Detailed Instructions

GasFinder3-MC with In-Line (ILX) Probe Assembly

Installation, Commissioning, Preventative Maintenance, & Support

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Revision	Date
Release	July 23rd 2020
Revision	January 21st 2021

Quick Introduction to the Equipment:

GasFinder3-MC (Multi-Channel):

Field Mounted Analyzer

GasFinder3-MC shown with four (4) Open Path (OPX) Head Assemblies

Use in Hazardous Area Applications
(A)Ex ib IIC T5 Tamb <70°C Gb (C1 Div1, G: A,B,C,D)

Up to Four (4) Measurement Heads
Can be connected to One (1) GasFinder3-MC

Dual Gas Capability
Two (2) Lasers for independent gas analysis

Up to 300m (1,000 ft) Cable Lengths
For connecting to the Measurement Heads

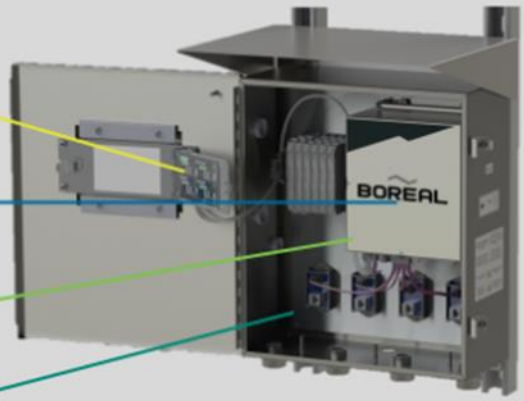
Ease of Integration

HMI Touchscreen
Provides local indication and user interface

Laser Analyzer Module
Designed for easy service, upgrade or replacement

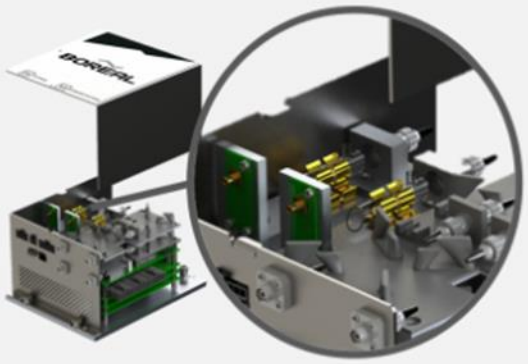
USB Accessible Data Storage
Store & access +20 years worth of generated data

Measurement Head Terminals
Fibre Optic (FC/APC) & CAT6/5e (RJ45) Connectors



Simple design means that this is easily installed by Instrument & Electrical Technicians

Internal Reference Cell



Internal Reference Cell is interrogated once every minute

Fail Safe Design + SIL2 Suitable
Diagnostics with no undisclosed failure modes

Essentially Zero Measurement Drift
Laser remains locked on desired absorption line

No Field Calibration
There is no field calibration required or available

No Field Intervention
Adjustments done autonomously & automatically

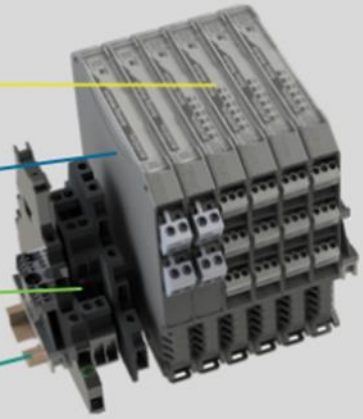
Power + Communication Options

Up to Four (4) Relay Modules
Six (6) Voltage Free Dry-Contact Relays per Module

Up to Two (2) Analog Modules
Four (4) HART 7 (via 4-20mA) Loops per Module

MODBUS via RS-485
Access to all sample and diagnostic data

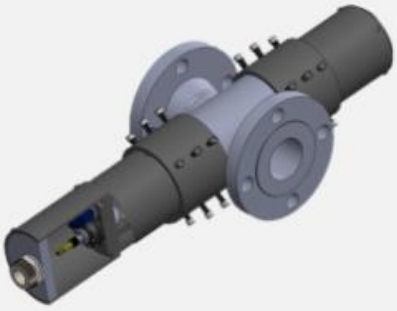
Power + Cartridge Fuse
24 VDC @ 20 Watts with 5x20 mm, 4A, Fast Fuse



Modular design means customized I/O options

In-Line (ILX) Probe Assembly:

Enhanced Sensing Element



In-Line (ILX) Probe shown with 3" 150# RF Flange Bolt-Up Arrangement

Direct + Non-Contact Measurements
No sensor poisoning and fouling

Fast Speed of Response + Recovery
New and independent result every single second

No Calibration + No Intervention
Due to the GasFinder's Internal Reference Cell

Fail Safe Operation + SIL2 Suitable
Diagnostics with no undisclosed failure modes

Where and Why is it Used?

Thrives Where Others Do Not Survive
Ideal for challenging monitoring applications

Need for Enhanced Performance
Early detection and rapid intervention saves lives

Operational Cost Savings
Low maintenance burden and no consumables

Use in Hazardous Area Applications
(A)Ex ib IIC T5 Tamb <70°C Gb (C1 Div1, G: A,B,C,D)

In-Line (ILX) Probe Assembly with Cable Lengths from 5-300m (15-1,000 ft)

About Tunable Diode Laser (TDL)

Target Gas Molecules shown passing through the Active Measurement Path of the In-Line (ILX) Probe

Laser Light is the Sensing Element
Class 1 Eye Safe: Near Infrared (NIR) laser light

This Counts the Target Gas Molecules
As the pass through the Active Measurement Path

Quantifiable Volumetric Result
Confirmation of both gas type and concentration

No Interference + No False Alarms
This only detects the specific target gas of interest

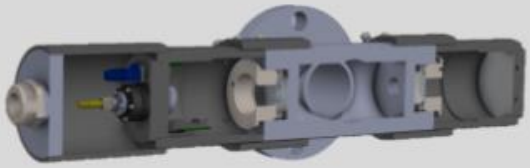
Transceiver Configuration

Form the Active Measurement Path
Within the In-Line (ILX) Probe

Lower Detection Thresholds
Doubling the path length enables lower detection

Superior Tolerance to Vibration
Vibration helps to integrate and quiet the analysis

High Laser Power + Tight Collimation
Optimized for use in short/long path applications



Cross Sectional View of the Transceiver within the Extractive Insertable (IPX) Probe

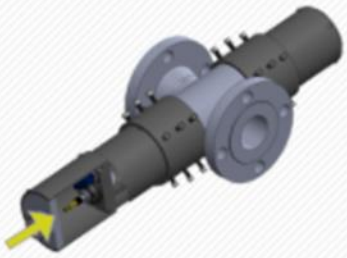
How the In-Line (ILX) Probe Assembly Works

Step-by-step explanation of the Measurement Head functionality

Laser Light is generated from the Laser Analyzer Module.

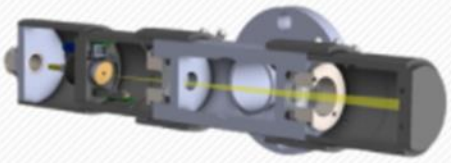
The Laser Light travels to the ILX Probe via Fiber Optic Cable.

The Fiber Optic Cable is connected in the In-Line (ILX) Probe.



The Laser Light is Collimated and Launched from the Optical Bench.

The Collimated Laser Beam enters the Retro-Array.



The Retro-Array returns the Laser Light back to the Optical Bench.

Any Target Gas Molecules present in the Laser Beam are “counted”.

The Collecting Optics focus the Laser Light on the Photodiode.

The Photodiode converts the Laser Beam to a small electrical signal.

Shielded CAT6/5e Cable carries the electrical signal to the GasFinder.

CAT6/5e Cables are landed in the GasFinder and performs its analysis.

The Data is then communicated via HART 7, Relays Outputs, & MODBUS.

Installation

While best efforts were made during the specification of this device, it is important to doublecheck to ensure that the GasFinder3-MC Assembly is suitable for use for the area of installation.

1. Area Classification: There are two options available for the GasFinder3-MC

    a. General Purpose: While the enclosure has a NEMA 4X and IP 66 protection rating this is not suitable for use in a Hazardous Area.

    b. Hazardous Area: If the GasFinder3-MC has the appropriate certification markings on the outside of the enclosure and Zener Barriers installed then the analyzer is suitable for use for Class 1 Div/Zone 2 IIC (Groups A,B,C,D), T5.

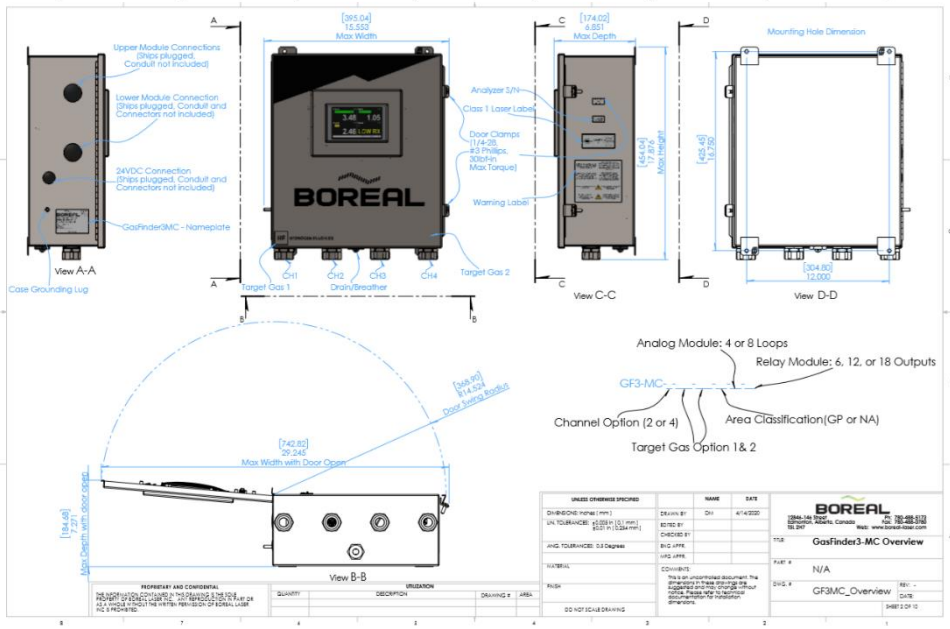
2. Environmental Conditions: The GasFinder3-MC can be mounted in locations that have an ambient temperature range from -55 to 65C
    a. If the ambient temperature is close to 60C and the GasFinder3-MC will be exposed to direct sunlight, it is recommended that a sunshade be installed to minimize the radiant heat exposure on the enclosure.

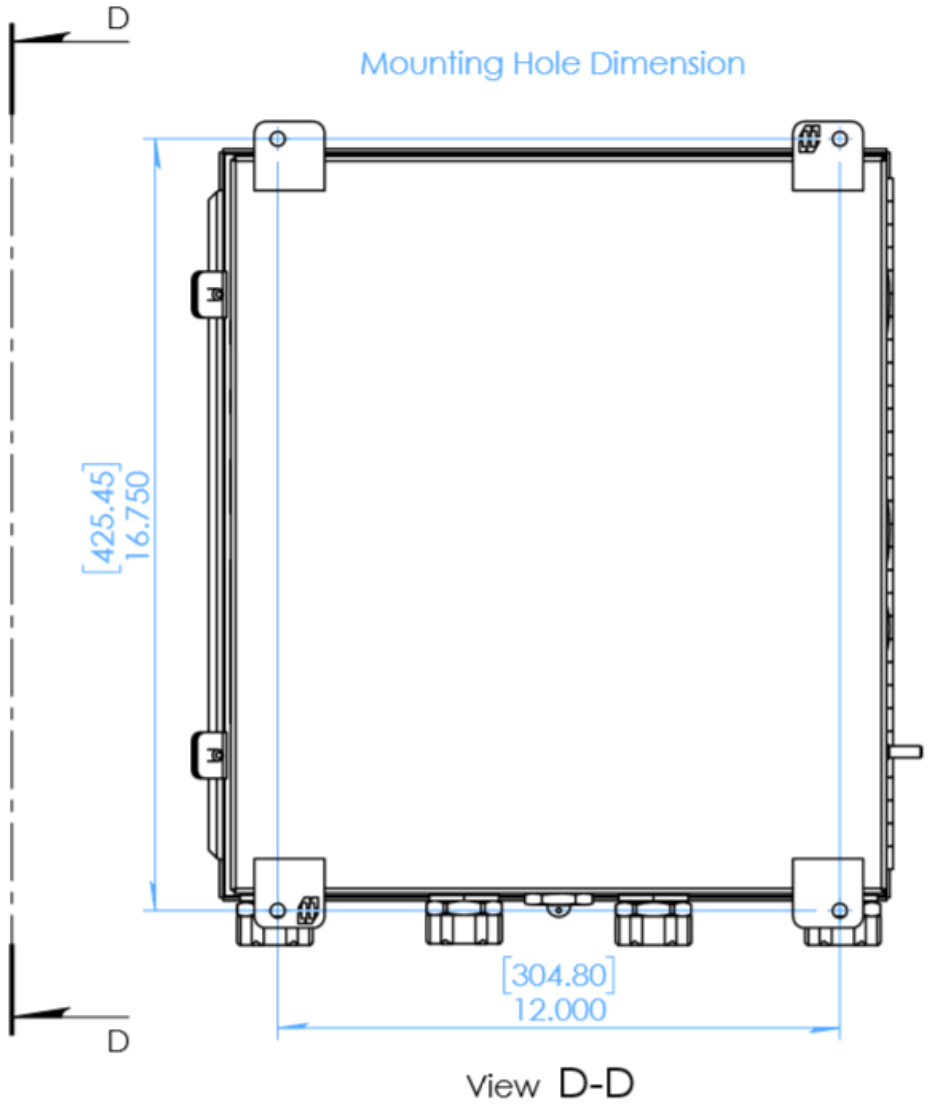
While best efforts were made during the design and equipment configuration selection, it is important to ensure that the In-Line (ILX) Probe Assembly is suitable for use within the desired environment:

1. Area Classification: The In-Line (ILX) Probe Assembly is for general purpose areas only.

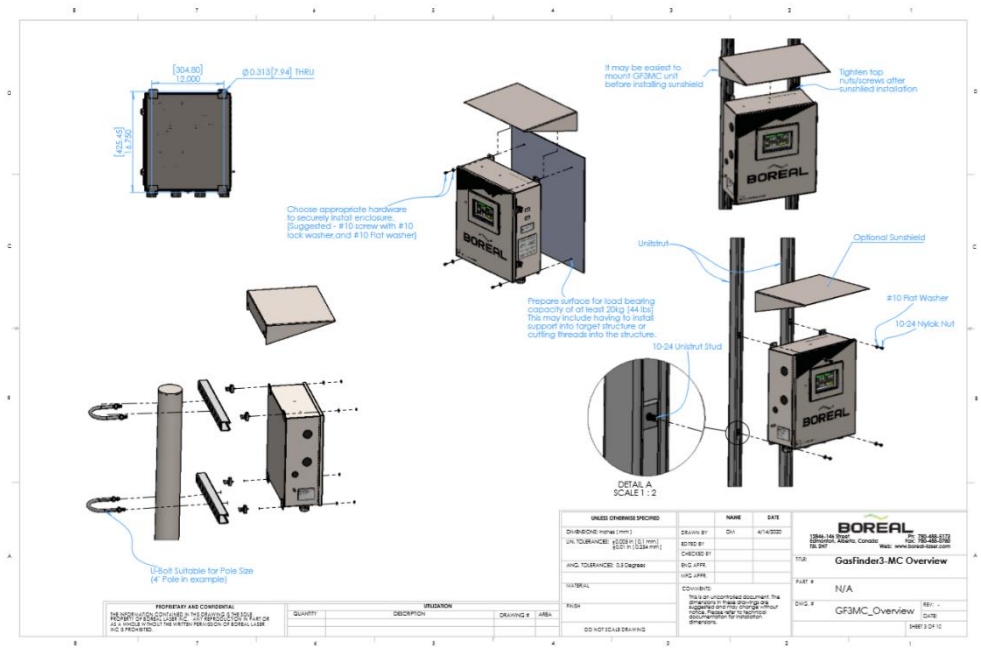
2. Environmental Conditions: The In-Line (ILX) Probe can be mounted in locations that have an ambient temperature range from -55 to 70C.

Below are the installation instructions for the installation of a GasFinder3-MC and an In-Line (ILX) Probe Assembly:

Installation Step	Description
Unbox GasFinder3-MC Assembly, In-Line (ILX) Probe Assembly, and any Accessories	1. Ensure that all equipment ordered and shipped has been received 2. Visually inspect equipment for damage during shipment Make note of any large or obvious damage on the external cardboard shipping container before unpacking the instrument. Report any damage to the freight carrier and Boreal Laser and photographically document the damage. 3. If time and space permits, most customers like to assemble, power-up, and test the equipment within the shop before assembling the equipment in the field a) The GasFinder3-MC should be placed on a flat surface for inspection b) Check for any large dents or deformities in the instrument enclosure
Review General Arrangement Drawings for GasFinder3-MC Enclosure	 **Note:** For additional detail, please reference the following document "General Arrangement – GasFinder3-MC with In-Line (ILX) Probe Assembly.pdf" and "Instrument Data Sheet – GasFinder3-MC with In-Line (ILX) Probe Assembly.pdf".

Confirm Mounting Requirements	The GasFinder3-MC can be mounted anywhere in a facility where there is a need to monitor ambient gas concentrations, provided the area falls under Class 1 Zone 2 classification. The system is intended to mount to a solid structure or Unistrut metal framing in a vertical orientation. In hot climates care should be made to locate the instrument out of direct sunlight or use the Boreal Laser Sunshade accessory (Part # BL-DCSS). Mount the GasFinder3-MC a suitable distance away from adjacent equipment to allow for conduit routing and access. Ensure there is sufficient space in front of the analyser in order to allow for operation and maintenance. 

