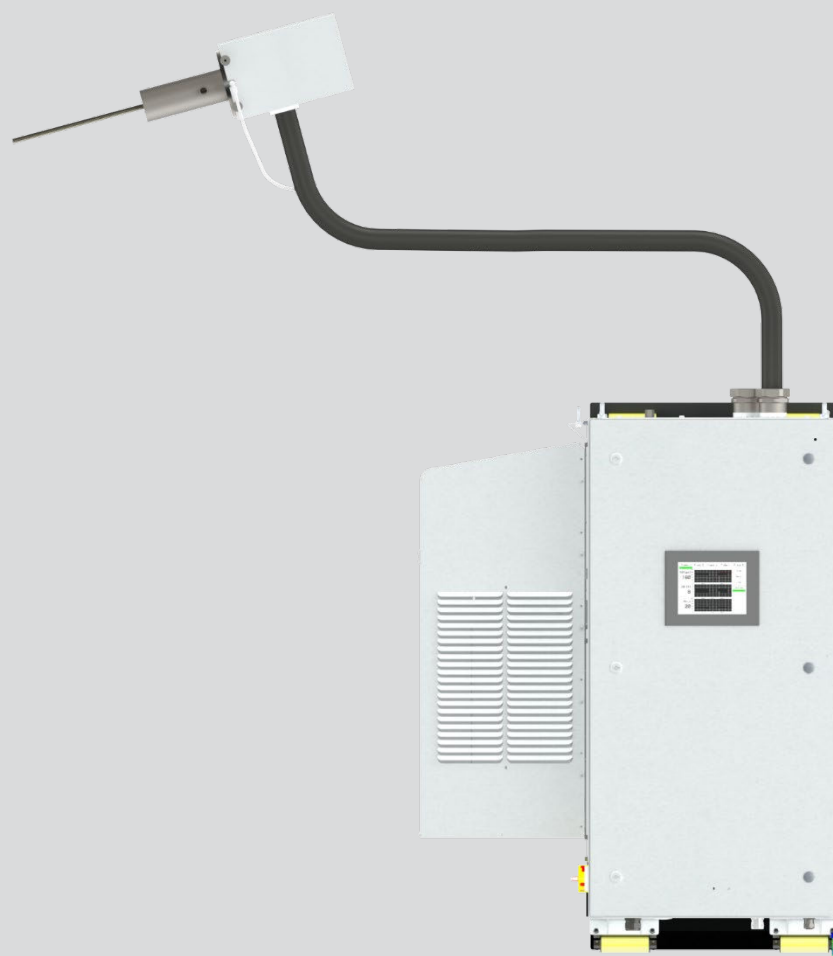


G7000

Multi Gas Monitoring System

User Manual



Document ID number: 03135

Maritime

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This user manual must be read carefully and must be kept for future use with the system.

For safe and proper use, read and follow all instructions in this manual. For spare parts, refer to the separate respective spare parts catalogue.

Green Instruments A/S reserves the right to make adjustments and improvements to its products and systems. This means that documentation is subject to change without notice.

Green Instruments A/S has taken all measures to ensure the information in this user manual is accurate and comprehensive. Green Instruments A/S reserves the right to make corrections and cannot be held liable for any errors or omissions in this manual.

All claims and inquiries for spares shall be addressed to Green Instruments A/S or our distributors. In all correspondence or when ordering spare parts, carefully state the equipment type, vessel IMO number, and the serial number, which can be found on the label on the equipment.

Green Instruments A/S appreciates all feedback and suggestions for improvement. If you have questions or comments relating to the user manual, contact Green Instruments A/S.

Contents

1. Terms and Abbreviations	6
2. Introduction	7
2.1 About the System	7
2.2 Technical Specifications.....	8
2.3 Storage and Handling	11
2.3.1 Storage	11
2.3.2 Handling.....	11
2.4 Delivery Check.....	11
3. Safety.....	12
3.1 Safety.....	12
4. HMI Structure	16
4.1 System Probes.....	16
4.2 Logged Data Screen.....	17
4.3 System Setup Login.....	19
4.4 System Status Screen.....	19
4.5 IO Status Screen	23
4.6 Manual Operation of System Components.....	27
4.6.1 Manual Reset of the System.....	27
4.6.2 Manual Setup.....	28
4.6.3 Probe Settings	29
4.6.4 Alarm and Warning Levels.....	30
4.6.5 Auto Calibration Settings.....	30
4.6.6 Average Settings.....	31
4.6.7 Changing Password	32
4.6.8 Changing the PLC IP Address.....	32
4.6.9 Function Buttons:	33
4.7 HMI Settings.....	36
5. Installation	37
5.1 Mechanical System installation.....	37
5.2 System enclosure.....	37
5.3 Heated sample lines.....	38

5.3.1	Connecting Heated Sample Lines	39
5.4	Probes.....	40
5.4.1	Choosing a Sampling Point.....	40
5.4.2	Fitting a Probe.....	40
5.5	System Enclosure Connections and Probe Connections (Electrical Connections)	41
5.5.1	Connecting Probes.....	41
5.5.2	Connecting Heated Sample Lines	42
5.5.3	Connecting External Power	42
5.5.4	Installing Cables.....	42
5.5.5	Terminals, Cables and Wires Marking.....	42
5.5.6	Communication.....	42
5.5.7	Communication Protocol Table Columns	43
5.6	Remote Control Flowchart.....	47
5.7	G7000 MGMS Remote Control	48
5.7.1	Remote (R/W).....	48
5.7.2	Probes on (R/W).....	48
5.8	Commissioning.....	50
5.8.1	Pre-commissioning Checklist	50
5.8.2	Probes.....	51
5.8.3	Heated Sample Lines.....	51
5.8.4	System Enclosure.....	52
5.8.5	Initial Leak Test Prior to Operation.....	53
5.9	Fitting the Probe Tubes.....	53
5.10	Technical Documentation List.....	54
6.	Operation.....	55
6.1	Operating the G7000 MGMS.....	55
6.2	Leak Test	56
7.	Validation and Calibration.....	57
7.3	Auto and Manual Calibration	57
7.4	Annual Calibration and Validation.....	57
7.4.6	Auto and Manual Calibration and Validation	58
7.5	Validation and Calibration Procedure.....	58
8.	Maintenance	60
8.1	Planned Maintenance Program.....	60

9. Lifetime Considerations	63
10. Services.....	65
10.1 Return of Equipment.....	65
11. Troubleshooting.....	66
11.1 General Troubleshooting	66
11.2 Flow Alarm Flowchart.....	68
11.3 Overview of Maintenance Instructions.....	69
12.System Hibernation	71
13.Maintenance Instructions.....	72
MI7000-0001	72
MI7000-0002	73
MI7000-0003	74
MI7000-0004	75
MI7000-0005	77
MI7000-0006	78
MI7000-0011	79
MI7000-0013	80
MI7000-0014	82
MI7000-0017	84
MI7000-0018	86
MI7000-0019	88
MI7000-0020	90
MI7000-0021	91
MI7000-0022	94
MI7000-0023	97
MI7000-0029	99
MI7000-0038	100
MI7000-0039	101
MI7000-0040	103
MI7000-0041	104
MI7000-0042	105

List of Figures

Figure 4-1 Home screen	16
Figure 4-2 Trend curve.....	17
Figure 4-3 Probe heating	17
Figure 4-4 trend display	18
Figure 4-5 Calendar icon	18
Figure 4-6 System setup login.....	19
Figure 4-7 System status screen	20
Figure 4-8 IO Status screen	23
Figure 4-9 Reset system	27
Figure 4-10 Setup screen	28
Figure 4-11 Customized button names.....	28
Figure 4-12 Default button names	28
Figure 4-13 Probe settings.....	29
Figure 4-14 CO2 level alarm	30
Figure 4-15 Alarm and warning level.....	30
Figure 4-16 Auto calibration settings	31
Figure 4-17 Average settings.....	31
Figure 4-18 T90 Graph for 200 ppm SO2 gas.....	32
Figure 4-19 Standby flush setting window.....	33
Figure 4-20 Condensate pump control window	34
Figure 4-21 HMI settings screen.....	36
Figure 5-1 Probe electrical connections.....	41
Figure 5-2 Flowchart for remote control.....	47
Figure 5-3 Remove the sealed plug	53
Figure 7-1 Validation and calibration procedure.....	59
Figure 11-1: Troubleshooting Flowchart	68

1. Terms and Abbreviations

The following table lists terms and abbreviations that are used in this user manual. The term is spelled out at the first mention with its abbreviation in parenthesis.

Description	Abbreviation
Multi Gas Monitoring System	MGMS
Continuous Emission Monitoring System	CEMS
Human Machine Interface	HMI
International Maritime Organization	IMO
Marine Environment Protection Committee	MEPC
Non-Dispersive Infrared	NDIR
Proportional–integral–derivative controller	PID
Programmable Logic Controller	PLC

2. Introduction

2.1 About the System

The G7000 Multi Gas Monitoring System (MGMS) monitors SO₂ and CO₂ concentrations in exhaust gas in accordance with IMO NO_x Technical Code 2008 and IMO resolution MEPC.259(68) and MEPC. 340(77).

The system is based on a modular design and be configured to monitor other gases. Customers must specify this during the ordering process. G7000 MGMS provides accurate measurements of SO₂ in ppm, CO₂ in percent, and SO₂/CO₂ as a ratio. Measurements are displayed on a Human Machine Interface (HMI) touchscreen, and the data is transmitted via Modbus TCP for logging and customer processing.

G7000 MGMS consists of a sampling and sample conditioning system, with up to two multigas analyzers. The unique dual sample conditioning unit prepares the next sample while measuring the current sample, ensuring fast response time. This unique feature allows the system to sample from up to 5 different sample points per system via the system's multiplexer. A simple and cost-effective system without multiplexer is also available for sampling from only one sample point.

G7000 MGMS is suitable for high ambient temperature because it uses an air conditioner to maintain an optimum working temperature inside the monitoring unit. All materials are specially selected to withstand the wet and acidic exhaust gas from a scrubber. The system is robust and designed to operate in harsh marine applications with long intervals between services.

G7000 MGMS is designed for easy calibration and maintenance. The system uses automatic calibration by means of built-in calibration cells and instrument air and can also be verified by test gases to confirm compliance.

2.2 Technical Specifications

Specifications are subject to change without notice.

G7000 MGMS	
Function	Monitoring of SO ₂ , CO ₂ and other required gases in accordance with IMO NO _x Technical Code 2008 and MEPC.259(68) and MEPC. 340(77)
Equipment	Multigas analyzer, optional multiplexer, gas cooler, gas pump, condensate pump, air conditioner, HMI, PLC, gas filter, condensate alarm
Power supply/consumption	220-230 VAC 50-60Hz
Display	7.5" TFT LCD color display with touchscreen
External Communication	Modbus TCP/IP
Alarm outputs	4 alarm relays: "System Warning", "System Alarm", "Level Warning" and "Level Alarm" (NO/NC)
Electrical connection	Refer to electrical drawings
Gas and fluid connections	Up to 5 probes with heated hose connected to one MGMS Refer to Installation Layout
Instrument air supply	Approx. 4 l/minute per probe during calibration Approx. 4 l/hour per probe during standby
Instrument air supply	ISO 8573-1 Class 2-2-2. Free from traces of measurement gases
Sample flow	Adjustable from 0.33–1.67 l/minute. Default is 1L/min.
Ambient temperature	Class A. 5–45 °C (tested to 55 °C)
Humidity	RH up to 96% at all relevant temperatures
Vibration	Class A
EMC	Class A
Enclosure	Painted steel RAL 7035 / IP55
Enclosure dimensions/weight	Weight: 225 kg Dimensions 1265 x 970 x 540 mm

Gas analyzer	
Measuring principle	Non-Dispersive Infrared (NDIR)
Measuring range	SO ₂ : 0–200 ppm CO ₂ : 0–10 % Optional: SO ₂ : 0–1000 ppm CO ₂ : 0–20 % Monitoring of other gasses if required
Accuracy/Linearity	≤ ±2 % of reading or ≤ ±0.3 % of full scale (whichever is larger)
Precision/Repeatability	≤ ±1 % of full scale above 100 ppm or ≤ ±2 % of full scale below 100 ppm
Noise	≤ ±2 % of full scale
Zero drift	≤ ±2 % of full scale
Span drift	≤ ±2 % of full scale
Self-calibration	Zero Calibration: Automatic using compressed air Span Calibration: Automatic using built-in optical filters and instrument air.
Annual calibration and validation	Connect certified gases for annual calibration and validation
Certificates	Download at https://greeninstruments.com/

Probes and heated sample lines	
Function	Extracts and filters sample gas. Heating elements keep temperature above dew point.
Equipment	Refer to component overview.
Number of probes	Up to 5. Refer to installation layout
Sample line length	4–25 m. Hose lengths > 25 m available on request
Exhaust gas pressure	-50 mm to +500 mm of water column
Probe Tube Material and Exhaust Gas temperature	316Ti (Max. 600°C) or Hastelloy (Max. 400°C) (to be specified upon order)
Flange dimensions	JIS B2220 5K 65A (DIN DN65/PN6)
Inserting length	500 mm (subtracted socket length). Refer to installation layout.
Power supply	Refer to electrical drawings
Electrical connection, probe end	2 preconfigured connectors for temperature alarm and power
Electrical connection, system enclosure	2 preconfigured connectors fitted to hose
Gas connections	Heated hose connections (included in scope of supply) Sample gas return line (not included in scope of supply) Refer to Installation Layout
Ambient temperature range	Class A. -20 °C to +45 °C (Tested to 55 °C)
Humidity	Class B. RH up to 96% at all relevant temperatures
Vibration	Class B
EMC	Class A
Enclosure	IP55
Probe dimensions/weight	Refer to installation layout
Certificates	Download at https://greeninstruments.com/

2.3 Storage and Handling

2.3.1 Storage

The ambient temperature must be 0–60 °C, and the relative humidity must be 20–90% RH. Keep the equipment stored in its original packaging. Store indoors, in a dry room where the equipment will not be exposed to vibration or dust.

2.3.2 Handling

Use a forklift truck to move the equipment. Refer to the relevant technical specifications for the weight of each component when unpacking, moving and installing the components.

The system enclosure is equipped with 4 eyebolts for lifting. Use appropriate lifting equipment that can lift the system enclosure securely and safely.

2.4 Delivery Check

Check the equipment upon arrival to ensure that the equipment has been transported properly.

Check for any damage. If any damage is found immediately make a note on the delivery document. Remove the packing and check for intrusive water or signs of humidity.

Check for missing parts against the packing list. Any discrepancy or damage should be reported to Green Instruments A/S immediately.

3. Safety

3.1 Safety

**Before operating the system,
read and understand the entire user manual.**



WARNING



Failure to follow the instructions can lead to serious injury or death. Follow the instructions:

- Install equipment on a robust structure that minimizes vibration and is strong enough to support the load.
- Ensure all power and signal cable connections are correct before operating the G7000 Multi Gas Monitoring System.
- Hot surface hazard. The multiplexer, probes, sample lines, air conditioner and heater elements become hot during operation and can cause burns. Avoid contact with hot components.
- Ensure the system air conditioner is operating and the supply of air/air intake is not obstructed.
- Wear personal protective equipment.

The system may only be installed in a safe, non-hazardous area. It must not be used with flammable media. This manual describes the most common and known situations. It does not describe every possible situation or circumstance relating to the installation of the system. This manual does not replace the specific training and education of personnel who will be installing the system.

Should a situation arise that is not described in this manual, and which cannot be resolved by normal known practice and good workmanship, then contact Green Instruments A/S.



WARNING

The use of unqualified, unskilled, and untrained personnel can lead to serious injury or death.

The installation and operation of this system and associated equipment must be carried out by trained professional personnel and follow best practice onboard vessels. Green Instruments A/S bears no responsibility for

the operation of the system and associated equipment. Correct and safe operation of this equipment depends on proper handling, installation, operation, and maintenance.

The equipment must only be used as described in this user manual. If the system is used in any other way not specified by Green Instruments A/S, equipment safety may become impaired. Only use parts and spares supplied by Green Instruments. Green Instruments A/S cannot be held liable for any resulting damage or bodily injury or death resulting from incorrect or improper installation, maintenance, or misuse of the system. The warranty will also be rendered void.

Keep the equipment safe from exposure to water, dust, and fire. Welding near the equipment is not recommended, but if welding near the equipment cannot be avoided, make the equipment safe from welding/grinding sparks, heat, electric current and electromagnetic effects.



Electric shock hazard

Disconnect the power before installing or servicing the equipment. Failure to disconnect power can result in severe personal injury or fatality and damage to materials. Read the installation instructions carefully to ensure all power and signal leads have been correctly connected.

Ensure that the correct supply voltage is connected to the system.

Circuit Breaker

The installation must include a means of isolating electrical power by a clearly marked external switch or circuit breaker. The external switch or circuit breaker must be in close proximity to the system and within easy reach of the operator.

The G7000 MGMS is equipped with a safety switch located underneath the air conditioner unit and this switch disconnects power to downstream components.

Overload Protection

In accordance with the safety requirements in IEC 61010-1 (2010), the installation must include a means of overcurrent protection to provide protection against excessive energy being drawn from the system power supply if the equipment has a fault.

Protective Earth

The system must be connected to protective earth.



Installation and Fault Finding

Electric shock hazard

Electrical installation and system fault finding may only be carried out by a suitably trained and qualified engineer.

EMC

In accordance with the EMC product standard IEC 60533 (1999), connection cables for the main power supply and communication signals must be shielded or have equivalent protection.

Probes and Heated Sample Lines



WARNING



Risk of damage/electrical shock. The probes and heated samples must be installed and connected before powering up the system. When the system is powered on, the connections to the probes and sample lines must not be disconnected. The equipment must not be exposed to strong mechanical shocks.

Sample lines must be protected from overheating, sharp edges, mechanical stress, chemicals, and from hanging loosely both during and after installation. For more information, see the Hose Handling and Installation Guide.

If sample lines must penetrate a deck or bulkhead or if there are special requirements relating to water tightness or fire protection, always follow the applicable safety regulations.



ATTENTION

Pressurized system. Never shut-off the pipeline to or from the system when the system is operating, as this may damage components. De-pressurize the system before removing any wetted components.



ATTENTION

Gas sampling system. Never block the gas sampling lines to/from the system when the system is operating, as this may damage components. Intentional blockage is only permitted for short periods when carrying out a leakage test.



WARNING

Harmful components: toxic gas hazard.

Avoid leaks of toxic gas. Sampling line components may only be

disconnected when carrying out troubleshooting or repairs. Escaped exhaust gas can damage equipment, causing faulty measurements. After carrying out troubleshooting or repairs or after reassembling components in the gas sampling lines, carry out a leakage test.



WARNING



Harmful components: toxic gas and chemical burns hazard.

The exhaust gas is hot and contains toxic media. Before removing a component ensure that the gas channel is plugged to prevent exhaust gas escaping.

Condensate from exhaust gas can be corrosive and cause chemical burns. Wear personal protective equipment whenever there is a risk of coming into contact with exhaust gas and condensate from gas cooler.

Equipment Disposal

Do not dispose of the equipment with normal waste. Disposal must be carried out in accordance with the requirements of the applicable statutory regulations.

Symbols and Warning Labels

The following safety alert symbols are used in this manual to draw your attention to important information about the safe operation of the system.

Symbol identification			
	Caution, risk of danger		Protective earth
	Caution, risk of electrical shock		Caution, hot surface
	Chemical burns and etching		The CE mark proves the compliance of the instrument with the requirements of the relevant EU directives.

4. HMI Structure

The following figure shows the MGMTS Human Machine Interface (HMI) home screen layout. The home screen displays the current state of the system, the state of the system's five probes, and all five probe readings. It has four main function buttons on the right side.

- **Home:** Returns to the home screen.
- **Log:** Displays logged measurements.
- **Status:** Displays the status screen.
- **Setup:** Displays the setup screen

Probe 1	Probe 2	Probe 3	Probe 4	Probe 5
Measuring	Measuring	OFF	OFF	OFF
Sample	SO2 [ppm]	CO2 [%]	Ratio	Home
Probe 1	18.9	5.0	3.8	Setup
Probe 2	14.2	3.8	3.7	Log
Probe 3	0.0	0.0	**.*	Status
Probe 4	0.0	0.0	**.*	Measuring
Probe 5	0.0	0.0	**.*	

Figure 4-1 Home screen

4.1 System Probes

You can select each of the system's five probes individually by pressing the relevant probe button. This displays the probe's reading trend and status.

A probe has three different operating statuses: "Heating", "Measuring" and "OFF".

If a probe is set to OFF, no readings will be displayed for the probe.

