GreenView

# Emissions Insight


# User Manual

Green Instruments

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For safe and proper use of the GreenView Emissions Insight, read this user manual carefully and keep it for future reference.

Green Instruments A/S reserves the right to adjust and improve its products and systems, and the user manual 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. This manual cannot replace the instruction and education of trained personnel. Address all claims and spare parts inquiries 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.

If you have questions or comments relating to the user manual, contact Green Instruments A/S.

# Contents

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# 1. Introduction

## 1.1 Document scope

This manual introduces you to GreenView Emissions Insight. In the following sections, it will guide you through its purpose and operating principles, explaining the advantages of using the carbon balance method. You will gain a comprehensive overview of the system, including how it integrates with various modules and data sources. The GreenView Panel PC serves as the central interface, collecting and displaying data from multiple onboard systems.

You will learn how each component contributes to the overall functionality, and how GreenView Emissions Insight connects with your vessel—both mechanically and digitally.

This document also walks you through:

- Receiving the equipment
- Installation and data integration
- Commissioning procedures

It outlines the contents of the shipment and where to expect each component. During installation, you will see how the system's parts interconnect, including guidance on placing and wiring modules. Since the GreenView Panel PC collaborates with other onboard systems, some components will be installed in different locations. This manual highlights those placements and provides cross-references to other systems when needed—for example, during installation, integration, or troubleshooting.

This manual also covers the G7990 Ambient Air Sensor Module, including its installation, commissioning, and troubleshooting procedures.

For detailed information on the G7200 Multi Gas Monitoring System, please refer to its dedicated user manual. Similarly, if your setup includes a Multiplexer, consult its specific documentation.

## 1.2 About the System

GreenView Emissions Insight is a platform that puts vessel, engine performance and fuel consumption in relation to exhaust gas measurements and provides mass emission reports. GreenView Emissions Insight is designed to log, visualize and generate report data from a continuous emission monitoring system (CEMS); the G7200 Multi Gas Monitoring System.

The GreenView Emissions Insight operates by applying the carbon-balance method with reference to the NOx Technical Code. By this, the emission mass flow is calculated from fuel consumption and exhaust gas concentrations, as specified in appendix 6 of the NOx Technical Code.

The resulting reports include key metrics of each individual gas emission measured as g/kWh, g/g fuel, kg/h, and %-slip which are directly comparable to tank-to-wake emission factors and GHG emission limits. This supports stakeholders not only with decision-making but also fleet management strategy based on comparable engine-to-engine, vessel-to-vessel and voyage-to-voyage emission data for optimization of performance, operational cost, environmental compliance and reporting.

The GreenView Emissions Insight platform provides the actual total emittance of the targeted pollutant gases and serves as a valuable tool for ETS, MRV, FuelEU Maritime and CSR reporting, making overestimation impossible. In contrast to the traditional method based solely on fuel oil consumption, GreenView Emissions Insight offers a more fact-based methodology which brings thorough insights needed for evaluation of operational and technical modifications implemented for EEXI and CII initiatives.