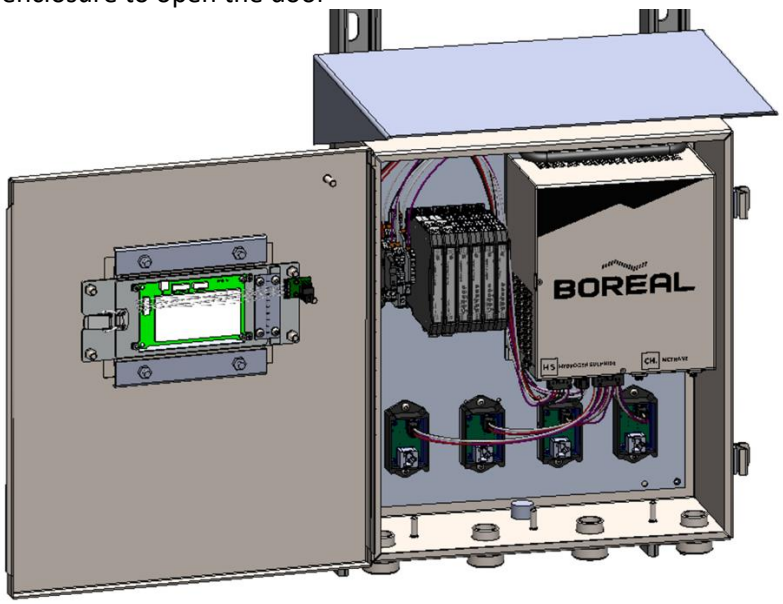
	Note: For additional detail, please reference the following document "General Arrangement – GasFinder3-MC with In-Line (ILX) Probe Assembly.pdf" and "Instrument Data Sheet – GasFinder3-MC with In-Line (ILX) Probe Assembly.pdf". Four 5/16" (7.94 mm) diameter through-holes are provided for mounting the GasFinder3-MC analyser. They are located on each of the four corners of the enclosure. The net weight of the analyser is 14.6 kg (32.2 lbs). Additional information about the net weight of the GasFinder3-MC is available in Section 1, Physical Data. Ensure that the bolt size used to mount the GasFinder3-MC analyser is capable of supporting up to 4 times the net weight (59 kg or 130 lbs).
Vertically Mount GasFinder3-MC Enclosure and Sunshade as per the figure below.	1. Select a suitable location to mount the instrument. 2. Locate mounting holes on all four corners of the instrument. The bottom two holes may be partially obscured from vision by the conduits. 3. Mark the center of the top two mounting holes of the instrument on the wall or framing. For metal framing, ensure that the hole spacing of the instrument lines up with the openings in the metal framing. 4. Drill the mounting holes. 5. Hold the GasFinder3-MC in place and fasten with the top screws. a. Note: May require two persons for this step. 6. Repeat the process above for the bottom two mounting holes. The GasFinder3-MC can weight up-to 14.6 kg (32.2 lbs) and it is important that the mounting structure and mounting hardware can support this weight.

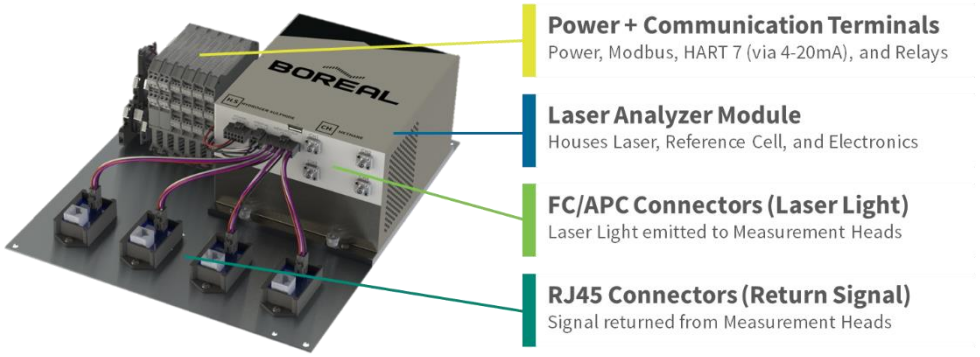
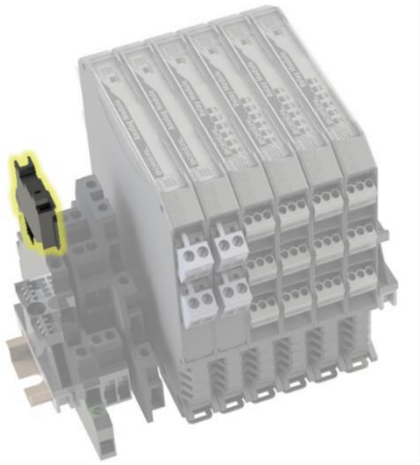


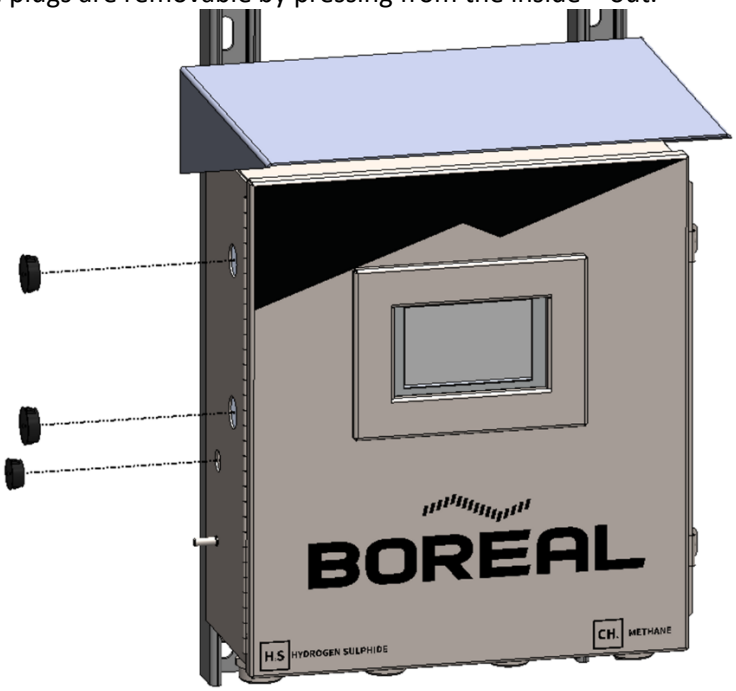
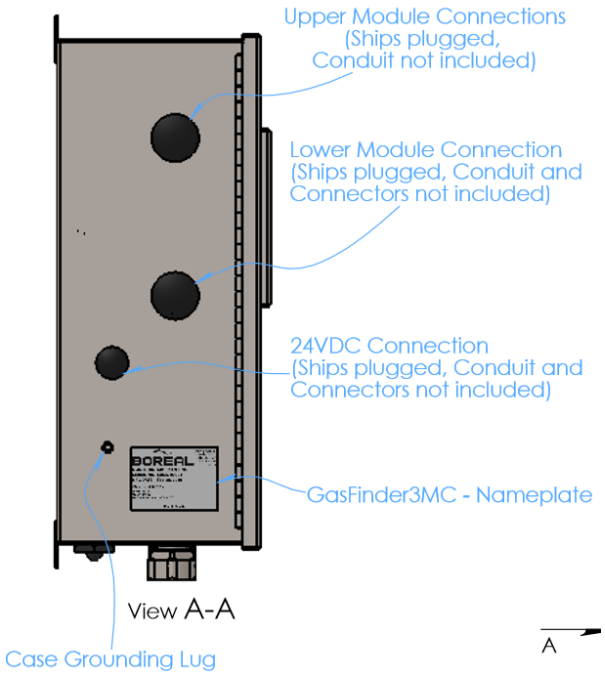
Note: For additional detail, please reference the following document “General Arrangement – GasFinder3-MC with In-Line (ILX) Probe Assembly.pdf” and “Instrument Data Sheet – GasFinder3-MC with In-Line (ILX) Probe Assembly.pdf”.

Open the GasFinder3-MC Enclosure.

With a flathead or phillips screwdriver, loosen the two screws on the right hand side of the enclosure to open the door



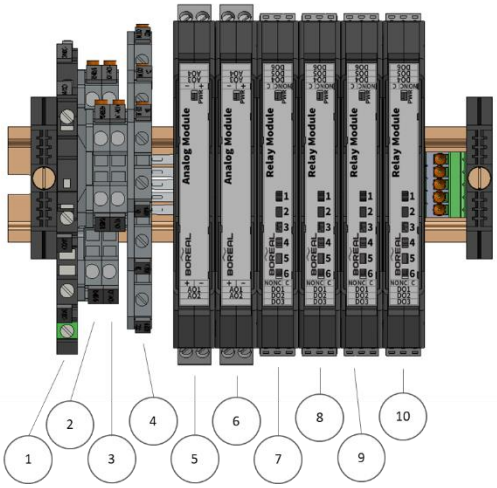
Familiarize yourself the with layout.	There four main areas within the inside of the GasFinder3-MC Enclosure: Power + Communicaiton, Laser Analyzer Module, FC/APC Fibre Connections, and the RJ45 CAT6 Connectors. 
Remove Fuse	As a best practice, we recommend removing the fuse while the installation of power, communication, and measurement head wires/cabling is being performed.  **Note:** To remove the fuse holder pull straight outward.

Remove Plugs on the GasFinder3-MC Enclosure	The plugs are removable by pressing from the inside – out. 
Intended Cable Locations	Note the intended connection locations for Power + Communication Cabling. 

Power + Communication Terminals

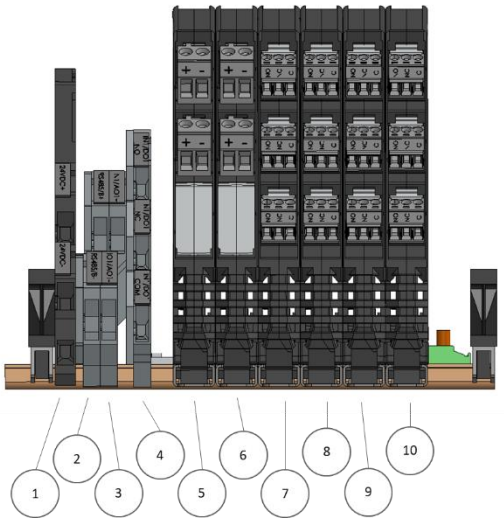
The Power + Communication Terminals are configured as follows:

FRONT VIEW



Item	Description
1	24 VDC Power Terminal
2	Modbus (RS-485) Terminal
3	HART 7 via Analog from Analyzer Board Stack
4	Relay (Voltage Free) from Analyzer Board Stack
5	Analog Module (4 HART/Analog Loops per)
6	Analog Module (4 HART/Analog Loops per)
7	Relay Module (6 Voltage Free Relays per)
8	Relay Module (6 Voltage Free Relays per)
9	Relay Module (6 Voltage Free Relays per)
10	Relay Module (6 Voltage Free Relays per)

BOTTOM VIEW



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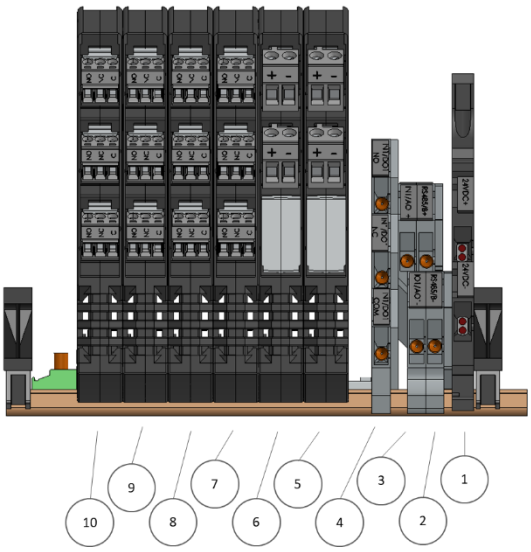
TOP VIEW



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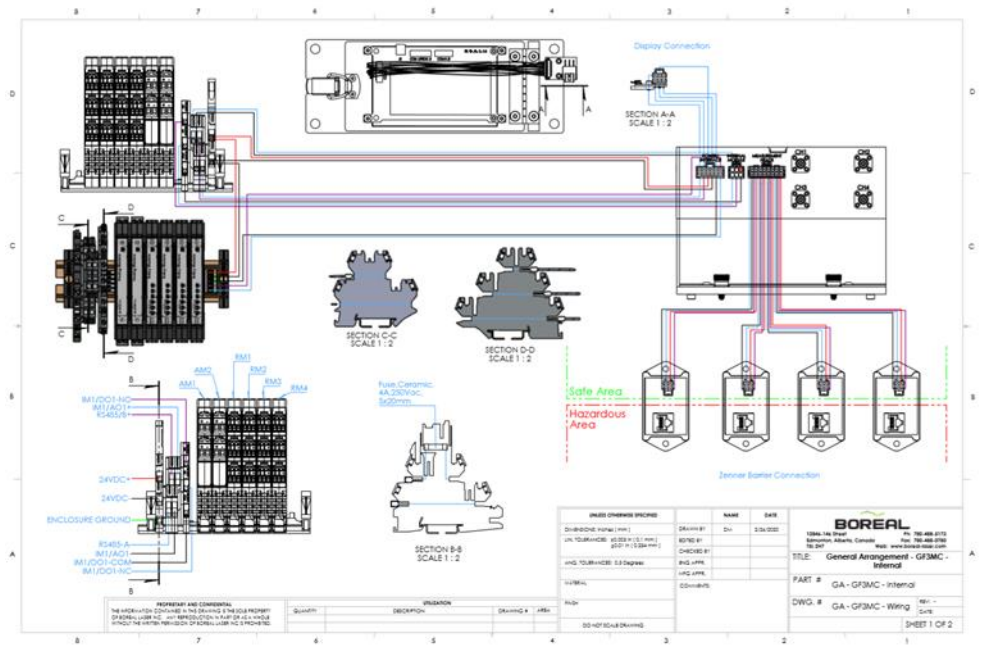
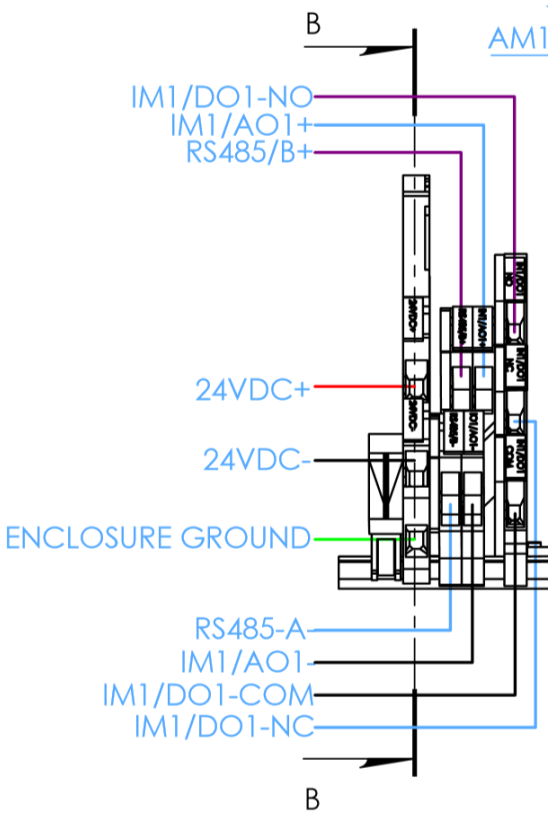
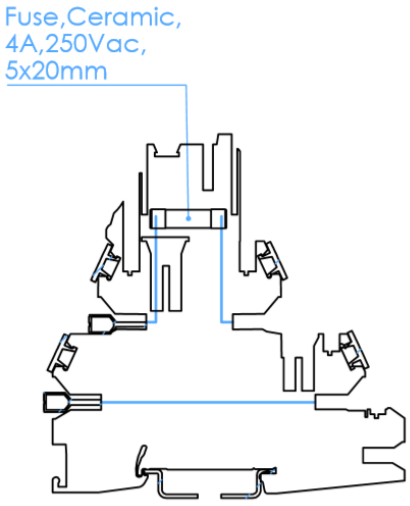
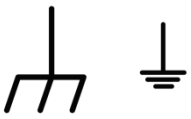
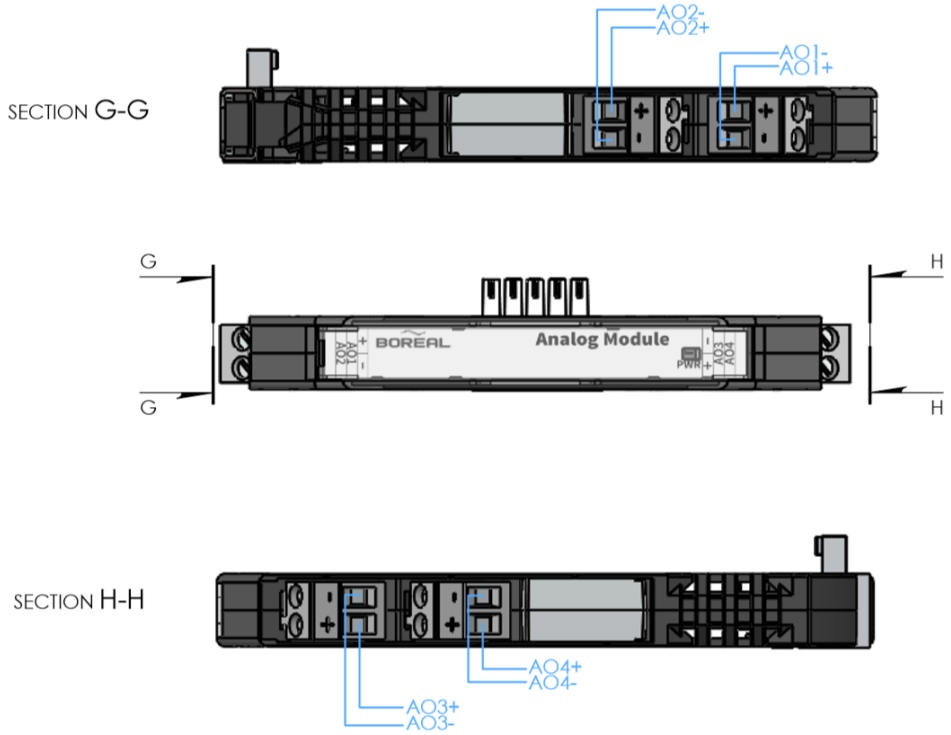
GasFinder3-MC Internal Wiring Overview



