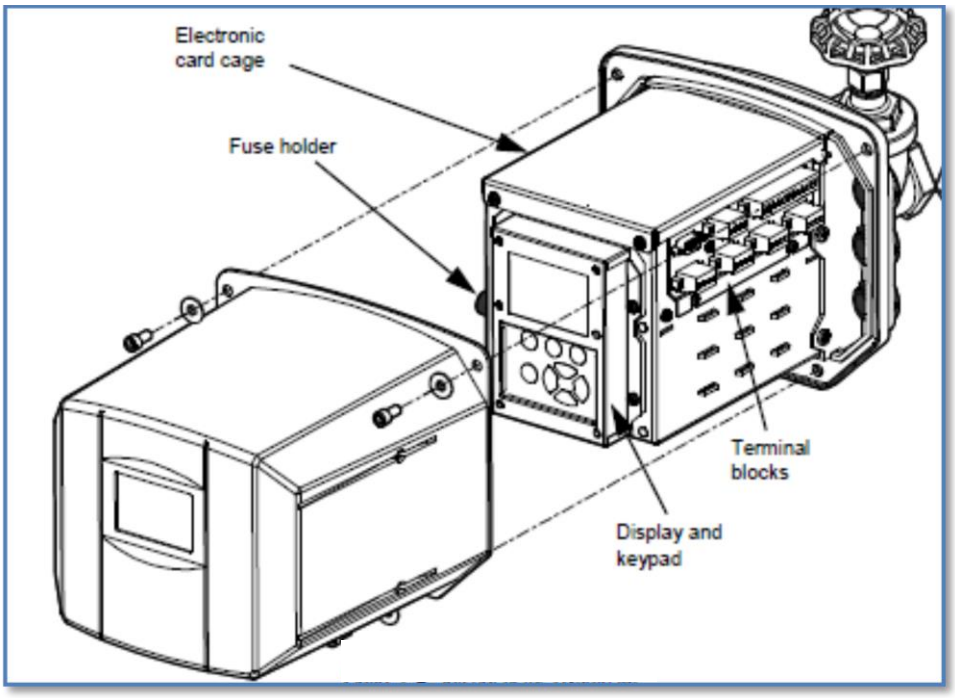


Figure 3-4: Interior of the Hydran M2-X

3.3 Electronic Card Cage

The user interface (display and keypad), terminal blocks, fuse holder and connectors are all mounted on the exterior of the electronic card cage (see Figure 3-4).

3.3.1 Front – Keypad and Display

The Hydran M2-X's user interface (see Figure 3-2) consists of an eight-key membrane keypad and a 128 x 64 pixels, backlit liquid crystal display (LCD) to use the Hydran M2-X as a stand-alone unit. For more information on the user interface, see Chapter 4.

3.3.2 Right Side – Terminal Blocks

The following connectors and terminal blocks are mounted on the right side of the electronic card cage (when facing the display; see Figure 3-5):

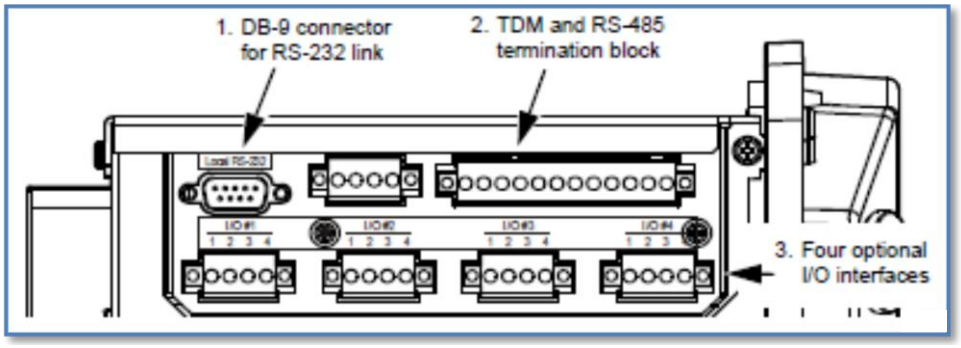


Figure 3-5: Right Side of the Electronic Card Cage

1. **DB-9 connector for RS-232 link**: This surge-protected, male connector allows local RS-232 communications between the Hydran M2-X and a laptop computer running the Perception software. For details, see Chapter 6.
2. **TDM and RS-485 terminal block**: This terminal block is used to connect the following signals (from left to right; for wiring details, see Appendix D.1):
   - *Terminals 1 to 4*: Standard TDM (time division multiplexing) signal. This TDM signal is provided for backward compatibility with the Hydran 201T*i*; see the *Hydran 201i System Instruction Manual*. This TDM signal transmits two pieces of information:
     - The percentage of gas level (where 100 % is 2,000 ppm for the standard model).
     - The state of the alarm relays 1 and 2.
   - *Terminals 5 to 12*: RS-485 network link input and output signals. These signals are used to connect two or more Hydran M2-X's in a daisy chain configuration to form a network. The network can be connected temporarily through the DB-9 connector to a laptop computer running the Perception software. For information on networking, see Chapter 6.
3. **Two optional I/O interfaces**: The following interfaces are available (any combination is allowed):
   - *4–20 mA general-purpose isolated input*: The Hydran M2-X can monitor up to four analog inputs. These analog inputs are typically used to monitor various transformer parameters (top oil temperature, load current, etc.). For wiring details, see Appenidx D.2.
   - *4–20 mA analog output*: Isolated (up to 2,500 Vac) current output that can supply a load up to 500 Ω (10 V maximum). This analog output is typically monitored by a SCADA system. For general and wiring details, see Appendix D.4. To convert ppm to mA, see Appendix K.1.

Note: Each I/O interface is identified by a label on its connector.

Note: When ordered with the Hydran M2-X, optional I/O interfaces are added to the Hydran M2-X at the General Electric's plant before shipping. To add an I/O interface after the assembly of the Hydran M2-X is completed, see Appendix E : Installing I/O Modules.

3.3.3 Left Side - Terminal Blocks

The following items are mounted on the left side of the electronic card cage (when facing the display; see Figure 3-6:

1. **Temporary plug**: This plug must be removed and replaced with a watertight fitting to connect the ac power supply cable (see Section 5.3.12.6).
2. **AC power supply terminal block**: The power supply is connected to the three terminals at the top of this terminal block. The three terminals at the bottom are connected to the three wires of the line filter located inside the electronic card cage. For wiring details, see Appendix D.7.

Note: The external ac power supply range is 100-120Vac or 200-240Vac, 50/60 Hz.

3. **AC power supply fuse:** The Hydran M2-X includes one fuse holder. For the technical specifications, see section 10.2.
4. **Alarm contacts terminal block:** This terminal block is used to connect the Hydran M2-X's five SPDT (single pole double throw) alarm relays to a SCADA system. Each relay requires three terminals; for wiring details, see SectionD.8. The first four sets of alarm contacts (terminals 1 to 12) can be assigned to different alarm conditions (see Section 4.3); the last set of alarm contacts (terminals 13 to 15) is always assigned to the system fault alarm conditions. For more information on alarms and relays, see Chapter 7.
5. **Expansion port**: Not used. This is used in Hydran S2 only.

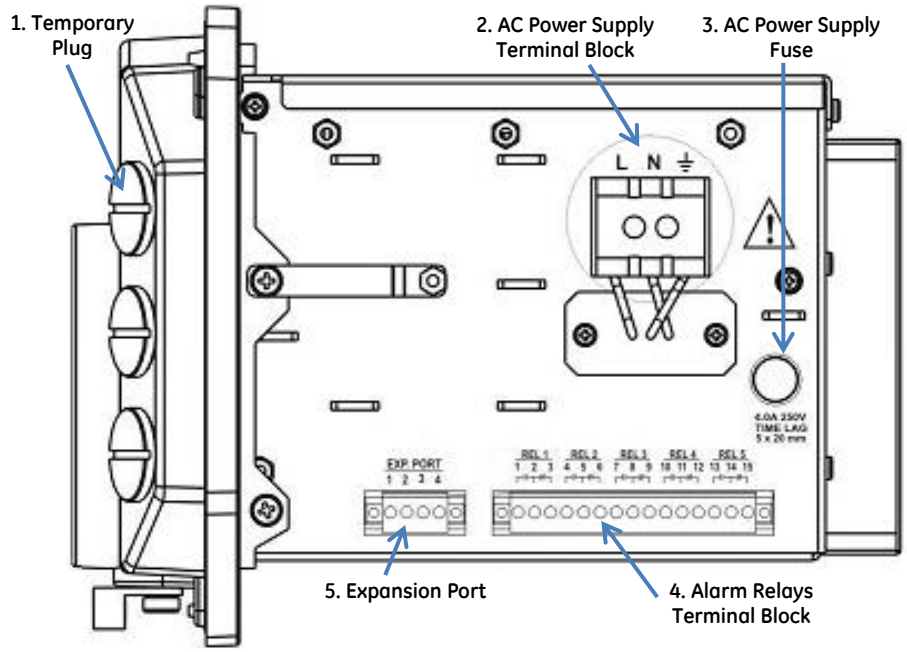


Figure 3-6: Left Side of the Electronic Card Cage

3.3.4 Inside

The electronic card cage contains the circuit boards (CPU, sensor card, etc.) and the battery.

3.3.4.1 Battery

The Hydran M2-X's battery is used to keep the real-time clock functioning and to retain the parameter values and data of the history files when the ac power is not available. For the specifications, see Section 10.3.1; should you need to replace the battery, see Appendix G : Replacing the Battery.

3.3.4.2 Internal Real Time Clock

An internal real-time clock (RTC) provides a calendar and a permanent clock, unless the battery is disconnected. The clock uses a crystal oscillator as its time base; its 0.01 % accuracy (four minutes per month) is independent of the ac power supply frequency. The calendar accounts automatically for leap years (366-day year).

To set the Hydran M2-X's date and time, see Section 4.4.3.

The Hydran M2-X's internal clock manages the following functions:

- History files date stamp (see Section 4.4.2)
- Delays of all alarm conditions (see Section 4.2.1)
- Semimonthly, automatic sensor tests (see Section 4.5)

3.3.4.3 Non Volatile Memory

The nonvolatile memory allows the Hydran M2-X to retain its data even during the following events:

- Disconnection of the Hydran M2-X's battery.
- Failure of the ac power supply.
- Update of the Hydran M2-X's embedded software.

The Hydran M2-X's nonvolatile memory is used to retain the following data:

- **Setup > Temperature Setup**
- **Service > Sensor Param**
- **View Readings > View History > View Sensor Card History**

3.4 Hydran M2-X Sensor

A standard Hydran M2-X sensor is calibrated for mineral oil, but other options for different types of transformer fluid must be made at the time of ordering. Table 3-1 lists the product options.

Option	Definition
Hydran M2-X	Uses a standard composite sensor calibrated for mineral oil.
Hydran M2-X-NE	Uses a standard composite sensor calibrated for natural ester oil.
Hydran M2-X-SE	Uses a standard composite sensor calibrated for synthetic ester oil.
Hydran M2-X-H2	Uses a hydrogen-specific sensor calibrated for mineral oil.

Table 3-1: Product options

CAUTION

Never touch the gas detector or moisture sensor inside the Hydran M2-X sensor. Touching them may damage the Hydran M2-X sensor and void the warranty.

3.4.1 Overview

The Hydran M2-X sensor is composed of a permeable-membrane gas detector and a thin-film capacitive humidity sensor.

The Hydran M2-X sensor (see Figure 3-7) is made of brass. It consists of the following parts:

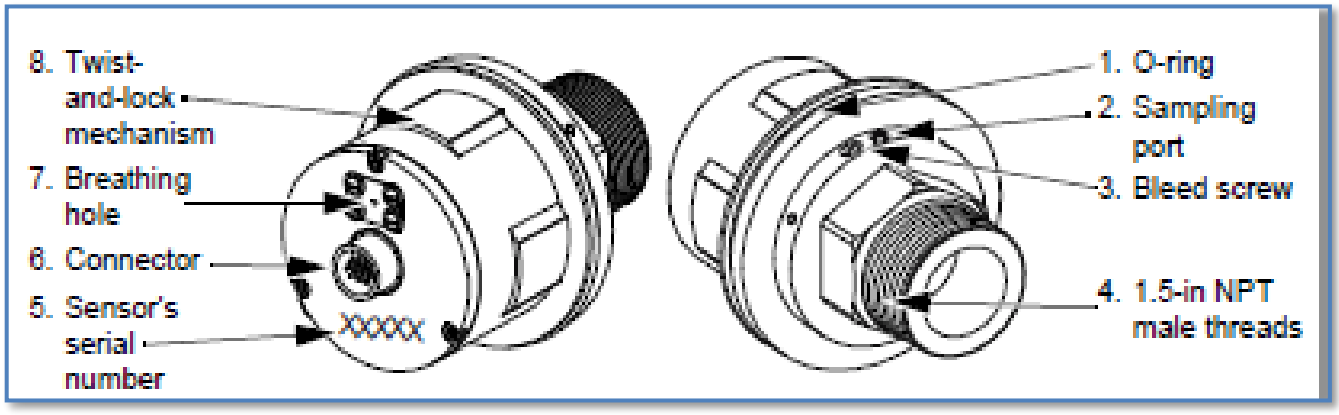


Figure 3-7: Parts of the Hydran M2-X Sensor

1. **O-ring**: To assure the water tightness of the enclosure.

2. **Sampling port**: See the bleed screw (item 3 below). The sampling port fits the Luer stopcock valve of a DGA syringe.
3. **Bleed screw**: The bleed screw and sampling port (item 2 above) are used to purge the air from the sensor during the installation and to sample oil for Dissolved Gas Analysis (DGA). The oil sampling procedure is described in Appendix J : Extracting an Oil Sample.
4. **1.5-in NPT male threads**: They are used to mount the Hydran M2-X directly on an open-bore valve of a transformer or any other oil-filled electrical equipment. The gas detector and moisture sensor are both mounted inside the sensor's threaded extremity.
5. **Sensor's serial number**: The serial number is also specified on the Test Certificate and Data Sheet (for an example, see Figure 4-12). Sensors are identified with a serial number as each one is unique and comes with a different set of calibration parameters.

   Note: Each Hydran M2-X is configured for a specific sensor. If several Hydran M2-X's are received, take the necessary precautions not to swap the sensors and Hydran M2-X's.

6. **Connector:** To link the sensor to the electronic card cage.
7. **Breathing hole**: Air penetrates through the watertight membrane vent (see item 5 in Figure 3-3) and inside the Hydran M2-X, and the breathing hole allows the air to reach the gas detector (inside the sensor). The gas detector requires air to work properly.
8. **Twist-and-lock mechanism**: This twist-and-lock feature is no longer used to attach the Hydran M2-X enclosure and the sensor together. This has been replaced by a clamp mechanism. Refer to Figure 5-3. The Hydran M2-X enclosure can be replaced without removing the sensor from the valve.

3.4.2 Measurements Performed by the Sensor

The sensor continuously makes three measurements:

- *Gas level*: Gas detection is based on combustible gases dissolved in the oil passing through a selectively gas-permeable membrane into an electrochemical gas detector (located inside the sensor). Within the gas detector, the gases combine with oxygen (from ambient air) to produce an electrical signal that is measured by an electronic circuit and converted to ppm. The gas detector is sensitive to the gases that are the primary indicators of incipient faults in oil-filled electrical equipment:
  - Hydrogen (H_2)
  - Carbon monoxide (CO)
  - Ethylene (C_2H_4)
  - Acetylene (C_2H_2)
- *Moisture level*: Moisture detection is performed by a thin-film capacitive moisture sensor. The capacitive value of this sensor varies according to the moisture level. This value is converted to an electrical signal that is digitalized for reading by the CPU.

- *Sensor temperature*: A thermistor is included within the sensor to measure its temperature.

Note: The Hydran M2-X also measures the heater plate temperature using thermistors mounted inside the heater plate; see Section 3.5.

3.4.3 Sensor Temperature

For the recommended operating temperature range of the sensor, see the technical specifications in Appendix A. The sensor temperature is controlled by the dynamic oil sampling system of the heater plate (see Section 3.5). The external factors that affect the sensor temperature are:

- Ambient air temperature surrounding the Hydran M2-X.
- Oil temperature behind the valve on which the Hydran M2-X is mounted

Note: A system fault alarm condition is detected when the sensor temperature is outside the operating limits. For more information, see Section 4.3.2.6 and Section 7.3.

3.5 Heater Plate (Dynamic Oil Sampling System)

The Dynamic Oil Sampling (DOS) system uses controlled heating and passive cooling to stimulate oil movement in front of the sensor to ensure a representative sample is supplied to the sensor at all times.

Heating is achieved using heating resistors mounted on the internal side of the heater plate. The heating power is controlled by a time-proportioning algorithm. This algorithm modulates the temperature around the desired set point. For more information, see Section 4.2.4.

Note: Detection of an open thermistor shuts the heating power off.

Note: The dynamic oil sampling system temperature is limited to 50°C (122°F). A thermal fuse with an 80°C (176°F) rating is located on the base plate and a FUI located on the power supply board to provide protection against any fault from the control circuitry

4 USER INTERFACE & SOFTWARE

The Hydran M2-X's user interface (see below) is located on the front of the electronic card cage. To access it, remove the cover.

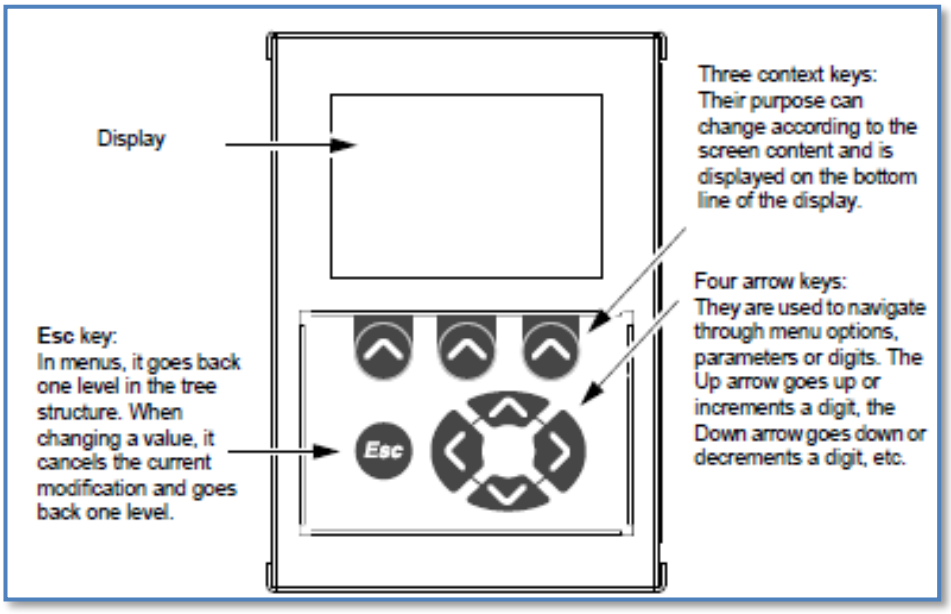


Figure 4-1: User Interface

The user interface allows the use of the Hydran M2-X as a stand-alone unit. It consists of a 128 x 64 pixels, backlit liquid crystal display (LCD) and an eight-key membrane keypad.

- The display requires no manual contrast adjustment and is equipped with temperature compensation. The backlight display allows easy reading of the display at night. When the Hydran M2-X is closed, the display remains visible through a window in the cover. The figure below shows a typical screen.

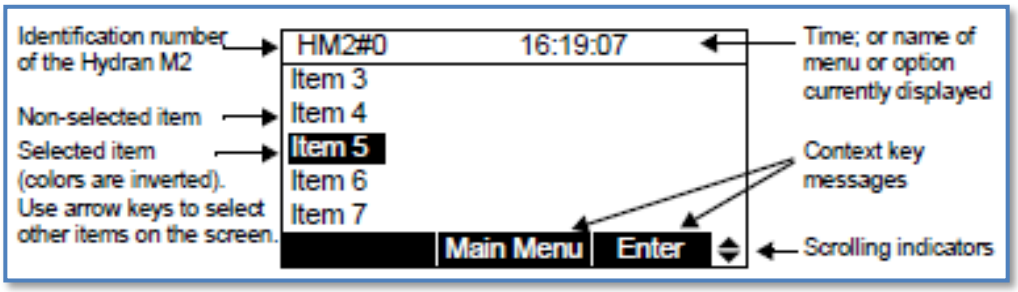


Figure 4-2: Typical Display

- There are eight keys (for more information, see Section 4.1):
  - Three context keys.
  - **Esc**
  - Four arrow keys: Up, Down, Left and Right

Both the display and keypad are designed to function under an extremely wide temperature range.

Note: It is recommended to use the Perception software rather than the Hydran M2-X's user interface (keypad and display; see Figure 4-1*); Only the analog I/O calibration and communication parameters cannot be accessed with the Perception software. All other parameters and commands can be accessed both with the Hydran M2-X's user interface and the Perception software.*

4.1 Using the Keypad Keys

4.1.1.1 Three Context Keys

The purpose of each of these keys can change according to the screen content. Their purpose is displayed on the bottom line of the display, directly above the keys (for an example, see Figure 4-2). A key that is not used will have no bottom line text.

A specific function is always assigned to the same context key. The Table below shows examples of common context keys in the Main Display mode (see Section 4.1.2.3).

Key Name	Key Location	Function
Main Menu	Middle	Return to the top level of the Main Menu
Enter	Right	Enter a submenu
Change	Right	Change the value of a parameter
Ackn.	Right	Acknowledge an alarm
Cancel	Left	Return to the previous value
Accept	Right	Validate the new value

Table 4-1: Examples of Common Context Keys

4.1.1.2 Four Arrow Keys

These keys are used as follows:

- They are used to navigate through options in a menu, parameters in a list or digits of a parameter value. When an item is selected, it is displayed in white on a black background. Use the arrow keys to select other items on the screen: the Up arrow goes up, the Down arrow goes down, etc.
- When changing the value of a parameter, the Up arrow increments the value of the selected digit and the Down arrow decrements it. Press and hold these keys for more than one second to accelerate the rate of increase or decrease.
- Any of the four arrow keys can be used to display the next screen of the Main Display mode (see Section 4.1.2.3).

4.1.1.3 Esc

The **Esc** key is used as follows:

- In the Menu Navigation mode (see Section 4.1.2.2), it is used to return to the preceding level in the menu hierarchy.
- When changing a value, it cancels the current modification and returns to the preceding level.
- It can be used to switch from the Main Display mode to the **Main Menu**, and vice versa.

4.1.2 Operating Modes

The Hydran M2-X's user interface has three operating modes:

- *First priority*: Unacknowledged Alarms mode (see Section 4.1.2.1). In this mode, the Hydran M2-X displays messages of unacknowledged alarms.
- *Second priority*: Menu Navigation mode (see Section 4.1.2.2). In this mode, the user accesses the Hydran M2-X's **Main Menu**'s options, parameters and commands.
- *Third priority*: Main Display mode (see Section 4.1.2.3). In this mode, the Hydran M2-X displays up to four screens of messages:
  - Gas readings and trends.
  - Moisture readings and averages.
  - Readings of the optional analog inputs (present only if one or more analog inputs are installed).
  - List of active alarms.

Note: The Hydran M2-X automatically returns to the Main Display mode if the keypad is not used for five minutes.

4.1.2.1 Unacknowledged Alarms Mode

Note: Alarms are explained in detail in Chapter 7. Alarm messages due to system fault conditions are listed in Section 9.1. Appendix I presents the list of all alarm messages that can be displayed by the Hydran M2-X and that can appear on the Perception software.

In this mode, the display shows the list of detected alarm conditions that have not yet been acknowledged; each displayed screen corresponds to one alarm condition. If two or more unacknowledged alarm conditions are present, the Hydran M2-X rotates through the screens; each one is displayed for five seconds. A screen example is shown in Figure 4-3.

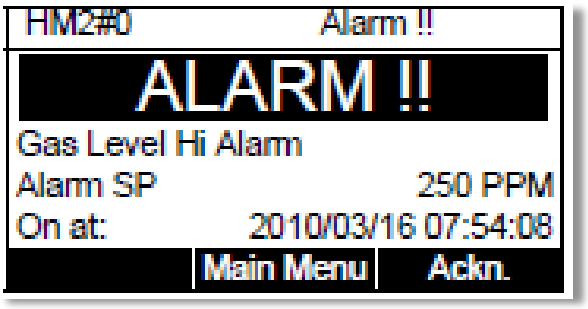


Figure 4-3: Example of Unacknowledged Alarm

Each screen contains:

- The name of the parameter responsible for the alarm.
- The value of this parameter.
- The date and time at which the alarm condition was detected.

The unacknowledged alarm screens are always displayed in priority. When an alarm condition occurs, the Main Display mode is immediately replaced by the Unacknowledged Alarms mode.

An alarm is acknowledged by pressing the **Ackn.** context key while the corresponding message is displayed. When acknowledged, the message is removed. The Hydran M2-X returns to the Main Display mode when all alarms have been acknowledged.

Acknowledged alarms that are still active are shown in a screen of the Main Display mode (see Section 4.1.2.3). When an alarm condition disappears, the corresponding message is removed from the Main Display mode screen.

4.1.2.2 Menu Navigation Mode

In the Menu Navigation mode, the keypad is used to access the **Main Menu**'s options, parameters and commands. The **Main Menu** gives access to *all* Hydran M2-X's parameters and commands To access the **Main Menu** (from the Main Display mode), press the **Main Menu** context key.

Each option of the **Main Menu** is described in detail in Section 4.3 to Section 4.6.

Note: The Hydran M2-X automatically returns to the Main Display mode if the keypad is not used for five minutes.

4.1.2.3 Main Display Mode

This mode is displayed automatically if there are no unacknowledged alarms and the keypad is unused for more than five minutes. To select this mode manually from the **Main Menu**, press the Esc key until screen 1 (described below) of the Main Display mode is reached.

In the Main Display mode, the Hydran M2-X displays four screens of messages:

- *Screen 1* (below) displays gas-related information (for more information, see Section 4.2.8.1):
  - **Gas Level**: The gas level in ppm.
  - **Gas Hourly Tr.:** The gas hourly trend in ppm/x hours.
  - **Gas Daily Tr.:** The gas daily trend in ppm/x days.

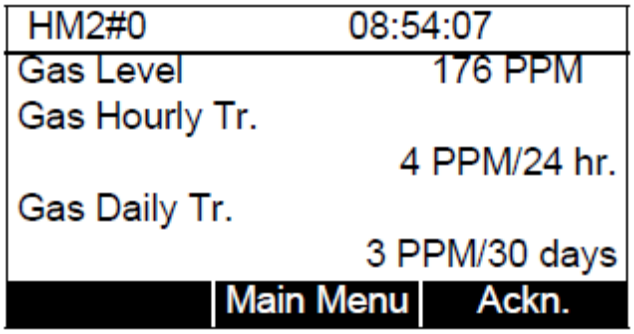


Figure 4-4: Screen 1 of Main Display Mode - Gas Readings Screen

- *Screen 2* (below) displays moisture-related information (for more information, see Section 4.2.8.2):
  - **%RH Level**: The relative humidity in percentage.
  - **Average**: The relative humidity average in percentage.
  - **PPM H2O Level**: The moisture level in ppm.
  - **Average**: The average moisture level in ppm.
  - **Sensor Temp**: The temperature of the sensor in °C.

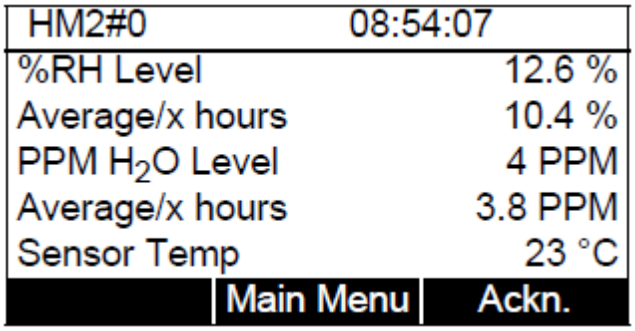


Figure 4-5: Screen 2 of Main Display Mode - Moisture Readings Screen

- *Screen 3* (see following page) displays the readings performed through the optional analog input(s) (if present).

  Note: The I/O names and units values are set in ***Setup > I/O Setup > An. Input Setup > IO#x(In.4-20mA) > Configuration > Identification****.*

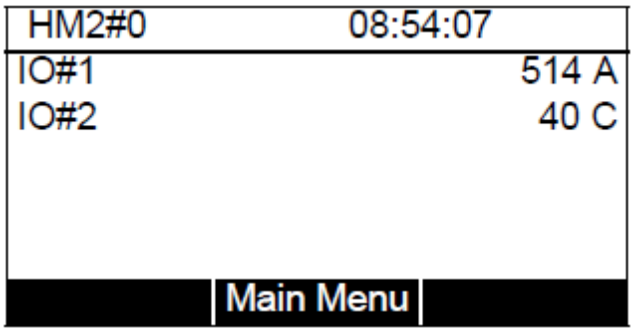


Figure 4-6: Screen 3 of Main Display Mode - Analog Input Readings Screen

Note: The readings of screens 1, 2 and 3 can also be accessed in ***View Readings > Current Readings*** *(see Section 4.4.1).*

- *Screen 4* (see below) displays the list of active alarms. Alarm conditions are listed in this screen only if an alarm occurred, if it was acknowledged and if the alarm condition is still present.

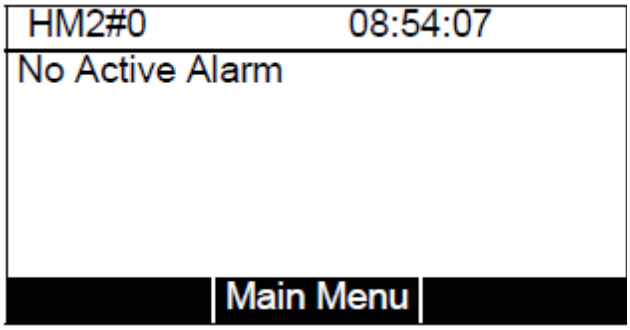


Figure 4-7: Screen4 of Main Display Mode - Active Alarms Screen

4.1.3 Changing the Value of a Parameter

Proceed as follows to change the value of a parameter:

1. Navigate to the desired parameter and press the **Change** context key. There are two possibilities:
   - For numeric parameters, a screen similar to the one shown in Figure 4-8 is displayed. This screen indicates the following information:
     - **Current Value**: Current value of this parameter.
     - **Min Value**: Lowest value at which this parameter can be set.
     - **Max Value**: Highest value at which this parameter can be set.
     - **New Value**: To set a new value for this parameter.

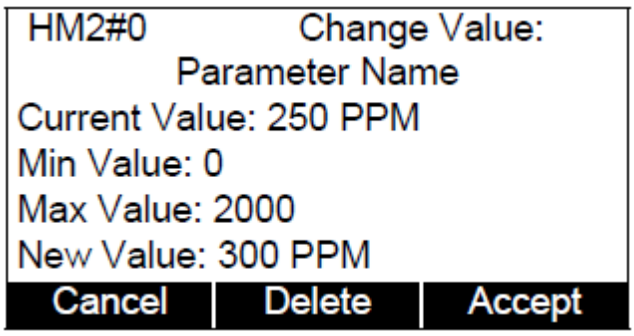


Figure 4-8: Typical Screen for Changing Numeric Parameters

- For alphanumeric parameters, a screen similar to the one shown in Figure 4-9 is displayed. This screen indicates the following information:
  - **Current Value**: Current expression of this parameter.
  - **New Value**: To set a new expression for this parameter.

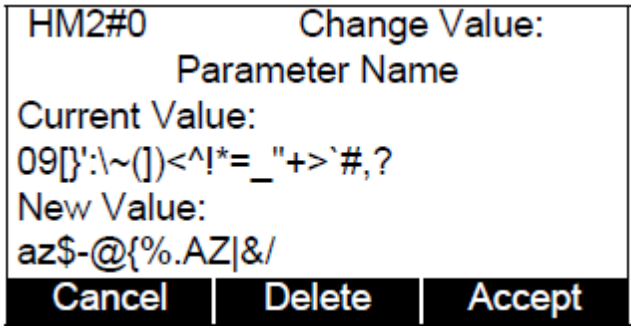


Figure 4-9: Typical Screen for Changing Alphanumeric Parameters

2. Use the Right or Left arrow key to position the cursor on the digit or character to be changed.
3. To change **New Value**, there are three possibilities:
   - For numeric parameters, use the Up or Down arrow key to increment or decrement this digit.
   - For alphanumeric parameters, use the Up or Down arrow key to scroll in ascending or descending order through the list of available characters. See Table 4-1.
   - Press the **Delete** context key to eliminate this digit from the value.

   Note: Press and hold the Up or Down arrow keys for more than one second to accelerate the rate of increase or decrease.
4. Repeat the last step for each digit or character you wish to change. To add digits or characters, press the Right key past the last digit or character.
5. Press the **Accept** context key to validate the new value; you can also press the **Cancel** context key or the **Esc** key to quit the screen and return to the previous value.
6. If the new value is validated using the Accept context key, the message **Value Changed** appears, as shown in Figure 4-10.

   Note: Each parameter has a default value. The Hydran M2-X resets each parameter to its default value when the battery is replaced (see Appendix G) or when the Hydran M2-X's embedded software is upgraded (see Appendix F).

1.	0 to 9	10.	[	19.	}	28.	'
2.	:	11.	\	20.	~	29.	(
3.	;	12.	]	21.	(empty space)	30.	)
4.	<	13.	^	22.	!	31.	*
5.	=	14.	_	23.	"	32.	+
6.	>	15.	`	24.	#	33.	,
7.	?	16.	a to z	25.	$	34.	-
8.	@	17.	{	26.	%	35.	.
9.	A to Z	18.	|	27.	&	36.	/

Table 4-2: List of Available Characters for Alphanumeric Parameters

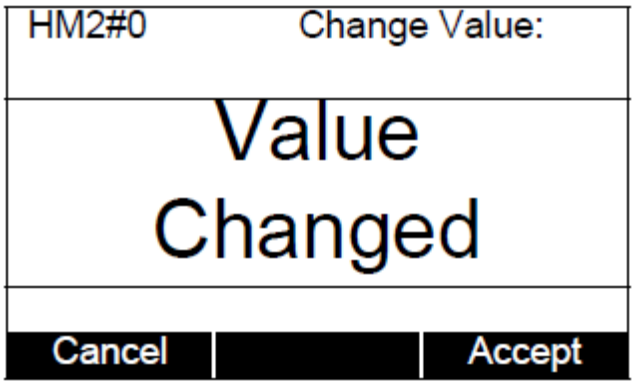


Figure 4-10: Message Value Changed

When an adjustable parameter is highlighted, the word **Change** is displayed above the context key on the right. If the word **Change** is not displayed, this item cannot be changed.

4.1.4 Scrolling Indicators

The Hydran M2-X's display can show up to seven lines of text at a time; if a screen contains more lines, scrolling indicators are displayed in the bottom right corner:

- ▼: Indicates there is at least one item *below* the displayed items. Press the Down arrow until these items are displayed.
- ▲▼: Indicates there is at least one item *above* and *below* the displayed items. Press the Up or Down arrow until these items are displayed.
- ▲: Indicates there is at least one item *above* the displayed items. Press the Up arrow until these items are displayed.

4.1.5 Passwords

The Hydran M2-X's user interface is protected by two passwords. A password is required to modify parameters:

- *Password No. 1 (first level)*: The password No. 1 is **1253**. It gives access to most variable adjustment functions.
- *Password No. 2 (second level)*: The password No. 2 is **1231**. It gives access to the following items:
  - **Setup > Calibration** (to calibrate the Hydran M2-X's I/O's and sensor board).
  - **Service > Install New Sensor** (to enter the sensor parameters).
  - **History Setup > Clear HM2-X History File** (to erase the history files).

Password protection prevents accidental or unauthorized change of the Hydran M2-X's parameters. The passwords should be disclosed to authorized personnel only, particularly password No. 2. The passwords are common to all Hydran M2-X's and cannot be changed.

When the Hydran M2-X requests a password, one of the two following messages is displayed:

- **Password 1?**

:1247

- **Password 2?**

:1247

Use the Up or Down keys to increment or decrement the displayed value, and press the **Enter** context key to accept the value. The user is now authorized to change the protected parameters until he quits the Menu Navigation mode. No password will be requested again unless a higher-level password is required.

Note: All modifications are recorded in the Events history file. See Section 4.4.2.3.

4.2 Setup Menu

4.2.1 Alarms Setup

These functions are identical to the ones in **Alarms > Alarms Setup**. See Section 4.3.2.

4.2.2 Date & Time

The **Date & Time** function is used to change the date and time of the Hydran M2-X.

The internal clock (see Section 3.3.4.2) provides the date and time unless the battery (see Section 3.3.4.1) is disconnected.

4.2.3 Relay Setup

4.2.3.1 Relay Test

The **Relay Test** parameters are used to set the operation mode of each of the five relays. The four operation modes are explained in Section 7.5.3.

4.2.3.2 Relay#1 Setup to Relay#4 Setup

These four options display all alarm conditions assigned to a relay. They are used to assign new alarms, or to remove some, to each of the four alarm relays. Individual alarm conditions can also be assigned to a relay through parameters **Alarm L-L Relay**, **Alarm Low Relay**, **Alarm Hi Relay** and **Alarm Hi-Hi Relay** from **Alarms > Alarms Setup** (see Section 4.3.2).

4.2.4 Temp Setup

The **Temp. Setup** parameters pertain to the operation of the Hydran M2-X's heater plate and dynamic oil sampling system.

- **Temp Set Point**: Set point of the sensor temperature (average target temperature of the heater plate). The default value is 35 °C.
- **Temp SP Modulation**: Temperature variation around the **Temp Set Point**. For example: if **Temp Set Point** is set to the recommended temperature of 35 °C (95 °F) and **Temp SP Modulation** to 10 °C (18 °F), the temperature varies between 30 and 40 °C (86 and 104 °F).
- **Temp Mod. Period**: Modulation period of the temperature variation. If **Temp Mod. Period** is set to 120 minutes (default value) in the above example; it takes 120 minutes for the heater plate temperature to go from 35 to 40 to 35 to 30 to 35 °C (from 95 to 104 to 95 to 86 to 95 °F).

For more information on the dynamic oil sampling system, see Section 3.5.

4.2.5 Calibration

The **Calibration** function is used to calibrate the following analog inputs:

- The gas sensor signal.
- The moisture sensor signal.
- The thermistor in the sensor.
- The thermistors in the heater plate.

CAUTION ***This function is used only for service purposes. Misuse of this function will render the Hydran M2-X inoperative.***

4.2.6 History Setup

The **History Setup** function is used to:

- Set the logging rate parameters of the Short Term and Long Term history files.
- Clear the contents of the history files.

4.2.6.1 History Log Rate

- **Short Term Rate**: Acquisition rate for Short Term recordings. This value can be set from 1 to 360 minute(s), thus spanning a period of 8 hours to 4 months. To change the value, click the arrows of the thumb wheel or type the value directly in the field. The total capacity is 4,760 records; for example:
  - A logging rate of 1 minute provides a capacity of 79 hours.
  - A logging rate of 5 minutes provides a capacity of 16 days.
  - A logging rate of 15 minutes (default value) provides a capacity of 50 days.
  - A logging rate of 60 minutes provides a capacity of 198 days.
  - A logging rate of 360 minutes (6 hours) provides a capacity of 1,190 days (40 months).
- **Long Term #1**, **#2**, **#3** and **#4**: One to four Long Term recordings can be set during one day. To disable a parameter, set it to **00:00**. **Long Term #1** cannot be turned off; **Long Term #2**, **#3** and **#4** however can each be turned off. The logging times must be set in chronological order, **Long Term #1** being the first of the day, **Long Term #2** being the second, etc. The total capacity is 4,760 records; for example:

  - 1 recording per day provides a capacity of 4,760 days (13 years).
  - 2 recordings per day provides a capacity of 2,380 days (6.5 years).
  - 3 recordings per day provides a capacity of 1,587 days (4 years and 4 months).
  - 4 recordings per day provides a capacity of 1,190 days (3 years and 3 months).

  Note: Once changed, the new value takes effect after the completion of the current period.

4.2.6.2 Clear HM2-X History File

The contents of the Short Term, Long Term and Events history files can be individually cleared. Proceed as follows:

1. Select the desired option:

- **Clear Short Term Hist**: To delete the content of the Short Term history file.
- **Clear Long Term Hist**: To delete the content of the Long Term history file.
- **Clear Event Hist**: To delete the content of the Events history file.

2. Press **Ok**. The message **History Cleared** is then displayed.

CAUTION

Clearing a history file deletes its data from the Hydran M2-X. This data cannot be recovered. To keep the data, download it using the Perception software before clearing the file.

4.2.6.3 Clear Sensor Hist File

Clr S.Card#1 Hist: To delete the content of the Sensor history file.

Note: Use this function only if the sensor card is replaced.

4.2.7 Comm Setup

Note: The Hydran M2-X's communication parameters can only be modified using the Hydran M2-X's keypad and display. They cannot be changed using the Perception software.

The **Comm Setup** function is used to:

- Set the network and Hydran M2-X's identification number.
- Set the communication baud rate and other communication parameters.

4.2.7.1 Identification

- **Power Station ID**: Power station's identification number, ranging from 1 to 9999. All Hydran M2-X's belonging to a local network must share the same power station identification number. This number is used when accessing a station remotely or when analyzing and displaying history file data in the Perception software. Each local network must have a different power station identification number.

- **Monitor ID**: Hydran M2-X's identification number, ranging from 1 to 254. An exclusive identification number must be assigned to each Hydran M2-X in a local network. If two Hydran M2-X's share the same number in a local network, they will not be able to communicate properly with the Perception software. The numbers can be assigned sequentially or using any other assignment method preferred by the user; it can be useful to assign numbers that correspond to the identification numbers of the transformers being monitored. For an example, the Table below.

Transformer	Hydran M2-X Monitor ID Parameter
Reserved	1[a]
T1AS	11
T1B	12
T1C	13
T2A	21
T2B	22
T2C	23

a. *At least one Hydran M2-X in a local network must be set to an identification number between 1 and 5 (inclusively).*

Table 4-3: Setting Example for Identification Numbers

Both identification numbers must be identical to those assigned to the same Hydran M2-X's and power station in the Perception software.

Note: The identification numbers of each Hydran M2-X must be kept on record for reference.

CAUTION ***The identification number of at least one Hydran M2-X in a local network must be set between1 and 5 (inclusively).***

4.2.7.2 Baud Rate and Other Parameters

- **RS-232 Baud Rate**: Baud rate of the RS-232 serial communication link (DB-9 connector). The available rates are: 1,200, 2,400, 4,800, 9,600, 19,200, 38,400, 57,600 or 115,200 bps (bits per second). The Perception software must be set to the same baud rate value.

Note: All Hydran M2-X's in a local network must be set to the same data communication speed. The recommended speed is 9,600 bps.

- **RS-485 Baud Rate**: Baud rate of the RS-485 serial communication link. The available rates are: 1,200, 2,400, 4,800, 9,600, 19,200, 38,400, 57,600 or 115,200 bps (bits per second); the default rate is 19,200 bps. All Hydran M2-X's belonging to one network must be set to the same baud rate.

- **RS232<->RS485 Bridge**: To enable or disable communications with the local network. Press **Change** to switch from **Enabled** to **Disabled**:
  - If **Enabled** (default value), the laptop computer connected to the DB-9 connector of a Hydran M2-X can communicate with all Hydran M2-X's in the RS-485 local network.

  - If **Disabled**, the laptop computer can only communicate with the Hydran M2-X to which it is connected.
- **Modem Dial String**: When an alarm condition is detected and the **Call on Alarm** mode is selected, the Hydran M2-X will send the **Modem Dial String** to the modem. The default string sent is: *ATDS0*. For information on how to change an alphanumeric parameter, see Section 4.1.3. This string could be changed, if needed, in function of the modem used.

4.2.8 Readings Setup

4.2.8.1 Gas Reading Setup

- **Daily Tr. Period**: Period of the daily trend (number of days used to calculate the gas daily trend). Increasing the period decreases the normal fluctuations of the readings, but increases the response time.
- **Hourly Tr. Period**: Period of the hourly trend (number of hours used to calculate the gas hourly trend). Increasing the period decreases the normal fluctuations of the readings, but increases the response time.
- **Hydran PPM Period B**: Part of the dynamic oil sampling system.

For information on the hourly and daily trends, see Section 7.2.5.

4.2.8.2 H_20 Reading Setup

- **%RH Average**: Time (in hours) used to calculate the **%RH Hourly Avg.** value.
- **PPM H_2O Avg.**: Time (in hours) used to calculate the **PPM H_2O Hr. Avg.** value.

These values are accessible in two menus:

- In **View Readings > Current Readings > H_2O Readings**.
- In the moisture readings screens of the Main Display mode (see Section 4.1.2.3). In these screens, both values are named **Average**.