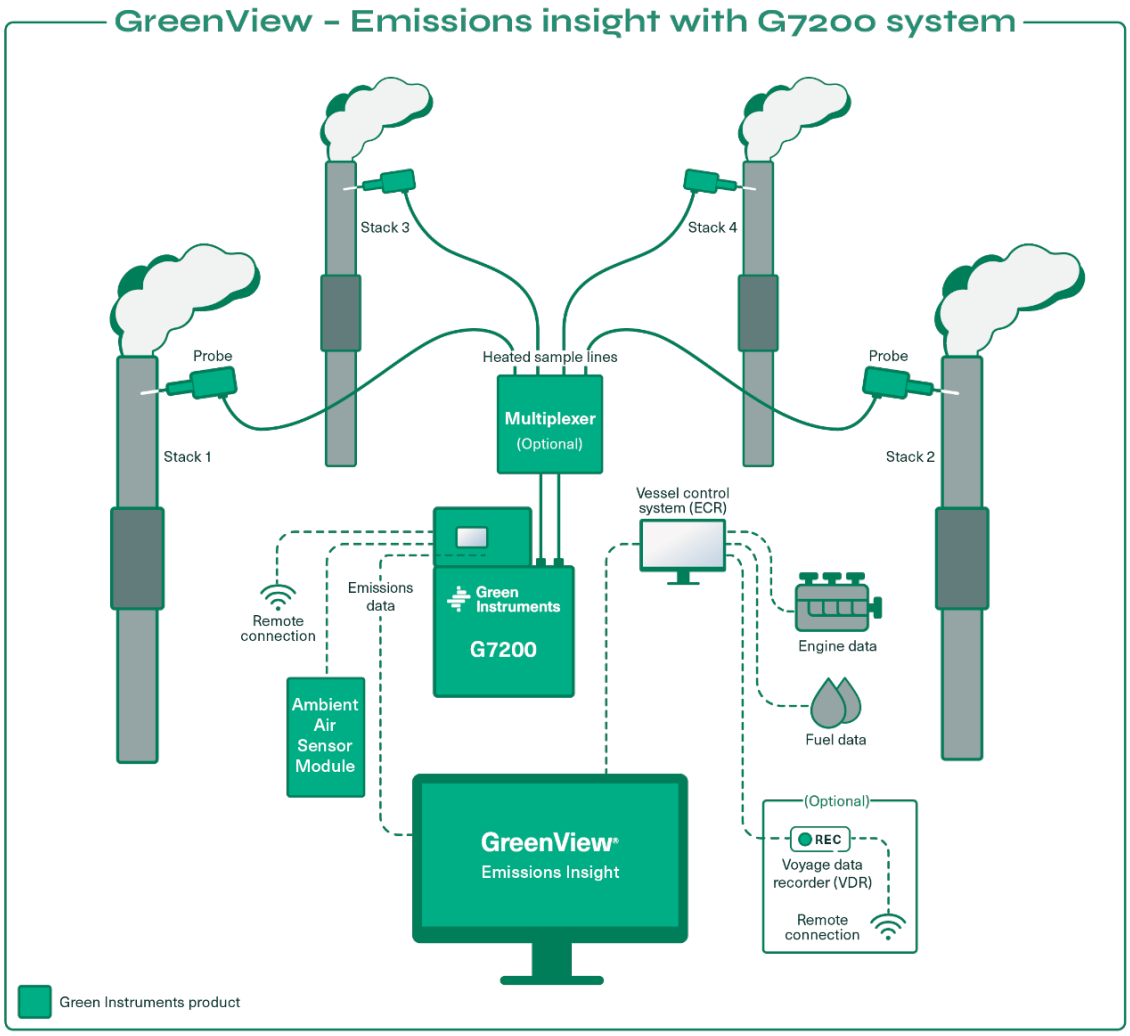



*Figure 1-1, GreenView Emissions Insight in context*

## 1.3 Inside the system: How it works

The GreenView Emissions Insight operates on a mass balance methodology, which compares the mass of air and fuel entering the engines with the mass of exhaust gases emitted, ensuring consistency in the overall mass flow. Not only is this method known as one of the most accurate methods to identify exhaust mass flow and thereby the mass emissions of each GHG, it is also a well described method and widely accepted in both maritime and land-based applications.

The benefits of using a mass balance method are:

- No need to install costly and potentially inaccurate flow transmitters into the exhaust gas stack.
- The exhaust gas mass flow is calculated with high accuracy throughout the entire engine load – an accomplishment which is hard to achieve with in situ flow transmitters due to turbulent and uneven flow distribution throughout the cross section of the exhaust gas stack.

- Traditionally, a CEMS is always needed to measure the emission of GHG in each exhaust gas stack, however for multiple stacks, additional dedicated flow transmitters are needed for each individual stack. This is not the case with mass balance methods since this method requires no additional hardware to be installed at each stack. In other words a mass balance is a truly scalable approach to cover emissions from multiple exhaust gas stacks.

In order to achieve the greatest accuracy in the mass balance, GreenView Panel PC obtains the relevant data for fuel consumption and fuel type composition. The G7990 Ambient Air Sensor Module located in the engine room measures data related to the ambient air conditions. In this way, the input mass of air and fuel to the mass balance is accounted for. Based on exhaust gas data obtained from the CEMS, the instant exhaust gas mass flow can be calculated. By combining the concentrations of the reported GHG measured by the CEMS with the exhaust gas mass flow, the mass emission of each individual GHG can be calculated and reported. Data is calculated every 20 seconds, following the requirements set by the NOx Technical Code which states the need of minimum 3 samples per minute.

Secured and trustworthy data will play an increasingly important role for the shipping industry navigating through the regulatory landscape. This is why the generated data is securely stored within the GreenView Panel PC database, from which verified data reports can be generated and submitted for regulatory purposes and for vessel management. On board the vessel, the generated data can also provide new insights to the crew in relation to optimal engine load distribution and to monitor combustion efficiency.