The system must warm the probe to the correct operating temperature before it can take readings using the probe. While the probe is being heated it will be in heating mode.

The following example shows the probe reading trend and status for Probe

1) Example trend curve for Probe 1

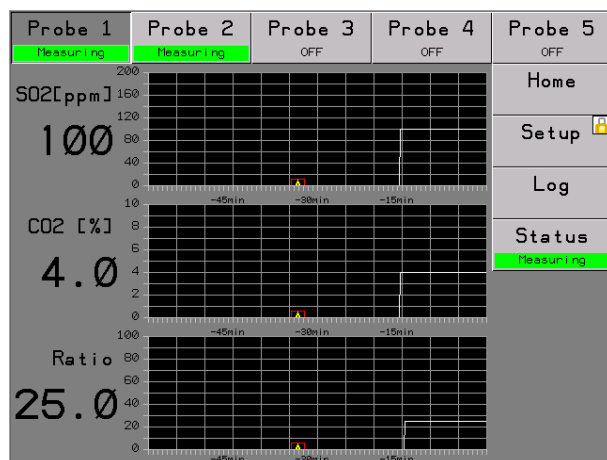


Figure 4-2 Trend curve

Example shows Probe 1 is heating (in standby mode), not yet ready to take readings.

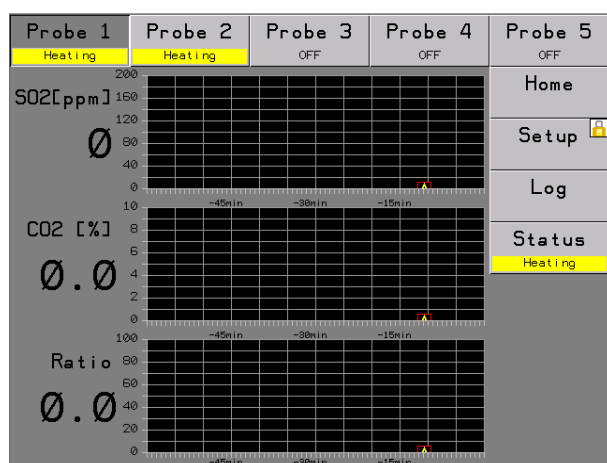


Figure 4-3 Probe heating

4.2 Logged Data Screen

Note: According to the IMO regulations in MEPC 259(68) and MEPC 340(77), the HMI logging function can't be used as a substitute for the data and recording device.

Trend logs cover a given 24-hour period, with readings captured every 5 minutes.

Press the **Log** button to access the logged data screen, which shows trend curves for all the probes.

Each probe has its own color identifier to easily identify trend curves in the log display.

- To view SO₂ trend curves, press the **SO₂** button.
- To view CO₂ trend curves, press the **CO₂** button.
- To view Ratio trend curves, press the **Ratio** button.

Example of trend display with SO₂ selected.

- Red arrow icon indicates the live reading.
- Green arrow indicates measuring for group 1.

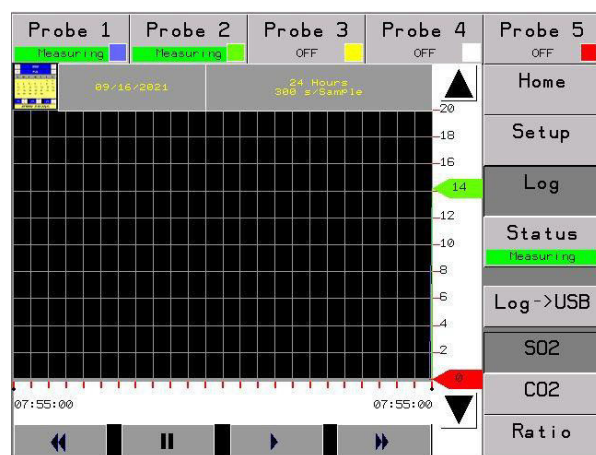


Figure 4-4 trend display

- Press the **Log ->USB** button to export logged measurements and alarm.
- Press the calendar icon below the **Probe 1** button to select a date for a 24-hour-period data history.



Figure 4-5 Calendar icon

Note: Do not remove the flash drive from the USB connector until the **Log ->USB** button has returned to its normal color. During data transfer, the button is accentuated with horizontal stripes.

The alarm data history is saved on the flash drive as a .csv file, that you can be import into a spreadsheet.

4.3 System Setup Login

If the Setup screen is locked, you must log in to the system as an administrator to be able to change the system setup.

1. Enter "Admin" in the **Name** field
2. Enter "1234" in the Password field.

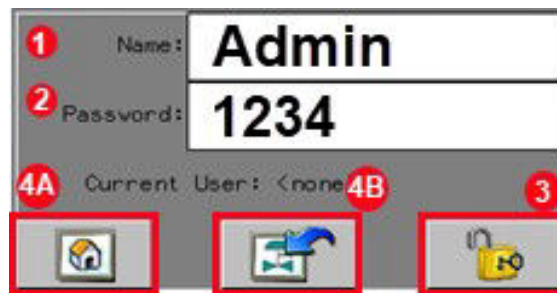


Figure 4-6 System setup login

3. Press the padlock icon **button** to log in to the system. If the display shows "Current user: Admin", the log in is successful.
4. Press the icon button to access **the** home screen.
5. Press the return button to return to **the** previous screen.

4.4 System Status Screen

Press the **Status** button to access the system status screen. The **Status** button also uses a color-coded system status message in the bottom of the button:

- **Heating**: The system is warming up.
- **Measuring**: The system is in operating mode.
- **Error**: The system has a triggered alarm.
- **Calibrating**: The system is in calibrating mode.

- **Validate:** The system is in validating mode.

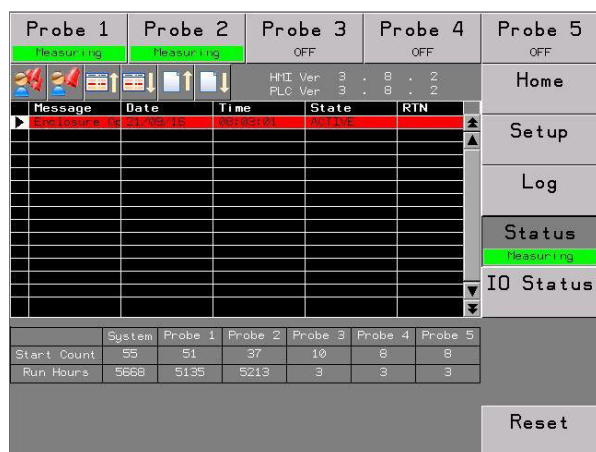


Figure 4-7 System status screen

The System Status screen displays a table of registered alarms that the user can scroll through.

- **Message:** Description of the alarm.
- **Date:** The date when the alarm was triggered.
- **Time:** The time when the alarm was triggered.
- **State:** The status of the alarm. This can be ACTIVE, UNACK (unacknowledged) or ACK (acknowledged).
- **RTN:** Returned to Normal and is the time when the alarm is no longer triggered.

The System Status screen can display the following errors via the alarm table:

Message	Warning	Alarm	Description
Gas Cool A		X	Gas Cooler A
Gas Cool B		X	Gas Cooler B
Analyzer		X	SO ₂ / CO ₂ Analyzer
Emg High Temp		X	Enclosure Emergency High Temperature
Enclosure H Temp		X	Enclosure High Temperature
Enclosure Temp		X	Enclosure Low Temp.
Enclosure Open	(X)		Enclosure Open. Information only.

Message	Warning	Alarm	Description
			Will not trigger warning / alarm relay. Air condition unit will be switched OFF
Flow A		X	Gas Flow A too Low
Flow B		X	Gas Flow B too Low
Hose 1 Temp	X		Heating Hose 1 Temp. Low
Hose 2 Temp	X		Heating Hose 2 Temp. Low
Hose 3 Temp	X		Heating Hose 3 Temp. Low
Hose 4 Temp	X		Heating Hose 4 Temp. Low
Hose 5 Temp	X		Heating Hose 5 Temp. Low
Liquid A		X	Condensate A level too High
Liquid B		X	Condensate B level too High
No Probe 1		X	Probe 1 selected, but not mounted
No Probe 2		X	Probe 2 selected, but not mounted
No Probe 3		X	Probe 3 selected, but not mounted
No Probe 4		X	Probe 4 selected, but not mounted
No Probe 5		X	Probe 5 selected, but not mounted
Probe 1 Temp	X		Probe 1 Temperature

Message	Warning	Alarm	Description
			Low
Probe 2 Temp	X		Probe 2 Temperature Low
Probe 3 Temp	X		Probe 3 Temperature Low
Probe 4 Temp	X		Probe 4 Temperature Low
Probe 5 Temp	X		Probe 5 Temperature Low
Multiplexer Temp		X	Multiplexer Temperature Low
Timeout		X	Heating timeout

The following general alarms and warnings are also available via digital relays and Modbus/TCP:

- **System Warning:** indicates either an error on a heating hose/probe or a system error (for example, a system component malfunction in either the A or B sampling lines).
- **System Alarm:** indicates an error in a system component. The system will stop monitoring.

The top right corner of the alarm table displays the software version and PLC version:

HMI Ver	3	.	8	.	2
PLC Ver	3	.	8	.	2

The top left corner of the alarm table has six function buttons:

-  Press to acknowledge all alarms.
-  Press to acknowledge selected alarms.
-  Press to move up the alarm list to select an alarm.
-  Press to move down the alarm list, for selecting an alarm.
-  Press to go to the previous alarm page.
-  Press to go to the next alarm page.

There are two other function buttons that are shown below the **Status** button:

IO Status

Press to see the status I/O signals. Use the associated manual select function to control several output signals.

Reset

Press to reset the system after a system error has been eliminated.

The system status screen also displays runtime statistics:

	System	Probe 1	Probe 2	Probe 3	Probe 4	Probe 5
Start Count	4	4	4	3	0	0
Run Hours	3	3	3	2	0	0

- **Start count:** This will increment by one every time the system or individual probes are heated (during start-up or when a probe is enabled).
- **Run hours:** The total number of accumulated operating hours for the system and probes (in their measuring state), respectively.

4.5 IO Status Screen

To access the IO status screen, press the **IO Status** button. The IO status uses color codes to provide an overview of the status of system components. The screen is useful for analyzing any system errors that may have occurred.

- **Green:** the component is powered and has no associated triggered alarms.
- **Grey:** the component is not powered or has not been configured for the system.
- **Red:** an associated alarm has been triggered.

Probe 1			Probe 2			Probe 3			Probe 4			Probe 5		
Measuring			Measuring			OFF			OFF			OFF		
Manual Select			All Output Off			161.0 Heat-Valve-Chamber						Home		
Sample-Probe1	Heat-Probe1	Heat-Hose1	161.0			Gas-ValveA1	Gas-ValveB1	ZeroAir Valve1			Setup			
Sample-Probe2	Heat-Probe2	Heat-Hose2	162.0			Gas-ValveA2	Gas-ValveB2	ZeroAir Valve2			Log			
Sample-Probe3	Heat-Probe3	Heat-Hose3	0.0			Gas-ValveA3	Gas-ValveB3	ZeroAir Valve3			Status			
Sample-Probe4	Heat-Probe4	Heat-Hose4	0.0			Gas-ValveA4	Gas-ValveB4	ZeroAir Valve4			Measuring			
Sample-Probe5	Heat-Probe5	Heat-Hose5	0.0			Gas-ValveA5	Gas-ValveB5	ZeroAir Valve5			IO Status			
33.0						Gas-coolA	Gas-coolB	502 S. 0000						
Heat-Enclosure	Enclosure closed	System Warning				Gas-PumpA	Gas-PumpB	002 S. 0000			Selector-Valve	Analyzer	Level Warning	
Airson	Airson Fan	System Alarm	60s 11s			Condensate PumpA	Condensate PumpB	0s ON 2661s OFF			Calibrated		Level Alarm	

Sample Probe 1–5

- **Green:** digital input is turned ON and the probe is activated.
- **Grey:** digital input is turned ON and the probe is not activated.
- **Red:** an associated alarm has been triggered or the probe is not ready.

Heat Probe 1–5

- **Green:** the probe is activated and is heating.
- **Grey:** power is OFF.
- **Red:** an associated alarm has been triggered or the probe is not ready.

Heat Hose 1–5

- **Green:** power is ON, and the hose is heating.
- **Flashing green:** the hose temperature is nearing the setpoint temperature and the proportional–integral–derivative controller (PID) is decreasing power to prevent the hose temperature from exceeding the setpoint temperature. The figure given on the right of the hose in question is the temperature of the hose.
- **Grey:** the temperature hose is off.
- **Red:** an associated alarm has been triggered

Heat Valve Chamber Multiplexer

- **Green:** the multiplexer temperature controller is heating up.
- **Grey:** the multiplexer temperature controller is OFF.
- **Flashing green:** the multiplexer is nearing the setpoint temperature and the PID is decreasing power to prevent the temperature from exceeding the setpoint temperature. The actual temperature is shown above the heat valve chamber button.

Gas Valve A–B

- **Green:** the valve is turned ON.
- **Grey:** the valve is turned OFF
- **Red:** an associated alarm has been triggered.

Gas Cool A-B

- **Green:** the gas cooler is turned ON.
- **Grey:** the gas cooler is turned OFF.
- **Extra green edge:** the gas cooler temperature is within the setpoint temperature limits.
- **Red:** an associated alarm has been triggered.

- **Extra red edge:** the gas cooler temperature is too high.

Gas Pump A–B

- **Green:** the pump is ON.
- **Grey:** the pump is OFF.
- **Extra green edge:** flow is OK.
- **Extra red edge:** a low flow alarm has been triggered.

Condensate Pump A–B

- **Green:** the pump is ON.
- **Grey:** the pump is OFF.
- **Extra green edge:** the condensate alarm is not triggered.
- **Extra red edge:** the condensate alarm has been triggered.
- Numbers next to a condensate pump button state the ON and OFF times of that condensate pump. The top number is how long the condensate pump has been ON. The bottom number is how long the condensate pump has been OFF since the last time the associated condensate alarm was triggered.

Heat enclosure

The number above the heat enclosure button shows the temperature inside the system enclosure. The temperature setpoint is 30 °C. The system will shut down if the temperature inside the system enclosure exceeds 45 °C.

Heating elements inside the system enclosure switch on if the ambient temperature outside the system enclosure falls below 5 °C. This ensures that the temperature inside the system enclosure does not fall below 15 °C.

Enclosure closed

- **Green:** the system enclosure door is closed.
- **Red:** the system enclosure door is open. If the system enclosure door is opened, it will deactivate the temperature controller.

Aircon

- **Green:** the air conditioner is ON.
- **Grey:** the air conditioner is OFF.

Analyzer

- **Green:** the gas analyzer is ready.
- **Red:** the gas analyzer is warming up. Red can also mean error; in which case it is followed by an alarm.

Calibrated

- **Green:** the gas analyzer has been calibrated.

To execute a calibration, press the calibrated button. The button turns red.

Note: To execute a calibration, you must log in as an administrator. See Chapter 7 Validation and Calibration.

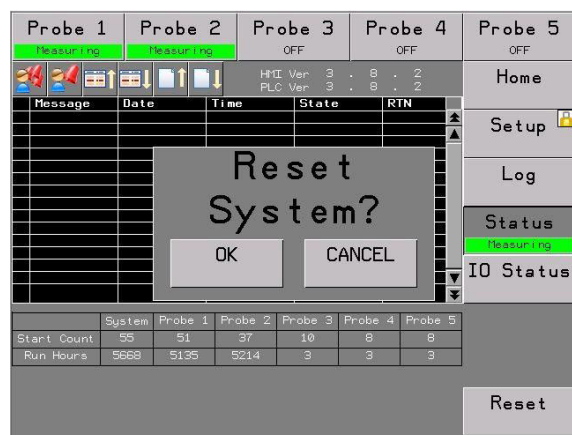
Selector AB Valve

- **Grey:** sampling is from Sample Line-A.
- **Green:** sampling is from Sample Line-B.

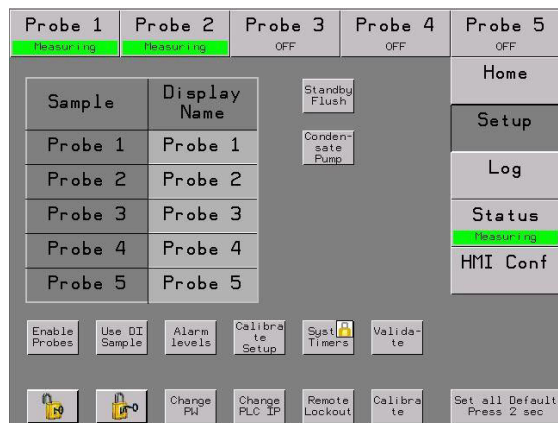
System Warning, System Alarm, Level Warning and Level Alarm

Indicates the status of the alarm relays for System Warning, System Alarm, Level Warning and Level Alarm.

- **Grey:** no alarm has been triggered
- **Green:** an alarm has been triggered



4.6.2 Manual Setup



1. To access the setup screen, press the **Setup** button.
2. If the Setup screen is locked, the **Login** screen appears. Log in as administrator.

You can change the Probe button names by editing the light grey boxes in the **Display Name** column. Changing the names might give the user a better understanding of what each button does.

Sample	Display Name
Probe 1	Probe 1
Probe 2	Probe 2
Probe 3	Probe 3
Probe 4	Probe 4
Probe 5	Probe 5

Sample	Display Name
Probe 1	Eng-1
Probe 2	Eng-2
Probe 3	DG-1
Probe 4	DG-2
Probe 5	Inc.

Figure 4-12 Default button names Figure 4-11 Customized button names

There are **HMI configuration** buttons and a sub-menu button below the **Status** button.

Remote Lockout and **Use DI Sample** do not have a settings screen.



- **Grey:** the system is controlled via Modbus TCP.
- **Green:** it is not possible to control the system via Modbus TCP, but measured values will still be provided.

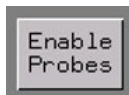


- **Grey:** it is possible to use digital inputs to start probe sampling.

- Green: it is not possible to use digital inputs to start probe sampling.



- This button is locked. It is only used for factory settings, and only Green Instruments can unlock this button to set factory settings.



- Use this button to access the Probe settings window.

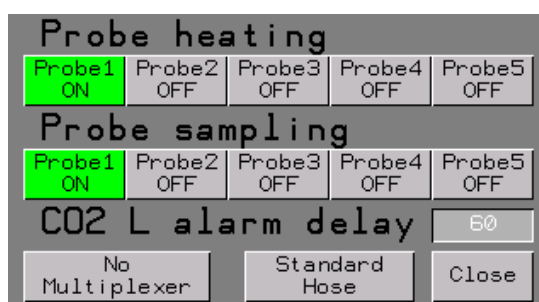


Figure 4-13 Probe settings

4.6.3 Probe Settings

- **Probe heating buttons:** Press the button with the relevant probe number to start heating of the probe so that it becomes active. The button turns green with the text ON.
- **Probe sampling buttons:** Press the button with the relevant probe number for manual control of sampling. When a probe is heated up to its operational temperature, the MGMS will start to sample from this probe.
- Deselect **Probe sampling** to stop sampling while the probe remains heated.
- Deselect **Probe heating** to turn off both the probe heating and sampling. This might be useful when carrying out repairs or with prolonged engine shut down.

CO2 Level Alarm

Probe heating				
Probe1 ON	Probe2 OFF	Probe3 OFF	Probe4 OFF	Probe5 OFF

Probe sampling				
Probe1 ON	Probe2 OFF	Probe3 OFF	Probe4 OFF	Probe5 OFF

CO2 L alarm delay 60

No Multiplexer	Standard Hose	Close
-------------------	------------------	-------

Figure 4-14 CO2 level alarm

If the CO2 level falls below 0.5% for a defined period, it might be caused by a potential leak in the gas path, and Ratio will be set to 100. This can be delayed for up to 360 minutes. The default setting is 60 minutes.

4.6.4 Alarm and Warning Levels



Press the **Alarm levels** button to access the alarm and warning levels settings window. Warning and alarm levels can be set for application requirements.

- **Warning levels:** SO2/CO2 ratio, SO2 High, CO2 Low, CO2 High
- **Alarm levels:** SO2/CO2 ratio, SO2 High, CO2 Low, CO2 High

Warning level			
4.0	20.0	1.5	9.0
Ratio	SO2	CO2L	CO2H

Alarm level			
5.0	25.0	0.5	10.0
Ratio	SO2	CO2L	CO2H

Close

Figure 4-15 Alarm and warning level

4.6.5 Auto Calibration Settings

- **Calibrate Setup:** Press the Calibration Setup button to access the calibration settings.
- **Interval [h]:** This is the interval in hours set between two automatic calibrations. The gas analyzer uses the internal optic filters for Span calibration and instrument air for Zero calibration.

