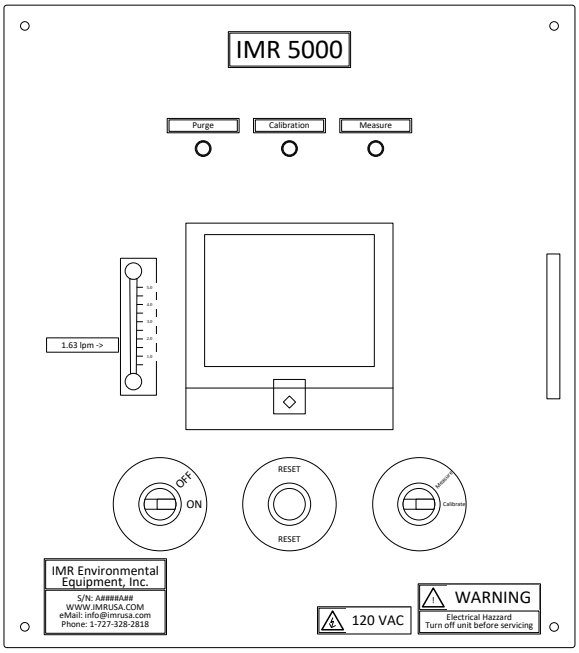
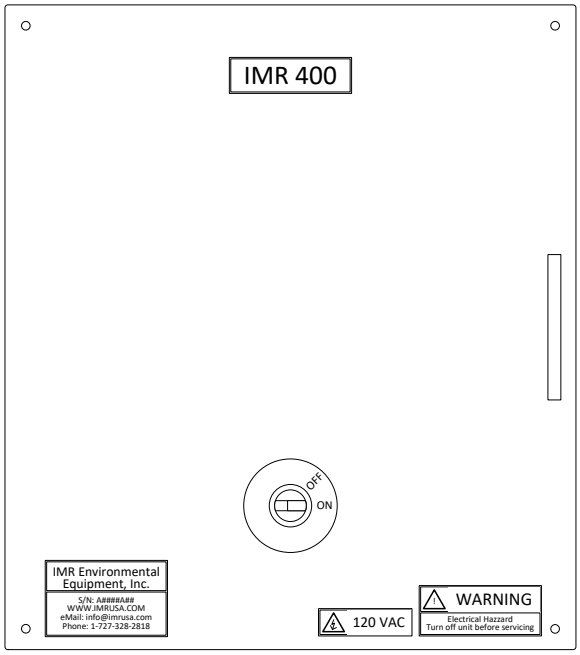
Environmental Equipment, Inc.

CEMS OPERATING MANUAL

[COMPANY NAME]

S/N: F1234X56





INTRODUCTION

Thank you for purchasing the IMR Continuous Emission Monitoring System!

This IMR CEMS installation is a state of the art combustion gas analysis system. Proper installation and maintenance is necessary to ensure optimal operational performance.

IMPORTANT INFORMATION:

- Use the instrument within the recommended temperature range
- Never operate the system without filters
- All filters must be replaced regularly or when dirty
- IMR or an authorized service facility/technician should check and adjust the instrument on a regular schedule or as needed

SAFTEY INFORMATION

- Read this section carefully to help prevent harm to the system or personnel.
- Follow all warnings and instructions noted on the instrument or indicated on the display
- All hardware that requires AC power needs a proper earth ground
- Avoid any adjustment or maintenance of the hardware while it is powered on
- Ensure that only qualified personnel maintenance the instrument
- Do not submerge the instrument in water
- Do not spill any liquid in the instrument

SYSTEM DESCRIPTION

This gas analysis system consists of the following items:

Gas Analyzer: IMR 5000

- Sensors: CO2, CO, NO, NO2
  Temperature, Flow
- Communication: Ethernet, RS485, 4-20mA

Gas Conditioning: IMR 400

- Probe: 300mm
- Heated Sample line: 1.5m
- Dryer Method: Peltier

Operating Conditions

- Power supply: 120 VAC / 60Hz
- Ambient temperature: 5°C - 40°C
- Storage temperature: -25°C - +65°C
- Circuit Breaker: 6A / 250VAC max

Logical System Operation:

- Sample gas is drawn from the sample point into the probe.
- The sample then flows through the heated sample line where it is heated to ~120℃
- Then the large particulate matter is separated by the filter in the IMR 400 case
- Any remaining fine particulate is filtered by the disposable plastic filter in the IMR 400
- The sample then has the moisture removed by the drying system
- The clean and dry sample then exits the IMR 400
- The sample then continues to the IMR 5000 where it measured by the sensors

INITIAL SET UP

IMPORTANT: after completing instillation the system will need to run for ~40m for the Heated Sample Line to reach operating temperature.

See the IMR CEMS install manual for guidance on setup.

OPERATION

The Heated Sample Line has a RED L.E.D. indicator; note the following states:

- LED is OFF when warming to temperature
- LED is ON when it reaches maximum temperature
- LED will FLICKER as it approaches operating temperature

NOTE: Condensate may drip from the Condensate Out port on the bottom of the IMR 400 enclosure.