## 1.4 Technical Specifications

NOTE: Specifications are subject to change without notice.

| **GreenView Emissions Insight** | | |
|---|---|---|
| Function | Logging and reporting of emission data based on carbon-balance calculations. | |
| Equipment including | A panel PC with integrated touch display, processor, hard drives onto which a bespoke calculation module and database is installed. | |
| Certification | DNV | |
| Number of engines connected | 1-8 depending on configuration | |
| Power Supply | 24 VDC | |
| Power Consumption | Refer to the electrical documentation | |
| Display | 15” TFT LCD color display with touch screen | |
| External Communication | Modbus TCP/IP (RJ45)<br>Optional Modbus RTU on request | |
| Ambient temperature | Class D, from 0°C to 55 °C | |
| Humidity | 10 – 90% RH | |
| Vibration | Class B | |
| EMC | Class B | |
| Enclosure Class | IP65F (On front panel when properly installed in an enclosure) | |
| Dimensions/Weight | Wall mount: | Dimensions (H x W x D)<br>310mm x 414mm x 90,2mm<br>Weight: 7,4kg |
| | Panel mount: | 264mm x 408mm x 83mm<br>Weight: 5,7kg |

| G7990 Ambient Air Sensor Module | |
|---|---|
| Function | Measures the temperature, pressure and humidity of the air in the engine room |
| Power Supply | 230 VAC – 50/60 Hz |
| Power Consumption | Refer to the electrical documentation |
| External Communication | Modbus TCP/IP |
| Electrical connection | Refer to the electrical documentation |
| Ambient temperature | Class D<br>From 0°C to 55 °C |
| Humidity | 10 – 90% |
| Enclosure Class | IP44 |
| Dimensions/Weight | 550mm x 320mm x 140mm (H x W x D)<br>Weight: 8,2 kg |

## DATA PROTECTION

Cyber Security: Green Instruments shall not be held liable for any damages resulting from malware or hacking incidents affecting the GreenView system. Users are responsible for implementing and maintaining appropriate security measures to protect their systems and data.

Data Integrity and Storage: Green Instruments shall not be held liable for any data losses. Users are solely responsible for the storage and safekeeping of their data. All data inputs, including time intervals, fuel types, and fuel composition, are user-defined. Therefore, it is the user's responsibility to ensure the accuracy and integrity of the entered information at all times.

## 1.5 Storage and Handling

### 1.5.1 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.

### 1.5.2 Handling

See the relevant technical specifications for the weight of each component when unpacking, moving, and installing the components.

Use appropriate lifting equipment that can lift the system modules securely and safely.

## 1.6 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 discrepancies or damage should be reported to Green Instruments A/S immediately.

## 1.7 Terms and Abbreviations

The following table lists terms and abbreviations used in this user manual.

| 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 |
| Programmable Logic Controller | PLC |
| Emission Factors | EF |
| Monitoring, Reporting and Verification | MRV |
| Engine Control Room | ECR |
| Emissions Trading System | ETS |
| Greenhouse Gas | GHG |
| Energy Efficiency Existing Ship Index | EEXI |
| Carbon Intensity Indicator | CII |

# 2. Safety

## 2.1 Safety

Read and understand the contents of the entire user manual before operating the system.

### 2.1.1 Symbols and Warning Labels

This manual uses the following symbols to identify essential information related to the correct and safe operation of the GreenView Emissions Insight. Follow the safety warnings to minimize the risk of electrical shock, burns and equipment damage when operating the system.

| Symbol identification | | | |
|---|---|---|---|
|  | General warnings sign |  | |
|  | Electric shock hazard |  | Protective earth |
|  | Chemical hazard | | |

**WARNING**

- Failure to follow the instructions can lead to serious injury or death. Follow the instructions:
- Do not install the system in hazardous and explosive environments such as EX-zones. It is not safe.
- Do not use the system for sampling and measurements of media that is explosive. It is not safe.
- 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 GreenView Emissions Insight.
- Wear personal protective equipment. The system must 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**

#### Electric shock hazard

Disconnect the power before installing or servicing the equipment. Failure to do so can cause 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.

## Overload and Short Circuit Protection

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

## 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 (2015), connection cables for communication signals must be shielded or have equivalent protection.