- **Zero check [h]:** This is the interval in hours between two Zero checks.
The gas analyzer uses instrument air for the Zero check.
- **Zero offset max:** If the gas analyzer zero point has drifted above this value, the gas analyzer will carry out an automatic calibration regardless of the automatic calibration interval.

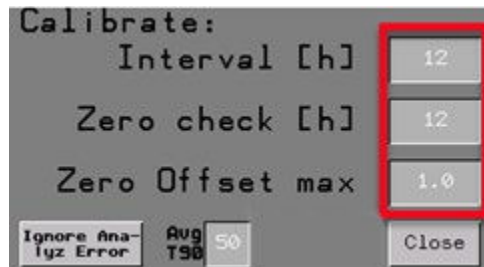


Figure 4-16 Auto calibration settings

- **Ignore Analyz Error:** When green, all errors from the gas analyzer will be ignored. This button is used during troubleshooting sessions with Green Instruments.
- When prompted by Green Instruments, deactivate “Ignore Analyz Error” to return to normal mode.



ATTENTION

Failure to respond to an analyzer error can result in damaged components.

4.6.6 Average Settings

To reduce fluctuating analyzer values, it is possible to alter the **Avg T90** time. See Figure 4-17 Average settings.

Recommended default settings for single-stack systems: T90 time = 50 seconds

For MGMS with multiplexers installed, the T90 time must not be above 25 seconds.

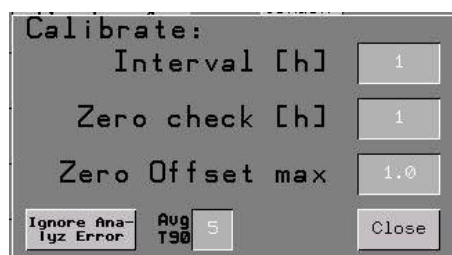


Figure 4-17 Average settings

With T90 set to 25 seconds, the sample will reach within 2 % of maximum test gas value during the 50 seconds of measuring sequence used in multiprobe systems. See Figure 4-18 T90 Graph for 200 ppm SO₂ gas.

4.6.7 Changing Password

1. Press the **Change PW** button to access the change password window.



2. Press the right arrow  to enter a new password.

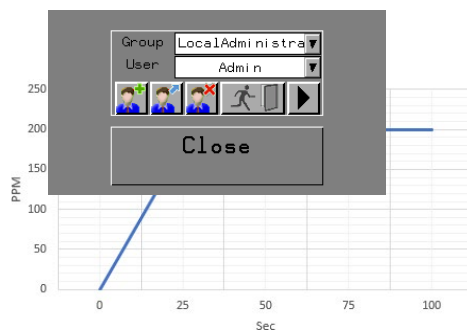
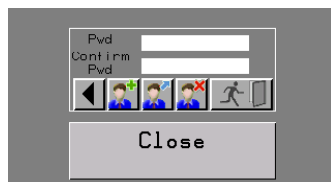


Figure 4-18 T90 Graph for 200 ppm SO₂ gas

3. Press  to confirm the password, and then press the **Close** button.

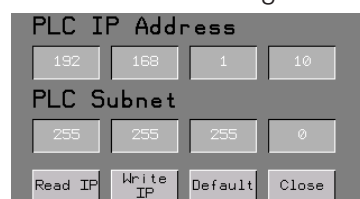


4.6.8 Changing the PLC IP Address

1. Press the **Change PLC IP** button to access PLC IP Address window.



The factory default PLC IP Address is **192 168 1 10** with PLC sub net **255 255 255 0**. The PLC IP Address can be changed according to the user's network configuration.



- To change the IP address, enter the new IP address and press the **Write IP** button.

4.6.9 Function Buttons:



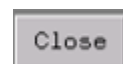
- Press this button to read the current IP address.



- Press this button to confirm a new IP address.

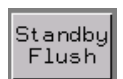


- Press this button to reset to the factory default IP address.



- Press this button close PLC IP Address setup window.

Standby Flush



Press the **Standby Flush** button to access the probe standby flush setup setting window. Here you can set the probe's standby flush time interval. The default setting is set for the system to flush for 1 minute every hour.

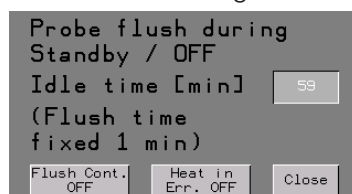
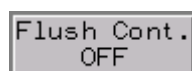


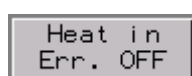
Figure 4-19 Standby flush setting window



- If **Flush Cont. OFF** is grey, the probe flushing is controlled by the timer.
- If **Flush Cont. OFF** is green, the probes are flushed continuously while the system is in standby mode.

Note: Continuous flushing will consume approx. 240 l/h of instrument air per probe. We recommend this, however, to maximize the system lifetime.

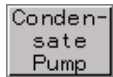
Heat in Error



- If **Heat in Error state OFF** is grey, the system deactivates heating of probes, hoses and multiplexer (*if installed*).
- If **Heat in Err. OFF** is green, the system components remain heated even if the system is in an Error State.

Note: The system will continue heating the probe even if the probe is the cause of the error.

Condensate Pump



Press the Condensate Pump button to access the Condensate Pump control window.

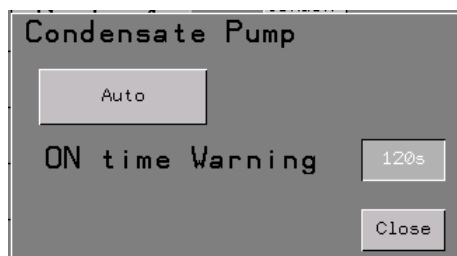
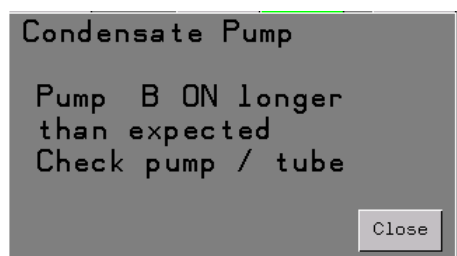
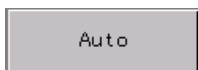


Figure 4-20 Condensate pump control window

When the condensate pump control is set to Auto mode, you can set a timer for a service warning message on the HMI, which will state if the condensate pump has been running for a prolonged period. The warning looks like the following:



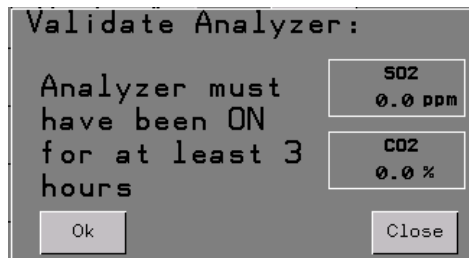
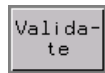
If condensate is detected for more than five minutes, the system will enter error mode.



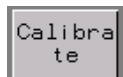
When the **Auto** button shows "Auto", the condensate pump will activate using the condensate level switch. If the **Auto** button shows "Always On", the pump will run continuously. We recommend that you use the Auto function.

Validate Analyzer

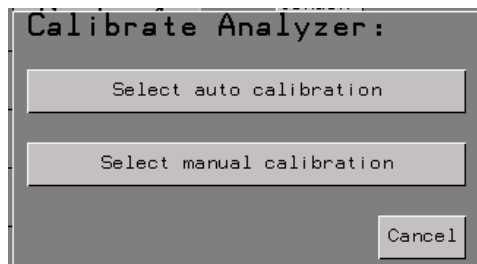
Press the **Validate** button to access the **Validate Analyzer** window.



Press the **Calibrate** button to access the manual analyzer calibration window.



Both buttons are shown on the Setup screen. For more information, see Figure 4-10 Setup screen.



4.7 HMI Settings

Press the **HMI Conf** button to access the HMI settings window. The most relevant settings are **Date/Time** and **Brightness**. Press the relevant button and follow the instruction on the screen.

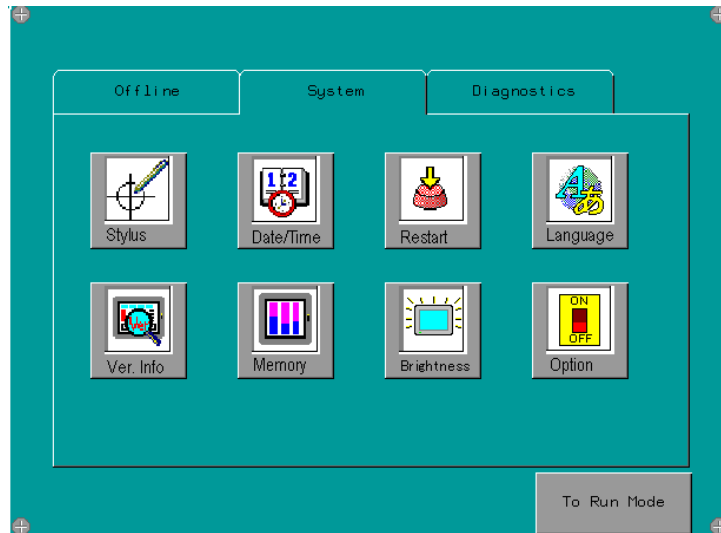


Figure 4-21 HMI settings screen

5. Installation

5.1 Mechanical System installation



WARNING/ATTENTION

Faulty operation/system failure hazard

This section provides critical information regarding the installation of the system and must be read carefully. Incorrect or improper installation may result in system failure or faulty operation. Failure to comply with the installation requirements may result in personal injury and/or damage to equipment and will render the warranty void.

Follow the instructions and comply with the requirements stated in Chapter 3 and throughout this manual, and consult the relevant technical documentation to ensure correct installation.

- Ensure that the installation always complies with system specifications and technical drawings.
- Ensure the correct connection of power, signal cables, fluid and air connections before operating the system.



ATTENTION

The installation instructions that follow are for general use only and apply to a complete MGMS, and do not consider specific installations.

Every MGMS is configured at the factory in accordance with the specific system configuration for the system in question.



WARNING

5.2 System enclosure



ATTENTION

Refer to the G7000 MGMS installation layout drawing (no. 05285) for detailed instructions before installing the system enclosure.

To ensure satisfactory and faultless operation with minimal maintenance:

- The system enclosure must be installed indoors and protected from direct contact from salt, mist, water, and oil spills. Avoid high humidity levels (see the max. permitted ambient RH in the technical specifications

section).

- The system enclosure and system must be fitted at a comfortable viewing level in an area that has good access for the operation and servicing of the system.
- The ambient temperature outside the enclosure must be between 5-45 °C.
- The system enclosure must be installed vertically.
- The system enclosure must not be fitted onto a thin-plated structure, such as casing plates or similar due to the risk of vibrations. It must be fitted mechanically to structural beams, pillars, or other similar main structures to ensure minimal vibrations.
- There must be sufficient free space for access to the system enclosure. Refer to the G7000 MGMS installation layout in the technical drawings for this and for the dimensions of the system enclosure.
- The system enclosure must be fitted using the mounting brackets bolted to the system enclosure.
- The length of heated hoses must be taken into consideration when determining the location for where the system enclosure and probes shall be installed,
- The G7000 MGMS enclosure produces acidic condensate. Therefore, ensure that a condensate outlet hose has been installed and fitted securely to a suitable drain.



ATTENTION

Once the system enclosure has been fitted, it must be left unpowered and in vertical position for at least 24 hours. This is to ensure the system enclosure air conditioner is operating correctly. Failure to follow this instruction may result in damaged components. The air conditioner starts at power up.

5.3 Heated sample lines



ATTENTION

Before installation, see the Hose Handling and Installation Guide (document ID 103389) for information about the positioning and protection of the heated sample lines. Failure to comply with the instructions might result in damaged components. See also sections see section 5.2 and 5.4

Heated sample lines can be delivered in different lengths ranging from 4–

25 meters. They are available in lengths greater than 25 m on request depending on the system configuration. Refer to the specification.

The sample lines must be protected from overheating, sharp edges, mechanical stress, chemicals, and from hanging loosely both during and after installation.

The heated sample line must have adequate ventilation. If penetrating deck or bulkhead with a heated sample line, do not fill with foam or insulation around the heated hose. Use bulkhead plates mounted with glands with internal diameter ranging from Ø38–Ø46mm. Do not over tighten the gland otherwise it might damage the hose.

Note: This connection method may be insufficient for deck or bulkhead penetrations which have special requirements relating to water tightness or fire protection.

5.3.1 Connecting Heated Sample Lines

After installation of the sample line, the heated sample line must be fitted and secured in accordance with the instructions in the heated hose installation layout drawing (no. 70-05980-02).

1. Insert the **Gas Stream 1** through **Gas Stream 1** gland in the cabinet top and connect to **Gas Valve 1**.
2. Fit the calibration gas hose to the calibrating valve in the system enclosure. Connect **Calibration hose 1** to **Calibration Valve 1** (placed in the top left corner of the system enclosure, in front of the PLC).
3. Connect the sample gas hose to the probe using the pre-fitted hose fitting underneath the probe insulation cover.
4. Connect the calibration gas hose to the calibration pipe on the side of the probe using the pre-fitted fitting. Before connecting the sample gas hose, remove the probe enclosure, the insulating cover, and the loose half of the hose clamp. Do not overtighten the hose clamp and its bolts.
5. The sample line and the probe are connected electrically via two plugs, located under the probe enclosure. The sample hose and the system enclosure are connected electrically using two pre-configured plugs. Refer to section 5.2 for the electrical installation instructions.

5.4 Probes



ATTENTION

Refer to the probe installation layout drawing (no. 05910_H) for detailed instructions before installing the probes.

5.4.1 Choosing a Sampling Point

Install the probe in a suitable location where it will extract the gas that is going to be monitored. The probe must be installed at a distance equivalent to of at least 10 x the pipe diameter after the outlet of the engine, turbocharger, or the last post-processing device (whichever is furthest downstream). This is to ensure that the exhaust gas has been uniformly mixed.

The probe must also be positioned at least 0.5 m or a distance equivalent to 3 x the pipe diameter upstream from the exit of the exhaust gas system (whichever is greater). This is to avoid ambient air from unintentionally entering the probe.

Refer to the probe installation layout drawing (no. 05910_H) for detailed installation instructions.

If it is difficult to determine where the probe must be installed, contact Green Instruments A/S for more instructions.

The sampling probe is intended for use in enclosed areas. If used outdoors, adequate protection from the weather must be provided.

The probe shall be installed where it is protected against mechanical damage. The flue gas temperature must not exceed the given temperature limit of the probe tube.

5.4.2 Fitting a Probe

The probe is designed to be fitted to a JIS B2220 5K 65A (DIN DN65/PN6) flange socket by means of four 12 mm bolts. Refer to drawing no.70-09736-03 for more flange information. The 3/8" threaded socket on the flange pipe can be used to connect a single sample gas return line from the G7000 MGMS. However, we recommend that this is not used. If this is not used for the sample gas return line, it must be plugged using a suitable 3/8" BSP male plug. The sample gas return line must be at least DN10, made from PTFE or similar material.

When welding the mounting socket JIS B2220 5K 65A (DIN DN65/PN6) to the stack, ensure that the bolt holes are aligned, so that the probe can be fitted with the sampling hose connection facing downwards. The probe tube must be self-draining by tilting downward at 15°.

Also ensure that the insert length of the probe is greater than 10 % of the duct diameter. Refer to the probe installation layout drawing (no. 05910) for detailed probe installation instructions.

Note: Any holes or leaks in the gas ducting system upstream and near to the probe might affect the accuracy of the measurement.

5.5 System Enclosure Connections and Probe Connections (Electrical Connections)

WARNING



Electric shock hazard

Refer to the electrical drawings for each system before carrying out the electrical installation.

5.5.1 Connecting Probes

The electrical connectors for power and alarms must be connected to the probe. These are clearly marked “Power” and “Alarm” as shown in the following figure:

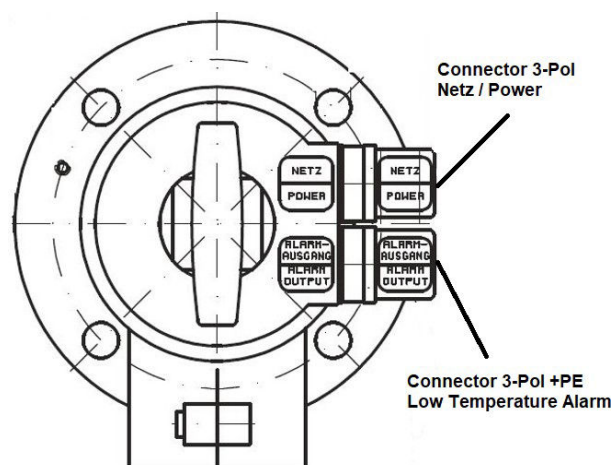


Figure 5-1 Probe electrical connections

5.5.2 Connecting Heated Sample Lines

The heated sample lines also include the connections for the probe. The connectors must be connected to the corresponding plugs found in the top right section of the system enclosure. In other words, the electrical plug Gas stream 1 must be inserted into the corresponding socket positioned on the multiplexer cabinet wall, or for single-probe systems (without a multiplexer), into the socket on the back-plate in the top right corner of the panel. The plugs and sockets are clearly marked for all systems.

5.5.3 Connecting External Power

The terminals for electrical power connections are located at the bottom left inside corner of the system enclosure.

Before connecting the external power supply, make sure that it complies with the power supply rating for the G7000 MGMS. Refer to the electrical drawings that are relevant for the installation.

5.5.4 Installing Cables

Cable types for each system are clearly defined in the electrical drawings. Make sure that you comply with the specification and best practice for installation of cables.

5.5.5 Terminals, Cables and Wires Marking

All terminals, cables and wires are marked with a unique number in accordance with the electrical documentation.

5.5.6 Communication

System communication is ensured by using digital IO or by using a Modbus TCP/IP communication line, where it acts as a slave device. The majority of systems use the Modbus communication line.

Always use the correct IP address for communication. The default IP address is: **192.168.10.1**

However, the IP address can be configured to suit the customer's network. For more information, see 4.6.8 Changing the PLC IP Address.

Note: If different MGMS are on the same network, they must have different IP addresses.

In the following table, highlighted text represents the different parts of the G7000 MGMS, covering the system in the enclosure, the probe and hose. Text written in bold in the first column of the table shows mandatory tags, which must be used to ensure successful integration with the G7000 MGMS.

5.5.7 Communication Protocol Table Columns

- **Address holding register:** Address of the tag. Addresses are 0 based and all are holding registers (Function Code 03)
- **Name:** Tag names that are used as a reference. If there is an issue with communication, refer to these names.
- **Description:** Provides information about the different tags in the protocol.
- **Type:** Shows values used by a tag.
 - Uint16 (16-bit unsigned integer) endian/byte swap
 - Bit array (16-bit bit array)
 - Real (floating point number, little endian, byte swap) 32-bit
 - Range: Shows the possible tag values.

The MGMS requires approximately 90 minutes to warm up. It is recommended that you allow the system to be powered ON even when not in operation. This ensures that the MGMS is ready to operate whenever the engine is started.

To ensure the maximum lifetime of components, it is recommended that the MGMS is put into standby mode whenever the system is not in operation. Standby mode stops sampling but keeps the relevant components heated and the system is ready to start sampling when necessary.

If the scrubber system needs to be out of operation for an extended period, the sample gas probes can be switched off using the G7000 MGMS HMI touchscreen. This will stop sampling from the probe but keep the probe and hose heated, while also maintaining the temperature of the components inside the enclosure.

The Modbus TCP/IP communication protocol is arranged as specified in the following table.

Note: The values for each probe are located with an address bias of 100 for probe 1, 200 for probe 2, and so on.

