

H2scan
ADVANCED HYDROGEN SENSING



OPERATION MANUAL

GRIDSCAN® 6000

Multi-Sense Monitor



27215 Turnberry Lane, Suite A
Valencia, California 91355, U.S.A.

Tel: (661) 775-9575 / Fax: (661) 775-9515
E-mail: sales@h2scan.com
Website: www.h2scan.com

IMPORTANT NOTICES

Read and understand this operation manual before installing or using the unit. If this equipment is used in a manner not specified by H2scan, the warranty may be void.

LIMITATION OF LIABILITY - seller shall under no circumstances be liable for any incidental, consequential, special, punitive, or other damages, including, but not limited to, loss of business or profit, promotional or manufacturing expenses, injury to reputation, or loss of customer, based on any alleged negligence, breach of warranty, strict liability, breach of contract, or any other legal theory arising out of the use, misuse, purchase, sale or possession of its goods or its performance of this contract to the extent that such liability extends seller's obligations beyond the price paid by buyer to seller for the item on which such claim is based. Seller advises buyer to perform acceptable tests on all hardware prior to deployment and to perform maintenance as described in the seller's instruction guide. Under no circumstances shall the equipment provided hereunder be used in a manner where it is the sole protective system for facilities, equipment, and personnel safety; the equipment is intended for use in conjunction with other appropriate protective systems.

LIMITED WARRANTY

H2scan Limited Warranty: Each GRIDSCAN® 6000 Multi-Sense Monitor ("Product") will conform, as to all substantial operational features, to the Product specifications set forth in this Manual and will be free of defects which substantially affect such Product's performance for 36 months from the ship date for such Product.

Must Provide Notice of Defect: If you have a Product that you believe is defective, you must notify H2scan in writing, within the warranty period of your claim regarding any such defect.

Return Product to H2scan for Repair, Replacement or Credit: The customer is responsible for shipping and handling costs. If the Product is found defective by H2scan, H2scan's sole obligation under this warranty is to either (i) repair the Product, (ii) replace the Product, or (iii) issue a credit for the purchase price for such Product, the remedy to be determined by H2scan on a case-by-case basis. A valid RMA number must be assigned by H2scan and clearly marked on the package when the unit is returned.

Voided Warranty: H2scan's three-year Limited Warranty is void for any of the following:

- Unauthorized repair work performed at the customer's location or conducted by anyone other than H2scan's factory trained technicians.
- Equipment or parts that have been tampered with, misused, neglected, mishandled, improperly adjusted, or modified in any way without the written consent of H2scan.
- Equipment or parts that have been damaged due to shipping, misuse, accidents, mishandling, neglect, or problems with electrical power sources.
- Repair work performed during the warranty period does not prolong the warranty period past the original period.
- System operation in incorrect or inappropriate environments.
- Usage that is not in accordance with system guidelines or an operator's failure to follow manual instructions.

Limitation of Warranty. THE ABOVE IS A LIMITED WARRANTY AS IT IS THE ONLY WARRANTY MADE BY H2SCAN. H2SCAN MAKES NO OTHER WARRANTY EXPRESS OR IMPLIED AND EXPRESSLY EXCLUDES ALL WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. YOUR SOLE REMEDY HEREUNDER IS REPAIR OR REPLACEMENT OF THE PRODUCT OR A CREDIT FOR THE PURCHASE PRICE FOR SUCH PRODUCT, THE PARTICULAR REMEDY TO BE DETERMINED BY H2SCAN ON A CASE-BY-CASE BASIS. H2SCAN SHALL HAVE NO LIABILITY WITH RESPECT TO ITS OBLIGATIONS UNDER THIS AGREEMENT FOR CONSEQUENTIAL, EXEMPLARY, OR INCIDENTAL DAMAGES, EVEN IF IT HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THE STATED EXPRESS WARRANTY IS IN LIEU OF ALL LIABILITIES OR OBLIGATIONS OF H2SCAN FOR DAMAGES ARISING OUT OF OR IN CONNECTION WITH THE DELIVERY, USE OR PERFORMANCE OF THE PRODUCTS.

1. BEFORE YOU START	5
1.1 SAFETY TRAINING	5
1.2 SENSOR SPECIFICATIONS	5
1.3 GROUNDING	5
1.4 EMERGENCY PROCEDURES.....	5
1.5 DOCUMENTATION.....	5
1.6 COMPLIANCE.....	5
1.7 PERSONNEL PROTECTION	5
2. INTRODUCTION	5
2.1 DIMENSIONS AND WEIGHT	5
3. PRE-INSTALLATION REQUIREMENTS	6
3.1 BOX CONTENTS	6
3.2 INSTALLATION TOOLS.....	6
3.3 CABLE	7
3.4 POWER SUPPLY	7
3.5 DIGITAL COMMUNICATION.....	7
3.6 ACCESSORY ATTACHMENT PLATFORM.....	8
4. INSTALLATION	8
4.1 SELECTING A MOUNTING LOCATION	9
4.2 MECHANICAL CONNECTION.....	10
4.3 BLEEDING AIR POST-INSTALLATION.....	11
4.4 ELECTRICAL CONNECTION.....	13
5. COMMISSIONING	14
5.1 STARTUP	14
5.2 RS-485.....	15
5.3 CONFIGURATION	16
5.4 FIRMWARE.....	16
APPENDIX A. SPECIFICATIONS	16
APPENDIX B: COMPLIANCE & CERTIFICATIONS	18

1. BEFORE YOU START

Observe the following precautions before installing the GRIDSCAN® 6000.

CAUTION

Using the equipment in a manner not specified by the manufacturer may void the warranty.