4.2.8.3 Sensor Temp Avg Per

Time (in hours) used to calculate the **View Readings > Current Readings > Temp**. **Readings > Sensor Temperature Avg**. value.

4.2.9 I/O Setup

The **I/O Setup** function is used to configure the optional I/O interfaces. For more information, see item 3 on page 28.

4.2.9.1 Analogue Input Setup

The **An. Input Setup** function is used to set up the optional analog inputs module.

- **Input1**, **Input2**, ...: To select the desired I/O**.**
- **IO State**: Actual input signal expressed as a percentage of full scale**.**
- **Analog Input**: Actual reading name. The name for this value is set in **Setup > I/O Setup >An. Input Setup > IO#*x*(In.4-20mA) > Configuration > Identification > Input Name.**
- **Sample Rate**: To set the frequency at which the signal is sampled. The readings are updated immediately after each sample.
- **An. Input Calibration**: To calibrate the analog input signal.
- **Configuration:**
  - **Identification:**
    - **Input Name**: This name is used to indicate the actual reading (see above).
    - **Input Short Name**: This name is used as the first part of an option name in **Alarms > Alarms Setup**, in **Setup > Alarms Setup** and in **Setup > I/O Setup > An. Input Setup > IO#*x*(In.4-20mA) > Alarm Setup**. It is always followed by **Alarm Setup**. For example, if **Input Short Name** is set to **I/O#1**, the option name would be **I/O#1 Alarm Setup**.
    - **Input Units**: This name is used to the right of the actual reading. For example, this parameter can be set to "C" to indicate °C.
  - **Reading Setup:**
    - **Reading Precision**: Number of decimals to be displayed. This value is used when displaying the actual reading for this analog input.
    - **Input Min.**: Minimum possible value for the range of this analog input. This value corresponds to a current of 4 mA. Refer to the sensor specifications.
    - **Input Max.:** Maximum possible value for the range of this analog input. This value corresponds to a current of 20 mA. Refer to the sensor specifications.

    *Note: For example, the reading range of a Magnetic-Mount Temperature Transmitter (part number 13298) is -40 to 150 ºC. For this sensor, the **Input Min.** parameter would be set to -40 ºC and **Input Max.** to 150 ºC.*

    - **Input Resolution:** Degree to which the result of the reading approximates the true reading. Set this parameter only if discrete values need to be displayed (for example, in the case of a tap changer position); otherwise, it is set to 0.
  - **Alarm Setup**: These parameters are identical to the ones in **Alarms > Alarms Setup > Analog Input Alarm Setup**. See Section 4.3.2.5.

4.2.9.2 Analogue Output Setup

The **An. Output Setup** function is used to set up the optional analog output signal.

- **Analog State**: Displays the state of the Hydran M2-X's analog output as a percentage of the maximum electric current. The analog output provides the gas level being measured; the displayed percentage is thus directly proportional to the gas level. For details on the analog output, see Section 3.3.2 and Appendix K.1.
- **Analog Mode**: To set the operation mode of the analog output. The three **Force x %** modes are used only to test the operation of the Hydran M2-X.

Table 4-4 shows the electrical current generated for each mode.

Type of Output	Operation Mode		
	Force 0 %	Force 50 %	Force 100 %
4–20 mA	4.00 ± 0.10 mA	12.00 ± 0.20 mA	20.00 ± 0.40 mA

Table 4-4: Electrical Current Generated by the Analog Output for Each Operation Mode

4.2.9.3 TDM Output Setup

The **TDM Output Setup** function is used to set up the TDM output signal. The TDM signal is monitored by a Hydran 201C*i*-1 or Hydran 201C*i*-4 Controller.

- **IO State**: Displays the state of the TDM signal in percentage. The displayed percentage by **IO State** is thus directly proportional to the gas level (% output = ppm/20; 2,000 ppm = 100 %).
- **IO Mode**: Used to set the operation mode of the TDM signal. The three **Force x %** modes are used only to test the operation of the TDM signal.
- **Comm #2 TDM Relay A**: Used to select a first relay. The state of this relay will be transmitted in the TDM signal.
- **Comm #2 TDM Relay B**: Used to select a second relay. The state of this relay will be transmitted in the TDM signal.
- **Sample Rate**: To set the frequency at which the signal is updated.
- **Configuration:**
  - **Reading To Output**: Indicates the value to transmit with the TDM signal. There are four choices: **%RH Level**, **PPM H2O Level**, **Gas Level** and **None**. If the TDM signal is connected to a Hydran 201C*i* controller, you must select **Gas Level**.
  - **Input Min.**: Indicates the minimum of the value to transmit.
  - **Input Max.**: Indicates the maximum of the value to transmit.

4.3 Alarms Menu

4.3.1 Current Alarms

The **Current Alarms** function displays the list of active alarm conditions. An alarm condition is listed only if it is not acknowledged or if the alarm condition is present. Press any arrow key to rotate through the list of current alarms. Each displayed screen corresponds to one alarm condition. If two or more alarm conditions are present, the Hydran M2-X scrolls through the screens, each one being displayed for five seconds. A screen example is shown below.

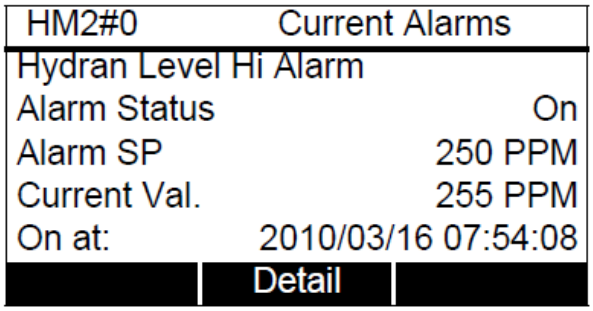


Figure 4-11: Example of Current Alarms

Each screen contains the following information:

- The name of the parameter responsible for the alarm.
- **Alarm Status**: The status of this alarm, which can be **Not ack.**, **On** or **Off.**
- **Alarm SP**: The set point of this alarm**.**
- **Current Val.**: The value currently measured**.**
- **On at**: .The date and time at which the alarm condition was detected.

4.3.2 Alarms Setup

The **Alarms Setup** functions are used to set the alarm parameters.

The operation of the relays and alarms is described in Chapter 6. In summary, an alarm is triggered if the alarm condition (value of parameter **Alarm Hi SP** or **Alarm Hi-Hi SP**) is *exceeded* for a period of time greater than the corresponding delay (parameter **Alarm Delay**); when an alarm condition is detected, the relay assigned to this alarm condition (parameters **Alarm Hi Relay** and **Alarm Hi-Hi Relay**) is activated.

The parameters in **Alarms Setup** are also located in **Setup > Alarms Setup**.

4.3.2.1 Hydran Alarms Setup

- The **Hydran Alarm Setup** functions give access to the parameters of the gas alarm conditions:
  - **Alarm Hi SP**: Set point of the gas level High alarm condition.
  - **Alarm Hi-Hi SP**: Set point of the gas level High-High alarm condition.
  - **Alarm Delay**: Alarm delay for both set points.
  - **Alarm Hi Relay**: Relay activated when a gas level High alarm condition is detected.
  - **Alarm Hi-Hi Relay**: Relay activated when a gas level High-High alarm condition is detected.
- **Hydran Hourly Trend Alarm**: Gives access to the hourly trend High and High-High alarm parameters:
  - **Alarm Hi SP**: Set point of the hourly trend High alarm condition.
  - **Alarm Hi-Hi SP**: Set point of the hourly trend High-High alarm condition.
  - **Alarm Delay**: Alarm delay for both set points. This delay is calculated in percentage of the hourly trend period; see parameter **Hourly Tr. Period** in **Setup > Reading Setup > Gas Reading Setup** in Section 4.2.8.1.

  - **Alarm Hi Relay**: Relay activated when a gas hourly trend High alarm condition is detected.
  - **Alarm Hi-Hi Relay**: Relay activated when a gas hourly trend High-High alarm condition is detected.
- **Hydran Daily Trend Alarm**: Gives access to the daily trend High and High-High alarm parameters:
  - **Alarm Hi SP**: Set point of the daily trend High alarm condition.
  - **Alarm Hi-Hi SP**: Set point of the daily trend High-High alarm condition.
  - **Alarm Delay**: Alarm delay for both set points. This delay is calculated in percentage of the daily trend period; see parameter **Daily Tr. Period** in **Setup > Reading Setup > Gas Reading Setup** in Section 4.2.8.1.
  - **Alarm Hi Relay**: Relay activated when a gas daily trend High alarm condition is detected.
  - **Alarm Hi-Hi Relay**: Relay activated when a gas daily trend High-High alarm condition is detected.
- **Hydran Sensor Temp Alarm**: See **Alarms Setup > Temp. Alarm Setup > Sensor Temp. Alarm** in Section 4.3.2.3.

Note: Each alarm of the Hydran M2-X can be assigned to any one of the four relays (1 to 4). More than one alarm can be assigned to a same relay. Appendix I presents the list of all alarm messages that can appear in the Perception software.

4.3.2.2 Moisture Alarms Setup

The **Moisture Alarm Setup** functions give access to the parameters of the moisture alarm conditions:

- **%RH Level Alarm**: Gives access to the %RH moisture level High and High-High alarm parameters:
  - **Alarm Hi SP**: Set point of the relative humidity High alarm condition.
  - **Alarm Hi-Hi SP**: Set point of the relative humidity High-High alarm condition.
  - **Alarm Delay**: Alarm delay for both set points.
  - **Alarm Hi Relay**: Relay activated when a relative humidity High alarm condition is detected.
  - **Alarm Hi-Hi Relay**: Relay activated when a relative humidity High-High alarm condition is detected.
- **H2O PPM Level Alarm**: Gives access to the ppm moisture level High and High-High alarm parameters:
  - **Alarm Hi SP**: Set point of the ppm moisture level High alarm condition in ppm.
  - **Alarm Hi-Hi SP**: Set point of the ppm moisture level High-High alarm condition in ppm.
  - **Alarm Delay**: Alarm delay for both set points.
  - **Alarm Hi Relay**: Relay activated when a moisture level High alarm condition is detected.
  - **Alarm Hi-Hi Relay**: Relay activated when a moisture level High-High alarm condition is detected.
- **%RH Hourly Average Alarm**: Gives access to the relative humidity average High and High-High alarm parameters:

- **Alarm Hi SP**: Set point of the relative humidity average High alarm condition.
- **Alarm Hi-Hi SP**: Set point of the relative humidity average High-High alarm condition.
- **Alarm Delay**: Alarm delay for both set points. T his delay is calculated using parameter **%RH Average** in **Setup > Reading Setup > H2O Reading Setup**; see Section 4.2.8.2.
- **Alarm Hi Relay**: Relay activated when a relative humidity average High alarm condition is detected.
- **Alarm Hi-Hi Relay**: Relay activated when a relative humidity average High-High alarm condition is detected.

- **H2O PPM Hourly Average Alarm**: Gives access to the average ppm moisture level High and High-High alarm parameters:
  - **Alarm Hi SP**: Set point of average ppm moisture level High alarm condition in ppm.
  - **Alarm Hi-Hi SP**: Set point of average ppm moisture level High-High alarm condition in ppm.
  - **Alarm Delay**: Alarm delay for both set points. This delay is calculated using parameter **PPM H2O Avg.** in **Setup > Reading Setup > H2O Reading Setup**; see Section 4.2.8.2.
  - **Alarm Hi Relay**: Relay activated when an average moisture level High alarm condition is detected.
  - **Alarm Hi-Hi Relay**: Relay activated when an average moisture level High-High alarm condition is detected.

  Note: Appendix I *presents the list of all alarm messages that can appear in the Perception software.*

4.3.2.3 Temperature Alarms Setup

- **Hydran Sensor Temp Alarm**: Gives access to the sensor temperature Low-Low, Low, High and High-High alarm parameters:
  - **Alarm Low-Low SP**: Set point of the sensor temperature Low-Low alarm condition.
  - **Alarm Low SP**: Set point of the sensor temperature Low alarm condition.
  - **Alarm Hi SP**: Set point of the sensor temperature High alarm condition.
  - **Alarm Hi-Hi SP**: Set point of the sensor temperature High-High alarm condition.
  - **Alarm Delay**: Alarm delay, in minutes, for all above set points.
  - **Alr C. Open Relay**: Relay activated when a sensor temperature Low-Low alarm condition is detected.
  - **Alarm Low Relay**: Relay activated when a sensor temperature Low alarm condition is detected.
  - **Alarm Hi Relay**: Relay activated when a sensor temperature High alarm condition is detected.
  - **Alr C. Short Relay**: Relay activated when a sensor temperature High-High alarm condition is detected.
- **Base Plate Temp Alarm**: Gives access to the base plate temperature Low-Low, Low, High and High-High alarm parameters:

- **Alarm Low-Low SP**: Set point of the base plate temperature Low-Low alarm condition.
- **Alarm Low SP**: Set point of the base plate temperature Low alarm condition.
- **Alarm Hi SP**: Set point of the base plate temperature High alarm condition.
- **Alarm Hi-Hi SP**: Set point of the base plate temperature High-High alarm condition.
- **Alarm Delay**: Alarm delay, in minutes, for all above set points.
- **Alr C. Open Relay**: Relay activated when a base plate temperature Low-Low alarm condition is detected.
- **Alarm Low Relay**: Relay activated when a base plate temperature Low alarm condition is detected.
- **Alarm Hi Relay**: Relay activated when a base plate temperature High alarm condition is detected.
- **Alr C. Short Relay**: Relay activated when a base plate temperature High-High alarm condition is detected.

Note: Appendix I presents the list of all alarm messages that can appear in the Perception software.

4.3.2.4 Battery Alarm Setup

The **Battery Alarm Setup** functions give access to the battery's alarm parameters:

- **Alarm Low-Low SP**: Set point of the battery voltage Low-Low alarm condition.
- **Alarm Low SP**: Set point of the battery voltage Low alarm condition.
- **Alarm Delay**: Alarm delay for both set points.
- **Alarm L-L Relay**: Relay activated when a battery Low-Low alarm condition is detected.
- **Alarm Low Relay**: Relay activated when a battery Low alarm condition is detected.

Note: Do not adjust without consulting the General Electric Customer Service (the coordinates can be found at the bottom of page 2).

A battery alarm is triggered if the voltage of the battery is *below* the Low or Low-Low set point for a period of time longer than the delay. For details, see Section 7.3.2.3.

Note: Appendix I presents the list of all alarm messages that can appear in the Perception software.

For explanations pertaining to the Hydran M2-X's battery, see Section 3.3.4.1; for the battery specifications, see Section 10.3.1; to replace the battery, see Appendix G.

4.3.2.5 Analog Input Alarm Setup

The first part of this function name (Analog Input) is set in **Setup > I/O Setup > An. Input Setup > IO#*x*(In.4-20mA) > Configuration > Identification >Input Short Name**.

There is one **Analog Input Alarm Setup** function for each input interface installed on the Hydran M2-X.

The **Analog Input Alarm Setup** function gives access to the alarm parameters for each optional input interface:

- **Alarm Low-Low SP**: Set point of the Low-Low alarm condition.
- **Alarm Low SP**: Set point of the Low alarm condition.
- **Alarm Hi SP**: Set point of the High alarm condition.
- **Alarm Hi-Hi SP**: Set point of the High-High alarm condition.
- **Alarm Delay**: Alarm delay for all set points.
- **Alarm L-L Relay**: Relay activated when a Low-Low alarm condition is detected.
- **Alarm Low Relay**: Relay activated when a Low alarm condition is detected.
- **Alarm Hi Relay**: Relay activated when a High alarm condition is detected.
- **Alarm Hi-Hi Relay**: Relay activated when a High-High alarm condition is detected.

4.3.2.6 System Fault Trigger

The **Sys. Fault Trigger** parameters are used to disable (**Off**) or enable (**On**) each system fault condition. Press the **Change** context key to enable or disable a condition. The disabled (**Off**) system faults:

- Do not trigger the Unacknowledged Alarms mode (see Section 4.1.2.1).
- Are not listed in **Alarms > Current Alarms**.

4.3.3 Alarm History

The data displayed in **Alarm History** is identical to the one in **View Readings > View History Data > Alarm History**. See Section 4.4.2.5.

4.4 View Readings Menu

4.4.1 Actual Readings

4.4.1.1 Temperature Readings

- **Sensor Temp**: Actual temperature of the sensor, in °C.
- **Sensor Temp Avg**: Average temperature of the sensor, in °C. The period used to calculate this value is set with parameter **Sens. Temp Avg Per.** in **Setup >Readings Setup** (see Section 4.2.8.3).
- **Heater Plate Temp**: Actual temperature of the heater plate, in °C.
- **Heater Power**: Actual heating power of the heater plate, in percentage of the maximum power.
- **Temp SP Current**: Actual temperature control set point (part of the dynamic oil sampling system).

4.4.1.2 Gas Readings

The gas readings displayed are the same as the ones shown in the Main Display mode.

- **Gas Level**: Actual reading of gas level, in ppm.
- **Gas Hourly Tr.**: Actual gas hourly trend, in ppm/x hours. Parameter **Hourly Tr. Period.** (in **Setup > Readings Setup > Gas Reading Setup**) specifies the period used to calculate this trend (see Section 4.2.8.1).
- **Gas Daily Tr.**: Actual gas daily trend, in ppm/x days. Parameter **Daily Tr. Period** (in **Setup > Readings Setup > Gas Reading Setup**) specifies the period used to calculate this trend (see Section 4.2.8.1).
- **Sensor Temp**: Actual temperature of the sensor, in °C.
- **Gas ServiceU**: Value of **ServiceU** variable.
- **Gas ServiceV**: Value of **ServiceV** variable.

4.4.1.3 Moisture Readings

- **%RH Level**: Actual level of relative humidity.
- **PPM H_2O Level**: Actual reading of moisture, in ppm.
- **Sensor Temp**: Actual temperature of the sensor, in °C.
- **%RH Hourly Avg.**: Relative humidity average. Parameter **%RH Average** (in **Setup > Reading Setup > H_2O Reading Setup**) specifies the period used to calculate this average; see Section 4.2.8.2.
- **PPM H_2O Hr. Avg.**: Average ppm moisture level. Parameter **PPM H_2O Avg.** (in **Setup > Reading Setup > H_2O Reading Setup**) specifies the period used to calculate this average (same as %RH); see 4.2.8.2.
- **Sensor Temp Avg.**: Average temperature of the sensor, in °C. The period used to calculate this value is set with parameter **Sens. Temp Avg Per.** in **Setup > Readings Setup** (see Section 4.2.8.3).
- **H_2O Cell mV**: Voltage of the electrical signal currently sent by the moisture sensor.

4.4.2 View History Data

The Hydran M2-X has an internal function that automatically records information such as gas and moisture levels, trend values, alarm messages and setup parameters. This information is stored in four sections, which are collectively referred to as *history files*.

The **View History Data** functions are used to consult the four history files:

- Short Term (recording at a fixed logging rate; example: every 15 minutes)
- Long Term (recording at fixed logging rates; example: each day at midnight)
- Events (recording at the time of events; example: alarms)
- Service (recording at the time of the semimonthly, automatic sensor test)

The maintenance procedure in Section 10 shows how the data of the history files can be used.

4.4.2.1 Short Term History

The **Short Term History** function gives access to the Short Term history file. From 1 to 360 minutes (adjustable; see parameter **Short Term Rate** in **Setup > History Setup > History Log Rate** [see Section 4.2.6.1]), the date and time plus several values are logged in this file. Its capacity is 4,760 records (if equipped with four analog input inter-faces); when the file is full, a new record erases the oldest one in a first in, first out method.

The following variables are recorded in the Short Term history file (this list is identical for the Long Term and Event history files):

- Gas level in ppm.
- Service U.
- Hourly trend in ppm/x hours (default value is 24 hours).
- Daily trend in ppm/x days (default value is 30 days).
- Service V.
- Relative humidity level in %.
- Relative humidity average in %/x hours.
- Moisture level in ppm.
- Moisture average in ppm/x hours.
- H_2O cell signal in V (microvolts).
- Heater plate temperature in ˚C.
- Heater plate output power in percentage.
- Sensor temperature in ˚C.
- Sensor temperature average in ˚C.
- Readings or output of optional I/O #1 to #4.

Navigation is performed as follows:

1. From **Short Term History**, press **Enter** to read the date and time of the last event recorded in the Short Term history file.
2. Press the Up or Down arrow keys to read the date and time of previous or next recordings.
3. Press **Enter** and the Up or Down keys to read the value of the variables at the selected date and time.

4.4.2.2 Long Term History

The **Long Term History** function gives access to the Long Term history file. From one to four times per day (adjustable; see parameter **Long Term Rate** in **Setup > History Setup > History Log Rate** [see Section 4.2.6.1]), the date and time plus several values are stored in this file. Its capacity is 4,760 records (if equipped with four analog input interfaces); when the file is full, a new record erases the oldest one in a first in, first out method.

Navigation in this file is performed as in the Short Term history file. The values recorded in the Long Term history file are also identical. See Section 4.4.2.1.

4.4.2.3 Event History

The **Event History** function gives access to the Events history file. When an event occurs, the date and time of occurrence, an event message and several values are stored in this file. Its capacity is 3,120 records (if equipped with four analog input interfaces); when the file is full and a new recording occurs, the oldest recording is deleted (first in, first out method). All event messages and their description are provided in Appendix H.

The following events are recorded:

- An alarm is triggered.
- An alarm is acknowledged by a user.
- An alarm is cancelled (the alarm condition has disappeared).
- A parameter is changed by a user.
- The date and time are set.
- A new sensor is installed.
- The Hydran M2-X is calibrated.
- A power-up or a shutdown occurs.
- The Hydran M2-X is put in service (first power-up).
- The self-test sequence has failed during power-up.
- The microprocessor is reset by the internal watchdog.

Navigation in this file is performed as in the Short Term history file. The values recorded in the Events history file are the same as the ones recorded in the Short Term file. See Section 4.4.2.1.

4.4.2.4 Service History

The **Service History** function gives access to the Service history file.

The Hydran M2-X performs a self test of its sensor on the first and fifteenth days of each month at midnight (fixed logging rate, non adjustable). After each test, the date and time of the test plus several variables are recorded in the Service history file. Its capacity is 1,470 records (if equipped with four analog input interfaces); when the file is full and a new recording occurs, the oldest recording is deleted (first in, first out method). The Service history file may be required for maintenance or trouble shooting purposes.

Navigation in this file is performed as in the Short Term history file. The values recorded in the Service history file are the same as the ones recorded in the Short Term file. See Section 4.4.2.1.

4.4.2.5 Alarm History

Navigation in this file is performed as in the Short Term history file. The values recorded in the Service history file are the same as the ones recorded in the Short Term file. See Section 4.4.2.1.

4.4.3 Date & Time

This function is identical to the one in **Setup > Date & Time**. See Section 4.2.2.

4.5 Test Menu

4.5.1 Sensor Test

The **Sensor Test** function is an internal diagnostic test that is initiated automatically for approximately 5 seconds, twice per month (on the 1st and 15th) to characterise the sensor performance. Upon completion of the test, the internal sensor test results will automatically update and are stored in the unit's Service history files.

If the internal sensor signal is within optimal range, the display on the M2-X will show **Good**, indicating that the sensor is operating as expected. No message will be recorded in the Events history file.

If the internal sensor signal is no longer optimal, the M2-X will trigger a sensor alarm indicating that there is an issue with the sensor and the corresponding alarm message will be displayed on the M2-X display. The Events history file will be updated with the appropriate message.

Note 1: All alarms are ignored for two minutes following a sensor test.

Note 2: In addition to the automatic sensor test that is initiated semi-monthly at midnight, the sensor test can also be initiated manually via the local keypad. For each automatic sensor test, certain parameters are recorded in the Service history file (see Section 4.4.2.4) for further analysis by General Electric.

4.5.1.1 Sensor Test Results

The alarm messages that can be displayed following a sensor test are shown in the Table below. For the troubleshooting procedure for each of these alarms, see Section 9.1.

Message	Significance
Good	Sensor operating as expected.
Replace Sensor Alarm	Sensor Test results outside optimal operating range. Sensor must be replaced.
Cable Open	Cable disconnected, misconnected or defective.
Cable Short	Sensor Cable misconnected or short-circuited.
Sensor Not Installed!	Unable to perform the test. Install Sensor.

Table 4-5: Messages that can be Displayed Following a Sensor Test

***Note**: The Hydran M2-X is equipped with a provisional alarm called the "Sensor Caution Alarm". By default, this alarm is disabled, but can be enabled by the user to give early notification of a potential impending issue with the sensor. If the "Sensor Caution Alarm" is subsequently raised, it signifies that the "Replace Sensor Alarm" is likely to occur soon. Users may wish to verify the DGA reading through comparison with a manual sample.*

4.5.2 Relay Test

The **Relay Test** parameters are used to set the operation mode of each of the five relays. The four operation modes are explained in Section 7.5.3.

The same parameters can be accessed in **Setup > Relay Setup > Relay Test**. See Section 4.2.3.1.

4.6 Service Menu

4.6.1 Sensors Parameters

4.6.1.1 Gas Sensor Param

The **Gas Sensor Param** function gives access to the parameters of the gas sensor. Each gas sensor has its own set of parameter values; the values are indicated on the Test Certificate and Data Sheet (for an example, see Figure 4-12) supplied with the Hydran M2-X. These options do not allow you to modify the displayed values. To change the values, use **Install New Sensor** (see Section 4.6.2).

The gas sensor parameters are:

- **Gas Serial No.**: Serial number of the sensor (engraved under the sensor connector). The same serial number is used for the gas sensor and humidity sensor.
- **B**, **M**, **N**, **S** and **A1** to **A6**: The ten parameters of the gas sensor in a normalized format (integer numbers).

  - The Hydran M2-X computes the gas level in ppm by performing two readings: the sensor temperature (provided by the thermistor incorporated in the sensor) and the gas sensor output (gas level). The calculation also requires these ten parameters (from **B** to **A6**).
  - These ten parameters characterize the behavior of the gas sensor by modeling its response according to the temperature.
  - The values of these ten parameters are stored in the Hydran M2-X's nonvolatile memory (see Section 3.3.4.3).
- **Gas Param CkSum**: Checksum of the above values. This value is added to the list to avoid erroneous values from being entered.

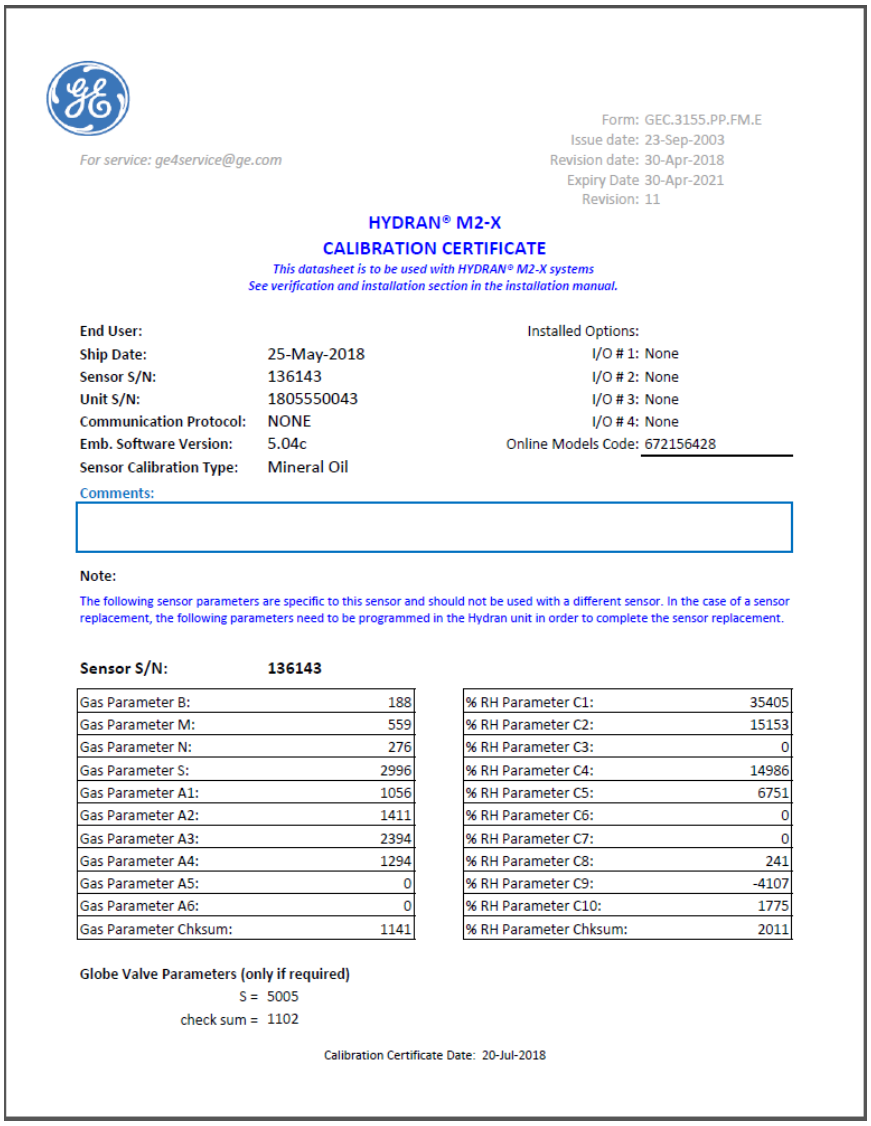
Note: The Hydran M2-X uses the proven technology of the Hydran M2-X sensor. For a complete description, see Section 3.4.

4.6.1.2 H_2O Sensor Param

The **H2O Sensor Param** function gives access to the parameters of the moisture sensor. Each moisture sensor has its own set of parameter values; the values are indicated on the Test Certificate and Data Sheet (for an example, see Figure 4-12) supplied with the Hydran M2-X. These options do not allow you to modify the displayed values. To change the values, use **Install New Sensor** (see Section 4.6.2).

- **H2O SerialNo.**: Serial number of the sensor (engraved under the sensor connector). The same serial number is used for the gas sensor and humidity sensor.
- **H_2O Param C1** to **C10**: The ten parameters of the moisture sensor in a normalized format (integer numbers).
  - The Hydran M2-X computes the moisture level in ppm by performing two readings: the sensor temperature (provided by the thermistor incorporated in the sensor) and the moisture sensor output (moisture level). The calculation also requires these ten parameters (from **C1** to **C10**).
  - These ten parameters characterize the behavior of the moisture sensor by modeling its response according to the temperature.
  - The values of these ten parameters are stored in the Hydran M2-X's nonvolatile memory (see Section 3.3.4.3).
- **H_2O Param CkSum**: Checksum of the above values. This value is added to the list to avoid erroneous values from being entered.

Note: The Hydran M2-X uses the proven technology of the Hydran M2-X sensor. For a complete description, see Section 3.4.



For service: ge4service@ge.com

Form: GEC.3155.PP.FM.E
Issue date: 23-Sep-2003
Revision date: 30-Apr-2018
Expiry Date 30-Apr-2021
Revision: 11

HYDRAN® M2-X
CALIBRATION CERTIFICATE

This datasheet is to be used with HYDRAN® M2-X systems
See verification and installation section in the installation manual.

End User:		Installed Options:	
Ship Date:	25-May-2018	I/O # 1:	None
Sensor S/N:	136143	I/O # 2:	None
Unit S/N:	1805550043	I/O # 3:	None
Communication Protocol:	NONE	I/O # 4:	None
Emb. Software Version:	5.04c	Online Models Code:	672156428
Sensor Calibration Type:	Mineral Oil		

Comments:

Note:

The following sensor parameters are specific to this sensor and should not be used with a different sensor. In the case of a sensor replacement, the following parameters need to be programmed in the Hydran unit in order to complete the sensor replacement.

Sensor S/N: **136143**

Gas Parameter B:	188	% RH Parameter C1:	35405
Gas Parameter M:	559	% RH Parameter C2:	15153
Gas Parameter N:	276	% RH Parameter C3:	0
Gas Parameter S:	2996	% RH Parameter C4:	14986
Gas Parameter A1:	1056	% RH Parameter C5:	6751
Gas Parameter A2:	1411	% RH Parameter C6:	0
Gas Parameter A3:	2394	% RH Parameter C7:	0
Gas Parameter A4:	1294	% RH Parameter C8:	241
Gas Parameter A5:	0	% RH Parameter C9:	-4107
Gas Parameter A6:	0	% RH Parameter C10:	1775
Gas Parameter Chksum:	1141	% RH Parameter Chksum:	2011

Globe Valve Parameters (only if required)

S = 5005
check sum = 1102

Calibration Certificate Date: 20-Jul-2018

Figure 4-12: Test Certificate

4.6.2 Install New Sensor

4.6.2.1 New Gas Sensor

This function is very similar to **Gas Sensor Param** (see Section 4.6.1.1), except that **New Gas Sensor** allows to change the values of the gas sensor parameters.

Enter the new value of each parameter and press the **Change** context key. The sensor is then immediately tested and the result (**Good** or else) is displayed after a few seconds. For details, see Section 4.5.1.

CAUTION ***Do not change these values unless you are installing a new sensor.***

4.6.2.2 New H_2O Sensor

This function is very similar to **H_2O Sensor Param** (see Section 4.6.1.2), except that **New H_2O Sensor** allows to change the values of the moisture sensor parameters.

Enter the new value of each parameter and press the **Change** context key. The sensor is then immediately tested and the result (**Good** or else) is displayed after a few seconds. For details, see Section 4.5.1.

CAUTION	***Do not change these values unless you are installing a new sensor.***

4.6.3 Sensor Test

The **H2 Sensor Test** function is identical to the one in **Test > Sensor Test** (see Section 4.5.1).

4.6.4 View Service Data

This function is used to read the value of internal parameters used by the General Electric personnel during the Hydran M2-X maintenance or troubleshooting procedures.

4.6.5 System Config

4.6.5.1 Current Config

- **Comm#1**: There is no device currently connected to the communication port #1 of the controller board.
- **Comm#2**: The TDM and RS-485 link board is currently connected to the communication port #2 of the controller board.
- **IO#1**: Used to connect one of the three types of optional I/O interfaces (analog input, 4-20 mA analog output or TDM signal).
- **IO#2**: Same as **IO#1**
- **IO#3**: Same as **IO#1**
- **IO#4**: Same as **IO#1**
- **Sensor Card #1**: Currently, this port is used by the **H2/H2O/B.P. Temp** card, which is an interface for the gas sensor, moisture sensor and heater plate temperature signals.
- **Sensor Card #2**: There is currently no such card.
- **Sensor Card #3**: There is currently no such card.

4.6.5.2 Detected Config

This function is identical to **Current Config**. See Section 4.6.5.1.

4.6.6 Service History

This function is identical to **View Readings > View History Data > Service Hist.** (see Section 4.4.2.4).

4.6.7 Software Version

- **HM2-X Version**: Version number of the Hydran M2-X software
- **Sensor Card#1**: Version number of the sensor card 1 software
- **Sensor Card#2**: Version number of the sensor card 2 software
- **Sensor Card#3**: Version number of the sensor card 3 software

4.6.8 Sensor Card Status

The **Sens. Card Status** function indicates which sensor card is detected by the Hydran M2-X. A card can be **Ok** (present) or **Not Present**.

5 VERIFICATION, INSTALLATION & CONFIGURATION

WARNING ***Read all warnings and recommendations in Chapter 1 before proceeding with the installation.***

5.1 Incoming Inspection

5.1.1 Reception and Unpacking

Upon reception, the shipping box contains one pre-assembled Hydran M2-X.

1. Open the shipping box, and remove the documentation and the small bag containing the accessories and tools.
2. Carefully remove the Hydran M2-X from the shipping box.

CAUTION ***Do not remove the plastic cap from the Hydran M2-X sensor. This cap protects the sensor's threads and membrane.***

Note: Keep the packing material for storage or further shipment of the Hydran M2-X.

5.1.2 Shipping List

This Section lists all items included in the shipment of a Hydran M2-X. If any item is missing, contact the General Electric Customer Service (the coordinates can be found at the bottom of page 2).

1. One pre-assembled Hydran M2-X, including:
   - Cover.
   - Sensor with protective plastic cap.
   - Electronic card cage with optional I/O.
   - Heater plate.
   - Sensor clamp.

2. Software and manuals:
   - The installation CD-ROM that includes the following items:
     – Perception Desktop software.
     – The latest version of the embedded programs (firmware; for more information, see Appendix F).
     – The three manuals in PDF format: *the Hydran M2-X Instruction Manual* (this manual), the *Hydran M2-X Installation Guide* and the *Perception Software Manual*.
       – The *Hydran M2-X Installation Guide*.

3. Set of tools and accessories:

- 3/16-in Allen key with 9-in T-shape handle (part number 11817), used for the four screws of the cover.
- 5/32-in Allen key with short L-shape handle (part number 10013), used for the sensor's bleed screw.
- 1/16-in Allen key with short L-shape handle (part number 18048), used for the sensor clamp set screw.
- Spanner wrench, used for the sensor clamp.
- Roll of Teflon tape (part number 10521).
- 1.8-m (6-ft) RS-232 cable (part number 12309).

5.1.3 Inspection

1. Using the shipping list (see Section 5.1.2), ensure all items are present.
2. Remove the four screws (for location, see Figure 3-3) that maintain the cover in place, using the long 3/16-in Allen key with a 9-in T-shape handle.
3. Remove the cover.
4. Inspect the cover, sensor and electronic card cage for any visual damage (bump, scratch or others).
5. Ensure the serial numbers of the following Hydran M2-X's components correspond to those indicated on the Test Certificate and Data Sheet (for an example, see Figure 4-12) and the shipping box:
   - Serial number of the sensor (located under the sensor's connector; see item 5 in Figure 3-7).
   - Serial number of the Hydran M2-X (located on the heater plate).

Note: Each Hydran M2-X is configured for a specific sensor. If several Hydran M2-X's are received, take the necessary precautions not to swap the sensors and Hydran M2-X's.

6. Ensure the installed I/O options (see item 3 in Figure 3-5) correspond to those indicated on the Test Certificate and Data Sheet (for an example, see Figure 4-12) and the purchase order.
7. Report any discrepancies to the company supervisor and the General Electric Customer Service (the coordinates can be found at the bottom of page 2).

Note: Never return equipment without first contacting the General Electric Customer Service (the coordinates can be found at the bottom of page 2).

5.1.4 Storage

If the Hydran M2-X is to be stored (or unpowered), it is recommended to keep the product in its original shipping box. The plastic cap must be left on the adaptor to protect its threads and the membrane. The product can be stored (or unpowered) for up to six months in a fully enclosed building that is free from damp and extremes in ambient temperature. The storage facility temperature should be between 5 and 45 °C (41 °F and 113 °F) with a non-condensing, relative humidity between 5 and 95%. If these limits are likely to be exceeded, please contact the General Electric Customer Service (the contact details can be found at the bottom of page 2). These restrictions do not apply to transportation.

If the product has been stored for more than six months, it is recommended to replace the battery before installation and powering-up. For the battery replacement procedure, see Appendix G.

5.2 Verification of Operation Prior to Installation

It is strongly recommended to verify the operation of all Hydran M2-X's before installation in the field (for the installation procedure, see Section 5.3). Verification confirms that no damage occurred during shipping and allows the user to become familiar with the Hydran M2-X.

Note: It is highly recommended that the parameters of each Hydran M2-X (identification number, power station identification number, communication speed, operation mode of relays, etc.) be set before field installation.

The Hydran M2-X's user interface (keypad and display) is described thoroughly in Chapter 4.

5.2.1 Preparation

1. Remove the four screws (for location, see Figure 3-3 that maintain the cover in place, using the long 3/16-in Allen key with a 9-in T-shape handle.
2. Remove the cover and place it aside.
3. Remove the plastic cover from the ac power supply terminal block.
4. Temporarily connect a three-wire cable to the Hydran M2-X's ac power supply terminal block. For identification, see Section 3.3.3; for wiring details, see Appendix D.4.

CAUTION ***Strip each wire to a maximum of 8mm before installing it. Be sure to insert all strands in the terminal.***

5. Connect this cable to the power supply.

WARNING

Turn off the electric power at the switch or circuit breaker provided for disconnection before making any electrical connections, and ensure a proper ground connecting is made before connecting line voltage. Failure to do so can result in property damage, personal injury and/or death.

Note: The external ac power supply range is 100-120 Vac or 200-240 Vac, 50/60 Hz.

6. Power up the Hydran M2-X. The **Main Menu** should be displayed.
7. Wait for five minutes or press the **Esc** key to switch to the Main Display mode (see Section 4.1.2.3). Observe the various readings in each of the three screens; it is normal for certain values to be low.

8. Wait a few minutes and touch the heater plate; it should be warm.
9. Proceed as follows to confirm keypad operation:
   - Press the **Main Menu** context key. The **Main Menu** should be displayed.
   - Click the Down arrow key two times to highlight **Setup** and press the **Enter** context key.
   - Try each arrow key and verify if the "cursor" moves in the corresponding direction.
10. Make a shadow over the Hydran M2-X's display and verify the backlighting is functioning. The display should be readable under all ambient lighting conditions.

5.2.2 Setting the Date and Time

1. Access **Setup > Date & Time**.
2. If necessary, set parameters Current Date and Current Time to local values.

5.2.3 Verifying the Sensor's Serial Number

1. Access **Service > Sensor Param > Gas Sensor Param** and press **Enter**.
2. Compare the serial number displayed on the screen with the one engraved under the sensor's connector (see item 5 in Figure 3-7).
3. Press Esc to return to the previous level, select **H_2O Sensor Param** and press **Enter**.
4. Again, compare the serial number displayed on the screen with the one engraved under the sensor's connector.

5.2.4 Verifying the State of the Gas Detector

1. Access **Service > Sensor Test > H2 Sensor Test** and press **Enter**.
2. Press **Ok** to start the test.
3. Wait for a few seconds; the Hydran M2-X's display should indicate the message **Good**. If another message is displayed, see Section 9.1.

5.2.5 Verifying the Battery Voltage

1. Access **Service > View Service Data**.
2. Read the value of the parameter Battery. The value must exceed 2.85 V. If not, contact the General Electric Customer Service (the coordinates can be found at the bottom of page 2).

5.2.6 Verifying the Alarm Relays (If Used)

The steps described in this Section may be used during the Hydran M2-X verification, maintenance and troubleshooting procedures.

Note: To verify the relays using the alarm contacts, connect an ohmmeter to the alarm contacts terminal block (15 terminals). To identify each terminal, see Appendix D.8.

1. Access **Test > Relay Test**.
2. Simulate an alarm by setting parameter Relay #1 Mode to Force On. Make sure:
   - The NO contact of this relay is closed.
   - The NC contact of this relay is open.
   - The state of the other alarm contacts has not changed.
3. Perform the same test for relays #2, #3 and #4.
4. Simulate an alarm due to system fault conditions by setting parameter SysOK Relay Mode to Force Off. Make sure:
   - The NO contact of the system fault relay is open.
   - The NC contact the system fault relay is closed.
5. Cancel the alarm due to system fault conditions by setting parameter **SysOK Relay Mode** to **Normal**. Make sure:
   - The NO contact of the system fault relay is closed.
   - The NC contact of the system fault relay is open.
6. Cancel the other alarms by setting parameters **Relay #1 Mode** to **Relay #4 Mode** to **Normal**. Make sure:
   - The NO contacts of relays #1 to #4 are open.
   - The NC contacts of relays #1 to #4 are closed.
   - The NO contact of the system fault relay is closed.
   - The NC contact of the system fault relay is still open.

6. If necessary, set parameters **Relay #1 Mode** to **Relay #4 Mode** and **SysOK Relay Mode** to their initial mode.

5.2.7 Verifying the Standard TDM Signal (If Used)

This procedure requires a Hydran 201C*i*-C Controller.

5.2.8 Verifying the Analog Input(s) (If Used)

The procedure described below should be performed for each optional 4–20 mA analog output interface installed on the right side of the electronic card cage. Each analog output terminal block has four terminals.

1. Configure the analog inputs before verifying them. See Section 5.4.7.
2. Connect a 4–20 mA calibrator-simulator (for example: Model CL-303-2 from Omega) to terminals 2 (**-**) and 3 (**+**) of the analog input terminal block to verify. For technical details on the terminal block, see Appendix D.2.
3. Access **Setup > I/O Setup** > **An. Input Setup** and select the analog input interface to verify. In the screen that is now displayed, proceed as follows:
   - Set the calibrator to 4 mA.
     - **IO State** should display 0.0 ± 0.1 %.
     - The line below **IO State** should display the minimum reading value (defined during the configuration).
   - Set the calibrator to 20 mA.
     - **IO State** should display 100.0 ± 0.1 %.
     - The line below **IO State** should display the maximum reading value (defined during the configuration).
   - Set the calibrator to 12 mA.
     - **IO State** should display 50.0 ± 0.1 %.
     - The line below **IO State** should display the middle reading value.
4. Disconnect the digital multimeter.

Note: If the input reading does not correspond to one of the above values, calibrate this analog input.