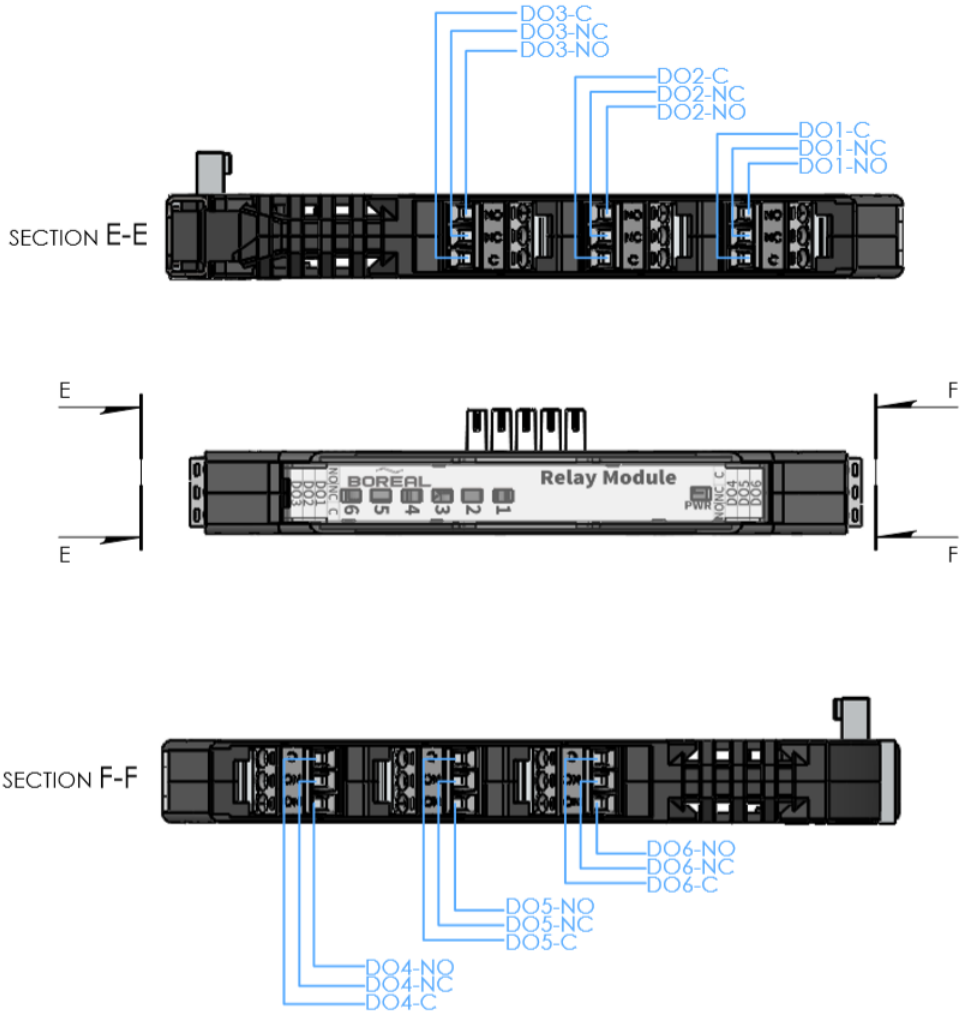
Note: For additional detail, please reference the following document in Appendix.

Terminate Power Wires	It is important to check the polarity of the power wires to ensure the +24 VDC wire is landed in the correct terminal. It is the installer's responsibility to ensure that the local electrical code is followed.  Consult the terminal block diagrams for further information regarding the power connections. All electrical work must be performed by qualified personnel. Watertight conduit seals should be used in compliance with local regulations.

Fuse and Fuse Holder	There is a fuse holder located on terminal block TB2-1. The fuse used here is a: **Littelfuse 5x20 mm, 4 A, Fast fuse, P/N: 0216004.HXP.**  Ensure all power is shut off to the wires before attaching the flying leads. The pre-connected instrument wiring should never be tampered with. Ensure a disconnect is installed in-line with the DC power supply. It is recommended that such a switch or circuit breaker is located near the GasFinder3-MC. There is no system power switch in the GasFinder3-MC. Installation of equipment must be carried out in compliance with local electrical code. Make sure to connect the flying lead with green insulation jacket to earth. This flying lead connects to the equipment's chassis and functional earth. Inside the enclosure of the GasFinder3-MC, the lugs for chassis and functional earth are labeled as pictured to the right. 

Terminate HART/Analog Loops	Each Analog Module has four (4) HART enabled Analog Loops that are Active (Source) and Isolated. 

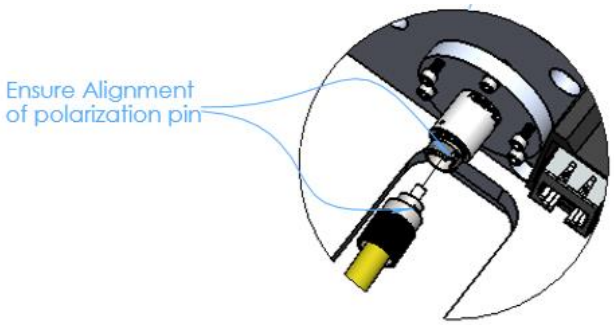
Terminate Relay Outputs	Each Relay Module has six (6) Voltage Free Dry-Contact Relays.



Mounting the In-Line (ILX) Probe	The In-Line (ILX) Probe is to be installed on the process piping. The process connections will be sized to the application in an ANSI appropriate flange. If the exterior of the In-Line (ILX) Probe is subject to a lower temperature than inside the cell, insulation and heating may be required to prevent condensation from forming on the optical windows. **Note:** For additional detail, please reference the following document "General Arrangement – GasFinder3-MC with In-Line (ILX) Probe Assembly.pdf".
Connecting the In-Line (ILX) Probe	The In-Line (ILX) Probe has 4 connections to be made. Connect the process piping via the flanged ends. Then connect the Fibre and Ethernet connections to the optical covers.

Fibre Optic Connections:

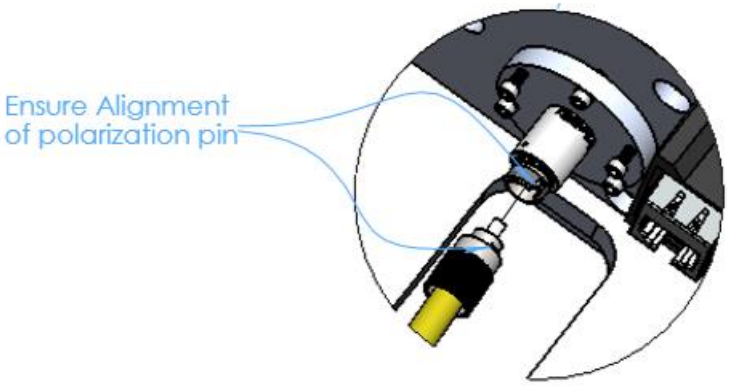
The fibre optic couplings are FC/APC and are used to connect two FC/APC fibre connectors. There is a key on the connector barrel to align with the keyway in the coupling. The key and keyway must be engaged in order for the connection to be made correctly.

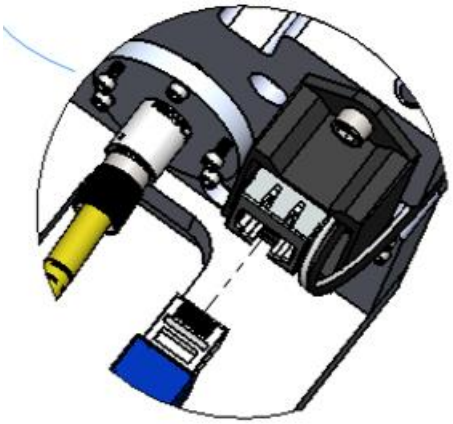


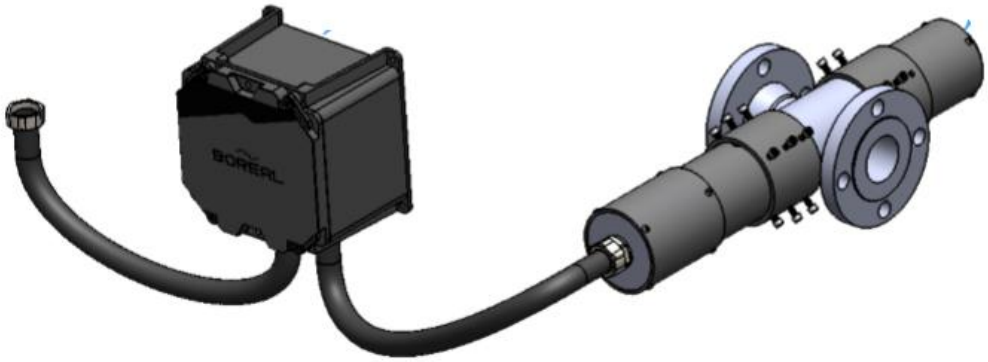
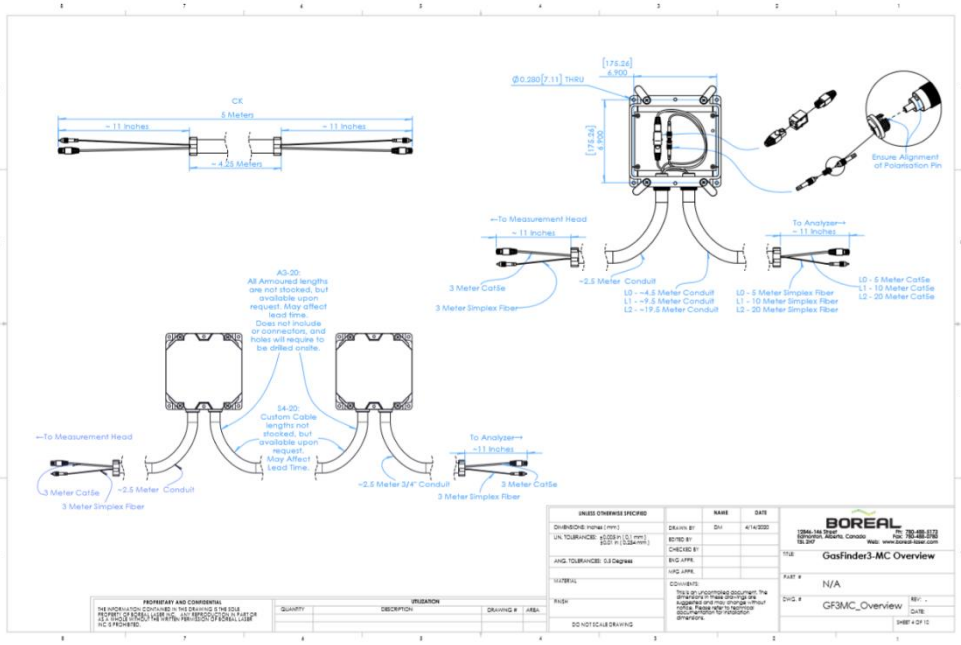
Cleanliness:

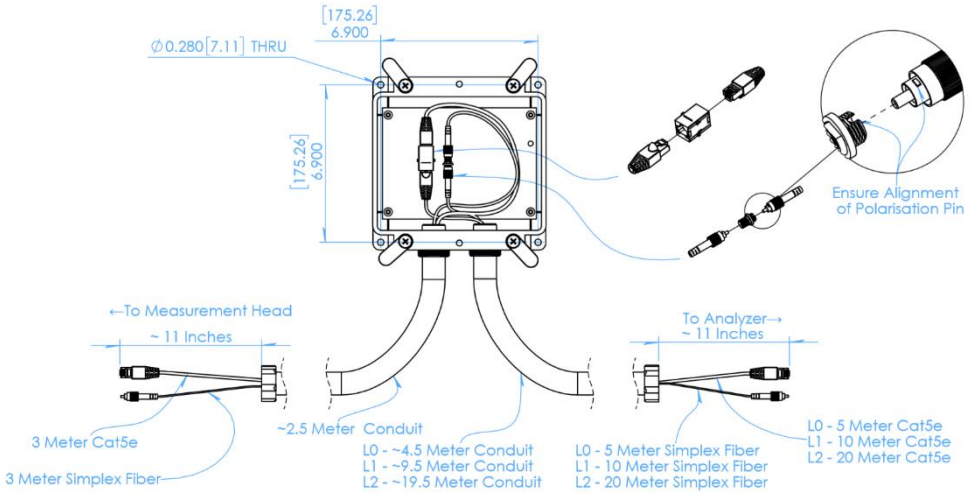
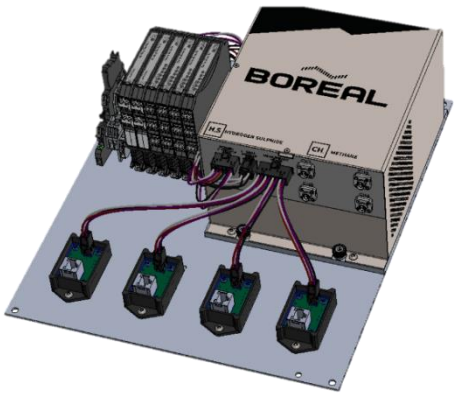
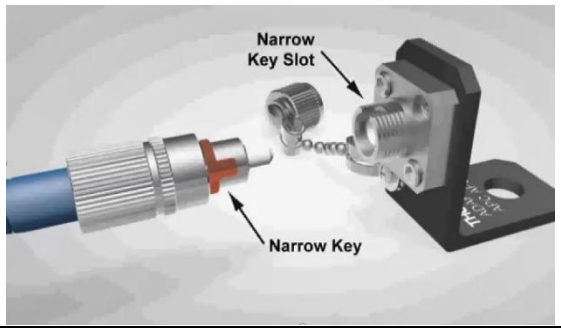
It is of paramount importance when dealing with fibre optic cables that clean work practices are followed. It is important to clean the tips of connectors before inserting them into the couplings. Using the fiber optic cleaning tape from the alignment kit, hold the end of the connector perpendicular to a clean section of tape. Gently move the connector tip in a figure eight motion two or three times. The connector is now cleaned, and may be inserted into the coupling. The cleaning tape is held in a dispenser which exposes a new section of tape as needed. **Do Not** use other methods or solutions to clean the fibre optic tip.

Ensure that alignment of the polarization pin on the FC/APC Connection is orientated correctly.



	Connect the CAT6/5e cable into the RJ45 Connector. 

Install Measurement Head Junction Box	Run/route cabling through desired locations. If the In-Line (ILX) Probe has a Measurement Head Junction Box, we recommend mounting it within accessible proximity for easy access using the Alignment Kit.  The Measurement Head Junction Box provides much easier access than the In-Line (ILX) Probe to connect alignment tools such as the Visible Laser or the Remote Light Meter (RLM).  **Note:** For additional detail, please reference the following document “General Arrangement – GasFinder3-MC with In-Line (ILX) Probe Assembly.pdf”.

Connecting Fibre and CAT6 Cabling in Measurement Head Junction Box	
Connecting Fibre and CAT6 Cabling in GasFinder3-MC	Ensure that the Fibre Cable and CAT6/5e Cabling from each In-Line (ILX) Probe are matched and paired to the appropriate channel (e.g. Fibre Optic and CAT6 from Measurement Head #1 goes to Channel #1). We recommend labeling to easily identify which cables belong to which In-Line (ILX) Probe. **Note:** Ensure that the polarization pin on the FC/APC Fiber Connector is orientated correctly.  **Note:** Ensure that the polarization pin on the FC/APC Fiber Connector is orientated correctly. 

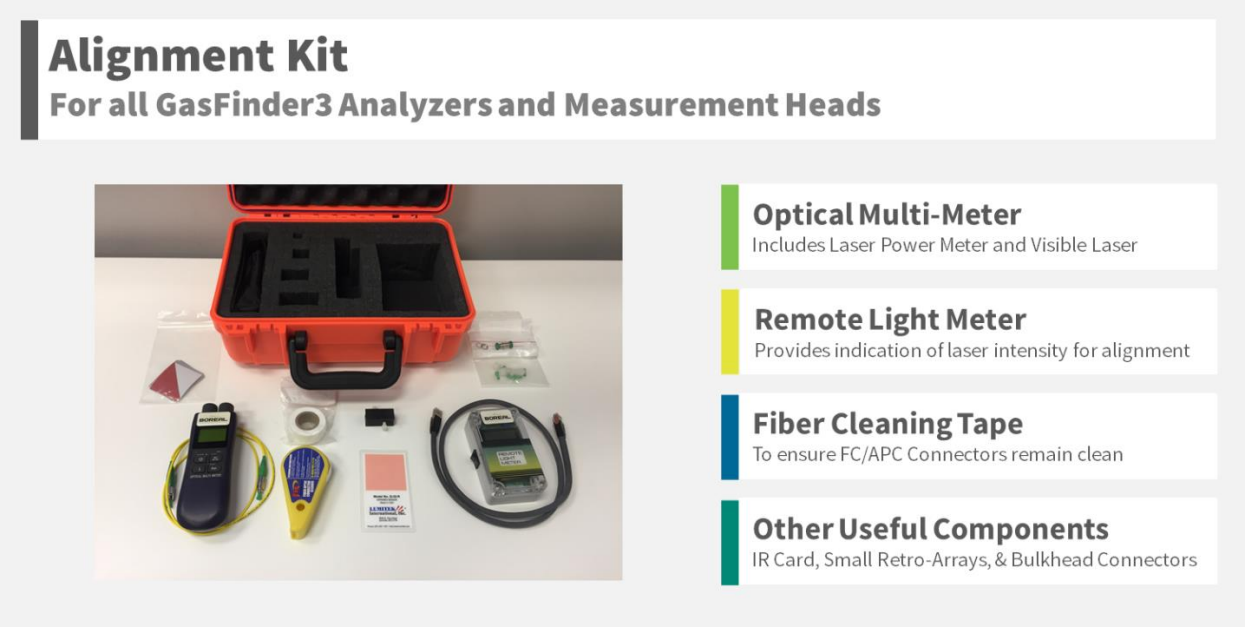
Start-Up + Commissioning

Please see “Commissioning Check Sheet – GasFinder3-MC with In-Line (ILX) Probe Assemly.pdf” for record keeping while commissioning.