1.1 SAFETY TRAINING

Ensure the personnel responsible for installing the multi-sense monitors are trained in handling electrical equipment and know the risks associated with power transformers and hydrogen gas. Operators must be trained before being allowed to perform the hazardous operation.

1.2 SENSOR SPECIFICATIONS

H2scan hydrogen monitors are specifically designed for the intended purpose and are compatible with the transformer environment. Check the specifications of the GRIDSCAN® 6000 to ensure the necessary sensitivity and accuracy matches your requirements to detect hydrogen gas at appropriate concentrations.

1.3 GROUNDING

Ground the monitors and associated equipment properly to minimize the risk of static discharges or electrical interference.

1.4 EMERGENCY PROCEDURES

Develop and communicate clear emergency procedures to follow in case the monitors detect high levels of hydrogen gas. This may involve shutting down the transformer, evacuating the area, and alerting appropriate personnel.

1.5 DOCUMENTATION

Maintain comprehensive documentation that includes monitor specifications, installation details, maintenance logs, and emergency procedures.

1.6 COMPLIANCE

Ensure the installation of the hydrogen multi-sense monitors complies with relevant safety standards, regulations, and guidelines specific to your region or industry.

1.7 PERSONNEL PROTECTION

The safety of any system incorporating the equipment is the responsibility of the assembler of the system.

2. INTRODUCTION

The GRIDSCAN® 6000 Multi-Sense Monitor detects hydrogen in various classes of transformers and other insulating fluid-filled devices. Hydrogen is the first gas to be created in an abnormal transformer condition; it is also the first gas to escape. Early detection of hydrogen generation can help prevent catastrophic failure of the transformer by allowing maintenance teams to remedy the fault condition. Once hydrogen is detected, operators can confirm the condition of the transformer through DGA (Dissolved Gas Analysis) sampling.

Through a digital interface, GRIDSCAN® 6000 monitors hydrogen, moisture, liquid temperature, and pressure in various liquid types and provides associated data to prevent dangerous events and determine the real-time health of a transformer. H2scan's patented auto-calibration technology allows the GRIDSCAN® 6000 to maintain accuracy of the hydrogen sensor over years of continuous operation.

2.1 DIMENSIONS AND WEIGHT

Overall dimensions: 7.63" x 3.47" x 3.15" (19.4 x 8.8 x 8.0 cm)

Weight: 4.01 lb (1.82 kg)

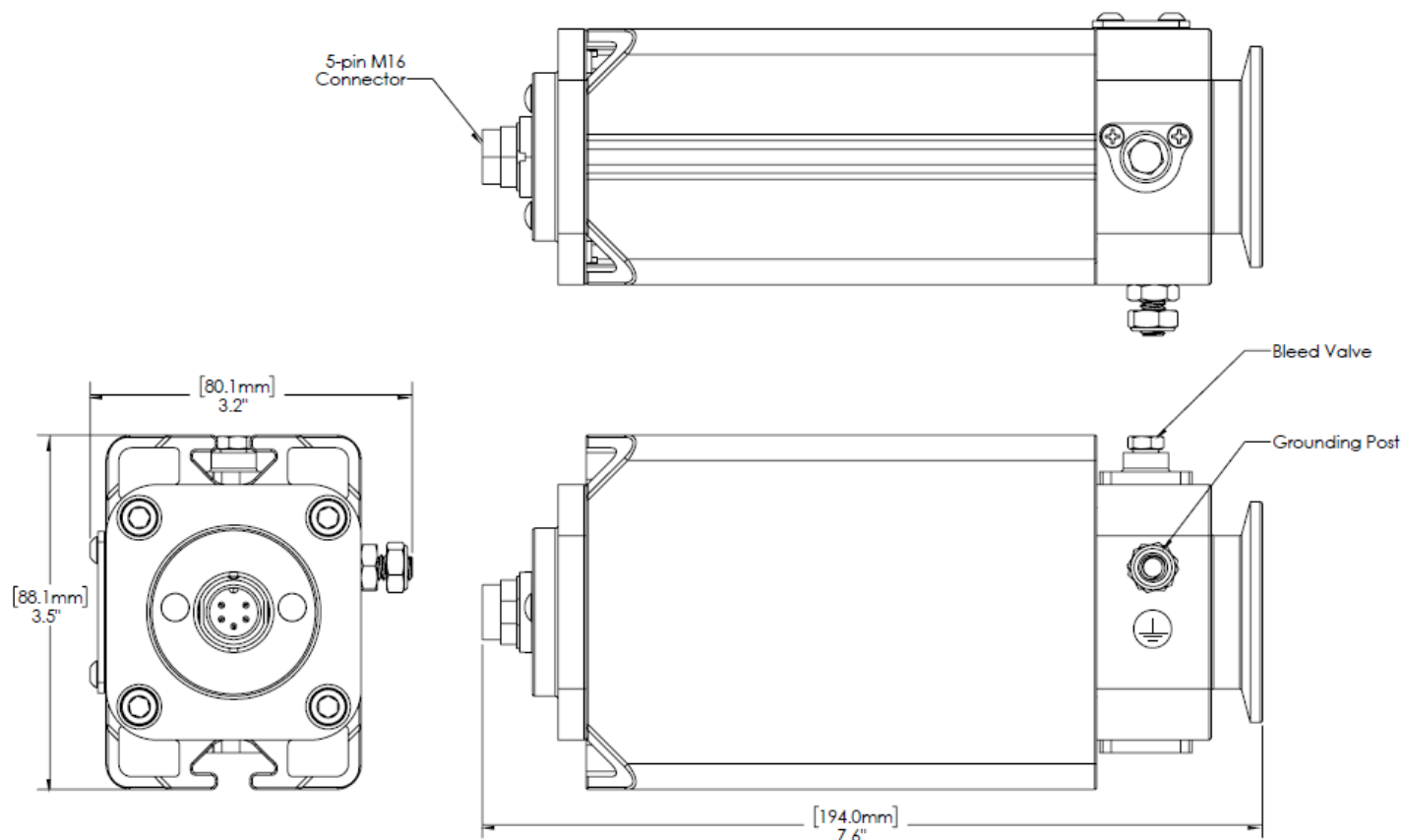


Figure 1: Dimensions

3. PRE-INSTALLATION REQUIREMENTS

3.1 BOX CONTENTS

The GRIDSCAN® 6000 ships with the following installation materials:

- Flange adapter
- KF-40 flange clamp
- Gasket
- Copper set screw lug

3.2 INSTALLATION TOOLS

The following materials are supplied by the end user for installation and operation of the GRIDSCAN® 6000.

