



InsuLogix[®] G2

Acetylene, Hydrogen, and Moisture Monitor

User Guide

**User Guide
for
InsuLogix® G2**

Acetylene, Hydrogen, and Moisture Monitor

Catalog Number 1015-313

Read this entire manual before operating.

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The information presented in this manual is believed to be adequate for the intended use of the product. If the product or its individual instruments are used for purposes other than those specified herein, confirmation of their validity and suitability must be obtained from Megger. Refer to the warranty information below. Specifications are subject to change without notice.

WARRANTY

Online monitoring products supplied by Megger are warranted against defects in material and workmanship for a period of two years following shipment. Our liability is specifically limited to replacing or repairing, at our option, defective equipment. Equipment returned to the factory for repair must be shipped prepaid and insured. Contact your MEGGER representative for instructions and a return authorization (RA) number. Please indicate all pertinent information, including problem symptoms. Also specify the serial number and the catalog number of the unit. We make no other warranty. The warranty is void in the event of abuse (failure to follow recommended operating procedures) or failure by the customer to perform specific maintenance as indicated in this manual.

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Upon Receipt of Product

Prior to operation, check for loosened hardware or damage incurred during transit. If these conditions are found, a safety hazard is likely, DO NOT attempt to operate equipment. Please ensure correct instrument + optional accessories are received as per order. If any deviation is found, please report to your Megger representative or to the Valley Forge factory (using Email VFSupport@Megger.com) referring to the reference order items were purchased under.



InsuLogix G2

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PRODUCT OVERVIEW – INSULOGIX G2

The InsuLogix G2 is a high-performance online monitor that detects and measures the evolution of Acetylene (C_2H_2) and Hydrogen (H_2) in oil filled apparatus such as power and distribution transformers, providing the transformer operator early warning of the presence of these two key gases that indicate the occurrence of internal faults.

WHY ACETYLENE AND HYDROGEN?

Fault gases are key indicators for flagging incipient faults but also to indicate the fault's severity and evolution in power transformers.

Monitoring the hydrogen rate of change in oil to detect faults in their early stages is a strategy that many utilities have been following for the last 30 years. Many times, however, the transformer operators simply keep increasing the hydrogen alarm thresholds until the more aggressive gases appear in oil.

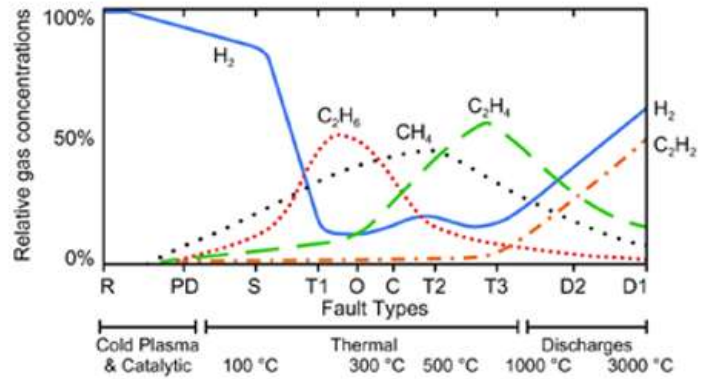
So-called nursing units (5, 6, 7, 8 and 9 gas monitors) are another strategy that transformer owners are employing in order to evaluate the transformer health and determine the right time for de-energizing the transformer while balancing the risk and the cost. The 5, 6, and 7 gas monitors are providing only partial online diagnostics. Almost always, the alarms generated by gas monitors – multi-gas or single gas – are validated by testing an oil sample in a laboratory before the transformer expert makes a decision.

Generated by oil decomposition as a result of thermal stress produced by faults such as arcing and partial discharge starting at 150 °C, hydrogen is the key gas for detecting most incipient faults.

Acetylene is the key gas generated by high energy faults with temperatures above 500 °C. Acetylene in 1 PPM concentration in oil requires immediate attention. An increasing acetylene trend requires immediate action. The presence of acetylene and an increasing trend in its concentration most often are the key elements leading to the decision to de-energize the transformer.

Note that, in Figure 1 on the following page, most of the gas generated due to oil decomposition under thermal stress signalling an incipient fault is hydrogen. The oil decomposition process under thermal stress generates acetylene when the temperature at the fault location reaches 500 °C. When the fault becomes aggressive, during discharges and arcing, most of the gas present in oil is represented by hydrogen and acetylene. Note that the chart below is a representation of the relative percentage of gases.

IEEE C57-104 2019



NOTE—See 3.2 for faults acronym and Annex C for faults type definition

Figure 1—Relative percentage of dissolved gas concentrations in mineral oil as a function of temperature and fault type

Front Panel

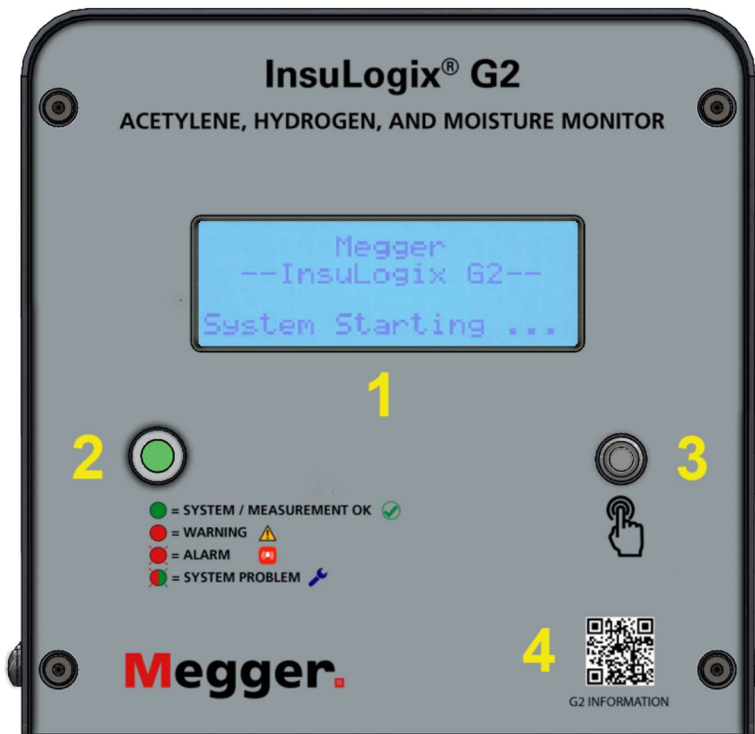


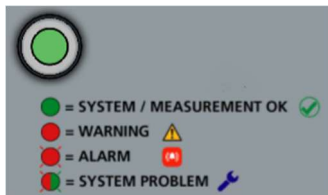
Figure 1-1: G2 Front Panel

Front Panel Facilities



1. LCD Display:

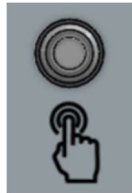
The 80-character (4 x 20) LCD display on the front panel of the monitor provides a local display to the system status and the current values of the acetylene, hydrogen, and moisture variables. The system will refresh the data on the LCD screen every 8 seconds at which time any value that has changed since the last refresh will update.



2. Status LED:

The status LED provides system status at a glance from a distance.

LED Color	Definition
Solid Green	System is operating normally
Solid Red	Measurement Warning is active
Flashing Red	Measurement Alarm is active
Flashing Red/Green	System Alarm is active



3. Function Button:

The function button activates the LCD backlight if it is not already on. Subsequent presses of the button toggle through the various LCD screens. After 60 seconds of inactivity, the LCD backlight will turn off and the currently displayed screen will remain on the display.



4. Product QR Code:

The product QR code is conveniently located on the front panel overlay of the G2. Scanning this code with any mobile device will enable the user to immediately access the product webpage for additional information.

Rear Panel

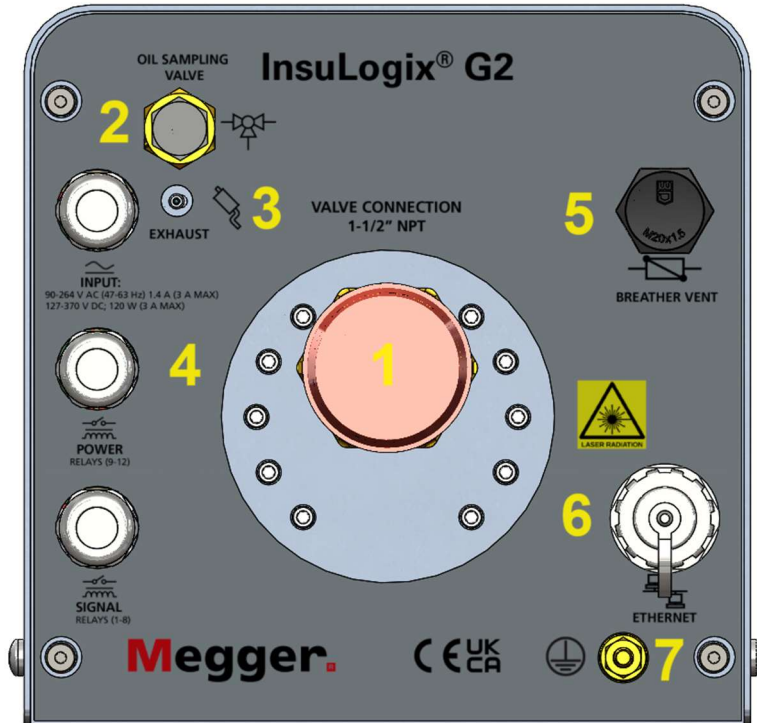
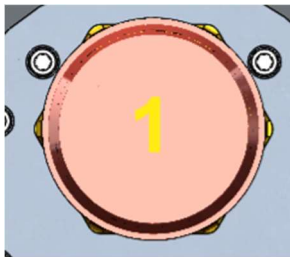


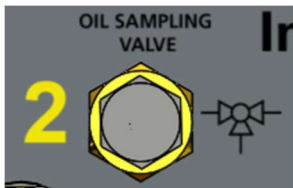
Figure 1-2: G2 Rear Panel

Rear Panel Facilities



1. Transformer Valve Connection:

A single 1 ½" male NPT fitting protrudes from the rear panel of the monitor for connection to the transformer valve. A union fitting and a 1 ½" nipple are offered as accessories to facilitate installation.



2. Oil Sample/Purge Valve:

The oil sample/purge valve is a compression style fitting from which the valve and manifold can be purged of air during installation. This port also provides a convenient location for manual oil sampling. The oil sample port quick connector (p/n 1015-318), supplied with the monitor, provides the means to perform both actions.



3. Exhaust (check) Valve:

The check valve on the rear panel is used for the zeroing cycle exhaust and is not a customer connection point.



4. 3/4" Conduit Glands:

Three (3) 3/4" conduit glands are provided for input power, relay output, analog output, and communication wiring. All conduit glands are supplied with plugs to maintain the device's IP67 rating if a particular gland is not used.

5. Breather Vent:

Provides ventilation for the enclosure.

6. Ethernet Port:

The IP67 Ethernet port provides an access point for connecting to the User Interface software locally. When used with the included IP67 rear panel Ethernet connector (p/n 1015-317) this port provides a weathertight point for permanent connection to the device.

7. Grounding Stud:

A 1/4"-20 stud is provided for chassis ground.

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SAFETY

Safety is the Responsibility of the User

Only qualified and trained operators should operate the InsuLogix G2. Each operator must read and understand this Instruction Manual prior to operating the equipment. The Safety precautions, herein, are not intended to replace your Company's Safety Procedures.

General Safety Precautions



Warning: Use of this product in a manner not specified by the manufacturer (Megger) or outlined in this product manual may result in damage to the equipment and the protection provided by the equipment may be impaired.



Warning: Additional combustible fault gases, not measured by this monitor, may be present in small quantities. Always follow site safety procedures when working with combustible gas.



Warning: This product contains a non-hazardous Class 1 laser.

Input Power Precautions

This device has an autosensing (AC or DC) power input and has 3 terminals on the power input board. L/DC+, N/DC-, and GND. Input power for the InsuLogix G2 must be within the following ranges:

Cat. No 1015-313 90V-264 V AC, 47-63 Hz, 160 VA; 127-370 V DC, 120 W



Figure 2-1: Input Power Board

When using AC, the neutral pole must be at ground potential. Before making connection to the power source, determine that the instrument rating matches the voltage of the power source. Do not bypass the grounding connection.

The ground terminal of the input supply (green or yellow/green wire) must be connected to the protective ground (earth) terminal of the line power source.

The control circuits of the instrument are fuse protected. The fuse is located on the input power board on the side panel and is replaceable by the operator. To avoid electric shock and fire hazard, use only the fuse specified below switch module on side panel.

F**WARNING**

Before replacing the fuses, disconnect the input power from the live power source.