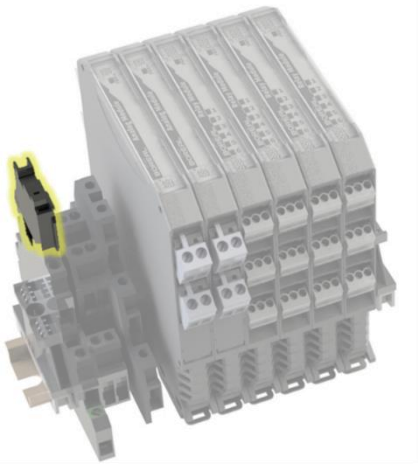
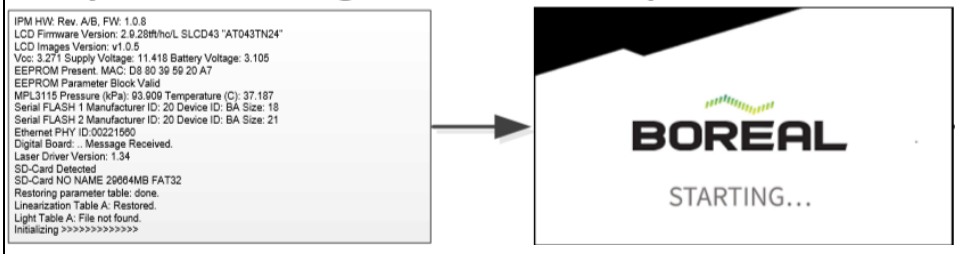
Recommended Equipment:

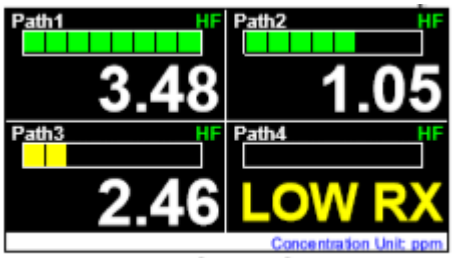
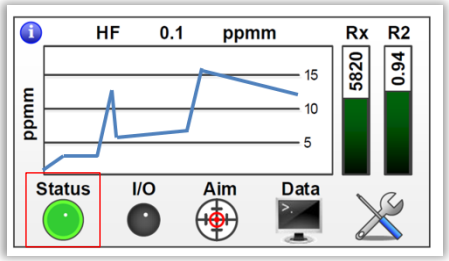
In addition to the GasFinder3-MC and In-Line (ILX) Probe Assemblies, we recommend the following accessories to assist with commissioning and on-going preventative maintenance.

The instructions below include the use of Boreal Laser’s Alignment Kit (Part #: BL-OAK) and its contents include.



Commissioning can be completed without the Alignment Kit but may require the assistance of an extra person and a radio/cell phone to complete.

Commissioning Step	Description
Meter-Out Power + Install Fuse	It is recommended to meter the power wires to determine which is the + 24 VDC and to ensure that the live wire is in the correct terminal. Install fuse. 
Start-Up Sequence	<u>Boot-up Screen:</u> This screen should last for 10-15 Seconds **System Boot Page** → **Splash Screen**  <u>Inner/Outer TEC Warm-Up Screen:</u> Here you will see the Inner and Outer TEC temperatures stabilize. The setpoint and actual temperature is displayed. • This screen should take 30-60 seconds to complete. **Warm-up Screen**

	Overview Page: Once the system warm-up is complete it will launch in the Overview page showing available channels touching anywhere on this page will take you to the home page.  *4 Channels* Home Page and Status Indication: On the home page there is a circular status indication that has three possible states: Green, Blue, and Red. By clicking on the circular status button, you'll see the exhaustive list of possible fault codes.  • Red: This is a general fault condition stating that the GasFinder is not able to generate a concentration measurement. User intervention may or may not be required. • Blue: This is to indicate that the GasFinder is going through its routine line centering procedure. This typically occurs once a minute and can last 1-3 seconds. No user intervention is required. • Green: This means the GasFinder has power, no fault codes are present, and enough returned laser light to perform its analysis.
Normal Operation	The GasFinder3-MC will be functional once powered. Fault conditions will be removed once the In-Line (ILX) Probe(s) are aligned and have enough returned laser light (Rx) to function.

Laser Power Level Channels #1-4	It is recommended to check the Laser Power Level at the GasFinder3-MC Enclosure, Measurement Head Junction Box, and Measurement Head. There should be less than 1 dB loss from the GasFinder3-MC to the In-Line (ILX) Probe. If there are greater losses than 1 dB, then clean connections again and straighten out sharp bends in the fibre optic cabling. Record these numbers within the "Commissioning Check Sheet – GasFinder3-MC with In-Line (ILX) Probe Assemly.pdf"
Configurable Variables	There may be additional variables that need to be configured to optimize the installation: 1. <u>System Parameters:</u> • Units of Measure: ppm-m, ppm, mg/Nm3 • R2 Cut-off Limit: (0.85 If required) • Temperature Compensation: Static, Internal, Inputs • Pressure Compensation: Static, Internal (Recommended), Inputs • Low Light Delay: 0-300 Seconds • Save Arrays to Log Files: ON (Default) or OFF 2. <u>Channel Specific:</u> • Path Length: • Cable Length Compensation: • Channel Description: 3. <u>Considerations for alarm settings:</u> • Select appropriate alarm thresholds • Be mindful of background concentrations (e.g. Methane 2 ppm and Carbon Dioxide 400-600 ppm) 4. <u>Outputs:</u> • Analog Loops: ▪ Configuration: Variable, Range, and HART Parameters ▪ Status: 2.7mA Low Light, 3.6mA General Fault • Dry-Contact Relays: Variable, Set Point • Modbus: Addressable Registers (ppm-m, path length, ppm, light level, R2 Confidence Factor, Status, Ref Light, Ref R2, Ref Concentration) 5. <u>Inputs:</u> • Analog Inputs: Temperature + Pressure Compensation
Forcing Outputs	Test Analog and Relay Outputs for proper function. i. Force Analog Outputs: Concentrations and Faults ii. Force Relay Outputs Menu: Settings→ System Parameters→ Output Forcing→ Analog Module or Relay Module.

Preventative Maintenance

Below are the typical steps to perform the manufactures recommended Preventative Maintenance.

PM Step	Description
Preventative Maintenance	The GasFinder3-MC requires very little preventative maintenance. It is recommended to inspect the system and record system performance indicators to trend the operation of the system. This can be accomplished by following the steps below and filling out the required information on a Preventative Maintenance Record sheet provided by Boreal Laser. To schedule a preventative maintenance visit from a trained technician. Contact Boreal Laser at Support@boreal-laser.com or the local distributor within the installation area. https://boreal-laser.com/distributors/
Visual Inspection of Physical Equipment	Boreal Laser recommends completing a visual inspection of the equipment. Check that the system is on and functioning with no fault codes. All enabled channels are generating readings and have returned laser light. Visual inspection includes the analyzer enclosure mounting structures and cabling. The cabling to the measurement heads to be free of damage. The measurement heads, optical path, and retro arrays are to have a clear line of sight with no large debris on window material. The mounting structures to be free of damage.
Fill out PM Check Sheet	Boreal Laser recommends filling out a preventative maintenance check sheet once a month. The PM sheet tracks system diagnostic values over the life of the installation. Maintaining a record of these values will establish a reference baseline to the values recorded at time of installation and commissioning.
Questions or require assistance?	For assistance with preventative maintenance tasks: 1. Call or email your Local Distributor: https://boreal-laser.com/distributors/ 2. Get a hold of Boreal Laser's Technical Support Team directly: • Phone #: 1-780-488-5173 Push 2 for Support • Email: Support@boreal-laser.com

Quarterly Diagnostic Data Review and Calibration Extension Certificate:

If the GasFinder unit continues to operate without fault codes, the system is still within calibration and will continue to provide accurate and reliable data. In some applications, customers' preventative maintenance and/or regulatory reporting obligations may require that proof-of-calibration and/or re-certification documentation have a "current date" and not just the date provided at calibration.

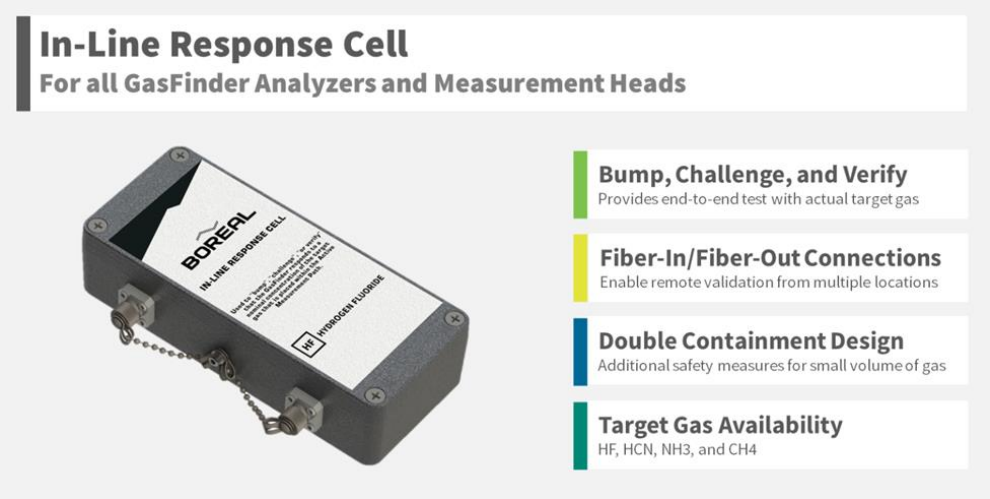
With the Quarterly Data Review Package, it is possible to get a Calibration Certificate Extension with a "current date" without sending the GasFinder unit to the factory by providing certain diagnostic data to Boreal Laser's Technical Support Team to perform a health-check that uses key diagnostic data to ensure operability.

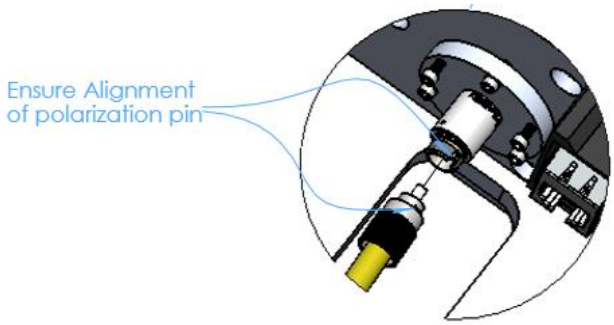
The Quarterly Data Review Package requires the following diagnostic data from the customer: Boreal Laser provided Preventative Maintenance Sheet, 3-7 Daily Logfiles, and at least 1 Array Transfer. This information is to be sent to support@boreal-laser.com every three (3) months. At all four (4) quarterly data reviews, Boreal Laser's Technical Support Team will provide email confirmation of GasFinder units performance.

Contact your local distributor (www.boreal-laser.com/distributor) or Support@boreal-laser.com for more information about this service.

Optional Preventative Maintenance:

The following items are not a requirement of the manufacture but are an optional preventative maintenance step if the end-user choses to do so.

PM Step	Description
In-Line Response Cell	 The In-Line Response Cell is to be connected in series with the fiber optic cabling anywhere between the GasFinder3-MC, Measurement Head Junction Box, and the In-Line (ILX) Probe.

	Fibre Optic Connections: The fibre optic couplings are FC/APC and are used to connect two FC/APC fibre connectors. There is a key on the connector barrel to align with the keyway in the coupling. The key and keyway must be engaged for the connection to be made properly.  Cleanliness: It is of paramount importance when dealing with fibre optic cables that clean work practices are followed. It is important to clean the tips of connectors before inserting them into the couplings. Using the fiber optic cleaning tape from the alignment kit, hold the end of the connector perpendicular to a clean section of tape. Gently move the connector tip in a figure eight motion two or three times. The connector is now cleaned and may be inserted into the coupling. The cleaning tape is held in a dispenser which exposes a new section of tape as needed. **Do Not** use other methods or solutions to clean the fibre optic tip.
Questions or require assistance?	For assistance with preventative maintenance tasks: 1. Call or email your Local Distributor: https://boreal-laser.com/distributors 2. Get a hold of Boreal Laser's Technical Support Team directly: • Phone #: 1-780-488-5173 Push 2 for Support • Email: Support@boreal-laser.com

Troubleshooting

Below are troubleshooting activities that could be common to the GasFinder3-MC and the In-Line (ILX) Probe Assembly.

Very Basic - If the GasFinder3-MC is operating properly, the following should happen:

1. Analyzer is powered on, HMI Touchscreen is on, and Startup complete
2. Measurement heads connected, aligned, and returning laser light
3. Status indicator- Green and readings on all channels are being updated

Fault Condition	Corrective Action
Power Related Issue	Symptom: HMI Touchscreen or LEDs on Modules do not turn on. Recommendation: 1. Check supply power (12-28 VDC) 2. Check polarity 3. Check fuse in GasFinder 4. Ensure proper grounding 5. Ensure connections are fully inserted and tightened
Intermittent Low Light (LowRX)	Symptoms: Status goes in and out of LowRX Status or 2.7mA on Analog Loop. Recommendation: 1. Investigate if intermittent beam blockage is caused by transient obscuration's (e.g. steam, particulate load, etc.) then implement a time delay. a. If cause of obstruction is intermittent then consider implementing End-User configurable time delay via the HMI Touchscreen. b. If the In-Line (ILX) Probe has heavy build up of particulate. Consider additional sample conditioning. c. If condensation is forming on windows, consider insulation or heating of the In-Line (ILX) Probe. 2. If no obvious obscurations are present during low light events then investigate if the fiber optic cabling between the GasFinder3-MC and In-Line (ILX) Probe are not properly inserted, loose, or broken. a. To inspect for broken fiber, connect the visible laser and look for any visible losses of the light within the fibre. The most common place for fibre optic cabling to break is at the green boots. 3. If fiber appears to be unbroken, clean all FC/APC connections using appropriate fiber cleaning tape, and ensure all connections are properly aligned in the keyway and fastened.

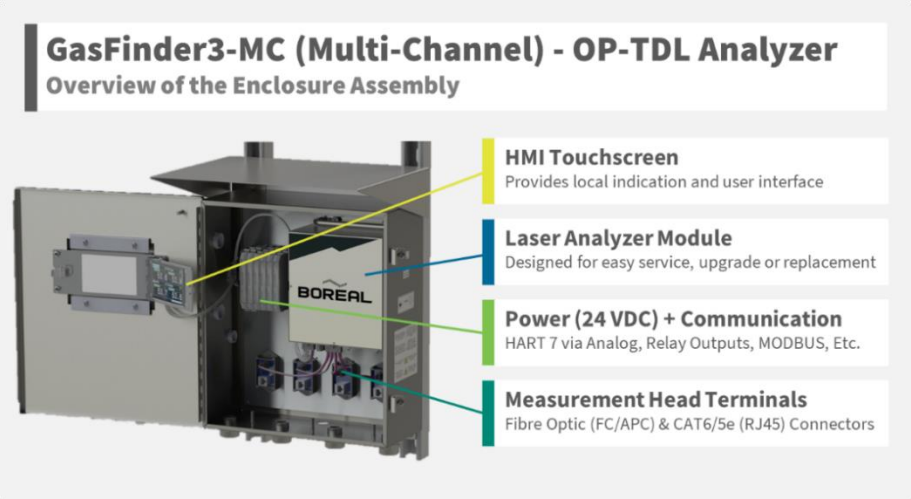
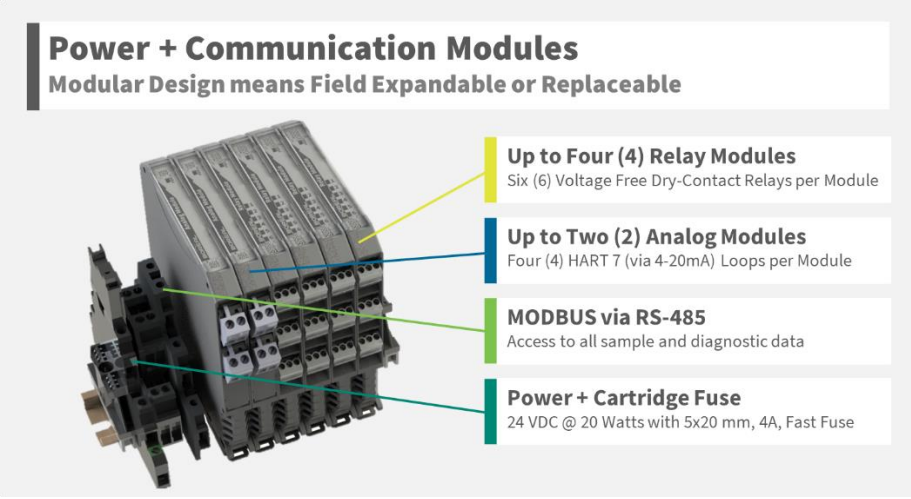
Continuous Low Light Status (LowRX)	Symptoms: The GasFinder3-MC continuously maintains a Low Light status code. Recommendation: 1. Check the In-Line (ILX) Probe for obstructions within Active Measurement Path. 2. Visually check if either of the In-Line (ILX) Probe Windows are dirty or obstructed (e.g. dust covered, particulate or process fluid, etc.). 3. Check for Laser Power at the GasFinder3-MC, Measurement Head Junction Box, and In-Line (ILX) Probe. a. Be sure to thoroughly clean each of the FC/APC Connections and remember to ensure that the key is in the keyway. b. Connect the visible laser and look for any obvious laser light loss from the fibre. Be sure to check the fibre by the green boots as this is the most likely place for the fibre to break. i. Note: it is normal to have a bit of laser light pass through the bends c. If fibre is broken, call your local Distributor or Boreal laser to order a replacement part.
Not Centered/Not Calibrated/Calibration Error (Intermittent)	Symptom: System intermittently displays status code. Recommendation: This is most likely just the GasFinder3-MC performing its routine line centering and no intervention is required.
Not Centered/Not Calibrated/Calibration Error (Continuous)	Symptom: Either or all these fault codes remain continuously. Recommendation: The system may have lost its ability to line center, try power cycling the system. If issue persists after restart: 1. Call or email your Local Distributor: https://boreal-laser.com/distributors 2. Get a hold of Boreal Laser's Technical Support Team directly: • Phone #: 1-780-488-5173 Push 2 for Support • Email: Support@boreal-laser.com