5.2.9 Verifying the Analog Output(s) (If Used)

The procedure described below should be performed for each optional 4–20 mA analog output interface installed on the right side of the electronic card cage. Each analog output terminal block has four terminals.

1. Configure the analog outputs before verifying them. See Section 5.4.8.

2. Set a digital multimeter to dc current (1 % accuracy and 0.1 mA resolution) and connect it to terminals 2 (**-**) and 3 (**+**) of the analog output terminal block to verify. For technical details on the terminal block, see Appendix D.3.
3. Access **Setup > I/O Setup** > **An. Output Setup** and select the analog output interface to verify. In the screen that is now displayed, set the **Mode** parameter as follows:
   - Press **Change**, select **0%** and press **Enter**.
     - For 4–20 mA analog outputs, ensure that the output current is 4.00 ± 0.1 mA.
   - Press **Change**, select **50%** and press **Enter**.
     - For 4–20 mA analog outputs, ensure the output current is 12.00 ± 0.1 mA.
   - Press **Change**, select **100%** and press **Enter**.
     - For 4–20 mA analog outputs, ensure that the output current is 20.00 ± 0.2 mA.
4. Set the **Mode** parameter back to **Normal**.
5. Check the 4–20 mA supply voltage.
6. Disconnect the digital multimeter.

Note: If the output current does not correspond to one of the three above values, calibrate this analog output.

5.2.10 Verifying the RS-232 Communications (If Used)

This verification procedure requires Perception software.

1. With the supplied RS-232 cable, connect the Hydran M2-X to a laptop computer through their DB-9 connector.
2. Access **Setup > Comm Setup > Identification**.
3. Note the value of parameter **Monitor ID** and set it to 1.
4. Run the Perception software on the laptop computer.
5. In the **Relays/Analog** menu of Perception, force on and off the alarm relays to test communications.
6. In the **Relays/Analog** menu set the state of the alarm relays to **Normal** upon completion of the tests.
7. Disconnect the RS-232 link cable.
8. Access **Setup > Comm Setup > Identification**.
9. Set parameter **Monitor ID** to its initial value (noted during step 3).

5.2.11 Conclusion

The Hydran M2-X verification is now completed.

1. Power down the Hydran M2-X.
2. Disconnect the power supply cable from the Hydran M2-X.

3. Close the Hydran M2-X's cover; make sure the gasket is properly positioned between the heater plate and the cover.
4. Store the Hydran M2-X in its shipping box, ready for installation.

Note: For storage information, see Section 5.1.4.

5.3 Installation

WARNING

All procedures in this manual must be strictly adhered to. Any deviation from these could cause irreversible damages to the Hydran M2-X and/or the transformer being monitored, and could lead to property damage, personal injury and/or death. Installation and maintenance of the Hydran M2-X must be carried out by qualified personnel only.

The installation and commissioning of the Hydran M2-X are divided in several steps. This Section provides a detailed description of each step; Appendix B provides a checklist for the entire installation procedure.

CAUTION

It is strongly recommended to verify the operation of all Hydran M2-X's before installation in the field. The verification also allows the user to become familiar with the Hydran M2-X; see Section 5.2.

Note: It is strongly recommended that the parameters of each Hydran M2-X (identification number, power station identification number, communication speed, operation mode of relays, etc.) be set before field installation.

5.3.1 Overview

The Hydran M2-X is typically installed on a full-bore gate or ball valve of a transformer. There are two cables:

- The Hydran M2-X's power supply cable is passed in a flexible (recommended) or rigid steel conduit toward a supervisory control and data acquisition (SCADA) system.
- The alarm cable is passed in a flexible (recommended) or rigid steel conduit toward a SCADA system.

5.3.2 Tools and Materials Required

In addition to the supplied tools and accessories (see the shipping list in Section 5.1.2), you will need the following ones to install the Hydran M2-X (see Figure 5-2):

- 3-mm (1/8-in) flat-blade screwdriver.
- #2 Phillips screw driver.
- Pliers or adjustable wrench.
- Wire stripper.
- Wire cutter.
- Bucket (or pan) and rag.
- Oil-absorbing rags.
- Optional) digital multimeter.
- 15-in (approximately 381 mm) adjustable wrench with smooth, non-marring 3 5/8-in (approximately 92 mm) jaws. An adjustable wrench can also be used.

CAUTION ***Never use a wrench with jagged jaws.***

The following material is also required:

- 1/2-in (approximately 12.7 mm) NPT cable fittings, PG-13 or M20, with locknuts and sealing gaskets.
- Cable ties.
- Conduits.
- Cables (for details, see Appendix D : External Connections).

Note: One cable fitting, conduit and cable are required to connect the ac power supply. Optionally, additional material is required for the alarms, RS-485 link, optional analog input(s), optional analog output(s), standard and optional TDM signals. More than one cable can pass through the same conduit, as long as the cables are connected to the same side of the electronic card cage. It is recommended to use flexible steel conduits rather than rigid ones. If preferable, an external junction box could be used.

5.3.3 Mounting Location of the Hydran M2-X

A Hydran M2-X monitor can be installed on any available transformer valve. However, care must be taken in selecting a suitable location while respecting the overall dimensions and weight of the monitor. To achieve optimal performance from the Hydran monitor, ensure that:

- the monitor is mounted horizontally on the transformer valve
- there is no restriction between the Hydran and the main body of oil
- there is a good circulation of oil flowing towards the Hydran.

5.3.3.1 Requirements

1. Always mount the sensor on a full-bore gate or ball valve where there is sufficient convective oil flow.

2. If the Hydran M2-X is mounted directly on the wall of the transformer tank, ensure it is installed below the oil level.
3. No obstructions (baffle, pipe, etc.) must exist behind the valve (inside the tank).
4. The Hydran M2-X is installed on a valve with a 1.5 in (approximately 38 mm) nominal diameter (NPT female threads) or larger. If necessary, use a reducing bushing.

Note: General Electric does not recommend installing the Hydran M2-X on a 1-in diameter valve, due to the weight of our instrument and the vibration of the transformer. Our tests have indicated that if a 1-in pipe is used to install the Hydran M2-X to a distance exceeding 63 mm (2.5 in), the pipe may break under certain conditions.

CAUTION

To ensure sufficient oil flow through the gas detector's membrane, the nominal diameter of the valve should never be below 25 mm (1 in).

5. *For valves 1.5 in or more in diameter*: The total distance between the Hydran M2-X and the mounting point of the valve *must not exceed six times the nominal diameter of the valve* (230 mm [9 in] for a 38-mm [1.5-in] valve); see Figure A - 7.
6. Ensure there is enough clearance above and below the Hydran M2-X to separate it from its sensor. For more information, see Appendix A.2.1.
7. The Hydran M2-X must always be easily accessible.
8. The body of the valve should be grounded.
9. The Hydran M2-X weighs approximately 7.5 kg (16.5 lb). If the selected valve is subject to strong vibrations, install a supporting bracket to reduce the load on the valve. *In case of doubt, consult the engineer responsible for the installation.*
10. Do not install the Hydran M2-X on an elbow or a fitting box (see Figure 2-5). The turbulent oil flow at these locations may result in inaccurate gas level readings.

5.3.3.2 Vertical Installations of the Hydran M2-X

Regardless of the selected location, it is recommended to mount the Hydran M2-X horizontally (as shown on Figure 5-1). If no horizontal valve is available, a vertical installation may be acceptable; contact the General Electric Customer Service (the coordinates can be found at the bottom of page 2).

If the Hydran M2-X is installed vertically, note the following points:

- The sensor's threaded extremity must be oriented upward.
- The oil temperature at this location must always be below 30 °C (86 °F).
- Do not use a 90° elbow to convert a vertical installation to a horizontal installation.
- It is recommended to set the temperature set point (parameter **Temp SetPoint** in **Setup > Temp. Setup**; see Section 4.2.4) of the sensor to 45 °C (113 °F).

5.3.3.3 Typical Locations

Figure 5-1 illustrates some *typical* valve locations to install the Hydran M2-X. These locations vary between transformers, but there are some valve locations on a transformer where the oil circulation is much better due to the nature of a transformer's operation.

The circulation of oil is generally the same in all transformers — the natural convection of the oil circulates from warm to cool as the transformer warms up. The oil at the bottom is usually cooler than the top as it returns from the cooling system, as illustrated in Figure 5-1.

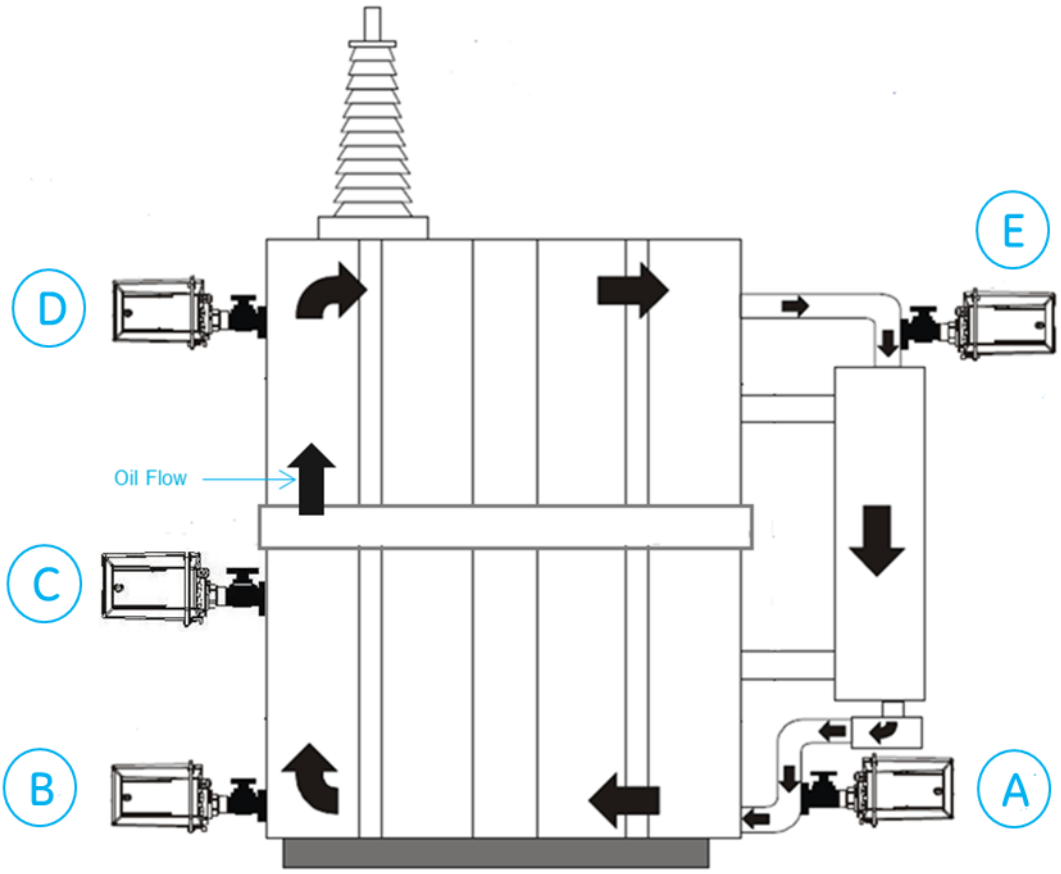


Figure 5-1: Typical Installation of the Hydran M2-X

Location #A: Cooling Return

Some transformers may have a valve that is on the pipe that joins the bottom of the cooling system to the transformer main tank. This location offers an excellent circulation of oil. It allows for easy access for installation and taking oil samples directly from the Hydran M2-X.

Note: If a pump is part of the cooling system, it is recommended that the Hydran M2-X be installed on the discharge side of the pump.

Location #B: Drain Valve

All transformers are equipped with a drain valve. This location allows for easy access for installation and taking oil samples directly from the Hydran M2-X. Oil flow is reduced compared to the other locations and over time there can be a build up of sludge which can further impede the oil flow.

Note: A minimum distance of 12 in. between the ground and the valve is required so that the Hydran enclosure and cables can be properly installed.

Location #C: Main Tank

Some transformers are equipped with a valve that is mounted towards the middle portion of the transformer main tank. This location offers good oil circulation and is easily accessible for installation and taking oil samples directly from the Hydran M2-X.

Location #D: Upper Filling Valve

Most transformers are equipped with an upper filling valve. This location offers excellent oil circulation, but is not easily accessible and may require an outage to install the Hydran M2-X.

Location #E: Top of Cooling System

Some transformers may have a valve that is mounted on the pipe that joins the top tank of the transformer to the top of the cooling system. This location offers an excellent circulation of oil; but is not easily accessible and may require an outage to install the Hydran M2-X.

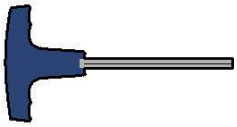
CAUTION

If these five recommended locations cannot be used, contact the General Electric Customer Service (contact information can be found at the bottom of page 2) to help you determine an acceptable alternative location.

5.3.4 Verifying the Serial Numbers

Ensure step 5 on page 65 has been performed.

SUPPLIED WITH THE HYDRAN M2-X



3/16-in Hex Key with 9-in Blade & Cushion Grip T- Handle

1/16-in and 5-32-in standard Hex (Allen) L-Keys

Spanner wrench

Roll of PTFE tape

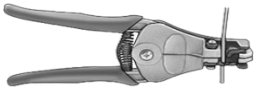
TO BE SUPPLIED BY THE INSTALLER

3-mm (1/8-in) Slotted Screwdriver

#2 Phillips Screwdriver

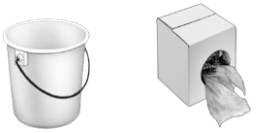
Adjustable Pliers or Wrench

Wire Stripper

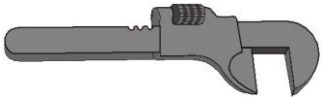


Wire Cutter

Bucket and Rags



Adjustable Wrench with smooth non-marking jaws



Anti-seize lubricant e.g. Loctite 8009

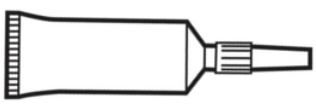


Figure 5-2: Tools Required for the Installation

5.3.5 Preparing the Valve

1. Wipe the outside of the valve.
2. Clean the valve's threads.
3. Dispose of the collected oil according to the company regulations.

5.3.6 Separating the Sensor from the Hydran M2-X

Separate the sensor from the Hydran M2-X. Proceed as follows (see Figure below):

1. Remove the set screw (arrow 1 on Figure 5-3 that secures the Hydran M2-X and its sensor together.

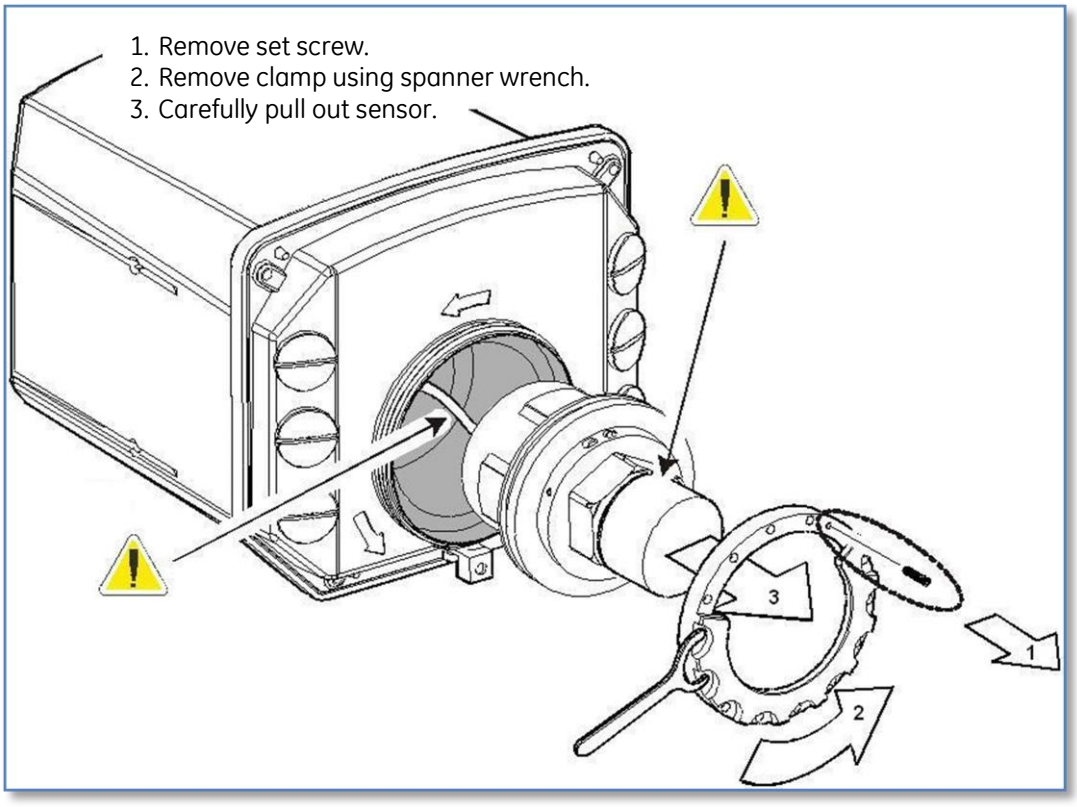


Figure 5-3: Separating the Sensor from the Hydran M2-X

2. Remove the sensor clamp using the spanner wrench.
3. Carefully pull the sensor a few centimeters from the enclosure.

CAUTION ***A cable connects the sensor to the electronic card cage.***

4. Disconnect the connector located at the back of the sensor (see Figure 5-3).
5. Rotate the connector anticlockwise (approximately 1/8 of a turn), then carefully pull it from the sensor.

CAUTION

Never touch the gas detector or humidity sensor inside the Hydran M2-X sensor. Touching them may damage the Hydran M2-X.

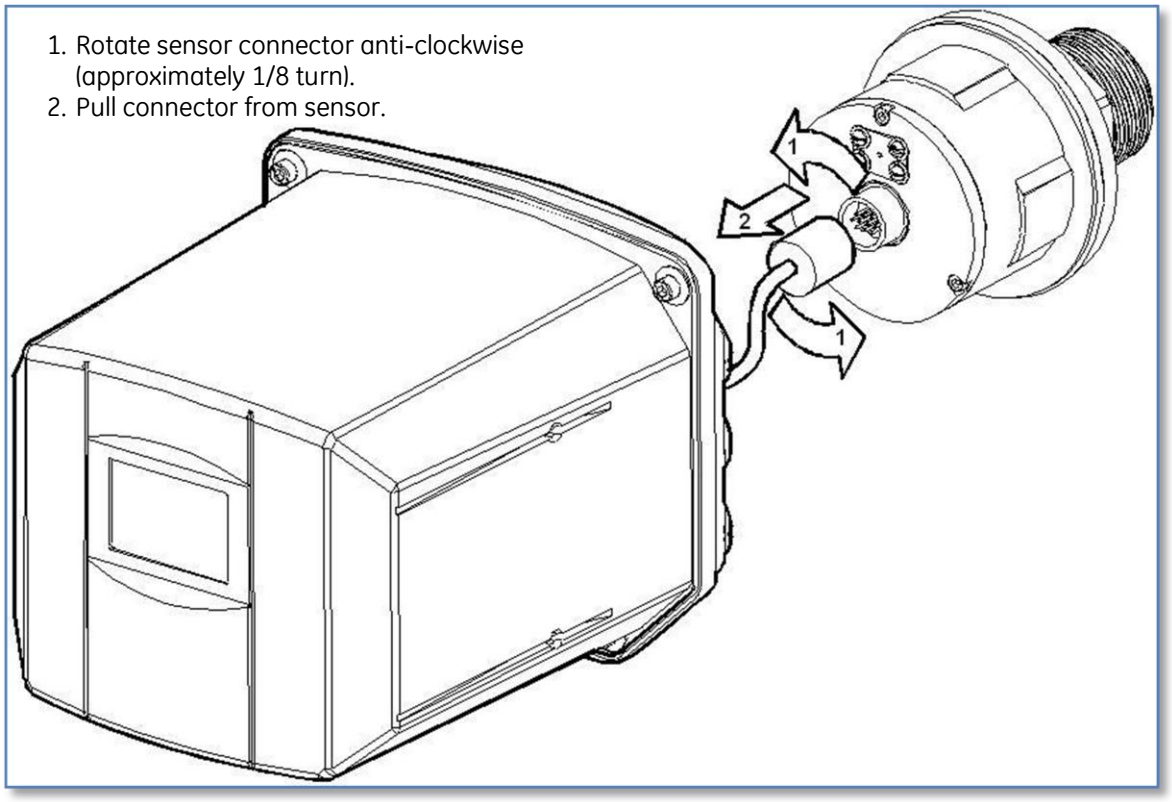


Figure 5-4: Disconnecting the Sensor Cable

6. Inspect the membrane inside the sensor by looking at it; its surface must be flat, without cut or tear (a small curl is normal).
7. Store all parts, including the sensor, in a box and in a safe place until ready for installation.

5.3.7 Installing the Sensor onto the Valve

The sensor has 1.5 in (approximately 38 mm) NPT male threads to screw onto the valve. If an adaptor is *not* required to mount the sensor onto the valve, skip steps 1 to 3.

1. If using a finned, high-temperature adaptor, a thin layer of thermal joint compound must be applied on the outside of the mounting adaptor before assembling all parts; remove excess of compound with solvent.
2. Wrap PTFE tape on the adaptor's threads.

CAUTION ***Use only PTFE tape to seal the adapter's threads. Wrap at least four to five layers of tape around the threads.***

3. Screw the adaptor onto the valve and tighten it using an adjustable wrench.

CAUTION ***Never use a wrench with jagged jaws.***

4. Wrap PTFE tape on the sensor's threads. See Figure 5-5.

CAUTION ***Use only PTFE tape to seal the sensor's threads. Wrap at least four to five layers of tape around the threads.***

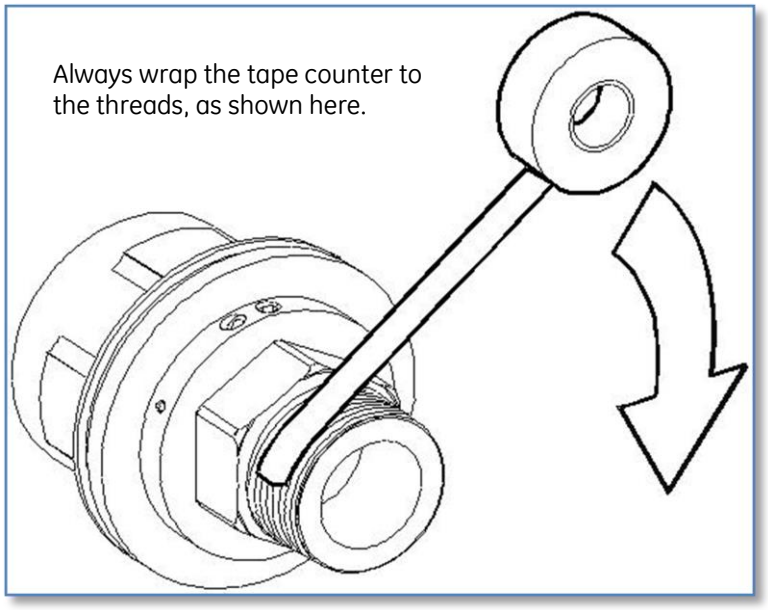


Figure 5-5: Wrap the Sensor's Threads with PTFE

5. Loosen the bleed screw.
6. Install the sensor clamp around the sensor. See Figure 5-6 overleaf.

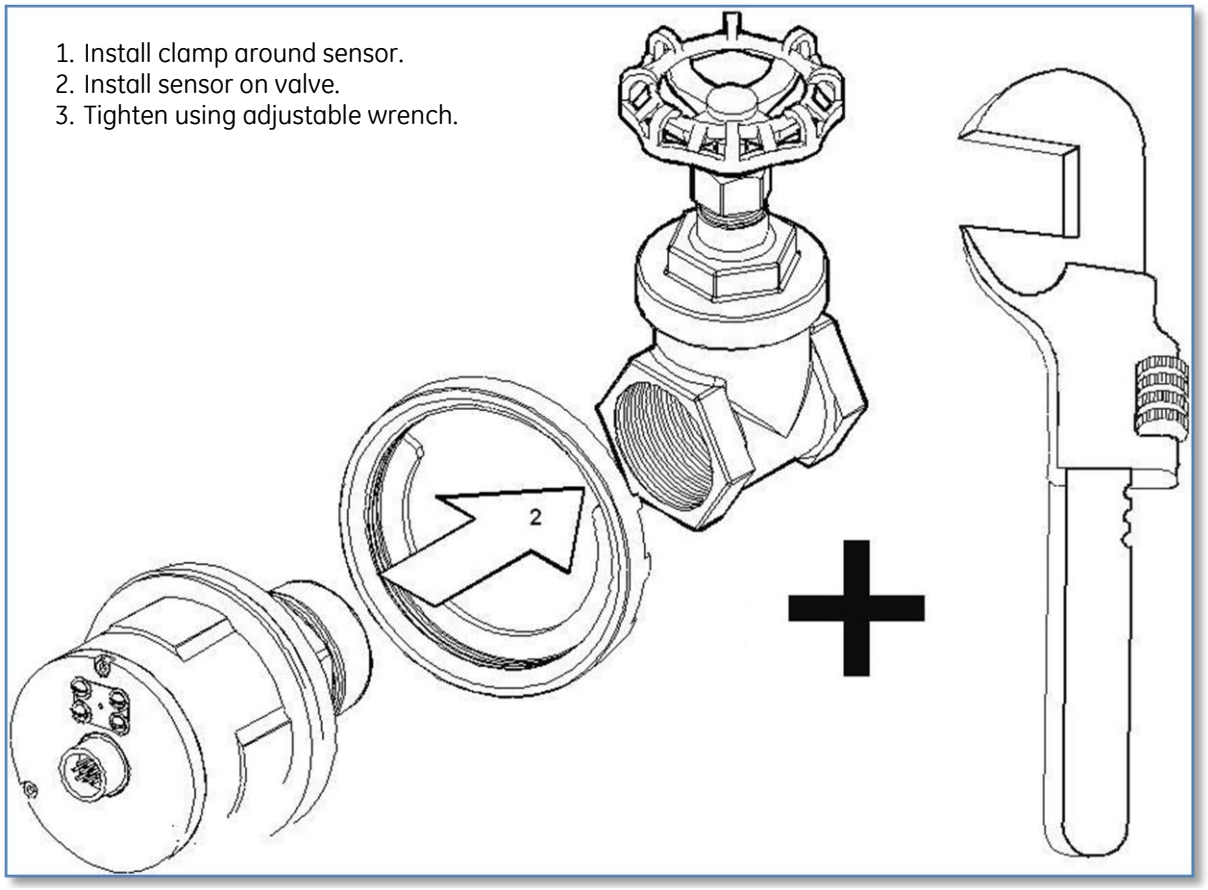


Figure 5-6: Mount the Sensor Manually onto the Valve and Tighten it, Using an Adjustable Wrench

7. Screw the sensor manually onto the valve.
8. Tighten the sensor using an adjustable wrench. Do not use excessive force when tightening the sensor onto the valve.

Note: If the sensor is installed horizontally, ensure the bleed screw is on top (at the "12 o'clock" position). See Figure 5-7.

9. Ensure the O-ring is in place on the sensor flange.

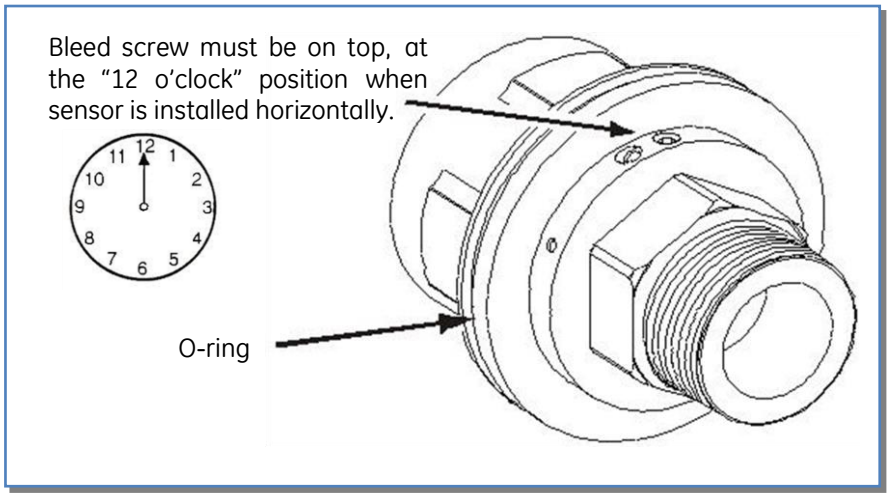


Figure 5-7: The Bleed Screw Must Be on Top, at the 12 O'clock Position

5.3.8 Opening the Valve and Purging Air from the Sensor

CAUTION

Perform this step according to company regulations. Proceed carefully to avoid introducing air into the transformer. Use a bucket to collect the oil.

Proceed as follows (see Figure 5-8):

1. Using the 5/32-in Allen key, fully close the sensor's bleed screw and then open it *1/8 of a turn*.
2. Slowly open partially the transformer valve until oil leaks out of the sensor's sampling port.
3. Wait until there are *no more air bubbles* present in the oil and shut the bleed screw tightly.
4. Open the valve completely.
5. Wipe all traces of oil from the sensor.

CAUTION

Do not use any solvent.

6. Inspect the sensor for oil leaks.
7. Tighten the bleed screw.
8. Dispose of the collected oil according to the company regulations.

Note: *Prior to installing the Hydran M2-X onto the transformer valve,* it is recommended *to drain approximately 2-4 liters of oil from the valve. This clears any contaminants and moisture that may have accumulated inside the transformer valve.*

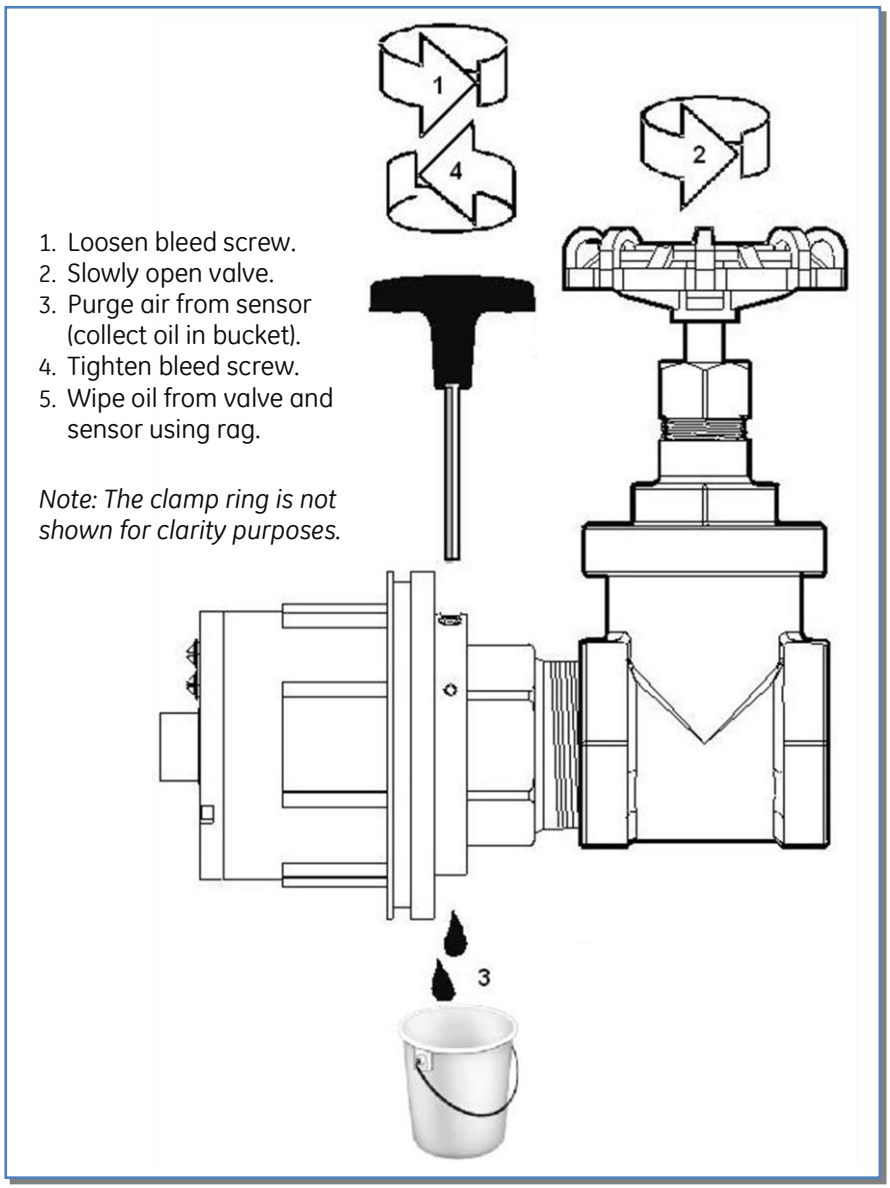


Figure 5-8: Opening the Valve and Purging the Air from the Sensor

5.3.9 Installing the Hydran M2-X on the Sensor

Proceed as follows (see Figure 5-9):

1. Push the sensor cable connector into the sensor connector.
2. Rotate the connector clockwise (approximately 1/8 of a turn).
3. Position the enclosure and push the Hydran M2-X onto the sensor.

CAUTION

Ensure the sensor cable is not squeezed between the sensor and the enclosure. Squeezing the cable may damage it.

1. Insert the sensor cable connector into the sensor connector.
2. Rotate connector clockwise (approximately 1/8 turn).
3. Position the enclosure and push it on to the sensor; taking care not to squeeze the sensor cable between the sensor and the enclosure.
4. Apply a thin layer of anti-seize lubricant to the threads of the M2-X base plate before attaching the brass ring.
5. Install the sensor clamp and tighten it using the supplied spanner wrench.
6. Tighten set screw using 1/16-in Allen key.

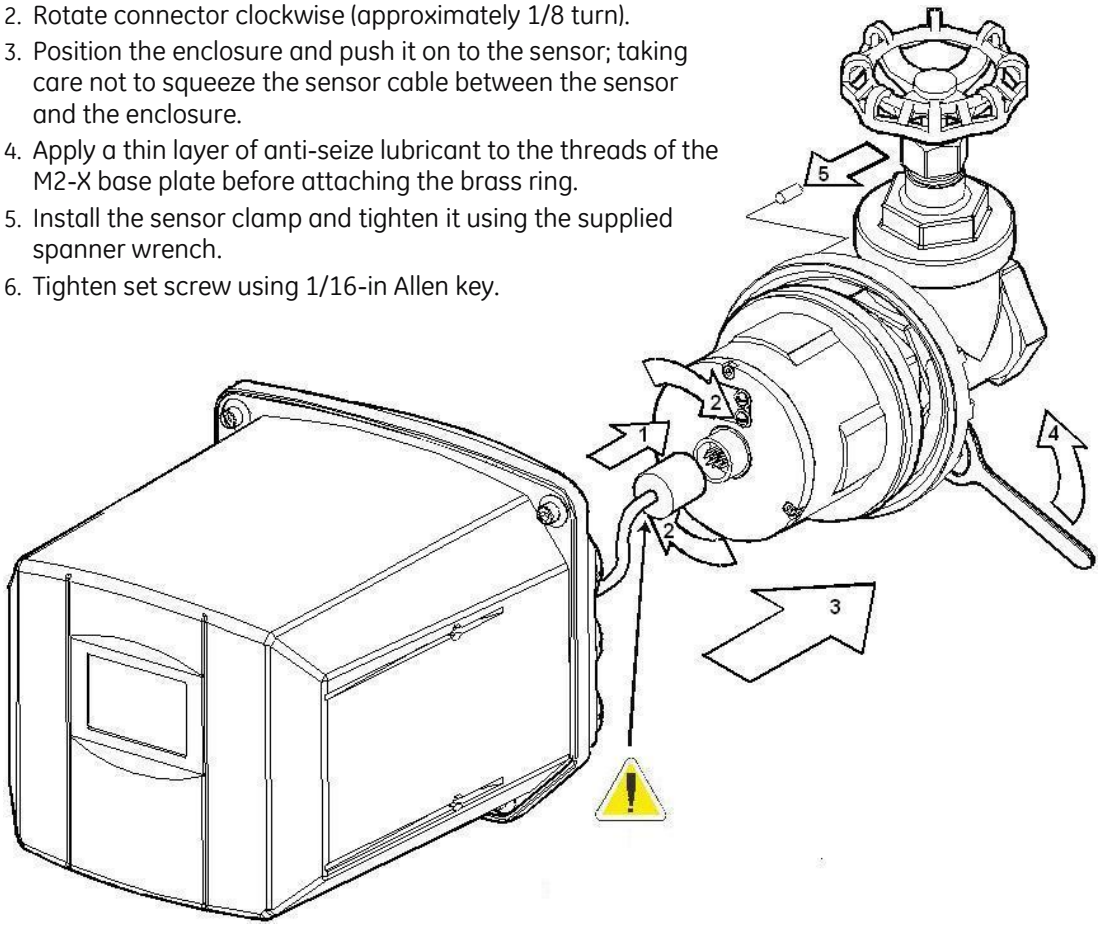


Figure 5-9: Installing the Hydran M2-X on the Sensor

4. Apply a thin layer of anti-seize lubricant to the threads of the M2-X base plate before attaching the brass ring.
5. Install the sensor clamp and tighten it using the spanner wrench.
6. Tighten the set screw using the 1/16-in Allen key.

5.3.10 Grounding the Hydran M2-X Enclosure

1. Connect a ground wire to the Hydran M2-X's external ground lug (see Figure 5-10), using a 10-6 AWG copper wire.
2. Ground the other end of this cable by connecting it to the transformer ground grid.

CAUTION

Improper grounding could cause erratic operation and damage the electronic circuit.

Note: If for operating consideration a non- grounded installation is required, contact the General Electric Customer Service (the coordinates can be found at the bottom of page 2).

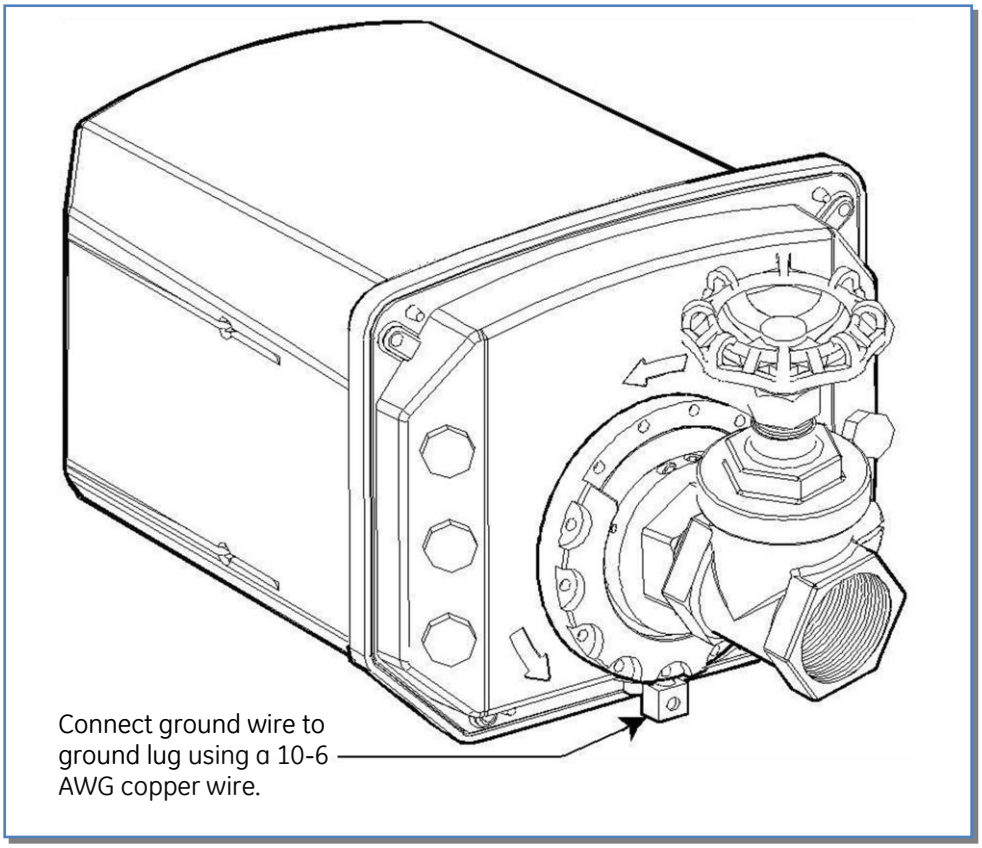


Figure 5-10: Grounding the Hydran M2-X Enclosure

5.3.11 Installing the Cable Conduits

Note the following considerations prior to installation:

- All cables connected to the Hydran M2-X must be run through steel conduits or must be armored.
- Conduits, or cable armors, should be made of steel to provide shielding against magnetic fields.
- Flexible rather than rigid conduits should be used near the Hydran M2-X to ease installation and servicing.

Proceed as follows:

1. Remove the cover's four retaining screws using the supplied Allen key. See Figure 5-11.
2. Pull the cover.
3. Remove the cap from the desired conduit fittings. Install the necessary watertight conduit fittings. See Figure 5-12.

WARNING ***All conduits, cables and fittings must be high quality and watertight to avoid water ingress in the Hydran M2-X.***

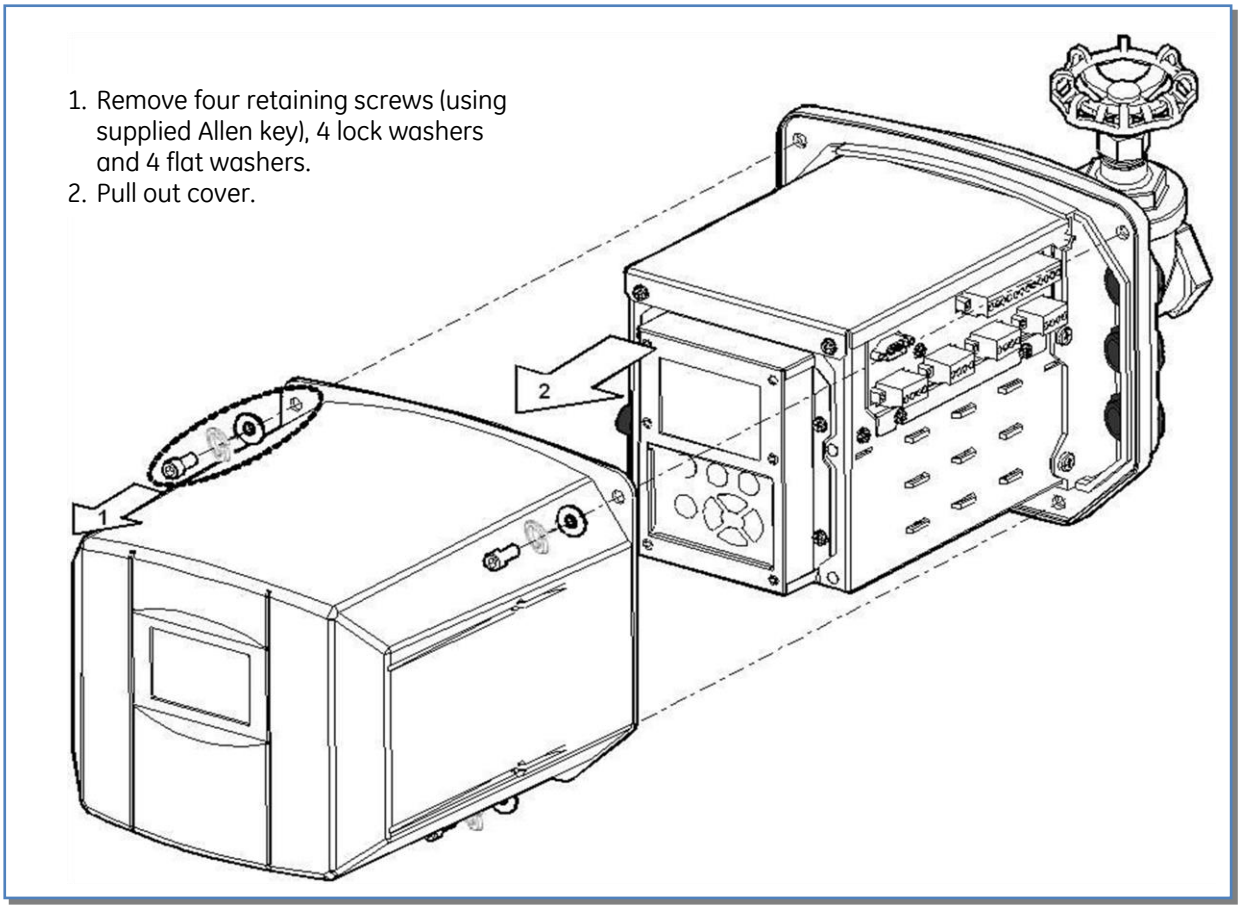


Figure 5-11: Removing the Hydran M2-X Cover

4. Mount a conduit to each conduit fitting. Cables connected to terminal blocks located on one side of the Hydran M2-X must pass through a conduit fitting mounted on the same side. When possible, more than one cable can be run in a single conduit. The following cables can be run (for the location of each terminal block, see Figure 3-5 and Figure 3-6):

   - Hydran M2-X's left side (when facing the display):
     - ac power supply cable.
     - Alarm contacts cable (connected to a SCADA system)
   - Hydran M2-X's right side:
     - Input cable of the RS-485 link (connected to another Hydran M2-X).
     - Output cable of the RS-485 link (connected to another Hydran M2-X or to a Hydran 2901Ci-C controller).
     - Up to four optional cables for I/O (analog inputs and/or outputs).