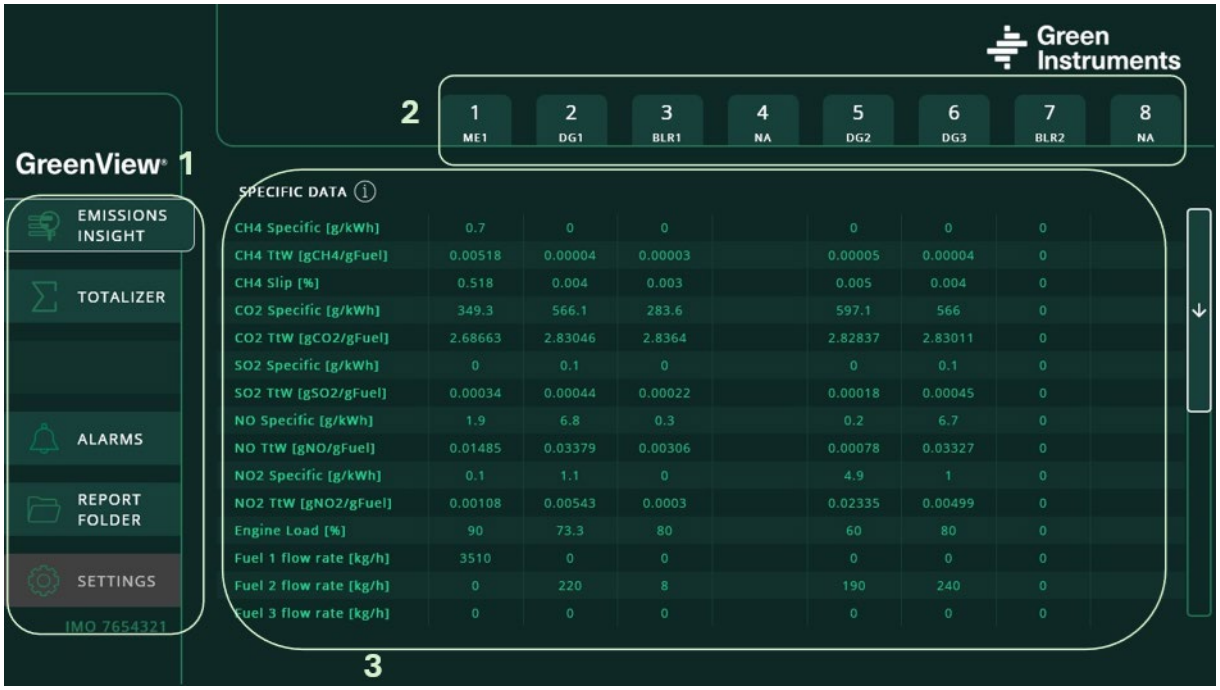
## Equipment Disposal

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

# 3. GreenView Panel PC

## 3.1 Home Page – Emissions Insight

This emissions insight menu is the first screen you will see in the GreenView. Here is an overview of calculated emissions based on measurement data.




| | | | | | | |
|---|---|---|---|---|---|---|
| CH4 Specific [g/kWh] | 0.7 | 0 | 0 | 0 | 0 | 0 |
| CH4 TtW [gCH4/gFuel] | 0.00518 | 0.00004 | 0.00003 | 0.00005 | 0.00004 | 0 |
| CH4 Slip [%] | 0.518 | 0.004 | 0.003 | 0.005 | 0.004 | 0 |
| CO2 Specific [g/kWh] | 349.3 | 566.1 | 283.6 | 597.1 | 566 | 0 |
| CO2 TtW [gCO2/gFuel] | 2.68663 | 2.83046 | 2.8364 | 2.82837 | 2.83011 | 0 |
| SO2 Specific [g/kWh] | 0 | 0.1 | 0 | 0 | 0.1 | 0 |
| SO2 TtW [gSO2/gFuel] | 0.00034 | 0.00044 | 0.00022 | 0.00018 | 0.00045 | 0 |
| NO Specific [g/kWh] | 1.9 | 6.8 | 0.3 | 0.2 | 6.7 | 0 |
| NO TtW [gNO/gFuel] | 0.01485 | 0.03379 | 0.00306 | 0.00078 | 0.03327 | 0 |
| NO2 Specific [g/kWh] | 0.1 | 1.1 | 0 | 4.9 | 1 | 0 |
| NO2 TtW [gNO2/gFuel] | 0.00108 | 0.00543 | 0.0003 | 0.02335 | 0.00499 | 0 |
| Engine Load [%] | 90 | 73.3 | 80 | 60 | 80 | 0 |
| Fuel 1 flow rate [kg/h] | 3510 | 0 | 0 | 0 | 0 | 0 |
| Fuel 2 flow rate [kg/h] | 0 | 220 | 8 | 190 | 240 | 0 |
| Fuel 3 flow rate [kg/h] | 0 | 0 | 0 | 0 | 0 | 0 |

*Figure 3-1, Emissions Insight menu*

The first menu shown on the GreenView Panel PC is the Emissions Insight menu. Here you have an overview of the current emissions measured at each engine's exhaust. More specifically, you will see:

1: Main menu: by default, the main menu to the left of the screen is always visible across the different features. In this menu you can select the information you want to display among emission data, data exploration, reports and settings.