- Adjustable wrench
- Container to collect fluid
- Rags/towels
- Chemical-resistant O-ring seal grease
- Channel lock plier
- Wire stripper
- Wire cutter
- Teflon tape

- Flathead screwdriver

Additional hardware, not included with the GRIDSCAN® 6000, may be required to secure it to the chosen mounting location.

NOTE: If using ScanH2 software for commissioning, a laptop with the software downloaded and an RS-485 to USB converter are also needed.

CAUTION

Use appropriate wiring and connectors that are suitable for the transformer environment and can withstand potential exposure to hydrogen gas, moisture, and varying temperatures. These connectors and cables are available from H2scan.

3.3 CABLE

A suitably rated cable assembly is required for most field applications.

Cable construction recommendations are:

- Five-pin, IP68-rated M16 female molded connector
- UV-rated outdoor cable for outdoor substation environments
- Jacket rated for -40°C—+35°C
- Minimum wire gauge size and construction:
 - Shielded cable is required (shield needs to be grounded at one end only)
 - Five conductors: Three 22 AWG conductors for data and communication ground, two 18 AWG conductors for power. Larger-gauge wires are permissible.

H2scan is not responsible for issues arising from the use of cabling and connectors that are not suited for the environment.

3.4 POWER SUPPLY

The GRIDSCAN® 6000 incorporates an internal isolated voltage regulator for operation in harsh electrical conditions. The DC ground line is electrically isolated from the metal case. In most installations, the GRIDSCAN® 6000 enclosure will be connected to earth ground through the mechanical connection to the transformer. The power supply is not included with the GRIDSCAN® 6000.

Use an industrial grade, substation-rated, fixed-output power supply that meets the following specifications:

- DC voltage output
- Output voltage: 18–30 VDC
- Output power: 15 watts minimum

24 VDC power supply is recommended.

3.5 DIGITAL COMMUNICATION

GRIDSCAN® 6000 is available with Modbus RTU (default) or DNP3 RTU (optional) to communicate with external equipment. The protocol selection is factory configured for Modbus or DNP3 as specified by the customer. Both protocols operate on an RS-485 bus and likely require configuration of the device ID, baud rate, and other communication settings.

Application software to configure the sensor — ScanH2 — is available from H2scan to run on a Windows PC. Configuration can also be performed using commercially available Modbus or DNP3 software applications. Refer to ScanH2 documentation for more information.

Sensor data collected and analyzed by SCADA is the recommended mode of operation.

3.6 ACCESSORY ATTACHMENT PLATFORM

The GRIDSCAN® 6000 has a standard-sized Tee slot that has the capability of user customization. The Tee slot can be used to mount a light beacon, run a cable through to the front of the monitor, and other mounting options, dependent on the user application.

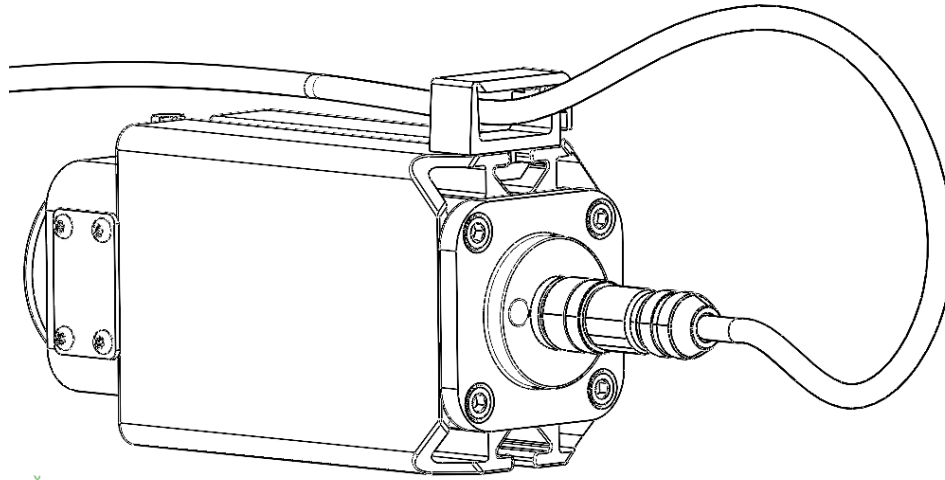


Figure 2: Tee slot with optional cable clamp accessory

4. INSTALLATION

The GRIDSCAN® 6000 has a rugged, waterproof mechanical assembly design for various transformer applications. Its IP68 rating and hard-anodized aluminum construction provide saltwater corrosion protection for use in vault and marine transformer applications.

⚠ WARNING

The sensor element may be damaged if exposed to hydrogen concentrations in liquid above 5,000 ppm or hydrogen concentrations in the headspace above 100,000 ppm.

Protect the GRIDSCAN® 6000 from damage during handling by observing the following precautions:

- Ensure nothing comes in contact with the sensor end of the device.
- Keep the protective cover in place until the time of installation.