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SPECIFICATIONS

Input Power

AC Input Voltage range: 90 – 264 V AC
(47 – 63 Hz); 1.4 A (3 A Max)
DC Input Voltage range: 127 – 370 V DC; 120 W
Internally fused at 3 A

Measurement Range

C2H2: 0.5-500 ppm (dissolved-in-oil)
H2: 25-5000 ppm (dissolved-in-oil)
H2O: 0-95 % RH

Accuracy

C2H2: ± 0.5 ppm or 15 % of reading**
H2: ± 25 ppm or 15 % of reading**
H2O: ± 4 ppm or 2 % RH
** whichever is greater

Low Detection Limit (LDL)

C2H2: 0.5 ppm (dissolved-in-oil)
H2: 25 ppm (dissolved-in-oil)

Repeatability

C2H2: 14 %
H2: 10 %

Oil Pressure Rating

Full vacuum – 100 psi

Analog Outputs

4 DC current outputs: 0/4-20 mA (optional)

Communication Protocols

Modbus RTU & TCP (standard)
DNP3, IEC 61850 (optional)

Environmental

Operating -40 °C to +65 °C -40 °F to +149 °F
Storage -40 °C to +85 °C -40 °F to +185 °F
Relative Humidity 5-95 % RH, non-condensing
Operating Altitude 0 - 2000 m
Protection Class IP66 (NEMA 4X)
Pollution degree 4 – Electrical equipment for outdoor use

Physical

Storage humidity 5-95 % RH non-condensing
Dimensions 227 mm x 229 mm x 333 mm
(8.9" x 9.0" x 13.1")
Weight 13.5 kg (29.76 lb)
Installation 1.5" NMPT connection from monitor

Alarm Relays

Signal Relays (1-8)
Rated Load: 0.50 A @ 125 V AC, 1A @ 24 V DC
Max Switching voltage: 125 V AC, 60 V DC
Power Relays (9-12)
Rated Load: 10 A @ 120 V AC, 8 A @ 30 V DC
Max Switching Voltage, 250 V AC, 125 V DC

Front Panel

LED status indicator: Green-Yellow-Red
LCD display: 80-character LCD display (4 x 20)
Display size: 146.00 x 62.50 mm (5.75 x 2.46 in)
Backlight: White LED
Operating temp: -20 °C to + 70 °C

Rear Panel

RJ45 IP67 receptacle with bayonet style locking cap; 10/100Base-T
Conduit Glands 3x – ¾" liquidtight type

User Interface Software

Residing in unit, Webserver based

Data Recording and Event Logs

10 years @ default (1 hour) recording frequency;
minimum 2 years

Regulatory

Safety

CAN/CSA-C22.2 No. 61010-1, Third Edition

EMI/EMC

IEC 61326-1:2013

FCC Part 15 Subpart B

Canada ICES-003 Issue 6

Vibration/Drop/Shock

IEC 60255-21-3 ed 1

IP66

C22.2 No. 94.2-07

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OPERATION

During normal operation, gases are extracted from oil through the gas extraction manifold (GEM) and are circulated in the gas phase of the system. The gas and moisture concentrations are monitored over the course of a one-hour measurement cycle. These values are then written to the database and the new recording cycle begins.

System and sensor information are stored in the monitor's database. The information captured in the database includes settings, thresholds, parameters, real-time data, trending data, alarm states, and relay states. Any user may download sensor specific data, for a selectable period, to a CSV file through the historical data page of the user interface. The complete database can also be downloaded through the user interface with an Administrator level login.

The user interface (UI) of the InsuLogix G2 is a locally hosted webserver. In addition to being a configuration tool, the UI displays the current values of the data in the system's database. Data on this interface is refreshed automatically every minute.

Data being transmitted over DNP3 is updated with the current values following each measurement cycle. The exception to this would be an alarm trigger which would be updated immediately due to the change of state.

System Startup

Prior to operating the system, refer to section 4 of the Installation Guide for information on parameters that shall be configured and/or confirmed to ensure the monitor reporting is optimized.

When the InsuLogix G2 is first turned on, the System Startup screen will be displayed for a short time. The LCD display will then change to the System Status screen and will show "Status: WAITING" as the various internal processes and components are started up.

Next in the startup sequence of the monitor, the Gas Extraction Manifold (GEM) and Acetylene Detection System (ADS) system are warmed up to their process-controlled temperatures. Warm up time of the monitor will vary between 10 and 90 minutes depending on the ambient temperature. During this period, the LCD display will display "Status: HEATING".

Once the system heating has stabilized, the monitor will enter normal mode where the gas path is run in a closed loop fashion to continuously analyze gas extracted from the

transformer oil. The LCD will display “Status: NORMAL.x” when the monitor is analyzing gas.

Cold Weather Start and Operation

In cases where the temperature, as measured by the internal temperature sensor, is $< 5\text{ }^{\circ}\text{C}$ the unit will enter “cold start” mode. During a cold start, the manifold will begin heating slowly on low power to ensure that no condensation is generated inside the monitor during warmup.

Once the temperature inside the monitor reaches $5\text{ }^{\circ}\text{C}$, the system will enter its normal warm up mode where the ADS will begin heating. The pump will remain off until the ADS has completed its warmup.

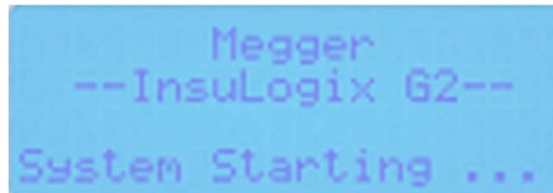
In extreme cold conditions ($< -15\text{ }^{\circ}\text{C}$) the LCD on the front panel of the InsuLogix G2 will turn off. The monitor will continue to operate, however.

System Components

The major system components of the InsuLogix G2 are discussed in the following pages.

LCD Display Screens

When power is first applied to the monitor, the System Startup screen will be displayed for 10 seconds.



The system will then display the Default Status screen. As described in the System Startup section, initially the status will display WAITING, then HEATING, and finally once the initialization period has completed it will display NORMAL.X as shown below where X = either E, S, or M depending on where in the measurement cycle the monitor is at that time.



Use the function button (3), located in the lower right of the front panel, to cycle between the available screens which include two for the gases, two for moisture (ppm & % RH), temperatures, system status, and a messages screen which displays the current active alarms.

Until the trend timeframe has elapsed, the data shown for that trend time will display ---. For example, the rate/hour will not display a value until after an hour has elapsed since the monitor has started to collect data. Trend data will update based on the frequency of data recording.

- Acetylene (C₂H₂) Screen



- Hydrogen (H₂) Screen



- Moisture (H₂O ppm) Screen



- Moisture (H₂O %RH) Screen



- Temperature Screen



- Messages Screen



As mentioned in the previous section, the LCD display is temperature sensitive. It will be turned off in extreme conditions where the temperature in the unit is $< -15\text{ }^{\circ}\text{C}$ or $> 60\text{ }^{\circ}\text{C}$. The InsuLogix G2 will continue to operate, and the LCD display will turn back on when the temperature comes back into its range of operation.

Gas Extraction Manifold (GEM)

The gas extraction manifold (GEM) contains a heater, temperature sensor, and a continuous coil of a gas extraction element. The heating element maintains a constant temperature which drives thermal convection in the manifold to facilitate oil mixing and creates flow across the surface.

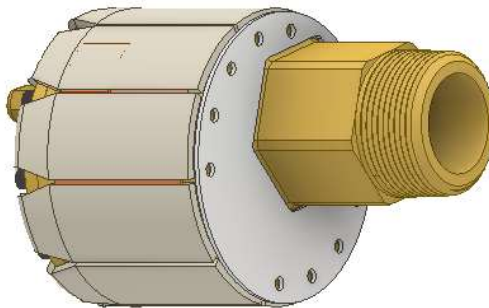


Figure 4-1: Gas Extraction Manifold (GEM)

The gas extraction tubing is permeable allowing the gas to penetrate it. Over a constant period, the gas reaches equilibrium with the gas dissolved in oil. The design of the GEM contains no consumable components, and it is resistant to vacuum.

Both oil purging and oil sampling pull the oil directly from the manifold.

Note: Though the GEM is resistant to vacuum, it is always good practice to close the transformer valve prior to pulling a vacuum on the tank during oil reprocessing.

Acetylene Detection System (ADS)

The Acetylene Detection System (ADS) module provides a continuous measurement of acetylene (C_2H_2) and moisture (H_2O) in gas extracted from oil by the GEM. This is accomplished using a laser spectrometer based on contactless, near-infrared absorption.

The module maintains a constant temperature for consistent operation and measurement of the gas.

Hydrogen Sensor

The hydrogen (H₂) sensor uses thermal conductivity technology for continuous measurement of H₂ in the gas extracted from oil by the GEM.

Gas Pump

The monitor's gas pump circulates the gas in the monitor across the sensors and runs at a slower than rated speed which greatly increases the life of this component to > 10 years.

Filter

A filter is used in the system to block any particles and oil vapors that could have made it into the gas phase. Filter life is expected to be in the range of 10 years.

Replacement of the filter can be done within 1 hour by qualified personnel with no need to unmount the monitor. See the Maintenance section of the manual for instructions on filter replacement.

Electronics

The InsuLogix G2 contains a main printed circuit board (PCB) and a separate input power board. The main board is located near the front of the monitor and contains the communications, relay output wiring terminals, and a single-board computer. A 5 A fuse is located on the board to protect the output of the DC power supply.

The input power board is located on the right side of the monitor, near the cable glands. This location provides a level of separation from the main board in the event of a surge. In addition, a 3.15 A (Schurter 0001.2509) ceramic fuse is located on this board for added protection. Replacing this board or the fuse on it takes only about 15 minutes.

Replacement fuses are available upon request at the time of order.

Note: Though all sensors are calibrated at the factory to be within the accuracy range in the specifications section of this manual, online monitoring is not a replacement for offline testing. It is good practice to validate monitor flagged alarms by having an oil sample tested by an ISO 17025 certified laboratory.

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USER INTERFACE

System configuration for the InsuLogix G2 is done through the Webserver User Interface (UI) software. Compatible with Chrome and MS Edge, this provides for a user-friendly experience using the latest in browser technology.

Connecting multiple InsuLogix G2 units to one network allows users access to all their devices from one location. Whether connected directly to the unit in the field or remotely from the office, the experience is identical.



Figure 5-1: User Interface Connection Options

Logging into the Monitor

To log into the InsuLogix G2:

1. Using a computer that is connected to the same LAN as the monitor or connected directly to the back of the unit, enter the IP address of the system in the navigation bar of the browser
 - a. This will launch the UI, which will open to the login screen shown below
2. Enter the appropriate username and password, then click the Login button
 - a. The default administrative username is **sysadmin**, and the default password is **G2Gen2**. It is recommended that the user change this password in the interest of increasing security.

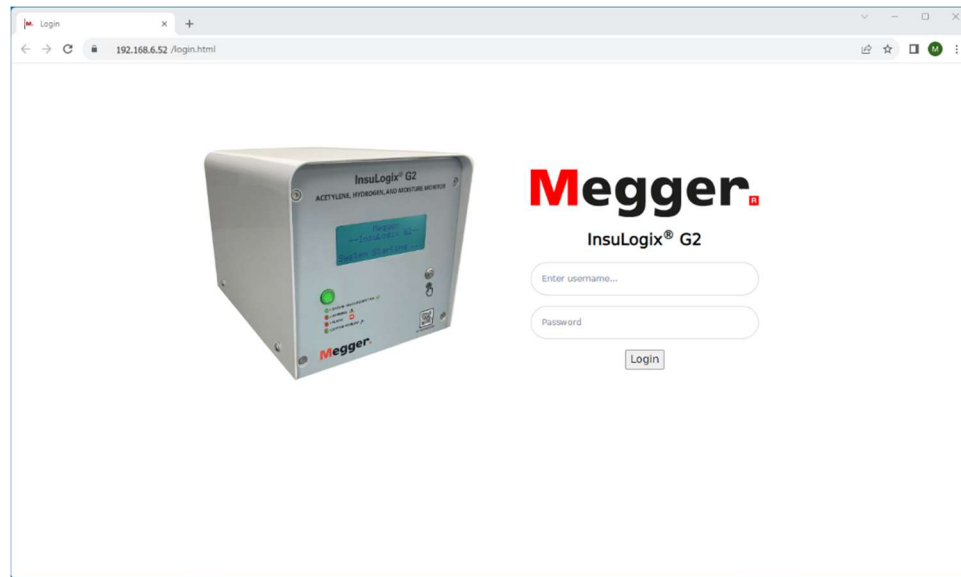


Figure 5-2: Login Screen

General Screen Features

Except for the login screen, the InsuLogix G2 User Interface screens follow a consistent layout providing for a user-friendly experience. The format of the screens is detailed below.

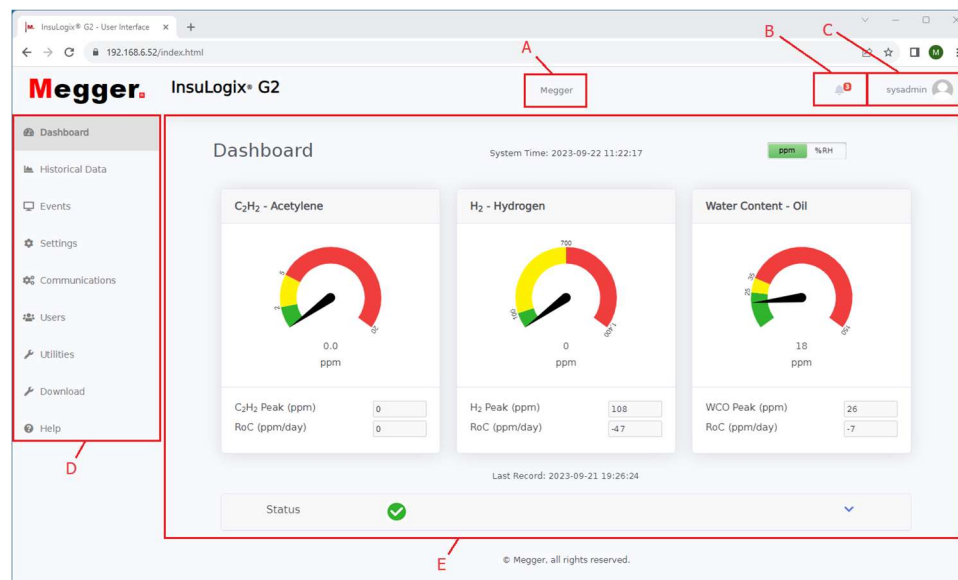


Figure 5-3: General Screen Features

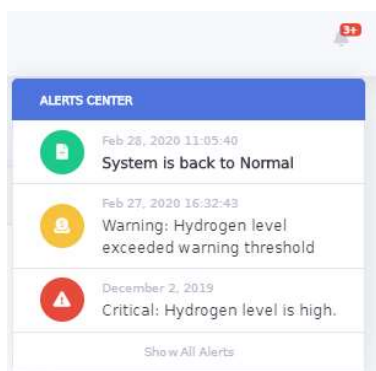
A. Transformer Name

The transformer name, as entered by the user in the Settings>Device tab, appears in the top center of each screen providing a clear indication of which unit's information is being displayed in the user interface.