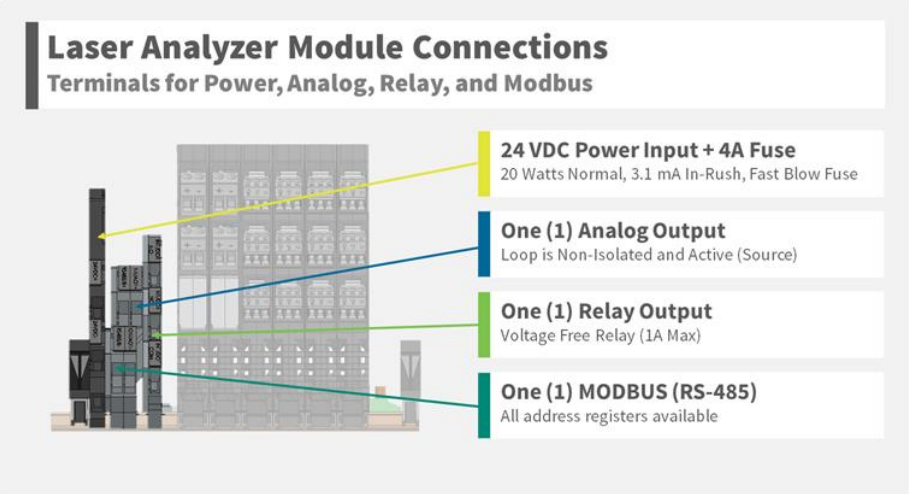
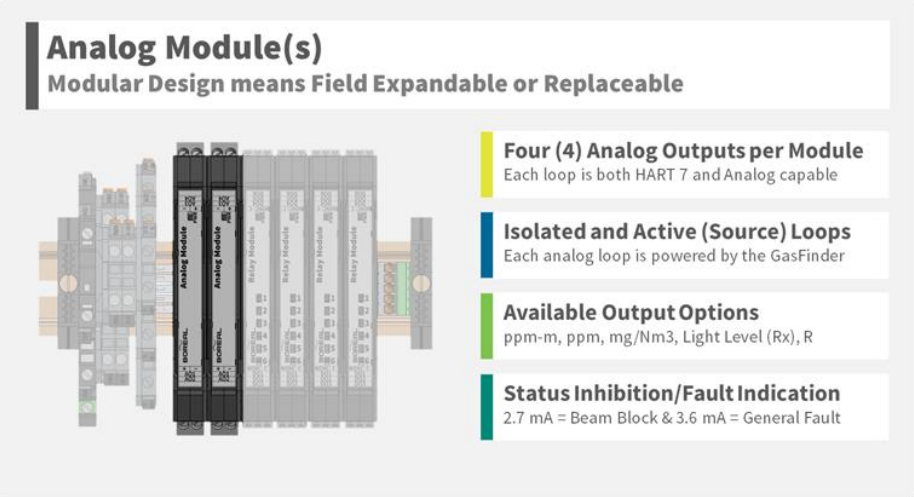
Reference Cell Error	Symptom: System displays fault code “Ref Cell Error”. Recommendation: 1. Check to make sure that the Ref Cell Light, Ref Cell Quality, and Ref Cell Concentration is within tolerance (refer to PM sheet): a. Settings > System Parameters > Page 2 > Reference Check 2. HF Reference cells will eventually permeate and lose concentration. All other gases are unlikely to lose concentration. A replacement Reference Cell may be required. 3. Call your local Distributor or Boreal Laser to discuss servicing the Reference Cell, or for further assistance and diagnosis. a. Note: Due to Dangerous Goods regulations, it may not be possible to ship a replacement Reference Cell on its own. In most cases, the Analyzer Board Stack is to be shipped back to Boreal Laser for a Check-Up and Calibration.
Nuisance Concentration Alarms with Target Gas Present	Symptom: Normal operational activities are causing Hi or Hi-Hi Alarms Recommendation: 1. Open Path Gas Detection differs from Traditional Gas Detection mainly because of these reasons: Large Area Coverage, Speed of Response, Low Detection Limits. 2. It could be possible that: a. Operational activities need be reviewed to mitigate known releases b. Either the Hi or Hi-Hi Alarm set points need to be increased (e.g. assumed path length is too short) or logic within the DCS/PLC needs to increase the number of consecutive seconds that a Hi or Hi-Hi Alarm needs to be present for alarm to activate.

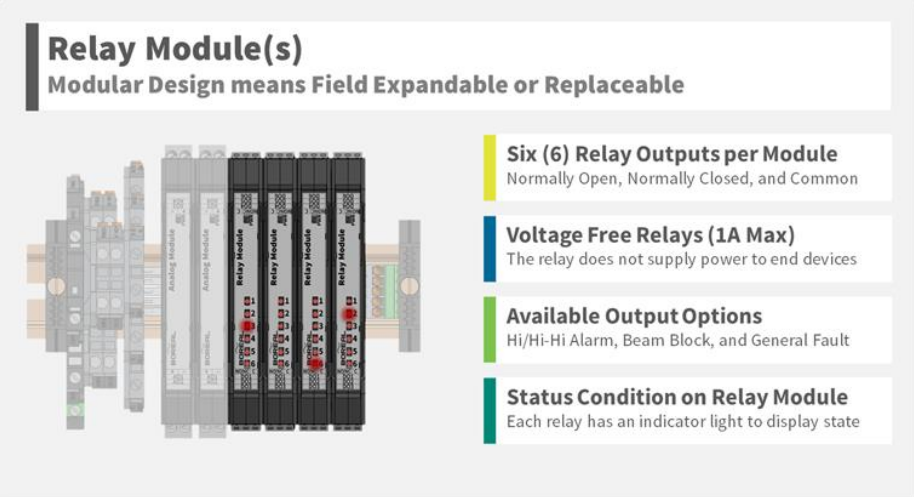
Nuisance Concentration Alarms with no Target Gas Present	Symptom: With no target gas being present the system occasionally and/or intermittently has concentrations exceeding the Hi or Hi-Hi set points causing false alarms. Recommendation: 1. Ensure that Hi and Hi-Hi Alarms are set within Actionable Concentrations and above the Minimum Recommended Alarm Thresholds (which is two times (2x) the stated Minimal Detectable Limit). a. Target Gas Specifications can be found on page _____ i. Check to ensure that a suitable R2 Cut-off Limit is implemented. If so, raise it to a recommended maximum of 0.95.
Any other Fault Code	Recommendation: 1. Call or email your Local Distributor: https://boreal-laser.com/distributors 2. Get a hold of Boreal Laser's Technical Support Team directly: • Phone #: 1-780-488-5173 Push 2 for Support • Email: Support@boreal-laser.com

Power, Communications, and Outputs Overview

The GasFinder3-MC Power terminals, Communications, and Outputs are all located within the Analyzer enclosure mounted to a standard din rail.

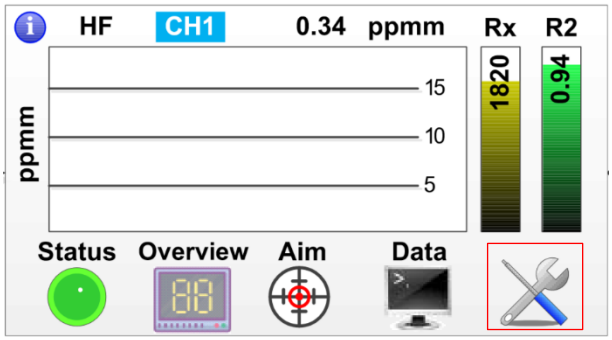
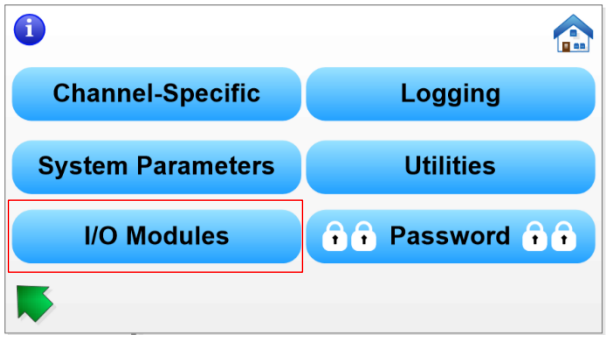
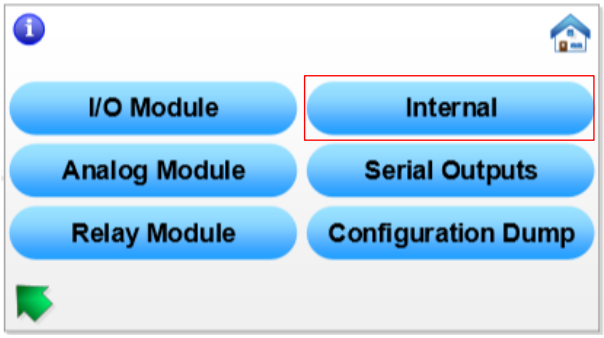
PM Step	Description
GasFinder3-MC Enclosure Overview	
Power and Communication Din Rail	

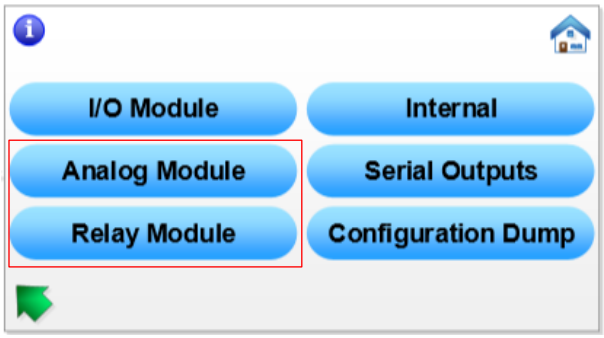
Laser Analyzer Module Connections	 • **<u>24 VDC Power Input + 4A Fuse:</u>** The GasFinder3-MC (Multi-Channel) is powered with **24 VDC and under normal operation draws 20 watts**. Upon powering the system, there is an In-Rush Current of 3.1A (For Hydrogen Fluoride Systems) and 2.5A (For All Other Gases) for a period of 100ms. On the power input terminals is a field replaceable **4A Fast Blow Cartridge Fuse (5-20mm)**. • **<u>One (1) Analog Output:</u>** From the Laser Analyzer Module within the GasFinder3-MC, there is **one (1) HART 7 over Analog Output** which is Non-Isolated and Active (Source). • **<u>One (1) Relay Output:</u>** From the Laser Analyzer Module within the GasFinder3-MC, there is **one (1) Discrete Output** which is Voltage Free and rated for 1A Max. • **<u>MODBUS via RS-485:</u>** All variables generated by the analyzer are **Addressable Registers**. Please refer to the register assignments tables in the Modbus RS485 Section.
Analog Modules	

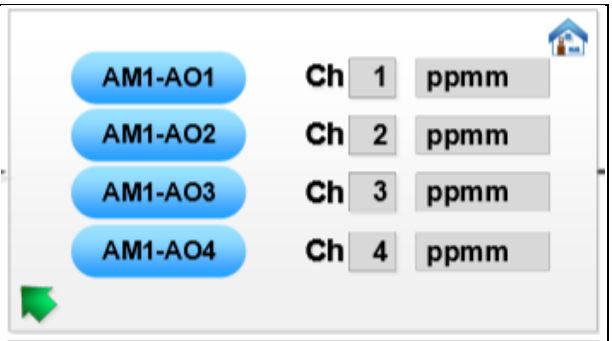
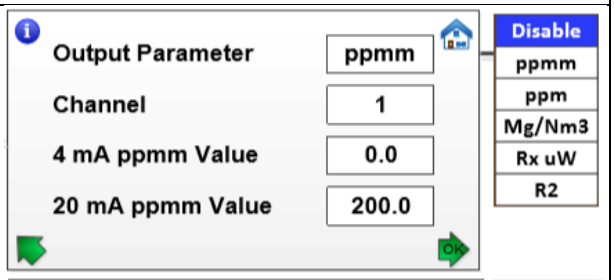
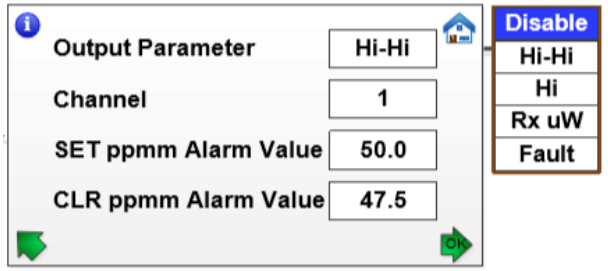
	Analog Module(s): • **Each Analog Module has four (4) HART 7 over Analog Outputs**. The GasFinder3-MC (Multi-Channel) can support up to Two (2) Analog Modules. Via the HMI Touchscreen, the end-user can easily configure what each Analog Loop will output such as: Path Integrated Concentration (**ppm-m**), Path Average Concentration (**ppm**), Standard Volume (**mg/Nm3**), Light Level (**Rx**), or R2 Confidence Factor (**R2**). • Each of the Loops on the Analog Module are **Isolated** and **Active/Source** (Powered by the GasFinder). • Two sub 4 mA variables to note: **2.7 mA = Low Light (Beam Block) and 3.6 mA = General Fault**. • Via HART 7 the variables, PV = Concentration, SV = Light Level, and TV = R2 Confidence Factor.
Relay Modules	 **Relay Modules:** • **Each Relay Module has six (6) Voltage Free Dry-Contact Relay Outputs**. The GasFinder3-MC can support up to four (4) Relay Modules. • Via the HMI Touchscreen, the end-user can easily configure the Relay Output to be a **Hi Alarm, Hi-Hi Alarm, Low Light (i.e. Beam Block), or General Fault**.

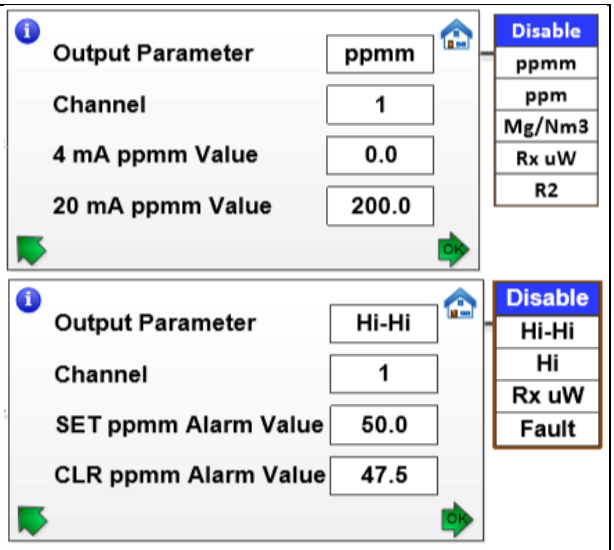
Configuring Analog/Relay Module Outputs

Below are the instructions to configure Analog and Relay Modules via the HMI Touchscreen.

Step	Description
Configure Analog and Relay Module Outputs	The GasFinder3-MC comes standard with a single 4-20ma output and a single dry contact relay output from the Laser Analyzer Module. Additional output modules can be added to the din rail mounted inside the GasFinder3-MC. Analog Modules have four (4) HART enabled Analog Loops that are Active (Source) and Isolated. Relay Modules have six (6) Voltage Free Dry-Contact Relays. To configure Analog and Relay Module parameters follow the steps below.
Enter Settings Menu	Select the settings icon in the bottom right of the touchscreen. (Wrench and screwdriver symbol) 
Select I/O Modules Menu	Select the "I/O Modules" icon. The I/O Modules menu will allow the user to configure communication settings on the Analyzer Module. 
To Configure the on-Board Analog and Relay output Select "Internal"	To configure the single Analog and single Relay output built into the GasFinder3-MC select "Internal". 

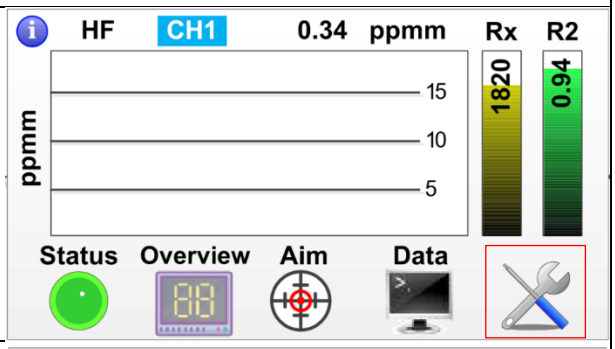
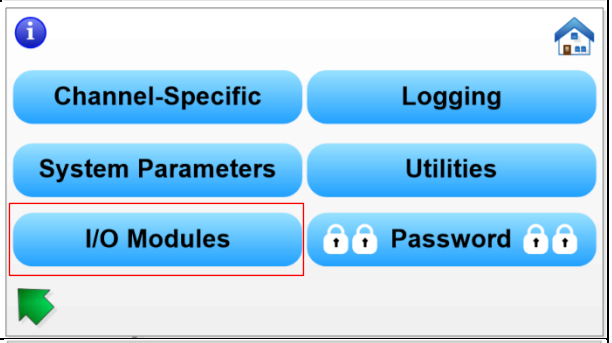
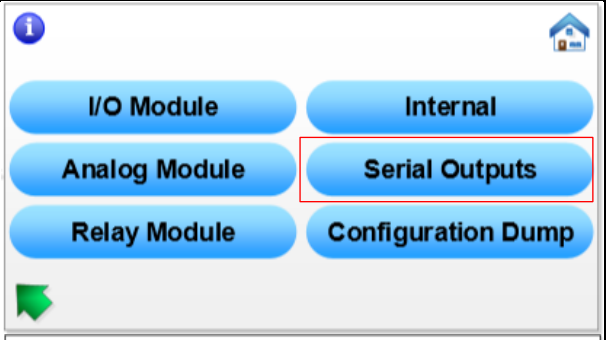
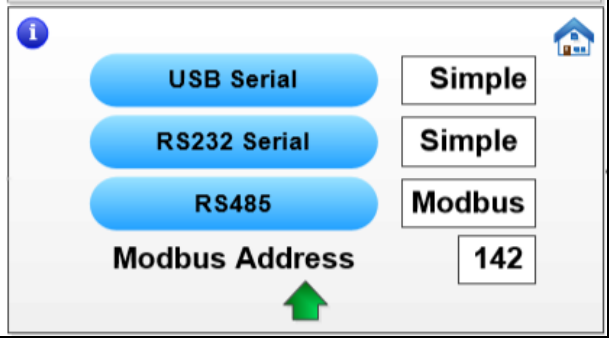
To Configure the "Analog Module" or "Relay Module"	To Configure the "Analog Module" or "Relay Module" select the icon for the output you wish to configure.	
Select the Module Number	Select the appropraite module number to configure, If more than one Analog or Relay Module is present.	