Address (Holding register Function code 03)	Name	Description	Type(Read/Write)	Range or Unit
System				
0	PLC_SW_MAJOR	Major PLC SW Rev. Major update might break. backward compatibility.	uint16 (Read)	0 - 255
1	PLC_SW_MINOR	Minor PLC SW Rev. Minor update will be backwards compatible, but may have new features	uint16 (Read)	0 - 255
2	PLC_SW_BUGFIX	Bugfix PLC SW Rev.	uint16 (Read)	0 - 255
3	HMI_SW_MAJOR	Major HMI SW Rev. Major update may break backward compatibility.	uint16 (Read)	0 - 255
4	HMI_SW_MINOR	Minor HMI SW Rev. Minor update will be backwards compatible, but may have new features	uint16 (Read)	0 - 255
5	HMI_SW_BUGFIX	Bugfix HMI SW Rev.	uint16 (Read)	0 - 255
6	SYSTEM_STATUS	0 = System Ready 1 = System Error 2 = System Warning 3 = Level Warning 4 = Level Alarm 5 - 15 = Reserved	Bit array. Active high (Read)	
7	PROBE_COUNT	Attached probes in the system	uint16 (Read)	1-5
8	REMOTE (R/W)	Enable remote control 0 = Local (Digital IO) 1 = Remote (Modbus TCP/IP)	uint16 (Read/Write)	0 - 1
9	PROBES_ON (R/W)	Probes ON. In Local control it shows enabled probes. In Remote control it enables probes 0 = Probe 1 1 = Probe 2 2 = Probe 3 3 = Probe 4 4 = Probe 5 5 - 15 = Reserved	Bit array. Active high (Read/Write)	
10	CALIBRATE	Calibrate 0 = Auto 1 = Start Calibrate 2 = Calibrate OFF	uint16 (Read)	0 - 2
11	CALIBRATE_STATUS	Calibrate Status 0 = Calibrated 1 = Calibrate pending	uint16 (Read)	0 - 3

Address (Holding register Function code 03)	Name	Description	Type(Read/Write)	Range or Unit
		2 = Calibrate in progress 3 = Calibrate error		
12	WARNING_LEVEL_SO2 (R/W)		real (Read/Write)	0.0 - 200.0
14	WARN- ING_LEVEL_CO2_HIG H (R/W)		real (Read/Write)	0.0 - 10.0
16	WARN- ING_LEVEL_CO2_LOW (R/W)		real (Read/Write)	0.0 - 10.0
18	WARNING_LEVEL_RA- TIO (R/W)		real (Read/Write)	0.0 - 100.0
20	ALARM_LEVEL_SO2 (R/W)		real (Read/Write)	0.0 - 200.0
22	ALARM_LEVEL_CO2_ HI GH (R/W)		real (Read/Write)	0.0 - 10.0
24	ALARM_LEVEL_CO2_L O W (R/W)		real (Read/Write)	0.0 - 10.0
26	ALARM_LEVEL_RATIO (R/W)		real (Read/Write)	0.0 - 100.0
Probe 1				
100	PROBE_STATUS_1	0 = Off 1 = Heating 2 = Standby 3 = Measure 4 = Error 5 = Level Warning 6 = Level Alarm 7 - 15 = Reserved	Bit array. Active high (Read)	
102	SO2	SO2 according to measuring range in PPM	real (Read)	ppm
104	CO2	CO2 according to measuring range in PPM	real (Read)	ppm
106	Ratio	Note: 100 indicates an error shown if the CO2 level is below 0.5 ppm for a prolonged period of time.	real (Read)	0-100
108	NOX	The typical range is given as an example	uint16 (Read)	0-2000 (ppm)
109	O2	The typical range is given as an example	uint16 (Read)	0-25(%)
110	CO	The typical range is given as an example	real (Read)	0-1000 (ppm)
Probe x				

Address (Holding register Function code 03)	Name	Description	Type(Read/Write)	Range or Unit
x00	PROBE_STATUS_x	0 = Off 1 = Heating 2 = Standby 3 = Measure 4 = Error 5 = Level Warning 6 = Level Alarm 7 - 15 = Reserved	Bit array. Active high (Read)	
x02	SO2	SO2 according to measuring range in PPM	real (Read)	ppm
x04	CO2	CO2 according to measuring range in PPM	real (Read)	ppm
x06	Ratio	Note: 100 indicates an error shown if the CO2 level is below 0.5 ppm for a prolonged period of time	real (Read)	0-100
x08	NOX	The typical range is given as an example	uint16 (Read)	0-2000 (ppm)
x09	O2	The typical range is given as an example	uint16 (Read)	0-25(%)
x10	CO	The typical range is given as an example	real (Read)	0-1000 (ppm)
Probe 5				
500	PROBE_STATUS_5	0 = Off 1 = Heating 2 = Standby 3 = Measure 4 = Error 5 = Level Warning 6 = Level Alarm 7 - 15 = Reserved	Bit array. Active high (Read)	
502	SO2	SO2 according to measuring range in PPM	real (Read)	ppm
504	CO2	CO2 according to measuring range in PPM	real (Read)	ppm
506	Ratio	Note: 100 indicates an error shown if the CO2 level is below 0.5 ppm for a prolonged period of time	real (Read)	0-100
508	NOX	The typical range is given as an example	uint16 (Read)	0-2000 (ppm)
509	O2	The typical range is given as an example	uint16 (Read)	0-25(%)
510	CO	The typical range is given as an example	Real (Read)	0-1000 (ppm)

5.6 Remote Control Flowchart

The following flowchart shows the minimum of settings for the remote control of the G7000 MGMS. It can be used as a visual aid when implementing the system communication between the G7000 MGMS and the Scrubber Control System.

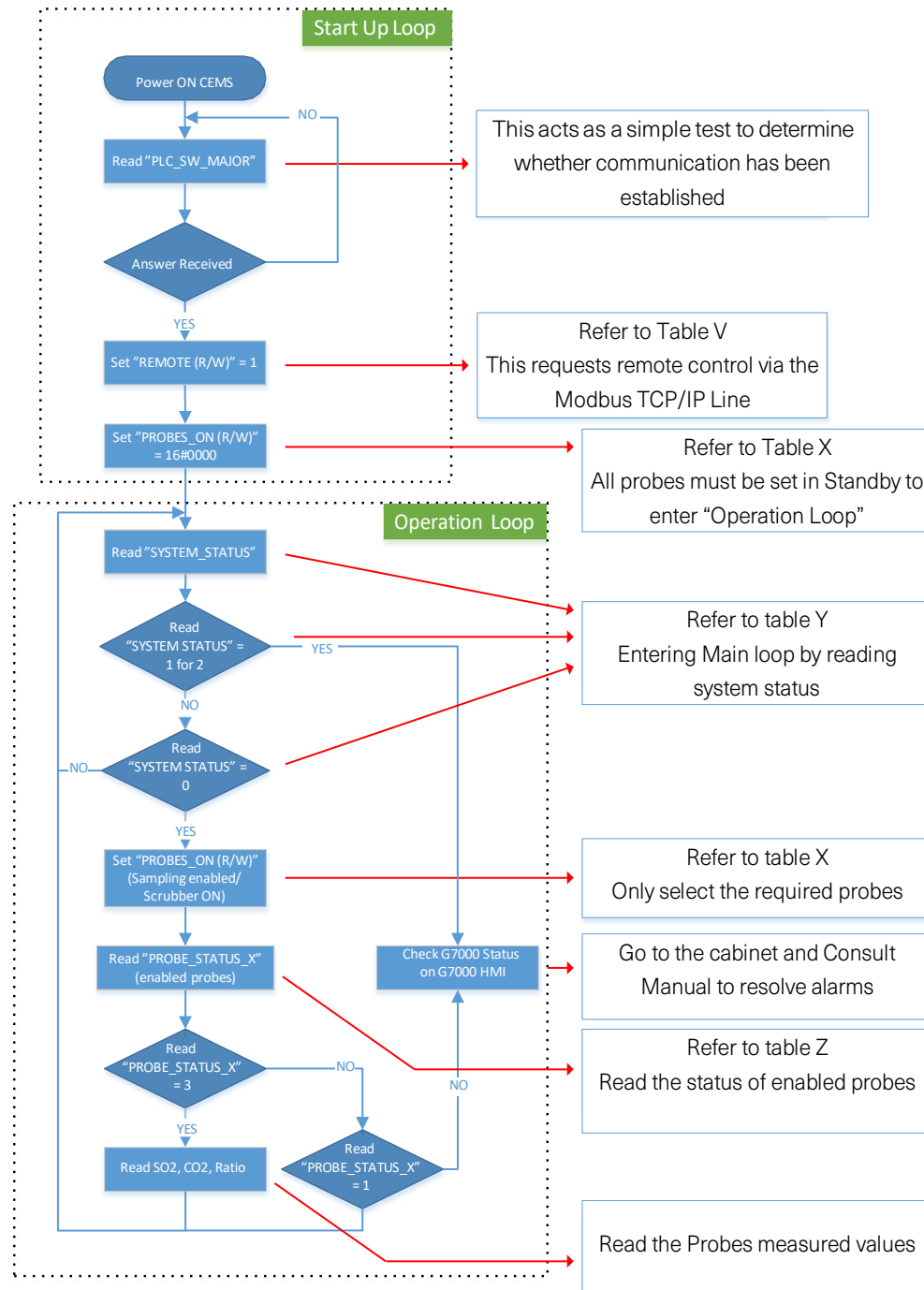


Figure 5-2 Flowchart for remote control

5.7 G7000 MGMS Remote Control

To check communication, the **PLC_SW_MAJOR** can be read and when an answer is received, the system is active.

5.7.1 Remote (R/W)

“**REMOTE (R/W)**” must be used to determine whether to control the system via digital in/outputs or via Modbus TCP/IP. When “Remote Lockout” is activated on the G7000 MGMS HMI touchscreen, the Modbus TCP/IP communication is stopped.

Table V

REMOTE (R/W)	Value
Local / Digital	0
Remote / Modbus TCP/IP	1

5.7.2 Probes on (R/W)

When the system is in local mode, **PROBES_ON (R/W)** shows enabled probes. When it is in remote mode, it enables probes.

“x” Indicates irrelevant characters

Table X

PROBES_ON (R/W)	Value
All Probes OFF	xxxx xxxx xxx0 0000
Probe 1 ON	xxxx xxxx xxxx xxx1
Probe 2 ON	xxxx xxxx xxxx xx1x
Probe 3 ON	xxxx xxxx xxxx x1xx
Probe 4 ON	xxxx xxxx xxxx 1xxx
Probe 5 ON	xxxx xxxx xxx1 xxxx
All Probes ON	xxxx xxxx xxx1 1111

To enter the operation loop, all probes must be disabled using “**PROBES_ON (R/W)**” = **16#0000**.

The system reads the status using “**SYSTEM_STATUS**” and enters the operation loop when bit “0” is 1.

“x” Indicates irrelevant characters

Table Y

SYSTEM_STATUS	Value
System ready	xxxx xxxx xxxx xxx1
System Error	xxxx xxxx xxxx xx1x
System Warning	xxxx xxxx xxxx x1xx
Level Warning	xxxx xxxx xxxx 1xxx
Level Alarm	xxxx xxxx xxx1 xxxx

Note: When a Level Warning appears during normal operation, the system will continue measuring.

To start measurements, there must be no system error and the system must be ready.

“PROBES_ON (R/W)” selects the probes from which measuring is required. Read the status of the probes using “PROBE_STATUS_X” for the enabled probes.

“x” Indicates irrelevant characters.

Table Z

PROBE_STATUS_X	Value
Off	xxxx xxxx xxxx xxx1
Heating	xxxx xxxx xxxx xx1x
Standby	xxxx xxxx xxxx x1xx
Measure	xxxx xxxx xxxx 1xxx
Error	xxxx xxxx xxx1 xxxx
Level Warning	xxxx xxxx xx1x xxxx
Level Alarm	xxxx xxxx x1xx xxxx

Note: When a Level Warning appears during normal operation, the system will continue measuring. A Level Alarm also activates the Level Warning.

The system reads the status of activated probes and if they are in measuring mode, the system will read the value.

Once the system starts sampling, it will automatically provide valid data for each probe. Refer to Figure 5.3: Flowchart for Remote Control.

5.8 Commissioning



ATTENTION

Once the installation of the system is complete, check that all connections have been executed properly and they are in accordance with the installation instructions, and carry out a leak test.

Note: Verification of the installation and system setup is required following the completion of the installation. Refer to the relevant section below for the unit that is to be verified.

5.8.1 Pre-commissioning Checklist

Vessel name:		MGMS - Serial No.:	
Description	Check	N/A	
Ambient conditions OK at installation sites for probes, hoses and monitoring cabinet	☐	☐	
Monitoring cabinet is installed on frame or bulkhead according to the instruction	☐	☐	
System cabinet kept unpowered at least 1 day in the fitted position	☐	☐	
Probe with sealed plug is installed on stack according to the instructions	☐	☐	
Heating sample line is installed according to the instructions	☐	☐	
Electrical connector of the heated hose at the probe end is connected	☐	☐	
Electrical connector of the heated hose at the cabinet end is connected to the terminals inside the top right corner of monitoring cabinet	☐	☐	
Sample gas hose from the heated hose is connected at probe end	☐	☐	
Sample gas hose from the heated hose is connected to the multiplexer or t-piece	☐	☐	
Calibration gas hose from the heated hose is connected at probe end	☐	☐	

Calibration gas hose from heated hose is connected to the relevant calibrating valve at monitoring cabinet end	☐	
Air supply is installed to the cabinet. Air quality is acc. to specifications.	☐	☐
Condensate hose is installed and securely connected to proper drain	☐	☐
The power cable is connected to monitoring cabinet, and power is ready to be switched on	☐	☐
Ethernet cable to monitoring cabinet is connected, and signal has been tested	☐	☐
Associated systems are ready for operation	☐	☐

Remarks

Date	Signature	Stamp

5.8.2 Probes

Check the following:

- Probes with the seal plugs have been installed in accordance with the instructions.
- The electrical connector of the heated hose at the probe end is connected.
- The sample gas hose (center hose) from the heated hose is connected at the probe end.
- The calibration gas hose (PVDF fitting) from the heated hose is connected at the probe end.

5.8.3 Heated Sample Lines

Check the following:

- The heated sample line has been installed in accordance with the instructions. Inspect installation for damages to the hoses.
- The electrical connector of the heated hose at the enclosure end has been connected to the terminals inside the top right corner of the system enclosure.
- The sample gas hose from the heated hose is connected to the

multiplexer at the system enclosure end. For a single-probe system, the sample hose is connected to a T-piece inside the enclosure.

- The calibration gas hose from the heated hose is connected to the calibration valves at the system enclosure end.

5.8.4 System Enclosure



ATTENTION

Once the system enclosure has been fitted, it must be left unpowered and in vertical position for at least 24 hours. This is to ensure the system enclosure air conditioner is operating correctly. Failure to follow this instruction may result in damaged components. The air conditioner starts at power up.

Check the following:

- The system enclosure has been installed in accordance with the instructions.
- The system enclosure has been installed in a location where the ambient temperature is always between 5–45 °C.
- The condensate outlet hose has been installed and is securely connected to the proper drain.
- The electrical connections have been executed in accordance with the instructions.
- Protective earth is connected.
- The communication connection has been executed in accordance with the instructions and the functions have been tested.
- The air supply for the system enclosure is installed and the air quality is in accordance with ISO 8573-1 Class 2-2-2. Free from traces of measured gases.
- Associated systems are ready for operation.
- The system powers up and starts properly: Power up the system by switching ON the automatic fuse located at the inside bottom left corner of the enclosure and switch ON the main safety-switch, positioned on the outside left of the enclosure. Check the start-up of the system. After the heating period, the system should perform an automatic calibration. Once the calibration has completed, the system is ready for the initial leak test.

5.8.5 Initial Leak Test Prior to Operation

It is essential that a leak test is carried out when commissioning the system.

The leak test must be performed in accordance with MI7000-0022:

Executing an external leak test.

If a leak exceeds the permitted limit, check the gas hose connecting the multiplexers/T-piece to the probes, and the calibrating hose connecting the probes to the calibrating valves. The internal gas connections are checked before delivery. However, if necessary, test them in accordance with MI7000-0021 Executing an internal leak test.

5.9 Fitting the Probe Tubes



WARNING

Hot surface hazard. Probes and sample lines are hot. Avoid contact with hot components.

Once the leak test has been completed, use the following procedure to fit the probes:

1. Set the switch to OFF and remove the probe from the flange socket, then remove the sealed plug.
2. Fit the probe tube to the probe and re-fit the probe on the flange socket. Set the switch to ON. It takes 0.5–1.5 hours for the probe to reach its temperature.

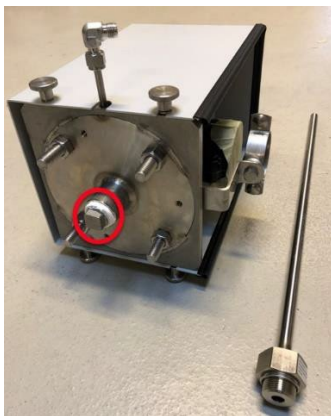


Figure 5-3 Remove the sealed plug

5.10 Technical Documentation List

No.	Document name	Document No.
1	G7000 – Installation Layout – MGMS	In documentation folder
2	G7000 – Installation Layout – Multigas probe	In documentation folder
3	G7000 – Installation Layout – Heated Hose	In documentation folder
4	G7000 – Component Overview – MGMS	In documentation folder
5	G7000 – Component Overview – Multigas probe	In documentation folder
6	G7000 – P&ID	In documentation folder
7	Electrical documentation	In documentation folder
8	Test and Configuration Sheet	Delivered with system

6. Operation

6.1 Operating the G7000 MGMS

- **Startup:** When switched on, the MGMS reaches its operating temperature in 0.5–1.5 hours, depending on the ambient temperature and cooling of the probes. Once all of the components have reached their operating temperature, sampling from the active probes starts and the measured values are displayed on the home screen. After a few minutes, the system will carry out an automatic calibration.
- **IO Status page:** The system status can be observed. Refer to section 4.5.1. The temperatures of the gas hoses, the valve chamber, multiplexer, and the enclosure are shown. Abnormal operating conditions, temperature/flow are indicated by a red line at the left side of the relevant buttons.
- **Setup menu:** All relevant probes must be selected in **Probe heating** and **Probe sampling**. Refer to section 4.5.4. By default, all installed probes are selected, and remote control is allowed via Modbus TCP.
- **Sample flow:** Recommended gas flow is 60 l/h. Increasing the flow above 60L/h can result in system degradation and accelerate end of life on components in contact with the exhaust gas. Sufficient gas flow is detected by an optical device fitted on each flowmeter. The alarm will trigger if flow has dropped below 40 l/h. Insufficient gas flow will trigger the flow alarm and the gas pump will stop. If it is not possible to achieve sufficient flow, the basic flow adjustment must be performed. Refer to section 5.3.6 Adjusting the gas flow.
- **Temperature control:** Temperature control of the enclosure is suspended if the door is open. This feature is implemented to avoid overloading of the air conditioner and proper operation of MGMS in case of high ambient temperature.



ATTENTION

Never tamper or modify the door switch, otherwise it may be ineffective and lead to damaged material.

Keep the door closed during operation, otherwise high temperatures in the enclosure may cause malfunction of the system.

If the ambient temperature falls below 15 °C, the integrated heating system will activate and prevent condensation forming inside the enclosure.

6.2 Leak Test

A leak test must be carried out If the system cannot be successfully verified using a certified gas, this may be due a leak in system and a leak test must be carried out. It is recommended that the test for internal leaks is accrued out before the test for external leaks is carried out.

To carry out the respective leak test, follow the instructions in:

- MI7000-0021 Executing an internal leak test
- MI7000-0022 Executing an internal leak test

7. Validation and Calibration



ATTENTION

The system requires compressed air for automatic calibration. The compressed air must not contain oil, water, or any traces of the sample gas components to be monitored, except from atmospheric CO₂ content.

Any presence of sample components in the analyzer during calibration will cause faulty measurements and/or a calibration error.

Negative readings can occur if there is no compressed air or insufficient compressed air during the self-calibration.

Negative readings can also occur if traces of sample components are present in the compressed air

7.3 Auto and Manual Calibration

The system is setup with automatic calibration by means of built-in calibration cells together with instrument air. The frequency of automatic calibrations can be configured to suit application requirements. See section 4.5.7 for auto calibration settings.

The system can also be manually calibrated by the same means. Manual calibration can be carried out whenever this is desired or required. For example, after a repair has been carried out.

To carry out a manual calibration, refer to MI7000-006.

If the analyzer indicates an error i.e., due to lack of instrument air during calibration, the analyzer must be recalibrated. Before re-calibration, press the **Ignore Analyzer Error** button in the calibration settings screen. Refer to section 4.5.7 and ensure that the system has sufficient instrument air.

7.4 Annual Calibration and Validation

The gas analyzer must be validated and calibrated at least once every 12 months or as needed.

Note: The G7000 analyzer is calibrated at the factory. Refer to the analyzer certificate. Validation of the calibration must be carried out in accordance with section 6 of Appendix 4 of the NO_x Technical Code 2008.

Calibration validation must:

- Use a zero gas and a span gas whose nominal value shall be more than 80% of full scale of the measuring range.
- For the two points considered, the value found must not differ by more than +/- 4% of full scale from the reference gas.