5. Ground the conduits and/or cable shields at some point. Follow the company regulations meticulously. To ground the conduit of the RS-485 cable, see Section 6.2.

CAUTION

The Hydran M2-X must always be grounded, even if the transformer tank is grounded at a single point and monitored for tank-to-ground currents.

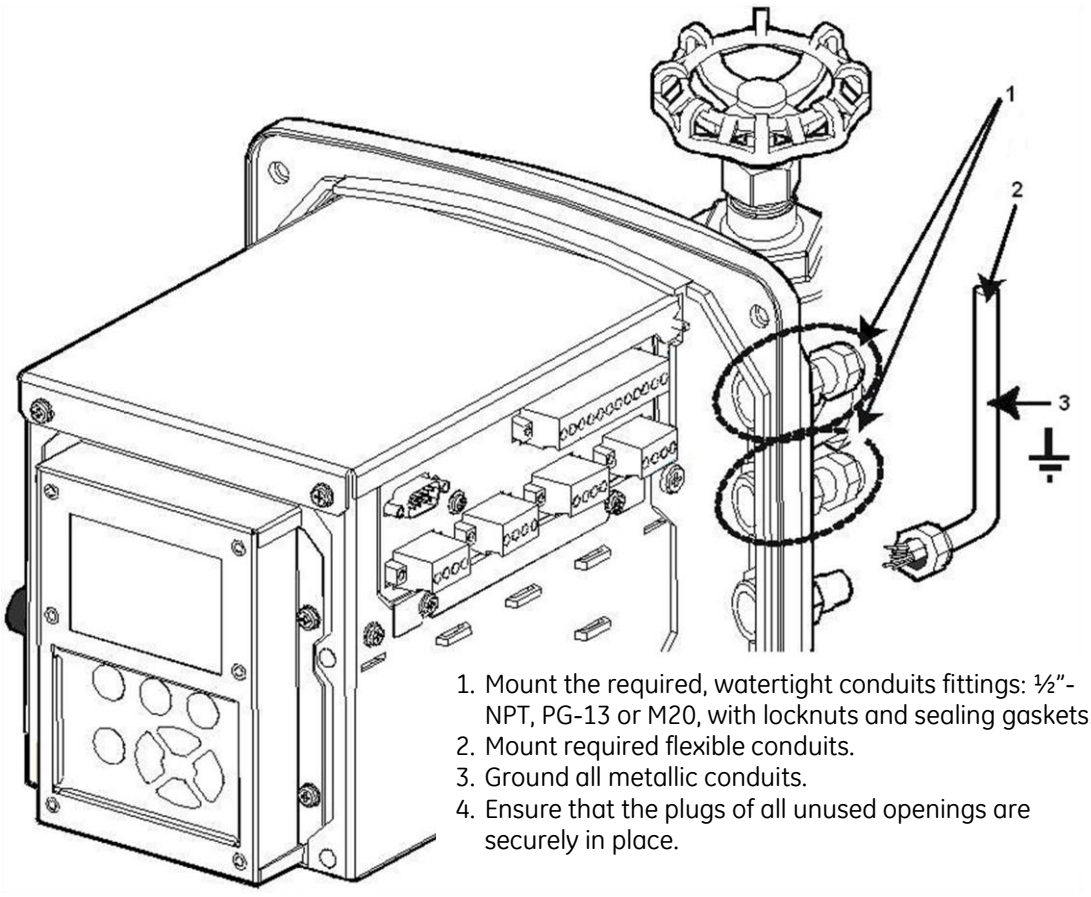


Figure 5-12: Installing Cable Conduits

5.3.12 Installing the Cables

CAUTION

The Hydran M2-X's operation may be affected if wires are not connected correctly. Be careful when installing and inserting each wire. Be sure to insert all strands in the terminal; strands that touch two terminals will cause problems. Strip each wire to a maximum of 8 mm before installing it. Do not leave trims of metallic strands inside the Hydran M2-X's enclosure.

CAUTION

The first temporary plug (see item 1 in Figure 3-6 must be removed and replaced with a watertight fitting to connect the ac power supply cable (Section 5.3.12.6).

5.3.12.1 Input and Output Cables of the RS-485 Link

For installation of the RS-485 network link cable, see Section 6.2.1.

5.3.12.2 Alarm Cable (if Used)

Proceed as follows:

1. Run the alarm cable through a conduit, from the Hydran M2-X to the SCADA or annunciator system.
2. Verify all wires are identified at both ends.
3. Connect the wires to the alarm contacts terminal block of the Hydran M2-X. For wiring details, see Appendix D.5.
4. Connect the other end of the cable to the SCADA or annunciator system.

5.3.12.3 Standard TDM Signal (Optional)

This TDM signal is supplied to be interfaced with a Hydran 201C*i* -1 or Hydran 201C*i*-4 Controller. For more information on the TDM signal, see the *Hydran 201i System Instruction Manual*.

Note: The TDM is used with the Hydran 201Ci-1 or Hydran 201Ci-4 Controller to display remotely the gas level and the status of alarm relays 1 and 2. There is no display of the water level or the status of alarm relays 3 and 4.

Proceed as follows:

1. Run the TDM cable (shielded triad) through a conduit, from the Hydran M2-X to the Hydran 201C*i*-1 or Hydran 201C*i*-4 Controller.
2. Verify all wires are identified at both ends.
3. Connect the wires to the TDM/RS-485 terminal block of the Hydran M2-X. For wiring details, see Appendix D.1.
4. Connect the other end of the cable to the Hydran 201C*i*-1 or Hydran 201C*i*-4 Controller.

5.3.12.4 Analog Input Cable (if Used)

Proceed as follows:

1. Run the cable through a conduit, from the Hydran M2-X to the sensor that supplies the analog signal.
2. Verify all wires are identified at both ends.
3. Connect the wires to the corresponding I/O terminal block of the Hydran M2-X. For wiring details, see Appendix D.2.
4. Connect the other end of the cable to the sensor.

5.3.12.5 Analog Output Cable (If Used)

Proceed as follows:

1. Run the cable through a conduit, from the Hydran M2-X to the SCADA system.
2. Verify all wires are identified at both ends.
3. Connect the wires to the corresponding I/O terminal block of the Hydran M2-X. For wiring details, see Appendix D.3.
4. Connect the other end of the cable to the SCADA system.

5.3.12.6 AC Power Supply Cable

WARNING

Turn off the electric power power at the switch or circuit breaker provided for disconnection before making any electrical connections, and ensure a proper ground connection is made before connecting the power supply. Failure to do so can result in property damage, personal injury and/or death.

Note: The external ac power supply range is 100-120 Vac or 200-240 Vac, 50/60 Hz.

Proceed as follows:

1. Run the cable through a conduit, from the Hydran M2-X to the power source.

CAUTION

The first temporary plug (see item 1 in Figure 3-6 must be removed and replaced with a watertight fitting to connect the ac power supply cable.

2. Remove the plastic cover from the ac power supply terminal block.
3. Connect the wires to the ac power supply terminal block of the Hydran M2-X. For wiring details, see Appendix D.7.
4. Connect the other end of the cable to the power source. An external circuit breaker must be installed on the ac source and labeled accordingly, complying with the applicable regulations.

Note: Fuses or an external circuit breaker must be installed and duly identified near the Hydran M2-X, in accordance with the IEC 947-1 and 947-3 standards, the local building codes or the current edition of the National Electrical Code.*

5. Power up the Hydran M2-X.
6. Verify the display is lit.

Note: The earth/ground terminal (E/G) must be connected to the power source ground (green wire) or directly to the transformer tank. For special considerations regarding grounding, see the note at the beginning of Section 5.3.10.

CAUTION

Never perform high-voltage tests (mega-ohm measurements using a Megger instrument) on cables connected to a Hydran

M2-X. Never apply high voltages to the Hydran M2-X terminals, as they are equipped with surge protection devices that could be damaged by Megger tests.

5.3.13 Verifying the Hydran M2-X Operation

1. After configuration of the Hydran M2-X (see Section 4.2 and Section 4.3), fasten the cover with the four screws. Ensure the gasket is properly positioned between the heater plate and the cover.
2. Verify all cable entry points are watertight.
3. Verify the heater plate is warm.

CAUTION

The surface of the base plate can be hot. Heating for the dynamic oil sampling system (Section 3.5) is achieved using heating resistors mounted on the internal side of the base plate.

5.4 Configuring the Hydran M2-X

The Hydran M2-X configuration can be performed using either the Hydran M2-X's keypad or the Perception software running on the host or laptop computer. It is recommended to use the Perception software because it makes the configuration task much easier. See the *Perception Software Manual*.

The parameter configuration detailed in the following pages is written for those who are using the Hydran M2-X's display and keypad. To set up the communication channel prior to the use of the Perception software, see Section 6.2.2 to Section 6.2.3.2.

Note: The values indicated in this Section are only given as an indication and may differ from user requirements. The value of the various parameters should be decided during the planning stage of the installation. Make sure to verify all parameters. It is recommended to log the value of the Hydran M2-X's parameters in Appendix B.

5.4.1 Setting the Date and Time

1. Access **Setup > Date & Time** (see Section 4.4.3).
2. If necessary, set the **Current Date** and **Current Time** parameters.

5.4.2 Setting the Parameters of the History Files

1. Access **Setup > History Setup > History Log Rate** (see Section 4.2.6.1).

2. Verify and set, as required, the **Short Term Rate** as well as the **Long Term #1** to **Long Term #4** logging hours.
3. Press **Esc**, select **Clear HM2-X Hist File** and press **Enter**.
4. Erase the content of the history files by selecting each option and pressing **Ok**.

5.4.3 Setting the Alarm Parameters

1. Wait at least 30 minutes after powering up the Hydran M2-X or until the gas and moisture levels read by the Hydran M2-X are stable.
2. Access **Alarms > Alarms Setup > Hydran Alarm Setup** (see Section 4.3.2.1). Verify and set, as required, all parameters.
3. Access **Alarms > Alarms Setup > H2O Alarm Setup** (see Section 4.3.2.2). Verify and set, as required, all parameters.
4. Access **Alarms > Alarms Setup > Temp Alarm Setup** (see Section 4.3.2.3). Verify and set, as required, all parameters.
5. Access **Alarms > Alarms Setup > Battery Alarm Setup** (see Section 4.3.2.4). Verify and set, as required, all parameters.
6. Access **Alarms > Alarms Setup > Analog Input Alarm Setup** (see Section 4.3.2.5). Verify and set, as required, all parameters.
7. Access **Alarms > Alarms Setup > Sys. Fault Trigger** (see Section 4.3.2.6). Verify and set, as required, all parameters.

5.4.4 Verifying the Battery Voltage

1. Access Service > View Service Data.
2. Verify the battery voltage (**Battery**) exceeds 2.85 V; if it is below 2.85 V, replace the battery (see Appendix G). For the battery specifications, see Section 10.3.1.

5.4.5 Setting the Dynamic Oil Sampling System Parameters

1. Access **Setup > Temp. Setup** (see Section 4.2.4).
2. Verify and set, as required, the dynamic oil sampling system parameters. For more information, see Section 4.2.4.
3. Clear the Sensor Hist File.

5.4.6 Setting the Readings Parameters

1. Access **Setup > Readings Setup > Gas Reading Setup** (see Section 4.2.8.1). Verify and set, as required, the gas reading parameters.
2. Press **Esc** and access **H2O Reading Setup** (ses Section 4.2.8.2). Verify and set, as required, the parameters for the moisture and relative humidity average calculation.

3. Press **Esc**; verify and set, as required, the **Sens. Temp Avg Per.** parameter (used for the temperature average calculation of the sensor).

5.4.7 Configuring the Analog Input(s) (If Used)

1. Access **Service > System Config** > **Current Config**. Verify that the displayed list corresponds to the Hydran M2-X configuration. If not, access **Service > System Config** > **Detected Config**; the Hydran M2-X detects the installed configuration. Press **Save** to reboot the Hydran M2-X.
2. Access **Setup > I/O Setup > Analog In Setup** (see Section 4.2.9.1).

   Note: The following steps must be performed for each analog input interface.

3. Select the analog input interface to configure; the corresponding parameter screen is now displayed.
4. Make sure **Input Range** is set to 4–20 mA.

   *Note: Analog input interfaces are calibrated at the factory for a 0–20 mA range. However, when parameter **Input Range** is set to 4–20 mA, the interface automatically adapts to this range.*

5. In the parameter screen, scroll down the list of parameters and select option **Configuration**. The **Configuration** screen is now displayed.
6. Select **Identification** and set all parameters as desired.
7. Press **Esc** to return to the **Configuration** screen and select **Readings Setup**. Set all parameters as required.
8. Perform the verification procedure described in Section 5.2.8.

5.4.8 Configuring the Analog Output(s) (If Used)

1. Access **Service > System Config** > **Current Config**. Verify that the displayed list corresponds to the Hydran M2-X configuration. If not, access **Service > System Config** > **Detected Config**; the Hydran M2-X detects the installed configuration. Press **Save** to reboot the Hydran M2-X.
2. Access **Setup > I/O Setup > Analog Out Setup** (see Section 4.2.9.2).

   Note: The following steps must be performed for each analog output interface.

3. Select the analog output interface to configure, and then select the option **Configuration**. The **Configuration** screen is now displayed.
4. Set all parameters as required.
5. Perform the verification procedure described in Section 5.2.9.

5.4.9 Verifying the Sensor

1. Access **Service > Sensor Test** (see Section 4.5.1).

2. Press **Ok** to start the test. After a few seconds, the Hydran M2-X's display should show message **Testing Success**. If another message is displayed, see Section 9.1.

   Note: The keypad cannot be used for two minutes following a sensor test. Wait before resuming the configuration.

5.4.10 Setting the Operation Mode of the Alarm Relays

For details on relays operation, see Section 7.5; for details on operation modes of relays, see Section 7.5.3.

1. Access **Test > Relay Test** (see Section 4.5.2).
2. Verify and set, as required, the operation mode of each relay.
3. Verify the relay status is properly monitored by the SCADA or annunciator system.

5.4.11 Verifying the Sensor Parameters

1. Access **Service > Sensor Param > Gas Sensor Param** (see Section 4.6.1.1).
2. Make sure the displayed serial number, the ten parameters (B, M, N, S and A1 to A6) and the checksum all correspond to the values on the Test Certificate and Data Sheet (for an example, see Figure 4-12).
3. Press **Esc** and access **H2O Sensor Param** (see Section 4.6.1.2).
4. Make sure the displayed serial number, the ten parameters (C1 to C10) and the checksum all correspond to the values on the Test Certificate and Data Sheet.

5.4.12 Logging Values of the Service Data

1. Access Service > View Service Data.
2. Write the values of each parameter in Table B - 5.

5.4.13 Resetting the Hourly Trend, Daily Trend and Period B

Resetting the hourly trend, daily trend and **Period B** consists in changing the value of their period and then restoring them to their initial value after five minutes. Perform this operation one hour after the initial power-up.

Proceed as follows:

1. Access **Setup > Reading Setup > Gas Reading Setup**.
2. Set parameter **Hourly Tr. Period** to 1 hour.
3. Set parameter **Daily Tr. Period** to 1 day.
4. Set parameter **Hydran PPM Period B** to 0 hour.
5. Wait five minutes and set these parameters to their default value:
   - **Hourly Tr. Period** to 24 hours

- **Daily Tr. Period** to 30 days
- **Hydran PPM Period B** to 24 hours

For details on trend computations and reset, see Section 7.2.5.4.

5.4.14 Conclusion

If the configuration has been performed locally at the Hydran M2-X using Perception software:

1. Access **Setup > Comm Setup** (see Section 4.2.7.2).
2. Disconnect the RS-232 link from the Hydran M2-X's DB-9 connector.
3. Put the Hydran M2-X's cover back in place (see Figure 5-13). Ensure the gasket is properly positioned between the heater plate and the cover.
4. Insert the four retaining screws and washers.
5. Using the supplied Allen key, screw until they touch the heater plate.
6. Tighten the screws one by one diagonally.

The Hydran M2-X configuration is now completed.

WARNING

When installing the cover, 4 screws must be tightened correctly. A minimum torque of 50 lbf-in (5.6 Nm) is recommended. Failure to do so may result in water ingress inside the enclosure.

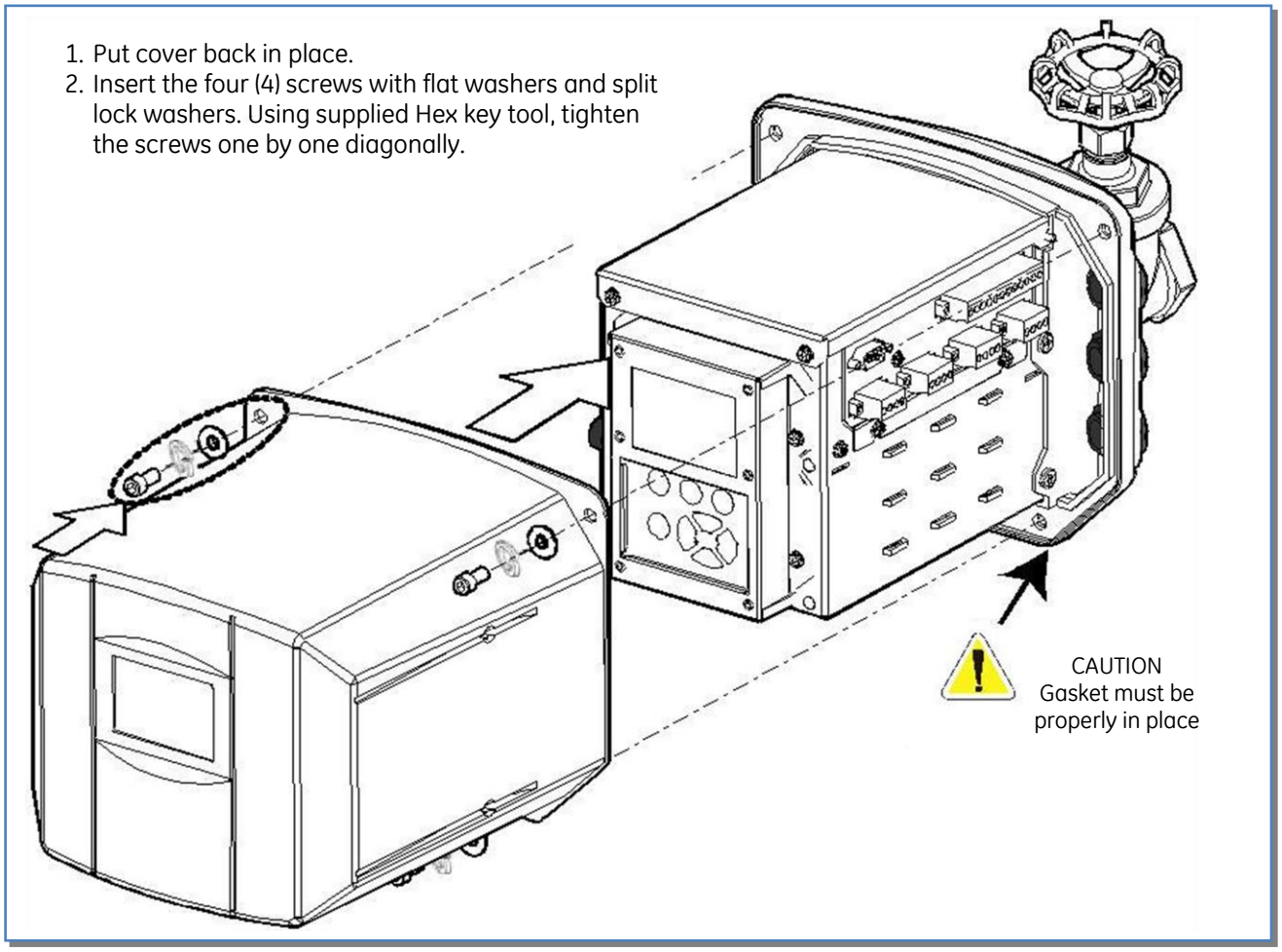


Figure 5-13: Fastening the Cover

5.5 Commissioning

1. Wait at least two hours for the Hydran M2-X to stabilize.
2. To verify the reading accuracy of the Hydran M2-X, compare the reading(s) with a recent dissolved gas analysis (DGA).
3. Log the following information and keep it in a safe place:
   - The serial number of each component of the network
   - A general description of the installation (transformer number, power station number, etc.).

The installation of the Hydran M2-X is now completed. If properly installed and maintained, the Hydran M2-X provides many years of trouble-free service.

Note: Proper adjustment of trend alarm requires an observation period of trend behavior to determine the optimal setting. See Section 7.2.5.4.

6 COMMUNICATIONS & NETWORKING

The Hydran M2-X can be used as a stand-alone unit or within a network of up to 32 Hydran M2-X's. Both configurations can be connected locally to a laptop computer, or remotely to the host computer through a modem or Ethernet (via copper wires or fiber optic).

6.1 Network Configuration Overview

As shown in the Figure below, a Hydran M2-X network is a daisy chain of Hydran M2-X's. The Hydran M2-X's in the network are connected together using an RS-485 link (for technical details, see Appendix D.1).

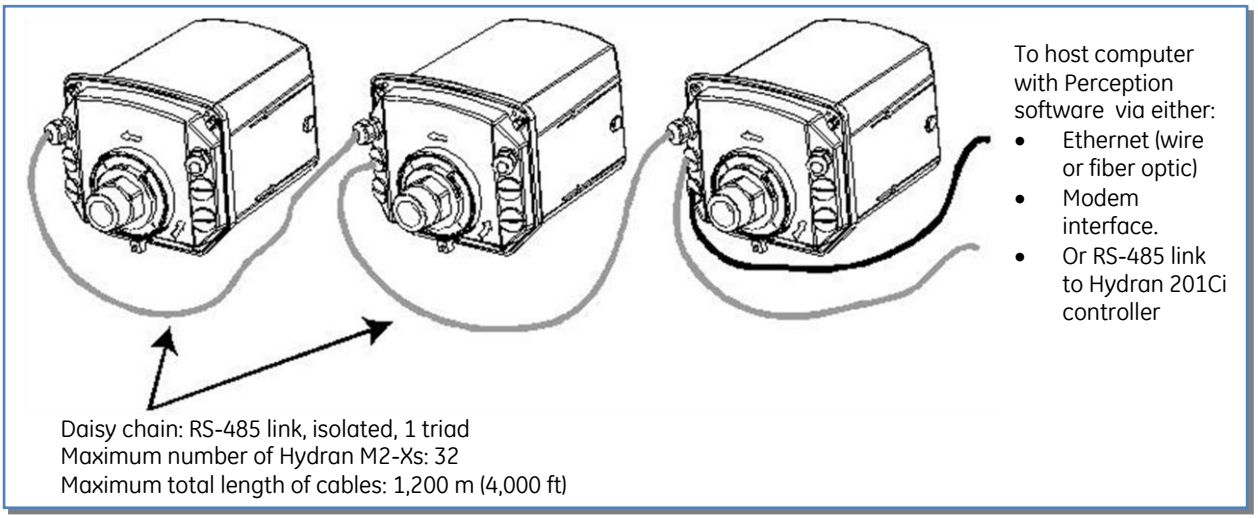


Figure 6-1: Network Overview (Daisy Chaining of Hydran M2-Xs)

LED transmitters for fiber optic are classified as IEC 60825-1 Accessible Emission Limit (AEL) Class 1. Class 1 devices are considered eye safe to the unaided eye. Do not view directly with optical instruments.

In a network, the Perception software can communicate with each Hydran M2-X individually because each one is identified by a unique identification number (**Monitor ID** parameter) set by the user (see Section 4.2.7.1).

The Hydran M2-X's manage all communications automatically (transmission and reception). Data transmission is half-duplex (one direction at a time, from a single source).

6.1.1 Local Communications with a Laptop Computer

For local communications, a single Hydran M2-X or a network of Hydran M2-X's can be linked directly to a laptop computer (see Figure 6-2) running Perception. To do this, one Hydran M2-X in the daisy chain must be temporarily linked to the laptop computer using the supplied RS-232 serial communication cable. The RS -232 cable is attached to the Hydran M2-X's DB-9 connector. The Hydran M2-X's RS-232 port should not be used for permanent connection to a computer.

Note: The maximum distance for an RS-232 local link is 7.5 m (25 ft).

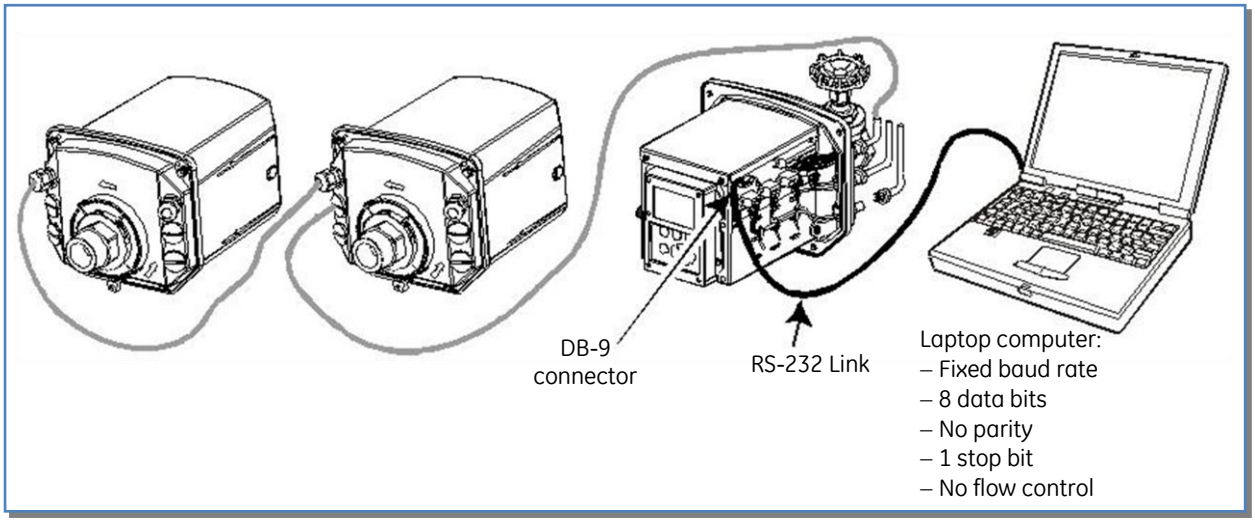


Figure 6-2: Local Communications with a Laptop Computer

6.1.2 Remote Communications with a Host Computer (via Modem)

For remote communications, a single Hydran M2-X or a network of Hydran M2-X's can be linked, through a modem, to the host computer running the Perception software. To do this, the first or last Hydran M2-X in the daisy chain must be linked to a Hydran 201Ci Controller (equipped with a modem) using a supervisory link (see Section 6.2.5). A typical configuration is shown in Figure 6-3.

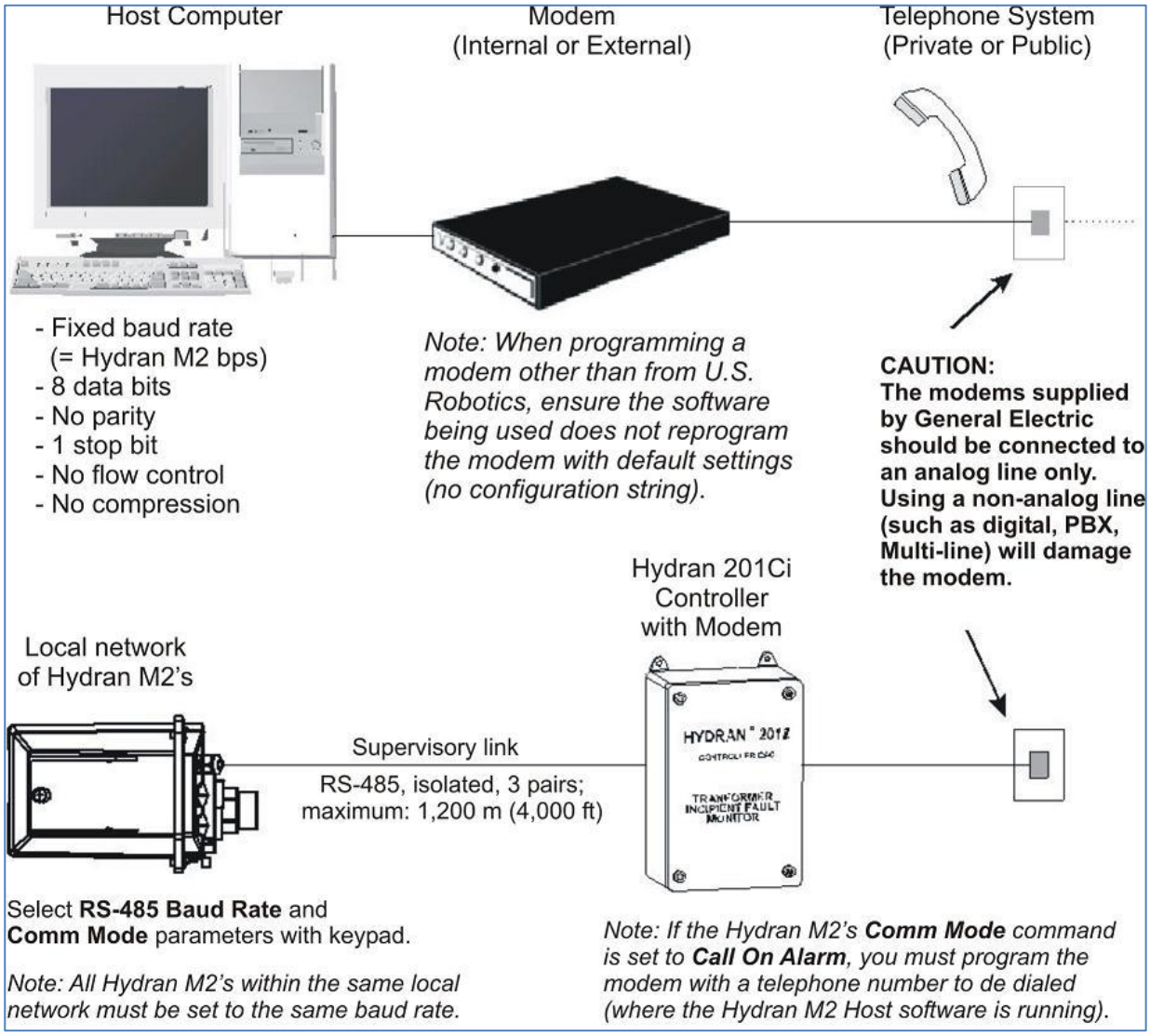


Figure 6-3: Remote Communications with a Host Computer via a Modem

6.1.2.1 Communications Modes

When using a modem, each Hydran M2-X in the network can be set to one of the following modes: **Call on Alarm** and **Answer Only**. For more information, see parameter **Comm Mode** in **Setup > Comm Setup** (see Section 4.2.7.2).

6.1.2.2 Sequence of Events in the Call on Alarm Mode

The sequence of events in the **Call on Alarm** mode is as follows:

1. An alarm condition is detected.
2. The Hydran M2-X sends, to the Hayes-compatible modem, the command indicated in the Setup > Comm Setup > Modem Dial String parameter (typically

ATS0; see Section 4.2.7.2).

3. The modem receiving this command dials the telephone number previously stored in its register 0; this number is redialed until the connection with the host computer's modem is established. Then, no other message is sent; the host computer has the responsibility to communicate with the Hydran M2-X in alarm condition.
4. The Perception software displays the alarm states and updates its data bank.
5. The user must acknowledge the alarm in the Perception software and take the appropriate measures.

6.1.3 Remote Ethernet Communications With a Host Computer (via Copper Wires or Fibre Optic)

For Ethernet communications, a single Hydran M2-X or a network of Hydran M2-X's can be linked directly to the host computer (see Figure 6-4 below) running the Perception software. To do this, one Hydran M2-X in the daisy chain must be linked to the host computer using an Ethernet cable to the Ethernet port, or a fiber optic cable to the fiber optic port.

In the case of fiber optic, the Rx and Tx connections on the Hydran M2-X must be connected respectively to the Tx and Rx connections of the fiber optic converter used with the PC.

WARNING ***The RJ-45 cable provided with the fiber optic option is not a standard Ethernet connection. Do not connect directly to a PC.***

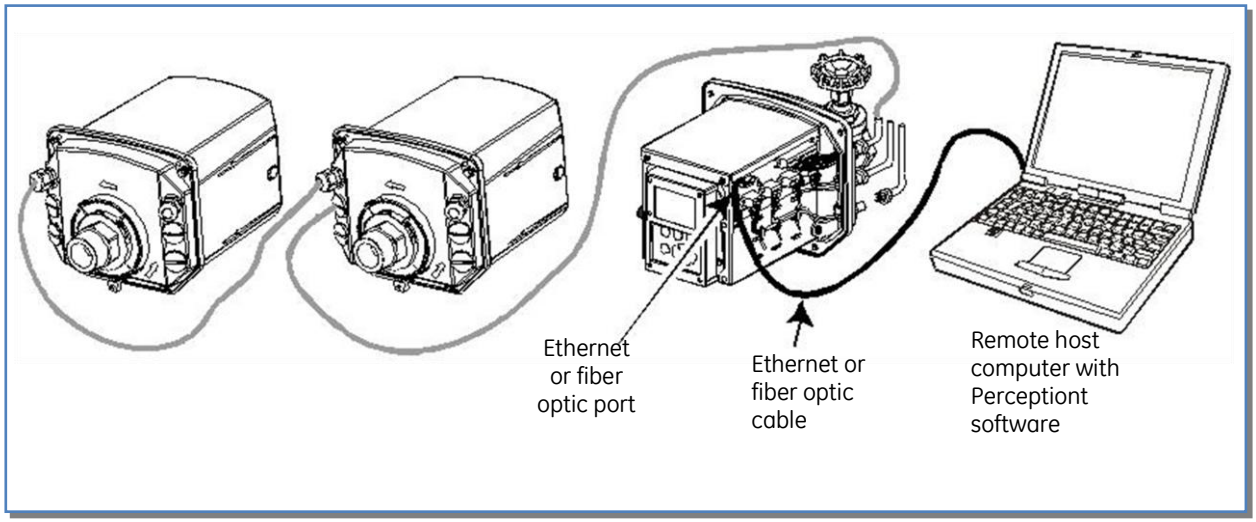


Figure 6-4: Remote Ethernet Communications with the Host Computer (Via Copper Wires or Fiber Optic)

6.1.4 Hydran Host Communication Protocol

For serial communications, General Electric Canada uses its own custom protocol. Data is transmitted in ASCII codes; data clusters being transmitted are verified and, if necessary, transmitted again. This ensures compatibility with the Hydran 201*i* System.

6.2 Installing a Network

An installation checklist is supplied in Appendix B.

6.2.1 Installing the RS-485 Network Link

Note: For information on the recommended type of cable and for wiring details, see Appendix D.1.

Proceed as follows:

1. Run the RS-485 cables through a conduit, from one Hydran M2-X to the next, to form a daisy chain.

Note: For notes and procedures regarding conduits, see Section 5.3.11. The total maximum length for all RS-485 cables in a network is 1,200 m (4,000 ft).

2. Ground each conduit at the extremity at which the RS-485 cable is connected to the RS-485 In terminals. See the Figure below. A conduit is grounded by connecting it to terminal 12 of the RS-485 terminal block.

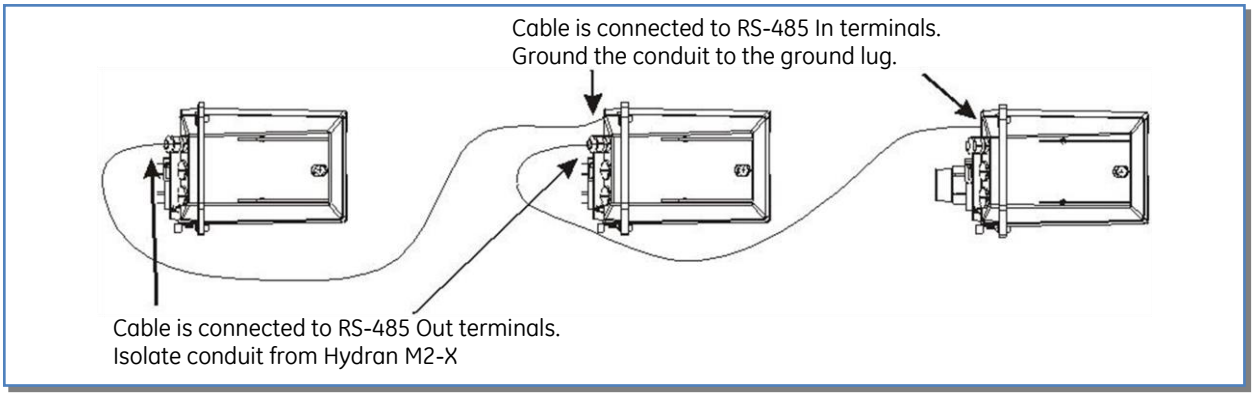


Figure 6-5: Grounding the RS-485 Conduits

3. Isolate from the Hydran M2-X the conduit extremity at which the RS-485 cable is connected to the RS-485 Out terminals. See Figure 6-5 above. Follow the
lations.
s are identified at both ends.
5. Connect the wires to the RS-485 terminal blocks.

CAUTION

The shield of each cable section must be grounded at one end only. Routing and shielding of the RS-485 cable is particularly important because all Hydran M2-X's belonging

to a network share a common reference with this link.

The operation of the complete Hydran M2-X network may be affected if wires are not connected correctly. Be careful when installing and inserting each wire. Be sure to insert all strands in the terminal; strands that touch two terminals will cause problems. Do not leave trims of metallic strands inside the Hydran M2-X's enclosure.

6.2.2 Configuring the Hydran M2-X's Communication Parameters

Note: The following procedure can only be performed using the Hydran M2-X's keypad.

Proceed as follows for each Hydran M2-X in the network:

1. Power up the Hydran M2-X.
2. Ensure it is operational (no alarm condition detected).
3. Access **Setup > Comm Setup > Identification** (see Section 4.2.7.1).
4. Set as required both identification numbers (**Power Station ID** and **Monitor ID**).
5. Press **Esc** and access the communication baud rate and the other communication parameters (see Section 4.2.7.2). Set as required the following communication parameters:
   - Set **DB9 Baud Rate** (the recommended value is 9,600 bps).
   - Set **485 Baud Rate** (identical for all Hydran M2-X's; the recommended value is 9,600 bps). Set to desired DNP or Modbus protocol.

6.2.3 Installing and Configuring a Laptop Computer

6.2.3.1 Connecting a Laptop Computer

Proceed as follows:

1. Remove the Hydran M2-X cover. Any Hydran M2-X in the network can be connected to a laptop computer.
2. Connect the supplied RS-232 cable to the Hydran M2-X's DB-9 connector (located on the right side of the electronic card cage).
3. Connect the cable's other end to one of the laptop computer's serial ports.

6.2.3.2 Configuring the Laptop Computer and Perception software

1. In Microsoft Windows, set the serial port to which the RS-232 cable is connected to the following values:
   - Fixed baud rate (must be identical to the value of the **Setup > Comm Setup > DB9 Baud Rate** Hydran M2-X parameter)
   - data bits

- No parity
- 1 stop bit
- No flow control

*Note: In Windows for example, proceed as follows to access the serial port settings: log on as administrator, click **Start**, point to **Settings**, click **Control Panel**, double-click **System**, click the **Hardware** tab, click **Device Manager** and click **Ports (COM & LPT)**.*

2. Launch the Perception software.
3. In Perception under the properties tab, configure the communication parameters.

6.2.3.3 Verifying the RS-232 Communications

Proceed as follows:

1. Using the Perception software, verify that communication is established with the Hydran M2-X. If communication cannot be established, ensure that the Hydran M2-X is connected to the appropriate serial port on the laptop computer and that it has the proper ID and baud rate. Confirm good communications in the **Relays/Analog** window of the Perception software, change the **Relay Mode** of each relay from **Force Off** to **Force On** and back; this should toggle the state of the Hydran M2-X's alarm relays.
2. After the test, in the Hydran M2-X Host software, set the **Relay Mode** of all relays back to **Normal**.

6.2.4 Installing a Hydran 201i Controller

1. Install a Hydran 201C*i* Controller (preferably a Hydran 201C*i*-C or a Hydran 201C*i*-1) equipped with an internal modem (optional; available from General Electric). For details on how to install a Hydran 201C*i* Controller, see the *Hydran 201i System Instruction Manual*.

Note: Electrical noise is one of the most important factors when selecting the location and installing a modem. Ideally, the Hydran 201Ci Controller should be located in a limited zone of an electrical substation (for example, the control room).

2. If necessary, connect the Hydran 201C*i* Controller to its modem using the supplied cable. The reception (Rx) and transmission (Tx) pins of this cable are not criss-crossed.

Note: The hardware and software of Hydran 201Ci Controllers' modems supplied by General Electric are installed, configured and tested at the factory. For configuration information, (Optional) To verify the configuration of the Hydran 201C*i* Controller's modem, proceed as follows:

- If necessary, disconnect the RS-232 link from the Hydran 201C*i* Controller.
- Connect the laptop computer to the modem.
- Verify the modem configuration using the communication software and manual supplied with the modem by General Electric.

6.2.5 Connecting a Hydran M2-X to the Hydran 201i Controller

The cable that links the Hydran M2-X to the Hydran 201C*i* Controller is called a supervisory link. Note the following considerations prior to installing:

- A supervisory link cable connected to a Hydran 201C*i*-1 or Hydran 201C*i*-4 Controller requires a cable with three twisted pairs and overall shield.
- A supervisory link cable connected to a Hydran 201C*i*-C Controller requires a cable with two twisted pairs and overall shield.

1. Run the supervisory link cable through a conduit, from the first or last Hydran M2-X in the daisy chain to the Hydran 201C*i* Controller.
2. Ensure all wires are identified.
3. Connect the wires to the Hydran M2-X's termination block. For wiring details, see Appendix D.
4. Connect the other end of the cable to the Hydran 201C*i* Controller. For wiring details, see the *Hydran 201i System Instruction Manual*.

CAUTION

The Hydran M2-X's operation may be affected if wires are not connected correctly. Be careful when installing and inserting each wire. Be sure to insert all strands in the terminal; strands that touch two terminals will cause problems. Do not leave trims of metallic strands inside the Hydran M2-X's enclosure.

7 ALARMS

This Chapter explains in detail the alarm features of the Hydran M2-X from an operator's point of view. The Hydran M2-X is a microprocessor-based instrument with sophisticated alarm features.

Note: Appendix I presents the list of all alarm messages that can appear in the Perception software. The troubleshooting procedures for the alarms due to system fault conditions are given in Section 9.

CAUTION

Wiring the alarm contacts (see Section 7.5.1) to safety tripping devices of the equipment monitored by the Hydran M2-X is not recommended because it is an early warning instrument for incipient faults. Information obtained using the Hydran M2-X should always be used in conjunction with other available information to decide if the monitored equipment should be removed from service.

This Chapter contains examples of how to set the gas alarm parameters of the Hydran M2-X. The values used are fictitious and do not correspond to any standard. General Electric Canada does not suggest nor recommend specific alarm set points for gases or moisture. It is solely the responsibility of the user to determine the appropriate settings.

7.1 Introduction

7.1.1 Setting Alarm Parameters

There are two methods to set the value of alarm parameters:

- Using the Perception software.
- Directly, using the Hydran M2-X's keypad and display. The menu system, keypad and display are explained in detail in Chapter 4.

7.1.2 Alarm Types

The Hydran M2-X is equipped with four types of alarms:

- Gas alarms.
- Moisture alarms.
- Alarms due to system fault conditions.
- Analog inputs alarms.

The gas and moisture alarms provide an *early warning of incipient faults* in transformers or any other oil-filled electrical equipment.

7.1.3 Alarm Conditions

An alarm is triggered when an *alarm condition* is detected. Each of the four alarm types has its own set of alarm conditions. Table 7-1 lists the alarm conditions monitored by the Hydran M2-X.