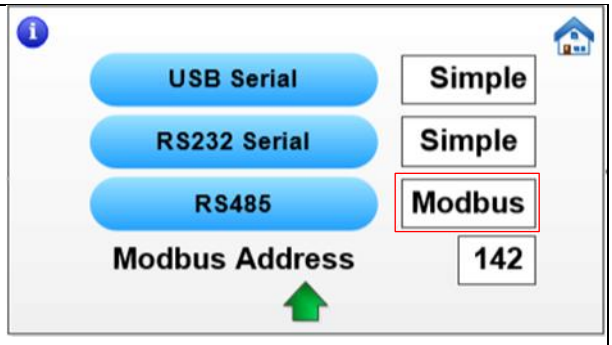
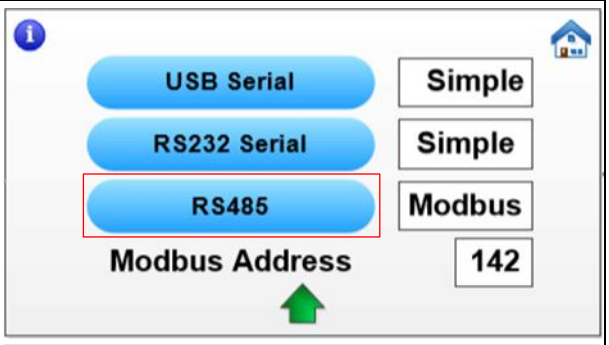
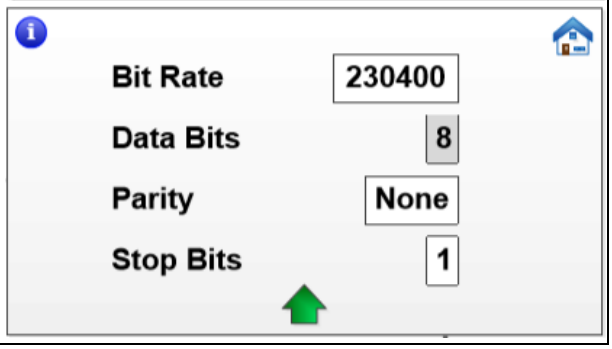
Select Which Output to be Configured	Select the output number to be configured on the module. Ex. AM1-AO1 “Analog Module 1 – Analog Output 1” RM1-DO1 “Relay Module 1 – Digital Output 1”.	
Adjust Configuration and Ranges for the Outputs	The outputs of the modules are fully configurable for user defined ranges and values. Select the desired output parameter, channel number, and desired scaled range/thresholds.	 

Once Outputs are Configured Press "OK" and Return the Analyzer to the Home Screen	Once the settings are configured ensure to accept the changes by pressing "OK". Then return the Analyzer to the home screen to resume "Normal" operation.	
Further assistance	For assistance with communication and I/O please contact: • Support@boreal-laser.com	

Modbus RS485

Below are the instructions to configure Modbus RS485 communication via the analyzer module.

Step	Description	
Enable Modbus Communication and Set Modbus Address	To enable Modbus communication from the Analyzer module and set the appropriate Modbus address follow the steps below.	
Enter Settings Menu	Select the settings icon in the bottom right of the touchscreen. (Wrench and screwdriver symbol)	
Select I/O Modules Menu	Select the "I/O Modules" icon. The I/O Modules menu will allow the user to configure communication settings on the Analyzer Module.	
Select "Serial Outputs"	Select the "Serial Outputs" icon. This will display the available serial communication outputs available from the GasFinder3-MC.	 

Ensure Modbus Is Enabled Beside RS485	By default Modbus will be enabled and the Modbus address will be “1”. The address can be changed simply by touching the address box and entering the new address.  By touching the “Modbus” square a small pop up window will allow the user to Disable RS485 communication, select serial, or Modbus. Modbus allows the the RS485 output to function as a Modbus slave in binary/RTU.
Set RS485 Communication Parameters	Select the “RS485” menu to configure the communication parameters. Configurable parameters include Bit Rate, Data Bits, Parity, Stop Bits.  

Modbus Map and Parameter Description

Standard Modbus Output Registers for GasFinder Analyzers

Mode: Slave, Binary/RTU, Decimal Integers.

Comport Out: RS485 1/Variable Baud/8/N/1

Register assignments GAS A (RS485):

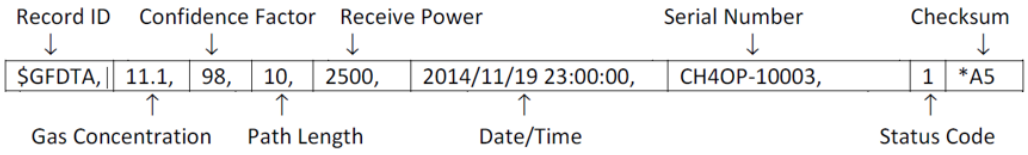
Channel	ppmm High	ppmm Low	ppmm Decimal	R2	Distance Decimeter	Light	Seconds	Status High	Status Low	ppm	ppm Decimal
1	41001	41021	41041	41061	41081	41101	41121	41141	41161	41181	41201
2	41002	41022	41042	41062	41082	41102	41122	41142	41162	41182	41202
3	41003	41023	41043	41063	41083	41103	41123	41143	41163	41183	41203
4	41004	41024	41044	41064	41084	41104	41124	41144	41164	41184	41204
5	41005	41025	41045	41065	41085	41105	41125	41145	41165	41185	41205
6	41006	41026	41046	41066	41086	41106	41126	41146	41166	41186	41206
7	41007	41027	41047	41067	41087	41107	41127	41147	41167	41187	41207
8	41008	41028	41048	41068	41088	41108	41128	41148	41168	41188	41208
9	41009	41029	41049	41069	41089	41109	41129	41149	41169	41189	41209
10	41010	41030	41050	41070	41090	41110	41130	41150	41170	41190	41210
11	41011	41031	41051	41071	41091	41111	41131	41151	41171	41191	41211
12	41012	41032	41052	41072	41092	41112	41132	41152	41172	41192	41212
13	41013	41033	41053	41073	41093	41113	41133	41153	41173	41193	41213
14	41014	41034	41054	41074	41094	41114	41134	41154	41174	41194	41214

$GFDBG	Internal Temp	Internal Temp Decimal	DC Offset	Ref Qual	Ref R2	Ref Status High	Ref Status Low	Supply Voltage	Amb Pressure High	Amb Pressure Low
	41300	41301	41302	41303	41304	41305	41306	41307	41308	41309

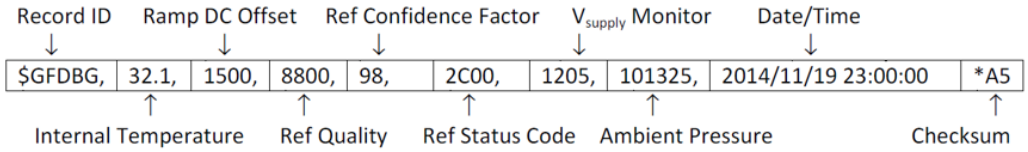
Register assignments GAS B (RS485):

Channel	ppmm High	ppmm Low	ppmm Decimal	R2	Distance Decimeter	Light	Seconds	Status High	Status Low	ppm	ppm Decimal
1	41501	41521	41541	41561	41581	41601	41621	41641	41661	41681	41701
2	41502	41522	41542	41562	41582	41602	41622	41642	41662	41682	41702
3	41503	41523	41543	41563	41583	41603	41623	41643	41663	41683	41703
4	41504	41524	41544	41564	41584	41604	41624	41644	41664	41684	41704
5	41505	41525	41545	41565	41585	41605	41625	41645	41665	41685	41705
6	41506	41526	41546	41566	41586	41606	41626	41646	41666	41686	41706
7	41507	41527	41547	41567	41587	41607	41627	41647	41667	41687	41707
8	41508	41528	41548	41568	41588	41608	41628	41648	41668	41688	41708
9	41509	41529	41549	41569	41589	41609	41629	41649	41669	41689	41709
10	41510	41530	41550	41570	41590	41610	41630	41650	41670	41690	41710
11	41511	41531	41551	41571	41591	41611	41631	41651	41671	41691	41711
12	41512	41532	41552	41572	41592	41612	41632	41652	41672	41692	41712
13	41513	41533	41553	41573	41593	41613	41633	41653	41673	41693	41713
14	41514	41534	41554	41574	41594	41614	41634	41654	41674	41694	41714

$GFDBG	Internal Temp	Internal Temp Decimal	DC Offset	Ref Qual	Ref R2	Ref Status High	Ref Status Low	Supply Voltage	Amb Pressure High	Amb Pressure Low
	41800	41801	41802	41803	41804	41805	41806	41807	41808	41809



ppmm – Concentration of gas will be represented with 32-bits and an extra 16-bits for decimal.
R2 – Confidence factor from 0-100.
Distance in Decimeter – Path length will be multiplied by 10 to get rid of decimal numbers.
Light – Received power as reported by the IPM.
Seconds – Heartbeat indicator. This will be the "seconds" in Date/Time field of the DATA statements. 0-60.
Status – 32-bit of Status Code from the DATA statements.
ppm – Concentration of gas divided by the path length. 16-bit for the whole number, and extra 16-bit for decimal.



Internal Temp – Internal temperature. 16-bits for whole number and 16-bits for decimal.
DC Offset – Ramp DC Offset.
Ref Qual – 16-bit of Reference Quality.
Ref R2 – Reference Confidence Factor from 0-100.
Ref Status – 32-bit of Status Code after Line Centering.
Supply Voltage – Supply voltage is already displayed as x100 to get rid of decimal numbers. Keep it as such.
Ambient Pressure – 32-bit of Ambient Pressure.

Channel 13 is now assigned to Reference Channel 1.
Channel 14 is now assigned to Reference Channel 2.

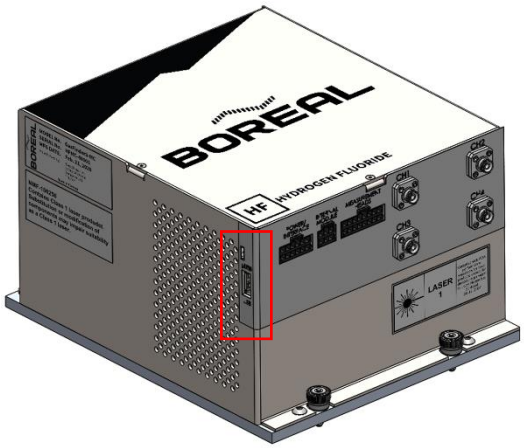
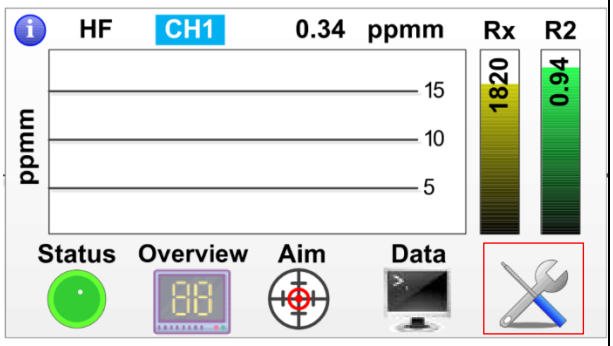
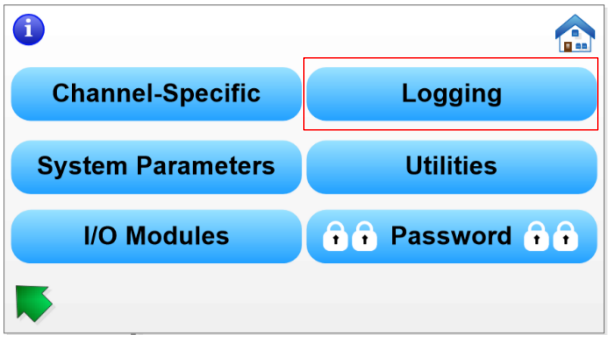
Note: For all high and low registers when the high bit is set or is nonzero. To reconstitute the value, you must multiply the high register value by 65536 and add the value of the low register.

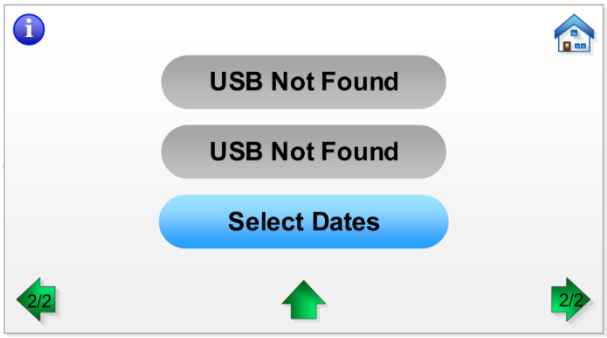
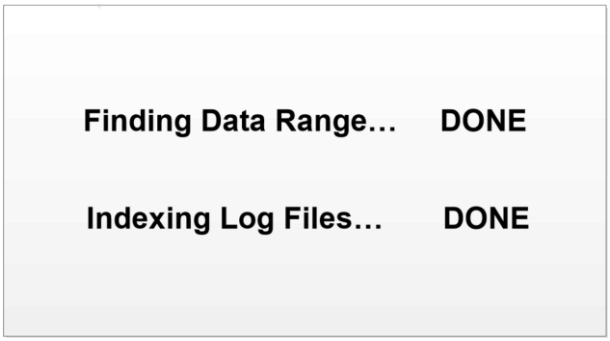
Further assistance	For assistance with communication and I/O please contact: • Support@boreal-laser.com

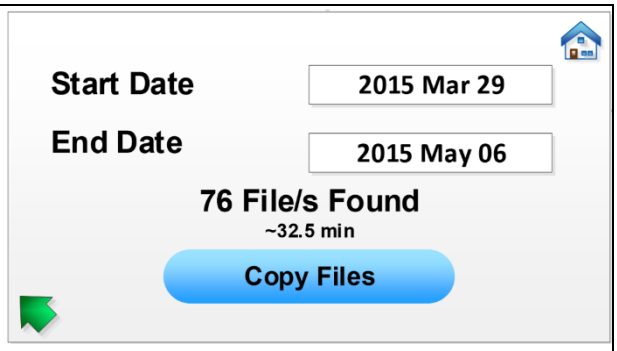
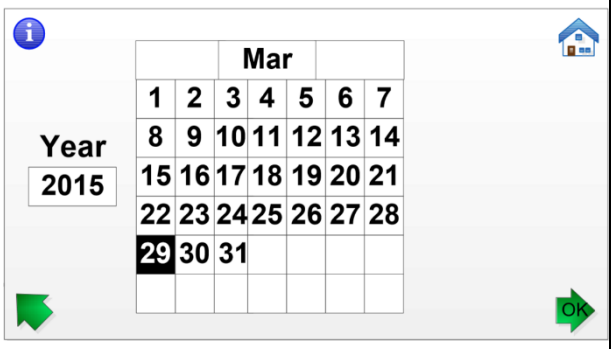
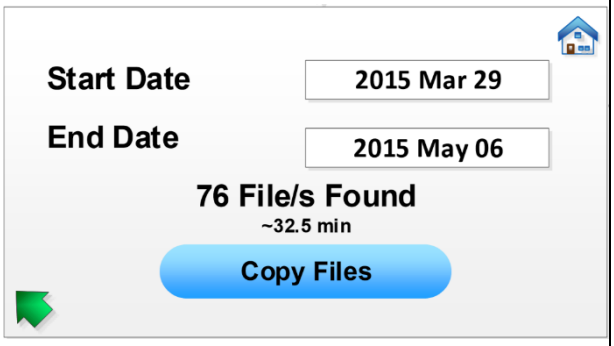
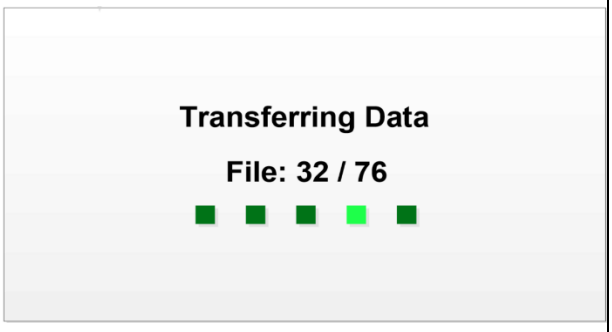
Data Download with USB Stick (Logfiles and Arrays)

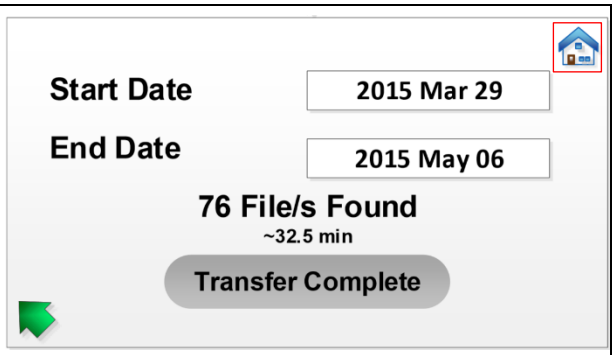
The GasFinder3-MC has an internal SD Card which stores all generated data. This data can be transferred via a USB Stick or Thumb Drive.