B. Alerts Center

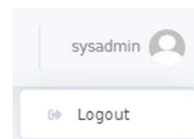
The alerts center (bell icon) provides a clear indication of any potential issues with the system and/or the data being monitored. When a red indicator is present over the alarm bell, new events are present. Clicking on the icon will open a flyout window as shown below. A brief description of the recent events, along with a time/date of when they occurred are displayed in this window. Navigate to the “Events” screen for more information on alerts.

To close this flyout, click on the alarm bell a second time.



C. Current User

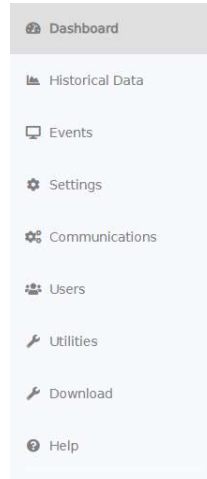
This field shows the name of the user who is currently logged in. Click on the username to open a flyout from which you can logout of the system. Click anywhere outside of this flyout to close it.



D. Navigation Menu

The navigation menu, located on the left side, lists all the available screens within the UI. The highlight over “Dashboard” in the list shown below indicates this is the current screen that is being displayed in the content section of the display. Keep in mind that some screens (i.e., Settings) have multiple tabs within them which will be detailed in their screen specific section of this manual.

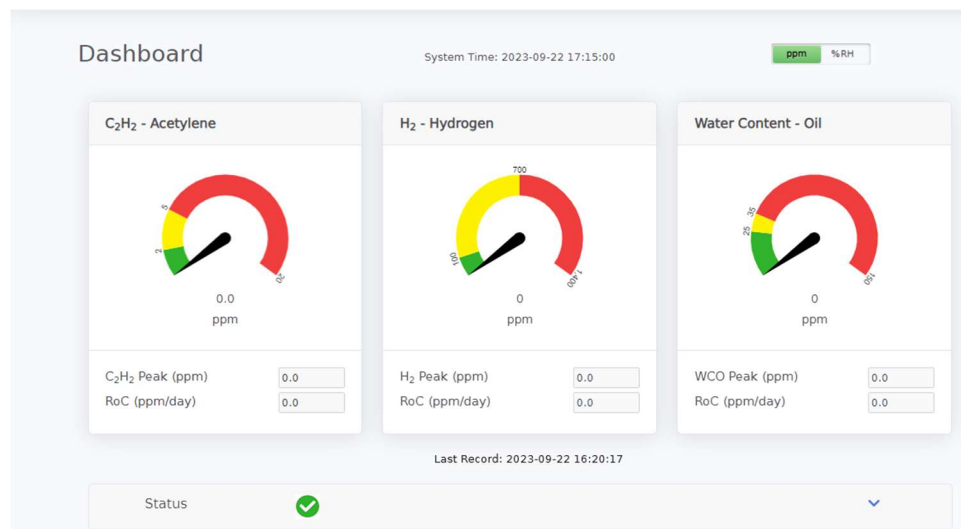
Available options in this menu are Dashboard, Historical Data, Events, Settings, Communications, Users, Utilities, Download, and Help. Each of these are detailed in the following pages.



E. Working Area

The central, working area, section of the screen contains the content for each of the selections in the navigation menu. Selecting a different screen in the navigation menu changes the content of the working area section of the screen.

This area is where the user can view data, graphs, and events, download data and log files, change settings, add/remove users, access and use the system utilities or view the help file.



The system time and date is displayed in the top center of the working area on each screen.

Viewing the Dashboard

Upon logging into the system, the Dashboard screen will be displayed. The Dashboard provides an overview of the system in real-time with information on each measured value and status icons for each of the relays. When on a different screen, click the Dashboard selection in the navigation menu on the left to return to the Dashboard.

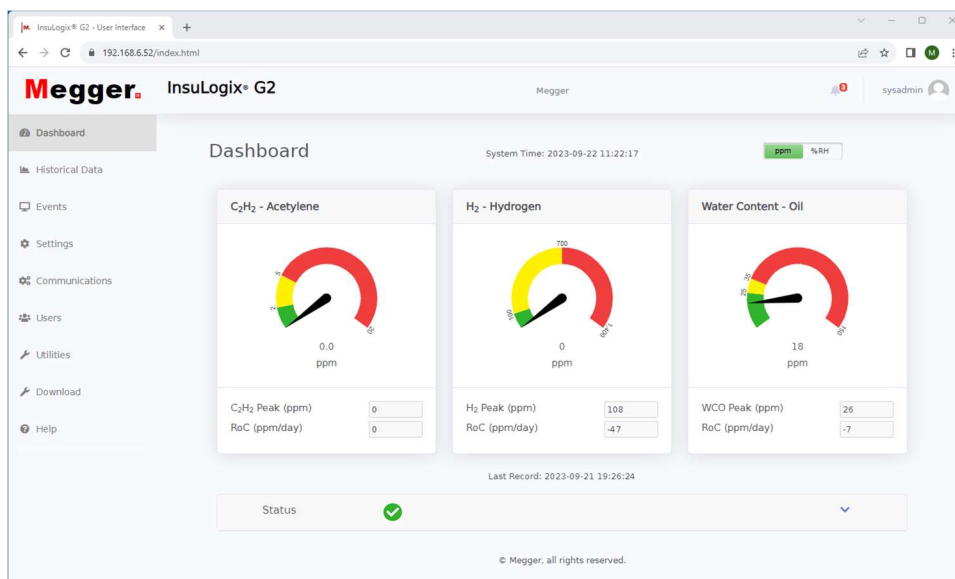


Figure 5-4: Dashboard Screen

The system date and time are displayed in the top center of this. To the right of the right of the system time are two buttons to switch the moisture display between percent relative humidity (% RH) and water content – oil (ppm).

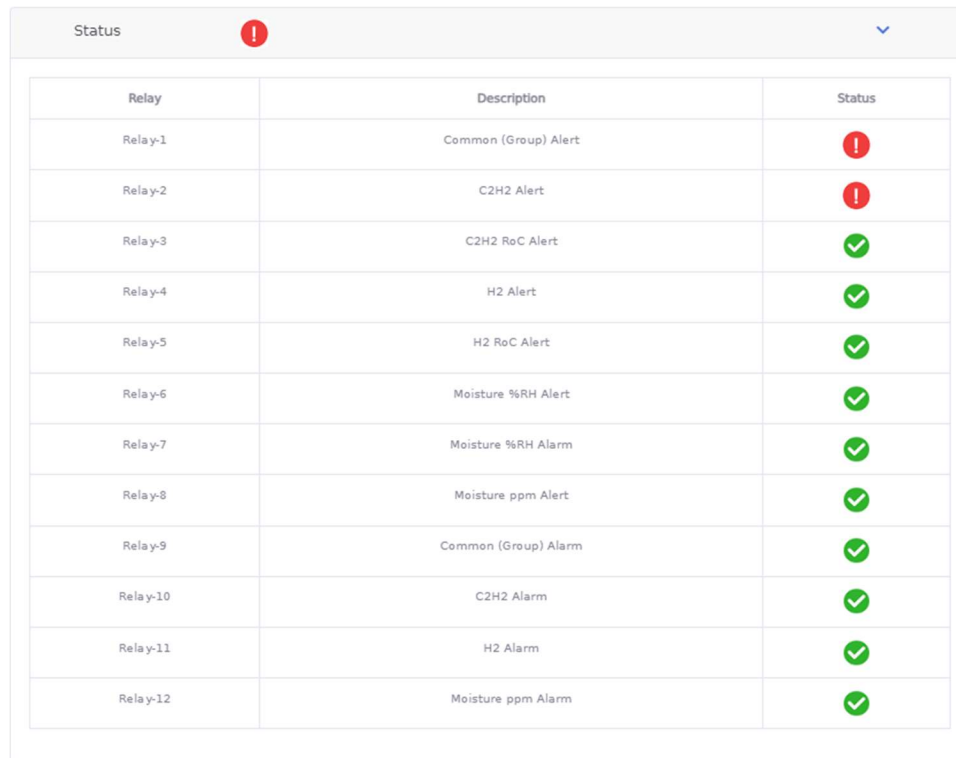
Each of the gases and water content (or % RH) are displayed on the Dashboard screen in a radial graph format. The transitions from green→yellow→red, as well as the setpoint values shown at these transition points are directly linked to the Alert and Alarm thresholds entered on the Thresholds tab of the Settings screen and update dynamically when one of those values is changed.

The coloring of the dial provides a visual indication of the state of each data point with respect to its alarm setpoints. When the needle of the graph is shown in the green area, the measured value is “Good” or below the configured alert & alarm threshold values. A needle in the yellow zone indicates that the measured value is in “Alert” (i.e., “Warning”) but has not yet reached the alarm state. Likewise, when the needle is in the red zone, the measured value is in “Alarm” and immediate action is required.

Immediately below the radial graph, the latest recorded value of the data is displayed along with its units for clarity. Continuing down the data window, the gas or moisture peak value and its rate of change (RoC) in units/day are also displayed.

The date and timestamp of the last values recorded by the monitor is displayed directly below the three radial graphs.

The status indicators in the lower part of the Dashboard screen provide a visual indication of each of the monitor's relay outputs. The indicator for Status will appear red if any of the alarms configured to any of the 12 relays is active. Click the arrow on the lower right side of the screen to expand the status window to make all relays visible.



Relay	Description	Status
Relay-1	Common (Group) Alert	!
Relay-2	C2H2 Alert	!
Relay-3	C2H2 RoC Alert	✓
Relay-4	H2 Alert	✓
Relay-5	H2 RoC Alert	✓
Relay-6	Moisture %RH Alert	✓
Relay-7	Moisture %RH Alarm	✓
Relay-8	Moisture ppm Alert	✓
Relay-9	Common (Group) Alarm	✓
Relay-10	C2H2 Alarm	✓
Relay-11	H2 Alarm	✓
Relay-12	Moisture ppm Alarm	✓

Figure 5-5: Dashboard Screen – Relay Detail

Historical Data

The Historical Data screen provides the user with direct access to the monitor's aggregated data. From this screen, a user may view specific timeframes of their data in a graph format, download these graphs to a PDF file, and download the raw data to a .CSV file.

Four pens are shown on the graph which provide a detailed look at the historical data for acetylene (C₂H₂), hydrogen (H₂), moisture as relative humidity (%RH), and water content in oil (WCO). Hovering the mouse over the graph will display a pop-up showing the values of the pens at that specific time.

Each of the pens can be removed from (and added back to) the graph by clicking on the desired pin in the legend to the right of the graph window. As pens are removed, the graph

will automatically scale the y-axis if there are no data points restricting this function. The y-axis will always start at 0 as a reference point.

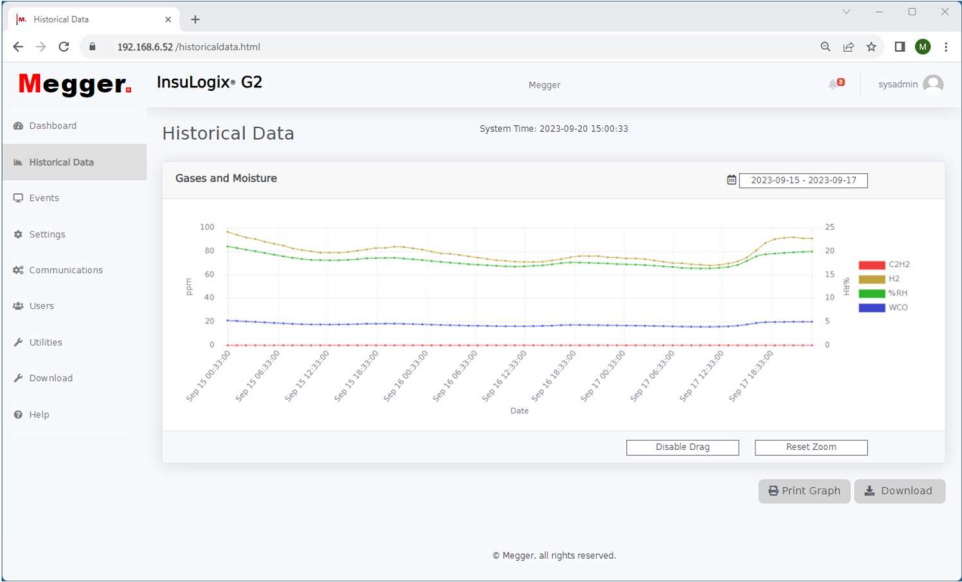
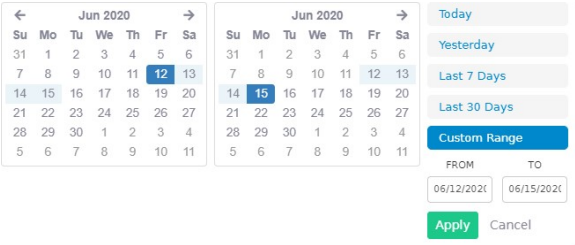


Figure 5-6: Historical Data Screen

Clicking on the date range in the top right opens a from-to calendar popup display from which the date range can be selected. Along the right of this popup, hot keys allow for selecting today, yesterday, the last 7 days, or the last 30 days.



Note: Viewing a large date range (> 90 days) can lead to an extended delay in graph population as the system loads the data.

Graphs can be zoomed in and out by either clicking and dragging in the plot area or, if the disable drag button is selected, by using the roller wheel on the user’s mouse. The reset zoom button resets the plot to the selected date range specified in the top right.



Using the Print Graph button in the lower right of the screen, the graph for the selected date range can be printed to a PNG file. This will open another window in the browser on which the graph will be displayed. It can then be downloaded to the user’s computer to be shared with others.