Source	Possible States			
Gas level	—	—	High	High-High
Gas hourly trend	—	—		
Gas daily trend	—	—		
Moisture level	—	—	High	High-High
Moisture average	—	—		
Relative humidity	—	—		
Relative humidity average	—	—		
Analog input[a]	Low-Low	Low	High	High-High
Sensor temperature[a]	Low-Low	Low	High	High-High
Base plate temperature[a]	Low-Low	Low	High	High-High
Battery voltage	Low-Low	Low	—	—
Sensor and connections	Cable[b] short	—	Replace sensor now	Cable[b] open

Table 7-1: Alarm Conditions Monitored by the Hydran M2-X

a. *The sensor temperature, the base plate temperature and each analog input could generate four alarm conditions.*

b. *Either one of the following cables (or connectors in the connection link): sensor, sensor thermistor or heater plate thermistor.*

7.1.4 Alarm Interface

The alarm interface between the Hydran M2-X and the user can take different forms. When an alarm is triggered, the following actions are generated:

1. An alarm message flashes on the Hydran M2-X's display. For the list of all alarm messages that can be displayed by the Hydran M2-X, see Appendix I. For details on the display of alarm messages, see Section 4.1.2.1.
2. The state of the corresponding alarm relay changes. The classic interface method consists in linking the relays' alarm contacts of the Hydran M2-X to an

alarm panel (or any other SCADA system) located in such a way that an alarm being triggered would immediately warn the operator. For details, see Section 8.1.2.

3. A call can be made to the host computer via modem. See Chapter 6.
4. During an alarm due to system fault conditions, the optional analog output of the Hydran M2-X drops to *zero*, and the NO fail alarm contact opens.
5. A message is recorded in the Events history file. Alarm messages are thus stored in memory. The Events file can contain up to 500 messages. Each message comes with a set of relevant parameters (gas and moisture levels, trends, etc.) and is identified with the recording date and time. For details, see Section 4.4.2.

7.2 Gas and Moisture Alarm Conditions

As listed in Table 7-1, there are a total of six gas alarm conditions (High and High-High for level, hourly trend and daily trend) and a total of eight moisture alarm conditions (High and High-High for moisture level, moisture average, relative humidity and relative humidity average).

Note: Each analog input could also generate four alarm conditions: Low-Low, Low, High and High-High.

For more information on the interpretation of gases in oil, refer to the following guides:

- IEEE* Standard C57.104-1991, "IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers"
- IEC 60599-1999, "Mineral Oil-Impregnated Electrical Equipment in Service – Guide to the Interpretation of Dissolved and Free Gases Analysis"

7.2.1 Sources

Alarms can be triggered by one or several of the following sources:

- *Gas sources*:
  - *Hydran level*: This value is *measured* by the Hydran M2-X gas detector.
  - *Hydran hourly trend*: This value is *calculated* based on the variation of gas level during a period of time ranging from 1 to 100 hours. The hourly trend is updated every five seconds.
  - *Hydran daily trend*: This value is *calculated* based on the variation of gas level during a period of time ranging from 1 to 100 days. The daily trend is updated every five minutes.

- *Moisture sources:*
  - *Relative humidity (%RH) level*: This value is *measured* by the Hydran M2-X moisture sensor.

- *Relative humidity (%RH) hourly average*: This value is *calculated* based on the relative humidity calculations made during a period of time ranging from 1 to 170 hours. The relative humidity average is updated every five seconds.
- *Moisture (H_2O ppm) level*: This value is *calculated* based on the relative humidity (%RH) and the temperature (see Appendix K.2).
- *Moisture (H_2O ppm) hourly average*: This value is *calculated* based on the moisture level readings obtained during a period of time ranging from 1 to 170 hours. The average moisture level is updated every five seconds.

7.2.2 High and High-High Conditions

The High and High-High alarm conditions are defined as follows:

- *High alarm conditions*: High conditions are set at a lower value than the corresponding High-High conditions. They are caution signs; set points for High alarm conditions should be set at values that indicate that the transformer (or other equipment) requires *closer monitoring*.
- *High-High alarm conditions*: High-High conditions are set at a higher value. They are warning signs; set points for High-High alarms should be set at values considered as critical by the user, meaning that the transformer requires *immediate action* according to standard utility procedures. In general, this alarm implies an evaluation of the equipment and its possible removal from service.

Note: Each analog input could also generate four alarm conditions: Low-Low, Low, High and High-High.

7.2.3 Detection of Alarm Conditions

Each gas and moisture alarm source has the same set of five parameters:

- Two set points: **Alarm Hi SP** and **Alarm Hi-Hi SP**
- One delay: **Alarm Delay**
- Two relay assignations: **Alarm Hi Relay** and **Alarm Hi-Hi Relay**

*Note: The parameters pertaining to gas alarm conditions are grouped in **Alarms > Alarms Setup > Gas Alarm Setup** (see Section 4.3.2.1). Those for moisture alarm conditions are grouped in **Alarms > Alarms Setup > H2O Alarm Setup** (see Section 4.3.2.2).*

A gas or moisture alarm condition is detected when a source *exceeds* one of its two set points for a period of time exceeding its delay. Upon detection, the relay assigned to this alarm condition is activated (energized) and a message appears on the display (see Section 4.1.2.1).

*Note: The above explanation is true if this relay is set to the **Normal** or **Latch** mode. For more information, see Section 7.5.*

7.2.4 Setting the High Alarm Condition

Before setting the gas or moisture level High alarm condition, the gas and moisture level readings should be monitored over a minimum period of two weeks. A simple method to monitor this value is to consult the Hydran M2-X's history files using its keypad (see Section 4.4.2).

Follow these rules:

- Adjust the High set point above the highest reading that was obtained.
- Adjust the High set point low enough to detect the earliest sign of an abnormal increase of gas.
- But set it at a value high enough to minimize the likelihood of unnecessary alarms.

Table 7-2 below contains *suggested* guidelines for setting the *gas level High alarm condition*, according to the maximum reading obtained during the monitoring period.

CAUTION

This Chapter contains examples of how to set the gas alarm parameters of the Hydran M2-X. The values used are fictitious and do not correspond to any standard. General Electric does not suggest nor recommend specific alarm set points for gases or moisture. It is solely the responsibility of the user to determine the appropriate settings.

Hydran M2-X Maximum Reading Obtained During the Monitoring Period	**Minimum Suggested Alarm Set Point** to Reduce the Risks of Unnecessary Alarms
Below 70 ppm	100 ppm
From 70 to 400 ppm	1.5 times the highest Hydran M2-X reading
Above 400 ppm	200 ppm above the highest Hydran M2-X reading

Table 7-2: Suggested Guidelines for Setting the Gas Level High Alarm Condition

7.2.5 Gas Hourly and Daily Trend Alarm Conditions

7.2.5.1 Purpose of Gas Hourly and Daily Trends

Detection of hourly and daily trend alarm conditions is a unique feature of the Hydran M2-X that provides early warning of slowly increasing gas levels.

For example, let us consider a transformer with a 50-ppm gas level and a gas level High alarm set point of 150 ppm.

Note: An increase of 25 ppm or more per month requires investigation.

- If no trend alarm condition is used and if the gas level reading starts increasing at the rate of 50 ppm per month (twice the concern rate), it will take two months before the gas level High alarm condition is detected and the investigation of the possible causes of the increase begins.
- If the *daily trend* High alarm condition is used and its alarm set point adjusted to 25 ppm, its period to 30 days and its alarm delay to 33 % of the period (10 days), the alarm would occur approximately 23 days after the beginning of the gas level increase. Investigation of the possible causes could thus start five weeks earlier. For details on trend computations, see Section 7.2.5.2.

7.2.5.2 Gas Hourly and Daily Trend Computations

A unique computation method is used for both the hourly and daily trends. In these computations, the gas level reading is processed through a first- order, digital, low -pass filter; the trend reading (slope) is then extracted using a first-order, digital, high-pass filter. The time constants for both filters are set to 33 % of the trend period for optimum results.

Table 7-3 and Table 7-4 below show two examples of trend computations.

Example 1: The gas level starts to increase at a rate of 10 ppm/24 hours. The hourly trend period is set to 24 hours.

Initial	After 8 hours	After 24 hours	After 48 hours
0 ppm/24 h	+4 ppm/24 h	+9 ppm/24 h	+10 ppm/24 h

Table 7-3: Evolution of the Gas Hourly Trend

Example 2: The gas level starts to increase at a rate of 50 ppm/30 days. The daily trend period is set to 30 days.

Initial	After 10 days	After 30 days	After 60 days
0 ppm/30 d	+20 ppm/30 d	+45 ppm/30 d	+50 ppm/30 d

Table 7-4: Evolution of the Gas Daily Trend

Note the following points:

- If the Hydran M2-X undergoes a power failure that lasts less than 1/6 of the trend period, the corresponding trend reading remains unchanged when the Hydran M2-X is powered up again.
- If the power failure lasts more than 1/6 of the trend period, the corresponding trend reading is reset to 0.0 ppm/period.
- If the user changes the hourly or daily trend period, the corresponding trend reading is reset to 0.0 ppm/period.

7.2.5.3 Guidelines for the Periods of Gas Trends

Here are a few guidelines on how to set the hourly and daily trend periods:

- The hourly trend period should be long enough to filter out reading fluctuations caused by short-term changes in ambient conditions and transformer operation. The factory default of 24 hours is a good starting value.
- The longer the trend period, the higher the trend value in ppm will be for a given steady increase in gas level reading. For example, a constant gas level increase of 10 ppm/24 hours will result in a 10 ppm/period reading if the period is set to 24 hours, but in a 20 ppm/period reading if the period is set to 48 hours.
- The longer the period, the smoother the trend readings will be. However, it will take longer for the trend to stabilize ("taper off ") to its final value. In the preceding example, it would take two days to obtain the final value of 10 ppm/24 hours; in the second case, it would take four days to reach the final value of 20 ppm/48 hours.

7.2.5.4 Guidelines for Setting Alarm Conditions of Gas Trends

Hourly and daily trend High and High-High alarm condition settings cannot be described in terms of absolute criteria. They are related to the user's field experience and the utility's standard practice. This Section provides a few guidelines to optimize both the hourly and daily trend alarm conditions.

1. The readings of the Hydran M2-X should be monitored over a minimum period of two to three times the trend period before setting these parameters. Follow the same rules as for the gas level High alarm condition listed in Section 7.2.4.
2. If a fast response to a sudden gas level increase is needed, it is best to rely on the gas level alarm conditions rather than on trend alarm conditions. Trend alarm conditions are ideal to detect slow and steady changes from fluctuating readings, but are not as good to detect abrupt changes.
3. The transformer (or other equipment) past history and the user's field experience are the most important criteria for alarm condition settings. If existing, records of previous dissolved gas analysis (DGA) for the equipment monitored should be used to help determine alarm condition settings in general and especially for the daily trend.

4. Trend alarm delays should be set according to each trend period (see guidelines in Section 4.2.8.1). For example:
   - If the hourly trend period is set to four hours, the hourly trend reading may show quite large, but short, positive and negative peaks during a day. In this case, an hourly trend alarm delay of 50 to 75 % of the period could avoid unnecessary alarms.
   - However, if the hourly trend period is set to 48 hours, daily fluctuations would not affect the trend reading significantly. In this case, the alarm delay could be set to 10 to 20 % of the period.

7.3 System Fault Conditions

An alarm due to system fault conditions warns the operator that the Hydran M2-X is not functioning properly. Such an alarm must therefore be verified and solved rapidly because it indicates that the *monitoring* system (the Hydran M2-X) of the transformer is faulty.

Note: An alarm due to system fault conditions does not concern the transformer.

7.3.1 Sources

An alarm can be triggered by one or several of the following system fault conditions:

- Sensor temperature (Low-Low, Low, High or High-High)
- Base plate temperature (Low-Low, Low, High or High-High)
- Battery voltage (Low-Low or Low)
- Sensor condition
- Faulty connection
- Power supply voltage loss
- Internal software loss
- Internal set-up loss

7.3.2 System Fault Triggers

System fault triggers are alarm conditions that can produce two actions:

- Display a message on the Hydran M2-X screen. The alarm message is displayed only if the corresponding alarm set point is adjusted to a value; if not, it is set to **Off**.
- Trigger the relay for the alarm due to the system fault condition, if the corresponding system fault trigger is turned **On** in **Alarms > Alarms Setup > Sys. Fault Trigger**.

Note: The alarm set point adjustment has priority over the relay triggering. In other words, the state of the relay is not changed if the alarm set point is adjusted to ***Off****.*

Some of the system fault conditions have High and High-High alarm set points and an alarm delay. These conditions are therefore detected the same way as the gas or moisture High and High-High alarms: the alarm due to system fault conditions is triggered when one of the system fault conditions *exceeds* the corresponding alarm set point for a period of time exceeding its alarm delay.

Other system fault conditions have Low and Low-Low alarm levels. For these conditions, the alarm due to system fault conditions is triggered when one of the system fault conditions is *lower than* the corresponding alarm set point during a period of time exceeding its alarm delay.

7.3.2.1 Hydran Sensor Temperature Alarm Conditions

The parameters pertaining to these alarm conditions are presented in Table 7-5 6-5 below. The sensor temperature is measured using a thermistor in the sensor.

Description[a]	Priority	Alarm Set Point[c]	Fault Trigger[d]
Low-Low sensor temperature	High	Alarm Lo-Lo SP	S. Temp L-Low Alr
Low sensor temperature		Alarm Low SP	S. Temp Low Alarm
High sensor temperature[b]		Alarm Hi SP	S. Temp Hi Alarm
High-High sensor temperature[b]		Alarm Hi-Hi SP	S. Temp Hi-Hi Alarm

Table 7-5: Hydran Sensor Temperature Alarm Conditions

a. *All conditions likely indicate a faulty heating system.*
b. *The High and High-High alarms could be caused by a very high oil temperature.*
c. *Found in* ***Alarms > Alarms Setup > Temp. Alarm Setup > Sensor Temp. Alarm***
d. *Found in* ***Alarms > Alarms Setup > Sys. Fault Trigger***

7.3.2.2 Base Plate Temperature Alarm Conditions

The parameters pertaining to these alarm conditions are presented in Table 7-6 below. The heater plate temperature is measured using two thermistors in the heater plate.

Description[a]	Priority	Alarm Set Point[c]	Fault Trigger[d]
Low-Low base plate temperature	High	Alarm Lo-Lo SP	B.P. Temp L-Low Alr
Low base plate temperature		Alarm Low SP	B.P. Temp Low Alarm
High base plate temperature[b]		Alarm Hi SP	B.P. Temp Hi Alarm
High-High base plate temperature[b]		Alarm Hi-Hi SP	B.P. Temp Hi-Hi Alarm

Table 7-6: Base Plate Temperature Alarm Conditions

a. *All conditions likely indicate a faulty heating system.*
b. *The High and High-High alarms could be caused by a very high oil temperature.*
c. *Found in **Alarms > Alarms Setup > Temp. Alarm Setup > Heater Plate Temp. Alarm***
d. *Found in **Alarms > Alarms Setup > Sys. Fault Trigger***

7.3.2.3 Battery Voltage Alarm Conditions

The parameters pertaining to the alarm conditions are presented in Table 7-7 below.

Description[a]	Priority	Alarm Set Point[c]	Fault Trigger[d]
Low-Low battery voltage	Average	Alarm Lo-Lo SP	Battery L-Low Alr
Low battery voltage	Very Low	Alarm Low SP	Battery Low Alarm

Table 7-7: Battery Voltage Alarm Conditions

a. *Battery should be replaced.*
b. *Battery replacement should be planned for the next transformer maintenance.*
c. *Found in **Alarms > Alarms Setup > Battery Alarm Setup***
d. *Found in **Alarms > Alarms Setup > Sys. Fault Trigger***

For explanations on the battery, see Section 3.3.4.1. For the specifications, see Section 10.3.1. Should you need to replace the battery, see Appendix G.

7.3.2.4 Sensor Operation and Connections Alarm Conditions

A sensor test is automatically performed on the first and fifteenth days of each month at midnight, and relevant parameters are recorded in the Service history file. The test can also be forced manually (in **Test > Sensor Test > H2 Sensor Test**; see Section 4.5.1), but this result is not recorded.

The parameters pertaining to the sensor operation and connections alarm conditions are presented in Table 7-8 below.

Description[a]	Priority	Alarm Set Point[c]	Fault Trigger[d]
Replace Sensor Alarm	Very high	None	Hyd. Rep.Sen.Alr
Cable[b] short			Hyd. C.Short Alarm
Cable[b] open			Hyd. C.Open Alarm

Table 7-8: Sensor Operation and Connections Alarm Conditions

7.4 Alarm Cancellation

Proceed as follows:

1. Find and solve the problem. For gas alarm conditions, the Hydran M2-X's reading generally must be verified by sampling the transformer's oil and performing a dissolved gas analysis (DGA).
2. Acknowledge the alarm using the Hydran M2-X's keypad (see Section 4.1.2.1) or the Perception software (see the *Perception Software Manual*). The alarm message should disappear from the Hydran M2-X's display.
3. If any, verify the value of the corresponding alarm delay. Ensure you wait until this period of time is over.

Note: To cancel an alarm condition that has an alarm delay, the alarm condition that triggered the alarm must disappear during a period of time exceeding its alarm delay.

4. Verify if the alarm condition is listed in the Main Display mode (see Section 4.1.2.3). If present, the problem was not corrected; start over from step 1.

7.5 Alarm Relays

The Hydran M2-X has five alarm relays. Typically the relays are assigned to alarm conditions as follows:

- Relay 1 to gas High alarm conditions
- Relay 2 to gas High-High alarm conditions
- Relay 3 to moisture High alarm conditions
- Relay 4 to moisture High-High alarm conditions
- Relay 5 to system fault conditions (this relay cannot be reassigned)

Note: Several conditions can be assigned to one alarm relay.

7.5.1 Alarm Contacts

Each relay has:

- A normally open (NO) contact
- A normally closed (NC) contact

- A common contact (type C)

Table 7-9 below lists the possible states of the alarm contacts.

	Off	On
NO contact	Contact open	Contact closed
NC contact	Contact closed	Contact open

Table 7-9: Possible Sates of the Alarm Contacts

All contacts are available on the alarm terminal block. See Figure 3-6.

7.5.2 States of Alarm Relays

Relays can only be in two states: On (coil energized) or Off (coil de-energized). Table 7-10 lists the possible states of all relays.

AC Power	Alarm	Relays			TDM Signal
		1 or 2	3 or 4	Fault[a]	
OK	None	Off	Off	On	Normal
OK	Alarm 1 or 2	On	Off	On	High or High-High
OK	Alarm 3 or 4	Off	On	On	-
OK	System fault	-	-	Off	System fault
Out	-	Off	Off	Off	System fault

Table 7-10: Possible States of All Relays

a. On = normal (no alarm); Off = alarm

The state of each relay can be determined as follows:

- By displaying each relay state on the Hydran M2-X's display.
- By verifying the state of the alarm contacts on the corresponding terminal block.

7.5.3 Operation Modes of the Alarm Relays

The mode of each alarm relay is set using the corresponding **Relay #x Mode** parameter in **Setup > Relay Setup > Relay Test** There are four operation modes:

- **Normal**
- **Latch**
- **Force On**
- **Force Off**

The Hydran M2-X's five alarm relays are independent. A relay can therefore be set to any operation mode regardless of the mode of the other relays.

7.5.3.1 Normal Mode

In this mode, the relay state changes if an alarm condition is detected for a period of time exceeding the corresponding alarm delay; the relay returns to its former state when the alarm condition disappears for a period of time exceeding the same alarm delay. The Normal mode is the default setting.

7.5.3.2 Latch Mode

In this mode, the relay state changes if an alarm condition is detected for a period of time greater than the corresponding alarm delay; the relay returns to its former state when the alarm condition disappears for a period of time greater than the same alarm delay *and* if the alarm has been acknowledged by the user (using the Hydran M2-X's keypad or using Perception software).

7.5.3.3 Normal and Latch Modes

In the **Normal** and **Latch** modes:

- Alarm relays 1 to 4 are *energized* when an alarm condition is detected.
- The system fault relay 5, however, is *de-energized* when an alarm condition is detected. The system fault relay is thus *energized* (NO contacts closed and NC contacts open) if there is no alarm condition.

7.5.3.4 Force Off Mode

In this mode, the relay does not respond to changes in alarm conditions; the relay's power always remains off. This mode is used mainly to test the alarm relays or disable an alarm circuit.

7.5.3.5 Force On Mode

In this mode, the relay does not respond to changes in alarm conditions; the relay's power always remains on. This mode is used mainly to test the alarm relays or disable an alarm circuit.

8 OPERATION

WARNING ***Read all warnings and recommendations in Chapter 2 before proceeding with the operation.***

8.1 Operating Methods

The Hydran M2-X can be operated using several methods. Each of these methods is explained in the following pages, from the simplest to the most powerful one:

- Periodic, visual monitoring (see Section 8.1.1)
- Alarm monitoring (see Section 8.1.2)
- Analog output monitoring (see Section 8.1.3)
- Combined alarm and analog output monitoring (see Section 8.1.4)
- Local monitoring with a laptop computer (see Section 8.1.5)
- Remote monitoring with host computer (see Section 8.1.6)

8.1.1 Periodic, Visual Monitoring

Among the Hydran M2-X operating methods, the *periodic, visual monitoring* is the simplest. If used, the following routine must be an integral part of the on-site, station inspection:

- Periodic, visual reading (once or twice a day) of the gas and moisture level on the display of the Hydran M2-Xs.
- On-site verification of alarms messages on the display of the Hydran M2-X's. For details on the alarms, see Section 4.1.2.1 and Section 4.2.1.
- Manual logging of above results

Only basic training to the station's personnel is required to implant this operating method. When an alarm is detected, the operator must report the alarm and take the appropriate actions for this type of alarm (follow the regulations and practices of the company).

If more information on data access is needed, refer to Section 8.2.

Note: With this method, the optional analog output and the alarm contacts are not connected to a SCADA system.

8.1.1.1 Method Drawbacks

The *periodic, visual monitoring* method has a long response time following the detection of an alarm, equal to the period of time between two inspections.

8.1.2 Alarm Monitoring

The *alarm monitoring* method solves the disadvantages of the *periodic, visual monitoring* method as follows:

- Connecting the alarm contacts to an alarm panel (or any other SCADA system) located in the station's control room.
- Continuous alarm monitoring.
- Visual, periodic (weekly) reading of the gas and moisture levels on the display of the Hydran M2-X's (for details, see Section 8.2).
- Manual logging of gas level readings.

For details on the alarms and relays operation, see Chapter 7.

8.1.2.1 Method Drawbacks

The *alarm monitoring* method solves the response time inadequacy of the *periodic, visual monitoring* method, but does not provide any information to anticipate and prevent alarms.

Moreover, there is no information immediately available for an evaluation of the severity of this alarm. A site inspection is required to perform the alarm evaluation.

8.1.3 Analog Outputs Monitoring

The *analog outputs monitoring* (gas and moisture level monitoring via the analog output) solves the disadvantages of the *alarm monitoring* method as follows:

- Connecting the Hydran M2-X's optional analog outputs to a SCADA system. The Hydran M2-X has analog outputs that allow you to monitor the gas and moisture level evolution.
- Using a SCADA system to generate alarms based on the collected data.
- Visual, periodic (weekly) reading of the gas and moisture levels on the display of the Hydran M2-X's (for details, see Section 8.2).

It is recommended to use a SCADA system that offers the following advantages:

- Gas and moisture level readings from the control room.
- Regular processing data analysis.
- Detection of any alarm when the specified alarm conditions are present. The system's response time must be short enough for the application's needs.
- Safe storage of the history files data in a format that allows easy analysis from a host computer.

8.1.3.1 Method Drawbacks

The *analog outputs monitoring* has the following disadvantages:

- Analog outputs are generally sensitive to electric noise. Care must be taken in cable installation and data interpretation.
- Each Hydran M2-X output must be cabled individually.

- Analog outputs carry only one type of information in only one direction: the gas or moisture level in oil.
- The Hydran M2-X trend computation and alarms are not available.

8.1.4 Combined Alarm and Analog Outputs Monitoring

As the name implies, this method combines the two previous monitoring methods:

- Although all alarms are now available at the same time, important information is still confined to the Hydran M2-X.
- Accessing the Hydran M2-X is still required to modify operation parameters.
- The amount of cabling required is high. For each Hydran M2-X, a minimum of seven pairs of wires is required to connect the analog outputs and the four sets of alarm contacts. To *receive* this information, four digital inputs and two analog inputs must be available in the SCADA system for each Hydran M2-X.

8.1.5 Local Monitoring With a Laptop Computer

The *local monitoring with a laptop computer* method consists of connecting a laptop computer running the Perception software to a Hydran M2-X using the local RS-232 serial communication link.

The Perception software performs numerous tasks, among which:

- Data reading (gas and moisture level, hourly and daily trends, etc.)
- Immediate detection of all alarms and their acknowledgment by the user
- Modification of alarm settings and other parameters
- History data upload and reading from one or several Hydran M2-X's
- Visualization of readings from up to four external sensors (optional)

For details, see the *Perception Software Manual*.

Note: Other software can be run on the laptop computer at the same time as the Perception software.

8.1.5.1 Method Benefits

The advantages of this method are as follows:

- Gas and moisture level monitoring can be fully integrated to the transformer or station monitoring.
- Cabling is minimized.
- Reliability and performances are greater than those of methods based only on alarms and analog outputs monitoring.
- The use of network electronic intelligent devices (such as the Hydran M2-X) is a mature technology with an extensive future.

8.1.6 Remote Monitoring With a Host Computer

The *remote monitoring with host computer* method consists of connecting a host computer running the Perception software to a Hydran M2-X or a network of Hydran M2-X's, through a modem connection or an Ethernet network. See Chapter 6.

Remote monitoring offers the same features and benefits as local monitoring, plus:

- Each power station can have its own, independent network.
- The station can be entirely automated (unmanned).
- A remote computer could monitor several stations from one location.

8.2 Data Reading

Data (gas and moisture level, hourly and daily trends, alarm messages, etc.) can be read as follows:

- Direct reading (Section 8.2.1).
- Reading of the history files data (Section 8.2.2).

8.2.1 Direct Data Reading

Data can be read directly as follows:

- *With the Hydran M2-X*: Its user interface includes a keypad and a display. For details, see Chapter 4.
- *With the Perception software*: A host computer running the Perception software remains the easiest way to read data. The host computer screen provides a more convenient interface than the one of the Hydran M2-X. For details, see the *Perception Software Manual*.

8.2.2 History Files Data Reading

The history files consist of information (self-explanatory message, date and time of occurrence, etc.) loaded by the Hydran M2-X when an event happens (alarm triggering, parameter modification by the user, etc.) and at fixed, configurable logging rates.

History files can be read as follows:

- *With the Hydran M2-X*: Simply access the **History** submenu with the Hydran M2-X's keypad. For details, see Section 4.4.2.
- *With the Perception software*: The Hydran M2-X's history files can be accessed easily using the Perception software. Simply download the history files from the Hydran M2-X.

9 TROUBLESHOOTING

WARNING

Read all warnings and recommendations in Chapter 2 before attempting one of the troubleshooting procedures listed in this Chapter.

The following useful references help to understand the instructions given in this Chapter:

- Alarms operation (see Chapter 7).
- Display of Hydran M2-X's alarm messages (see Section 4.1.2.1).

9.1 Alarm Messages that can be Displayed due to System Fault Conditions

Appendix I presents the list of all alarm messages that can be displayed by the Hydran M2-X. This Section contains, in alphabetical order, all alarm messages that can be displayed due to system fault conditions.

9.1.1 Battery L-Low Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: Low-Low battery voltage.
- *Alarm message on the Perception software*: Battery Low-Low.
- *Priority*: Average.
- *Parameter(s) involved*:
  - **Batt. LL**; **SysOK Relay;FaultTrig.** submenu; see Section 4.2.3.
  - **Batt.Alr LL** (alarm set point); **Service;VoltPile** submenu; see Section 4.3.2.3.
  - **BattAlr Delay**; **Service;VoltPile** submenu; see Section 4.3.2.4.
- *Alarm cause(s):* Battery voltage below the Alarm Lo-Lo SP alarm set point.

Replace the battery within the next three months. For details, see Appendix G.

9.1.2 Battery Low Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: Low battery voltage.
- *Alarm message on thePerception software*: Battery Low.
- *Priority*: Very low.
- *Parameter(s) involved*:
  - **Batt. L**; **SysOK Relay;FaultTrig.** submenu; see Section 4.2.3.

- **Batt.Alr L** (alarm set point); **Service;VoltPile** submenu; see Section 4.3.2.4.
- **BattAlr Delay**; **Service;VoltPile** submenu; see Section 4.3.2.4.

- *Alarm cause(s)*: Battery voltage below the **Alarm Low SP** alarm set point.

Replace the battery within the next nine months. For details, see Appendix G.

9.1.3 B.P. Temp Hi Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: High base plate temperature.
- *Alarm message on the Perception software*: Base Plate Temp High.
- *Priority*: High.
- *Alarm cause(s)*: Temperature of the base plate above the **Alarm Hi SP** alarm set point.

9.1.4 B.P. Temp Low Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: Low base plate temperature.
- *Alarm message on the Perception software*: Base Plate Temp Low.
- *Priority*: High.
- *Alarm cause(s)*: Temperature of the base plate below the **Alarm Low SP** alarm set point.

9.1.5 B.P. Tmp C. Open Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: Low-Low base plate temperature.
- *Alarm message on the Perception software*: Base Plate Temp Cable Open.
- *Priority*: High.
- *Alarm cause(s)*: Temperature of the base plate below the **Alarm Lo-Lo SP** alarm set point.

9.1.6 B.P. Tmp C. Short Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: High-High base plate temperature.
- *Alarm message on the Perception software*: Base Plate Temp Cable Short.
- *Priority*: High.

- *Alarm cause(s)*: Temperature of the base plate above the **Alarm Hi-Hi SP** alarm set point.

9.1.7 Gas C.Open Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: Cable open (not connected).
- *Alarm message on the Perception software*: H2 Sensor Test Cable Open.
- *Priority*: Very high (repair cable immediately).
- *Parameter(s) involved*:
  - **CableOpen**; **SysOK Relay;FaultTrig.** submenu; see Section 3.2.3
  - No set point nor delay
- *Alarm cause(s)*: Faulty connection with one of the following cables:
  - Hydran M2-X sensor cable.
  - Sensor thermistor cable (reading of -75 °C during one minute).
  - Heater plate thermistor cable (reading of -75 °C during one minute).

Proceed as follows:

1. Identify the cable that triggers the alarm.
   - Verify if the **SensorTemp** value in the **Temperature** submenu displays -75 °C. If so, the sensor thermistor cable (or a connector in the chain of connections) is the one causing the alarm.
   - Verify if the **HeaterTemp** value in the extended **Temperature** submenu displays -75 °C. If so, the heater plate thermistor cable (or a connector in the chain of connections) is the one causing the alarm.
   - If the two above temperature readings are correct, execute the **Force Sensor Test** command in the **Service** submenu. If the result is different than **Good**, the sensor cable is probably the one causing the alarm.
2. Locate the corresponding cable and connectors in the Hydran M2-X (see Section 3.3).
3. Verify thoroughly the chain of connections for this cable, including the connectors.
4. Once the problem is fixed, perform another sensor test to reset the Hydran M2-X and cancel the alarm.
5. Wait at least two minutes. Verify the alarm has disappeared and, if applicable, the corresponding temperature has returned to a normal value.

9.1.8 Gas C. Short Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: Short-circuited cable.
- *Alarm message on the Perception software*: H2 Sensor Test Cable Short.
- *Priority*: Very high (repair cable immediately)
- *Parameter(s) involved*:
  - **CableShort**; **SysOK Relay;FaultTrig.** submenu; see Section 4.2.3.
  - No set point nor delay.

- *Alarm cause(s)*: Faulty connection with one of the following cables:
  - Sensor cable.
  - Sensor thermistor cable (reading of 200 °C during one minute).
  - Heater plate thermistor cable (reading of 200 °C during one minute).

Proceed as described for the **Gas C.Open Alarm** (see Section 9.1.7), but replace all mentions of "-75 °C" with "200 °C".

9.1.9 Gas Sens. Bad Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: Replace sensor now.
- *Alarm message on thePerception software*: H2 Sensor Test Bad.
- *Priority*: Very high.
- *Parameter(s) involved*:
  - **SensRep Now**; **SysOK Relay;FaultTrig.** submenu; see Section 4.2.3.
  - No set point nor delay.
- *Alarm cause(s)*: The sensor sensitivity has dropped significantly or the sensor is not functioning.

Replace the sensor as soon as possible.

Note: The Hydran M2-X's sensor is verified twice a month (the first and fifteenth days of the month at midnight); the relevant parameters are recorded in the Service history file. This test can also be performed manually using the ***Force Sensor Test*** *command (in the* ***Service*** *submenu), but no results are recorded. In both cases, one of the following two messages is displayed if the test fails:* ***Gas Sens. Weak Alr*** *or* ***Gas Sens. Bad Alr****.*

9.1.10 S. Card Comm Err Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: Communication error alarm.
- *Alarm message on thePerception software*: Sensor Comm. Failure.
- *Priority*: High.

9.1.11 S. Temp C. Open Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: Low-Low sensor temperature.
- *Alarm message on the Perception software*: Sensor Temp Cable Open.
- Priority: High.
- *Parameter(s) involved*:

- **SensTemp LL**; **SysOK Relay;FaultTrig.** submenu; see Section 4.2.3.
- **STempAlr LL** (alarm set point); **Temperature** submenu; see Section 4.3.2.1.
- **TempoAlr Delay**; **Temperature** submenu; see Section 4.3.2.1.

- *Alarm cause(s)*: Temperature of the sensor below the **Alarm Lo-Lo SP** alarm set point

The sensor sensitivity is very low; repair the Hydran M2-X's dynamic oil sampling system.

9.1.12 S. Temp Hi Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: High sensor temperature.
- *Alarm message on the Perception software*: Sensor Temp High.
- *Priority*: High.
- *Parameter(s) involved*:
  - **SensTemp H**; **SysOK Relay;FaultTrig.** submenu; see Section 4.2.3.
  - **Alarm Hi SP** (alarm set point); **Temperature** submenu; see Section 4.3.2.1.
  - **TempoAlr Delay**; **Temperature** submenu; see Section 4.3.2.1.
- *Alarm cause(s)*: Temperature of the sensor above the **Alarm Hi SP** alarm set point.

Although the sensor is not affected by the temperature, monitor its temperature regularly.

9.1.13 S. Temp Low Alarm

- *Alarm type*: Due to system fault conditions.
- *Non-abbreviated description*: Low sensor temperature.
- *Alarm message on the Perception software*: Sensor Temp Low.
- *Priority*: High.
- *Parameter(s) involved*:
  - **SensTemp L**; **SysOK Relay;FaultTrig.** submenu; see Section 4.2.3.
  - **STempAlr L** (alarm set point); **Temperature** submenu; see Section 4.3.2.1.
  - **TempoAlr Delay**; **Temperature** submenu; see Section 4.3.2.1.
- *Alarm cause(s)*: Temperature of the sensor below the **Alarm Low SP** alarm set point.

Although the sensor is not affected by the temperature, monitor its temperature regularly.

9.1.14 S. Tmp C. Short Alarm

- *Alarm type*: Due to system fault conditions.

- *Non-abbreviated description*: High-High sensor temperature.
- *Alarm message on thePerception software*: Sensor Temp Cable Short.
- *Priority*: High.
- *Parameter(s) involved*:
  - **SensTemp HH**; **SysOK Relay;FaultTrig.** submenu; see Section 4.2.3.
  - **STempAlr HH** (alarm set point); **Temperature** submenu; see Section 4.3.2.1.
  - **TempoAlr Delay**; **Temperature** submenu; see Section 4.3.2.1.
- *Alarm cause(s)*: Temperature of the sensor above the **Alarm Hi-Hi SP** alarm set point.

CAUTION ***The sensor can be damaged if exposed to temperatures above the Alarm Hi-Hi SP alarm set point.***

Proceed as follows:

1. The oil is probably too hot at the location where the sensor is installed; install the Hydran M2-X at another location on the transformer tank, preferably at the bottom. For details on typical installations, see Section 5.3.1.
2. If not already done, install the finned, high-temperature adaptor shown in Figure A-6. This adaptor is available at General Electric.

9.2 RS-232 and RS-485 Communications

9.2.1 No Communication when the Host or Laptop Computer is Connected Directly or by Modem to the Hydran M2-X's DB-9 Connector

1. Ensure the Hydran M2-X's CommChannel parameter (communication channel; Communication submenu; see Section 4.2.7) is set to H201Ti-DB9.
2. Ensure the Hydran M2-X's BaudRate parameter (data transmission speed; Communication submenu) is identical to the one indicated in the Perception software.
3. Ensure the Hydran M2-X's H201Ti ID and PowerStat. ID parameters (identification numbers of the Hydran M2-X and the power station; Communication submenu) are identical to the ones indicated in the Perception software.
4. In the Perception software, ensure the specified communication port is valid.
5. Verify the RS-232 link cable.
6. Ensure the modem's configuration string is correct.

9.2.2 No Communication when the Host or Laptop Computer is Connected Directly or by Modem to the Hydran 201Ci Controller's DB-9 Connector

1. Ensure the CommChannel parameter (communication channel; Communica-tion submenu; see Section 4.2.7) of all Hydran M2-X's connected to the H201Ci Controller is set to Supervisory Link.
2. Ensure the BaudRate parameter (data transmission speed; Communication submenu) of all Hydran M2-X's connected to the H201Ci Controller is identical to the one indicated in the Perception software.
3. Ensure the H201Ti ID and PowerStat. ID parameters (identification numbers of the Hydran M2-X's and the power station; Communication submenu) of all Hydran M2-X's connected to the H201Ci Controller are identical to the ones indicated in the Perception software.
4. In the Perception software, ensure the specified communication port is valid.
5. Verify the supervisory link cable.
6. Verify the RS-232 link cable.
7. Verify the power supply and the operation of the H201Ci Controller.
8. Ensure the modem's configuration string is correct.

9.2.3 No Communication between the Host Computer and the Network of Hydran 201Ci Systems

1. Connect the host computer to each Hydran 201Ci Controller and perform the tests listed in Section 9.2.2.
2. Verify all RS-485 network link cables.
3. Disconnect all RS-485 link cables and "rebuild" the network, one H201Ci Controller at a time.

9.3 Hydran M2-X and Hydran 201Ci Controller's Analog Outputs at Zero

1. If the H201Ci Controller's display is blank, read the alarm message on the Hydran M2-X's display to identify the cause of the alarm. Then see Section 9.1.
2. Verify the fuses and power supply of the H201Ci Controller and the Hydran M2-X.
3. Verify the connections of the TDM signal at both ends of the cable.
4. Verify the Hydran M2-X's analog output circuit by setting the Hydran M2-X's AnalogMode parameter (Relays/Analog;Analog Out submenu; see Section 4.2.9.2) to Force 50% or Force 100%. Verify the result via the Perception software or the SCADA system.
5. Verify the H201Ci Controller's analog output circuit by setting the Hydran M2-X's TDM Mode parameter (Relays/Analog;TDM Out submenu; see Section 4.2.9.3) to Force 50% or Force 100%. Verify the result via the Perception software or the SCADA system.

9.4 Alarms

9.4.1 Intermittent Gas Alarms

1. Alarm set points are too low. Consult the Hydran M2-X's Short Term and Long Term history files, and compare the set points with the variations of gas level, hourly trend and daily trend.
2. Verify the Hydran M2-X's gas alarm delays.

9.4.2 An Alarm Relay does not Reset, even if the Alarm Condition has Disappeared

1. The corresponding alarm delay has not yet expired.
2. The RelayMode parameter (Relays/Analog submenu; see Section 4.2.3) of the Hydran M2-X's corresponding relay is set to Force On or Force Off.
3. The RelayMode parameter of the Hydran M2-X's corresponding relay is set to Latch: the alarm must be acknowledged using the Hydran M2-X's keypad (and the alarm condition must have disappeared) to cancel the alarm.
4. Verify the relay's contacts and the circuit by setting the corresponding RelayMode parameter to Force On and Force Off in the Hydran M2-X's Relays/Analog submenu.

9.4.3 Irregular Gas Readings

1. Ensure the valve (on which the Hydran M2-X is installed) is fully open.
2. Confirm the valve type is acceptable (full bore, gate or ball, no restriction between valve and tank).

CAUTION	***Read all warnings and recommendations in Section 5.3.3.1 before proceeding.***

3. Verify the sensor's serial number and parameters in the Hydran M2-X's **Service;SensorCal Data** submenu (see Section 4.6.1.1).
4. Execute the Hydran M2-X's **Force Sensor Test** command (**Relays/Analog** submenu) to test sensor operation.
5. Verify the value of the **HourlyTr Period** parameter (period of the hourly trend; **Gas;HourlyTrend** submenu).
6. Verify the value of the **DailyTr Period** parameter (period of the daily trend; **Gas;DailyTrend** submenu).
7. Verify the value of the **Period B** parameter (**Temperature;DynOil Sampl** submenu).

8. Verify the parameters pertaining to the sensor temperature (**Temperature** submenu).
9. Consult the General Electric Customer Service (the coordinates can be found at the bottom of page 2) to optimize the value of the parameters and the location of the sensor.

9.4.4 Inaccurate Gas Readings

1. Verify the transformer's level of fault gases-in-oil immediately by performing a dissolved gas analysis (DGA; see Section 10.4.2.
2. Ensure the valve (on which the Hydran M2-X is installed) is fully open.
3. Confirm the valve type is acceptable (full bore, gate or ball, no restriction between valve and tank).

CAUTION ***Read all warnings and recommendations in Section 5.3.3.1 before proceeding.***

4. Verify the sensor's serial number and parameters in the Hydran M2-X's **Service;SensorCal Data** submenu (see Section 4.6.1.1).
5. Execute the Hydran M2-X's **Force Sensor Test** command (**Relays/Analog** submenu) to test the sensor operation.
6. Verify the parameters pertaining to the sensor temperature (**Temperature** submenu).
7. Consult the General Electric Customer Service (the coordinates can be found at the bottom of page 2) to optimize the value of the parameters and the location of the sensor.

9.4.5 Moisture Reading of the Hydran M2-X does not correspond with that of a Validation Method

The probable cause is an inappropriate mounting location or installation of the Hydran M2-X. Ensure:

1. There is sufficient oil flow (forced or convective) at the mounting location of the Hydran M2-X (see Section 5.3.3).
2. The transformer valve type is full-bore, gate or ball.
3. There is no restriction between the valve and the tank.
4. The valve is fully open.
5. The maximum distance between the Hydran M2-X and the mounting point of the valve is not exceeded. See Figure A - 7 and Figure A - 8.

9.4.6 Moisture Readings Remain at 0%

Probable causes:

1. If there is no display (see Figure 4-1), the 24-Vdc power supply of the Hydran M2-X has failed. Verify the wiring at both ends of the dc power supply cable.
2. The analog output cable is disconnected or broken.

9.4.7 Irregular Readings (Moisture and Temperature)

On a transformer in operation, it is normal to observe variations in the moisture of the oil. This parameter is sensitive to the temperature as the quantity of water that can be absorbed by the oil increases logarithmically with the temperature. For a constant water concentration (ppm), the moisture drops rapidly as the oil temperature rises. For example, in a relatively dry transformer (1 % moisture in the paper), a 15 °C (27 °F) variation between day and night can produce a variation in moisture of 2 to 3 %; this effect is stronger in a wet transformer. The oil warming causes a reduction of its moisture, thus resulting in a water transfer from the paper into the oil. When the oil is hot (70–100 °C [158–212 °F]), this transfer is significant and contributes to stabilize the moisture reading; at low temperatures, this transfer is very slow and has a low impact over a 24-hour cycle.

The probable cause of irregular readings is electric interference. Verify the grounding and shielding of the analog output cable.

10 MAINTENANCE

The maintenance schedule suggested in this Chapter provides optimum performance and reliability from the Hydran M2-X. The maintenance routines should be performed in fair weather.

WARNING

All procedures in this manual must be strictly adhered to. Any deviation from these could cause irreversible damages to the Hydran M2-X and/or the transformer being monitored, and could lead to property damage, personal injury and/or death. Installation and maintenance of the Hydran M2-X must be carried out by qualified personnel only.

Note: Some steps in the maintenance procedures described in this Chapter may not apply, depending on the option(s) installed.

CAUTION

Please advise the station operator prior to maintenance. Working inside the Hydran M2-X may trigger unwanted alarms due to parameter changes, power shutdown, system rebooting or electro-static discharge.

The Hydran M2-X requires very little maintenance.

10.1 Cleaning the Enclosure Exterior

WARNING

Do not remove the cover, to prevent electric shock.

There are no inside parts that you can service; maintenance or cleaning of internal parts is not necessary.

To clean the exterior of the enclosure, use a clean cloth that is dry or slightly damp.

CAUTION

Do not use cleaning agents or chemicals, as they may damage the plastic parts or lettering.

10.2 Replacing the Fuse

In case the fuse of the Hydran M2-X has blown off, remove the fuse holder and replace the fuse.

WARNING

The replacement of the fuse must be executed by trained service personnel only.