After validation has been carried out, execute the calibration routine. The analyzer is now calibrated.

7.4.6 Auto and Manual Calibration and Validation

Validation with certified test gases:

- Zero gas: 100% N₂ (other gases without SO₂/CO₂ can be used as alternatives)
- Mixed span gas: 200 ppm SO₂ + 10% CO₂

To access the auto or manual gas calibration and validation screens, the user must log in as an administrator. Refer to section 4.3.

ATTENTION



Some safety features will be disabled during manual mode operation. The analyzer must be switched ON for at least 3 hours before carrying out validation and calibration of the analyzer.

A calibration is only possible after a successful validation of both SO₂ and CO₂.

If the validation is carried out using separate span gases, SO₂ or CO₂, then two separate validation tests must be carried out. The value of the gas used for testing must be accepted, i.e., if only CO₂ is applied, then only the CO₂ value must be accepted.

7.5 Validation and Calibration Procedure

The following flow chart shows the validation and calibration procedure.

To carry out validation and auto or manual calibration, follow the maintenance instructions:

- MI7000-0017 Executing manual validation
- MI7000-0018 Executing auto and manual calibration

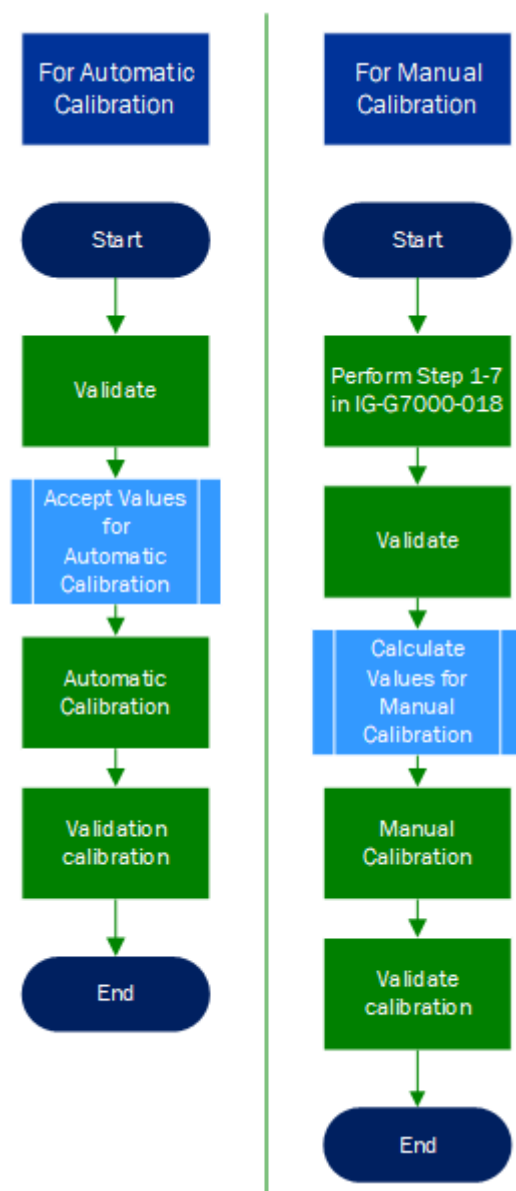


Figure 7-1 Validation and calibration procedure

8. Maintenance

8.1 Planned Maintenance Program

NOTE

The following maintenance program is for general use and must be adjusted in accordance with your specific system requirements, conditions, and experience.

The maintenance program interval is based on the use of standby mode whenever the scrubber is not in operation and a maximum sample gas flow of 60L/h. Furthermore, the maintenance program reflects optimum conditions and compliance with the system specifications. Failure to comply with the system specifications and relevant service letters can affect warranty and maintenance intervals for the system and its components.

Specific conditions can affect how often maintenance must be carried out.
For example:

- The sample flow is above the recommended setpoint.
- Soot blowing occurs frequently.
- The system, spares or components are not handled in proper manner.
- A high amount of water droplets and salts are present in the sampling point, e.g., because of an ineffective demister.
- A high amount of unburnt fuel is present in the exhaust gas.

Planned Maintenance Program										
Action	If necessary	Weekly	Monthly	Every 2 month	Every 3 month	Every 6 month	Every 9 month	Every 12 months	Every 2 years or less	Maintenance Instruction
Gas analyzer										
Gas analyzer – annual calibration.								x		MI7000-0017 MI7000-0018
Gas analyzer – Replacement	x									MI7000-0007

Planned Maintenance Program											
Action	If necessary	Weekly	Monthly	Every 2 month	Every 3 month	Every 6 month	Every 9 month	Every 12 months	Every 2 years	Every 2 years or less	Maintenance Instruction
Air conditioner											
Inspect the filter and clean If necessary		x									Refer to Section 8.2 Air Conditioner and MI7000-0020
Replace the filter (03385)								x			MI7000-0020
Probe											
Inspect the probe and clean/repair if necessary			x								
Replace the filter and O-rings of probe (03370+03231)						x					MI7000-0004
Heated hoses											
Inspect heated hoses	x		x								
Leaking gas line											
Check if CO2 level drops below expected level.		x									
Condensate switch											
Inspect the condensate switch					x						MI7000-0013
Replace the condensate alarm (03182)										x	MI7000-0015
Condensate pump											

Planned Maintenance Program

Action	If necessary	Weekly	Monthly	Every 2 month	Every 3 month	Every 6 month	Every 9 month	Every 12 months	Every 2 years	Every 2 years or less	Maintenance Instruction
Inspect the condensate pump			x								MI7000-0014
Replace the condensate pump hose (03386)						x					MI7000-0014
Condensate pump rotor w. springs								x			
Gas pump											
Replace the gas pump's bellow and by-pass valve (03387 and 03234)								x			MI7000-0023
Gas filter											
Replace the internal gas-filter (03235)				x							MI7000-0003
Water trap											
Replace the water trap (103830)								x			MI7000-0042
Secondary Water trap maintenance						x					MI7000-0038
Secondary Water trap exchange	x										
3-way solenoid valves											
Replace the 3-way solenoid valves (02391)										x	MI7000-0024
Multiplexer											
Replace the heating elements in multiplexer (03044)										x	MI7000-0025
Calibration air											
Test the calibration air supply.								x			MI7000-0029

9. Lifetime Considerations

In every application the below listed items are considered consumable parts.

- Gaskets
- Filters
- Condensate pumps incl. all mechanical parts and parts in contact with media.
- Sample gas pumps incl. all mechanical parts and parts in contact with media.
- Water traps
- Gas analyzers and sensors incl. all mechanical parts and parts in contact with media.
- Air conditioners incl. all mechanical parts and filters.
- Gas coolers
- Glass fuses

Furthermore, all components that are in contact with sampling media must be considered consumable parts because they will eventually suffer from physical or chemical exposure including clogging, fatigue, and similar.

Particular attention must be drawn to:

- The gas analyzer(s) which can have sudden end of life if soot or liquids enters the device.
- The heated hose(s) which can have sudden end of life mainly due to local overheating, mechanical stress, and voltage peaks.

Regardless of application, the lifetime will be reduced by various operational factors of which the most common are:

- Excessive sampling flow.
- Exposure to liquids e.g., condensate, aerosols, acids, or similar.
- All mechanical forces including shock, drop, impact, and bends.
- Exposure to substances with content of organics with low boiling point, unburned fuel, lead, phosphorus, silicon, or halogens.
- Contaminants e.g., soot, dust, salts, ash, or similar deposits.
- Pressure including over- and under pressure and pulsations.

- Thermal stress due to temperature variations including power on/off cycles.

Furthermore, installation, operation, and maintenance must follow best practice and the latest version of the product manual and must pay respect to the limitations of the product type approval. Failure to comply with service letters can also affect lifetime.

The aforesaid information on lifetime for which the product has been construed shall in no case be a guarantee regarding the condition or quality of the product.

10. Services

Upon request, our service engineers can perform several tasks on-board, including a full system calibration and advanced troubleshooting.

Our service engineers have in-depth system knowledge of our product and of installation and operation correction.

Contact Green Instruments service department by e-mail at service@greeninstruments.com



ATTENTION

Faulty component hazard

Failure to comply with the service due date can affect the accuracy, performance, and functionality of the system, resulting in failure to comply with the requirement(s) of the regulatory agencies.

On request, our service engineers can perform a full calibration at our factory or on-board the vessel. A new calibration certificate will be issued.

Contact Green Instruments A/S for more information.

10.1 Return of Equipment

Return of equipment must be coordinated with manufacturer. You will receive a "Return form".

Use a secure transport container that is suitable for the equipment that is being returned. All returned equipment must be free of any hazardous substances (acids, alkalis, solvents, etc.). Therefore, it is important to carefully clean the equipment prior to returning.

IMPORTANT: Clearly mark the equipment with the system serial number and return confirmation number.

IMPORTANT: Fill out the "Return form" prior to returning the equipment. Return this form along with the equipment to be returned.

11. Troubleshooting

For troubleshooting of the system, please refer to the PI diagram of each system.

Troubleshooting should always be carried out by trained professional personnel.



WARNING/ATTENTION

Electric shock hazard

The continuous emission monitoring system is connected to hazardous electric voltages, which can cause personal injury or mechanical damage if not handled correctly and in accordance with normal safety regulations.

11.1 General Troubleshooting

Problem	Possible Cause	Action
Display is dead	Circuit breaker Power supply	Check the circuit breaker Check power supply – the power supply needs to be at the correct voltage Check the electrical wiring
Display screen shows nothing despite power supply and circuit breaker are OK	Display is defective	Replace the display
The system cannot communicate with the HMI	Faulty ethernet port Faulty ethernet cable	Check communication cable to HMI Replace the HMI or PLC
Flow alarm	Follow the flow alarm flowchart	MI7000-0001 MI7000-0002 MI7000-0003 MI7000-0004 MI7000-0005 MI7000-0012

Problem	Possible Cause	Action
		MI7000-0023
Temperature alarm	Check the air conditioner automatic fuse Check the electrical connections Check the air conditioner unit Check/control air conditioner temperature Check enclosure heating elements	MI7000-0019 MI7000-0020
Incorrect indication of SO ₂ /CO ₂ value	Check if there is any leakage Manually calibrate the analyzer Check the air supply calibration	MI7000-0006 MI7000-0021 MI7000-0022 MI7000-0029
Condensate alarm	Check the condensate alarm Check the condensate pump	MI7000-0013 MI7000-0014
No heat in multiplexer	Faulty wiring. Check the wiring Replace the heating elements	MI7000-0025
Condensate alarm not operating	Defective condensate alarm. Replace the condensate alarm	MI7000-0015
Condensate pump not operating	Defective condensate pump. Replace the condensate pump	MI7000-0016
3-way valve not operating	Defective 3-way valve. → Replace the 3-Way valve	MI7000-0024

11.2 Flow Alarm Flowchart

In case of a flow alarm, you can use the flowchart to help locate the problem. Some of the maintenance instructions require an active gas pump. To activate the gas pump, follow the instruction in section 4.5.1. Ensure that the gas pump can be manually activated before starting troubleshooting.

Note: Before replacing any component, we recommended that flow adjustment is carried out. Refer to maintenance instruction MI7000-002.

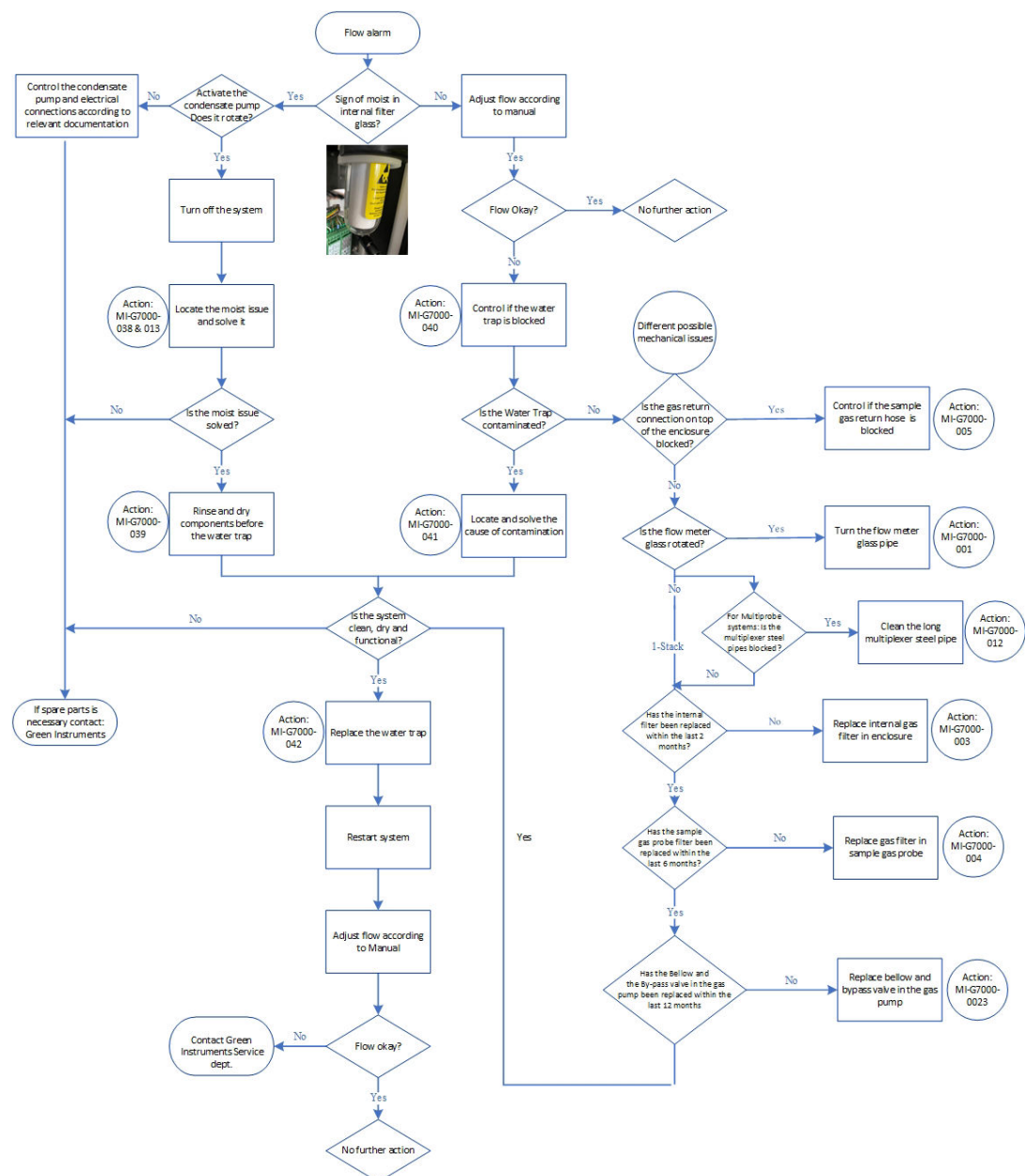


Figure 11-1: Troubleshooting Flowchart

11.3 Overview of Maintenance Instructions

The following is a list of G7000 Maintenance Instructions. Some of the instructions are only available on request.

Number	Procedure	In user manual	On request
MI7000-0001	Checking for an incorrectly fitted flowmeter glass tube	X	
MI7000-0002	Adjusting the gas flow for the gas pump	X	
MI7000-0003	Replacing the internal gas filter	X	
MI7000-0004	Replacing a sample gas probe filter	X	
MI7000-0005	Checking for a blocked sample gas return hose	X	
MI7000-0006	Calibrating using the built-in calibration cells	X	
MI7000-0007	Replacing the gas analyzer		X
MI7000-0008	No data log		X
MI7000-0009	No remote log		X
MI7000-0010	No display		X
MI7000-0011	Operating the system in manual mode	X	
MI7000-0012	Cleaning/replacing the multiplexer steel pipe		X
MI7000-0013	Checking the condensate alarm and condensate pump	X	
MI7000-0014	Checking or replacing the hose in the condensate pump	X	
MI7000-0015	Replacing the condensate alarm		X
MI7000-0016	Replacing the condensate pump		X
MI7000-0017	Executing manual validation	X	
MI7000-0018	Executing auto and manual calibration	X	
MI7000-0019	Checks following a temperature alarm	X	
MI7000-0020	Replacing or cleaning the air conditioner filter	X	
MI7000-0021	Executing an internal leak test	X	
MI7000-0022	Executing an external leak test	X	
MI7000-0023	Replacing bellow and by-pass valve in gas pump	X	
MI7000-0024	Replacing 3-way valve		X
MI7000-0205	Replacing heating elements in multiplexer		X
MI7000-0029	Checking calibration air supply	X	
MI7000-0030	Replacing sample gas hose		X
MI7000-0038	Locating moisture and resolving the issue	X	

MI7000-0039	Cleaning the system	X	
MI7000-0040	Checking the water trap	X	
MI7000-0041	Locating contamination and resolving the issue causing it	X	
MI7000-0042	Replacing the water trap	X	

12. System Hibernation

Note: We recommend that you keep following spare parts in stock so that they are available when the system is used again following an extended period of inactivity (>30 days):

1. System filters including probe filters
2. Water Trap
3. Sample gas pump(s)
4. Condensate pump spares

13. Maintenance Instructions

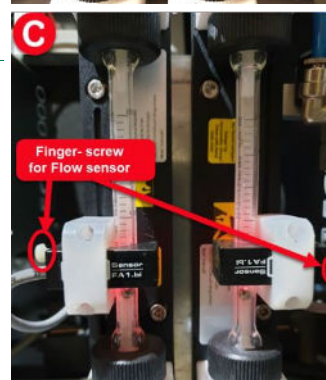
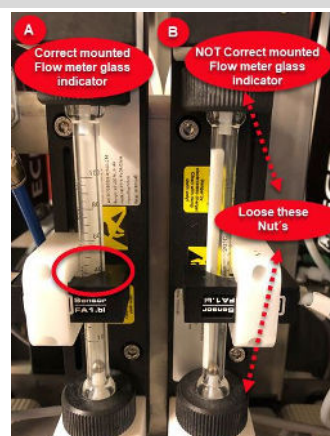
System Type	G7000 Multi gas system	MI7000-0001
Task:	Checking for an incorrectly fitted flowmeter glass tube	
Task description:	This procedure describes how to adjust the flowmeter glass tube if it is fitted incorrectly and causes a flow alarm. This procedure may only be carried out by a trained professional technician.	
Difficulty 1-5	Overhaul Interval	Estimated time consumption



Procedure

Tools: Multigrip pliers

1. Turn OFF power to the relevant gas pump. Refer to MI7000-0011 Operating the system in manual mode
2. Loosen the large black nuts in the top and the bottom of the flowmeter. See image B and loosen the finger screw on the flow sensor. See image C. Rotate the glass to the correct position, ensuring that the white color forms the background, as seen in image A.
3. Ensure that the flowmeter sensor is mounted at the alarm level at 40 l/h. See the red circle on image A.
4. Hold the glass in the correct position by hand and tighten the large black nuts in the top and/bottom. Do this by hand to begin with and then use the multigrip pliers to finish with.
5. Tighten up the finger screw for the flowmeter sensor. See image C.
6. Go to the Status screen to reset the system.



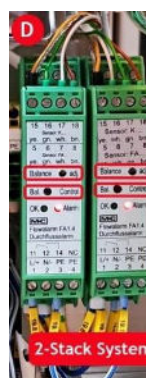
Tools: Ballpoint pen, Screwdriver

Sensitivity adjustment of the electronic controller

This procedure is necessary if the flowmeter glass tube has been turned.

1. Turn OFF power to the gas pump.
2. Gently Press the Bal. Control button using a ball point pen, and carefully turn the Balance adj. screw at the same time. Exercise caution: do not overturn the adjustment screw.
3. Turn the adjustment screw right or left a few revolutions at a time to find the switch point where the LED indicator changes from Red to Green or Green to Red. See image D.
4. The exact adjustment is where the OK/Alarm changes from Green to Red.
5. Go to the Status screen to reset the system.

Refer to MI7000-0011 Operating the system in manual mode.