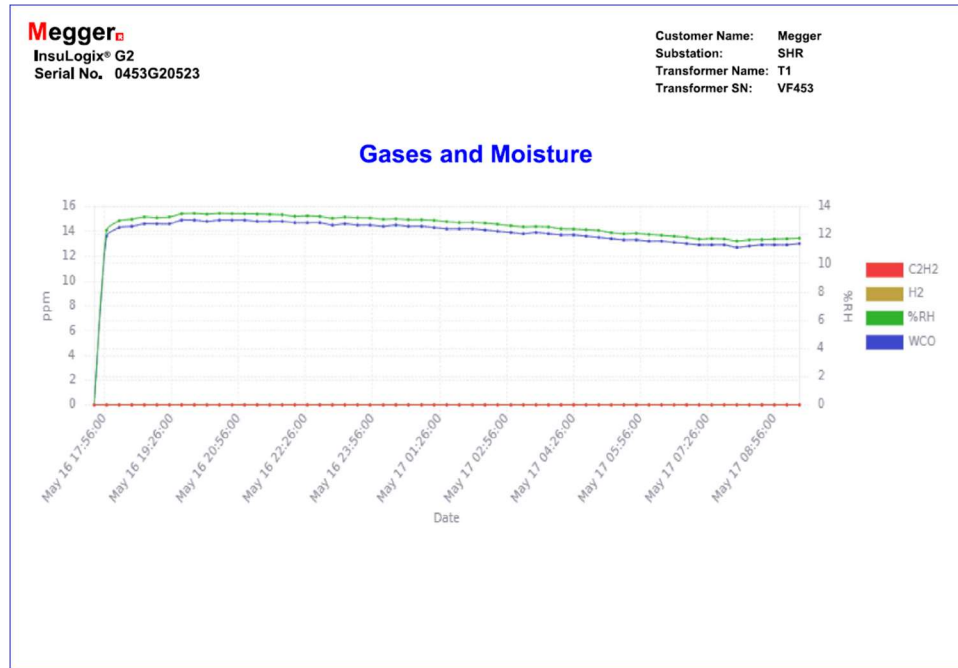


Figure 5-7: Historical Data Graph Printout

Clicking on the Download button will create a CSV file of the data within the selected date range. This file will be saved to the default download location specified in the connected computer’s settings.

Timestamp	C2H2	H2	%RH	WCO	GasCellTemperature	OilTemperature
5/16/2023 17:58	0	0	12.32	13.6	55	40
5/16/2023 18:15	0	0	12.99	14.3	55	40
5/16/2023 18:32	0	0	13.1	14.4	55	40
5/16/2023 18:49	0	0	13.26	14.6	55	40
5/16/2023 19:06	0	0	13.21	14.6	55	40
5/16/2023 19:23	0	0	13.26	14.6	55	40
5/16/2023 19:39	0	0	13.49	14.9	55	40
5/16/2023 19:56	0	0	13.52	14.9	55	40
5/16/2023 20:13	0	0	13.46	14.8	55	40
5/16/2023 20:30	0	0	13.52	14.9	55	40
5/16/2023 20:47	0	0	13.5	14.9	55	40
5/16/2023 21:04	0	0	13.49	14.9	55	40
5/16/2023 21:21	0	0	13.47	14.8	55	40

Figure 5-8: Historical Data CSV File

The owner information for company, substation, transformer name, and transformer serial number is displayed on the top of both the printed graph and CSV files for easy identification of what transformer the data belongs to.

Note: Commas (,) are used as the characters to separate the values in this file. If using the InsuLogix G2 in a country that uses a different character to separate values in CSV files, such as a semi-colon (;) in many European countries, the file will need to be converted using a text

editor to find/replace all the commas with the domestically used character. Once this converted file is saved, it will be able to be opened and properly displayed in a local spreadsheet program.

As is the case with the graph printout, the header of the CSV file contains the owner and transformer information to easily distinguish it from other units. Each record, or line item, in the file is timestamped and contains the following information:

Item	Description	Units
C2H2	Acetylene	ppm
H2	Hydrogen	ppm
%RH	Relative Humidity	%
WCO	Water Content in Oil	ppm
GasCellTemperature		°C
OilTemperature		°C

Events

All events pertaining to data alerts & alarms, and system component errors are logged by the InsuLogix G2. When a new event is recorded, a red indicator will be present over the alarm bell icon in the header of all UI screens.




Navigate to the Event screen to obtain more information on the specific event(s) including a timestamp of when it occurred, what event occurred, the type of alarm, the status level, the event ID, and any recommended actions that should be taken as a result.

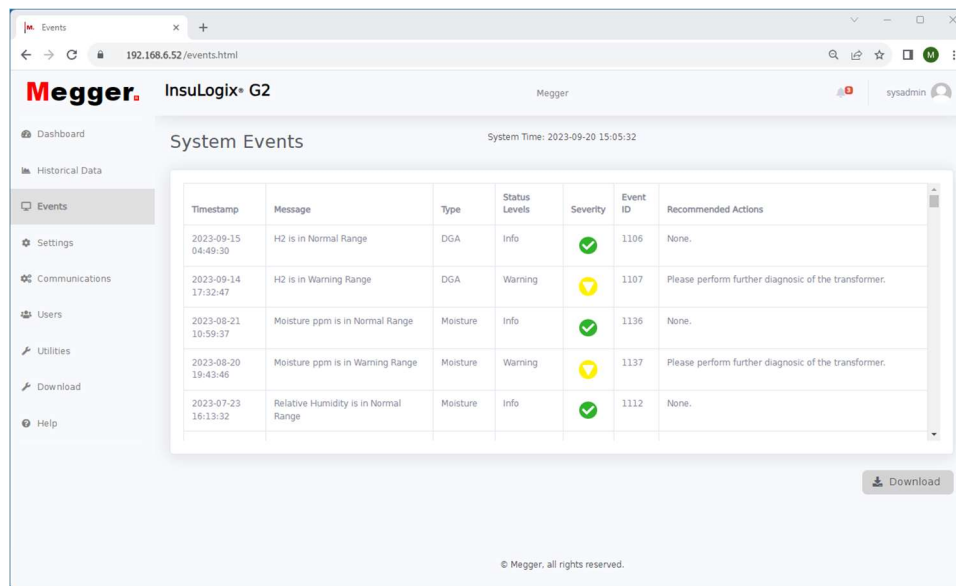
In general, each event is defined using the following parameters:

- Message
 - Description of event
- Type
 - DGA – Based on measured gas data
 - Moisture – Based on measured data
 - Hardware – Based on the state of the monitoring components
 - System – Based on system activity
- Status Level
 - Info – No action warranted

- Warning – Take notice. Some action may be needed
- Critical – Action required
- Normal – Parameter has returned to its normal range
- Severity

The severity column provides a clear visual indication of the status level in green, yellow, or red

- Info, Normal - 
- Warning - 
- Critical - 
- Event ID
 - Unique identifier given to each different event message
- Recommended Actions
 - Provides guidance on what steps to take, if any, for the given event








Timestamp	Message	Type	Status Levels	Severity	Event ID	Recommended Actions
2023-09-15 04:49:30	H2 is in Normal Range	DGA	Info		1106	None.
2023-09-14 17:32:47	H2 is in Warning Range	DGA	Warning		1107	Please perform further diagnostic of the transformer.
2023-08-21 10:59:37	Moisture ppm is in Normal Range	Moisture	Info		1136	None.
2023-08-20 19:43:46	Moisture ppm is in Warning Range	Moisture	Warning		1137	Please perform further diagnostic of the transformer.
2023-07-23 16:13:32	Relative Humidity is in Normal Range	Moisture	Info		1112	None.

Figure 5-9: Events Screen

The events table will be stored for the life of the unit and can be downloaded to a CSV file by clicking on the Download button in the lower right corner of the screen.

Settings

Other than communications, analog module configuration, and setting the system time and date, user configuration of the InsuLogix G2 is contained within the Settings screen tabs on the UI. These include Device, Thresholds, and Relays.

Note: Settings can only be modified at the Administrator login level.

Device Information

The Device tab contains the monitor’s factory information, owner information, and user configurable calibration parameters.

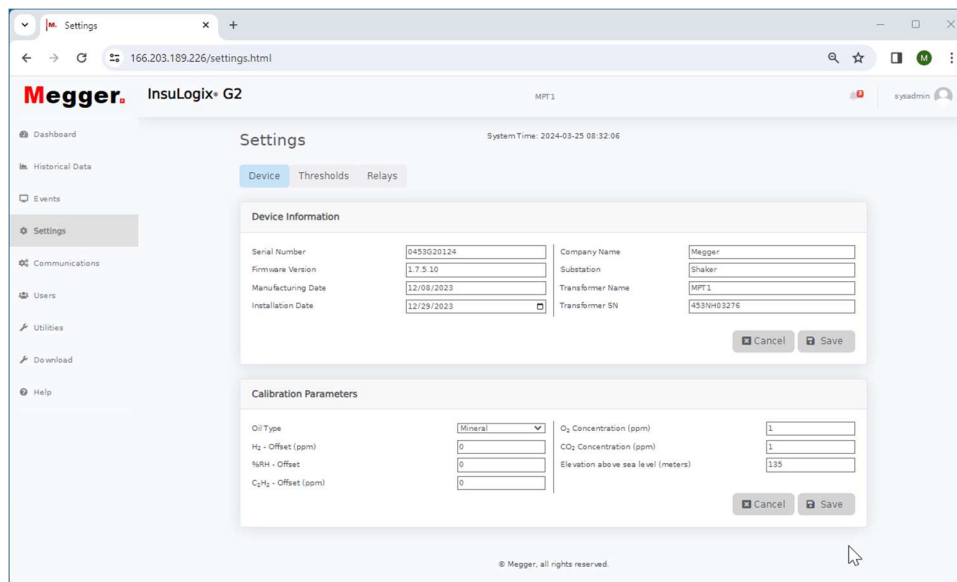
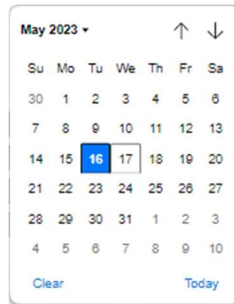


Figure 5-10: Device Settings Screen

In the Factory Information window, the serial number and manufacturing date of the monitor are set at the factory and cannot be updated in the field. The firmware version is also a read only field as this information is pulled automatically from the system and would only change when a firmware update is performed.

The installation date can be updated by either entering the information directly in the field, or by clicking on the calendar icon and choosing the date from the pop-up calendar.



To select today's date, simply click on the Today button at the bottom right corner of the calendar.

The Owner Information section contains the owner's company name as well as fields to identify the substation and transformer where the unit is installed. The information in these fields will be displayed on the printable graphs and will also be included in the CSV files.

The calibration parameters section of the device settings contains all the editable parameters which are used to dial in the output of the monitor. Oil type, elevation, O₂ concentration (ppm), and CO₂ concentration (ppm) shall be confirmed when commissioning the G2 on a transformer, while the offset parameters would generally not need to be updated in the field on a new unit that was recently calibrated at the factory.

Offset parameters are useful when one wants to correlate lab results to the online monitor in the event of a discrepancy. It is important to confirm any discrepancy between lab results and monitor readings with multiple offline samples prior to making any updates to the G2 offset values.

O₂ and CO₂ concentration inputs are provided for the user to input from an offline test report. Entering these values will allow the monitor to compensate for the effects of these two gases on the H₂ sensor.

The table below lists each of the calibration parameters along with their default values and allowable data entry ranges.

Parameter	Default Value	Allowable Range	UI Configurable (Y/N)
Oil Type	Mineral	Mineral Natural Ester	Y
H ₂ Offset (ppm)	0	-500 – 500	Y
%RH Offset	0	-20 – 20	Y
C ₂ H ₂ Offset (ppm)	0	-5 – 5	Y
Elevation (m)	0	0-4000	Y
O ₂ Concentration (ppm):	0	1-40000	Y
CO ₂ Concentration (ppm):	1	0-40000	Y

Note: After updating any of the settings in this section, you MUST click on the Save button to save the updates to the monitor. Navigating away from the page without pressing save will have the same effect as clicking the Cancel button.

Alarm Threshold Settings

Configuration of all software driven alarms pertaining to measured data is performed on the Thresholds tab of the Settings screen. The setpoint values of Alert and Alarm thresholds will trigger these events when exceeded for the corresponding Alarm Delay. These are also the values used on the radial graphs shown on the Dashboard screen.

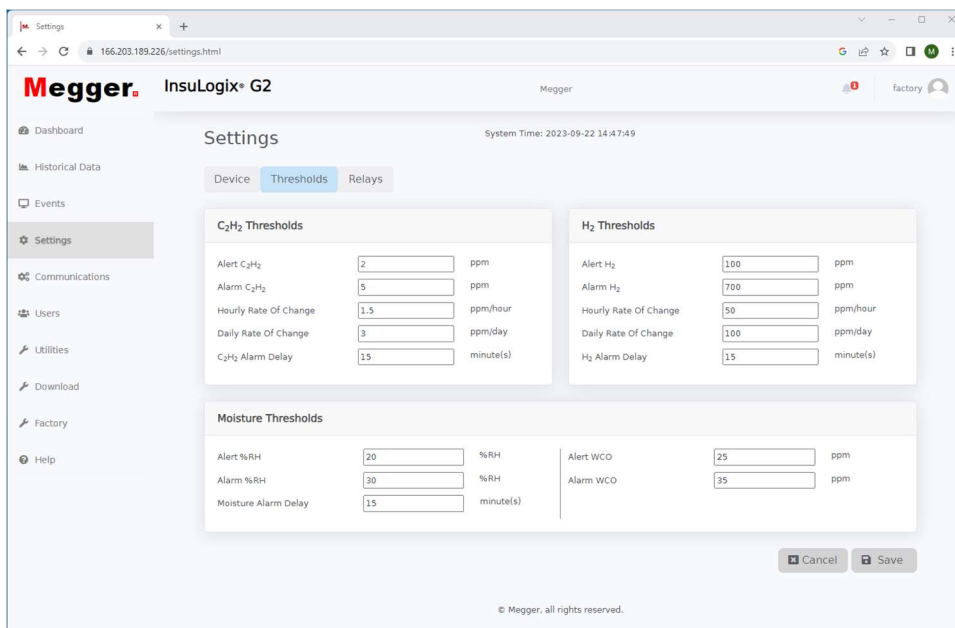


Figure 5-11: Thresholds Settings Screen

The following table lists each of the parameters on this screen along with their default threshold values and allowable data entry ranges.