Fuse specifications:

- GE part number: 16426
- Fuse size: 5 x 20 mm
- Fuse type: Time delay
- Fuse rating: 4A, 250V
- Recommended models: 0218004.MXP (Littelfuse), S506-4-R (Bussman)

10.3 Replacing the Battery

The battery is used to keep the real-time clock functioning and to retain the historic data when the Hydran M2-X unit is not powered.

Every five years, it is recommended to replace the Lithium battery used in the unit.

Note: When the battery becomes too weak, an alarm message will be displayed and broadcast. In this case, the battery has to be replaced as soon as possible.

WARNING ***The replacement of the battery must be executed by trained service personnel only. Refer to Appendix G for the procedure.***

10.3.1 Battery Specification

For Hydran M2-X units built as from 2013 (S/N: 13xxxxxxxx), the battery specifications are the following:

- GE part number: 18670.
- Battery size and type: 1/2AA, Lithium 3.6 V, 1.2 Ah.
- Battery life: Five years (RTC backup).
- Recommended model: SB-AA02 (Vitzro Cell), ER14250/W (OmniCel), TL-5276/W (Tadiran).

For Hydran M2-X units built prior to 2013, the battery specifications are:

- *Type*: Lithium cell.
- *Diameter*: 17.0 mm.
- *Length*: 33.5 mm.
- *Nominal voltage*: 3V.
- *Nominal capacity*: 1,200 mAh.
- *Recommended model*: Panasonic BR-2/3A.

10.3.2 Battery Life

The Hydran M2-X's battery is used to keep the real-time clock functioning and to retain the historic data when the unit is not powered. The shelf life of the battery in the Hydran M2-X is 2.5 years when the unit is stored at 25 °C (77 °F). If the Hydran M2-X has

been stored for more than one year, it is strongly recommended to replace the battery before installation and powering-up.

The set points of battery alarms (see **Setup > Alarms Setup > Battery Setup** in Section 4.3.2.4) are the following:

- Low alarm = 3.35V (or 2.75V for units before 2012).
- Low-Low alarm = 3.05V (or 2.45V for units before 2012).

When the Low alarm is generated, the battery must be replaced within a period of three months. When the Low-Low alarm is generated, the battery must be replaced immediately.

10.4 Periodic Maintenance

The person in charge of maintenance must already be familiar with the Hydran M2-X to:

- Use and set the Hydran M2-X's parameters with its keypad.
- Use the Perception software.

If not, reviewing the previous Chapters will help in performing maintenance routines.

WARNING

Before proceeding with any maintenance operation, review local safety regulations. Read all warnings and recommendations in Chapter 2**.**

Table 10-1 below summarizes the maintenance routines and their frequency. Each routine is explained in detail in the Section indicated in the table.

Routine	Frequency
History files verification (see Section 10.4.1)	Annually or on alarm
Dissolved gas analysis (DGA; see Section 10.4.2)	
Hydran M2-X verification (see Section 10.5): • Visual inspection (see Section 10.5.1) • LED's, heater, display and keypad verification (see Section 10.5.2) • Parameter verification (alarm set points, etc.; see Section 10.5.3) • Alarm relays verification (if connected; see Section 10.5.4) • Analog output verification (if connected; see Section 10.5.5) • Verification of sensor[a] (see Section 10.5.6)	Annually or on alarm due to system fault conditions

Table 10-1: Maintenance Routines and their Frequency

a. *The Hydran M2-X sensor is tested automatically twice a month, and the results are stored in the Service history file.*

10.4.1 History Files Verification

Frequency: Annually or on alarm

In addition to the annual or on-alarm verification, the user must also read and save regularly the Hydran M2-X's history files, using the Perception software.

If the data is read from the Hydran M2-X, follow the instructions in Section 4.4.2. The data can be collected using the host or laptop computer running the Perception software.

The history files are verified as follows:

1. Consult the Events history file to investigate suspicious alarms and other events.
2. Consult the Short Term and Long Term history files to study the evolution of the gas level, moisture level, hourly and daily trends, and averages.
3. Ensure the hourly and daily trends periods are optimized; change the values if necessary.
4. Examine every alarm setting; change the values if necessary.

Note: Alarm setting should be modified by authorized personnel only.

10.4.2 Dissolved Gas Analysis (DGA)

Frequency: Annually (minimum) or on alarm

The DGA is the reference method used to determine the exact level of dissolved gases in oil. A DGA should be performed at least once a year.

To verify the readings of the Hydran M2-X using a DGA, proceed as follows:

1. Note the Hydran M2-X's gas level reading.
2. Take an oil sample from the sensor's sampling port (see Appendix J).
3. Send the sample to a qualified laboratory.

The DGA results include the concentrations, in parts per million (ppm), of the following gases:

- Hydrogen (H_2)
- Carbon monoxide (CO)
- Acetylene (C_2H_2)
- Ethylene (C_2H_4)
- Methane (CH_4)
- Ethane (C_2H_6)
- Carbon dioxide (CO_2)
- Nitrogen (N_2)
- Oxygen (O_2)

The Hydran M2-X gives a composite reading of the first four gases in the above list, in other words the gases generated by transformer incipient faults. This reading can be compared to the DGA results using the following formula:

$$\text{Hydran M2-X reading} = 100\ \%\ [H_2] + 15\ \%\ [CO] + 8\ \%\ [C_2H_2] + 1.5\ \%\ [C_2H_4]$$

A few examples are given in Table 10-2 below. The difference between the actual and the calculated readings should fall within the technical specifications of the Hydran M2-X.

Dissolved Gas Analysis (DGA) in ppm				Hydran M2-X Reading (ppm)
Hydrogen (H_2)	Carbon Monoxide (CO)	Acetylene (C_2H_2)	Ethylene (C_2H_4)	
100	0	0	0	100
100	1,000	0	0	250
100	100	0	0	115
100	100	50	0	119
100	100	50	200	122

Table 10-2: Gas Reading Comparisons Between DGA and Hydran M2-X

10.5 Maintenance Verification

Frequency: Annually or on alarm due to system fault conditions.

CAUTION

Please advise the station operator prior to maintenance. Working inside the Hydran M2-X may trigger unwanted alarms due to parameter changes, power shutdown, system rebooting or electro-static discharge

CAUTION

The surface of the base plate can be hot. Heating for the dynamic oil sampling system (Section 3.5) is achieved using heating resistors mounted on the internal side of the base plate.

10.5.1 Visual Inspection

CAUTION

Read all warnings and recommendations in Chapter 2 before handling the sensor.

1. Check for oil leaks.
2. If necessary, clean and retighten the sensor.
3. Check for water or dust infiltration inside the enclosure; clean and fix the enclosure if necessary.
4. Check for loose connections on terminal blocks and connectors; retighten if necessary.

WARNING ***AC power supply or DC station voltage is present on most terminals.***

10.5.2 Heater, Display and Keypad Verification

1. Touch the heater plate. If warm, this indicates that the Hydran M2-X is being heated to maintain the temperature of the sensor close to the corresponding set point.
2. Ensure the Hydran M2-X is in Main Display mode. For details, see Section 4.1.2.3.
3. Press the **Main Menu** context key once and ensure the **Main Menu** is displayed. Ensure all of the other keys are operating properly.

10.5.3 Parameter Verification

The Hydran M2-X's operation parameters can be verified using the Hydran M2-X's keypad or the Perception software running on the host or laptop computer:

1. Verify all parameters in **Alarms > Alarms Setup**.
2. Verify the date and time in **Setup > Date & Time**.
3. Verify the parameters in **Setup > Temp. Setup**.
4. Verify the parameters in **Setup > History Setup > History Log Rate**.
5. Verify the parameters in **Setup > Comm Setup**; these parameters can only be accessed using the Hydran M2-X's keypad.
6. Verify all parameters in **Setup > Readings Setup**.
7. Verify all parameters in **Setup > I/O Setup**.
8. Verify the operation mode of the five relays in **Test > Relay Test**.
9. Ensure the two sets of serial numbers, the sensor parameters and the checksum in **Service > Sensor Param** correspond to those written on the Test Certificate and Data Sheet (for an example, see Figure 4-12).
10. Verify the battery voltage and the other parameters in **Service > View Service Data**.
11. Verify the operation mode of the TDM signal (**Relays/Analog > TDM Out** submenu).

10.5.4 Alarm Relays Verification (If Connected)

Verify the alarm relays only if the Hydran M2-X's alarm contacts are used (connected to a SCADA system). For the verification procedure, see Section 5.2.6.

10.5.5 Analog Inputs Verification (If Connected)

Verify the analog inputs only if they are used. For the verification procedure, see Section 5.2.8.

10.5.6 Analog Outputs Verification (If Connected)

Verify the analog outputs only if they are used (connected to a SCADA system). For the verification procedure, see Section 5.2.9.

10.5.7 Sensor Tests

The Hydran M2-X's sensor test is automatically performed twice a month (the first and fifteenth days of the month, at midnight). The results are recorded in the Service history file.

10.5.8 RS-232 Communications Verification

Follow the procedure described in Section 6.2.3.3.

Note: Skip this step if a laptop is used for the present verification process.

10.5.9 RS-485 Communications Verification (for a Network)

If the Hydran M2-X is not polled regularly or if the last monitoring indicates that one or more units do not answer, follow the procedure described in Section 6.2.3.3.

11 DECOMMISSIONING THE HYDRAN M2-X

The Hydran M2-X is designed to be permanently installed for autonomous opera-tion on a transformer. If however, the Hydran M2-X must be decommissioned, the procedure to be followed is described in this chapter.

11.1 Powering-off

WARNING

The following procedure must be carried out thoroughly. Failure to do so may result in property damage, personal injury and/or death.

The decommissioning of the Hydran M2-X must be executed by trained service personnel only.

1. Switch OFF the circuit breaker to which the power cable of the Hydran M2-X unit is connected.
2. Verify, with a voltmeter, there is no AC or DC voltage on the power cable.
3. Disconnect the power cable from the circuit breaker.
4. Remove the cover of the Hydran M2-X unit to be decommissioned.
5. Verify there is no AC or DC voltage on the mains supply terminals of the unit.
6. Verify there is no AC or DC voltage on the cables connected to the analog inputs, analog outputs or/and digital inputs if present.
7. Verify there is no AC or DC voltage on the cables connected to the alarm relays.
8. Verify there is no AC or DC voltage on the cable connected to the RS-485 terminals.
9. If any of the cables is still fed by an external source, identify and isolate the source.

11.2 Cable Disconnection

After verification that there is no AC or DC voltage on all cables connected to the Hydran M2-X unit, proceed as following:

1. Disconnect the power supply cable and remove this cable.
2. Disconnect the cables from the analog inputs, analog outputs or/and digital inputs if installed and remove these cables.
3. Disconnect the cable from the alarm relays terminals and remove this cable.
4. Disconnect the cable from the RS-485 terminals and remove this cable.
5. Disconnect the ground cable from the ground lug.

11.3 Removing the Hydran M2-X

1. Refer to Section 5.3.2 for the tools required.

CAUTION ***Perform this step according to company regulations. Proceed carefully to avoid introducing air into the transformer. Use a bucket to collect oil.***

2. Close the valve to which the Hydran M2-X is mounted.
3. Remove the sensor clamp using the spanner wrench. Refer to Figure 5-3.
4. Carefully separate the sensor from the enclosure. Put aside the electronic enclosure.
5. Disconnect the sensor cable from the sensor. Rotate the connector anticlockwise (approximately 1/8 of a turn), then carefully pull it from the sensor. Refer to Figure 5-4.
6. Using the 5/32-in Allen key, carefully open the bleed screw on the sensor about 1/8 of a turn.
7. Unscrew the sensor from the valve using an adjustable wrench. It is recommended not to use a wrench with jagged jaws as these may damage the sensor.
8. Use disposable paper to absorb the oil from the sensor. Allow the sensor to drip overnight on disposable absorbent paper.
9. Dispose of the collected oil and paper according to the local power utility regulations.
10. Store the sensor and electronic enclosure.

Appendix A : Technical Specifications

A.1 General

GENERAL

Description	Continuous, on-line, intelligent gas-in-oil and moisture transmitter with optional, external sensors monitoring
Components	Combined dual-function sensor and electronic enclosure
Response	Hydrogen (H_2), carbon monoxide (CO), acetylene (C_2H_2), ethylene (C_2H_4), relative humidity in oil (%RH)
Medium	Mineral, insulating oil for transformers
Application	Transformer monitoring, moisture level measurement (for the evaluation of dangerous conditions, bubbling temperature and aging rate) and detection of incipient faults in oil-filled electrical equipment

ANALYTICAL PERFORMANCE

Principle	• Gas: Vacuum-resistant gas-permeable membrane and combustible gas detector
	• Moisture: Thin-film capacitive sensor
Sampling Method	• Flooded port with 1.5 in NPT male threads
Measurement Range	• Gas: 25-2,000 ppm (volume/volume, H2 equivalent)*
	• Moisture: 0-100% RH
Accuracy	• Gas: ± 10 % of reading ± 25 ppm (Ref.: ASTM D3612)
	• Moisture: ± 2 %RH (Ref.: saturated salt solutions)
Repeatability Limit	• Gas: Better than ± 5 % or ± 5 ppm
	• Moisture: 2 %RH
Gas Relative Sensitivity	• H2: 100 % of concentration
	• CO: Typical 15 ± 4 % of concentration
	• C2H2: Typical 8 ± 2 % of concentration
	• C2H4: Typical 1.5 ± 0.5 % of concentration
Response Time	• 10 minutes sensor response (90 % of step change)

Hydran M2-X H2 accuracy is specified up to 2000ppm; at concentrations above 2000ppm the device continues to provide trending to 5000ppm, but potentially outside the published accuracy specification.

This is because the Hydran M2-X H2 calibration and performance is optimised and tested in the factory in the key range of concentrations for Transformer diagnostics. At values >2000 ppm, the H2 level has exceeded IEEE Condition 4 (Major event at > 1800ppm), hence customer action should have already occurred within the specified measurement range for the M2-X.

External Sampling Port
- Designed for glass syringe with Luer stop cock; closed with 5/32-in (approximately 4 mm) Allen screw

ELECTRONIC UNIT

Hardware
- Microprocessor; watchdog; clock with battery backup

Software
- Real-time operating system; menu-driven interface

Functions
- Gas level, hourly trend and daily trend readings
- Gas level and gas trends alarms
- Moisture level and moisture average alarms
- Alarms due to system fault conditions
- History data logging (Short Term, Long Term, Events and Service)
- Periodic sensor test
- Calibration, configuration and self-test
- Networking
- Remote embedded software upgrading

Display
- Backlit liquid crystal display (LCD); graphic 128 x 64 pixels

Keypad
- Keypad 8 keys: Up, Down, Left, Right, Esc and 3 context functions Alarm Contacts

Alarm Contacts

4 SPDT alarm relays (Type C) which can be configured for:
- Gas (level and trend) and analog High contacts
- Gas (level and trend) and analog High-High contacts
- Moisture (level and average) and analog High contacts
- Moisture (level and average) and analog High-High contacts

Relay contact maximum switching capacity:
- Resistive load: 50 VA, 60 W (power factor = 1)
- Inductive load: 25 VA, 30 W (power factor = 0.4, L/R = 7 ms)

Relay contact maximum operating current:

- Resistive load: 3 A (ac/dc)
- Inductive load: 1.5 A (ac/dc)

Communications Ports

- One RS-232 port for local laptop computer connection
- One RS-485 port for connection to local Hydran network or remote communication

Optional Communications Port

1 of the following to be specified when ordering:

- Integrated serial to Ethernet 10/100BaseT; Part Number 17046
- Integrated Fiber Optic Ethernet 100BaseFX, ST Multimode; Part Number 18321
- Integrated dial-up Modem V.92/56k; Part Number 16868

Optional I/O

Up to 4 of the following to be specified when ordering:

- General-purpose 4–20 mA analog input; 2,000 V RMS isolation; Part Number 16528
- Analog 4–20 mA output; 500-Ω maximum loading; 2,000 V RMS isolation; Part Number 16529
- Dual digital inputs for dry contacts; internal wetting 24 VDC; 2,000 V RMS isolation; Part Number 17464

MISCELLANEOUS

Enclosure

- Type NEMA 4X (IP56)
- Cast aluminum, powder pint, white
- External dimensions: 315 mm long x 219 mm wide x 196 mm high (12.4 x 8.63 x 7.72 in)

For details, see Section A.2.1.

Electronic Modules

Totally encased CPU and I/O electronics

Sensor Heating

Heater plate to maintain sensor between 15 and 65 °C (59 and 149 °F) in normal transformer operating conditions to force oil convection

Oil Temperature

- Oil at the valve: -40 to +90 °C (-40 to +194 °F)
- Oil at the valve up to 105 °C (221 °F), with optional finned, high-temperature adaptor, Part Number 18065
- Possible short-duration exposure: Oil up to 120 °C (248 °F)

Oil Pressure

- Vacuum-resistant sensor; 0–700 kPa (0–100 psia)

Power Supply

- 100-120 Vac, 200-240 Vac, 50/60 Hz, 650 VA maximum

EMC Compatibility

Meets standards ENV 50204, EN 55022, IEC 60255-22-1, EN 61000-3-2, EN 61000-4-2, EN 61000-4-3, EN 61000-4-4, EN

61000-4-5, EN 61000-4-6, EN 61000-4-8, EN 61000-4-11

Environment Meets standards IEC 60068-2-1, IEC 60068-2-2, IEC 60068-2-6, IEC 60068-2-30

Safety Meets standard IEC 61010-1/EN 61010-1

Weight
- Installed: 7.5 kg (16.5 lb)
- Shipping: 9 kg (20 lb)

ENVIRONMENTAL CONDITIONS

Operation
- Ambient temperature: -40 to +55 °C (-40 to +131 °F)
- Relative humidity: 95 % RH, non-condensing
- Altitude: up to 2,000 m (6,500 feet).

Storage
- Temperature: 5 to +45 °C (41 to +113 °F)
  Storage period should not exceed six months.

Note: General Electric has made every reasonable attempt to ensure the completeness and accuracy of these technical specifications. However, the information contained in these technical specifications is subject to change without notice, and does not represent a commitment on the part of General Electric.

A.2 Dimensions

A.2.1 Enclosure Dimensions

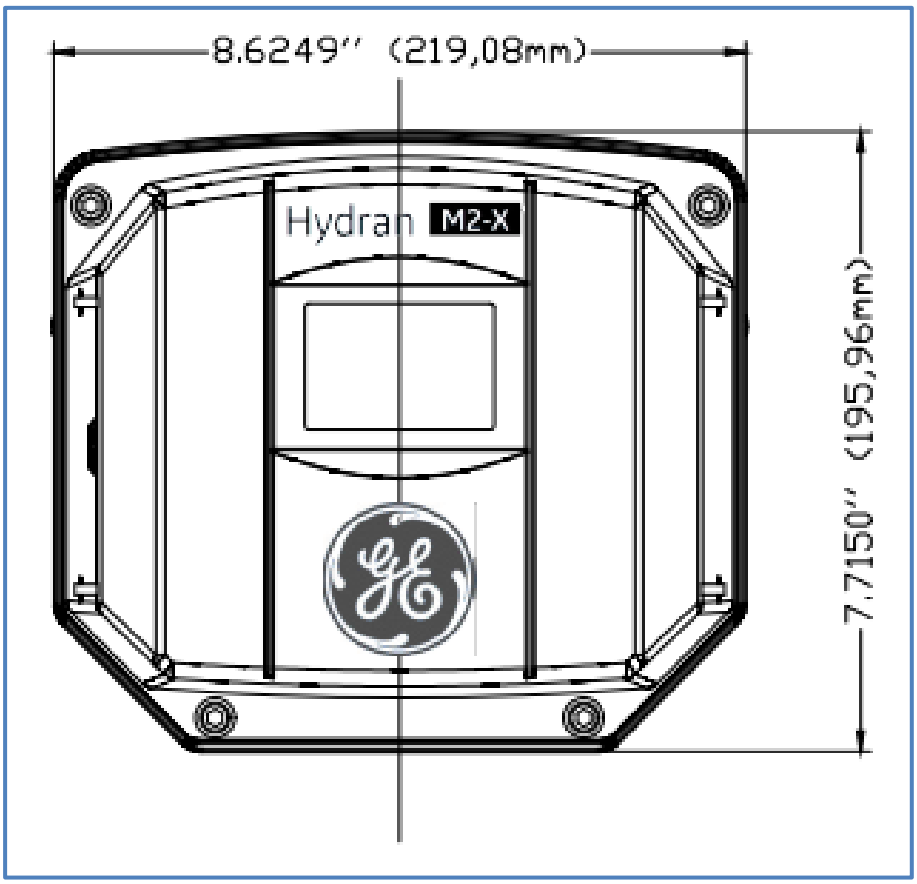


Figure A - 1: Dimensions of the Hydran M2-X Enclosure Front View

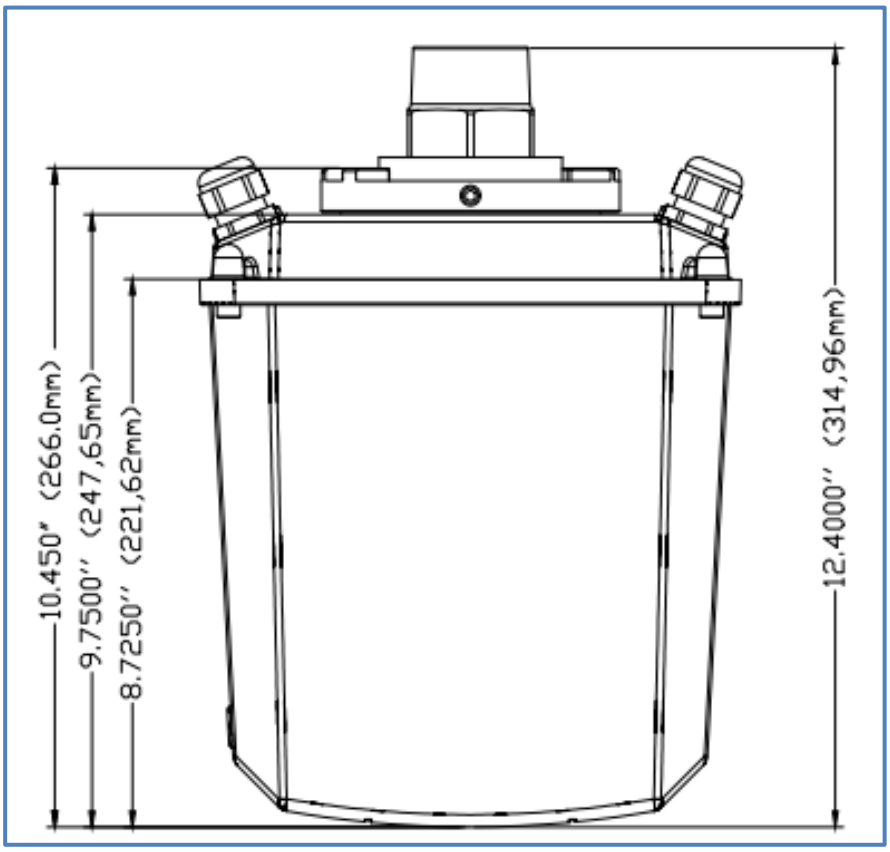


Figure A - 2: Dimensions of the Hydran M2-X Enclosure - Top View

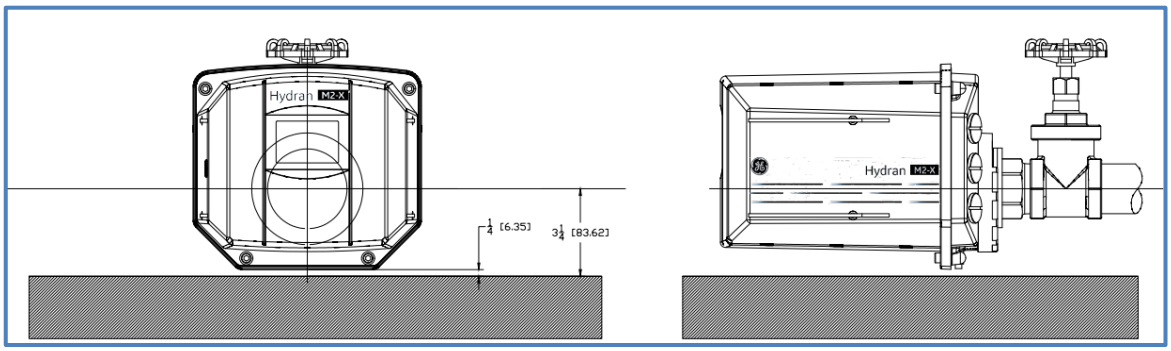
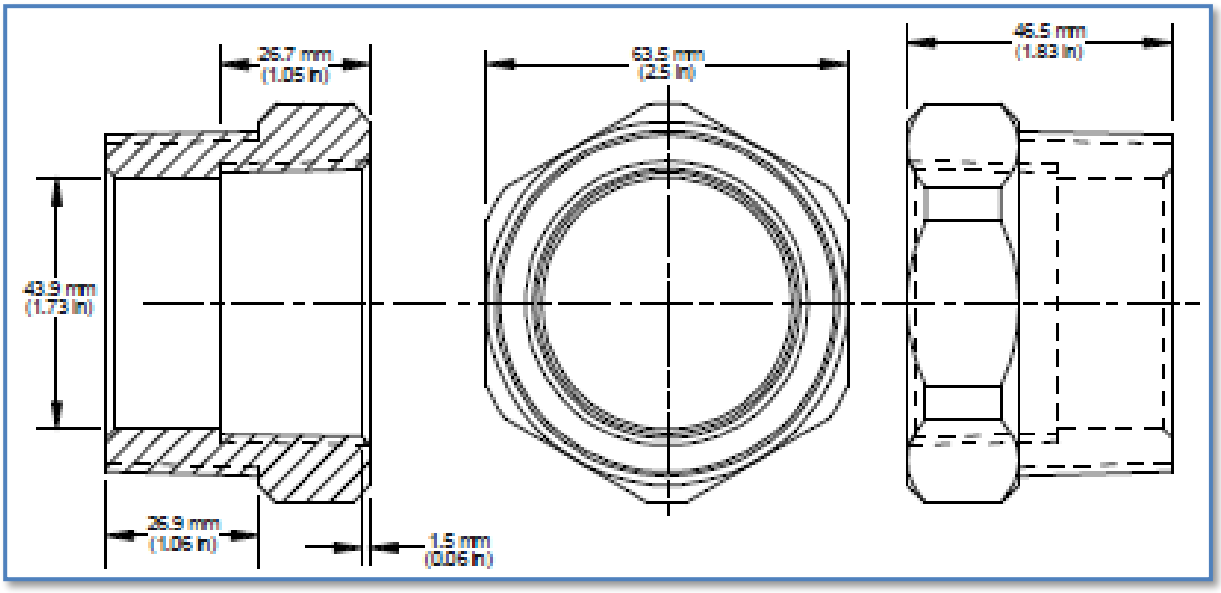


Figure A - 3: Bottom Clearance

A.2.2 Optional Adaptors Dimensions

Figure A - 4: Dimensions of the 2in NPT Reducing Bushing (Optional: Part Number 16296)



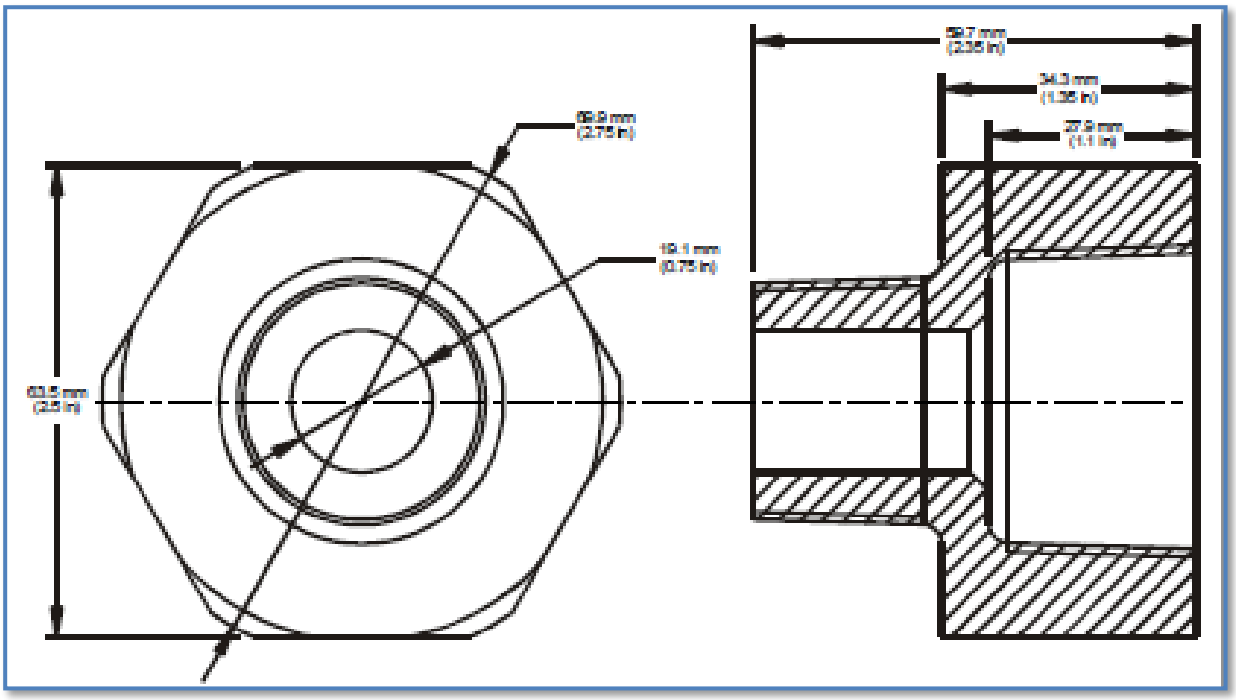


Figure A - 5: Dimensions of the 1in to 1.5in Adaptor (Optional; Part Number 16480)

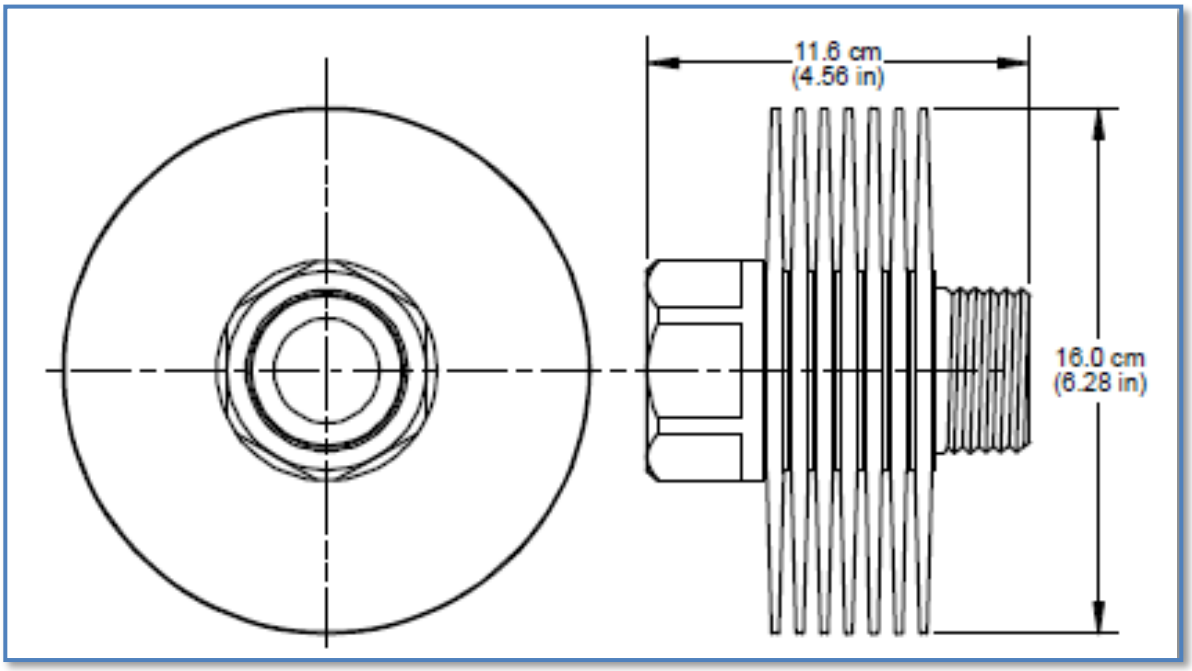


Figure A - 6: Dimensions of the 1.5in NPT Finned, High Temperature Adapter (Optional; Part Number 16290)

A.2.3 Maximum Dimensions

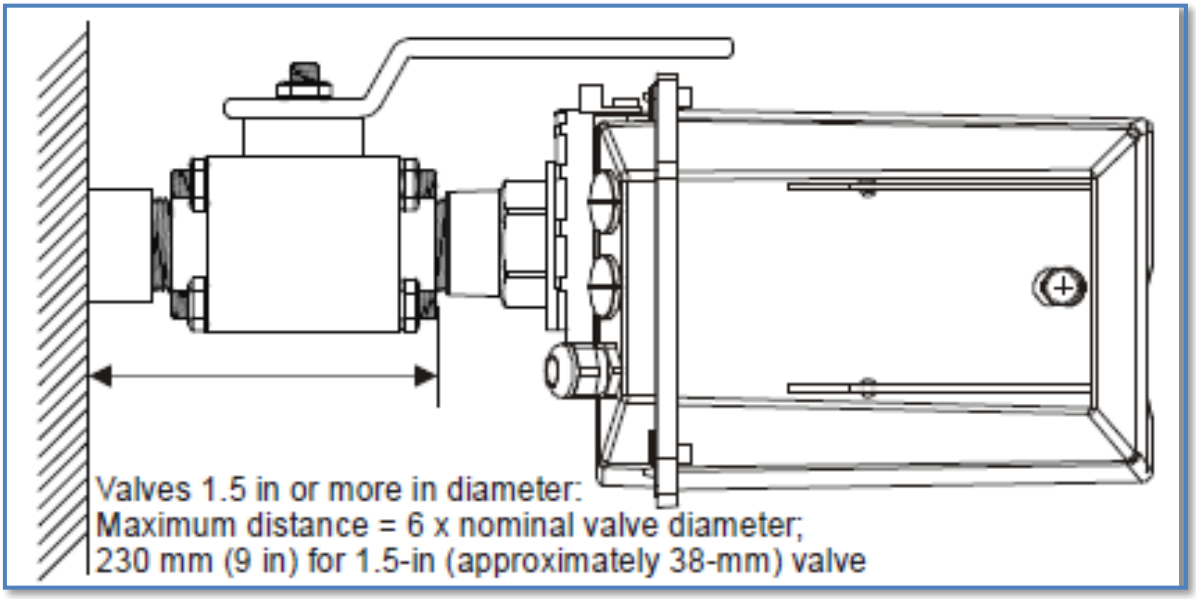


Figure A - 7: Maximum Distance for Valves 1.5in or More in Diameter

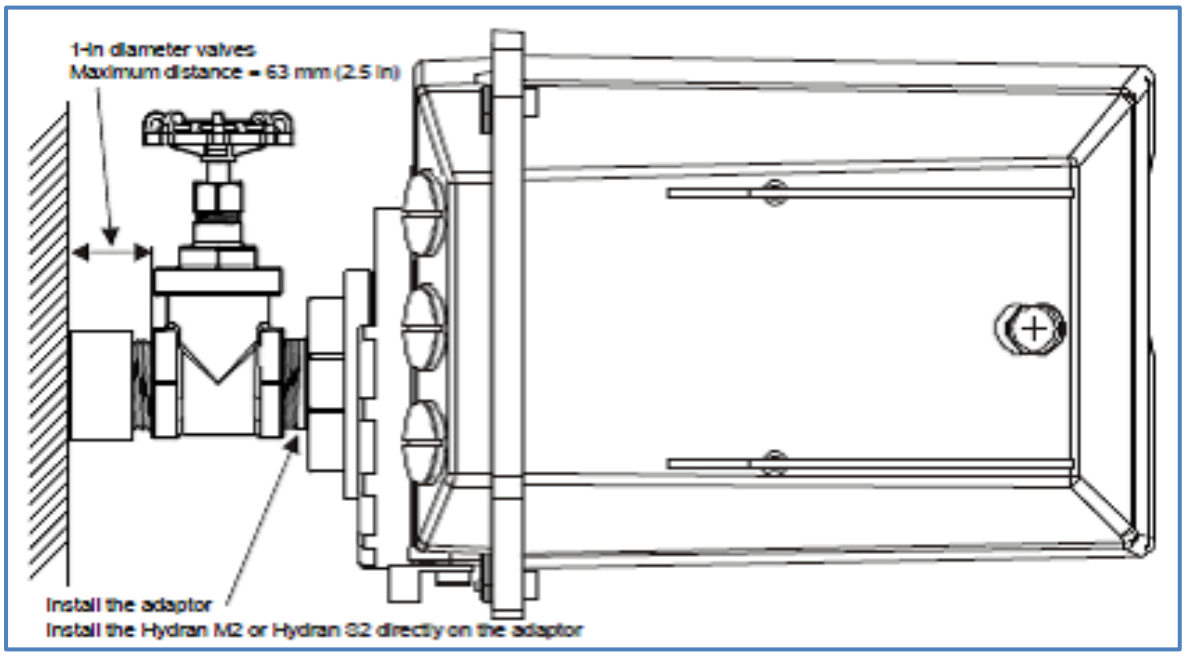


Figure A - 8: Maximum Distance for 1in Diameter Valves

Appendix B : Installation Checklist

WARNING ***Read all warnings and recommendations in Chapter 2 before proceeding with the installation.***

This Appendix lists every step of the installation procedure. The numbers on the left indicate the Section numbers; those on the right indicate the page where this Section is located.

2. Set the **Gas Level Alarm** parameters (log values in Table B-1) [ ]
3. Set the **Gas Hourly Trend Alarm** parameters (log values in Table B-1) [ ]
4. Set the **Gas Daily Trend Alarm** parameters (log values in Table B-1) [ ]

Parameter Name	Gas Level Alarm	Gas Hourly Trend Alarm	Gas Daily Trend Alarm
Alarm Hi SP	ppm	ppm	ppm
Alarm Hi-Hi SP	ppm	ppm	ppm
Alarm Delay	min	%	%
Alarm Hi Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]
Alarm Hi-Hi Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]

Table B - 1: Logging the Values of the Gas Alarm Setup Parameters

Note: The trend might need to be readjusted after an observation period

5. Set the **H_2O %RH Alarm** parameters (log values in Table B-2) [ ]
6. Set the **H_2O PPM Alarm** parameters (log values in Table B-2). [ ]
7. Set the **H_2O %RH Average Alarm** parameters (log values in Table B-2) [ ]

Parameter Name	H_2O %RH Alarm	H_2O PPM Alarm	H_2O %RH Average Alarm	H_2O PPM Average Alarm
Alarm Hi SP	%RH	ppm	%RH	ppm
Alarm Hi-Hi SP	%RH	ppm	%RH	ppm
Alarm Delay	%	%	%	%
Alarm Hi Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]
Alarm Hi-Hi Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]

Table B - 2: Logging the Values of the H_20 Alarm Setup Parameters

8. Set the **H_2O PPM Average Alarm** parameters (log values in Table B-2) [ ]
9. Set the **Sensor Temp. Alarm** parameters (log values in Table B-3) [ ]
10. Set the **Base Plate Temp. Alarm** parameters (log values in Table B-3) [ ]

Parameter Name	Sensor Temp. Alarm	Heater Plate Temp. Alarm
Alarm Low SP	˚C	˚C
Alarm Hi SP	˚C	˚C
Alarm Hi-Hi SP	˚C	˚C
Alarm Delay	min	min
Alr C. Open Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]
Alarm Low Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]
Alarm Hi Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]
Alr C. Short Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]

Table B - 3: Logging the Values of the Temp. Alarm Setup Parameters

11. Set the **Battery Alarm Setup** parameters [ ]

- **Alarm Low-Low SP** to _____ V [ ]
- Set **Alarm Low SP** to _____ V [ ]
- Set **Alarm Delay** to _____ minutes [ ]

12. If input modules are installed, set the **Analog Input Alarm Setup** parameters (log values in Table B-4) [ ]

13. Set the **Sys. Fault Trigger** parameters [ ]

5.4.4 Verifying the Battery Voltage 90

5.4.5 Setting the Dynamic Oil Sampling System Parameters 90

1. Set **Temp Set Point** to _____ °C [ ]
2. Set **Temp SP Modulation** to _____ °C [ ]
3. Set **Temp Mod. Period** to _____ minutes [ ]

5.4.6 Setting the Readings Parameters 90

1. Set the **Gas Reading Setup** parameters:

- Set **Hourly Tr. Period** to _____ hours [ ]
- Set **Daily Tr. Period** to _____ days [ ]
- Set **Hydran PPM Period** B to _____ hours [ ]

2. Set the **H2O Reading Setup** parameters:

- Set **%RH Average** to _____ hours [ ]
- Set **PPM H2O Avg**. to _____ hours [ ]

- Set the **Sens. Temp Avg Per**. parameter to _____ hours [ ]

Parameter Name	Input #1	Input #2	Input #3	Input #4
Alarm Low-Low SP				
Alarm Low SP				
Alarm Hi SP				
Alarm Hi-Hi SP				
Alarm Delay				
Alarm L-L Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]
Alarm Low Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]
Alarm Hi Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]
Alarm Hi-Hi Relay	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]	1[ ] 2[ ] 3[ ] 4[ ]

Table B - 4: Logging the Values of the Analog Input Alarm Setup Parameters

5.4.7 Configuring the Analog Input(s) (If Used) 91

1. Configure the optional analog input(s) (log values in Table B-5) [ ]
2. Check the optional analog input(s) [ ]

Parameter Name	#1	#2	#3	#4
Sample Rate				
Input Name				
Input Short Name				
Input Units				
Reading Precision				
Input Min.				
Input Max.				
Input Resolution				

Table B - 5: Logging the Values of the Analog Input Alarm Setup Parameters

Parameter	Value	Parameter	Value
Service L		**Service V**	
Service I		**Service U**	
Service A		**Service F**	

Table B - 6: Logging the Values of the Service Data

	3. (Optional) Verify the configuration of the modem	[ ]
6.2.5	**Connecting a Hydran M2-X to the Hydran 201i Controller**	**102**
	1. Run the supervisory link cable through a conduit from the first or last Hydran M2-X in the daisy chain	[ ]
	2. Ensure all wires are identified	[ ]
	3. Connect the wires to the Hydran M2-X's termination block	[ ]
	4. Connect the other end of the cable to the Hydran 201Ci Controller	[ ]

Appendix C : Functional Block Diagram

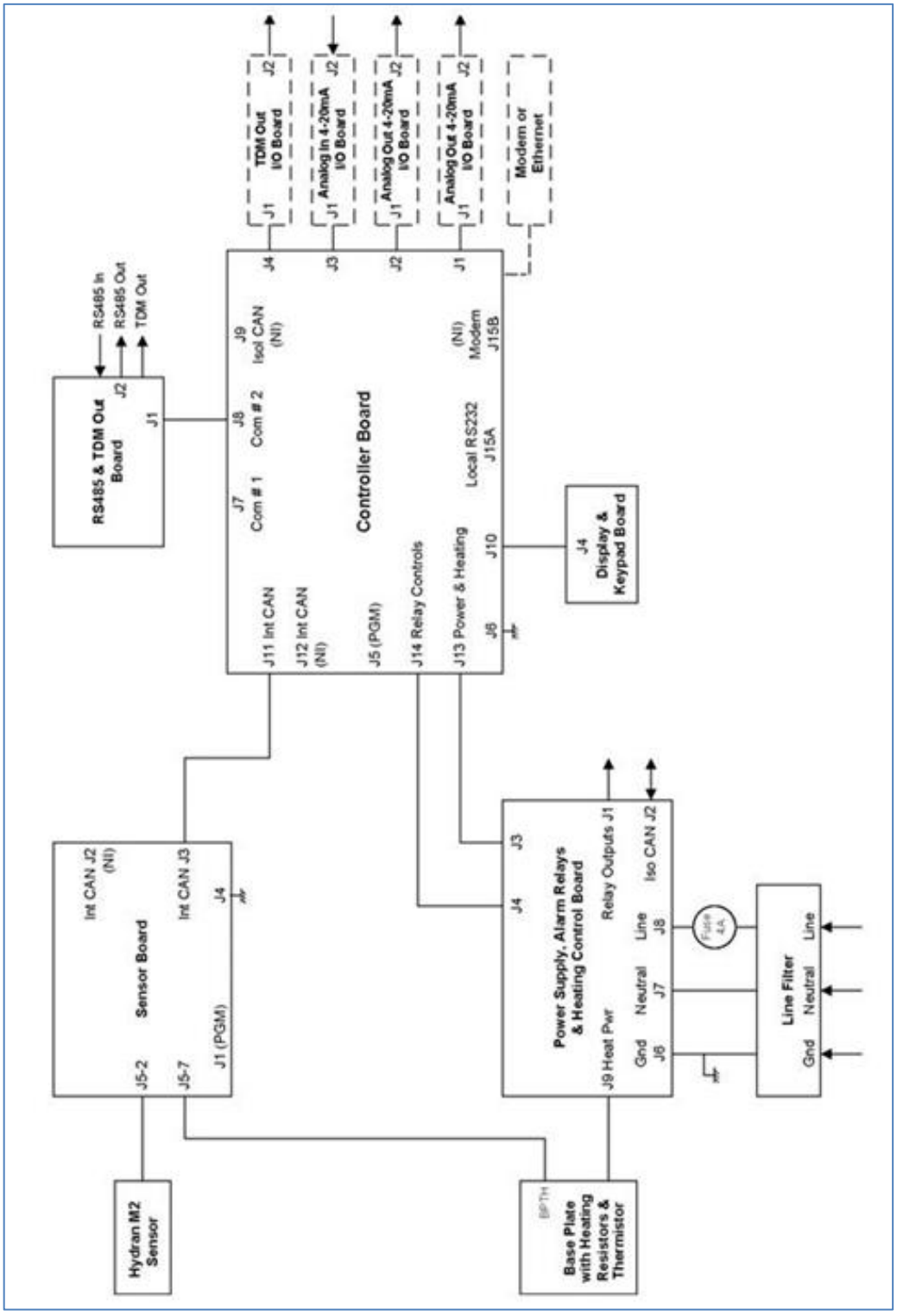


Figure C - 1: Functional Block Diagram of the Hydran M2-X

Appendix D : External Connections

D.1 TDM and RS-485 Network Link Terminal Block

This terminal block is located on the right side of the electronic card cage (see Figure D-1).