CAUTION

Ensure the personnel responsible for installing the sensors are trained in handling electrical equipment and know the risks associated with power transformers and hydrogen gas. Operators must be trained before being allowed to perform the hazardous operation. The individual(s) installing this equipment should read this manual prior to installation and be familiar with working on or around transformers, in addition to following all the required safety regulations particular to the specific site.

CAUTION

Conduct a thorough risk assessment of the transformer installation site to identify potential hazards and to determine the optimal locations for sensor placement.

4.1 SELECTING A MOUNTING LOCATION

The most convenient location on the transformer may not be conducive to optimal monitor performance. Avoid areas of stagnant oil flow, if possible. Install oil-calibrated monitors horizontally. Install gas-calibrated monitors horizontally or vertically.

CAUTION

Install monitors at locations where hydrogen gas is likely to accumulate in case of a fault. Common locations include the transformer's head space and other potential gas accumulation points.

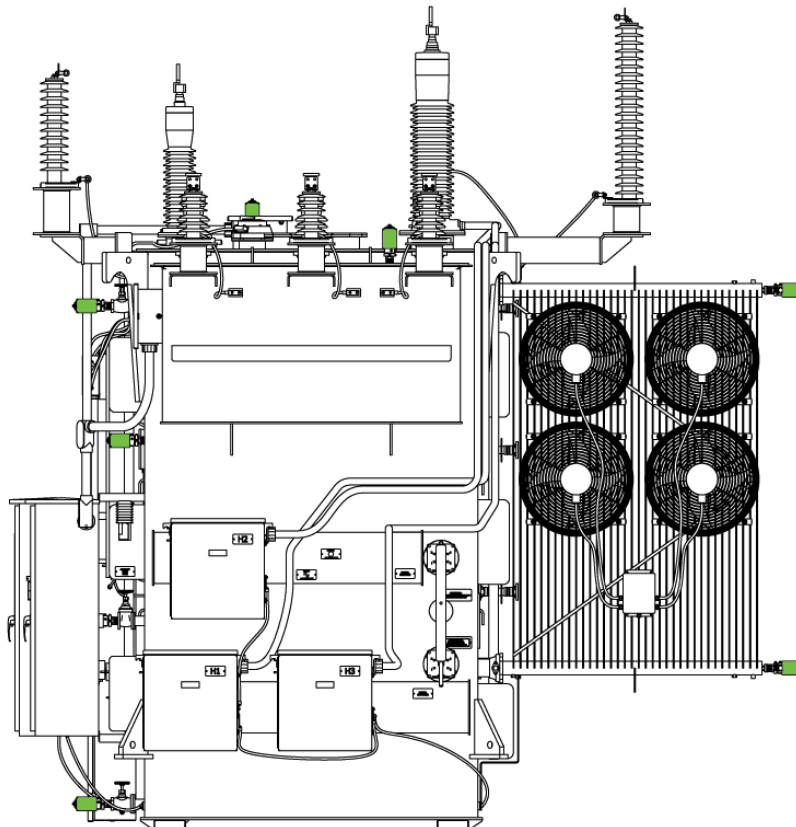


Figure 3: Typical GRIDSCAN® 6000 Installation Locations

Mount the monitor as close to the transformer tank as possible.

⚠ WARNING

Do not use GRIDSCAN® 6000 as a step.

When installed in liquid, the monitor must be mounted horizontally as illustrated in Figure 4. Vertical or horizontal mounting is acceptable in a gas-only location.

The equipment must be installed in an application that can produce an alarm when the ppm level reaches a configurable set point.

Do not install the GRIDSCAN® 6000 at a location with turbulent liquid flow.

When selecting a location, consider how the following variables affect the time required for hydrogen to reach the GRIDSCAN® 6000:

- Pipe length (recommended no longer than 6" from valve)

- Valve/pipe diameter
- Valve type (gate or ball valve recommended)
- Liquid flow near installation location
- Liquid temperature (warmer liquid will absorb higher concentrations of hydrogen)

4.2 MECHANICAL CONNECTION

A KF-40 flange fitting is provided for attaching the monitor to a transformer. Mount the GRIDSCAN® 6000 by installing the flange adapter on the valve and clamping the GRIDSCAN® 6000 to the adapter, capturing the gasket/screen between the flange adapter and the GRIDSCAN® 6000.