Type	Parameter	Default Value	Units	Allowable Range
C ₂ H ₂	Alert C ₂ H ₂	2	ppm	0.5-500
	Alarm C ₂ H ₂	5	ppm	0.5-500
	Hourly Rate of Change	1.5	ppm/hour	0.5-500
	Daily Rate of Change	3	ppm/day	0.5-500
	C ₂ H ₂ Alarm Delay	15	minutes	0-1440
H ₂	Alert H ₂	100	ppm	25-5000
	Alarm H ₂	700	ppm	25-5000
	Hourly Rate of Change	50	ppm/hour	25-5000
	Daily Rate of Change	100	ppm/day	25-5000
H ₂ O	H ₂ Alarm Delay	15	minutes	0-1440
	Alert %RH	20	%RH	0-100
	Alarm %RH	30	%RH	
	Moisture Alarm Delay	15	minutes	
	Alert WCO	25	ppm	
	Alarm WCO	35	ppm	

Alarm %RH	30	%RH	0-100
Alert WCO	25	ppm	0-9500
Alarm WCO	35	ppm	0-9500
Moisture Alarm Delay	15	Minutes	0-1440

Note: Remember to click the Save button if any updates are made to these settings before navigating away from this page.

Relay Settings

Configuration of the twelve (12) form C solid-state relays is performed using the Relays tab of the Settings screen. Each of the relays is listed on this page along with a dropdown menu from which a specific Alert or Alarm condition can be assigned to it. The full list of configuration options is available on the right side of the screen.

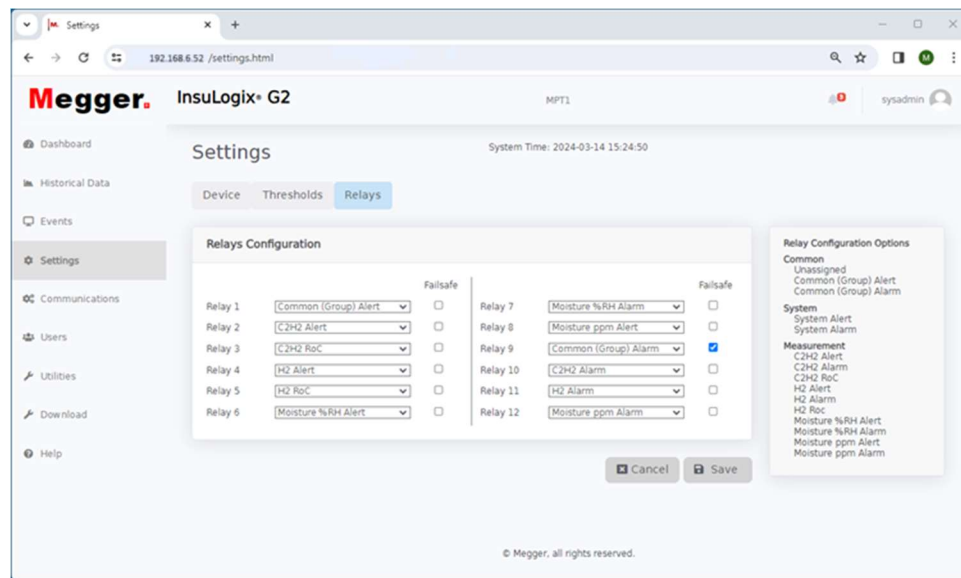


Figure 5-12: Relay Settings Screen

The default configuration of the relays is shown in the table below.

Relay	Function
R1	Common (Group) Alert
R2	C ₂ H ₂ Alert
R3	C ₂ H ₂ RoC
R4	H ₂ Alert
R5	H ₂ RoC
R6	Moisture %RH Alert
R7	Moisture %RH Alarm
R8	Moisture ppm Alarm

R9	Common (Group) Alarm
R10	C ₂ H ₂ Alarm
R11	H ₂ Alarm
R12	Moisture ppm Alarm

To the right of each relay is a checkbox to configure that relay as failsafe. When a relay is configured as “failsafe” it will be energized when the associated alarm condition is not in an alarm state. This is useful to see positive confirmation that all is OK and to detect a power failure to the unit as the relay will de-energize when the monitor loses power resulting in a change of state on that circuit.

System Alert and System Alarm are triggered by device alerts and alarms only. The Common (Group) Alert is an OR function of all measurement alerts, while the Common (Group) Alarm is an OR function of all measurement and system alarms.

Communications

Configuration of the communication protocol settings is performed using the communications screen. The first two fields in the protocol settings are for use with DNP3 to set the Outstation ID (ID of InsuLogix G2 on network) and the Ethernet port that the protocol will use. The same is true of the next two fields when using Modbus protocol.

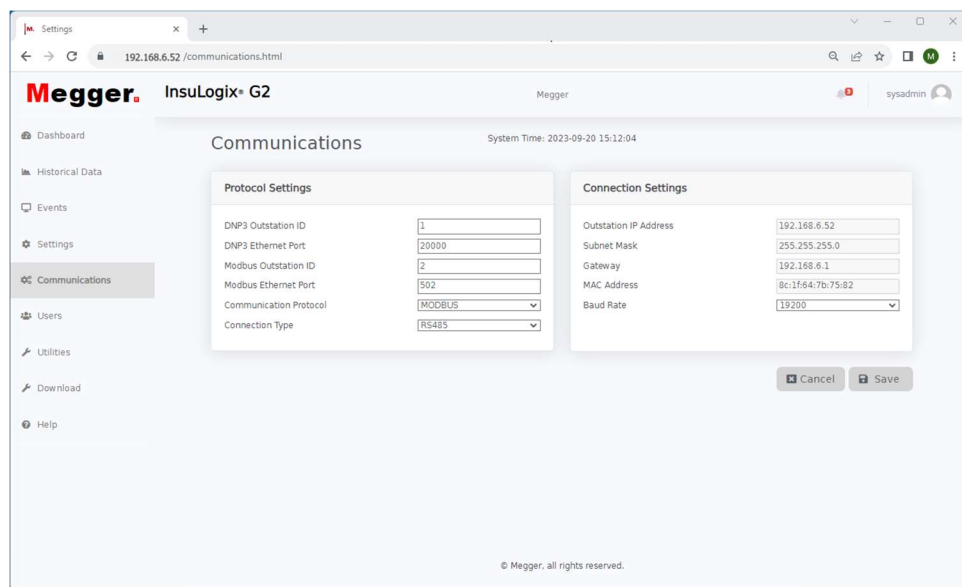


Figure 5-13: Communications Screen

Using the last two fields at the bottom of the list of Protocol Settings the user selects Communication Protocol (Modbus, DNP3, or IEC 61850) and the Connection Type (RS485 or TCP/IP). To follow best practices for processor usage, only the selected connection type will be active for protocol communication.

Note: Regardless of the selection for the Connection Type for the protocol communication, the UI will always be accessible by a computer on the same LAN as the InsuLogix G2.

The Protocol Settings default values are:

Parameter	Default Value	Allowable Range	UI Configurable (Y/N)
DNP3 Outstation ID	1	0-65535	Y
DNP3 Ethernet Port	20000	0-65535	Y
Modbus Outstation ID	2	0-254	Y
Modbus Ethernet Port	502	0-65535	Y
Communication Protocol	Modbus	Modbus DNP3* IEC 61850*	Y
Connection Type	RS485**	RS485 TCP	Y

* - DNP3 & IEC 61850 only available if licensing purchased at time of order

** - For IEC 61850 applications, the connection type automatically updates to TCP

The Connection Settings default values are:

Parameter	Default Value	Allowable Range	Configurable from Communications Page (Y/N)
Outstation IP Address	192.168.6.52		N
Subnet Mask	255.255.255.0		N
Gateway	192.168.6.1		N
MAC Address	varies		N
Baud Rate	19200	9600 19200	Y

Note: Ethernet port settings are configured using the System tab on the Utilities page

Users

The Users screen displays a list of all configured users for the system and what their designated Access Control level is.

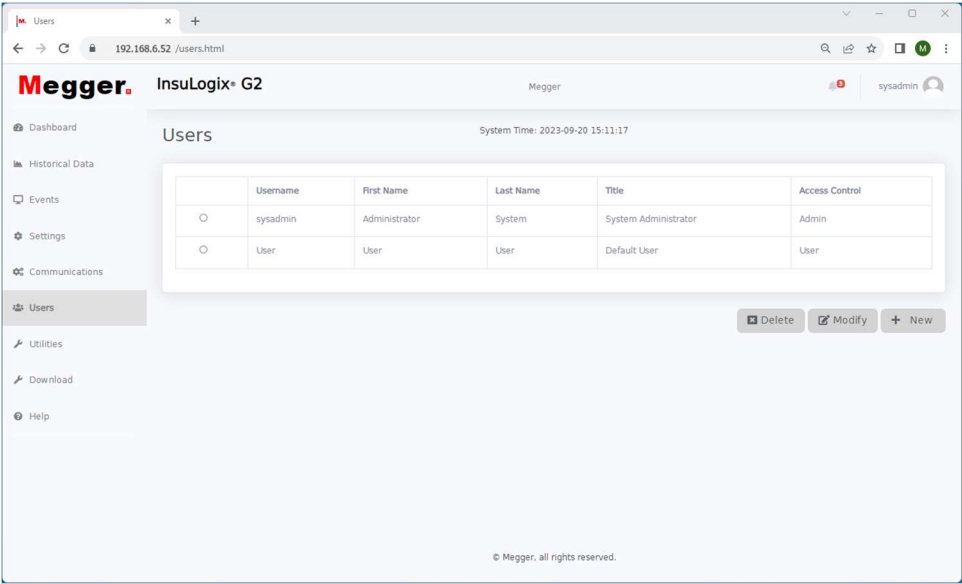
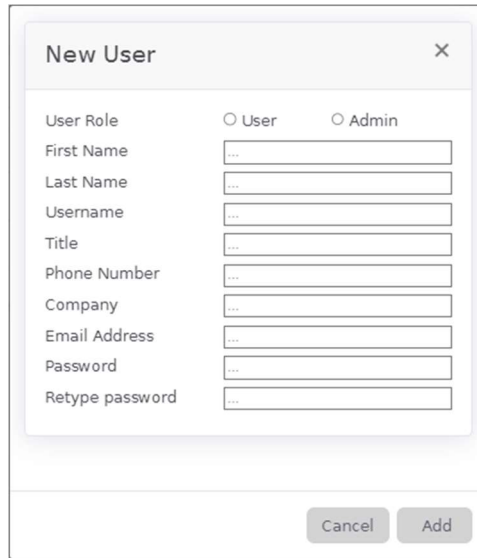


Figure 5-14: Users Screen

A User level login is read-only, while an Admin level login allows for system configuration and new user creation. A full list of permissions is provided in the table below.

Action	User Level Permission	Admin Level Permission
View Data	Y	Y
Change graph date range	Y	Y
Download data	Y	Y
Print Graph	Y	Y
Edit Settings	N	Y
Configure Relays	N	Y
Change password for current user	N	Y
Change password for another user	N	Y
Create/Modify/Delete user	N	Y
Utilities (relay test tool, start/stop services, software reboot, upgrade system software & firmware, configure/test analog output module)	N	Y
Download Software Logs, IEC 61850 ICD File	Y	Y
Download Configuration, System Database	N	Y

To create a new user, click on the New button and fill in the username and password fields at a minimum.



The image shows a 'New User' dialog box with a close button (X) in the top right corner. It contains the following fields and options:

- User Role: Radio buttons for 'User' and 'Admin'.
- First Name: Text input field.
- Last Name: Text input field.
- Username: Text input field.
- Title: Text input field.
- Phone Number: Text input field.
- Company: Text input field.
- Email Address: Text input field.
- Password: Text input field.
- Retype password: Text input field.

At the bottom right, there are two buttons: 'Cancel' and 'Add'.

When modifying or deleting a user, click in the radial button next to the desired user to select them, then click either Modify or Delete to complete this task.

<input checked="" type="radio"/>	olduser				User
----------------------------------	---------	--	--	--	------

Utilities

The tabs within the Utilities screen provide some advanced tools that are only available to an Admin level login. Three tabs are always available on the Utilities page: Relays, Upgrade, and System. On these tabs, the Administrator can perform functions such as manually toggling the relays, upgrading the system software and firmware, stopping and starting system services, initiating a system software reboot, and configuring the time/date, recording interval and Ethernet port settings.

When the optional Analog Output Module (1015-315) accessory has been purchased, a fourth tab, Analog, will be present on the Utilities to allow the user to configure and test the analog output module.

Relay Test Tool

Located on the Relay tab, the relay test tool provides a means for the user to test the system relays manually. This is useful during factory testing and commissioning to validate that the wiring is correct back to the transformer control cabinet or customer SCADA system.



WARNING: Use of this tool will physically toggle the state of the associated relay. Ensure all circuits connected to the relays are in a safe state prior to use to avoid any unintended consequences.