LEDs – IMR 5000

- Calibration: Calibration Mode – "Cal Gas In" port is active
- Purge: Purge Mode - Flue Gas is venting from "Purge Out" port - Sensors are "Zeroing"
- Measure: Measurement Mode - Normal runtime – Flue Gas is being analyzed

Dials – IMR 5000

- ON/OFF: Powers instrument on and off
- RESET: Resets cycle timer - Sensors will return to "Zero"
- CALIBRATE/MEASURE: Switches between normal flue gas analysis and calibration mode

1. Configuration: Recorder

The sensor display unit will display the gas sensor(s) in ppm, %, or mg/Nm3 values.

1.1. Technical Specifications:

Sensor	Sensor Technology	Measuring range
CO2	NDIR	0 – 20 % vol.
CO	Electrochemical	0 – 2000 ppm
NOx	Electrochemical	0 – 1000 ppm
SO2	Electrochemical	0 – 200 ppm
T/C Gas	Type-K	0 – 1100 °C
Velocity	Solid State	0 – 40 m/s

1.2. Factory Configuration:

S/N: F1234X56

Slot 1 AI 206	Name	Offset	Input Type	Range Low	Range High
AI1	CO2 in	-0.003	V	0.000	5.000
AI2	CO in	-0.010	V	0.000	5.000
AI3	NO in	-0.005	V	0.000	5.000
AI4	NO2 in	-0.005	V	0.000	5.000
AI5	T/C in	0.0	T/C K Type	-270.0	1370.0
AI6	Flow in	-0.064	mV	-20.000	20.000

Slot 2 AO 206	Description	Type	Output	Expression
AO1	CO2 out	Current	4-20mA	4+16*Math1/20
AO2	CO out	Current	4-20mA	4+16*Math2/2000
AO3	NO out	Current	4-20mA	4+16*Math3/1000
AO4	NO2 out	Current	4-20mA	4+16*Math4/200
AO5	T/C out	Current	4-20mA	4+16*(AI5-(-270.0))/(1370.0-(-270.0))
AO6	Flow out	Current	4-20mA	4+16*(Math6-(-40.0))/(40.0-(-40.0))

1.3. Factory Calibration Configuration

Channel	Name	Expression	Unit	Decimal
Math1	CO2	HI((AI1*(8.882/0.479)),0)	%	2
Math2	CO	HI(((AI2-AI3*(0.1/0.8))*(402.2/0.8)),0)	ppm	0
Math3	NO	HI((AI3*(406.5/0.8)),0)	ppm	0
Math4	NO2	HI((AI4*(39.63/-0.08)),0)	ppm	0
Math5	T/C	AI5	°C	1
Math6	Flow	AI6*(28/0.13)	m/s	1

2. System Start up

Verify that all the connections for electrical and tubing are secured.

Also check:

- Enclosures are securely mounted
- Cables and tubing are not over stretched
- Heated Sample line connections are secure on both ends
- Gas Sampling Probe is set at the proper depth and secured
- Temperature Probe is secured
- Data outputs from the recorder are connected (RS232/RS485, Ethernet, 4-20mA)

2.1. Warm-up cycle

After initial setup is completed set the selector switch to Calibration mode before the unit is powered on.

- This cycle will have the analyzer purge the sensors with fresh air
- Ensure that the "Cal. Gas In" port has access to fresh uncontaminated air
- The unit should be kept in this cycle for ~30 minutes
- Check the output of the sensors after the initial 30 minute warm up; if the sensor output is stable then switch to Measurement mode
    - If the zero-points are not satisfactory, then output may need to be adjusted
    - NOTE: NO and H2S sensors may require additional time to stabilize (6003 Attached)
    - See section 3.2 for the zero point adjustment procedure

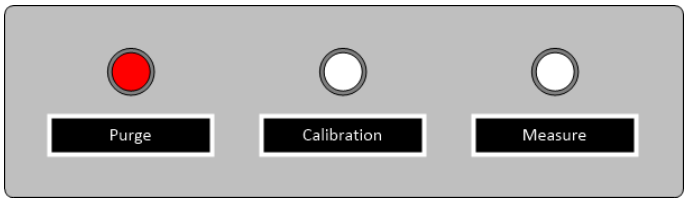
2.2. Purge Mode

The instrument will begin this mode when:

- First powered on with the Measure/Calibrate dial set to Measure
- Switching from Calibration mode to Measure mode
- The Reset button is pressed

Instrument operation during a Purge cycle:

- All flue gas sensors are being flushed with "fresh air" from the "Air In" port, and are settling to their zero point
- Flue gas will be vented from the "Bypass Out" port
- The Red "Purge" L.E.D. will be illuminated



The Purge cycle is 15 minutes (Default, duration is user configurable).

NOTE: This instrument purges the gas line between the stack and IMR 400 every time Purge Mode is started. See Section 5 for details.