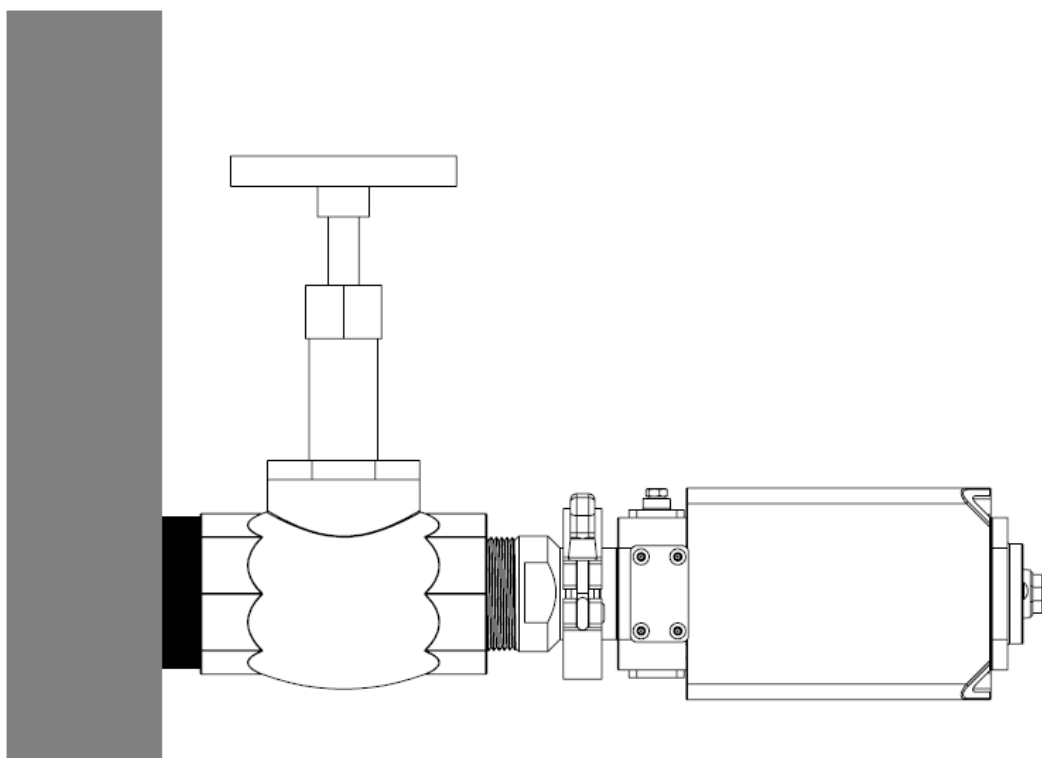


Figure 4: Typical Valve Installation in Liquid

1. Ensure the valve at the chosen mounting location is fully closed.
2. Remove any plug that may be installed and ensure the threads are clean.
3. Apply Teflon tape or a suitable pipe-thread sealant to the threads of the flange adapter.
4. Insert and securely tighten the adapter to the transformer valve.
5. Remove the protective cap from the GRIDSCAN® 6000.
6. Insert the gasket between the flange adapter and the monitor.
7. Place the KF-40 clamp over the flanges of the adapter and the monitor.
8. Align the unit vertically before tightening the clamp with the included wrench. The bolt on the clamp should swing up from the bottom and be secured in the notch on top of the clamp. Ensure the washer is captured under the nut on top of the clamp and the nut is tightened fully.

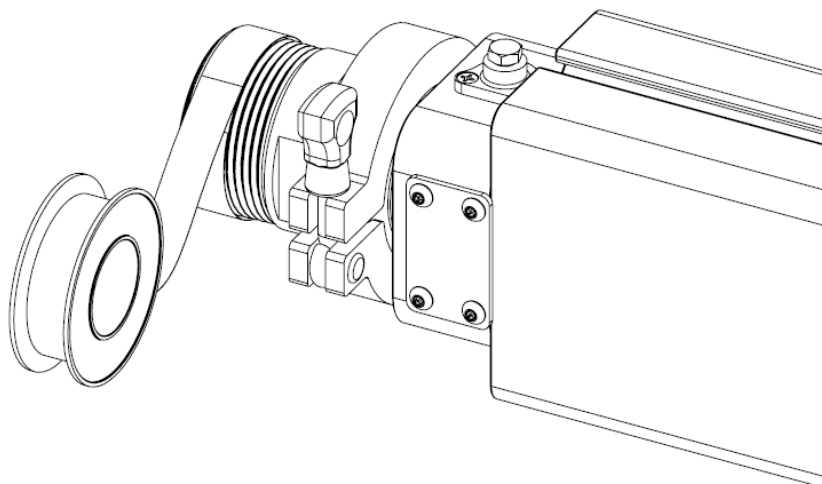


Figure 5: Flange Adapter and Gasket/Screen

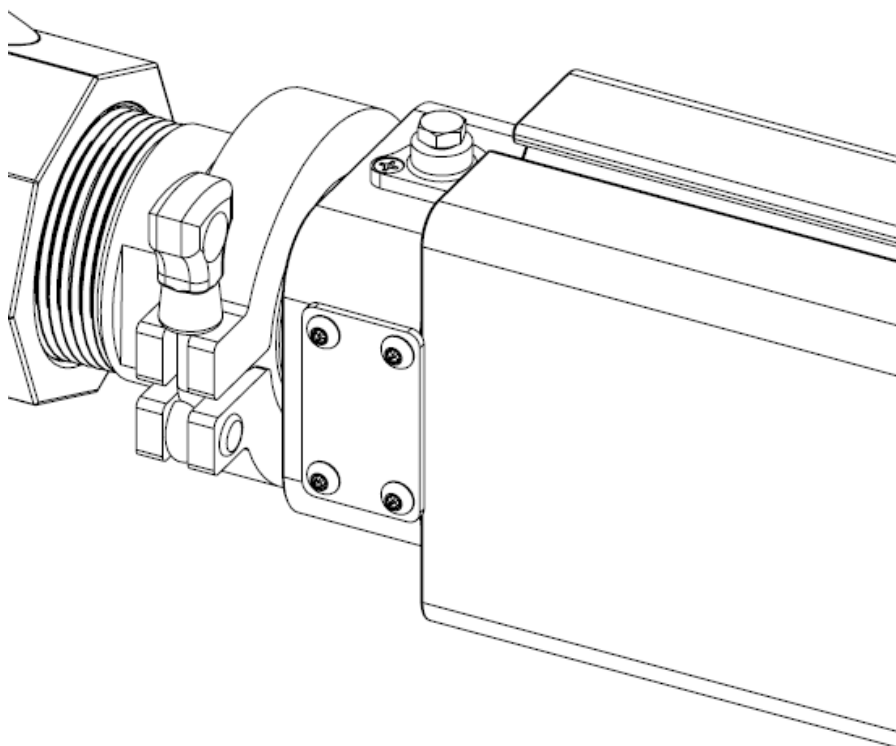


Figure 6: Clamp Installation

4.3 BLEEDING AIR POST-INSTALLATION

The GRIDSCAN® 6000 features an integrated bleed valve. Once the GRIDSCAN® has been installed onto the valve, any air trapped in the assembly must be removed by following the steps below.