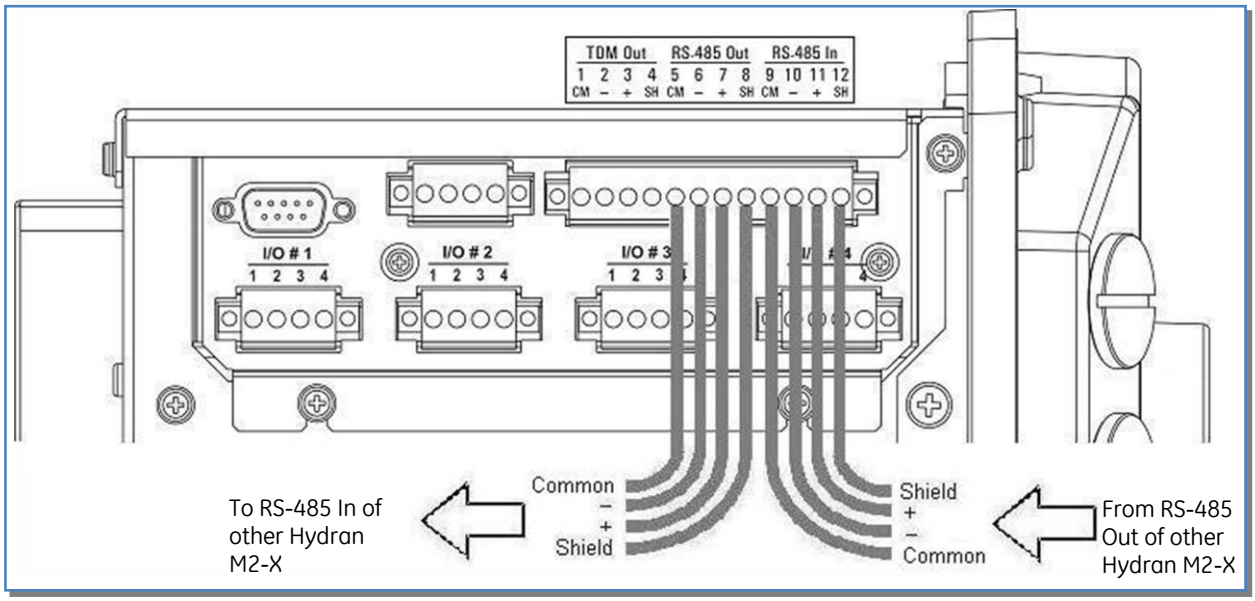


Figure D - 1: General Wiring of the RS-485 Terminal Block

The RS-485 link requires instrumentation grade or armored cables (shielded triad).

Table D-1 describes the connections for the TDM and RS-485 network link terminal block.

Terminal	Description	Direction (External)	Comments
1	TDM common	To Hydran 201Ci Controller	For gas level monitoring by Hydran 201Ci Controller; optional TDM interface for moisture monitoring
2	TDM Out-		
3	TDM Out+		
4	TDM shield		
5	RS-485 Out common[a]	To RS-485 In terminals of other Hydran M2-X or to Hydran 201Ci Controller	32 Hydran M2-X's can be daisy-chained in a network[d]; can also be used with Hydran 201R Model i
6	RS-485 Out-		
7	RS-485 Out+		
8	RS-485 Out shield[b]		
9	RS-485 In common a	From RS-485 Out terminals of other Hydran M2-X	
10	RS-485 In-		
11	RS-485 In+		
12	RS-485 In shield[c]		

Table D - 1: Connections for the TDM and RS-485 Network Link Terminal Block

a. *The RS-485 link is not electrically isolated. The Hydran M2-X's from a single network thus share the same ground reference (common).*
b. *The shield at this terminal is internally connected to ground through a spark gap and capacitor. The other end of the cable must be connected to the In terminal of the next Hydran M2-X or to the Hydran 201Ci Controller.*
c. *This terminal is internally connected directly to ground.*
d. *The total length of all RS-485 link cables in a single network must not exceed 1,200 m (4,000 ft).*

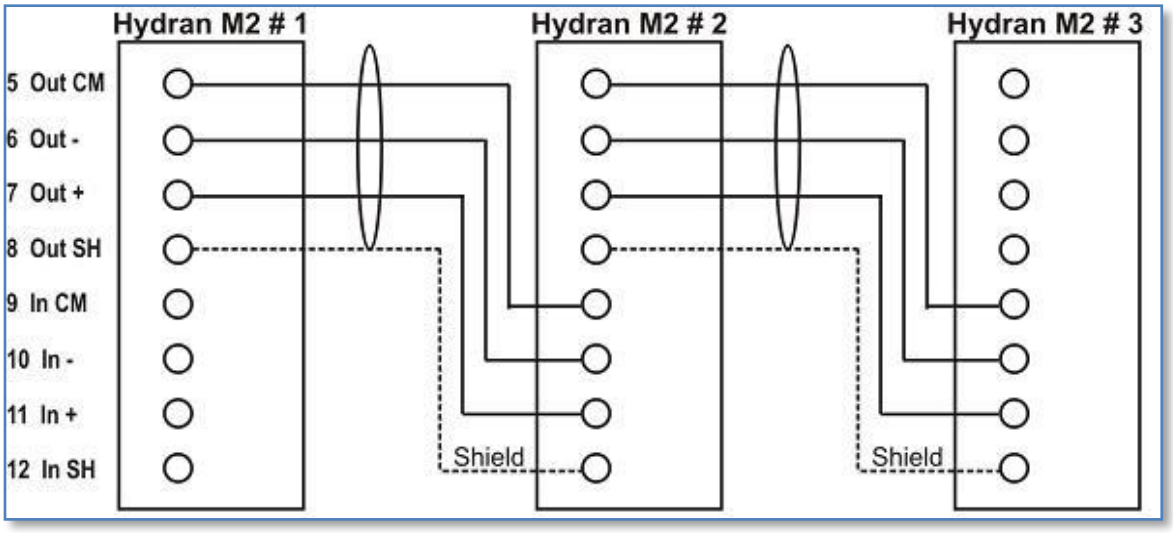


Figure D - 2: Wiring Details of the RS-485 between 3 or more Hydran M2-Xs

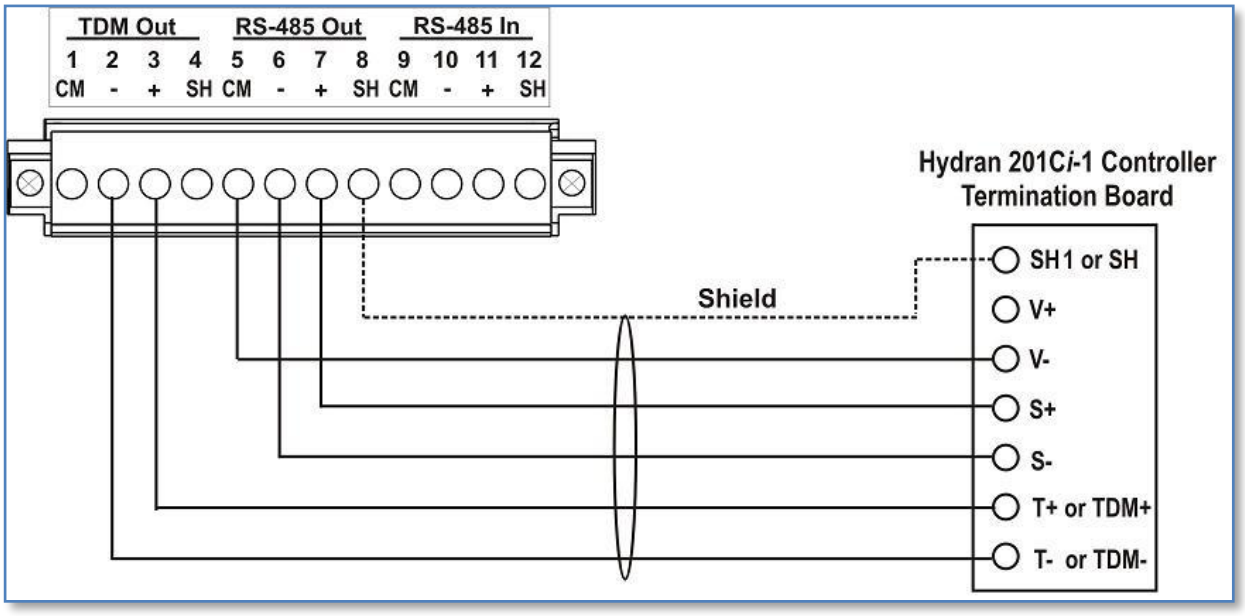


Figure D - 3: Wiring of the Supervisory Link between a Hydran M2-X and a Hydran 201Ci-1 Controller

Note: The Hydran 201Ci-1 Controller can only display the gas level measured by the Hydran M2-X, not the moisture level.

Note: Use the same wiring to connect the optional TDM terminal block to a Hydran 201Ci Controller. If the RS-485 link is already connected to the controller as shown in the above figures, connect only the optional TDM terminal block as directed.

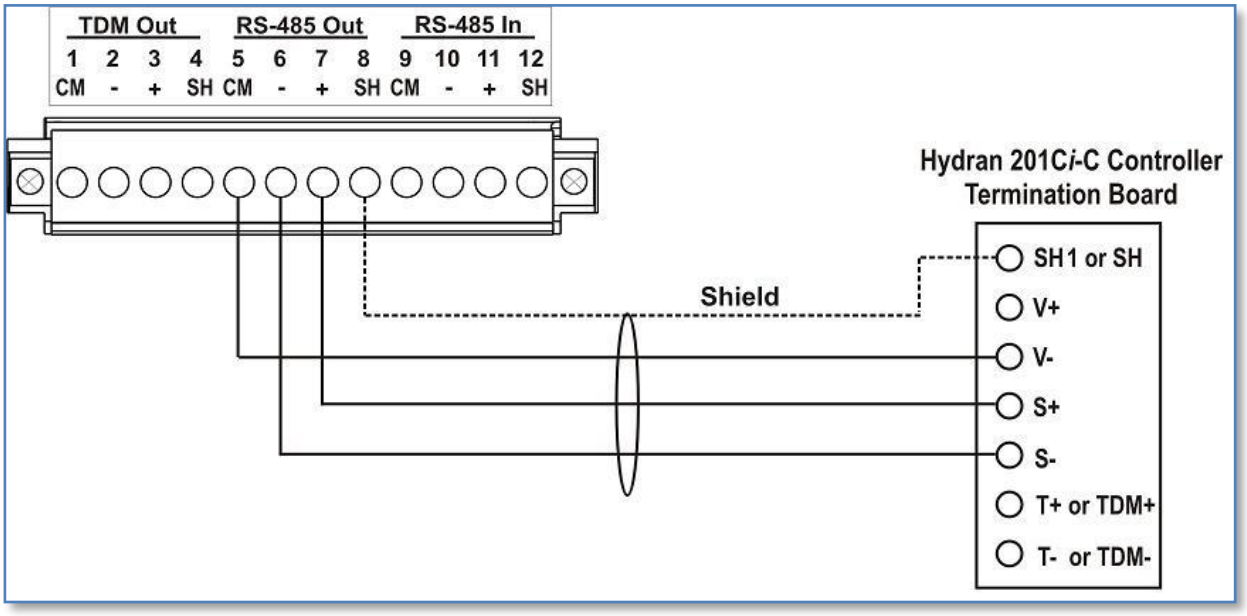


Figure D - 4: Wiring of the Supervisory Link between a Hydran M2-X and a Hydran 201Ci-C Controller

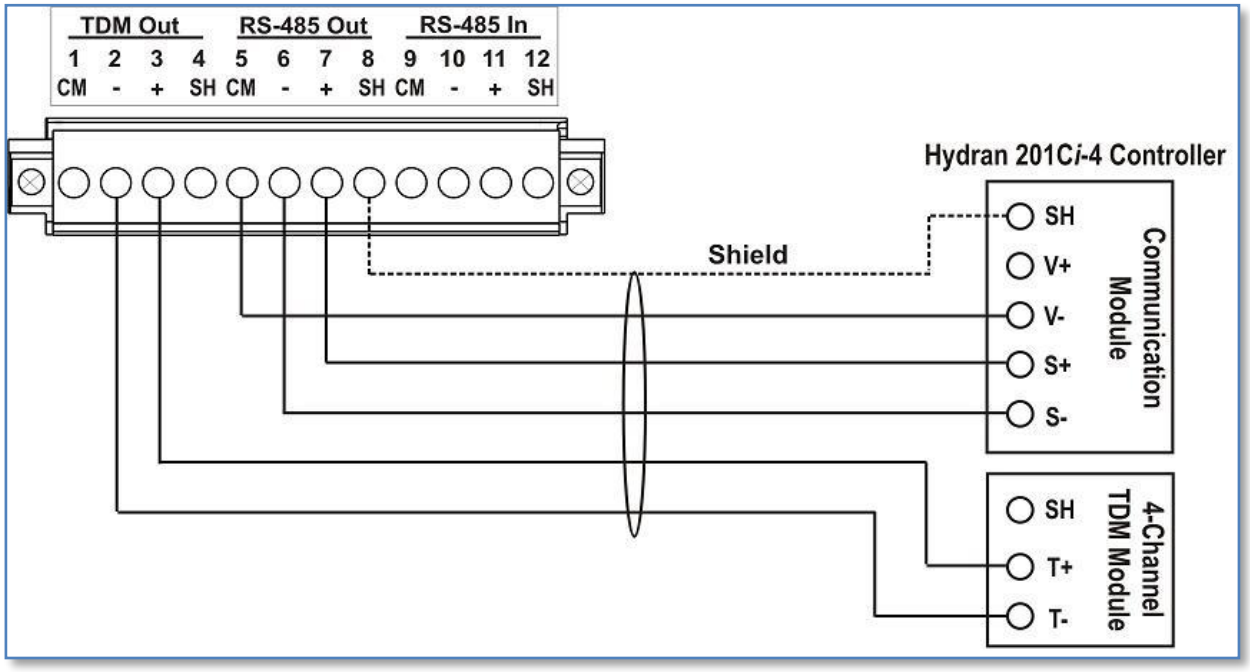


Figure D - 5: Wiring of the Supervisory Link between a Hydran M2-X and a Hydran 201Ci-4 Controller

Note: The Hydran 201Ci-1 Controller can only display the gas level measured by the Hydran M2-X, not the moisture level.

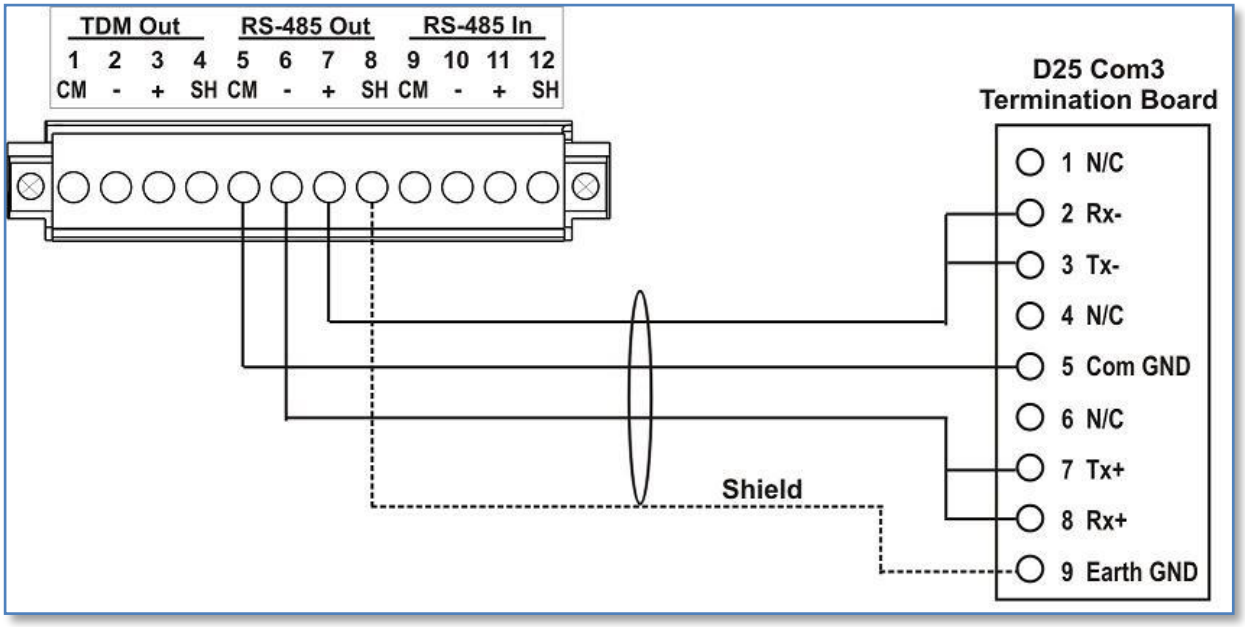


Figure D - 6: Wiring of the RS-485 Network Link between a Hydran M2-X and a D25

D.2 Analog Input Terminal Block

Table D-2 describes the connections for the analog input terminal block. This terminal block is located on the right side of the electronic card cage (see Figure D-7).

Terminal	Description	From (External)	Comments
1	Power	External sensor (typically a top oil temperature or load current sensor)[a]	4-20 mA general purpose input; 1,500V rms isolation level
2	4-20 mA analog input-		
3	4-20 mA analog input+		
4	Shield		

Table D - 2: Connections for the Analog Input Terminal Block

a. Magnetic-mount temperature and current sensors are available at General Electric. See Figure D-8 to Figure D-10 on the following pages.

The recommended cable is: instrumentation grade, individually twisted and shielded pairs or triads of copper multi-stranded wires, with a shield, a steel armor and a PVC overall jacket.

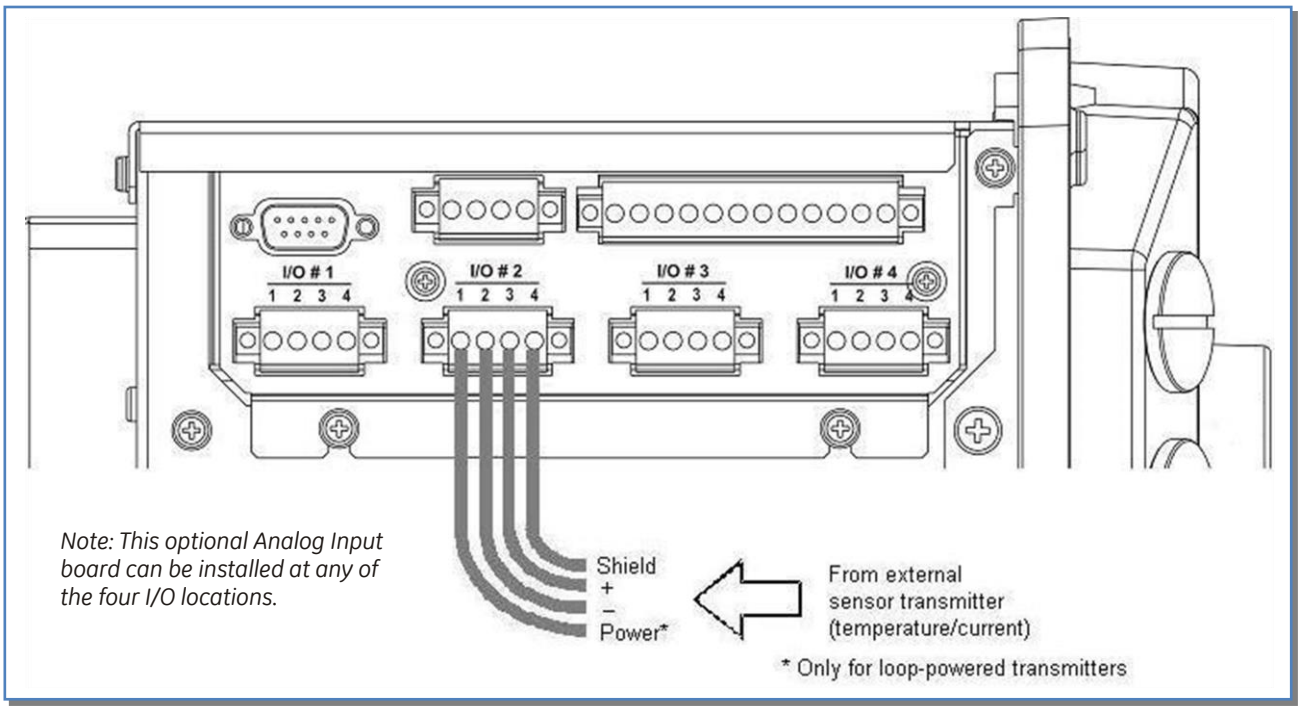


Figure D - 7: General Wiring of the Analog Input Terminal Block

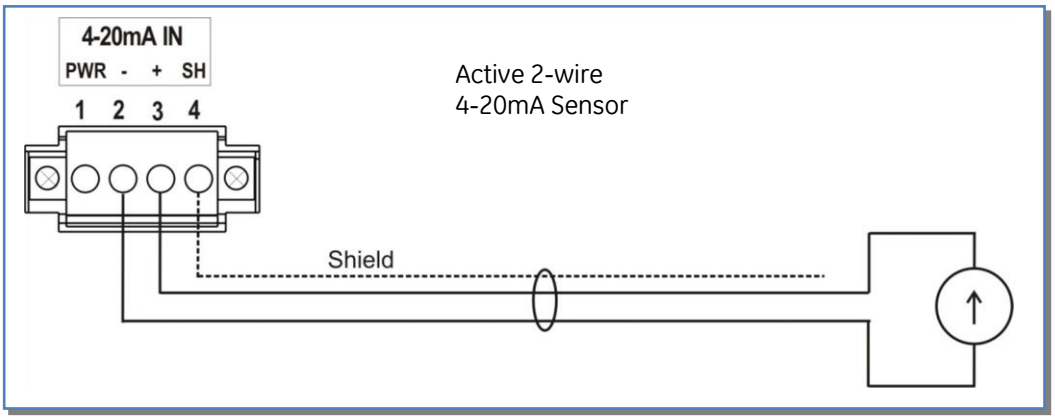


Figure D - 8: Wiring of Self-Powered, Analog Inputs

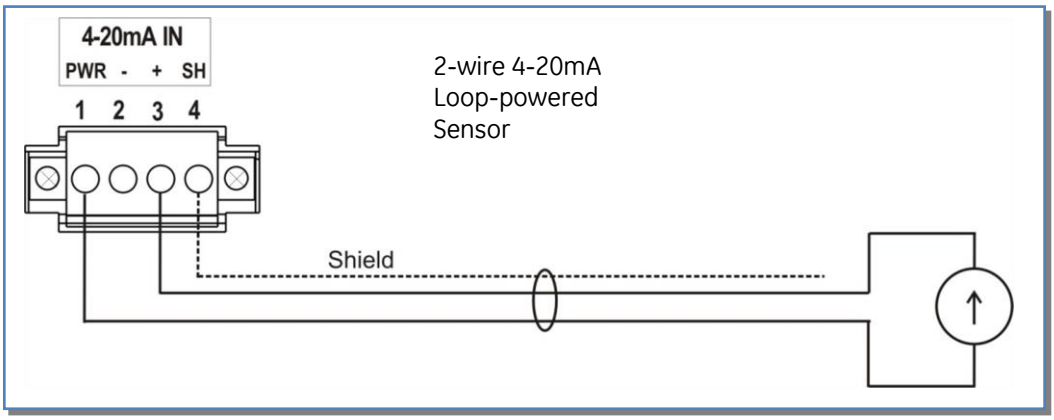


Figure D - 9: Wiring of Two-Wire, Loop-Powered, Analog Inputs

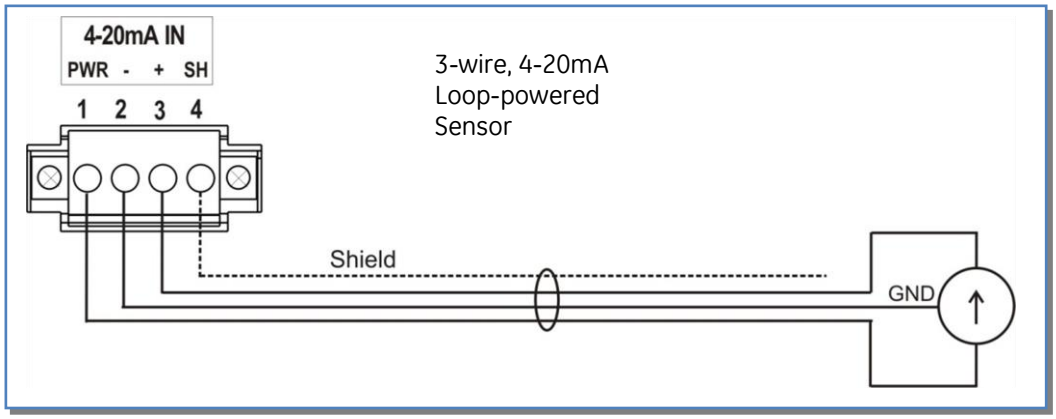


Figure D - 10: Wiring of Three-Wire, Loop-Powered, Analog Inputs

D.3 Analog Output Terminal Blocks

These terminal blocks are located on the right side of the electronic card cage (see Figure D-11).

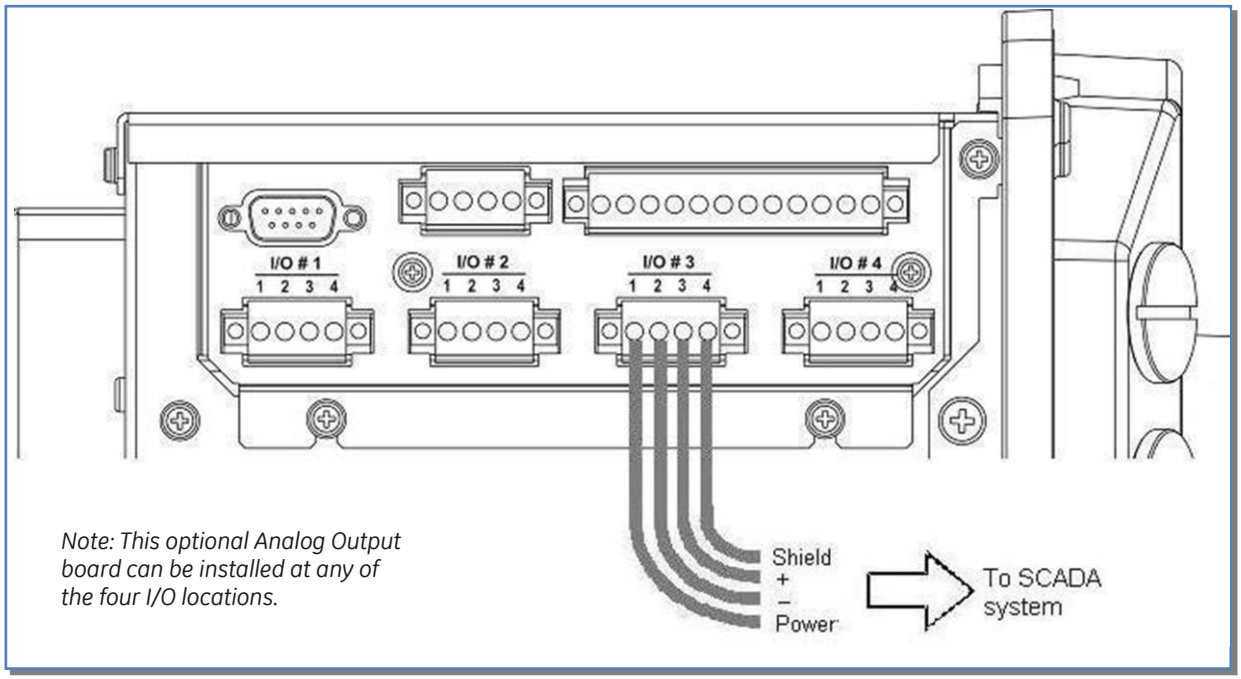


Figure D - 11: General Wiring of the Analog Output Terminal Block

The recommended cable is: individually twisted and shielded pairs of copper multi-stranded wires, with a shield, a steel armor and a PVC overall jacket.

D.4 "4-20" mA

Terminal	Description	From (External)	Comments
1	Configuration[b]	SCADA system	4-20 mA = 0-2,000 ppm; 500-Ω maximum load; 2,500V rms isolation level; for either ppm gas level. %RH or oil temperature monitoring
2[a]	4-20 mA analog input-		
3	4-20 mA analog input+		
4	Shield		

Table D - 3: Connections for the 4-20mA Analog Output Terminal Block

a. Use one shielded pair (100 % cover), twisted, 18 AWG (0.93 mM2-X)
b. The CFG terminal is only used by General Electric to test the analog output card to ensure it gives a good voltage.

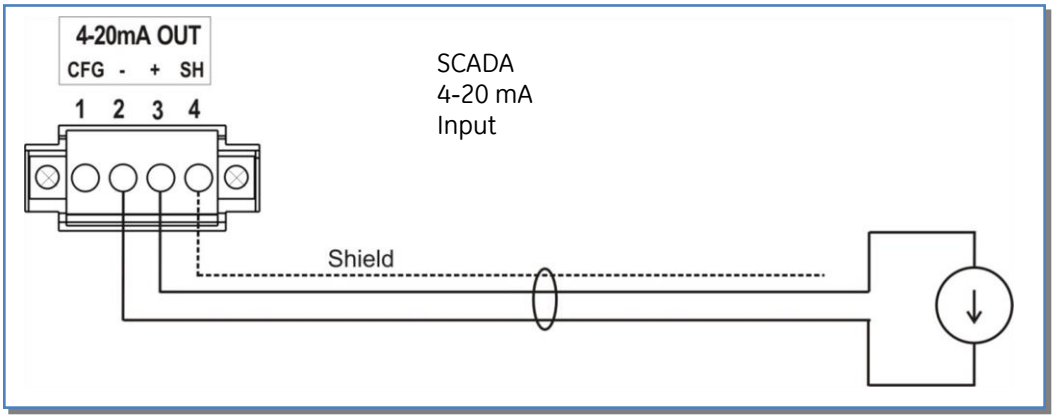


Figure D - 12: Wiring of the 4-20 mA Analog Output Terminal Block

D.5 Limitations

In a current loop, any length of cable and number of devices can be connected in series provided that the following conditions are met:

- All devices have floating differential inputs (*both* leads of signal input are ungrounded).
- The total loop resistance does not exceed 300 Ω.

D.6 Converting Current to Voltage

Recording devices with voltage inputs can be converted to current inputs by shunting their input terminals with an appropriate resistor. The resistor value is calculated as follows: Resistor ( ) = 50 x Input voltage range of recording device. For example, a chart recorder with an input range of 1 V uses a 50- (1 %, 1 W) resistor across the recorder input.

Note: Do not exceed 300 Ω (see Appendix D.5 on the previous page).

D.7 AC Power Supply Terminal Block and External Ground Lug

The ac power supply terminal block is located on the left side of the electronic card cage (Figure D - 13 below). The connections are described in Table D - 4.

The ac cable must have multi-stranded copper wires, an inner shield, a steel armor and an overall PVC jacket. The conductor size depends on the cable length; refer to the applicable standards and local regulations. Ground the cable armor.

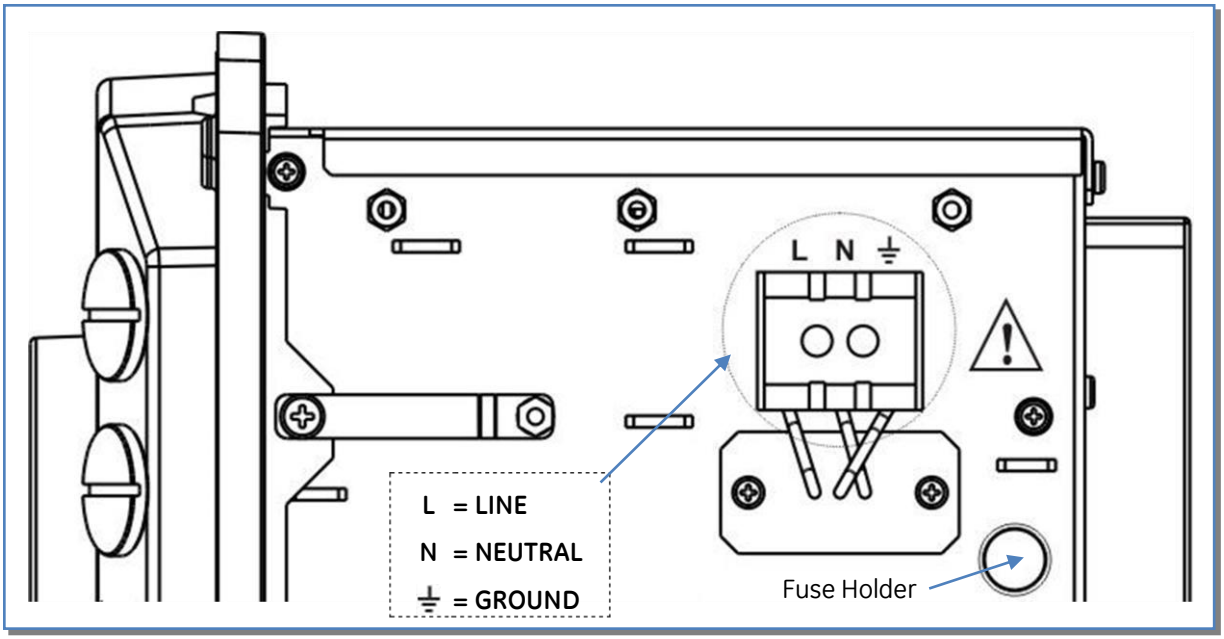


Figure D - 13: Wiring of the AC Power Supply Terminal Block

Terminal	Description	From (External)	Comments
L	Line	Live side of AC supply	AC supply is 100-120Vac or 200-240Vac 50/60Hz. Maximum load is 4A.
N	Neutral	Other side of AC supply	
⏚	Enclosure ground (Earth)	Unless otherwise required by the application local regulations, the ground wire from the power supply cable *must not* be connected to this terminal	Use external ground lug instead[a]

Table D - 4: Connections for the AC Power Supply Terminal Block

1. *Connect a ground wire to the external terminal lug. Use a 10-6 AWG (approximately 5.3 – 13.3 mM2-X) copper wire.*

WARNING ***Not connecting the ground terminal will cause operational failure.***

D.8 Alarm Contacts Terminal Block

The Hydran M2-X is equipped with five SPDT (single pole double throw) alarm relays. The alarm contacts of these relays are located on the left side of the electronic card cage (see Figure D-15). The connections are described in Table D - 5.

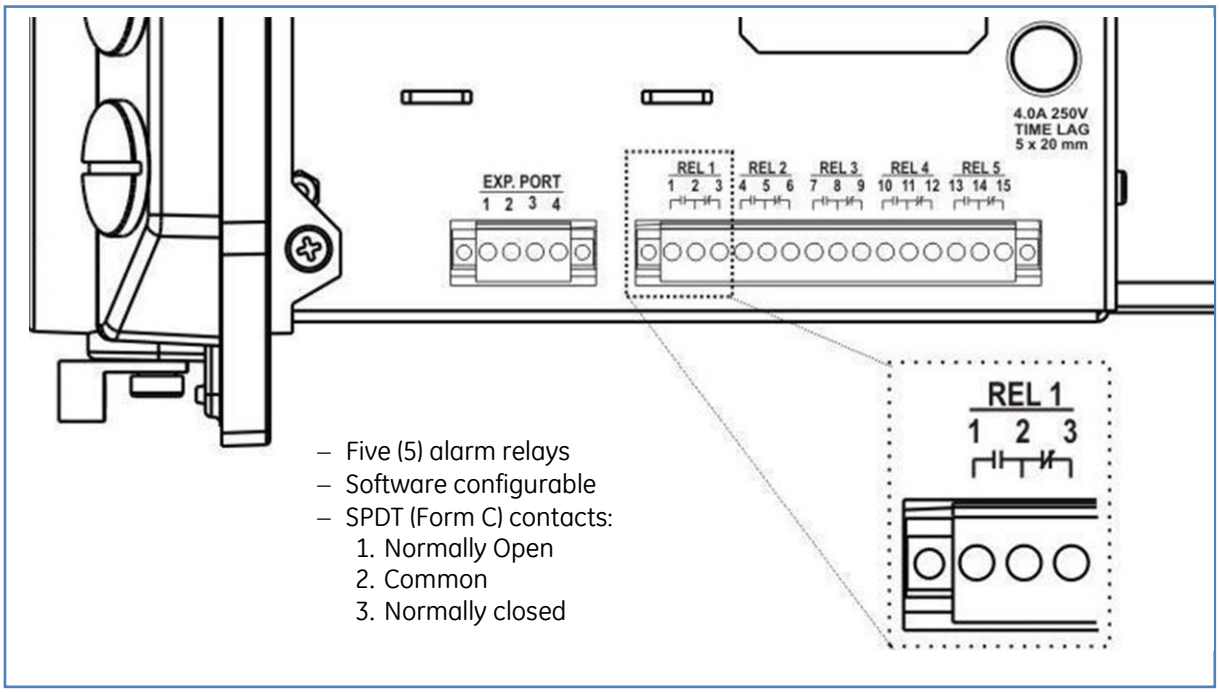


Figure D - 14: Wiring of the Alarm Contacts Terminal Block

The recommended alarm cable has multi-stranded copper, 600-V multi-conductors, as well as an inner shield, a steel armor and a PVC overall jacket.

Terminal[a]	Relay[b]	Description[c]	To (External)	Comments
1	1	NO	SCADA system, Hydran 201C*i*-1 or Hydran 201C*i*-4	User-configurable; normally assigned to gas High alarms
2		Common		
3		NC		
4	2	NO		User-configurable; normally assigned to gas High-High alarms
5		Common		
6		NC		
7	3	NO		User-configurable; normally assigned to moisture High alarms
8		Common		
9		NC		
10	4	NO		User-configurable; normally assigned to moisture High-High alarms
11		Common		
12		NC		
13	5	NO		Not configurable; used only for alarms due to system fault conditions; NO is closed if system is OK, NC is closed if system fails
14		Common		
15		NC		

Table D - 5: Connections for the Alarm Contacts Terminal Block

a. *Designed for 16-14 AWG (1.37-2.03 mM2-X) wires*
b. *Electric specifications for all relays: 125 VA @ 250 Vac, 60 W @ 220 Vdc*
c. *NC = Normally Closed (contact is closed when the relay is not energized);*
NO = Normally Open (contact is open when the relay is not energized)

Appendix E : Installing I/O Modules

Note: Installing I/O modules requires only a Phillips screwdriver.

Proceed as follows:

1. Remove the four screws holding in place the Hydran M2-X cover and remove this cover. See Figure 5-11: Removing the Hydran M2-X Cover.
2. Remove the four screws holding in place the cover plate of the electronic card cage and remove this plate. See Figure E-1 below.

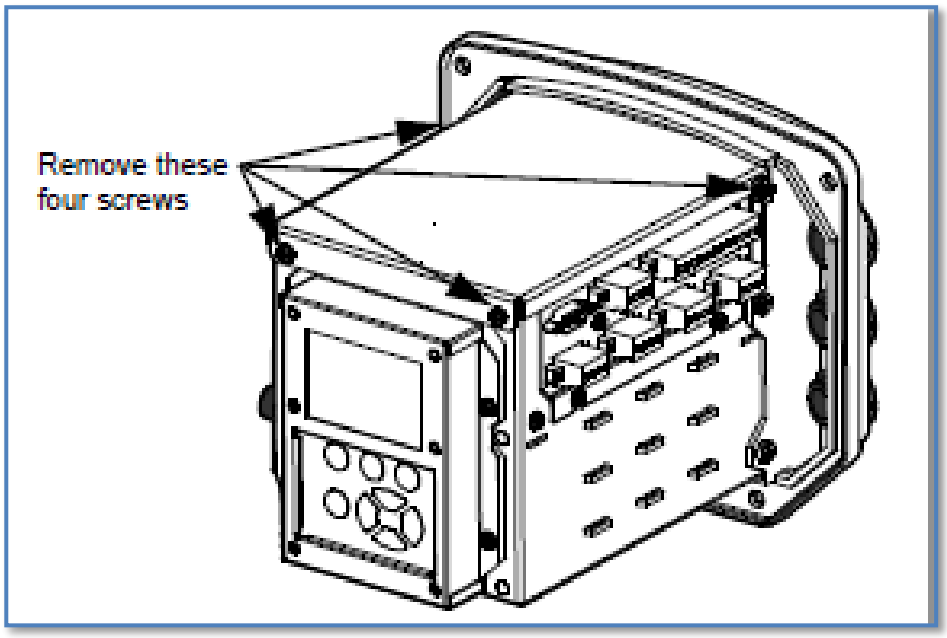


Figure E-1: Opening the Electronic Card Cage

3. Carefully disconnect connectors J10, J11, J13 and J14.
4. Remove the four screws holding in place the controller board.
5. Remove the two screws holding in place the I/O assembly, and remove the I/O assembly from the electronic card cage. See Figure E-2.
6. Secure each I/O interface in one of the four locations using the following parts:
   - Two screws (PAN, 6-32, 5/16, SS, Phillips; part number 16423).
   - Two washers (flat, #6, ID = 0.143, OD = 0.267, SS; part number 16445).
   - Two lock washers (#6, SP/SP, W2024; part number 12085).
7. Put back the I/O assembly in the electronic card cage. Reinstall the two screws removed during step 5. See Figure E-2.
8. Carefully reconnect connectors J10, J11, J13 and J14.
9. Put back and tighten the four screws holding the controller board in place.