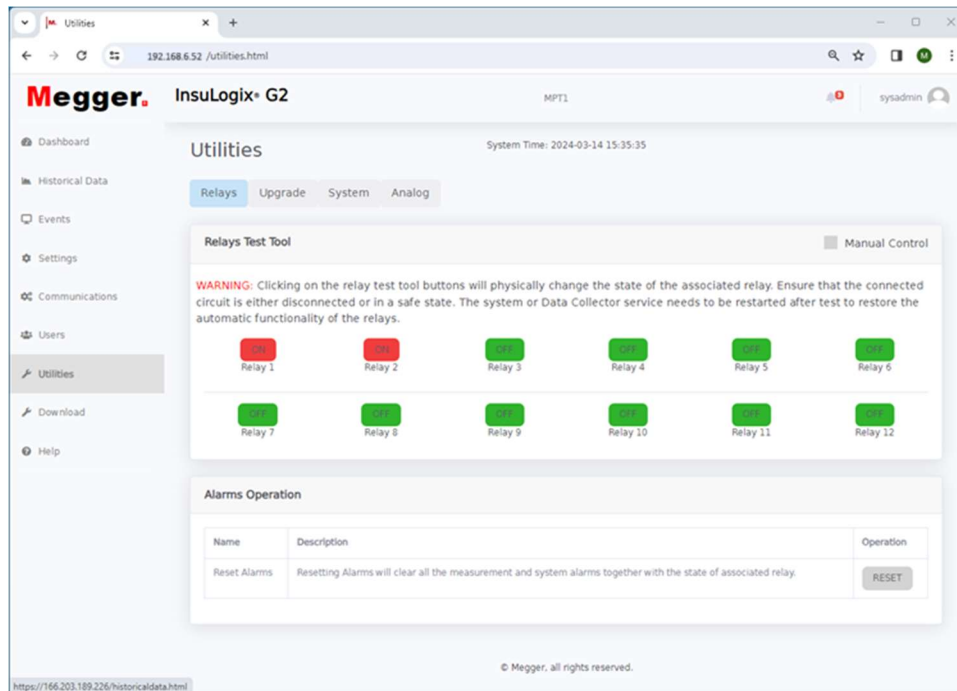


Figure 5-15: Relay Test Tool

To change the state of a relay, click on the associated ON/OFF button. The relay will physically change state and the indicator on the UI will update as well. Once a relay is toggled using this tool, the Manual Control indicator will turn red indicating to the user that the relays are in Manual mode. It is necessary to restart the Data Collector on the Utilities>System screen following use of this tool to return the relays to Auto mode where they will be driven by the threshold logic.

The measurement alarms on the monitor will automatically reset if the measured values fall below the threshold settings, however system alarms will not. To reset all alarms and relays, click on the Reset button in the Alarms Operation window at the bottom of the Relays page. If an alarm condition still exists, the associated alarm will trigger again once the alarm delay period has expired.

Software/Firmware Upgrade Utility

As enhancements are made throughout the life of the monitor, system software and firmware updates will be released by Megger periodically. Using the Upgrade tab on the Utilities page, the Administrator can upgrade the system software and/or firmware using the encrypted upgrade files supplied by Megger.

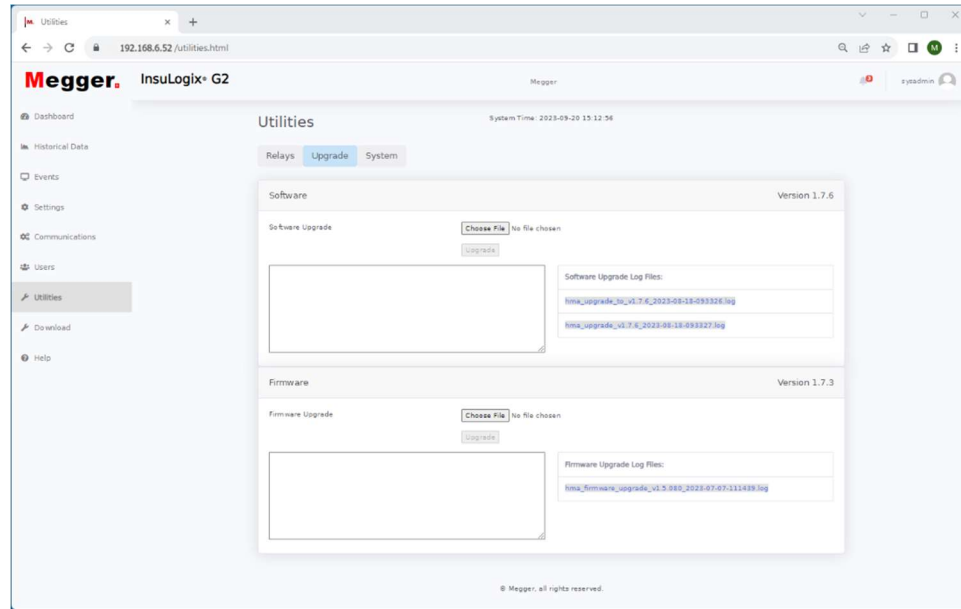
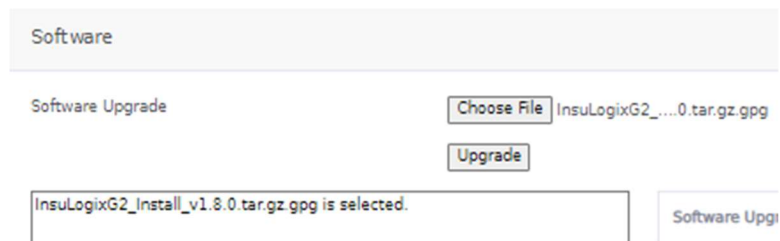
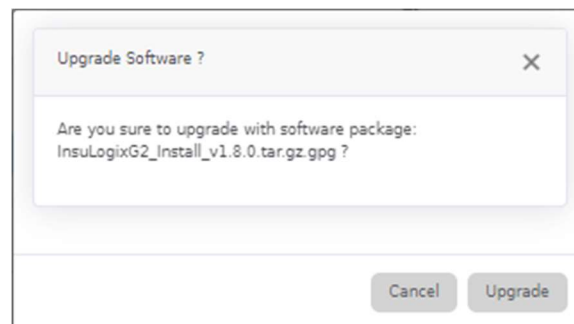


Figure 5-16: Software/Firmware Upgrade Utility

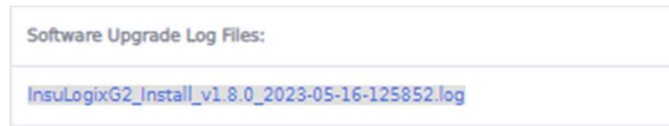
To perform an upgrade, click on choose file for the type of upgrade you are performing (software or firmware). A Windows Explorer pop-up will appear allowing you to select the encrypted upgrade file from your laptop. Once selected, the file name will appear beside the Choose File button and in the progress window for that upgrade.



Click the Upgrade button to start the selected upgrade. A pop-up window will appear asking for confirmation to begin the upgrade.



Click the Upgrade button on the pop-up to proceed. Upgrading the monitor should take < 2 minutes. Once the upgrade has completed, an upgrade log file will be created and will appear in the log file window on the right side of the screen.



Each upgrade package will come with a Release Notes document that will provide step by step instructions on how to perform the upgrade and what step shall be taken following the upgrade (i.e., reboot unit, restart a certain service, etc.)

It is always best to review the log file following an upgrade and search for the word “Error” to ensure that there were no issues with the upgrade.

System Utilities

System settings such as date/time, data recording interval, Ethernet port settings, and G2 services are all found on the System tab.

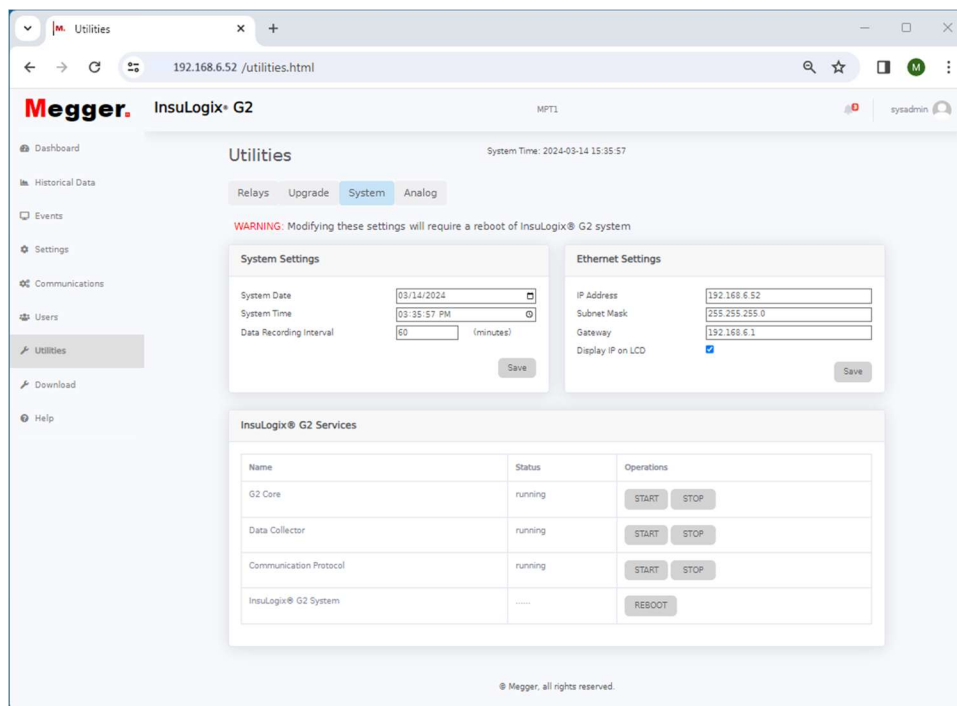
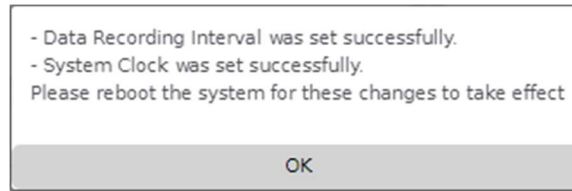
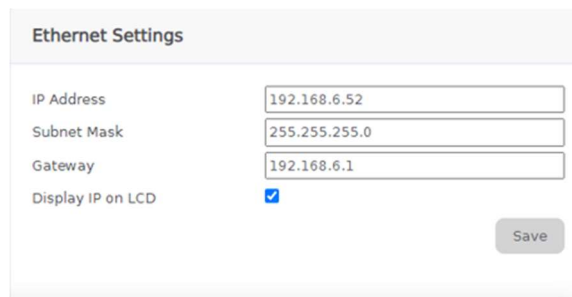


Figure 5-17: System Utilities

In the System Settings section, there are fly outs for System Date and System Time as well as a data entry field for the Data Recording Interval. The G2 will need to be rebooted, per the pop-up below, if any of these parameters are modified once save is pressed.



On the right side of the System tab, the current Ethernet settings are displayed and can be modified if desired. The checkbox at the bottom of the window controls whether the IP address is displayed on the front panel of the monitor. The default state of this setting is enabled.

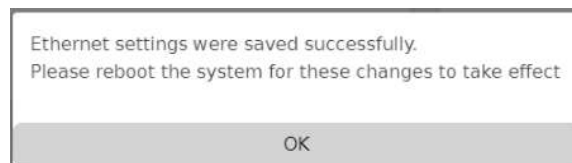


Ethernet Settings

IP Address: 192.168.6.52
Subnet Mask: 255.255.255.0
Gateway: 192.168.6.1
Display IP on LCD:

Save

As was the case with the System Settings, if any changes are made to the Ethernet Settings, the G2 must be rebooted.



Note: In the event that an invalid address is entered for any of the Ethernet port settings, an error message will be displayed alerting the user to the issue. These settings cannot be saved to the monitor with an invalid value in one of these fields.



As a step in an upgrade or when directed by Megger support, a service or the InsuLogix G2 system, may need to be restarted. This is done using the Stop and Start buttons for the services or the Reboot button for the entire system.

InsuLogix® G2 Services		
Name	Status	Operations
G2 Core	running	START STOP
Data Collector	running	START STOP
Communication Protocol	running	START STOP
InsuLogix® G2 System	---	REBOOT

Analog Utilities

When the optional 4 channel analog output module has been purchased with the InsuLogix G2, the Analog tab will be visible. Here, the user can configure the analog outputs of the system by adjusting the Min and Max current and Max engineering scale values. Engineering scale values are shown in ppm.

Each output channel can be tested by setting the Output (mA) Min value to the desired signal level and pressing the Save button in the lower right corner of the screen. Once testing is completed, remember to reset the Min values to the desired level, typically 4 mA.

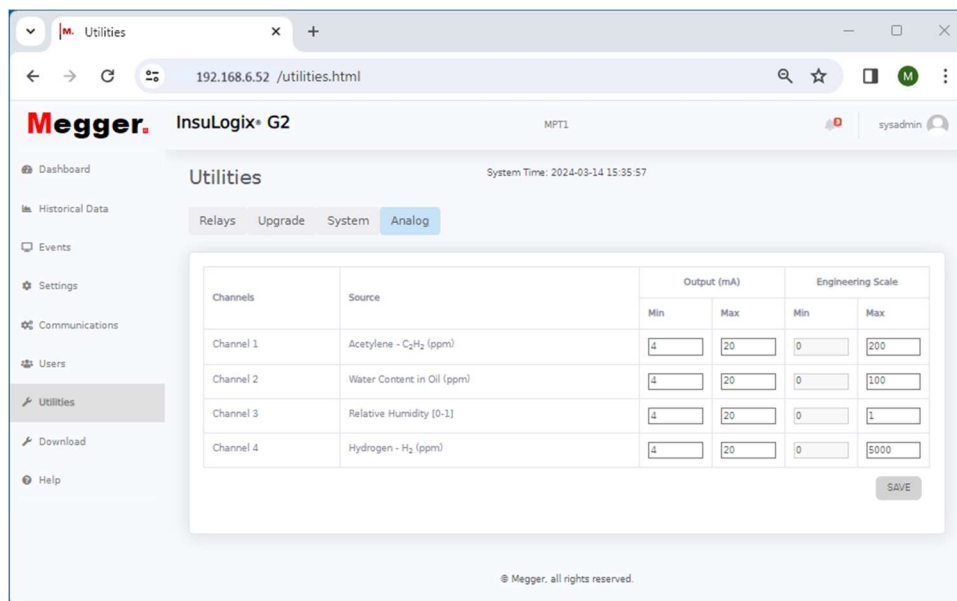


Figure 5-18: Analog module configuration

Download

The Download screen provides a set of functions to download various logs and databases from the unit that are helpful in the debugging process should an issue arise with the system. These are Software Logs, Configuration, and the System Database. Additionally, a user level login can download the IEC 61850 .icd file (only available if IEC 61850 is enabled on the system), which can then be uploaded into an RTU or other master device to facilitate integration of the G2 into the substation network.