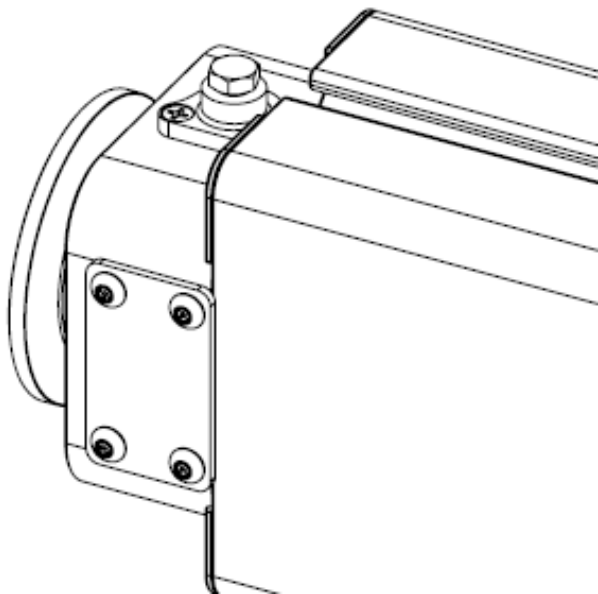


Figure 7a: Standard bleed valve

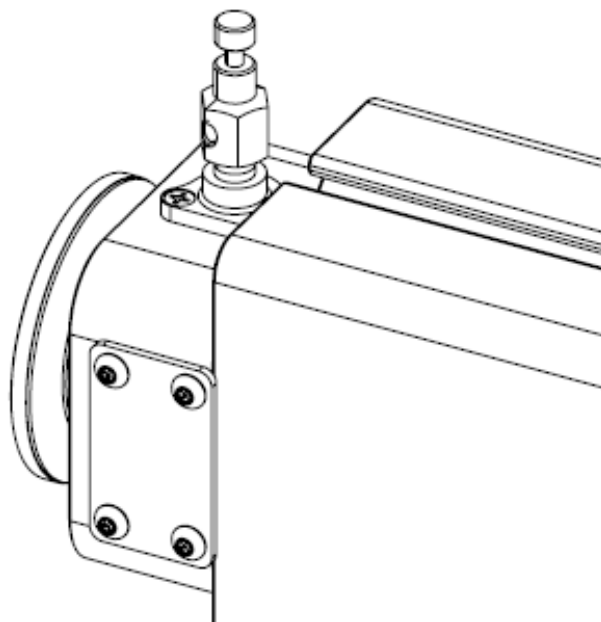


Figure 7b: Optional bleed valve accessory

1. Ensure all fittings are tight and all threads are sealed either with Teflon tape or a suitable pipe-thread sealant.
2. Ensure all valves and plugs are initially closed.
3. Place a suitable container under the GRIDSCAN® 6000 to catch any liquid.
4. Remove the bolt on the bleed valve by turning it counter-clockwise to expose the hole.
5. Slowly open the transformer valve just enough to see a small stream of liquid flow from the hole on the bleed valve.

CAUTION

Fluid may rush from bleed hole quickly. Be prepared to close the transformer valve immediately.

6. Once no air is seen in the flow, close the transformer valve and re-install the bolt.
7. Fully open transformer valve and check for leaks.

If desired, the standard bleed valve may be removed prior to installing the GRIDSCAN® 6000 and replaced with an off-the-shelf bleed valve/sample port assembly that can be threaded into the #10-32 bleed valve port. The plug at the top of the bleed valve may be used to plug a #10-32 threaded sample port.

⚠ WARNING

Do not fully remove the bleed screw or a geyser will occur.

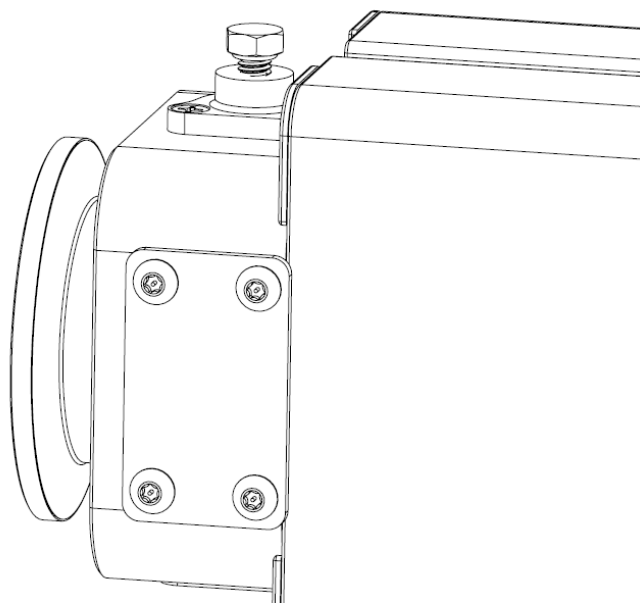


Figure 8: Bleed Valve Removal

4.4 ELECTRICAL CONNECTION

All electrical connections to the GRIDSCAN® 6000 are supplied through a single five-pin M16 connector. The key (notch) location and pin numbers are shown in Table 1.

Table 1: Pin Numbers

FRONT VIEW	PIN	SIGNAL NAME	WIRE COLOR
	1	DC Power	Brown
	2	DC Ground	White
	3	RS-485 Ground	Gray
	4	RS-485 Data+	Blue
	5	RS-485 Data-	Black

NOTE: If using the optional conduit adapter accessory, ensure that the cable is routed through the accessory first before connecting to the GRIDSCAN® 6000.

For more details on the conduit adapter accessory and installation refer to the Conduit Adapter Quick-Start Guide.