2: Engine menus: the engine buttons give access to each engine and their emissions' data individually. There can be up to 8 engines connected to the system.

3: Specific data: table that shows the actual calculated emissions for each engine. The gases visualized will depend on the application.

If clarification regarding the data should be needed, click on the icon ⓘ. A pop-up window will appear with further information.

## 3.2 Engine menu


*Figure 3-1, Engine menu*

The engine menu shows engine and exhaust gas data from the selected engine, as well as ambient air information. There can be up to 8 engines connected to the GreenView Emissions Insight. If the system is connected to one G7200 Multi Gas Monitoring System, there is a maximum of 4 sample points measured. With the optional second G7200 system, another additional 4 sample points can be coupled.

On this screen you can see the fuel type inputs (see next section) of the vessel. You can modify the fuel input as well as the name of the engine. If you wish to change the name of an engine, click on the keypad figure at the “Engine Alias”.

### 3.2.1 Fuel type input

The fuel in use on board the vessel can be selected through the engine menu, directly on the GreenView Panel PC, or through modbus addresses. You can see the procedure for either option in the diagram below. Remember that either way, the fuel composition needs to be correct to produce valid data reports. If you are using a fuel where the predefined composition on GreenView Panel PC does not match the bunker delivery note, you must enter the correct values. If the fuel type is custom, and you do not have the specific values for each component, we will help you calculate it in section 5.1.