System Type	G7000 Multi gas system	MI7000-0002
Task:	Adjusting the gas flow for the gas pump	
Task description:	This procedure describes how to adjust the flow at the gas pump and flowmeter to avoid a flow alarm. This operation must only be carried out by a skilled technician	
Difficulty 1-5	Overhaul Interval	Estimated time consumption
		20 minutes

Procedure

Note

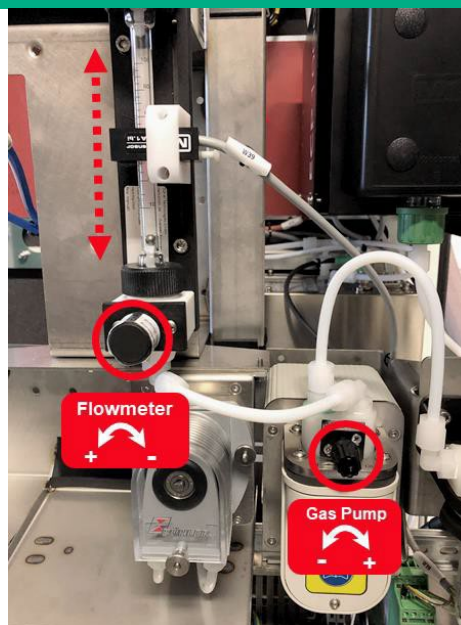
The gas pump must be active. Refer to MI7000-0011: Operating the system in manual mode

Flow adjustment:

1. Open the flowmeter valve completely by turning the valve to the left (+).
2. Adjust the flow to 100 l/h* on the gas pump.
3. Use the needle valve on the flowmeter to decrease the flow to 80 l/hour.
4. Increase the flow again to 100 l/h on the gas pump.
5. Decrease it to 60 l/h on the flowmeter.
6. Manually stop the gas pump
7. Refer to MI7000-0011 Operating the system in manual mode.
8. Go to the Status screen and reset the system to remove the alarm on the display.
9. *If it is not possible to adjust the flow to 100 l/h, refer to MI7000-0004 on how to change the sample gas probe filter.

Alarm level setting

Check if the sensor is correctly fitted at the flowmeter glass tube. The top edge should be set at 40 l/h, as shown in the image here.



System Type	G7000 Multi gas system	MI7000-0003
Task:	Replacing the internal gas filter	
Task description:	This procedure describes how to replace the internal gas filter. This operation must only be carried out by a skilled technician.	
Difficulty 1-5	Spare parts	Estimated Time Consumption
	#03235 Filter insert- pack	10 minutes

Procedure

1. Turn off safety switch. The system will be out of service during the operation
2. Pull the locking ring off.
3. Gently pull down the filter-glass to release it.
4. Pull down out the used filter.
5. Fit a new filter.
6. Refit the filter glass.
7. Plug-in the locking ring.

The filter must be changed in accordance with the planned maintenance program.



System Type	G7000 Multi gas system	MI7000-0004
Task:	Replacing a sample gas probe filter	
Task description:	This procedure describes how to replace a sample gas filter. This operation must only be carried out by a skilled technician	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
		10 minutes

ATTENTION: Cleaning and reusing of sample gas probe filter or O-ring is strictly prohibited. Sample gas probe filters and O-rings may only be replaced with new ones.

- When it is not possible to reach a gas flow of 100 l/h, it may be necessary to replace the sample gas probe filter.
- Filters should also be replaced in accordance with the Planned Maintenance Program.
- Only remove the filter if you are replacing it. A visual inspection of the filter will not show its condition or whether it is clogged.
- If the filter is removed for any reason, the filter and the O-ring must be replaced.
- Ensure that you have a new filter and new O-ring at hand when replacing the filter.
- Ideally, the MGMS, scrubber and engine should be shut down during a filter change to avoid unfiltered exhaust gas entering the MGMS and surroundings.
- If the scrubber and engine are active the following steps must be carried out to protect the MGMS:
- Stop the sample gas pump. For manual operation refer to MI7000-0011 Operating the system in manual mode
- Open the calibrating air valve by pressing the "Sample Probe" button. For manual operation refer to MI7000-0011 Operating the system in manual mode.
- Probe heating must remain active.
- Replace the filter and O-ring in accordance with these instructions.
- After replacing the filter and O-ring the system must be set back to AUTO mode.

WARNING



Hot surface hazard. Probes and sample lines become hot during operation. Avoid contact with hot components.

ATTENTION: Make sure that you have a new O-ring and new sample gas filter ready before replacing the sample gas filter

Dust particles collect inside the filter, making it difficult to see the amount of contamination.

The used filter in the picture shows particles in the center.

The used filter in the picture is completely blocked.

In a worst-case scenario, a blocked filter may



cause damage to other parts of the system.

The filter must be changed in accordance with the planned maintenance program.

Procedure to change the probe filter:

1. Follow the initial instructions stated at the start of this maintenance instruction.
2. Loosen the 4 thumb screws to gain access to the probe handle and filter.
3. Loosen the handle by rotating it 90° and pull out to grant access to the probe filter.
4. Remove the old filter and O-ring from the handle.
5. Fit a new O-Ring on the handle – remember to apply silicon grease on the O-ring.
6. Put the silicone grease on the O-rings inside the filter
7. Fit the new filter to the probe handle
8. Fit the probe handle now with the new filter back inside the probe and turn the handle 90°
9. Refit the probe housing using the 4 thumb screws.
10. Start or reset the system.

ATTENTION: Do not reuse O-rings or probe filters.



System Type		G7000 Multi gas system	MI7000-0005
Task:	Checking for a blocked sample gas return hose		
Task description:	This procedure describes how to check if the sample gas return hose is blocked. This operation must only be carried out by a skilled technician		
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption	
		30 minutes	
Procedure			
1. Disconnect the sample gas return hose from the sample gas return connector in top of the enclosure. Check for any sharp kinks in the sample gas return hose. 2. Check if the hose is blocked by blowing air through the sample gas return hose. 3. Attention: Avoid damaging the Analyzer. Do not blow compressed air backwards into the sample gas return fitting. 4. If the sample gas return hose is blocked, remove the blockage or replace the sample gas return hose.			

System Type	G7000 Multi gas system	MI7000-0006
Task:	Calibrating using the built-in calibration cells	
Task description:	This procedure describes how to calibrate the built-in calibration glasses. This operation must only be carried out by a skilled technician.	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
		15 minutes

Procedure

NOTE: You must log in to the system as an administrator to carry out this procedure. Refer the relevant logging in section. Refer to MI7000.011 Operating the system in manual mode.

Ensure that there is sufficient instrument air flushed through the system for this process.

The system will calibrate automatically using the built-in cells after the system is switched ON.

You can use the “IO Status” screen to calibrate the system using the built-in cells. See picture A.

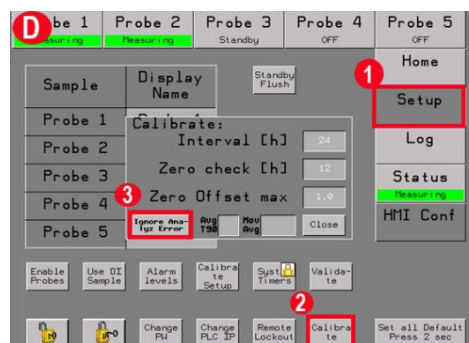
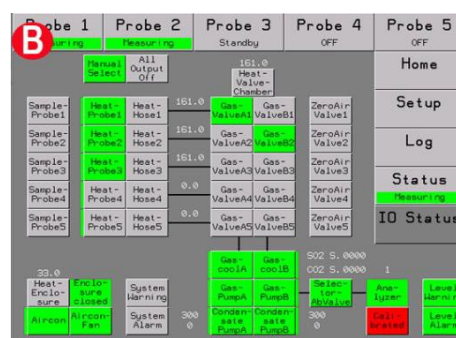
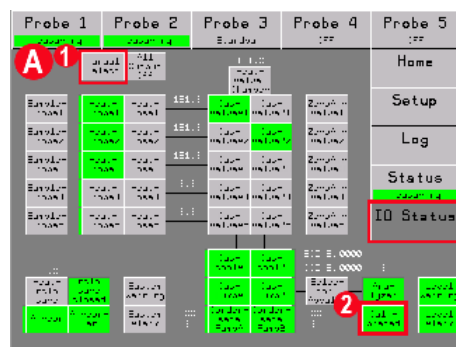
1. Press the “Manual Select” button (1)
2. Press the “Calibrated” button (2)
3. The “Calibrated” button will turn RED. See picture B.
4. The calibration of the internal calibration glass will be executed.

The calibration is finished when the Calibrate button turns green.

If the gas analyzer reports an error with the digits xxx, as in picture “C” the following procedure must be followed prior to a calibration of the built in cells: Ignore Analyzer Error

1. Press the “Setup” button (1) button. See Picture D.
2. Press the “Calibrated” button (2)
3. Press the “Ignore Analyz. Error” (3) button and then press the “Close” button.
4. Restart Calibration from step 1.

ATTENTION: You must deselect the “Ignore Analyz. Error” button after calibration has finished

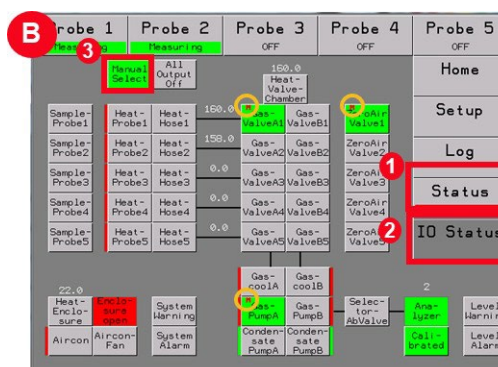


System Type	G7000 Multi gas system	MI7000-0011
Task:	Operating the system in manual mode	
Task description:	This procedure describes how the system outputs can be operated manually from the IO Status screen. Attention: Some safety features will be disabled during operation in manual mode. This operation must only be carried out by a skilled technician.	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
		5 minutes

Procedure

You must log in to the system as an administrator to carry out this procedure. Refer the relevant login section.

1. Procedure to activate manual mode:
2. Press the Status button (1).
3. Press the IO Status button (2).
4. Press the Manual Select button (3), which will turn Green.
5. Press any button intended for manual operation.
6. The selected buttons will show the letter M in red, indicating manual operation.
7. Press the manual select button again. It will turn grey.
8. Any button with a red M can be turned "ON" or "OFF" manually.
9. When the button is turned "ON", there will be an "ON" indication on that button.
10. Deactivate manual mode:
11. To deactivate manual operating mode, press the "Manual Select" button, so it turns green.
12. Press the buttons with red M.
13. Press the manual select button again and it will turn grey.
14. Press the buttons with "ON" written to deactivate the manual operation.



Component activation list:

- Gas pump
- Condensate pump
- Gas cooler
- Enclosure heating elements
- Valves
- Multiplexer heating
- Hose heating
- Probe heating

Remember to turn off activated components when finished using them!

System Type	G7000 Multi gas system MI7000-0013	
Task:	Checking the condensate alarm and condensate pump	
Task description:	This procedure describes how to check the condensate alarm and condensate pump. This operation must only be carried out by a skilled technician.	
Difficulty 1-5 	Overhaul Interval	Estimated Time Consumption 20 minutes

Procedure

Inspection of the 2 types of level switches:

Note: Spillage during the replacement or check of the limit switch can damage the electronic components.

Cover all components below before starting.

Before checking the condensate alarm, verify that the Condensate OUTLET is intact and not blocked. See image 1.

Condensate alarm type with a level float sensor:

The level switch is located behind the gas filter.

Check to ensure that:

- The glass is filled with condensate.
- The level switch is installed correctly, with the magnet in the bottom of the glass.
- The level switch hoses are intact and not blocked.
- The wires to the level switch are connected correctly.
- The level switch glass is undamaged.
- The limit switch vent is not blocked. See image 3.
- The drain holes inside the limit switch are not blocked. See image 4.

Note: To ensure the electrical wiring is connected correctly, refer to the relevant electrical circuit diagram in the documentation.

If the level switch is blocked and cannot be cleaned or is defective, it must be replaced in accordance with the user manual instructions.

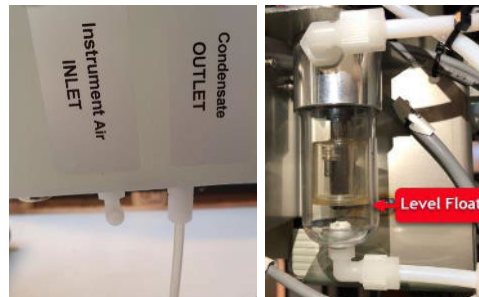


Image 1 Image 2



Image 3



Image 4

Condensate alarm type with capacitive sensor: Inspection of the level switch sensor

The level switch is located below the gas cooler.

Check to ensure that:

- The level switch sensor is active. It will emit orange and/or green light when energized. See image 5.
- If there is no light on the level switch sensor, it is not energized control the wiring. See image 6.
- The level switch hoses are intact and not blocked or bent.

NOTE:

- Operation of the limit switch sensor - SW V. 3.8.2 or greater.
- The condensate pump will only run when there is condensate in the limit switch housing.

With active limit switch sensor

- No Condensate in the limit switch housing
=> Orange and green light => Condensate pump stops. See image 7.
- Condensate in the Limit Switch Housing
=> Green Light => Condensate pump run. See image 7.

The minimum activation time for the condensate pump is 60 seconds.

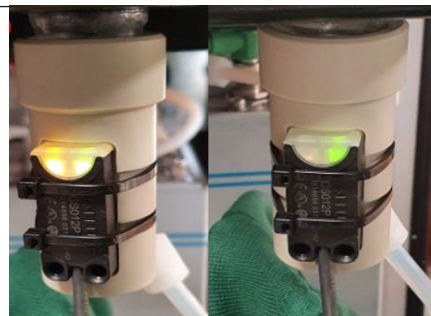


Image 5



Image 6



Image 7

System Type	G7000 Multi gas system	MI7000-0014
Task:	Checking or replacing the hose in the condensate pump	
Task description:	This procedure describes how to check and replace the hose in the condensate pump. This operation must only be carried out by a skilled technician.	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
		20 minutes
Procedure		

Turn OFF safety switch. The system will be out of service during the procedure.

The hose in the condensate pump will become deformed over time and reduce the ability to pump condensate.

NOTE:

- Stop the condensate pump if necessary.
- Refer to MI7000-0011 Operating the system in manual mode.

The hose must be changed at regular intervals in accordance with the planned maintenance program in the user manual to ensure pump functionality.

- Check the state of the condensate hose – see illustration 1.
- The hose must not be bent, folded or ruptured. See image 2.
- It may be necessary to disconnect the hose for inspection to ensure it is intact and undamaged.
- Image 3 shows the difference between a new hose and a deformed hose.
- Image 4 shows an example of a damaged hose which must be replaced.

To disconnect the hose from the pump, follow the instructions on the following page.

ATTENTION:



Condensate may be aggressive and cause corrosion and chemical burns. PPE must be worn whenever there is a risk of contact with combustion gas and condensate. Protective gloves and safety goggles must be worn.

NOTE:

Spillage during replacement of the pump hose can damage the electronic components. Cover all components below before starting. Stop the condensate pump.

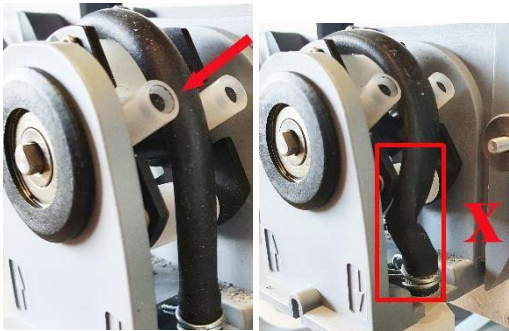


Image 1

Image 2

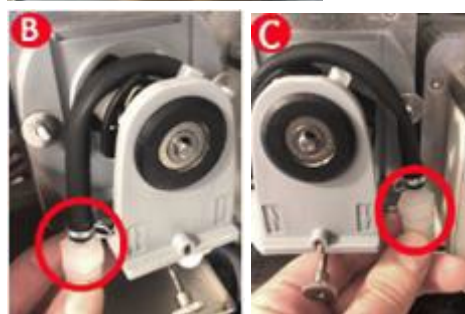


Image 3



Image 4

1. Loosen the thumb screw on the condensate pump. See image A.
2. Pull off the cover.
3. Loosen the two PVDF hoses (Inlet and Outlet) on the finger nuts.
4. Disconnect the pump hose on both sides of the condensate pump. See image B and C.
5. Connect the new pump hose back in the fittings on both sides of the pump.
6. Fit the cover and fully tighten the thumb screw on the front of the condensate pump.
7. Retighten the two PVDF hoses (Inlet and Outlet) using the finger screws.
8. Restart the condensate pump by deactivating manual mode.



System Type	G7000 Multi gas system	MI7000-0017
Task:	Executing manual validation	
Task description:	This procedure describes how to perform a manual validation. This operation must only be carried out by a skilled technician.	
Difficulty 1-5	Spare parts	Estimated Time Consumption
Procedure		

ATTENTION

- This instruction requires software greater than V3.4.0.
- Carry out the calibration and validation using certified test gases i.e.,
 - Zero gas bottle: 100% N2
 - Span gas bottle: 200 ppm SO2 + 10% CO2

NOTE: The gas analyzer must be turned, “ON” for at least 3 hours prior to operation.

You must log in to the system as an administrator to carry out this procedure. Refer the relevant login section.

Refer to MI7000-0011 Operating the system in manual mode.

1. After you have logged in, press the “Setup” button and then the “Validate” button. See picture A.
2. Remove the plug to the “Test Gas Inlet” at the bottom of the enclosure. See picture B.

Zero Gas Validation:

1. Apply certified test gas. N2 100% using the 6/4 mm hose to the “Test Gas Inlet” (push to connect it).
2. The flow regulator in the certified #03810 test gas bottle is preset to 1 l/minute. See picture C.
3. Check that the hose is intact, clean, and not bent/broken.
4. Press “OK” to confirm that the hose is connected. See picture A of Image 1.
5. An information window appears with the message: “Wait 5 minute for stable readings for
6. SO2 ppm and CO2 %”. Press the “OK” button. See picture B of image 1.
7. When you press “OK”, the analyzer executes an internal adjustment of the built-in optical calibration glasses. See picture C of image 2.
8. After approx. 5 minutes the analyzer performs an internal calibration with the built-in optical calibration glasses, and the results of the Zero validation can be observed. See picture D of image 2.

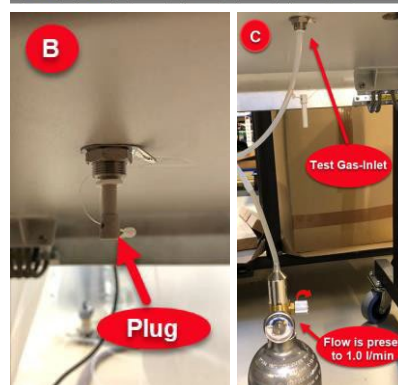
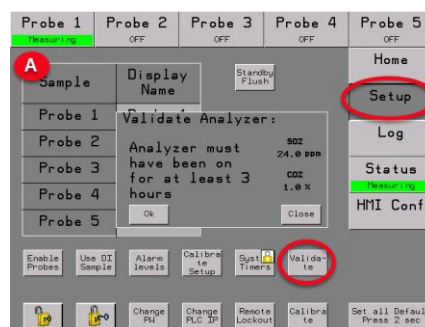


Image 1



Image 2

For manual calibration, note and save this value in a logbook for further reference. It is used for calculating the manual calibrations "Factor and Offsets".

Press "OK" to accept tolerance of the Zero Validation.

Remember to close the zero-gas bottle after the test is finished.

Zero GAS example	Accepted tolerance	Min example	Max example
SO ₂ ppm	+/- 8 ppm	- 8 ppm	+ 8 ppm
CO ₂ %	+/- 0.40 %	- 0.40 %	+ 0.4 %

SPAN Gas Validation

1. Apply the certified mixed Span gas to the "Test Gas Inlet" (Refer to the span test gas bottle, i.e., SO₂ = 200 ppm and CO₂ = 10 %). The flow regulator in the #03881 test gas bottles is preset to 1 l/minute. See image 3, A.
2. Wait approx. 5 minutes until the SO₂ ppm and CO₂% gas value are stable. Then press "OK". See Image 3, B.
3. The span gas validation result can be observed. See image 4, C.
4. If a calibration must be executed, the following procedure must be followed:

For manual calibration note and save this value in a logbook for future reference. See picture C of image 4.

For Auto Calibration press the SO₂ and/or CO₂ values on the screen. When the button turns GREEN the value is accepted. See picture D of image 5.