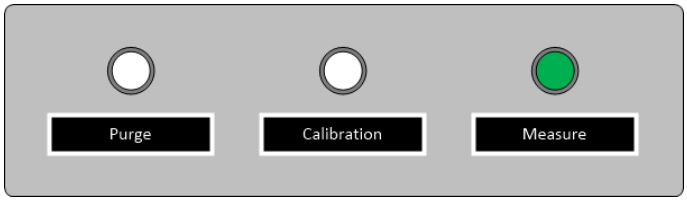
2.3. Measure Mode:

The instrument will begin this mode when:

- The Measure/Calibrate dial is set to Measure AND a Purge cycle has ended

Instrument operation during a Measurement cycle:

- All sensors are receiving dried and clean flue gas from the "Flue Gas In" port
- The Green "Measure" L.E.D. will be illuminated



The Measurement cycle runs for 8 hours (Default, duration is user selectable).

2.4. Calibration Mode:

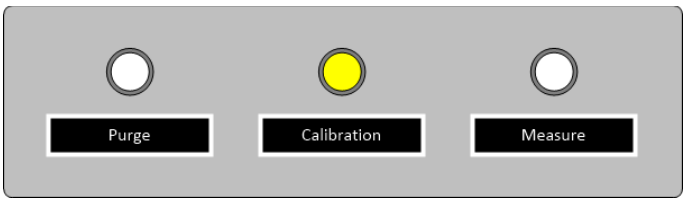
The instrument will begin this mode when:

- The Measure/Calibrate dial is set to Calibrate

Note: The Reset button has no effect if the instrument is set to Calibration mode.

Instrument operation during Calibration Mode:

- All flue gas sensors are receiving air from the "Cal Gas In" port
- Flue gas will be vented from the "Bypass Out" port
- The Yellow LED will be illuminated



Note: it is important that the Cal. Gas In port is only pulling in fresh air. If the instrument is housed in an enclosed area it may be necessary to connect tubing to this port and run it outside of the enclosure in order to ensure an accurate zero point can be established for calibration.

3. Calibration

Certified calibration gas is needed to calibrate the sensor(s).

Single gas tanks (with N2 or O2 balance) are recommended. Do not use calibration tanks with multiple test gases.

The calibration should be checked once a month to ensure the accuracy of the measurement.

3.1. Calibration Setup

There are two standard methods for calibration:

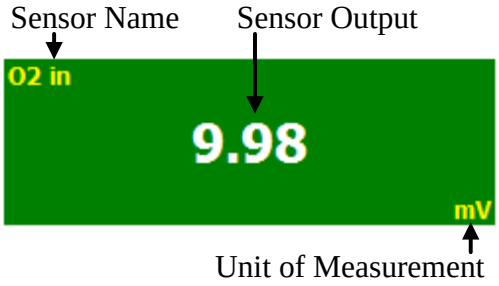
1. Using the Observer software and connecting to the Recorder via Ethernet
2. Manual key in at the Recorder

For simplicity this guide will cover the Manual key in method.

3.2. Adjusting the Zero Point:

To begin set the Measure/Calibrate knob to Calibrate, and wait 15 minutes for the sensor readings to settle to Zero.

On the Recorder press  , then press Realtime, and then Overview. The Overview page will now be displayed. There will be several boxes as shown below.



The specific sensor name will change per sensor input so will the UOM. Only the values from boxes that have “in” after the sensor name will be used for adjusting the zero point.

If any of the values are above zero change the “Offset” on the AI (analog input) page for that sensor. An O2, CO2 sensor zero point can be found by using any test gas that does not contain these gases.

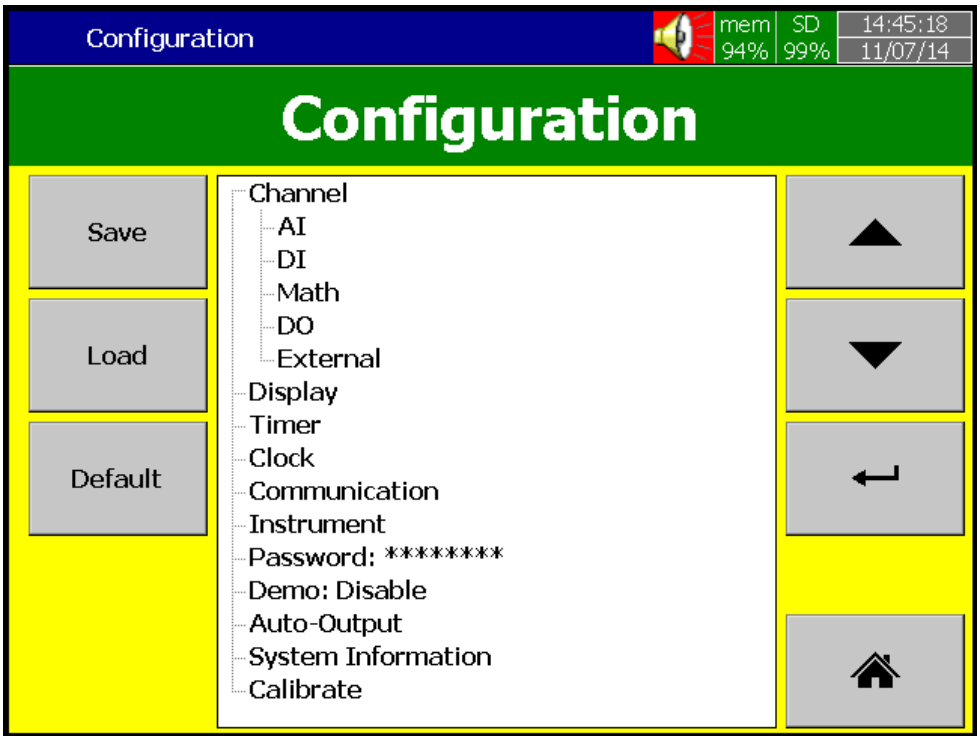
All zero points should be negative numbers (except for NO2 and other negatively reacting sensors). If the sensor idles above zero then enter a value into the “Offset” field that will cause the sensor to idle below zero.