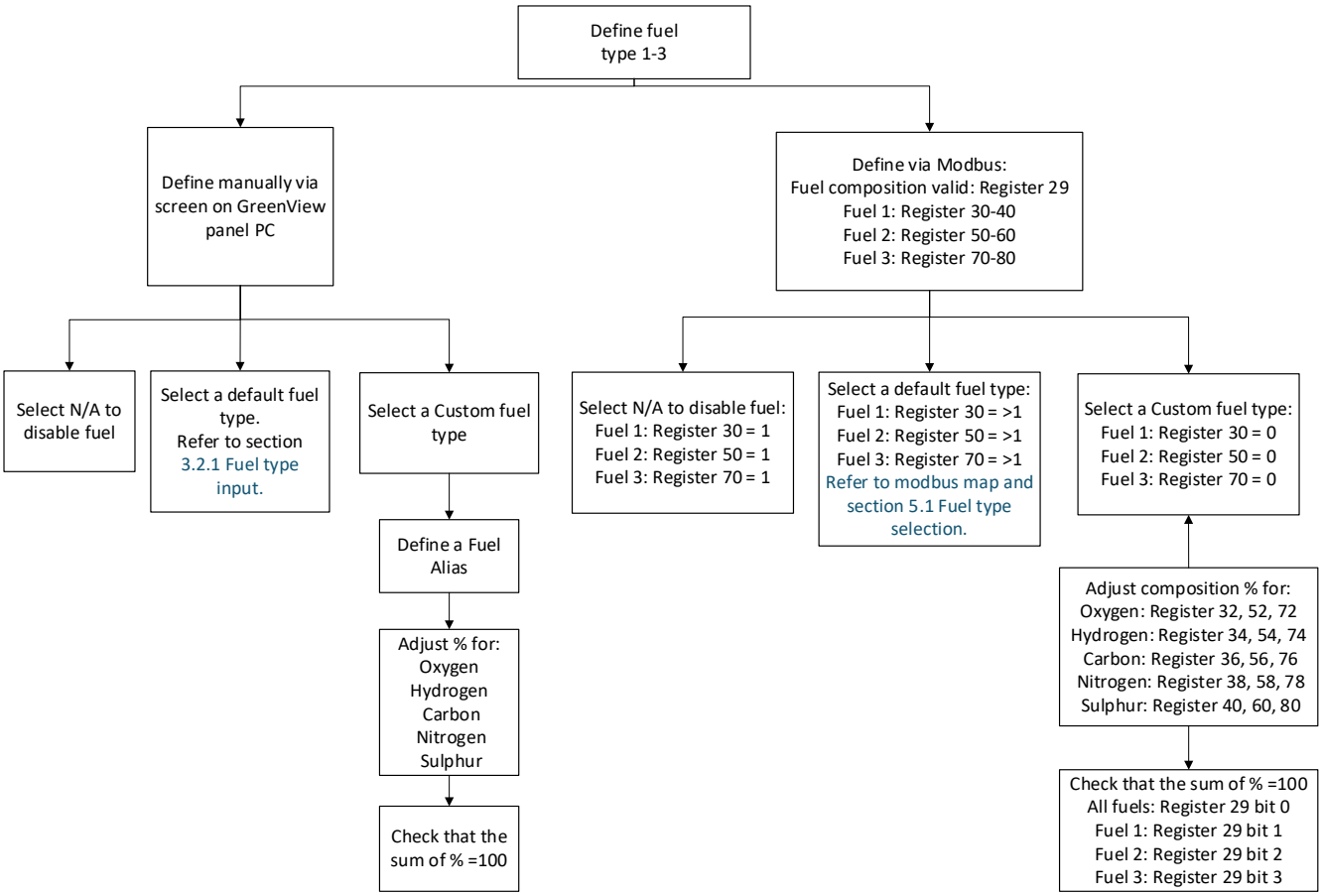



*Figure 3-2, Fuel type input procedures*

If you wish to define the fuel types via modbus, go to section 4.4 Communication.

**ATTENTION**

It is imperative that the fuel is updated on an ongoing basis so that it always reflects the fuel in use. This will provide information needed to measure the emissions from the ship. Editing the fuel and its composition is done manually. Remember to add the correct parameters for the different fuel components, as specified by the fuel supplier. You can read more on how to calculate the corresponding chemical composition on section 5.1.

The engine menu hosts the fuel type inputs. If you want to select the type of fuel, click on the corresponding fuel type to open the “fuel type definition” window. GreenView Emissions Insight has a number of fuel types predefined that you can choose from, which have their chemical composition predefined. If these do not match the values of the fuel on board the vessel, you can select a custom fuel and adjust the chemical composition to the one that is in use. If there are no fuels in use for the chosen fuel type, select N/A for “not applicable”. In case of loss of power, if one of the selected fuel types is a custom fuel, GreenView Panel PC will remember your choice of fuel and the parameters you selected.

You can choose a name for your custom fuel by clicking on the keypad “Fuel type alias”, which will prompt an in-screen keyboard to appear.

Press the button “Save & Close” at the top right corner of the window once all desired editing is done. All changes will be saved and the GreenView Panel PC will use the updated data inputs to make the calculations.

If the fuel you select is customized, you can see how to calculate the correct chemical composition on section 5.1.