Note: Transferring log files will enter the system into a fault condition as analysis is paused until the file transfer is completed. Ensure that operations is aware or that alarms are by-passed.

PM Step	Description
Plug-in USB Stick into the Laser Analyzer Module	Insert the USB stick on the left of the analyzer module enclosure. 
Select "Settings"	Select the settings icon in the bottom right of the touchscreen. (Wrench and screwdriver symbol) 
Select "Logging"	Select the logging tab. The Logging menu will allow the user to copy the internally stored data logs to the USB drive plugged into the Analyzer Module. 

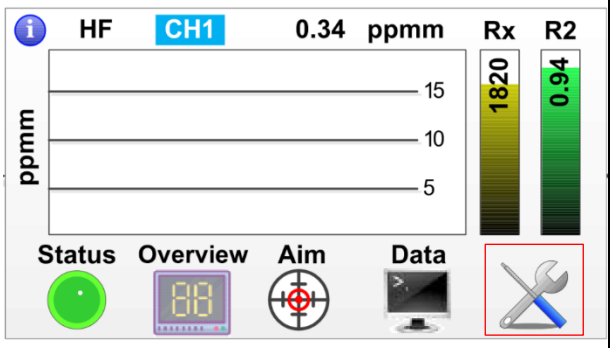
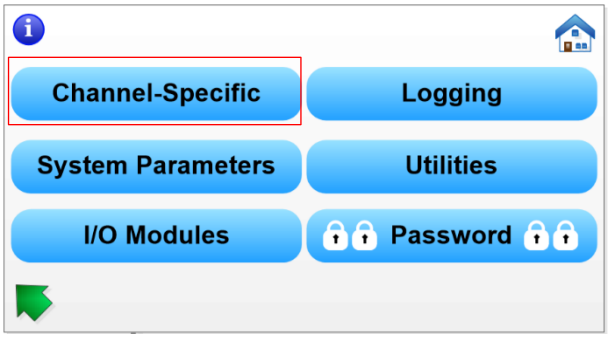
Choose Dates to Download	"Copy Today's Log" – This option if selected will immediately start to copy the log file currently being written to that day, as well as the previous days log file in the current month. "Copy Last 7 Days"- This option if selected will immediately start to copy the last 7 days of recorded log files in the current month, as well as the current day log file. "Select Dates"- This option will allow the user to select the range of days in calendar format that they wish to download.
If a USB Stick is not entered or recognized	Exit the menu, remove the USB stick. Re-insert the USB stick before navigating back to the logging menu.  Note: The USB stick must be FAT32 format. This is the typical format for USB sticks however some external hard drives and storage devices are not.
Status Screen	The system is accessing the stored log files on it's internal storage drive. Please wait. 

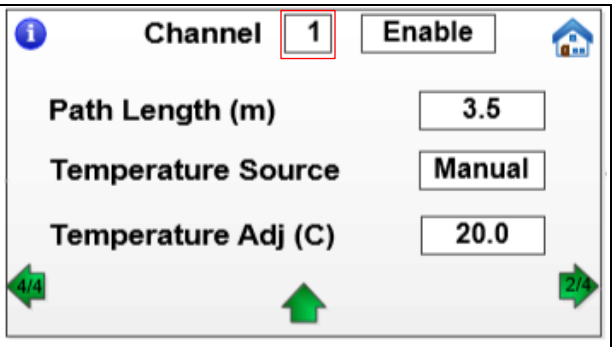
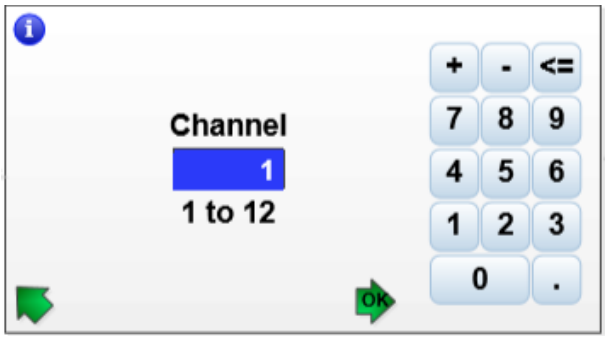
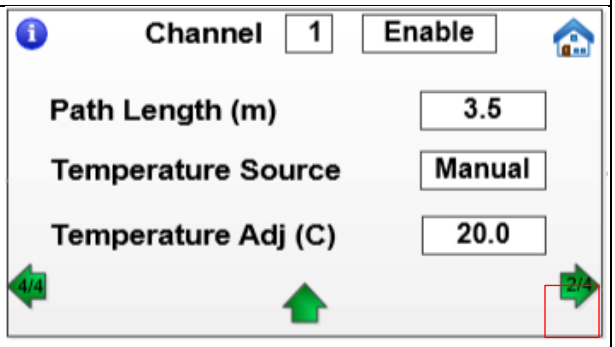
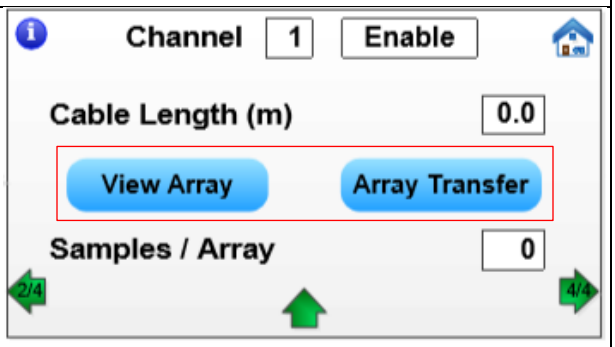
Selecting Dates	Select “Start Date” to choose the beginning day you wish to download log files from a calendar menu will allow the year month and day to be selected. Select “End Date” to specify the last day of log files you wish to collect. A calendar menu will allow the year month and day to be selected. Once the range of dates is selected, the system will index the files and display the number of files found in the range of dates as well as an estimated length to copy the files the USB stick. Once “Copy files” is selected the screen will display the current progress of transferring the files.	  
Status Screen while Copying Files	The Indicator Lights below will cycle, and file transfer progress is displayed. The system will show how many files have been copied out of the total selected files to be copied.	

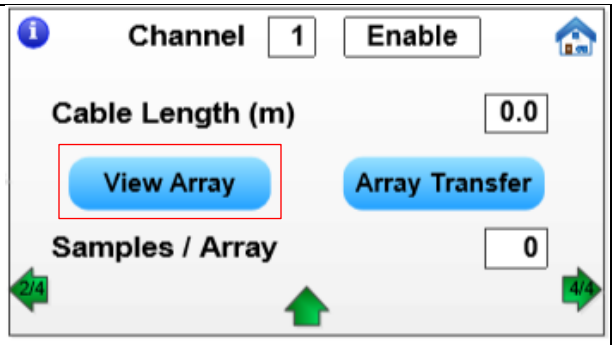
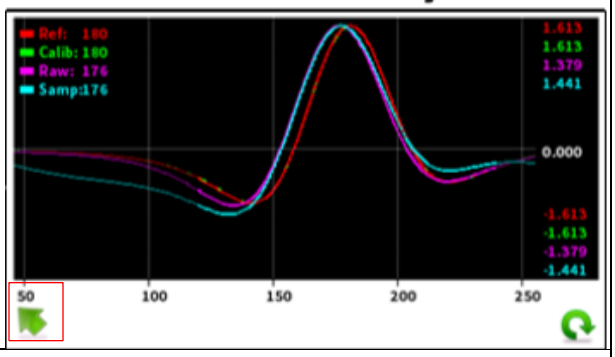
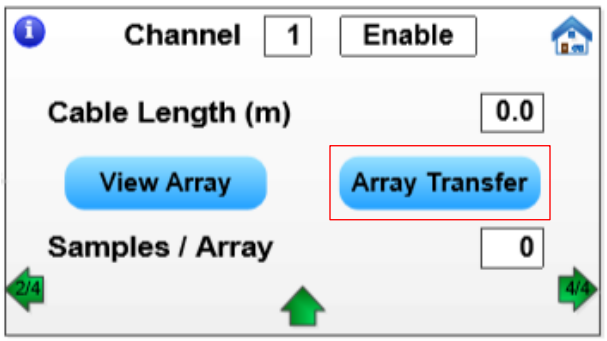
Transfer Complete	The USB stick can now be removed from the analyzer module. The log files should be on the USB stick stored in a folder labelled with the first two letters of the system gas and the system serial number.  Note: Once the file transfer is complete, it is important to hit the home button in the top right of the screen. This will return the system to normal operation.

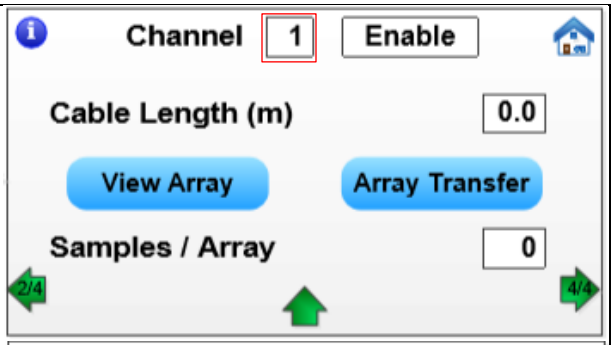
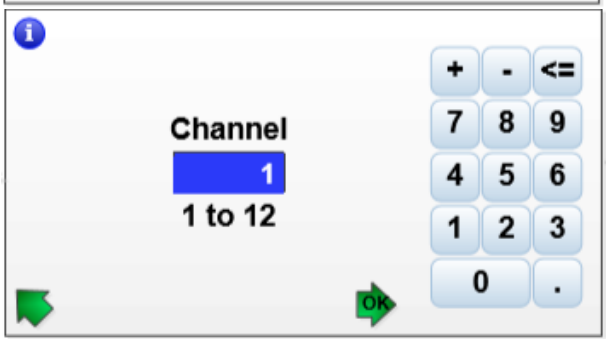
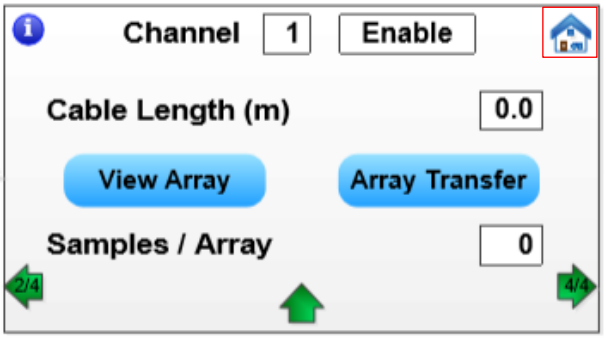
Capturing an Array Transfer (Channel Specific)

The GasFinder3-MC has a function to capture a detailed sample from a specific channel to be visualized for analysis and diagnostics purposes by Boreal Lasers' Support Team.

PM Step	Description
General Notes	Array Transfers from the system are stored within the GasFinder3-MC logfiles. Once the steps of capturing an Array Transfer for specific channels are complete. It will be necessary to follow the steps of transferring the logfiles from the appropriate day that this task was performed. See section "Data Download with USB Stick (Logfiles and Arrays)" Best practice would be to complete the Array Transfer steps and shortly after following the steps to download the current days logfile to a USB drive. The Array Transfers can then be extracted from the logfile using the Boreal Excel Macros. Once extracted they can be visualized using the Boreal Excel Macro by following the "Visualize Logfile/Arrays with Excel Macro" section within this document.
Select Settings	Select the settings icon in the bottom right of the touchscreen. (Wrench and screwdriver symbol) 
Select Channel-Specific	Select the Channel-Specific tab. The Channel-Specific menu will allow the user to initiate an Array Transfer or view an Array. The Array will be stored to the current days logfile for each specific channel these steps are performed on. 

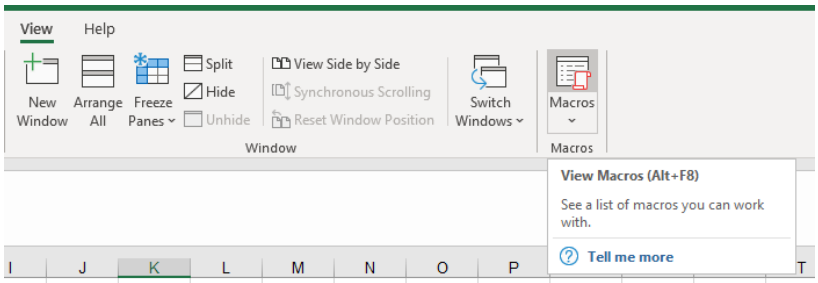
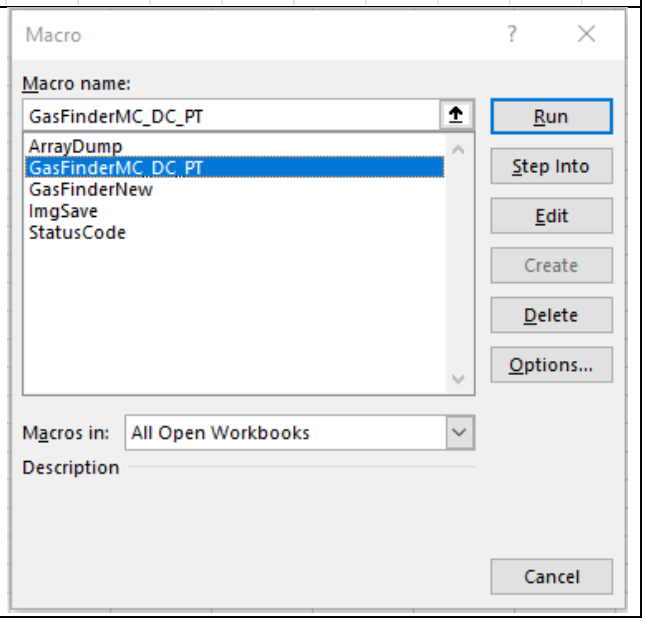
Channel parameters selecting channel number	Within the Channel-Specific menu you will find the parameters for each channel available. To change which channel parameters are displayed press the channel number icon at the top of the page. Once pressed enter the channel number you wish to display and edit parameters for. Press OK.	  Note: Array Transfers are channel specific. If an array is needed for a specific channel, ensure to select the channel that an array is required for. To capture an array for each channel it will have to be done individually for each channel in the steps below.
Navigate to the Array Transfer Page	Use the bottom right arrow to change pages in the Channel Specific menu. Navigate to page “3” for Array Transfers.	
Array Transfer Page	On the Array Transfer Page two buttons are available, both will transfer an Array once pressed. “View Array” and “Array Transfer”. Pressing either one of these will save an array transfer to the current logfile.	

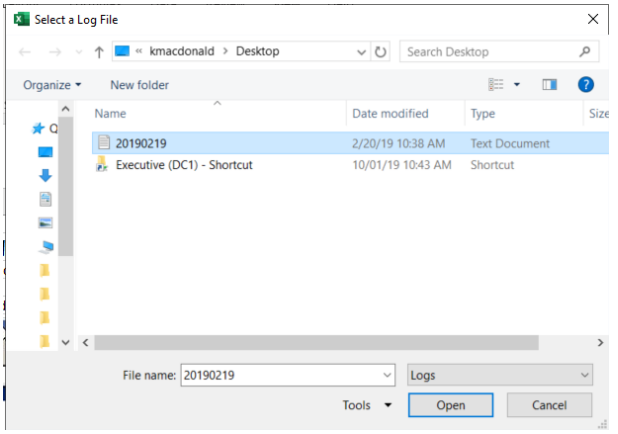
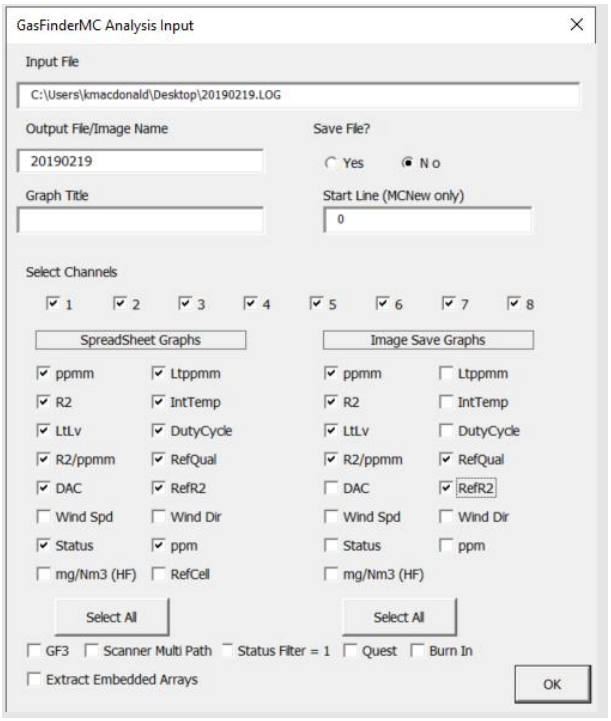
View Array Option	Pressing the "View Array" button will acquire an array and display it on the LCD screen to view. It will also save the array to the current logfile that day. To exit the array simply press the back arrow in the bottom left of the display.	 View Array 
Array Transfer Option	Pressing the "Array Transfer" button will simply aquire an array in the background and save it to the current logfile that day. Note: There is no notification that an array transfer is completed. It is simply recommended to be pressed once and the transfer will be completed in the background.	