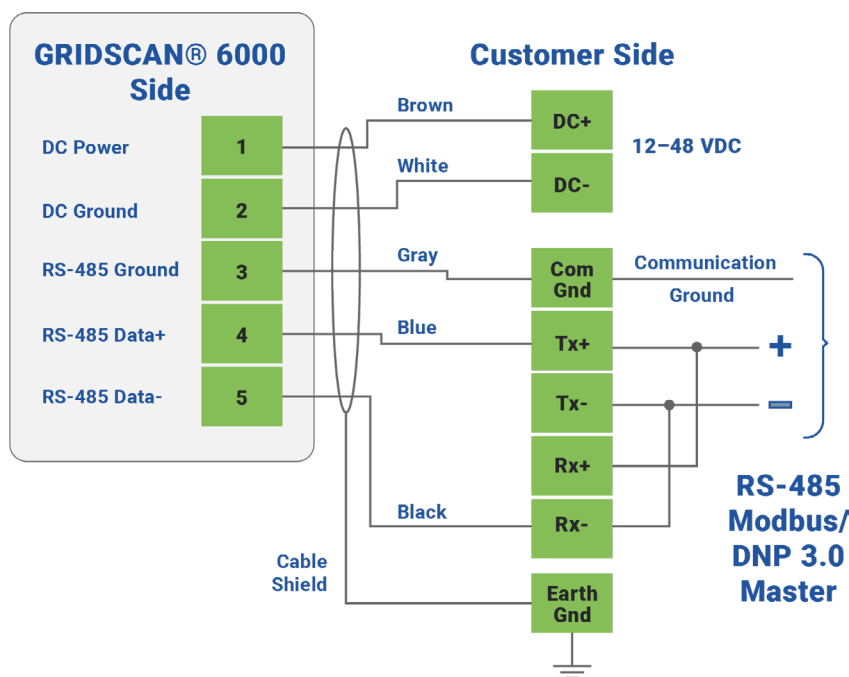


Figure 9: Typical Wiring

Before energizing the equipment, complete the following steps:

1. Install the cable between the GRIDSCAN® 6000 and power/communication equipment.
2. Connect the cable to the power/communication equipment.
3. Connect the cable to the GRIDSCAN® 6000. The connector is keyed and will only fit when correctly oriented.

The connector to the GRIDSCAN® 6000 must be fully tightened to ensure the IP68 rating.

5. COMMISSIONING

5.1 STARTUP

After the cable is connected and power is supplied, the monitor requires up to 16 hours to execute a startup sequence consisting of four operations.

- Power-on system self-test
- Restoration of configuration settings from non-volatile memory
- Initial liquid temperature and hydrogen measurement
- Auto-calibration sequence to stabilize monitor as needed (monitor may show initial value before auto-calibration is complete)

Prior to placing the monitor in operation, perform the following steps:

1. Connect the monitor to power for at least five minutes to recharge the supercapacitor, which may have discharged if the monitor has been without power for several months.
2. Reset the date/time.
3. Cycle the power to clear any errors.

After a short power interruption, the monitor reports approximate hydrogen readings within 30 minutes of power restoration. On new installations and after long power interruptions, the monitor can take up to 16 hours to stabilize and report accurate hydrogen readings.

Power on the GRIDSCAN® 6000. Power status is confirmed with the green LED.

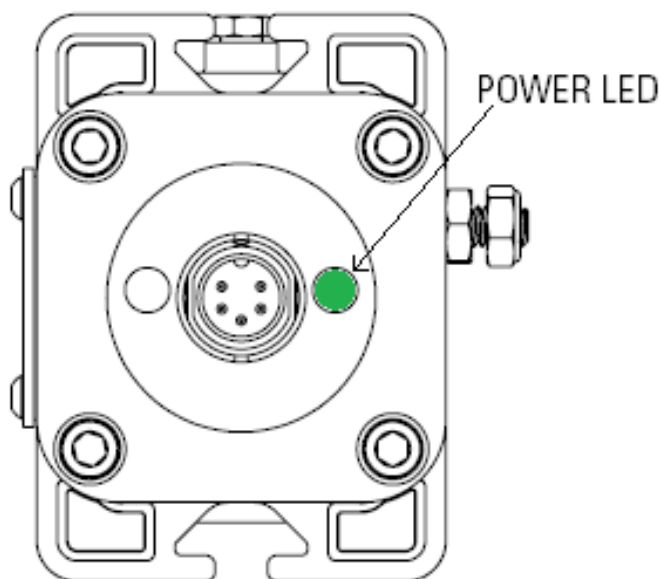


Figure 10: GRIDSCAN® 6000 LEDs

5.2 RS-485

The RS-485 input is galvanically isolated inside the GRIDSCAN® 6000 to improve noise immunity in harsh electrical environments.

When daisy chaining multiple sensors, the GRIDSCAN® 6000 has a programmable 120 Ohm termination resistor for RS-485 communications. The default is to have the termination resistor enabled.

- RS-485 Termination Enable support in Modbus:
 - The Modbus Holding Register is 158.
 - Usage:
 - Reg 158 = 1 (enable)
 - Reg 158 = 0 (disable)
- RS-485 Termination Enable support in DNP3:
 - Analog Output Command (Object Group 41, Point Index 16, Variation 2 (short)
 - 1= Enable
 - 0 = Disable

It is recommended the following data points should be collected and analyzed periodically by SCADA:

- Hydrogen
- Moisture
- Temperature
- Pressure
- Device status
- Error status

The time between collecting this set of data is determined by the customer installation, typically one minute. The minimum time is one second; there is no maximum.

The GRIDSCAN® 6000 only provides data to SCADA. No alarm setpoints can be implemented in the GRIDSCAN® 6000.