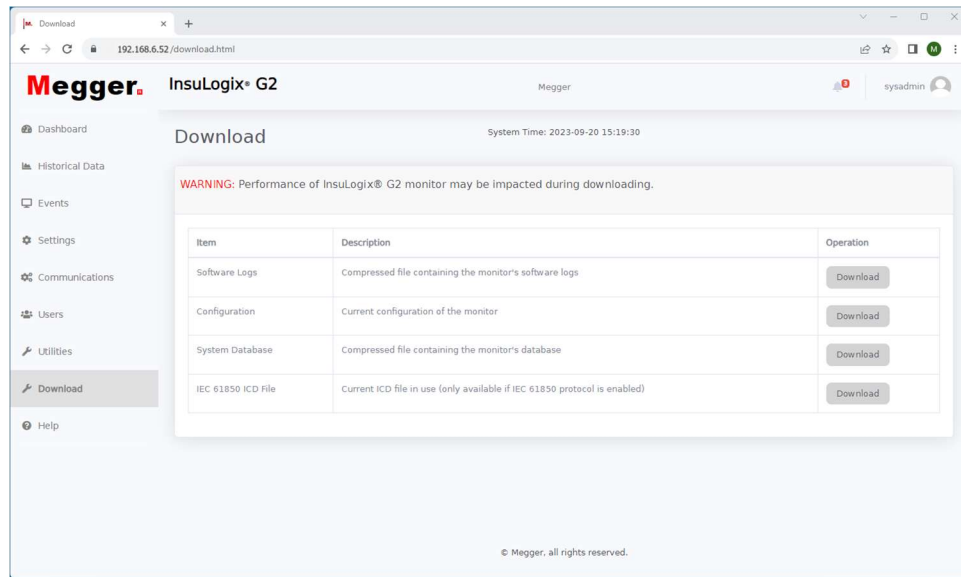


Figure 5-19: Download Screen

Help

The help screen contains the latest version of this manual in its entirety, eliminating the need to carry a hardcopy to site.

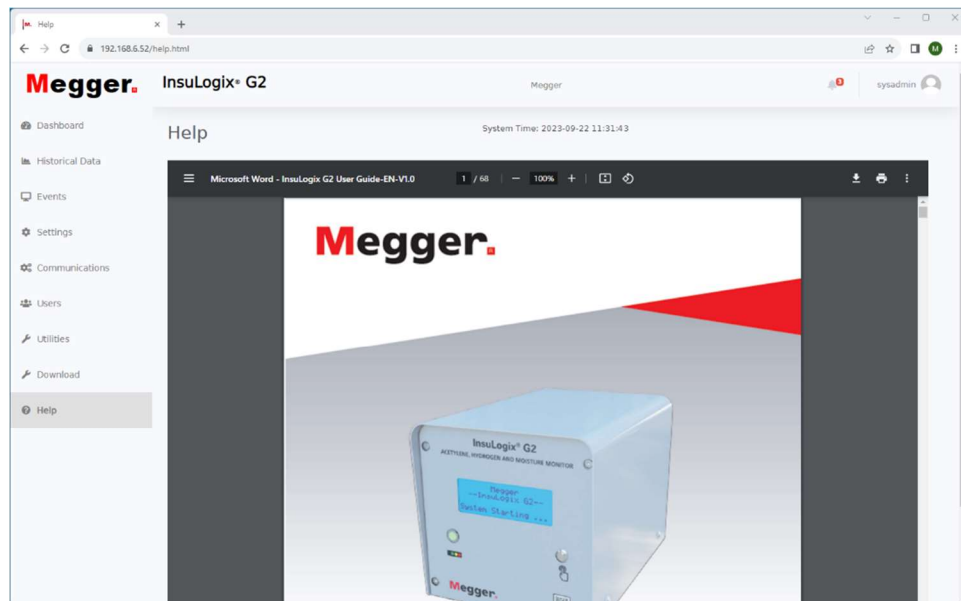


Figure 5-20: Help Screen

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TROUBLESHOOTING

The Troubleshooting Guide is arranged to help you evaluate the reasons for G2 system malfunction. The table lists possible malfunctions which may be encountered during operation and lists possible causes. Electronic circuit repairs should not be attempted in the field.

MALFUNCTION	POSSIBLE CAUSE
Unit is not communicating or responding	<ul style="list-style-type: none"> ▪ No input power. ▪ Defective line cord. ▪ Defective fuse(s). ▪ Defective display or electronics. ▪ Ambient temperature outside of LCD operating temperature (< -15 °C)
Unit is “stuck” in heating mode	<ul style="list-style-type: none"> ▪ Defective LGD <p>* - Confirm unit is not simply in Cold Start Mode. See section 4 “Operation” for more information.</p>
Unit is not sending protocol data	<ul style="list-style-type: none"> ▪ Bad communication cable ▪ Disconnected communication cable ▪ Outstation ID set incorrectly ▪ Connection Type set incorrectly ▪ Incorrect Communication Protocol selected

Troubleshooting

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ORDERING INFORMATION

ORDERING INFORMATION	
Item (Qty)	Cat. No.
Online DGA InsuLogix G2	1015-313
Included Accessories	
Oil sample port quick connector with 25 cm (10 in) tubing	1015-318
Oil port sample tubing 61 cm (24 in)	2016-324
Modbus Protocol (RTU & TCP)	Included in unit
IP67 rear panel Ethernet connector	1015-317
User Manual, electronic version only	Included in unit
Optional Accessories	
DNP3 Protocol	1015-314
IEC 61850 Protocol	1015-316
Analog output module	1015-315
Mounting hardware kit (Union + Nipple, 1.5 in)	1015-565
Sunshade kit – G2	1015-561
G2 Extended Warranty/year (2-year included) (3 Additional years maximum available)	Y12-WARRANTY-G2
	Y24-WARRANTY-G2
	Y36-WARRANTY-G2

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SERVICE

Maintenance

Maintenance should be performed only by qualified persons familiar with the hazards involved with high-voltage test equipment. Read and understand Section 2, *Safety*, before performing any service.

No routine maintenance is required for the InsuLogix G2 components, however periodic inspection of the cabling/conduit connections is recommended to ensure that their integrity has not been compromised.

The appearance of the G2 can be maintained by occasionally cleaning the cover, front panel and cables/conduits.

1. Clean the cover of the monitor with detergent and water. Dry with a clean, dry cloth.
2. Clean the front control panel with a cloth dampened with detergent and water. Polish with a soft, dry cloth, taking care not to scratch the display screen cover.
3. Clean the cables/conduits and mating panel receptacles with isopropyl or denatured alcohol applied with a clean cloth.

Fuse Replacement

The electronic circuits in the G2 online monitor are protected by two fuses, one for the input power and one for the output of the DC power supply. Fuse replacement may be indicated if the monitor does not function. Refer any fuse replacement to qualified personnel. Please consult the manufacturer for proper replacement fuses to avoid electric shock and fire hazard.



WARNING

Before replacing the fuses, disconnect the power input from the live power source.

To replace a fuse, proceed as follows:

1. Ensure that input power circuit has been de-energized (i.e., circuit breaker off, fuse pulled, etc.)
2. Remove the cover of the monitor using a 1/8" Allen wrench to remove the 4 screws.
3. Using a small flathead screwdriver, carefully remove the cover from the fuse holder
 - a. The input power board fuse is installed on the G2's right side.
 - b. The DC power supply output is located on the main board. It is necessary to remove the front panel from the monitor to access this and therefore shall only be performed by a Megger representative.
4. Remove and properly dispose of blown fuse(s).
5. Install new fuse(s) making sure to use the type specified by the manufacturer.
6. Reinstall the fuse holder in its receptacle and reattach the front panel if it was removed.
7. Reenergize the input power circuit to the G2 monitor and confirm unit powers as expected. If the unit still does not function properly, contact the factory for service.
8. Replace the cover of the monitor and secure it with the four (4) Allen screws.

Filter Replacement

In the event that the filter in the unit becomes clogged, it may be necessary to replace the internal element of the filter. This shall be done by qualified personnel only using the following procedure.



Warning: Attempting to blow out the filter in an effort for clean it may result in damage to the component or the introduction of contaminants into the G2 system. Any damage to the system as a result of this act will void the warranty.



Warning: Before replacement, ensure that the air filter is not pressurized.



Warning: After replacement, check for leaks before starting operation of the G2.

1. Disassembly
 - a. Rotate the bowl assembly counterclockwise until it is released from the filter head. If the bowl assembly is tightened too much to be removed, use a hook spanner until it can be loosened by hand.

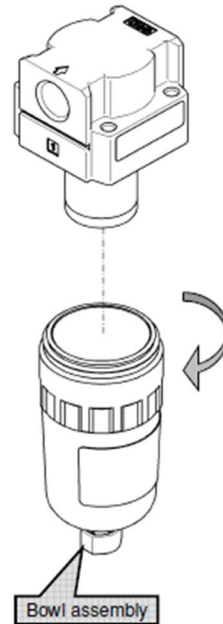


Figure 8-1: Filter bowl removal

- b. Hold the element with a hook spanner and rotate it counterclockwise to remove it.

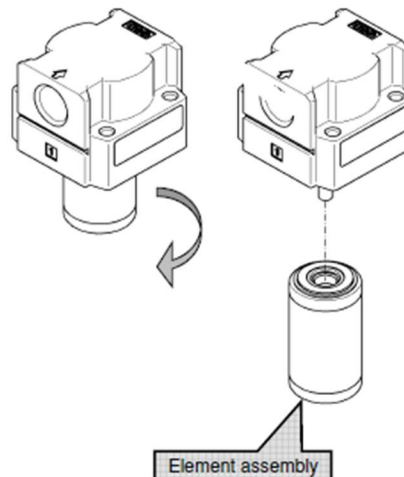


Figure 8-2: Filter element removal

2. Assembly

- a. Hold the element with a spanner to rotate it clockwise to reattach it to the filter head (product). Snug with a tightening torque of $0.49 \text{ N}\cdot\text{m}$ ($4.3 \text{ lbf}\cdot\text{in}$)

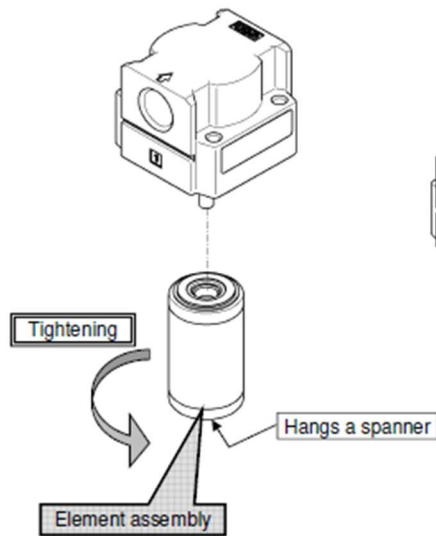


Figure 8-3: Filter element assembly

- b. Rotate the bowl assembly clockwise and secure it to the filter head (product). Hand tightening first, then snug to a tightening torque of $2.1 \text{ N}\cdot\text{m}$ ($18.6 \text{ lbf}\cdot\text{in}$)

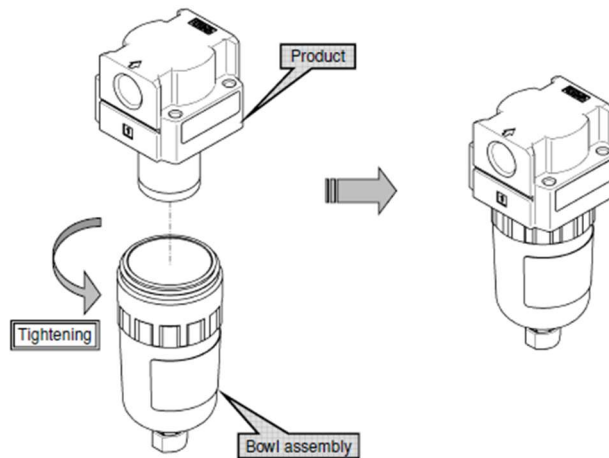


Figure 8-4: Filter bowl assembly

Calibration

The InsuLogix G2 is designed to automatically re-baseline itself once a month. No other calibration is necessary in the field.

Repairs

Any service or repair of this equipment should only be performed by qualified persons who are aware of electrical hazards and the necessary precautions required to prevent injury.

Megger offers a complete Repair Service and recommends that its customers take advantage of this service in the event of any equipment malfunction.

In the event that Service is required, contact your Megger representative for a product Return Authorization (RA) number and shipping instructions.

Ship the product prepaid and insured and marked for the attention of the Megger Repair Department. Please indicate all pertinent information, including catalog number, serial number, and problem symptoms.