## 3.3 Totalizer menu

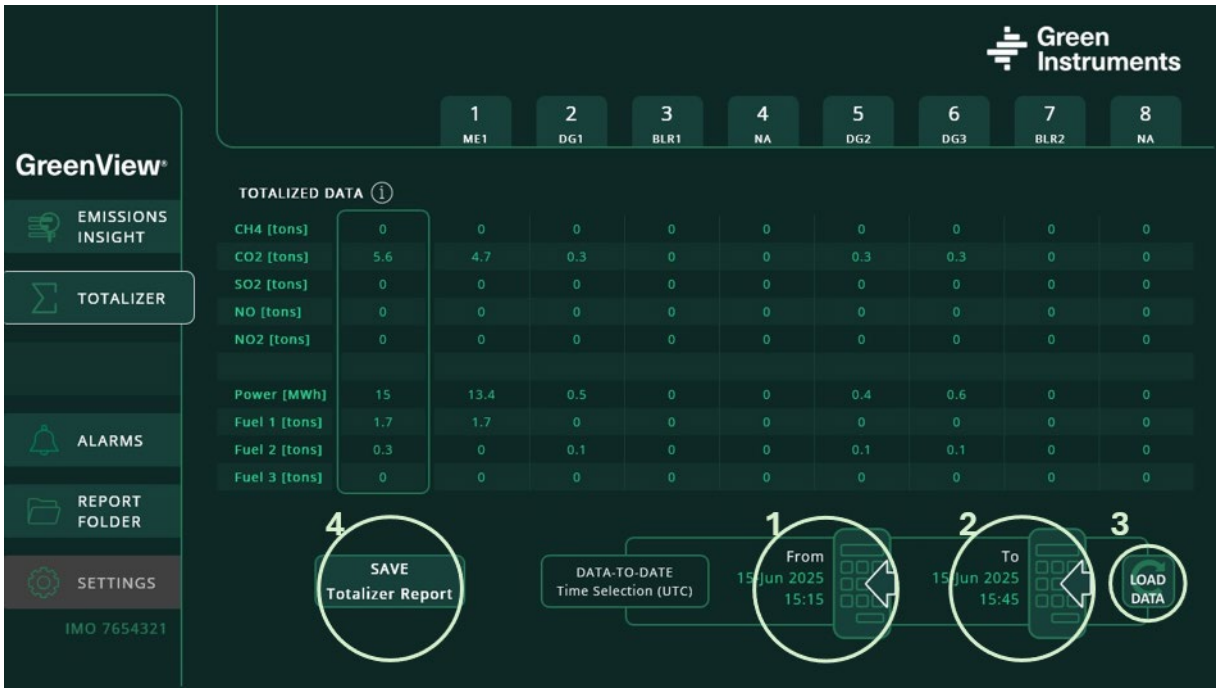



*Figure 3-3, Totalizer menu*

The totalizer gathers information about the total emissions from the vessel’s exhaust in tons, for a given time interval. The first column shows the sum of all engines’ emissions per exhaust gas element, the total energy produced, and the amount of fuel of each type that has been used. The succeeding columns present the total emissions and fuel consumption from each engine individually.

Under the “Totalized data” table, you can choose the time interval for the totalized emissions data, by selecting the wished start and finish dates on the keypads “From” (1) and “To” (2). Once the timeframe is selected, click on “Load Data” (3) to the right.

Now the data is ready to be saved on a report. Click “Save Totalizer Report” (4) to save a copy of the data on a report, that can be found and downloaded at the report folder.

## 3.4 Alarms menu

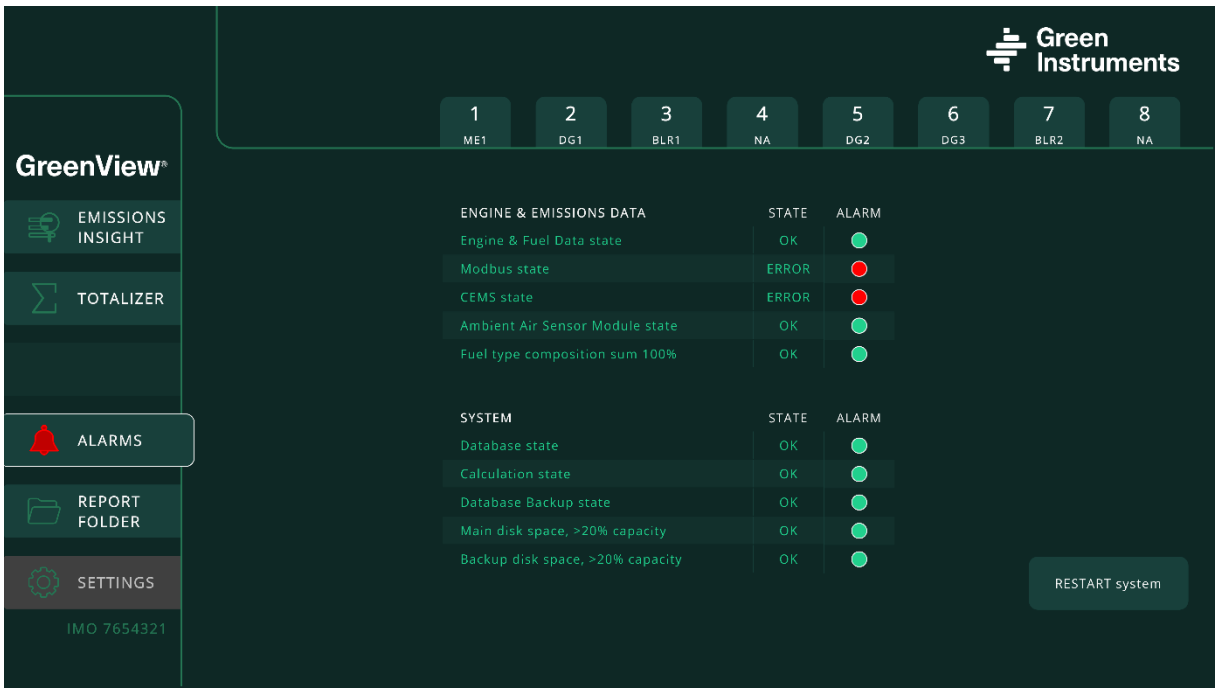



*Figure 3-4, Alarms menu*

The alarms page will give you an overview of the data and system elements which trigger the warnings. You will first notice that the bell symbol of the alarm menu blinks red. You can then click on the alarms menu to see where they originate from. The alarms come in two groups: the ones that are hardware or software related, and those that come from connected modules, as engine and emissions data.

You can restart the GreenView Emissions Insight system if needed, as part of troubleshooting the system alarms. Alarms related to input errors will automatically disappear when the cause is solved. If problems persist, contact support.

If you need more information on possible causes triggering the alarms, refer to section 7 Troubleshooting.