5.3 CONFIGURATION

Configure the GRIDSCAN® 6000 with the ScanH2 Configuration Utility or similar Modbus application.

The GRIDSCAN® 6000 is a multi-sensor device capable of measuring hydrogen dissolved in fluid, moisture dissolved in fluid, fluid temperature, and fluid pressure. Digital communications over an RS-485 bus provide real-time measurement data. Configuring communication settings and initializing the real-time clock are the only required actions. Optional actions include setting customer identification data, fluid type, and operating mode for the device.

When connected to a GSAO-2 Control Hub from H2scan, the GRIDSCAN® 6000 is automatically detected and its real-time information is displayed on the GSAO-2, and can be configured from the HMI. Refer to GSAO-2 documentation for more information.

Default communication settings:

- RS-485, half duplex, 19200 baud, 8 data bits, 1 or 2 stop bits, no parity.
- Default Modbus ID is 1.

5.4 FIRMWARE

The GRIDSCAN® 6000's firmware is field-upgradeable. When a firmware update is available, H2scan will provide files.

APPENDIX A: SPECIFICATIONS

Table 2: Operating Conditions

Parameter	Value			Units
	Minimum	Nominal	Maximum	
Environment – Insulating Liquid				
Temperature (Operating)	-20		105	°C
Temperature (Survival)	-20		135	°C
Pressure (Operating)	0.7 (10.2)	1.0 (14.7)	2.0 (29.0)	Bar absolute (psia)
Pressure (Survival)	0.1 (1.5)		3.0 (43.5)	Bar absolute (psia)
Insulating Liquid Supported	Mineral oil, silicone, natural ester, synthetic ester			
Environment – Ambient				
Operating Temperature	-20	25	70	°C
Storage Temperature	-20		85	°C
Ingress Protection	IP68; 25' water for 14 days (IEC 60529)			
Corrosion Resistance	Marine-rated; salt-water condensing (IEC 60068-2-11 & DIN EN ISO 12944)			
Operating Altitude	Up to 3000 m above sea level			

Parameter	Value			Units
	Minimum	Nominal	Maximum	
Mechanical				
Vibration	Three-axis Sinusoidal, Wideband and Random (IEC 60068-2-6 table C.2, IEC 60068-2-64 paragraph A.2, category no. 2, IEC 61373: 2010 Cat 1B section 9)			
Shock	30 g, shock duration 18 ms (IEC 60068-2-27)			
Weight	4.01 lb (1.82 kg)			
Electrical				
Voltage Input	18	24	30	VDC
Power Consumption (for GS6K without pump)		5	7	W

Table 3: Hydrogen Measurement Specifications

PARAMETER	VALUE
Measurement Range	25–5000 ppm
*Response Time, T ₉₀	<60 minutes
Accuracy	±20% of reading or ±25 ppm, whichever is greater
Repeatability	±10% of reading or ±15 ppm, whichever is greater
Cross Sensitivity	Less than 2% cross-sensitivity to other gases (CO, CO ₂ , Hydrocarbons)

*Once hydrogen reaches the sensor, the sensor will respond in 60 minutes or less.

Table 4: Moisture & Temperature Measurement Specifications

ATTRIBUTE	SPECIFICATION
Measurement Range (Water Activity)	0–95 %RS
Temperature Accuracy at 20 °C (68 °F)	±2.5 °C (0.9 °F)
Long-Term Drift	0.2 %RS per year typical
Lower Detection Limit	2 ppm
Accuracy	±2 %RS at <20 %RS ±8 %RS at 20–50 %RS

NOTE: % water relative saturation is water activity multiplied by 100.

Table 5: Pressure Measurement Specifications

ATTRIBUTE	SPECIFICATION
Measurement Range	0–200 kPa (0–30 psia) absolute
Overpressure	400 kPa (60 psia) absolute
Burst Pressure	600 kPa (90 psia) absolute

ATTRIBUTE	SPECIFICATION
Compensated Temperature Range	0–70 °C (32–158 °F)
Static Accuracy (In Compensated Range)	±0.5 %FSO typical
Linearity (In Compensated Range)	0.1 %FSO typical
Long-Term Stability of Offset	0.1 %FSO per year
Long-Term Stability of FSO	0.1 %FSO per year

APPENDIX B: COMPLIANCE & CERTIFICATIONS

GRIDSCAN® 6000 Multi-Sense Monitor complies with the following standards:

- IEC 60068-2-2 & EN 50155 Clause 13.4.4
- IEC 60068-2-11 & DIN EN ISO 12944
- IEC 60529 Clauses 13.4 & 13.6
- IEC 60529 Table 3 & Clause 14.2.8
- IEC 60068-2-6 Table C.2
- IEC 60068-2-64 Spectrum A.2, category no. 2
- IEC 60068-2-27
- EN 61326-1: 2013 (IEC 61326-1 :2012)
- EN 55011 Emission Class A (2009)A1(2010) Group 1 Radiated Emissions
- CISPR 11 Emission Class A (2008)A1(2009)
- FCC Part15/18 Emissions
- ICES-001/ICES-003 Emissions
- EN 61000-4-2: 2009 (IEC 61000-4-2:2008)
- EN 61000-4-3:2007+A1: 2008+A2: 2011 (IEC 61000-4-3:2006+A1: 2007+A2:2010)
- EN 61000-4-4:2013 (IEC 61000-4-4:2012)
- EN 61000-4-5:2014 (IEC 61000-4-5:2013)
- EN 61000-4-6:2014 (IEC 61000-4-6:2013)
- EN 61000-4-8:2010 (IEC 61000-4-8:2009)
- EN 61000-4-11:2010 (IEC 61000-4-11:2009)
- IEC 61010-1:2010, +A1:2016
- EN 61010-1:2010, +A1:2019