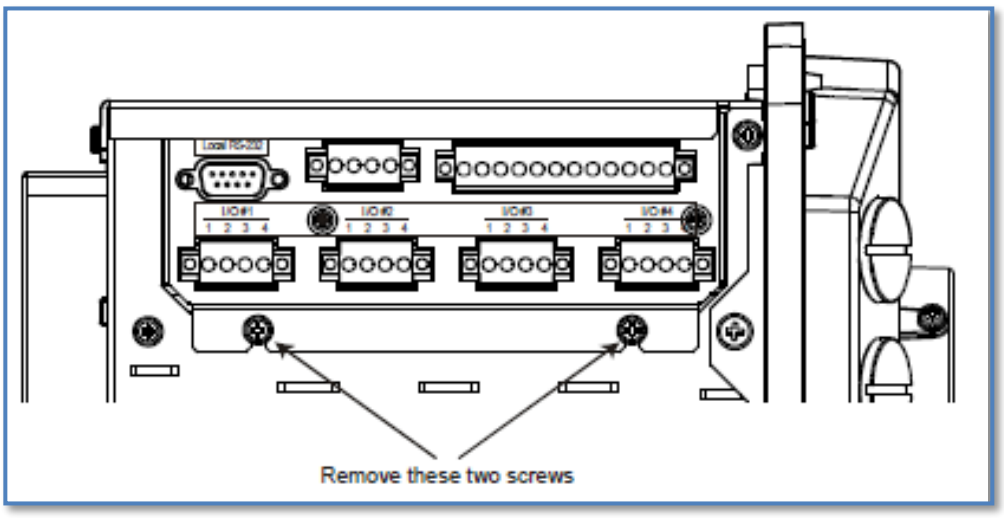


Figure E-2: Removing the I/O Assembly

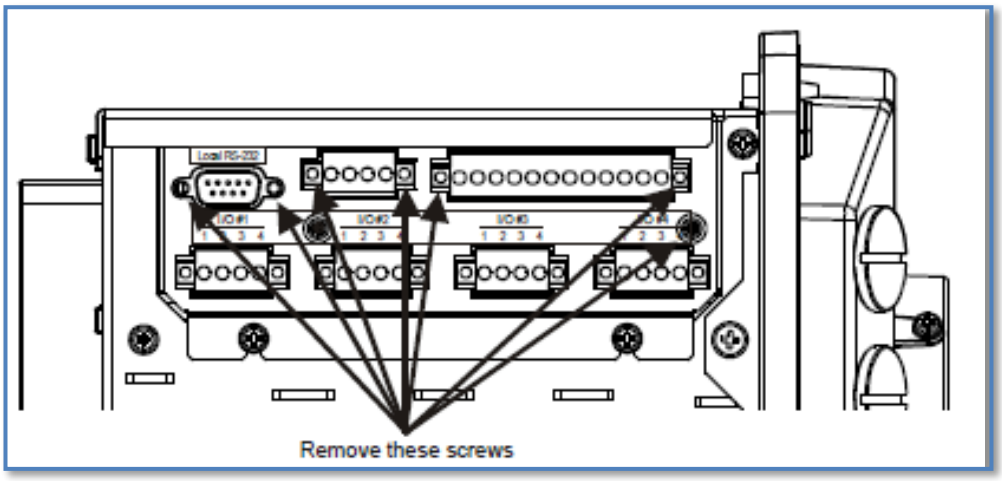
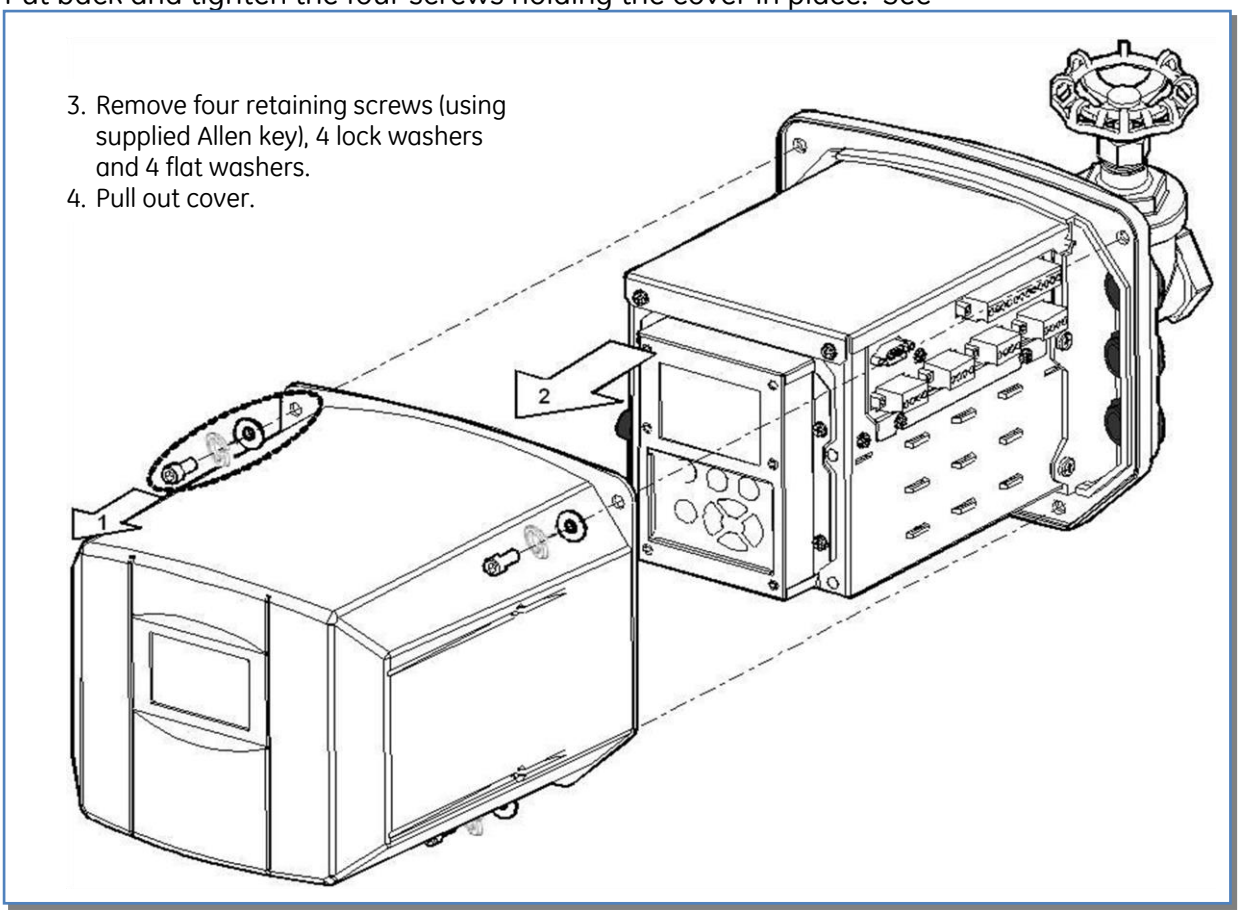


Figure E-3: Removing the I/O Plate

10. Put back and tighten the four screws holding in place the cover plate of the electronic card cage. See Figure E-1 E-3 above.
11. Put back the Hydran M2-X cover.

12. Put back and tighten the four screws holding the cover in place. See



13. **Figure 5-11: Removing the** Hydran M2-X Cover

The hardware installation of the I/O interface(s) is now complete.

See the following sections to verify the I/O interface(s) that have just been installed:

- Analog input: Section 5.2.8.
- Analog output: Section 5.2.9.

Appendix F : Upgrading the Embedded Programs (Firmware)

Upgrading the embedded programs consists in uploading a new version of the programs residing in the flash memory. The flash memory allows you to upgrade its content using a software instead of physically replacing a memory chip.

Each Hydran M2-X is controlled by two embedded programs:

- The controller board program.
- The sensor interface board program.

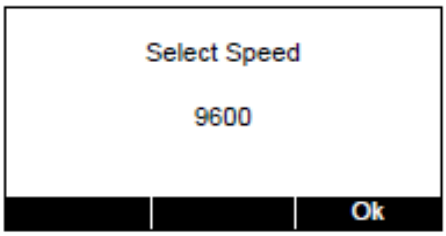
Both programs can be upgraded locally.

The controller board program can also be upgraded, locally only, and one Hydran M2-X at a time, using a program called BootDownloader; proceed as follows:

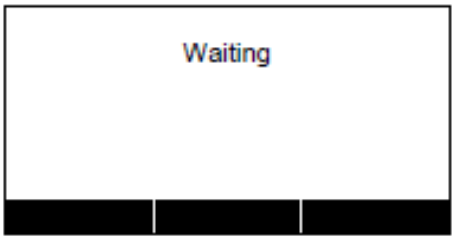
1. Ensure you have the **CB.APP** file, which contains the upgrade for the controller board program. It can be found in the following folder of the installation CD:

   [drive letter]:\HM2-X Firmware\Control Board *x.yz*, where ***x.yz*** is the version number.

2. Verify the version number of the controller board program currently running. To do so, access Main Menu > Service > Software Version using the Hydran M2-X's keypad. Verify the version number again after the upgrade procedure to confirm its success.
3. Connect a null modem cable between the Hydran M2-X's **Local RS-232** connector and the laptop computer's COM port.
4. Remove the Hydran M2-X's cover and power off the Hydran M2-X by unscrewing the fuse holder. Then, power on the Hydran M2-X by screwing the fuse holder back in place while pressing the left and middle context keys. The Hydran M2-X now displays:



5. Select an appropriate baud rate using the Up and Down arrow keys. The recommended setting is 115,200 bps for low-noise environments; if communication problems arise, try again with a lower baud rate. Press Ok when done. The Hydran M2-X now displays:



6. On the laptop computer, launch the **BootDownloader.exe** program, normally stored in the Hydran M2-X installation folder (typically **C:\Program Files\Hydran M2-X**). The **HM2-X Downloader for Boot Mode** screen, shown in Figure F - 1 below is now displayed. Proceed as follows:

   - In **Comm port:**, select the appropriate COM port.
   - In **Baud rate:**, select the same baud rate as in step 6.
   - Click **Browse...** to locate the **CB.APP** file.
   - Click **Download** to start the program upgrade.

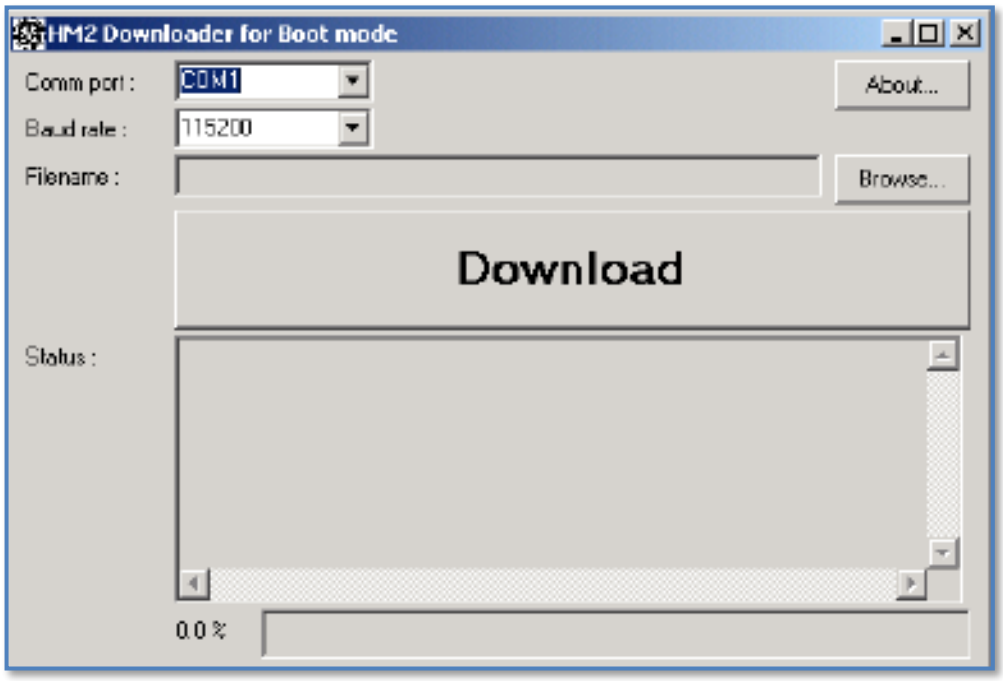
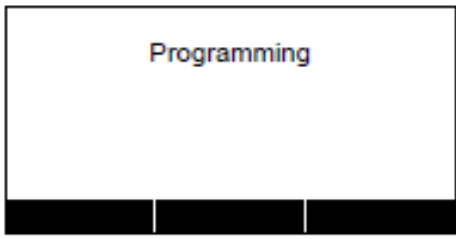


Figure F - 1: Upgrading the Embedded Program Using BootDownloader.exe

7. The Hydran M2-X now displays the screen below. The **HM2-X Downloader for Boot** Mode screen now displays status messages in the **Status**: area as well as the progress percentage at the bottom; when the upgrade is completed, it displays the message **Upgrade Completed** in its **Status**: area.



8. Once the upgrade is completed, the Hydran M2-X reboots automatically and then resumes normal operation. Ensure the upgrade process has been successful by verifying the version number of the controller board program. To do so, access **Main Menu > Service > Software Version** using the Hydran M2-X's keypad.

Note: If the communication link is broken during the upgrade process, start the procedure again from the beginning.

Appendix G : Replacing the Battery

The battery must be replaced when its voltage is too low (battery Low or Low-Low alarm). When the battery is disconnected for its replacement, the value of the following parameters is saved:

- **Setup > Temperature Setup**
- **Service > Sensor Param**
- **View Readings > View History > View Sensor Card History**

However, when the battery is removed, the value of the following parameters is lost:

- **Setup > Alarms Setup**
- **Setup > Date & Time**
- **Setup > Comm Setup**
- **Setup > History Setup**
- **Setup > Relay Setup**
- **Setup > I/O Setup**
- **Alarms > Alarms History**
- **View Readings > View History Data**

To replace the battery, proceed as follows:

Note: Step 1 below can be skipped if the Hydran M2-X was never put in service and if the Hydran M2-X's default parameter values have not been changed.

1. Because some Hydran M2-X's parameters are lost (see above) when the battery is disconnected, they must be recorded. There are two methods:
   - Use the Perception software. For connection details, see Chapter 5; for details on the software, see the Perception *Manual*.
     - History files are transferred automatically as soon as the communication is established between the Perception software and the Hydran M2-X. The **Histo Download in Progress**... message remains displayed in the Perception window during the transfer.
     - Manually note all parameters in the Hydran M2-X's Communication submenu. These parameters are the only ones that cannot be accessed from the Perception software.
   - If the Perception software cannot be used, manually note the values of all Hydran M2-X's parameters. This method is more difficult and can be source of errors.
2. Power off the Hydran M2-X.
3. Remove the cover.
4. Remove the two screws holding the cover of the electronic card cage.
5. Carefully lift off the cover.
6. Using a small screwdriver, remove the plastic holder on top of the battery and remove the battery.

7. Replace the battery.

Do not dissemble, crush, puncture or incinerate the battery. Handle a damaged or leaking battery with extreme care. If you touch the electrolyte, wash the exposed skin with soap and water. If the electrolyte contacts your eye, flush the eye with water for 15 minutes. If you have inhaled the electrolyte, move to fresh air, and monitor breathing and circulation. In each case, seek immediate medical attention. When discarding a battery, follow applicable safety procedures or contact your local waste disposal provider regarding local restrictions on the disposal or recycling of batteries.

This product contains a battery that cannot be disposed of as unsorted municipal waste in the European Union. See the product documentation for specific battery information. The battery is marked with this symbol, which may include lettering to indicate cadmium (Cd), lead (Pb), or mercury (Hg). For proper recycling return the battery to your supplier or to a designated collection point. For more information see www.recyclethis.info

8. Put back in place the plastic holder.
9. Put back in place the cover of the electronic card cage and fasten it using the two screws removed during step 4.
10. Reconnect the Hydran M2-X's power supply, reinstall the cover and power on the Hydran M2-X.

Note: Except for the sensor and calibration parameters, all Hydran M2-X's parameters are now reset to their hardware default values.

11. Using the Perception software or the Hydran M2-X's keypad, enter the values noted during step 1 above.

Appendix H : History File Messages

This Appendix complements Section 4.4.2. The messages are sorted in alphabetical order:

Event	Message Description
AnalogMode chg	Modification of the analog output's operation mode
Batt.Alr Ack	Battery voltage alarm has been acknowledged
BattAlr L chg	Modification of the Low battery voltage alarm's set point
BattAlr L OFF	Low battery voltage alarm turned off
BattAlr L ON	Low battery voltage alarm turned on
BattAlr LL chg	Modification of the Low-Low battery voltage alarm's set point
BattAlr LL OFF	Low-Low battery voltage alarm turned off
BattAlr LL ON	Low-Low battery voltage alarm turned on
BattDelay chg	Modification of the battery voltage alarm's delay
BaudRate c.	Modification of the transmission rate (bits per second)
CableOpen OFF	Open cable alarm turned off
CableOpen ON	Open cable alarm turned on
CableShort OFF	Short circuit cable alarm turned off
CableShort ON	Short circuit cable alarm turned on
CommMode chg	Modification of the communication mode
Date&Time chg	Modification of the date and/or time
DayAcqRate chg	Modification of the daily trend period
DayAlr Ack	Daily trend alarm has been acknowledged
DayAlr H chg	Modification of the High daily trend alarm's set point
DayAlr H OFF	High daily trend alarm turned off
DayAlr H ON	High daily trend alarm turned on
DayAlr HH chg	Modification of the High-High daily trend alarm's set point
DayAlr HH OFF	High-High daily trend alarm turned off
DayAlr HH ON	High-High daily trend alarm turned on
DayAlr L chg	Modification of the Low daily trend alarm's set point

DayAlr L OFF	Low daily trend alarm turned off
DayAlr L ON	Low daily trend alarm turned on
DayAlr LL chg	Modification of the Low-Low daily trend alarm's set point
DayAlr LL OFF	Low-Low daily trend alarm turned off
DayAlr LL ON	Low-Low daily trend alarm turned on
DayDelay chg	Modification of the daily trend alarm's delay
DefaultChan chg	Modification of the default communication channel
GasAlr Ack	Gas level alarm has been acknowledged
GasAlr H chg	Modification of the gas level High alarm's set point
GasAlr H OFF	Gas level High alarm turned off
GasAlr H ON	Gas level High alarm turned on
GasAlr HH OFF	Gas level High-High alarm turned off
GasAlr HH ON	Gas level High-High alarm turned on
GasAlr HH chg	Modification of the gas level High-High alarm's set point
GasAlr L chg	Modification of the gas level Low alarm's set point
GasAlr L OFF	Gas level Low alarm turned off
GasAlr L ON	Gas level Low alarm turned on
GasAlr LL chg	Modification of the gas level Low-Low alarm's set point
GasAlr LL OFF	Gas level Low-Low alarm turned off
GasAlr LL ON	Gas level Low-Low alarm turned on
GasDelay chg	Modification of a gas level alarms' delay
H201 ID chg	Modification of the Hydran M2-X identification number
HistoEvent Clr	Events history file has been cleared (erased)
HistoLogRate c	Modification of the logging rate of the Short Term history recordings
Hist LogTime chg	Modification of one of the four logging times of the Long Term history recordings
HistoLong Clr	Long Term history file has been cleared (erased)
HistoRam Bad	RAM memory test of history files has failed
HistoService Clr	Service history file has been cleared (erased)
HistoShort Clr	Short Term history file has been cleared (erased)
HourAlr Ack	Hourly trend alarm has been acknowledged

HourAlr H chg	Modification of the hourly trend High alarm's set point
HourAlr H OFF	Hourly trend High alarm turned off
HourAlr H ON	Hourly trend High alarm turned on
HourAlr HH chg	Modification of the hourly trend High-High alarm's set point
HourAlr HH OFF	Hourly trend High-High alarm turned off
HourAlr HH ON	Hourly trend High-High alarm turned on
HourAlr L chg	Modification of the hourly trend Low alarm's set point
HourAlr L OFF	Hourly trend Low alarm turned off
HourAlr L ON	Hourly trend Low alarm turned on
HourAlr LL chg	Modification of the hourly trend Low-Low alarm's set point
HourAlr LL OFF	Hourly trend Low-Low alarm turned off
HourAlr LL ON	Hourly trend Low-Low alarm turned on
HourDelay chg	Modification of the hourly trend alarm's delay
HourAcqRate chg	Modification of the hourly trend period
InternalErr 0	Internal error No. 0
InternalErr 1	Internal error No. 1
InternalErr 2	Internal error No. 2
InternalErr 3	Internal error No. 3
InternalErr 4	Internal error No. 4
InternalErr 5	Internal error No. 5
NewSensor	Installation of a new sensor
Period A chg	Modification of the Period A parameter
Period B chg	Modification of the Period B parameter
PowerDown	Power-down of Hydran M2-X
PowerUp	Power-up of Hydran M2-X
PowStat ID chg	Modification of the power station's identification number
ProgRam Bad	RAM memory test of program data has failed
ProgUpgraded	Hydran M2-X's embedded software has been upgraded
RelayMode chg	Modification of a relay's operating mode

SensorCaution OFF	Sensor Caution alarm turned off
SensorCaution ON	Sensor Caution alarm turned on
RTC Bad	Real-time clock has failed
SensTstAlr Ack	Sensor fail alarm has been acknowledged
SetupLost Ack	Setup lost alarm has been acknowledged
SetupLost OFF	Setup lost alarm turned off
Set-up Lost ON	Setup lost alarm turned on
Soft WatchDog	Reset of Hydran M2-X induced by the software watchdog
Sp Span chg	Modification of the sensor temperature set point's range
STempAlr Ack	Sensor temperature fail alarm has been acknowledged
STempAlr H chg	Modification of the sensor temperature High alarm's set point
STempAlr H ON	Sensor temperature High alarm turned on
STempAlr HH chg	Modification of the sensor temperature High-High alarm's set point
STempAlr HH ON	Sensor temperature High-High alarm turned on
STempAlr L chg	Modification of the sensor temperature Low alarm's set point
STempAlr L ON	Sensor temperature Low alarm turned on
STempAlr LL chg	Modification of the sensor temperature Low-Low alarm's set point
STempAlr LL ON	Sensor temperature Low-Low alarm turned on
STempDelay chg	Modification of the sensor temperature alarm's delay
STemp H OFF	Sensor temperature High alarm turned off
STemp HH OFF	Sensor temperature High-High alarm turned off
STemp L OFF	Sensor temperature Low alarm turned off
STemp LL OFF	Sensor temperature Low-Low alarm turned off
STempSetP chg	Modification of the sensor temperature set point
SystemCalib	Calibration of Hydran M2-X
TDM Mode chg	Modification of the TDM signal's operating mode
Unit in Service	Hydran M2-X back in service after the battery was disconnected
Watchdog	Reset of Hydran M2-X induced by the hardware watchdog

Appendix I : Alarm Messages

Table I-1 below presents the list of all alarm messages that can be displayed by the Hydran M2-X and that can appear in the Perception software

Alarm Name	Alarm Message on the Hydran M2-X Display	Alarm Message in the Perception Software
Hydran Level Hi Alarm	Gas Level Hi Alarm	H2 PPM Level High
Hydran Level Hi-Hi Alarm	Gas Level Hi-Hi Alr	H2 PPM Level High-High
Hydran Hourly Trend Hi Alarm	Gas Hr.Tr. Hi Alarm	H2 PPM Hourly Trend High-High
Hydran Daily Trend Hi Alarm	Gas Dy.Tr. Hi Alarm	H2 PPM Daily Trend High
Hydran Daily Trend Hi-Hi Alarm	Gas Dy.Tr. H-Hi Alr	H2 PPM Daily Trend High-High
%RH Level Hi Alarm	%RH Hi Alarm	H2O RH% Level High
%RH Level Hi-Hi Alarm	%RH Hi-Hi Alarm	H2O RH% Level High-High
H2O PPM Level Hi Alarm	H2O PPM Hi Alarm	H2O PPM Level High
H2O PPM Level Hi-Hi Alarm	H2O PPM Hi-Hi Alarm	H2O PPM Level High-High
%RH Hourly Average Hi Alarm	%RH Avg.Hi Alarm	HighH2O RH% Hourly Average
%RH Hourly Average Hi-Hi Alarm	%RH Avg. Hi-Hi Alr	H2O RH% Hourly Average High-High
H2O PPM Hourly Average Hi Alarm	H2O PPM Avg. Hi Alr	H2O PPM Hourly Average High
H2O PPM Hourly Average Hi-Hi Alarm	H2O PPM Av. H-H Alr	H2O PPM Hourly Average High-High
Hydran Sensor Temp Low-Low Alarm	S. Temp C.Open Alr	Sensor Temp Cable Open
Hydran Sensor Temp Low Alarm	S. Temp Low Alarm	Sensor Temp Low
Hydran Sensor Temp Hi Alarm	S. Temp Hi Alarm	Sensor Temp High
Hydran Sensor Temp Hi-Hi Alarm	S. Tmp C.Short Alr	Sensor Temp Cable Short
Base Plate Temperature	B.P. Tmp C.Open Alr	Base Plate Temp Cable

Alarm Name	Alarm Message on the Hydran M2-X Display	Alarm Message in the Perception Software
Low-Low Alarm		Open
Base Plate Temperature Low Alarm	B.P. Temp Low Alarm	Base Plate Temp Low
Base Plate Temperature Hi Alarm	B.P. Temp Hi Alarm	Base Plate Temp High
Base Plate Temperature Hi-Hi Alarm	B.P. Tmp C.Shrt Alr	Base Plate Temp Cable Short
Battery Low-Low Alarm	Battery L-Low Alr	Battery Low-Low
Battery Low Alarm	Battery Low Alarm	Battery Low
(An. User Defined #1) Low-Low Alarm	IO#1 LL Alr	IO 1 Low-Low
(An. User Defined #1) Low Alarm	IO#1 L Alr	IO 1 Low
(An. User Defined #1) Hi Alarm	IO#1 H Alr	IO 1 High
(An. User Defined #1) Hi-Hi Alarm	IO#1 HH Alr	IO 1 High-High
(An. User Defined #2) Low-Low Alarm	IO#2 LL Alr	IO 2 Low-Low
(An. User Defined #2) Low Alarm	IO#2 L Alr	IO 2 Low
(An. User Defined #2) Hi Alarm	IO#2 H Alr	IO 2 High
(An. User Defined #2) Hi-Hi Alarm	IO#2 HH Alr	IO 2 High-High
(An. User Defined #3) Low-Low Alarm	IO#3 LL Alr	IO 3 Low-Low
(An. User Defined #3) Low Alarm	IO#3 L Alr	IO 3 Low
(An. User Defined #3) Hi Alarm	IO#3 H Alr	IO 3 High
(An. User Defined #3) Hi-Hi Alarm	IO#3 HH Alr	IO 3 High-High
(An. User Defined #4) Low-Low Alarm	IO#4 LL Alr	IO 4 Low-Low
(An. User Defined #4) Low	IO#4 L Alr	IO 4 Low

Alarm Name	Alarm Message on the Hydran M2-X Display	Alarm Message in the Perception Software
Alarm		
(An. User Defined #4) Hi Alarm	IO#4 H Alr	IO 4 High
(An. User Defined #4) Hi-Hi Alarm	IO#4 HH Alr	IO 4 High-High
Hydran Sensor Cable Open Alarm	Gas C.Open Alarm	H2 Sensor Test Cable Open
Hydran Sensor Cable Short Alarm	Gas C.Short Alarm	H2 Sensor Test Cable Short
Hydran Replace Sensor Now Alarm	Gas Sens. Bad Alr	H2 Sensor Test Bad
Sensor Card #1 Comm. Error Alarm	S.Card Comm Err Alr	Sensor Comm. Failure

Table I - 1: Alarm Messages on the Hydran M2-X Display and on the Perception Software

Appendix J : Extracting an Oil Sample

WARNING

This procedure is valid only if positive oil pressure is present at the sensor. If negative pressure exists (possible for sealed transformer), do not use this method.

1. Open the Luer stopcock valve of the glass syringe and ensure the syringe is free of air.

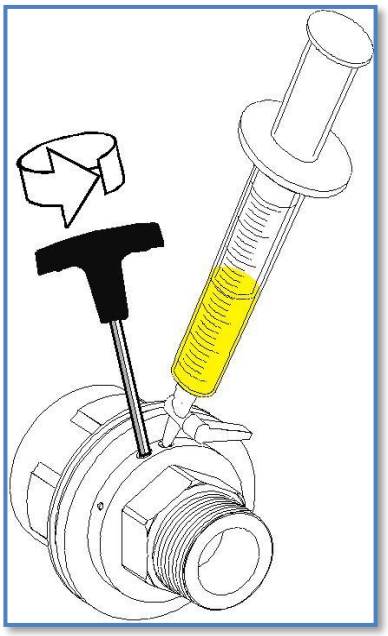


Figure J-1: Extracting an Oil Sample from the Sensor's Sampling Port Using a Glass Syringe and a 5/32 in Allen Key

2. Insert and adjust the tip of the syringe valve into the sensor's sampling port.
3. Using the 5/32-in Allen key, slowly open the sensor's bleed screw.
4. Generally, the oil pressure by itself should fill the syringe. If not, slowly pull the syringe's plunger.
5. When the syringe is full, shut off the bleed screw.
6. Close the stopcock valve of the syringe.
7. Withdraw the syringe.
8. Empty the syringe; ensure all air bubbles are purged from the syringe. This first extraction allows oil to wet the inner walls of the syringe with liquid to assure better accuracy of sampling.
9. Repeat steps 2 to 7 to extract the oil sample.
10. Purge all air bubbles from the syringe.
11. Fill an identification card for this sample. Indicate the relative humidity and temperature readings performed by the Hydran M2-X at the time of extraction.

Appendix K : Unit Conversions

K.1 Analog Outputs – Converting ppm to mA (or Vice Versa)

To convert mA (milliamperes) into ppm (or vice versa), use the following formulas:

- *4–20 mA configuration: ppm = 125 x (mA - 4); or mA = 4 + (ppm / 125)*

  Example: For a 4.8-mA current, the level of gases in oil is 100 ppm. Likewise, if the display reads 250 ppm, then the current value is 6.0 mA.

K.2 Moisture Level and Relative Humidity (Converting to ppm Concentration)

The relative saturation (RS), often called the relative humidity (%RH), is expressed in units of percent. It is the concentration of the water dissolved in the oil (PPM), relative to the solubility or concentration of water the oil can hold (PPMs) at the measurement temperature, as shown in Equation 1:

$$RS = \frac{PPM}{PPMs} \times 100 \quad (Equation\ 1)$$

where PPM and PPMs are in weight/weight

In Equation 1, RS is measured by the Hydran M2-X. We need to know the PPMs in order to calculate the PPM.

The solubility of water in the oil depends on the nature of the oil (composition, oxidation, etc.) and its temperature. For typical naphthalenic oils, the following equation is given1 to calculate the PPMs:

$$PPMs = e^{\frac{-4107.1}{273+T} + 17{,}749} \quad \text{(Equation 2)}$$

where T is the measurement temperature in °C. By combining Equations 1 and 2 and by adding an offset of 2.4 ppm (typical value of bonded water for new oil), we have:

$$PPM = \frac{RS}{100} \times e^{\frac{-4107.1}{273+T} + 17{,}749} + 2.4 \quad \text{(Equation 3)}$$

This is the equation used by the Hydran M2-X to convert the RS into PPM, and the resulting PPM value can be read on the display.

It is important to note that the value displayed by the Hydran M2-X is accurate only for the new Voltesso 35 oil[2]. The user has the responsibility to determine his own Equation 3 based on the nature of the specific transformer oil, in order to ensure the accuracy of the computed PPM values. Otherwise, caution should be exercised when comparing the displayed PPM value with a laboratory's Karl Fischer result.

As an example, Table K - 1[3] and Figure K - 1[4] show the water solubility (or often called saturation) curves of various oils as a function of the oil composition and temperature.

The user should keep in mind that in practice, the independent measurements of relative saturation and PPM are necessary in order to obtain complete information on the water content in the oil, and both measurements are complementary.

[2] Esso Petroleum Product Data Sheet on Voltesso 35
[3] V. Sokolov, P. Griffin and B. Vavin, "Moisture Equilibrium and Moisture Migration Within Transformer Insulation Systems," Cigre Report WG12.18
[4] S.P. Mehta and T.M. Golner, "Moisture Removal on Energized Power Transformers"

Oil No	Aromatic Content (%)	Solubility (ppm)		
		20˚C	40˚C	70˚C
1	5	42.8	97.5	279
2	8	46.8	108	316
3	16	56.2	128.3	369.2
4	21	75	162	436

Table K - 1: Water Solubility as a Function of the Oil Composition and Temperature

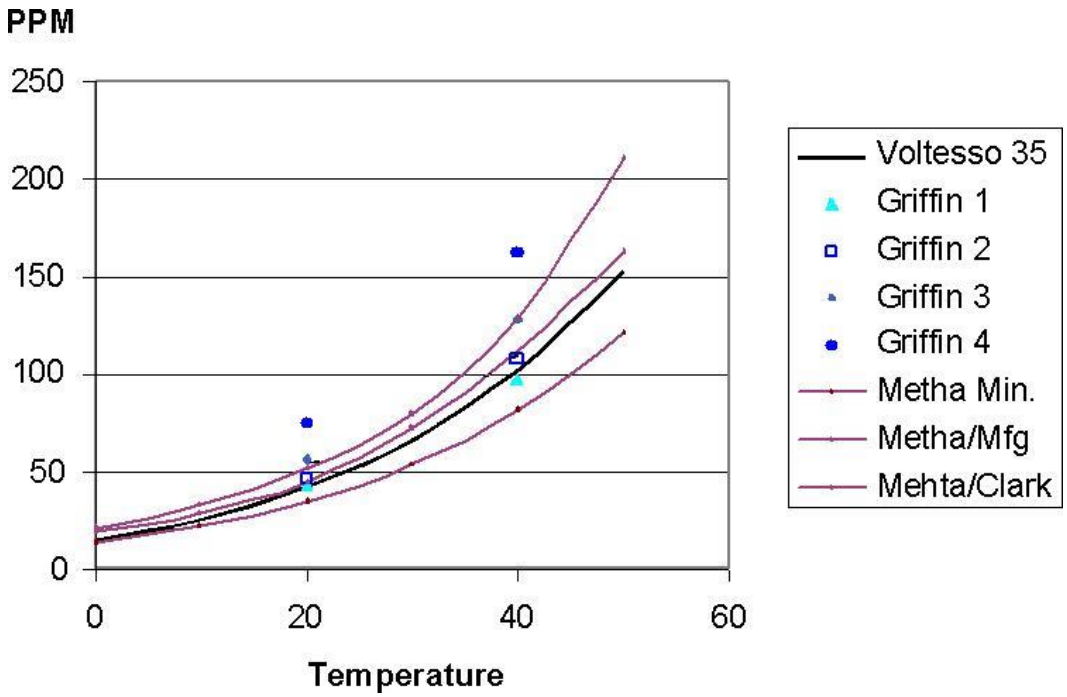


Figure K - 1: Water Solubility Curves According to Different Sources

The Hydran M2-X measures the relative saturation of water in the oil, which gives the following information:

Relative saturation of the oil at the operation temperature

- Temperature at which the water will saturate and condense in the oil
- Estimation of the water percentage in the paper insulation system

For instance, in the calculation of the moisture content in the insulating paper, the relative saturation is more significant than the absolute water content. The Hydran M2-X provides directly the relative saturation, thus avoiding inaccuracies linked with a poorly defined saturation curve.

Appendix L : Other Products and Accessories

L.1 Hydran 201C-i-C Communications Controller

The Hydran 201C*i* -C Communications Controller (H201C*i*-C) is used as an interface between a network of Hydran M2-X's and a remote host computer. The H201C*i* -C does not have a numerical display, analog outputs or alarm contacts, see the illustration below.

Figure L - 1: Hydran 201C*i*-C Communications Controller

The H201C*i*-C is built into a heated Type NEMA 4X enclosure (approximately 20 x 30 x 12 cm [8 x 12 x 4.75 in]).

The H201C*i*-C includes:

- A digital circuit board to control all communications, including networking
- A terminal block for ac power connections
- Connectors for RS-232 and RS-485 communication cables

L.2 Vibration-Absorbing Rubber Pads

The vibration- absorbing rubber pads (Figure L - 2) are used to protect the Hydran 201C*i* Controllers against vibrations. These pads can be ordered separately or with the Hydran M2-X.

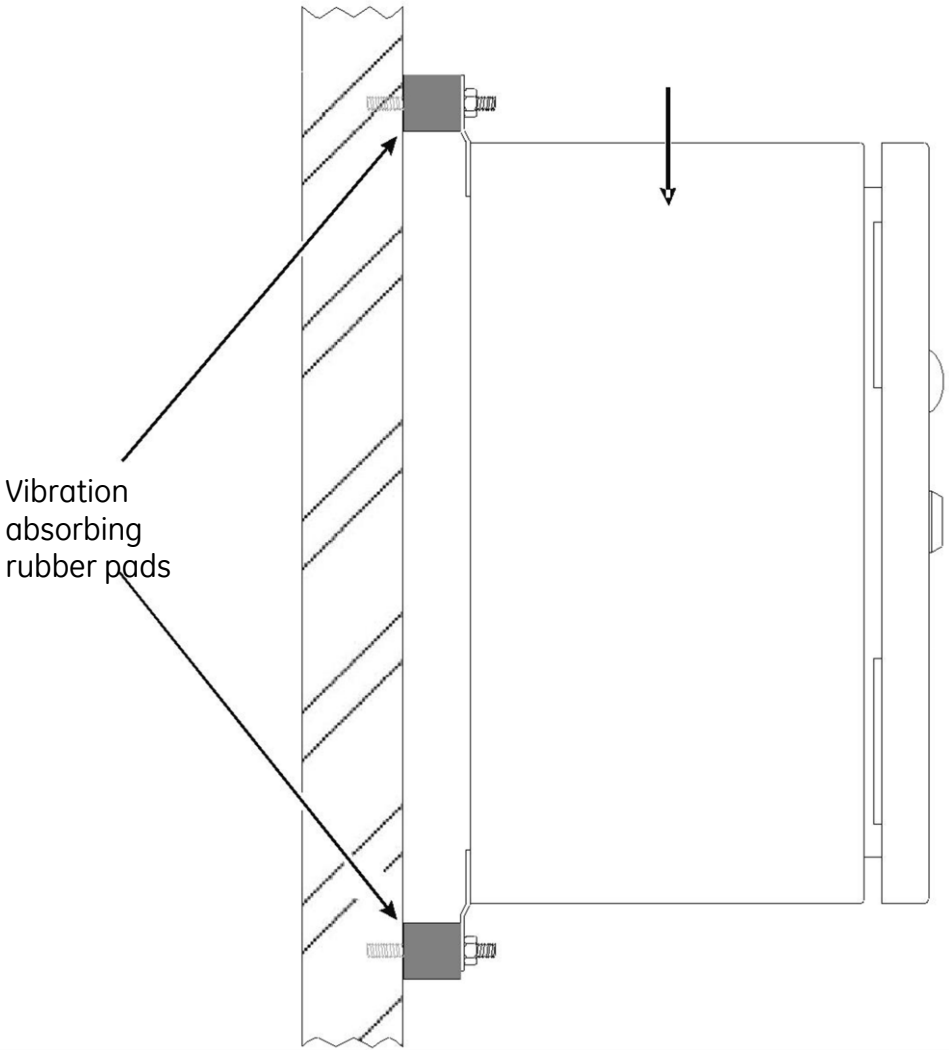


Figure L - 2: Vibration-Absorbing Rubber Pads

Appendix M : Glossary

A	Ampere
ac	Alternating Current
ACK	ACKnowledge
A/D or ADC	Analog-to-Digital Converter
Alarm	Condition when a data point value exceeds a set point
Alarm Contact	Contact of an alarm relay
Analog Output	Analog signal proportional to gas or moisture level
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
AWG	American Wire Gauge
B.P.	Base Plate with heating resistors
bps	Bit Per Second
CD-ROM	Compact Disc - Read-Only Memory
CE	Conformité Européenne (European Conformity)
CH_4	Methane (gas)
C_2H_2	Acetylene (gas)
C_2H_4	Ethylene (gas)
C_2H_6	Ethane (gas)
CO	Carbon monoxide (gas)
CO_2	Carbon dioxide (gas)
COM	COMmunication port on a PC
Combustible Gas	Fault gas in the dielectric oil of a transformer
CPU	Central Processing Unit
CSA	Canadian Standards Association
CT	Current Transformer
D/A or DAC	Digital-to-Analog Converter
Daily Trend	Variation during a time period (days)
Daisy Chain	Daisy connection of devices using RS-485 link cable
dc	Direct Current
DGA	Dissolved Gas Analysis
Digital Output	Output in form of a digital signal (e.g. relay contact)
DIN	Deutsches Institut für Normung (German Standards Institute)
Download	Transferring data from a device

EC	Electronic Controller
EEC	European Economic Community
E/G	Earth/Ground
Embedded Software	Software to control micro-controller based machines or devices with fixed hardware, such as Hydran M2-X. Application is specific to the operation of the device.
EMI	Electro-Magnetic Interference
Error	Deviation of a measurement from its expected value
Esc	ESCape (key)
ESD	Electro-Static Discharge
Extended Menu	Menu that gives access to all operation parameters and commands (including those of the Main Menu) of the Hydran M2-X
Fault	Abnormal condition
FCC	Federal Communications Commission
FIFO	First In, First Out (type of memory)
Gas Level	Gas concentration measured by device
GE	General Electric
GND	GrouND (Earth)
GUI	Graphical User Interface
H or **Hi**	High alarm
H_2	Hydrogen (gas)
HH or **Hi-Hi**	High-High alarm
History File	This include Short Term, Long Term, Events and Service data that are stored in the Hydran M2-X's memory
HMI	Human/Machine Interface
H_2O	Water
Host Computer	Computer connected remotely to a Hydran M2-X or a network of Hydran M2-X's
Hourly Trend	Variation during a time period (hours)
Hydran 201Ci	Refer to one of the Hydran 201 family of controllers: Hydran 201Ci-C, 201Ci-1 or 201Ci-4.
Hydran 201Ci-1	One-channel controller and display designed to supervise one Hydran 201Ti unit
Hydran 201Ci-4	Four-channel controller and display designed to supervise up to four Hydran 201Ti units.
Hydran 201Ci-C	Communications controller designed to supervise up to four Hydran 201Ti units
Hydran 201i System	System comprising of a Hydran 201Ti unit together with a Hydran 201Ci Controller

Hydran 201Ti	Intelligent combustible gas monitor and transmitter device for dissolved gas in oil
Hydran M2-X	Intelligent combustible gas and moisture monitor and transmitter device for dissolved gas in oil
Hz	HertZ (unit for frequency)
ID	IDentification
IEC	International Electrotechnical Commission
IED	Intelligent Electronic Device
IEEE	Institute of Electrical and Electronics Engineers
in	INch
I/O	Input/Output
IP	Internet Protocol
kVA	Kilo Volt-Ampere
L or **Lo**	Low alarm level
Lab Data	Data obtained from laboratory analysis of gas samples
LAN	Local Area Network
LCD	Liquid Crystal Display
LED	Light-Emitting Diode
LL or **Lo-Lo**	Low-Low alarm
Local Network	Local network of Hydran M2-X units or Hydran 201i systems using RS-485 link
Local Site	User location where the data of the remote site is being analyzed
mA	milli-Ampere
mAdc	milli-Ampere Direct Current
Main Menu	Menu that gives access to the most frequently used operation parameters and commands of the Hydran M2-X
Menu	Group of parameters and values accessed through a hierarchical, treelike structure
MHz	Mega-Hertz
Modem	MOdulator/DEModulator (a communication device)
MOV	Metal Oxide Varistor
MVA	Mega Volt-Ampere
mV/A	milli Volt per Ampere
N_2	Nitrogen (gas)
NC	Normally Closed (contact)
NEMA	National Electrical Manufacturers Association
Network	See Local Network
NO	Normally Open (contact)

NPT	National Pipe Thread
Null Modem	Communication method to connect a Hydran M2-X directly to a computer using an RS-232 serial cable.
O_2	Oxygen (gas)
Perception	Application software (running on Microsoft Windows) used to interface with one or several Hydran M2-X units using a laptop or host computer.
PC	Personal Computer
PCB	Printed Circuit Board
PCBA	Printed Circuit Board Assembly
PDF	Portable Document Format
PLC	Programmable Logic Controller
P/N	Part Number
POT	POTentiometer
ppm	Part Per Million (unit used for gas concentration)
PT	Potential Transformer
PVC	PolyVinyl Chloride (type of plastic)
RAM	Random Access Memory
Range	The limit of measurement values that an instrument is capable of reading
RAS	Remote Access Service
RDBMS	Relational Data-Base Management System
Real-Time	Pertaining to a system or operating mode under which computation is performed during the actual time when an external process occurs.
Remote	A connection with Hydran M2-X unit(s) using a modem or Ethernet connection through a distant host computer
Repeatability	Ability of an instrument to measure the same input to the same value over a short period of time
Response Time	Time a system (Hydran M2-X) unit takes to react to a given input (gas concentration change)
RFI	Radio-Frequency Interference
%RH	Relative Humidity in %
RMS	Root Mean Square
RS-232	Serial communications based on TIA-232-F standard
RS-485 Network Link	Network using RS-485 serial connection
RTC	Real-Time Clock
RTD	Resistance Temperature Detector
RTDB	Real-Time Data Base
RTU	Remote Terminal Unit

RTV	Room Temperature Vulcanization
SCADA	Supervisory Control And Data Acquisition
SH	SHield
S/N	Serial Number
SP	Set Point
SPDT	Single Pole Double Throw
SQL	Structured Query Language
SSR	Solid-State Relay
Submenu	A branch of the treelike structure of a menu
TB	Terminal Block
TCP/IP	Transmission Control Protocol/Internet Protocol
TDM	Time Division Multiplexing
Teflon	polyTEtraFLuOrethyleNe
TM	TradeMark
TUV	Technischer Überwachungs-Verein (Technical Inspection Association)
User	Person operating the device (Hydran M2-X)
User-Friendly	An interface application easy to use
User Interface	Means provided to interface with a device (display, keypad, push button, etc.)
µV	Microvolt
V	Volt
VA	Volt-Ampere
Vac	Volt Alternating Current
Vdc	Volt Direct Current
VDE	Verein Deutscher Elektrotechniker (Association for Electrical, Electronic and Information Technologies)
V RMS	Volt Root Mean Square
W	Watt
WAN	Wide Area Network,
Watchdog	Process used periodically to test condition of a micro-controller based system
% w/w	Percentage Weight by Weight

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