Example: CO sensor in fresh air has a response of 0.009 V. The Offset can be set to -0.010. The result would be a new fresh air idle of -0.001.

The goal is to keep the standard sensor fluctuation in fresh air below 0.

To reach the AI pages. Press  , then More and then Configuration.

The screen below will be displayed.

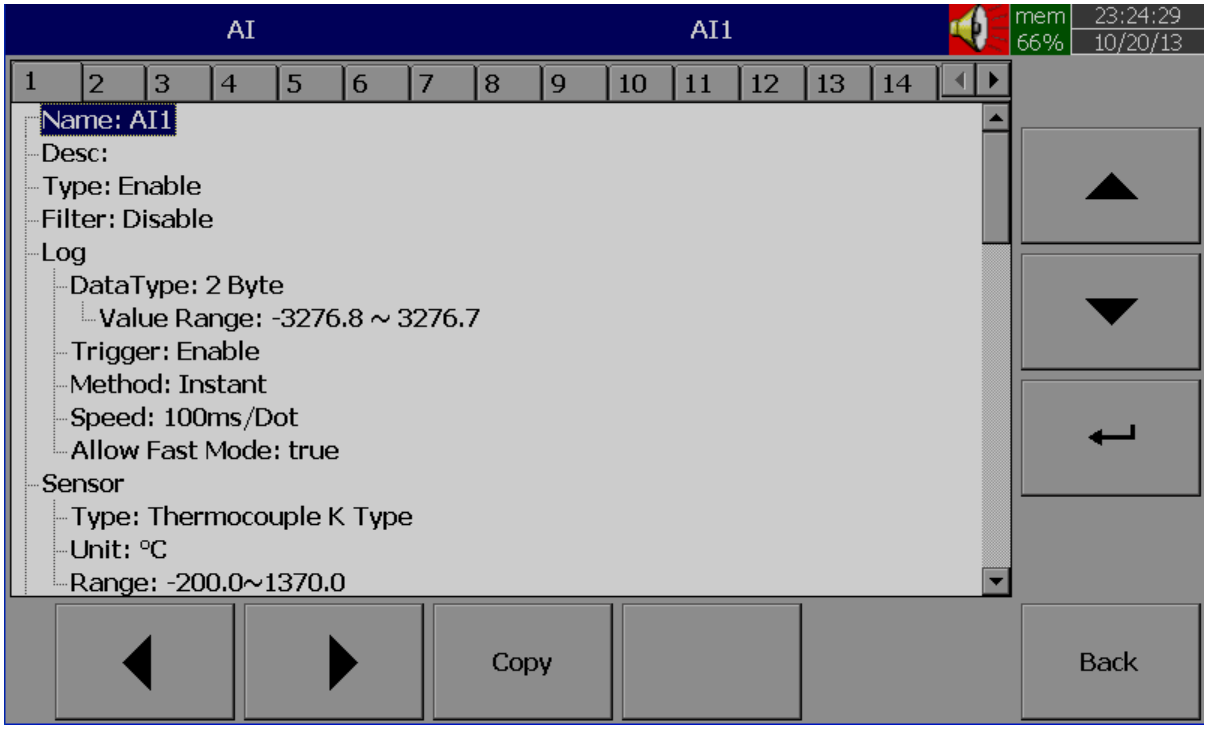


Under Channel tap AI and then press  .

Change sensor pages by taping on the numbers across the top of the screen or by using the left and right arrow buttons on the bottom of the screen.

Scroll down to find the “Offset” field by using the scroll bar on the right or the up and down arrows on the right.

Once the “Offset” field is located press ↵ to edit the field. Using the information from the Overview page set a new zero point.



Once all sensor zero points have been set continue on to setting the Span.

NOTE: The zero point for O2, CO2 sensors can be found by using any test gas that does not contain these gases.

3.3. Adjusting the Span:

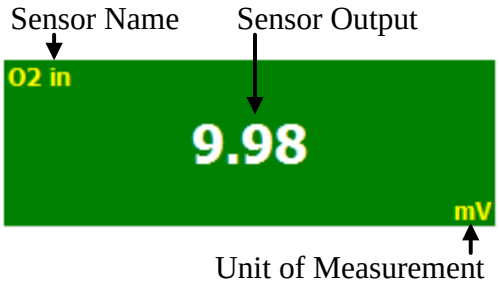
To begin setting the span first locate the “Cal. Gas In” port on the side of the enclosure.

Determine the flow rate at the Cal. Gas In port as this flow rate will need to be equal or greater from the calibration gas tank.