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APPENDIX A – COMMUNICATION PROTOCOLS

A1. Modbus

Fields	Info
Default Modbus Slave Address	0x02
Serial Transmission Mode	RTU
Serial Port Settings	Timeout=100ms, Parity=None, Bytesize=8, Stopbits=1
Encoding	Big-Endian
Supported Registers	Holding Registers, Discrete Inputs, and Input Registers
Supported Function Codes	0x02 (Read Discrete Inputs), 0x03 (Read Holding Registers) , and 0x04 (Read Input Registers)
Supported Connection Types	RS485 and TCP

Discrete Inputs (FC2)

Address	Data Access	Data Type	Unit	Description
0	R	Bit		Relay 1: Off = open; On = closed
1	R	Bit		Relay 2: Off = open; On = closed
2	R	Bit		Relay 3: Off = open; On = closed
3	R	Bit		Relay 4: Off = open; On = closed
4	R	Bit		Relay 5: Off = open; On = closed
5	R	Bit		Relay 6: Off = open; On = closed
6	R	Bit		Relay 7: Off = open; On = closed
7	R	Bit		Relay 8: Off = open; On = closed
8	R	Bit		Relay 9: Off = open; On = closed
9	R	Bit		Relay 10: Off = open; On = closed
10	R	Bit		Relay 11: Off = open; On = closed
11	R	Bit		Relay 12: Off = open; On = closed
12	R	Bit		System Alert: Off = Normal; On = Triggered
13	R	Bit		System Alarm: Off = Normal; On = Triggered
14	R	Bit		C2H2 Alert: Off = Normal; On = Triggered
15	R	Bit		C2H2 Alarm: Off = Normal; On = Triggered
16	R	Bit		C2H2 RoC Alarm: Off = Normal; On = Triggered
17	R	Bit		H2 Alert: Off = Normal; On = Triggered
18	R	Bit		H2 Alarm: Off = Normal; On = Triggered
19	R	Bit		H2 RoC Alarm: Off = Normal; On = Triggered
20	R	Bit		%RH Alert: Off = Normal; On = Triggered
21	R	Bit		%RH Alarm: Off = Normal; On = Triggered
22	R	Bit		Moisture ppm Alert: Off = Normal; On = Triggered
23	R	Bit		Moisture ppm Alarm: Off = Normal; On = Triggered
24-30		Bit		Reserved

Holding Registers (FC3)

Address		Data Access	Data Type	Unit	Description
Start	End				
0	1	R	Float	ppm	C2H2 value
2	3	R	Float	ppm/hour	C2H2 Hourly Rate of Change
4	5	R	Float	ppm/day	C2H2 Daily Rate of Change
6	7	R	Float	ppm	H2 ppm
8	9	R	Float	ppm/hour	H2 Hourly Rate of Change
10	11	R	Float	ppm/day	H2 Daily Rate of Change
12	13	R	Float	%RH	Moisture %RH
14	15	R	Float	%RH/hour	Moisture %RH Hourly Rate of Change
16	17	R	Float	%RH/day	Moisture %RH Daily Rate of Change
18	19	R	Float	ppm	Moisture in ppm
20	21	R	Float	ppm	Moisture in ppm Hourly Rate of Change
22	23	R	Float	ppm	Moisture in ppm Daily Rate of Change
24	31				Reserved
32	33	R	Float	°C	Gas cell temperature
34	35	R	Float	°C	Oil temperature
36	41				Reserved
42	43	R	Float	ppm	C2H2 parameter - Gain
44	45	R	Float	ppm	C2H2 parameter - Offset
46	47	R	Float	ppm	H2 parameter - Gain
48	49	R	Float	ppm	H2 parameter - Offset
50	51	R	Float	%RH	Moisture %RH parameter - Gain
52	53	R	Float	%RH	Moisture %RH parameter - Offset
54	61				Reserved
62	63	R	Float	ppm	C2H2 Alert Threshold
64	65	R	Float	ppm	C2H2 Alarm Threshold
66	67	R	Float	ppm	C2H2 Hourly RoC Threshold
68	69	R	Float	ppm	C2H2 Daily RoC Threshold
70	71	R	Float	minutes	C2H2 Alarm Delay
72	73	R	Float	ppm	H2 Alert Threshold
74	75	R	Float	ppm	H2 Alarm Threshold
76	77	R	Float	ppm	H2 Hourly RoC Threshold
78	79	R	Float	ppm	H2 Daily RoC Threshold
80	81	R	Float	minutes	H2 Alarm Delay
82	83	R	Float	%RH	Moisture %RH Alert Threshold
84	85	R	Float	%RH	Moisture %RH Alarm Threshold
86	89				Reserved
90	91	R	Float	minutes	Moisture Alarm Delay
92	93	R	Float	ppm	Moisture ppm Alert Threshold

94	95	R	Float	ppm	Moisture ppm Alarm Threshold
96	101				Reserved

Input Registers (FC4)

Address		Data Access	Data Type	Descriptions
Start	End			
0	9	R	String	Device Serial number
10	19	R	String	Device Firmware version
20	29	R	String	Device Software version
30	39	R	String	Device Manufacturing date
40	49	R	String	Device Installation date
50	59	R	String	Company Name
60	69	R	String	Substation
70	79	R	String	Transformer Name
80	89	R	String	Transformer Serial number

A2. DNP3

Object Group 1 – Binary Input

Point Index	Object	Var	Type	Unit	Description
0	1	1	Bit		Relay 1: 0 = open; 1 = closed
1	1	1	Bit		Relay 2: 0 = open; 1 = closed
2	1	1	Bit		Relay 3: 0 = open; 1 = closed
3	1	1	Bit		Relay 4: 0 = open; 1 = closed
4	1	1	Bit		Relay 5: 0 = open; 1 = closed
5	1	1	Bit		Relay 6: 0 = open; 1 = closed
6	1	1	Bit		Relay 7: 0 = open; 1 = closed
7	1	1	Bit		Relay 8: 0 = open; 1 = closed
8	1	1	Bit		Relay 9: 0 = open; 1 = closed
9	1	1	Bit		Relay 10: 0 = open; 1 = closed
10	1	1	Bit		Relay 11: 0 = open; 1 = closed
11	1	1	Bit		Relay 12: 0 = open; 1 = closed
12	1	1	Bit		System Alert: 0 = normal; 1 = triggered
13	1	1	Bit		System Alarm: 0 = normal; 1 = triggered
14	1	1	Bit		C2H2 Alert: 0 = normal; 1 = triggered
15	1	1	Bit		C2H2 Alarm: 0 = normal; 1 = triggered
16	1	1	Bit		C2H2 RoC Alarm: 0 = normal; 1 = triggered
17	1	1	Bit		H2 Alert: 0 = normal; 1 = triggered
18	1	1	Bit		H2 Alarm: 0 = normal; 1 = triggered
19	1	1	Bit		H2 RoC Alarm: 0 = normal; 1 = triggered
20	1	1	Bit		%RH Alert: 0 = normal; 1 = triggered
21	1	1	Bit		%RH Alarm: 0 = normal; 1 = triggered
22	1	1	Bit		Reserved
23	1	1	Bit		Moisture ppm Alert: 0 = normal; 1 = triggered
24	1	1	Bit		Moisture ppm Alarm: 0 = normal; 1 = triggered
25-30	1	1	Bit		Reserved

Object Group 30 – Analog Input

Point Index	Object	Var	Type	Unit	Description
0	30	5	Float	ppm	C2H2
1	30	5	Float	ppm/hour	C2H2 Hourly Rate of Change
2	30	5	Float	ppm/day	C2H2 Daily Rate of Change
3	30	5	Float	ppm	H2
4	30	5	Float	ppm/hour	H2 Hourly Rate of Change
5	30	5	Float	ppm/day	H2 Daily Rate of Change
6	30	5	Float	%RH	Moisture %RH
7	30	5	Float	%RH/hour	Moisture %RH Hourly Rate of Change
8	30	5	Float	%RH/day	Moisture %RH Daily Rate of Change
9	30	5	Float	ppm	Moisture in ppm
10	30	5	Float	ppm	Moisture in ppm Hourly Rate of Change
11	30	5	Float	ppm	Moisture in ppm Daily Rate of Change
12-15	30	5			Reserved
16	30	5	Float	°C	Gas cell temperature
17	30	5	Float	°C	Oil temperature
18-20	30	5			Reserved
21	30	5	Float	ppm	C2H2 parameter - Gain
22	30	5	Float	ppm	C2H2 parameter – Offset
23	30	5	Float	ppm	H2 parameter - Gain
24	30	5	Float	ppm	H2 parameter - Offset
25	30	5	Float	%RH	Moisture %RH parameter – Gain
26	30	5	Float	%RH	Moisture %RH parameter - Offset
27-30	30	5			Reserved
31	30	5	Float	ppm	C2H2 Alert Threshold
32	30	5	Float	ppm	C2H2 Alarm Threshold
33	30	5	Float	ppm	C2H2 Hourly RoC Threshold
34	30	5	Float	ppm	C2H2 Daily RoC Threshold
35	30	5	Float	minutes	C2H2 Alarm Delay
36	30	5	Float	ppm	H2 Alert Threshold
37	30	5	Float	ppm	H2 Alarm Threshold
38	30	5	Float	ppm	H2 Hourly RoC Threshold
39	30	5	Float	ppm	H2 Daily RoC Threshold
40	30	5	Float	minutes	H2 Alarm Delay
41	30	5	Float	%RH	Moisture %RH Alert Threshold
42	30	5	Float	%RH	Moisture %RH Alarm Threshold
43-44	30	5			Reserved
45	30	5	Float	minutes	Moisture Alarm Delay
46	30	5	Float	ppm	Moisture ppm Alert Threshold
47	30	5	Float	ppm	Moisture ppm Alarm Threshold
48-50	30	5			Reserved

Object Group 110 – Octet String

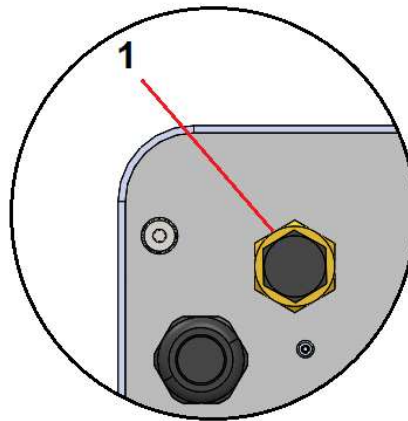
Point Index	Object	Type	Description
0	110	String	Device Serial number
1	110	String	Device Firmware version
2	110	String	Device Manufacturing date
3	110	String	Device Installation date
4	110	String	Company Name
5	110	String	Substation
6	110	String	Transformer Name
7	110	String	Transformer Serial number

APPENDIX B – OIL SAMPLING INSTRUCTIONS

Note: The act of oil sampling is not dependent on the monitor being in a certain mode. It may be done at any time when the transformer valve is open and site conditions allow for this task to be done safely.

Steps to be done before sampling, as referenced in D923 ASTM standards:

- Sample should be collected when the relative humidity is below 50% and there is no rain or snow
- Inspect for visual leaks and any unsafe situation in the work area
- Adequately protect the area from spillage by the use of such measures as oil absorbent pads and catch pans
- Do not sample the unit while under negative pressure

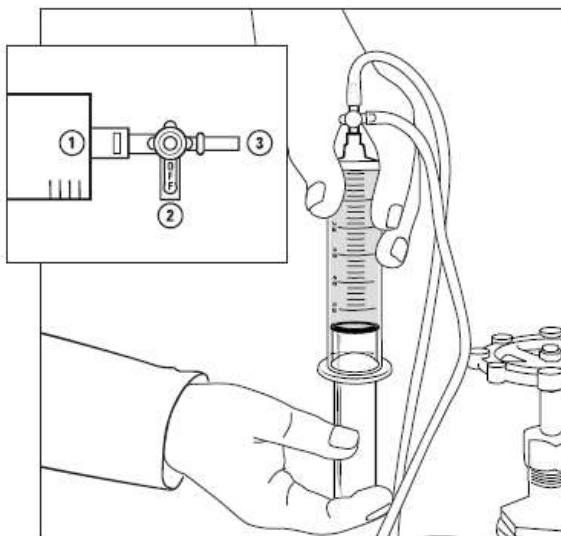


Item	Type	Comments
1	Sample/Purge Valve	High Flow L Valve, 1/4" – 18 NPTF

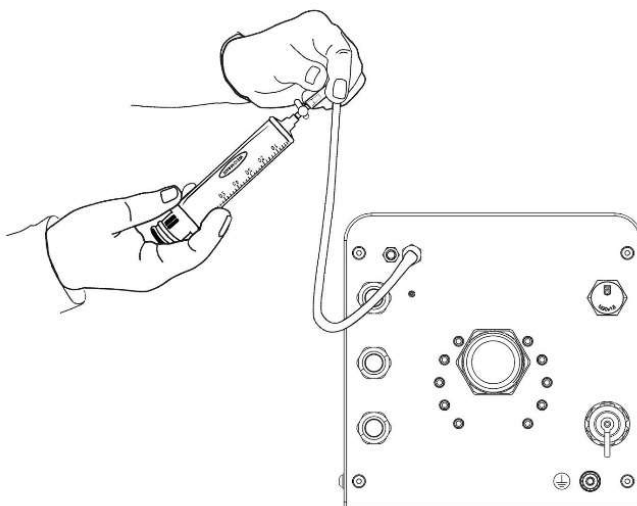
1. Connect a piece of 1/4" ID tubing to the barb fitting of the supplied LT Sample Probe.



2. Connect the other end of the tubing to fitting on the syringe's 3-way stopcock that is opposite the syringe itself. See position 3 in the illustration in step 3.
3. Another piece of tubing can be connected to the side exit (position 2) from the 3-way stopcock for easy draining.



4. Unscrew the cap on the sample/purge valve on the back panel of the InsuLogix G2. The cap is tethered to the valve by a small chain to prevent loss or contamination of the cap.
5. Using an oil pan to catch any drips, with the handle of the stopcock closed (handle towards position 1), screw the LT sample probe into the sample valve enough to allow oil to flow and flush the system. Allow at least 600 mL (20 oz) of oil to flow out and ensure there are no longer any bubbles.



6. Turn the stopcock slowly to the open position (handle towards position 2 in inset). Fill the syringe slightly past the last demarcation. Turn the stopcock so that the handle points directly away from the syringe (handle pointing towards position 3 in diagram), drain the

oil from the syringe making sure to expel any air bubbles present. Turn the stopcock again to the open position and allow the liquid to fill the syringe to the last demarcation. Close the stopcock (handle pointing towards position 1 in inset).

7. Remove the LT sample probe from the sample/purge valve on the InsuLogix G2 to stop the flow of oil and disconnect the syringe from the tubing.
8. Next, to fill a sample bottle, hold the bottle so that the liquid will run down the inside of the container and limit aeration of the liquid. Partially fill the sample bottle 2 to 3 times, and gently swirl the liquid. Discard the liquid after each rinse. Obtain the sample for evaluation by allowing the liquid to flow down the sides of the container or from the bottom up, filling the bottle to the bottom of the neck threads.

Properly identify both syringe and bottle on the AVO Diagnostics Solutions Sample Data Sheet available on the AIM Portal.

9. Remove the tubing and wipe down the assembly with a clean rag to remove any and all oil from the exterior of the piping, purge port, and back panel of the monitor.