Only press the value corresponding to the applied type of gas

Accepted span validation tolerance

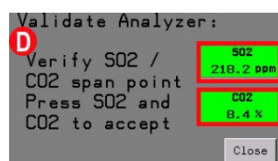
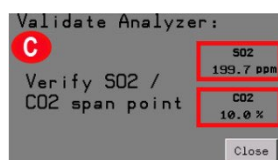
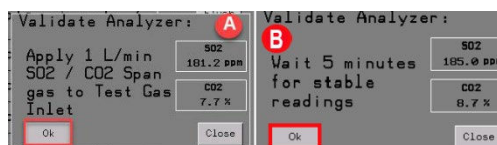
Span gas example	Accepted tolerance	Min example	Max example
SO ₂ 200ppm	+/- 8 ppm	192,0 ppm	208,0 ppm
CO ₂ 10 %	+/- 0.40 %	9.6 %	+/- 10.4 %

5. When validation is done press "Close". Remember to close the bottle of the mixed span gas after completion of the test.

NOTE: Both SO₂ and CO₂ must be validated to complete a validation.

NOTE: Min/Max. in the table are the calculated test gasses: 200 ppm SO₂ and 10% CO₂.

See the exact gas certification value on the test gas bottle.



System Type	G7000 Multi gas system		MI7000-0018
Task	Executing auto and manual calibration		
Task description	This procedure describes how to carry out an auto or manual calibration. This operation must only be carried out by a skilled technician.		
Difficulty 1-5	Spare part	Estimated Time Consumption	
	#03881 Certified Test gas kit	60 minutes	

Procedure

You must log in to the system as an administrator to carry out this procedure. Refer the relevant login section.

Refer to MI7000-0011 Operating the system in manual mode.

ATTENTION:

This instruction requires software greater than version 3.4.0.

Carry out calibration and validation using certified test gases, i.e., Zero gas bottle: 100% N2 and Span gas bottle: 200 ppm SO2 + 10% CO2.

Auto Calibration

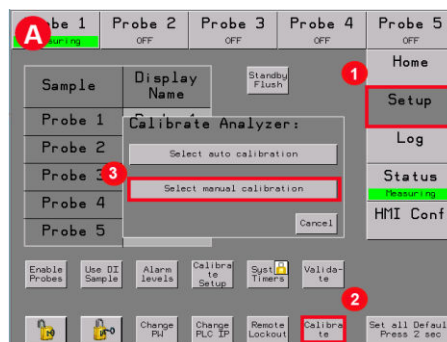
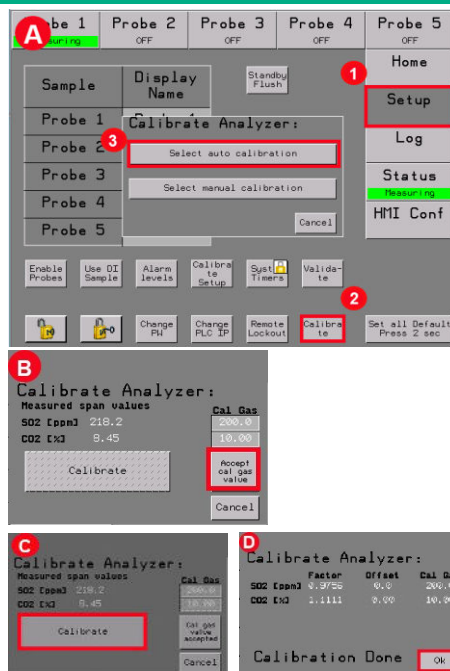
- After you have logged in, press the "Setup" button (1), and then the "Calibration" button (2). Next, press the "Select auto calibration" button (3). See picture A.
- The accepted value from the validation is now present. To continue the auto calibration, press the "Accept cal gas value" button. See picture B.
- Press the "Calibrate" Button to start the auto calibration with the accepted validation values. See picture C.
- The calibration is complete, and the screen shows the new calculated Factor and Offset values for SO2 and CO2. Press "OK." See picture D.

NOTE: To verify the new Factors and Offset values for SO2 and CO2 a validation must be performed.

Refer to MI7000-0017 Executing manual validation.

Manual Calibration:

- After you have logged in, press the "Setup" button (1) and then the "Calibrate" button (2). Now press the "Select Manual Calibration" button (3). See picture A.
- To edit the numeric value, press the "Edit Value Unlocked" button. See picture B.
- Enter 1.0000 in both SO2 and CO2 Factor fields. See picture B.
- Enter 0.0 in both SO2 and CO2 Offset fields.
- Enter the Cal Gas values from the certificate of the span gas.



6. Press the "OK" button.
7. Run validation as described in MI7000-0017 Manual validation procedure and note both the zero and span values for SO₂ and CO₂. Old values will be overwritten; so, we recommend that you note these values manually in a logbook for future reference.

Use the equations below to calculate the Factor and Offset for SO₂ and CO₂

1. Calculate Factor for SO₂. Example:

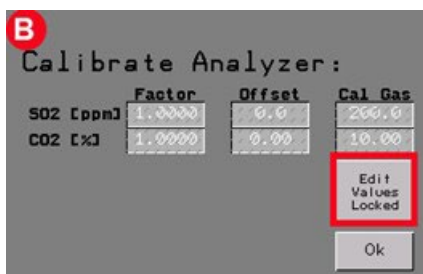
$$\text{SO}_2 \text{ factor} = \frac{0 - \text{SO}_2_{\text{Bottle Gas}}}{\text{SO}_2_{\text{Zero}} - \text{SO}_2}$$

$$= \frac{0 - 200}{6.3 - 202.3} = 1.02$$

2. Write it in SO₂ Factor See picture "C".
3. Calculate Offset for SO₂ (can normally be set to 0).
Example:

$$0 - 1.02 * 6.3 = -6.4$$

4. Write it in SO₂ Offset See picture "C".

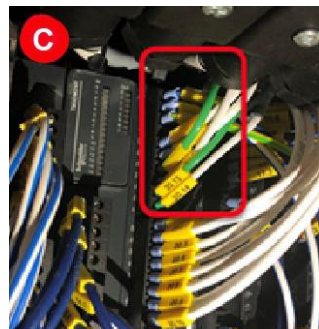
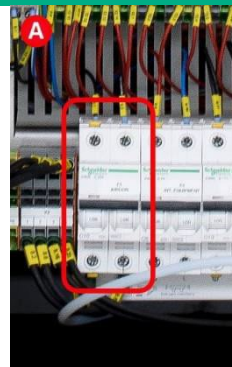


System Type	G7000 Multi gas system	MI7000-0019
Task:	Checks following a temperature alarm	
Task description:	This procedure describes which equipment must be checked in the event of an enclosure temperature alarm. This operation must only be carried out by a skilled technician.	
Difficulty 1-5	Spare part	Estimated Time Consumption
	# 03136 Temperature sensor Ø3 x 30 mm	45 minutes

Procedure

NOTE: When the enclosure door is open the temperature control will be deactivated.

1. Check that the door switch functions.
2. Check if the F1 automatic fuse "AIR CON" is activated. See picture A for how to activate the automatic fuse - the switch must be as shown upwards.
3. Check that the air conditioner is switched ON. See picture B.
4. Check the connection to the thermocouples, positioned on the PLC inside the enclosure. To check, pull gently on the white/green cables. See picture C.
5. Note: Refer to the electrical diagrams in the documentation folder for the correct connection and reconnection of wires and electrical components.
6. Check that the air condition display is "ON"
7. Ensure that the setpoint is correctly adjusted to the right temperature at the air conditioner by following the steps below:
8. Press "SET" (1) to view the Setpoint. It is specified as 30°C.
9. Make sure that the air condition filter is clean. Refer to MI7000-0020 Replacing or cleaning the air conditioner filter.

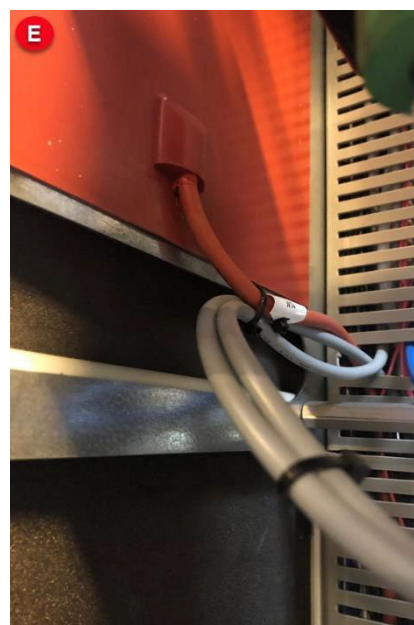


Procedure to adjust the setpoint If not correctly adjusted.

Default Setting = 30°C

1. Press and hold the "SET" button (1) for 2 seconds. See picture C. In the display, "°C" will start flashing. The setpoint can now be adjusted by using the Up/Down button (2). See picture D.
2. Check the connection for the heating element inside the enclosure. See picture E.
3. Check the enclosure temperature on the HMI screen. See picture F. If the temperature is below 5°C the system will automatic shutdown.
(Normally, the working temperature is between 5–45°C. The system is able to start at temperatures below 5°C)
4. Set the "Heat Enclosure" to "ON" and check for rising temperatures on the heating elements.

Refer to: MI7000-0011 Operating the system in manual mode.





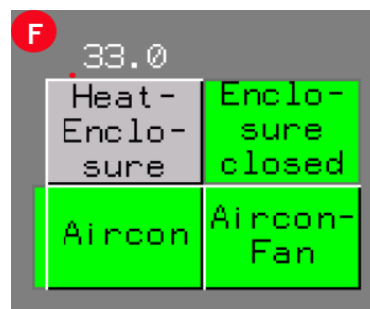
WARNING: Hot surface hazard.
The heating elements can be hot. Avoid
contact with hot components.

NOTE: To avoid overheating of the heating elements,
Turn the heating elements OFF after testing.

When in manual mode, the temperature control is
OFF.

5. Check for damaged thermocouples/temperature sensor
wiring.
6. Check thermocouples- resistance using a multimeter

NOTE: Refer to the electrical diagrams in the
documentation folder for the correct connection and
reconnection of wires and electrical components.



System Type	G7000 Multi gas system	MI7000-0020
Task:	Replacing or clean the air condition filter	
Task description:	This instruction identifies how to clean and replace the air condition filter. This operation must only be carried out by a skilled technician.	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
	#03385 AC-Filter Insert	15 minutes

Procedure

The air conditioner filter requires regular cleaning.

1. Loosen the two thumb screws at the side of the air conditioner unit. See picture A.
2. User a screwdriver to push the filter in the slot end and pull it sideways out of the guide.
3. Do NOT use acid wash as this will reduces the lifetime of the filter. Only clean the filter with mild soap and water. Dry thoroughly before re-fitting the filter.
4. If the filter is damaged or cannot be cleaned, replace with a new filter.
5. After cleaning or replacing the filter, fit it in the slot and secure it using the two thumb screws.



System Type	G7000 Multi gas system	MI7000-0021
Task:	Executing an internal leak test	
Task description:	This procedure describes how to carry out an internal leak test. This operation must only be carried out by a skilled technician	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
	# 02366 Elbow Fitting 6/4mm – 1/4" PVDF	60 minutes

Procedure

An internal leak test needs to be carried out if:

- Commissioning is being carried out.
- The analyzer has to be calibrated.
- The analyzer has been replaced.
- Hoses, components or fittings have been damaged or dismantled.
- SO₂ and CO₂ values are lower than expected.
- Tools to be used for internal leak test.
- PVDF elbow fitting 6/4mm - 1/4" *
- Silicon hose 6/4mm
- Glass of water
- Spanner 12 mm
- Stopwatch.



*If not already connected

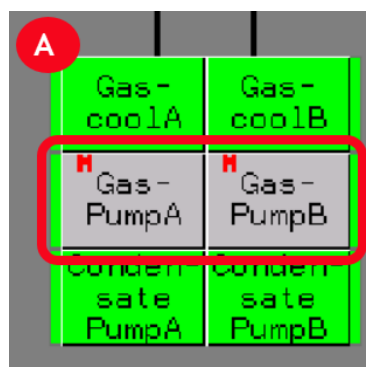
ATTENTION



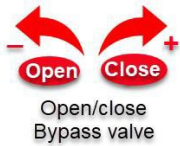
Do not block the gas sampling pipes to or from the system when the system is in operation otherwise it could damage components. Blocking is allowed (for short periods) only during a leak test.

You must log in as an administrator to carry out this procedure. Refer to MI7000-0011 Operating the system in manual mode.

1. Turn off (grey) all gas pumps in the "IO Status" window and manual select buttons. See picture A.
2. Disconnect the return gas connection on top of the enclosure (if installed) and connect a soft 6/4mm silicon hose with the elbow fitting. See picture B.



3. Close the bypass valve on the gas pump. See picture D.



For a single-stack system without multiplexer installed, see image 1:

4. **For single-stack systems (only B-side installed)** disconnect the sample gas inlet hose at the T-piece connector in the top right corner of the enclosure.
5. On the T-piece connector (single probe system) block the gas inlet with your thumb.
6. **For systems with a multiplexer installed**, ensure that all gas valves are closed (grey) in the IO Status window.
7. Press manual select, and then select all of the valves individually.
- 8.
- **For systems with multiplexer installed:** On the IO Status window, press the Manual Select button, and then press GasPumpA. See picture A.
 - **For single-stack systems:** On the IO Status window, press the Manual Select button, and then press GasPumpB (only B-side installed).
9. Wait until the flowmeter ball lies still at the bottom of the flow meter glass tube. See picture B.
10. If not possible to achieve a steady ball, a leak is present!
11. Squeeze the silicone hose flat before submerging it in water. See picture C

ATTENTION: Risk of water flowing back the into the system. Loosen the grip slowly and make sure NO water is entering the hose.

If water enters the hose, squeeze quickly and remove the hose from the water!

Remove any water droplets in the hose and repeat the procedure from step 11.

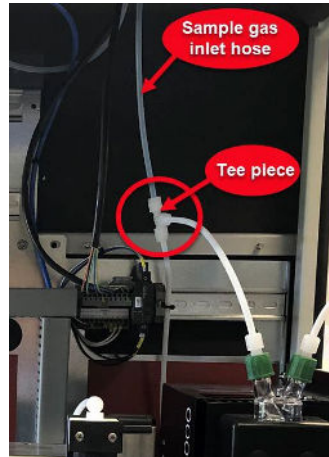
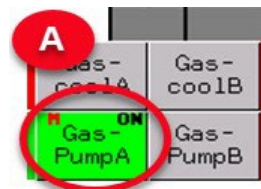
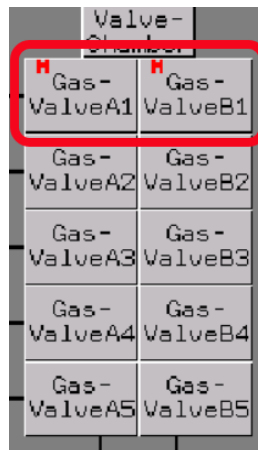


Image 1



12. Count the bubbles in the water: Up to 40 bubbles /minute is allowed*.
13. If the number of bubbles is < 40 /minute, the system is airtight, and has passed the leak test.

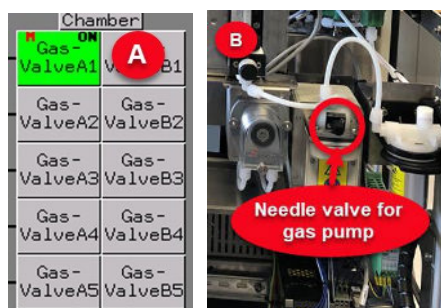
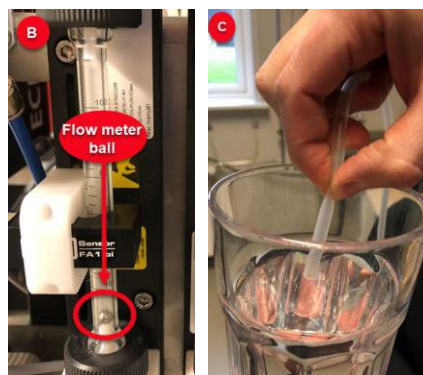
ATTENTION



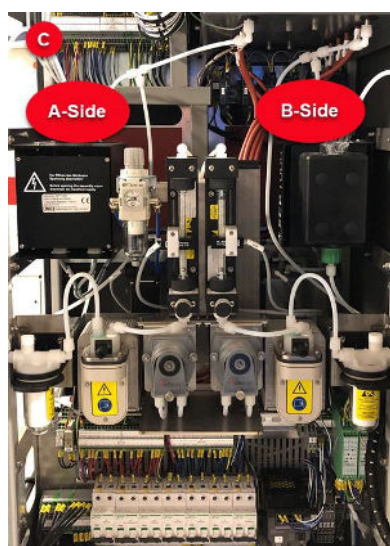
Risk of damaging components.

Avoid water entering the analyzer! Remove the silicone hose from the glass of water, immediately after the test is completed.

14. On the IO Status window, press the Manual Select button, and then turn off the active gas pump.
15. *(If the number of bubbles exceeds 40 bubbles/minute then search for a leak somewhere inside the cabinet and perform a leak test again.)
16. For systems with a multiplexer installed: Repeat step 8-13 with Pump B for the B-side
17. For single- stack systems. Remove your thumb from the sample gas inlet connection. Refit the hose to the fittings.
18. For systems with a multiplexer installed: On the IO Status window, press the Manual Select button, select" A or B. See picture A.
19. Start the gas pump for a brief period of time (1-2 minutes) to normalize the pressure in the system. See picture B.
20. For systems with a multiplexer installed: The internal leak test procedure needs to be carried out for both the A-side and B-side. See picture C.
21. All manual functions shown on the "IO Status" screen must be de-selected for the system to resume in auto mode.



Gas Pump:
Adjust Flow



System Type	G7000 Multi gas system	MI7000-0022
Task:	Executing an external leak test	
Task description:	This procedure describes how to perform an External leak test. This operation must only be carried out by a skilled technician	
Difficulty 1-5	Spare part	Estimated Time Consumption
	# 02366 Elbow Fitting	30 minutes

Procedure

NOTE: The system will be out of service during this operation. Leaks causes faulty measurements.

An external leak test must be performed when:

- Carrying out commissioning on a new system and want to ensure there is no leak at the heated hose and the probe.
- An internal leak test has been executed successfully but a leak is still suspected.
- A heated hose, probe or fittings have been dismantled.
- SO₂ and CO₂ values are lower than expected.

Required tools for external leak test:

- PVDF Elbow fitting 6/4mm - ¼"
- Silicon hose 6/4mm
- "Glass" of water
- Spanner 12 mm
- Stopwatch

ATTENTION



Do not block the gas sampling pipes to or from the system when the system is in operation otherwise it could damage components.

Blocking is allowed (for short periods) only during a leak test.

Commissioning

Initial leak test before operation

As a part of commissioning, a leak test must be carried out to ensure there is no leakage in the system, heated hose or probe.

ATTENTION: The sealed plug must be fitted during the commissioning process. See picture A.

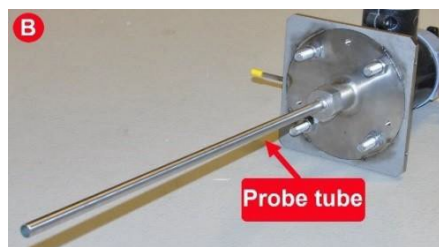
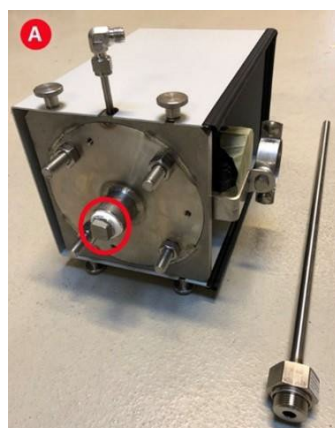


WARNING



Hot surface hazard.

Probes, sample line and multiplexer are hot and can cause burns. Avoid contact with hot components.



For systems in operation

You must log in as an administrator to carry out this procedure. Refer to MI7000-0011-Operating the system in manual mode.

An external leak test can only be carried out when the probe is sealed with a sealed plug.

NOTE: For systems with a multiplexer installed, the leak test must be carried out for one hose at the time.

1. Disconnect all of the probes from the stacks and remove the probe tubes. See picture B. Seal the probes with 3/4" sealed plugs. See picture C.
2. On the IO Status window, press the Manual Select button, and then turn OFF (grey) all gas pumps. See image 1A.
3. Disconnect the return gas connection on top of the enclosure and connect a soft 6/4mm silicon hose to the elbow fitting. If there is not already an elbow, then mount a PVDF Elbow fitting 6/4mm - 1/4" to the 1/4" NPT connection. See image 1B.
4. Close the bypass valve on the gas pump. See image 1D



**Open/close
Bypass valve**

5. The external leak test can be performed for "Gas Valve" [A1,2,3,4,5] or [B1,2,3,4,5]
6. To open (green) or close (grey) the "Gas Valves" use the "IO Status" screen. See image 1F.
7. Start the corresponding gas pump (A or B) See image 1G.
8. Wait until the flowmeter ball lies still at the bottom of the flow meter glass tube. See image 1H. If it is not possible to achieve a steady flowmeter ball, the system has a leak.
9. Squeeze the silicone hose flat before submerging it into the water See image 1I.