A flow meter should be used in conjunction with the calibration tanks if one is not already installed in the instrument.

Apply the calibration gas to the instrument

On the Recorder press  , then press Realtime, and then Overview. The Overview page will now be displayed. There will be several boxes as shown below.



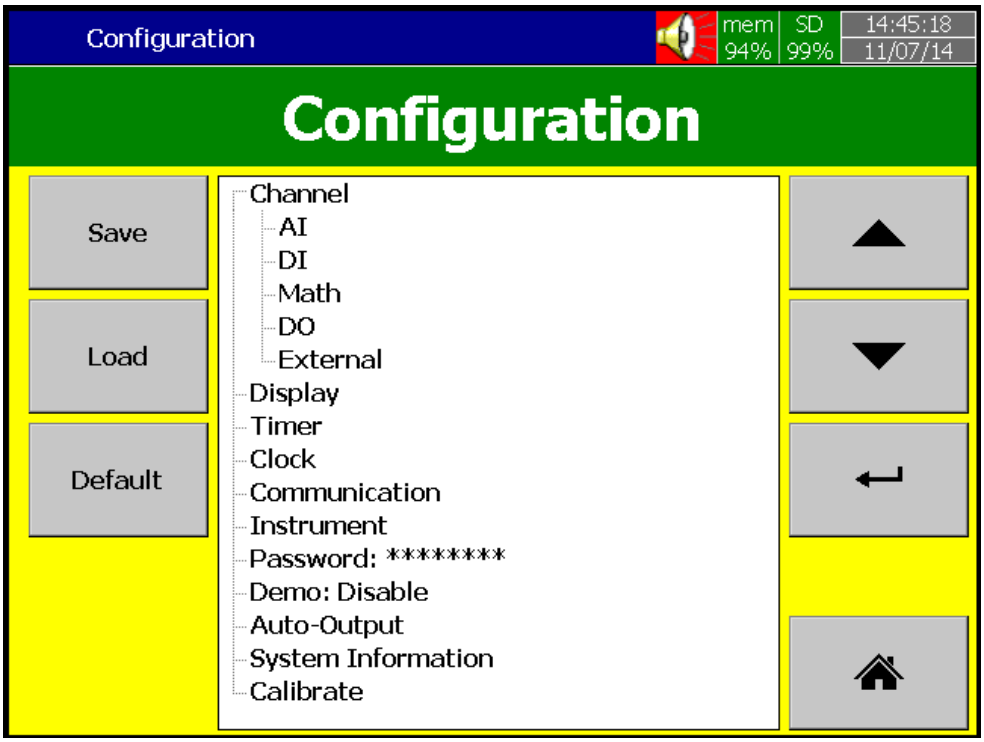
The specific sensor name will change per sensor input so will the UOM. Only use values from the boxes that have “in” after the sensor name.

Once the Sensor Output has stabilized record the value. The reading should stabilize within three minutes.

Now the calibration math needs to be modified.

To reach the Math pages. Press  , then More, and then Configuration.

The screen below will be displayed.

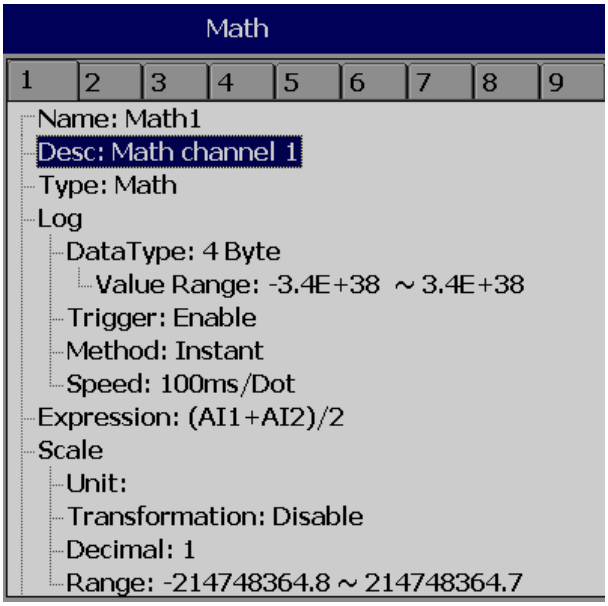


Under Channel tap Math and then press  .

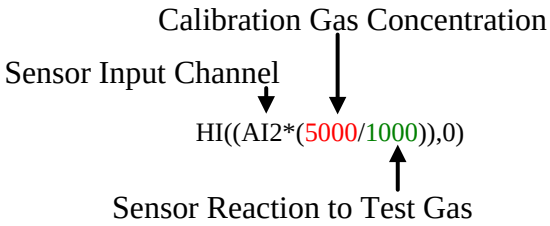
Change sensor pages by taping on the numbers across the top of the screen or by using the left and right arrow buttons on the bottom of the screen.

Scroll down to find the “Expression” field by using the scroll bar on the right or the up and down arrows on the right.

Once the “Expression” field is located press ↵ to edit the field and using the information from the Overview page set a new span.