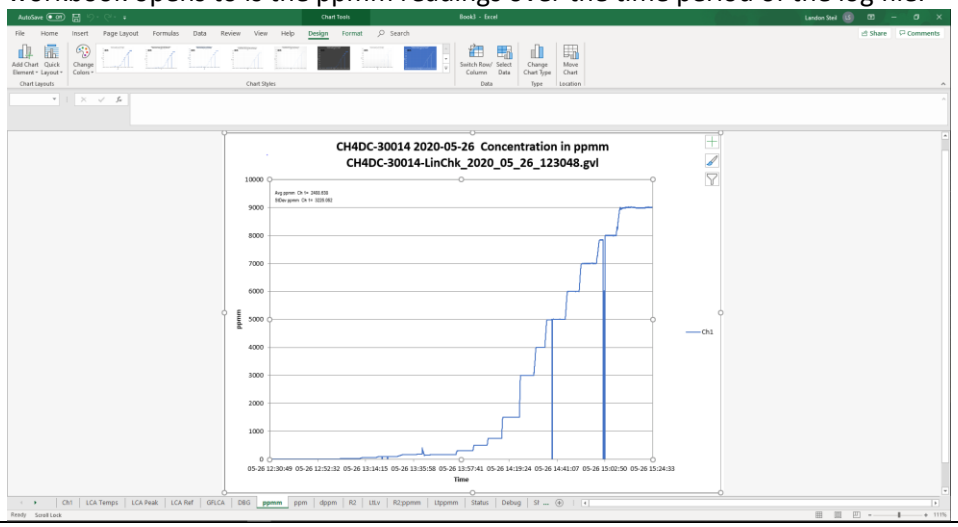
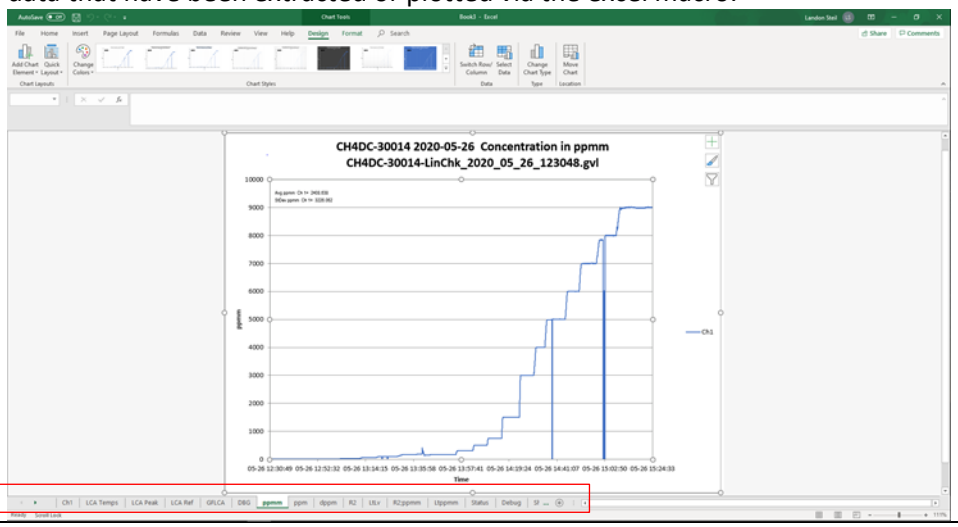
Capturing an Array on other channels	To complete an array transfer for other channels simply press the channel number at the top of the display. Select the appropriate channel number. Press OK. Repeat steps “Array Transfer Page” “View Array” Or “Array Transfer” for each channel.   Note: Array Transfers are channel specific. If an array is needed for a specific channel, ensure to select the channel that an array is required for. To capture an array for each channel it will have to be done individually for each channel in the steps below.
Exit to main display and download current logfile	Once array transfers have been completed. It is important to download the current day’s logfile containing the arrays. To download the current logfile follow the “Data Download with USB Stick (Logfiles and Arrays)” section within this document.  Note: Once the user has finished array transfers, it is important to press the home button in the top right of the screen. This will return the system to normal operation.

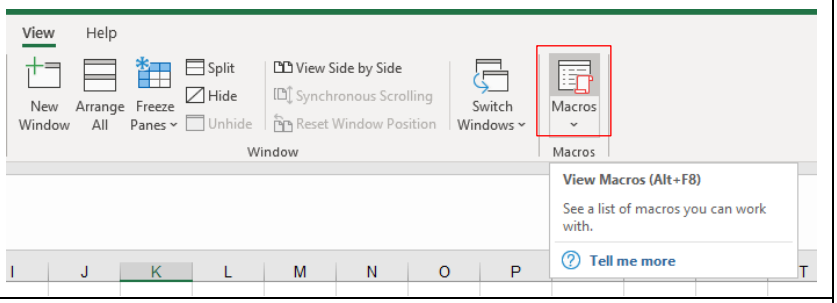
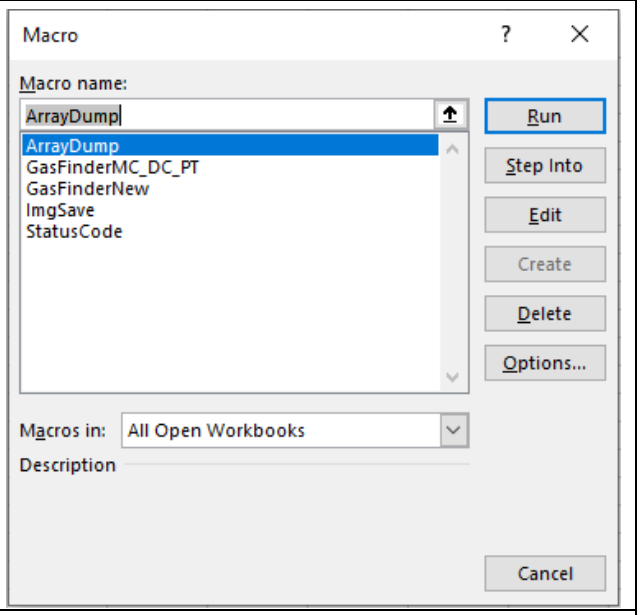
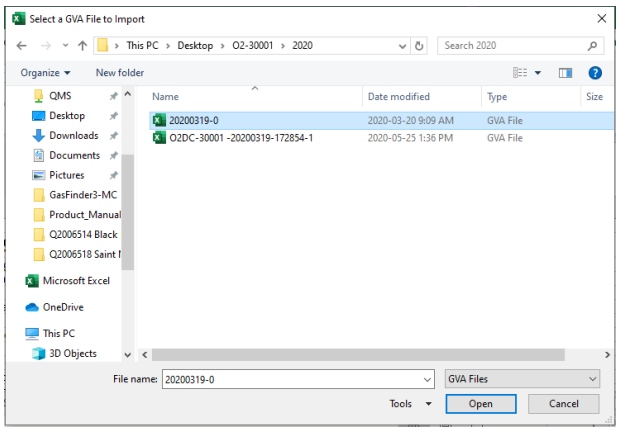
Visualize Logfiles/Arrays with Excel Macro

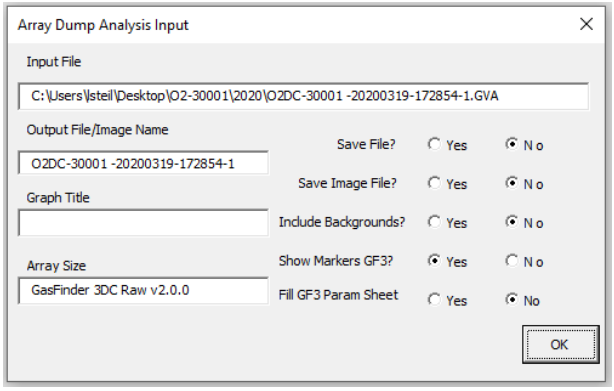
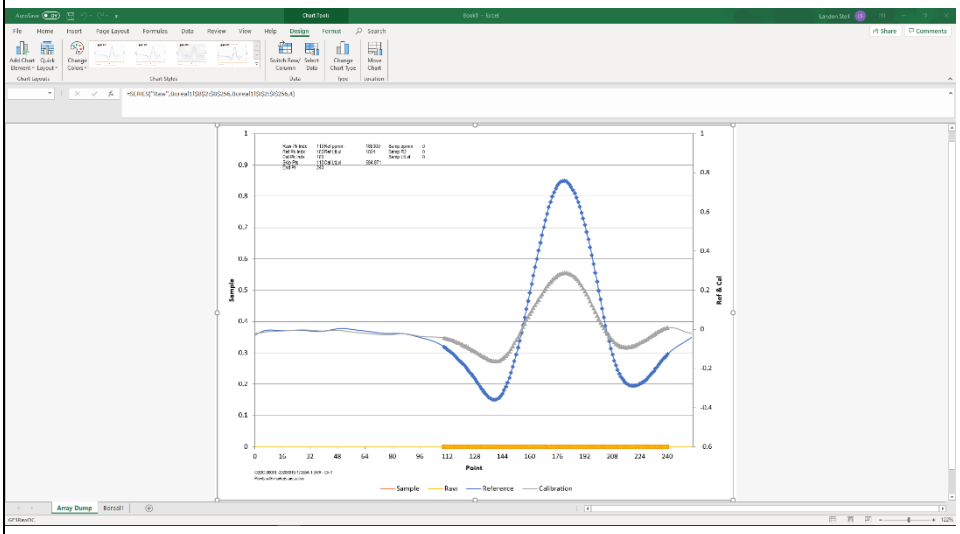
The downloaded Logfiles and Arrays, can be visualized with an Excel Macro.

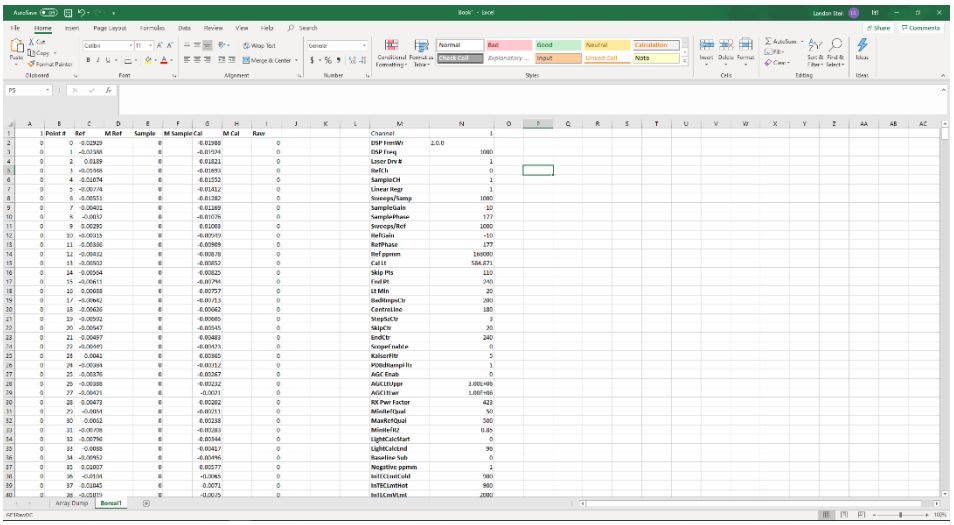
Step	Description
Access the Excel Macro	The Excel Macro is available from Support@boreal-laser.com
Open Excel Spreadsheet and Enable the Macro	Open the Boreal Laser Excel sheet provided containing the macros. Excel may ask to enable content. You must enable content to have the macros available.
Use ALT+F8 (Macro shortcut) Or Navigate to View tab and Macros	Selecting the macros button or using the shortcut keys will bring up a window with the available macros to run. 
Select GasFinderMC_DC_PT	From the Macro selection window. Select “GasFinderMC DC PT” for logfiles from GasFinder systems. Press Run. 

Select Logfile	Navigate to the appropriate logfile you wish to open. Select Open. 
Select optional graphs or save graphs as images	Once the macro finishes compiling the data from the logfile a window with additional options will open. This menu is for selecting additional options, graphs, and data to display. (The default populated selections are typically all that is required.) Press OK. 

Navigating the logfile in Excel	An Excel workbook should now open with several workbook tabs for the various graphical and raw data from the logfile. The default graph the workbook opens to is the ppmm readings over the time period of the log file. 
	The bottom row of the excel workbook contains the available graphs and raw data that have been extracted or plotted via the excel macro. 
Further assistance or detailed review	For assistance navigating or detailed review of log file data please contact: • Support@boreal-laser.com

Opening an array file	With the Boreal Macro Excel sheet still open. Use ALT+F8 (Macro shortcut) Or Navigate to View tab and Macros 
Select Array Dump	From the Macro selection window. Select "ArrayDump" for array transfers from GasFinder systems. Press Run. 
Select array file	Navigate to the appropriate Array Transfer file you wish to open. Select Open. 

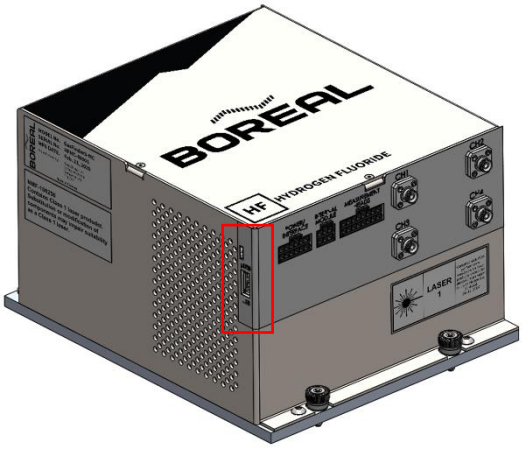
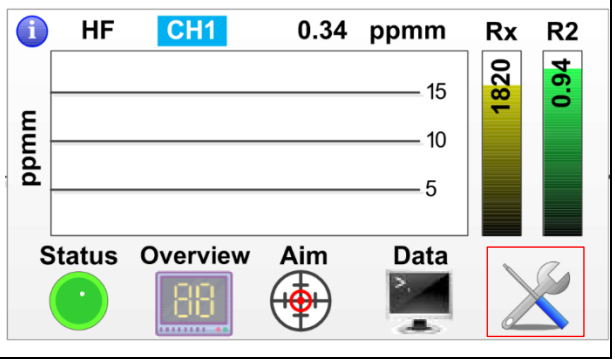
Select options to save file or save as image	Once the macro finishes compiling the data from the array file a window with additional options will open. This menu is for selecting additional options, (The default populated selections are typically all that is required.) Press OK. 
Navigating the array transfer file	The default open workbook in the Excel file is the Array Transfer from the system. This is a visualization of the waveform from a sample of the measurement path. 

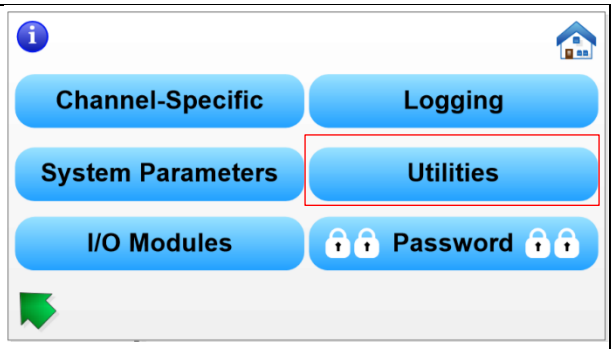
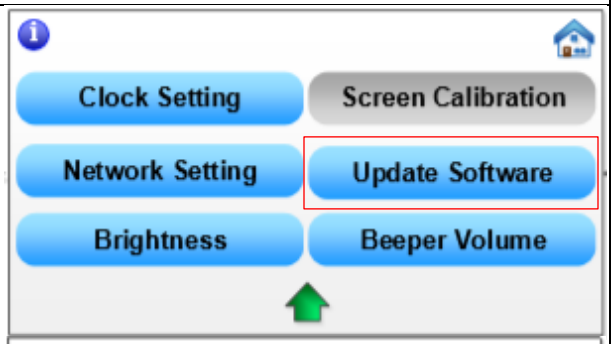
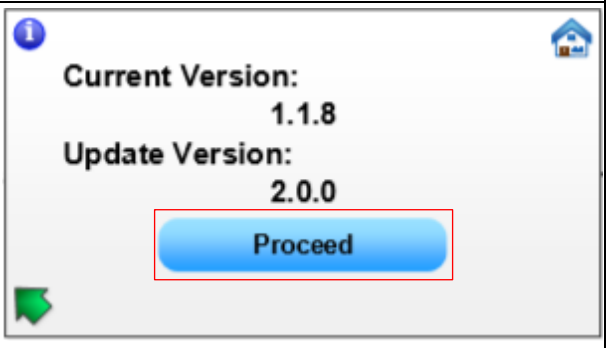
Navigating the array transfer file (continued)	The second workbook present in the Array Transfer file is the raw data captured from the analyzer. Along with the raw data it also includes several system parameters and diagnostic information. 
Further assistance or detailed review	For assistance navigating or detailed review of array transfer data please contact: Support@boreal-laser.com

Firmware Upgrade

Below are the instructions to update the firmware on the analyzer modules.

Note: This will require the system to be power cycled upon completion of each module update.

Step	Description
Copy file to the root directory of a USB Stick	Update files are available from Support@boreal-laser.com Copy the provided files directly to the root directory of a USB stick. There will be up to 4 update files, one for each of the internal modules within the analyzer. Note: The USB stick must be FAT32 format. This is the typical format for USB sticks however some external hard drives and storage devices are not.
Plug-in USB Stick into the Laser Analyzer Module	Insert the USB stick on the left of the analyzer module enclosure. 
Enter Settings menu	Select the settings icon in the bottom right of the touchscreen. (Wrench and screwdriver symbol) 

Select Utilities menu	Select the "Utilities" icon. The Utilities menu will allow the user to adjust clock and network settings along with perform software updates.	
Select "Update Software"	Select the "Update Software" icon. This will display 4 modules that are available for software updates. These include updating the IPM module, LCD Display, LDD Module, and DSP Module.	
Confirm software versions. Select proceed	Once a module is selected to be updated the system will verify and check the update file on the USB. It will then list the current version of firmware on the module and the version found on the USB drive. Proceed If the current version is older than the update version.	

Update status screen	Once proceed is selected the system will begin the update process on the module. A status screen with indicator lights will cycle. **Note:** Do not interrupt or power off the GasFinder during this process.
Power Cycle System	Once the update is complete the system will prompt the user to power-cycle the analyzer. Doing so will reboot the GasFinder3-MC. The system checks all it's software upon initial start up. **Note:** The system will perform its internal checks and a warmup sequence to stabilize temperatures. Once stabilization is complete the system will return to normal operation. This process should take less than 2 minutes.
Repeat section for other modules	Repeat this sections steps to update the other analyzer modules if required.
Array Transfer	It is recommended once software updates are completed to capture an array transfer and send the days logfile to Support@boreal-laser.com See section "Capturing an Array Transfer (Channel Specific)" to perform this step.
Further assistance	For assistance with software updates please contact: • Support@boreal-laser.com