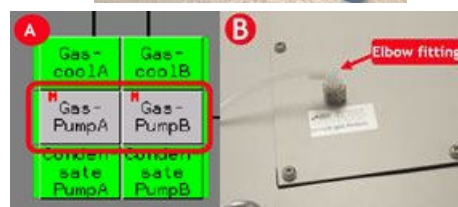
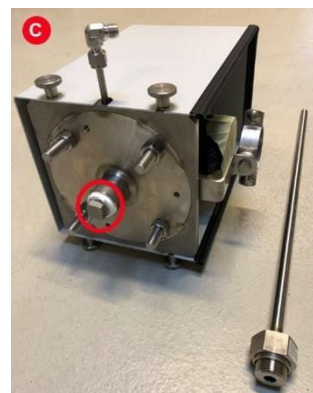


Illustration 1

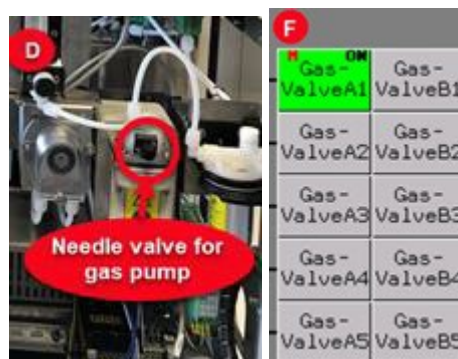
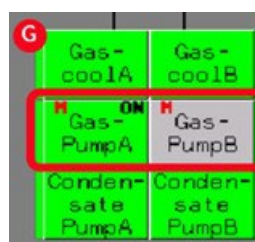


Illustration 1



ATTENTION:



Risk of water entering the system backwards. Loosen the grip slowly and make sure NO water is entering the hose.

If water enters the hose, squeeze quickly, and remove the hose from the water.

Remove any water droplets in the hose and repeat the procedure from step 8.

10. Count the number of bubbles in the water: Up to 40 bubbles /minute is allowed*

11. If the number of bubbles is < 40 pcs/minute, the system is airtight, and it has passed the leak test.

ATTENTION:



Avoid water in the gas analyzer! Remove the silicone hose from the glass of water, immediately after the test is completed. Turn OFF the gas pump via "IO Status" immediately after ended leak test, to avoid damage on the system See picture image J.

12. Remove the sealed plug from the tested streams.

13. Refit all dismantled components after the test is completed.

14. All manual functions shown on the "IO Status screen" must be de-selected for the system to resume in auto-mode or reset the system to resume normal operation.

15. After the test is completed, the flow needs to be re-adjusted:

Refer to: MI7000-0002-Adjusting flow for the gas pump

WARNING



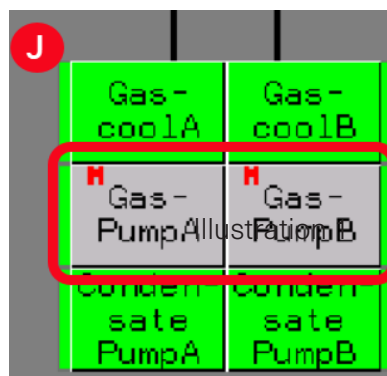
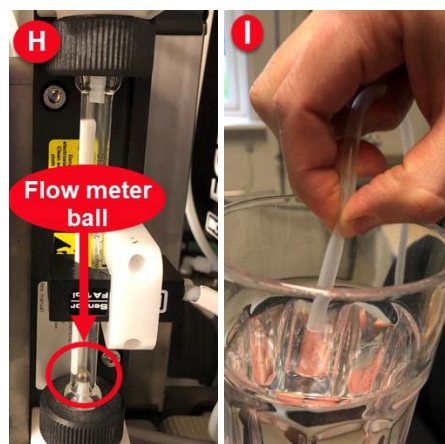
Hot surface hazard.

Probes, sample line and multiplexer are hot and can cause burns. Avoid contact with hot components.

ATTENTION:



If the number of bubbles exceeds 40 bubbles/minute then search for a leak on the corresponding heated hose and probe and perform the leak test again.



System Type	G7000 Multi gas system	MI7000-0023
Task:	Replacing the bellow and bypass valve in gas pump	
Task description:	This procedure describes how to clean or replace the bellow and bypass valve in gas pump. This operation must only be carried out by a skilled technician	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
	#03387 Bellow f. Gas Pump #03234 By-pass v/v f. gas pump	45 minutes

Procedure

Turn OFF the safety switch. The system will be out of service during the procedure.

Required tools:

- 1 x Torx 10 Screwdriver
- 1 x Torx 20 Screwdriver
- 1 x PH 1 Screwdriver
- 1 x Spanner 12 mm
- 1 x Spanner 13 mm
- 1 x Spanner 14 mm

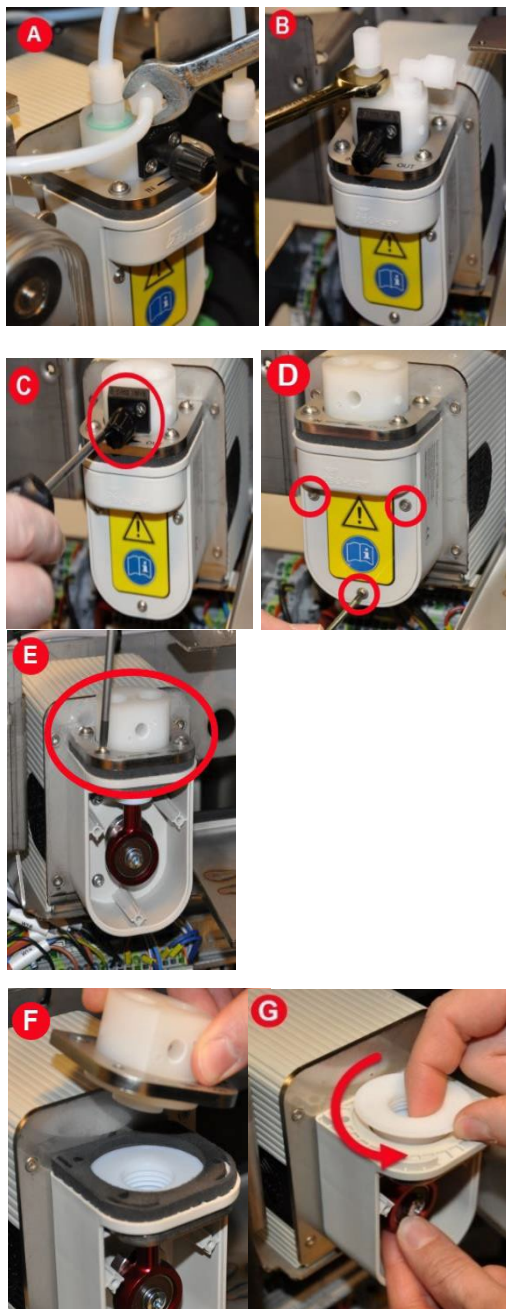
1. Disconnect the 2 hoses on the gas pump using the 12 mm spanner. See image A.
2. Remove the straight fittings using the 13 mm spanner and remove the elbow fittings using the 14 mm spanner. See image "B" Mark the fittings and hoses for correct fitting position after the replacement!
(Remove old Teflon tape from the elbow fittings and wrap with new Teflon tape. See image H.)
3. Remove the selector on the bypass valve using the PH 1 screwdriver. See image C.
4. Remove the front of the gas pump using the Torx 10 screwdriver. See image D.
5. Remove the top of the gas pump using the Torx 20 screwdriver. See image E
6. Remove the bypass valve from the gas pump. See image F.

ATTENTION:



Exercise caution. The gasket is fragile.

7. Remove the bellow by turning counterclockwise. See image G.
8. Now the bellow is removed and can be replaced with a new bellow.
9. When the new bellow is installed, the new bypass valve can be fitted, and the screws can be fitted.
10. Refit the gasket carefully and make sure the orientation is correct.
11. Fit the new bypass valve and make sure the orientation is



correct.

12. Re-fit the bypass valve at top of the pump using the Torx 20 screwdriver.
13. Refit the selector on the bypass valve using the PH 1 screwdriver
14. Re-fit the cover for the gas pump using the Torx 10 screwdriver.
15. Refit the PVDF fittings and the hoses on the bypass valve. See the procedure given below for the correct handling of the fittings-

Technical information:

Reinstallation procedure for PVDF fittings:

1. Tighten the union nut by hand until you feel perceptible resistance.
2. Tighten the union nut by 1 rotation using a wrench.



Wrap the Elbow fittings with new Teflon tape



System Type	G7000 Multi gas system	MI7000-0029
Task:	Checking calibration air supply	
Task description:	This procedure describes how to check there is sufficient calibration air present for the calibration. This operation must only be carried out by a skilled technician	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption



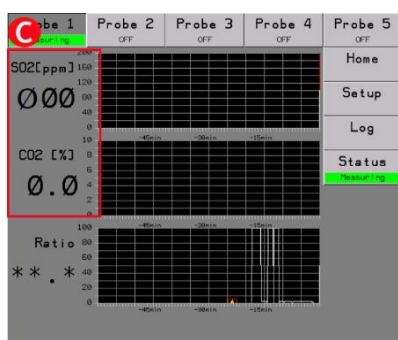
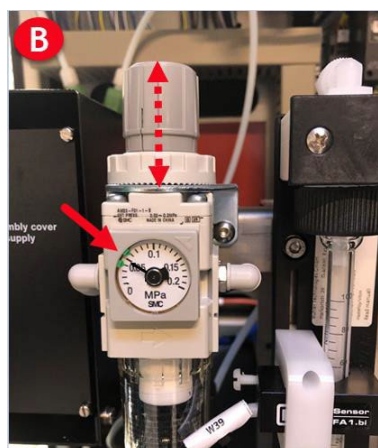
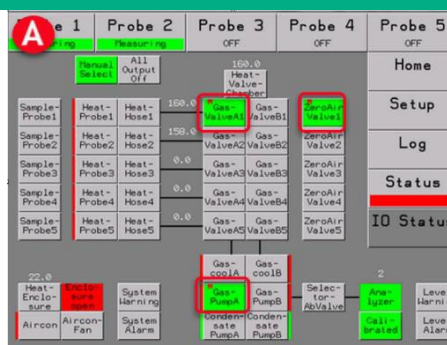
10 minutes

Procedure

NOTE: The system must be operated in manual mode when carrying out this procedure.

Refer to MI7000-0011 Operating the system in manual mode.

1. Activate the Gas ValveA1, Zero Valve1 and the Gas PumpA. See image A.
2. Check the airflow at the filter regulator when the gas pump is active. Correct pressure = 0.03–0.05 MPa. If the pressure is wrong, then pull up the button of the filter regulator and adjust the airflow. See image B.
3. Wait approx. 2 minutes and then read the measurement for Probe 1. The value should be 0% - CO₂ and 0 ppm-SO₂
4. Deactivate the gas pump, close the valves, and deactivate manual mode.



System Type	G7000 Multi gas system	MI7000-0038
Task:	Locating moisture and resolving the issue	
Task description:	This procedure describes how to locate signs of moisture and how to resolve the issue causing it. This operation must only be carried out by a skilled technician	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
		20 minutes

Procedure

For a thorough explanation of how to change a filter, see the relevant sections in this manual.

- Turn the system OFF
- Water location in gas cooler

It is possible to see small droplets or mist in the gas cooler glass. This is caused by the condensation of the hot exhaust gas and is not a sign of a fault in the system. See image A.

Condensate with air bubbles must not be present.

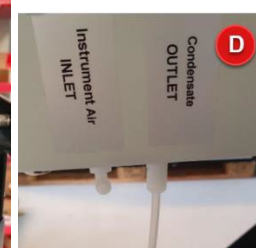
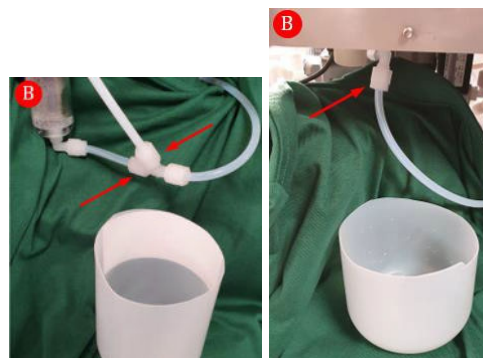
WARNING:



Condensate from gas coolers may be aggressive and cause corrosion and chemical burns. PPE must be worn whenever there is a risk of contact with combustion gas and condensate.

- When checking the gas cooler, place a cloth and container below collect any potential condensate. See image B.
- Control the amount of water in the gas cooler glass by removing the condensate hose from the cooler and the hose from the limit switch at the T-piece and put the hose ends in a container. See image B.
- If necessary, loosen a gas fitting on the gas cooler top to help evacuate water. See image C.
- Check the "Condensate OUTLET" is intact and not blocked. See image D.

If water is present in the gas cooler, follow maintenance instruction MI7000-0013 to resolve the issue.



System Type	G7000 Multi gas system	MI7000-0039
Task:	Cleaning the system cleaning	
Task description:	This procedure describes how to clean components and hoses if moisture has entered the system. This operation must only be carried out by a skilled technician	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
		30 minutes
Procedure		

WARNING:

Condensate from gas driers may be aggressive and cause corrosion and chemical burns.

PPE must be worn whenever there is a risk of contact with combustion gas and condensate.

NOTE: Before restarting the system, all components must be cleaned.

Cleaning must be carried out using mild soap.

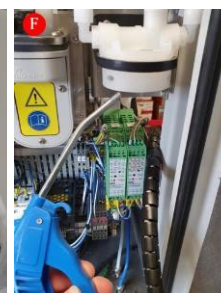
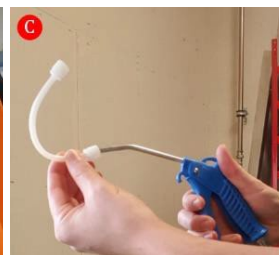
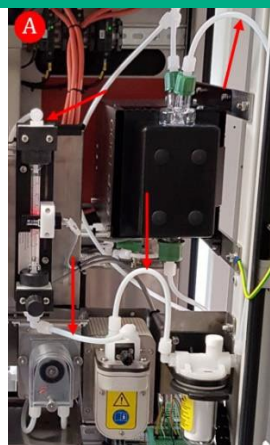
Cleaning the gas hoses

1. Remove all of hoses in the gas line from the cooler outlet to the water trap inlet. See image A.
2. Wash the loose hoses in mild detergent and water. See image B.
3. Dry the hoses with compressed air. See image C.

Cleaning the gas filter housing and glass

1. Remove the gas filter glass and dispose of the gas filter. See image D.
2. Clean the filter housing and glass using mild detergent and water
3. Dry the glass with a cloth. See image E.
4. Dry the housing with compressed air. See image F.

When moisture has entered the system or after the system has been cleaned, a new gas filter must be fitted.



Cleaning the gas pump

1. Loosen the 4 screws to refit the top of the gas pump. See image G.
2. Carefully clean the bellow using a cloth, water, and mild detergent. See image H.
3. Carefully dry the bellow with compressed air. See image I.

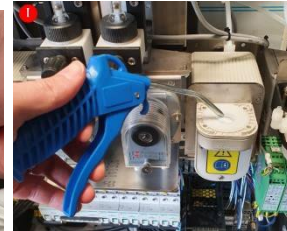
ATTENTION: Be careful not to remove the bellow when cleaning

Cleaning the flow meter

1. Remove the fitting on top of the flowmeter. See image J.
2. Remember to use new Teflon tape when refitting the fittings.
3. Carefully rinse the flowmeter glass tube using water and mild detergent.
4. Place a container below the flowmeter inlet to collect the water. See image K.
5. Dry the pipe with compressed air blown carefully through the top. See image L.

When the cleaning is complete, reassemble the system with the dry and clean components.

6. Mount the top of the gas pump
7. Reconnect fittings and hoses
8. Use Teflon tape and do not overtighten fittings
9. Reinstall the new gas filter and filter glass



System Type	G7000 Multi gas system	MI7000-0040
Task:	Checking the water trap	
Task description:	This procedure describes how to check the water trap is contaminated when there is no sign of moisture in the gas filter housing.	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption



20 minutes

Procedure

For a thorough explanation regarding filter change etc. see the relevant sections in this manual.

During normal operation the flow will lower over time because the filters become contaminated.

The water trap can become dark on the **GAS-IN** side if it is contaminated. See image A.



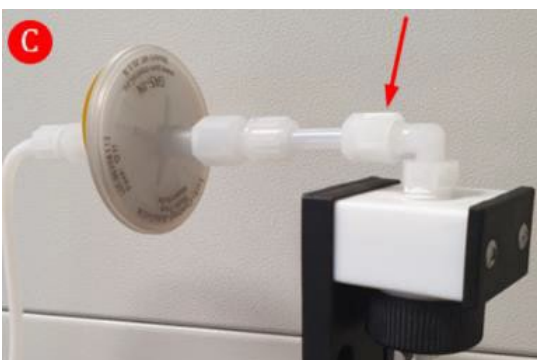
Section #1 Check for contamination and flow through the water trap

1. Loosen the fitting on the gas filter outlet. See image B.
2. Manually activate the gas pump and adjust the flow to 100 l/h.
3. If 100 l/h cannot be reached - Go to Section #2
4. If 100 l/h can be reached when the hose disconnected, the water trap is not contaminated. See the flow alarm flowchart this manual.



Section #2 Direct control of water trap contamination and flow

1. Loosen the fitting on the flowmeter outlet. See image B.
2. Manually activate the gas pump and adjust the flow to 100 l/h.
3. If 100 l/h can be reached when the water trap is disconnected, the water trap needs to be replaced.
4. If 100 l/h cannot be reached when the water trap is disconnected. See the flow alarm flowchart in this manual.



System Type	G7000 Multi gas system	MI7000-0041
Task:	Locating contamination and resolving the issue causing it	
Task description:	This procedure describes how to locate a source of contamination and how to resolve the issue	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
1		15 minutes

Procedure

The water trap will clog over time because of contamination of the small pores.

This is not necessarily an issue but if the water trap is contaminated, the system needs to be checked.

Gas filter

1. Check if the gas filter is installed and fitted correctly.
2. The filter must be placed in top of the housing. See image A.
3. Check the gas filter for damage or collapse. See image B
4. Change the gas filter if it is damaged or collapsed.
5. Check the system if there are any disconnected hoses.
6. The probe filter must be checked for damage. it is important follow the instructions in MI7000 004.



System Type	G7000 Multi gas system	MI7000-0042
Task:	Replacing the water trap	
Task description:	This procedure describes how to replace the water trap when it needs to be replaced.	
Difficulty 1-5	Overhaul Interval	Estimated Time Consumption
		15 minutes

Procedure

ATTENTION:

The replacement of a water trap that has become clogged because of moisture or dirt should only be carried out when the system components and hoses are clean and dry.

Be aware of "GAS IN" direction.

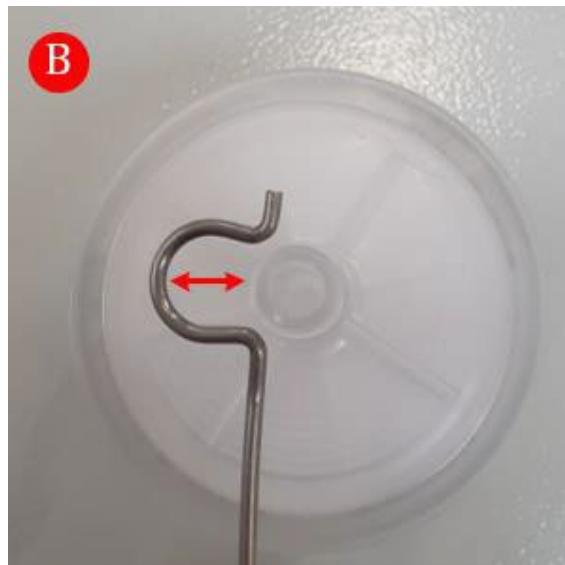
Changing the water trap

1. Loosen the fittings on the water trap. See image A.
2. Pull the water trap sideways out of the spring holder. See image B.
3. Install the new water trap in the spring holder.
4. Tighten the fittings on the water trap. DO NOT OVERTIGHTEN

ATTENTION:



Overtightened water trap fittings can cause the flow to become obstructed. Restart the system and adjust the flow according to MI7000-001.



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