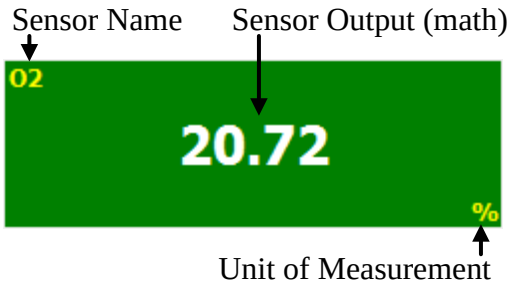
Set the formula for the current sensor being calibrated; where red is the concentration of the calibration gas and green is the value on the Overview page for the sensor being calibrated while calibration gas is applied.



NOTE: Only the values in RED and GREEN need to be modified. The above math expression is not the same for every input. Expect differences!

After the math have been updated press 

and then press  to return to the Overview page and verify calibration accuracy.



On the Overview page the boxes that are only labeled with the sensor name only (ex. “CO”) are the fields where the completed Math is output. Here you can verify the calibration for accuracy.

If output has changed since the math was set then refer to the AI field on the Overview page of the relevant sensor and return to the Math expression and adjust it as necessary.

After sensor output is stable. Disconnect the calibration tank hose from the “Cal. Gas In” port and turn off the tank valve.

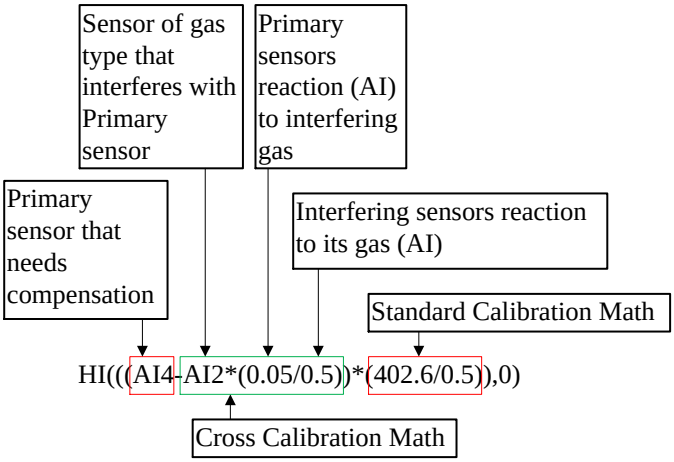
Wait for 5 minutes or until the sensors reach their zero point and then apply the calibration gas again. Repeat the span process until a stable result is obtained

When all the sensors are calibrated set the selector knob back to Measurement

IMPORTANT: If a sensor needs to be replaced then a new calibration point must to be set.

3.4. Interfering Gas Calibration Compensation

Some sensors are sensitive to test gases other than the ones they are designed for. This is a normal occurrence for electrochemical sensors. These sensors may require additional math as seen below. This compensation is not necessary for all sensors.



In the example above:

- AI4 is the Sensor that requires the cross calibration compensation (Ex. SO2)
- AI2 is the Senor of the gas type that interferes with the Primary sensor (Ex. CO)
- 0.05 is the Primary sensors reaction to the interfering gas (Ex. SO2 sensors reaction to a CO test gas).
- 0.5 in the green box is the Sensor of the interfering gas type (Ex. CO sensors reaction to a CO test gas).
- 402.6/0.5 is the Primary sensors standard calibration math (See section 3.3 for adjusting the span)

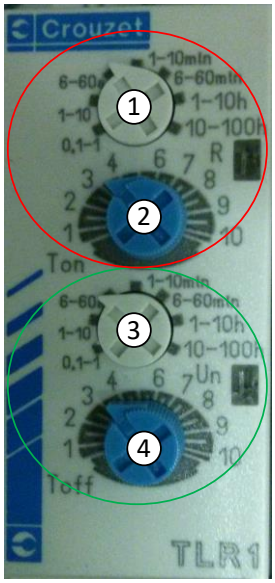
The section in the green box may be repeated if more than one gas interferes with the measurement of a sensor. It may also appear in another Math page and be referenced in the calibration formula as “Math##”.

Contact IMR if assistance is required with calibration

4. Cycle Timer

The Cycle Timer handles the automatic switching between fresh air Purge and the flue gas Measurement cycles.

See section 2.2 and 2.3 for when this system is active.



Purge

Measure

- Dial (1) is the course adjustment for the Purge cycle
- Dial (2) is the fine adjustment for the Purge cycle
- Dial (3) is the course adjustment for the Measurement cycle
- Dial (4) is the fine adjustment for the Measurement cycle

The default setting is 15 minute Purge and 8 hour Measure.

Example:

- White dial is set to 6-60
- Blue dial is set to 4
- Result: 24 seconds

5. Compressed Air Cleanout

This instrument has special configuration for a Solenoid Valve. When Purge Mode starts the sample probe and heated sample line will begin to be purged with compressed air (facility provided). This will last for 30 seconds (user configurable) and is independent of the Purge cycle duration.

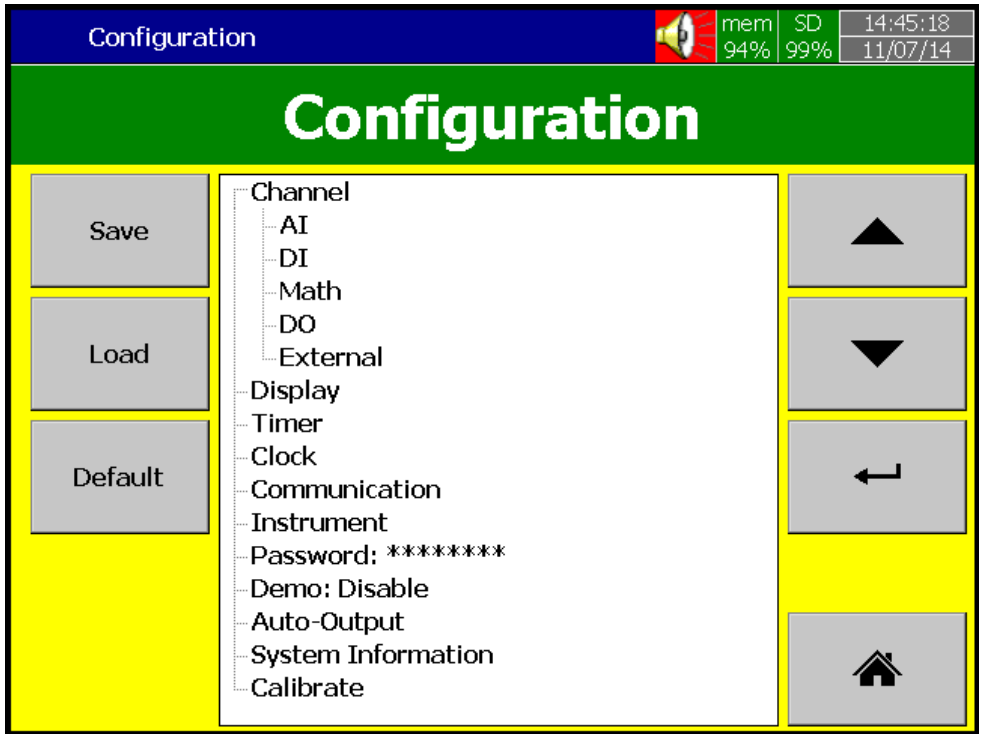
NOTE: It is important that the compressed air be attached at port (2). If the compressed air is attached to the wrong port the valve may fail or not work as intended.

5.1. Changing cleanout duration

How to change the duration that the Sample Gas line is being purged by Compressed Air:

Tap  then More and then Configuration.

The screen below will be displayed.



Tap Timer and then press  .

Timer (1) controls the duration that the valve is open. The default is 30s.

6. Web Server

The Recorder Trend and Digital graph data can be viewed on a local LAN or in any place in the world if with a static IP address provided by your local ISP.

7. Modbus

The Recorder has the ability to communicate with Third party Interfaces via protocols such as Modbus TCP/IP or Modbus RTU as either a Modbus Master or Modbus Slave. For additional information on Modbus mapping contact IMR. Below are the most common addresses used.

Modbus Address Mapping

Register (3xxxxx) Parameter Table for Modbus RTU Slave / TCP Server

AI Channel Data (Integer Type – 2 byte)

Modbus Address	Notation	Register Name	Access
2	AI1	AI 1 process value	R
3	AI2	AI 2 process value	R
4	AI3	AI 3 process value	R
5	AI4	AI 4 process value	R
6	AI5	AI 5 process value	R
7	AI6	AI 6 process value	R
8	AI7	AI 7 process value	R
9	AI8	AI 8 process value	R
10	AI9	AI 9 process value	R
11	AI10	AI 10 process value	R
12	AI11	AI 11 process value	R
13	AI12	AI 12 process value	R

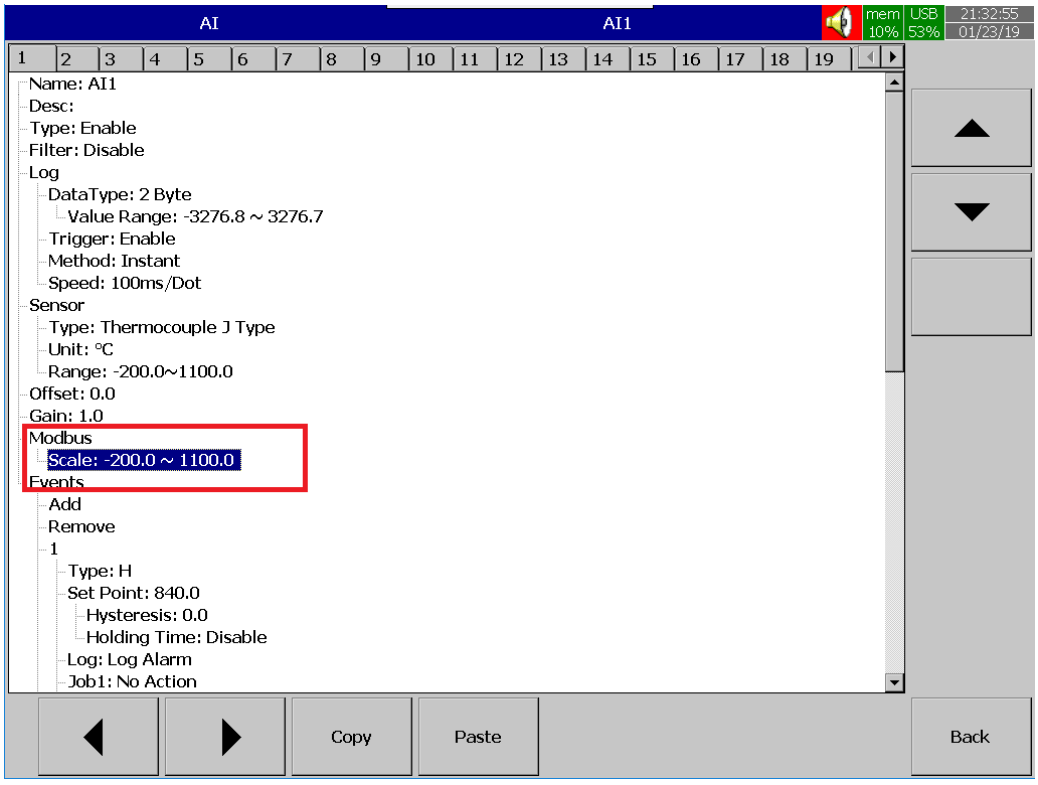
Communication error if output value is 65534

Math Channel Data (Float Type – 4 byte)

Modbus Address	Notation	Register Name	Access
1401	Math1	Math 1 process value	R
1403	Math2	Math 2 process value	R
1405	Math3	Math 3 process value	R
1407	Math4	Math 4 process value	R
1409	Math5	Math 5 process value	R
1411	Math6	Math 6 process value	R
1413	Math7	Math 7 process value	R
1415	Math8	Math 8 process value	R
1417	Math9	Math 9 process value	R
1419	Math10	Math 10 process value	R
1421	Math11	Math 11 process value	R
1423	Math12	Math 12 process value	R

Communication error if output value is 3.0+E38

Scale Lo and Scale Hi can be found on the AI/Math page of the relevant value.



MAINTENANCE

- Check the calibration once a month.
- Check the dust filter for dirt and replace as necessary.
- Check the gas outlets/fittings for debris.
- Check the condensation outlet of the gas-conditioning unit.
- Check the filters of the gas-conditioning unit and replace as necessary.
- Check the filter element of the probe and replace as necessary.

CONSUMABLES	Part No.
Dust filter (Plastic Housing)	72200
Paper Filter (Long)	72650
CO2 Sensor	CO2-NDIR-20%
CO Sensor	480105
NO Sensor	480001
NO2 Sensor	480009

SPARE PARTS	Part No.
Silicon Tubing	SL-1814
Valves (Solenoids)	VQD1151-5MO
Pump 24V	Pump 24V-S
Stainless Filter Housing (Long)	05001-Filt-LB
100mm Mounting Flange	MT-FL-5000-3
24V 1.7A Power Supply	MDR-40-24
5V 3A Power Supply	MDR-20-5
1.5m Heated Line at 110VAC	H226-1.5-110

IMPORTANT: Send the Serial Number and model of the analyzer when ordering spare parts.

Specify the maximum range when ordering sensors.

Ask about special items!

WARRANTY

The company IMR Environmental Equipment International, Inc., 3632 Central Ave., St. Petersburg, FL 33711, USA states the following:

IMR as manufacturer hereby grants the following worldwide IMR guarantee for an IMR unit purchased from an authorized dealer.

1. The IMR guarantee shall entitle every IMR customer to demand a free replacement or repair of the defect parts of the IMR unit from any IMR dealer authorized for the respective IMR unit.

2. The IMR guarantee shall be granted on the factory new unit and shall commence on the date of the delivery of the original IMR unit to the customer.

3. The IMR guarantee shall refer to absence of faults with respect to the state of the art nature of the sold unit in terms of material and finish. The guarantee for all parts fitted during the twelve month guarantee period shall end with the unit guarantee.

4. After the establishment of a material or production fault by IMR or the authorized IMR dealer, the faults will be eliminated by means of free repair or replacement. Replaced parts shall become the property of IMR.

5. No guarantee claims may be made for maintenance and setting work, cleaning or other utility materials required for the function of the unit and other wear parts unless they have a direct bearing on work performed under the guarantee.

6. The terms and conditions for the acknowledgement of this guarantee shall be the presentation of the fully completed guarantee card which must contain the confirmation from the authorized IMR dealer on its delivery and, if applicable, the prescribed maintenance work.

7. The IMR guarantee shall only be applicable if:

   a. the IMR unit has been maintained in accordance with the instructions issued by the manufacturers and the operating instructions by an authorized IMR dealer
   b. only original IMR spare parts have been used for any repairs
   c. the unit has been used properly, the operating instructions observed and the unit has not been used for a purpose other than the one for which it has been designed
   d. the IMR unit has been left in its original design and meets the original IMR specifications
   e. the fault is not due to external influences or use for a purpose other than the one for which it has been designed
   f. exclusively authorized IMR dealers have made repairs to the IMR unit
   g. the IMR unit has been sent to an authorized IMR dealer immediately after the fault was discovered

8. Warranty time for the analyzer, including electrochemical sensors is 12 months.

Company Information

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