## 3.5 Report folder and data

The report folder shows the saved emission reports from older to newer. To generate emission reports, go to the totalizer menu. Thereafter you can find the saved reports in the report folder, where you can scroll up and down through the window to see all stored reports in the GreenView Panel PC.

Here you can select the reports (multiple selection is possible) to then choose an action:

- Delete: remove selected reports from the **Report folder** in the GreenView Panel PC. A pop-up comes up when clicking on **Delete** to confirm the deletion. The button will light up once there is an active selection of reports. If a disk space alarm turns on, you must contact Green Instruments.
- Download: once you have selected the reports you are interested in, a pop-up window will guide you through the necessary steps for downloading. Save the selected reports to a FAT32 formatted USB drive. You will get a zip format file which is based on UTC time. After collecting the desired files, when the download is complete, you can safely remove the USB.

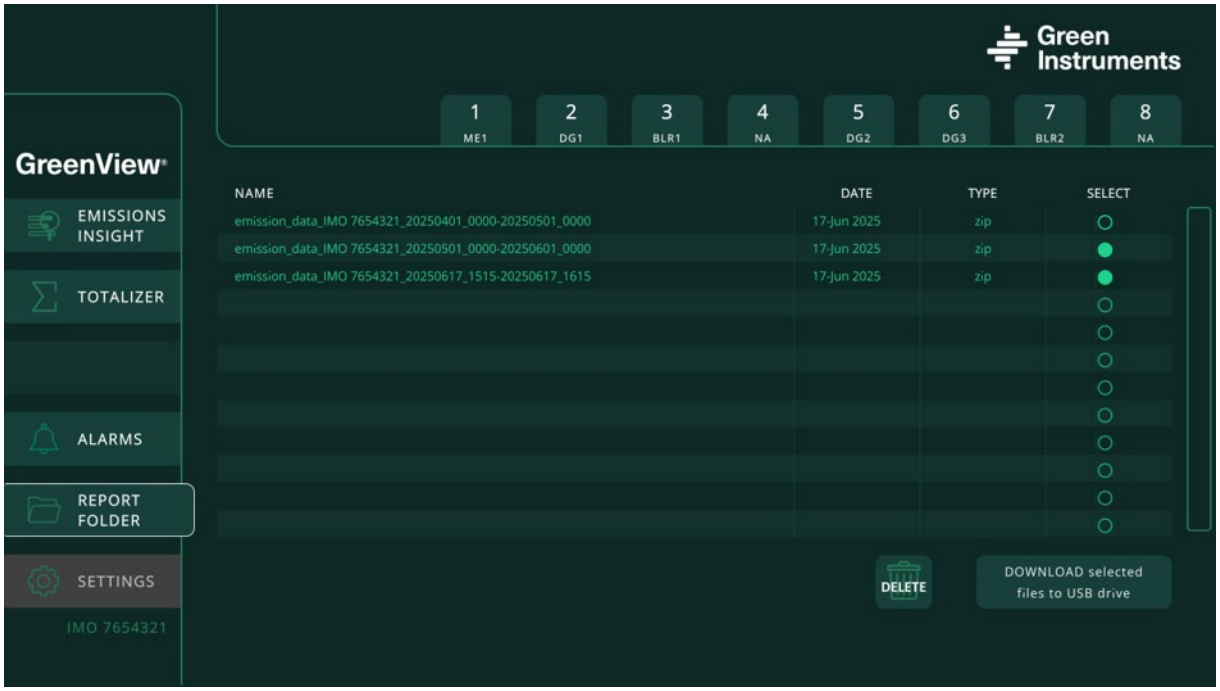



*Figure 3-5, Report folder menu*

### 3.5.1 Data output and storage

The GreenView Emissions Insight provides the following reports:

- Totalizer report: retrieve the accumulated emissions data across the different engines for a given time interval in one report. The data will be shown as mass emissions in tons, produced energy in MWh and fuel consumption in tons. The file will be named with the IMO number of the vessel and the selected time interval.
  Emission data logs: stores each logged information from all input data into the database. It helps to document the data foundation for each of the engines totalizer report. The file will be csv format, and it will be named with the vessel's IMO number, engine ID and the selected period.

GreenView Panel PC will automatically generate a monthly and full-year Totalizer report with mass emissions, fuel consumption and produced energy. In case of corrupted data, contact Green Instruments.

GreenView Panel PC logs data from each source into the database every 20 seconds, as estipulated in the NOx Technical Code, which requires to sample a minimum of 3 times per minute. In order to extract a report, you need to use a FAT32 formatted USB and transfer the desired files to a computer.

Data is stored for a maximum of 18 months, after which records will begin to be deleted by oldest date.

## 3.6 Settings

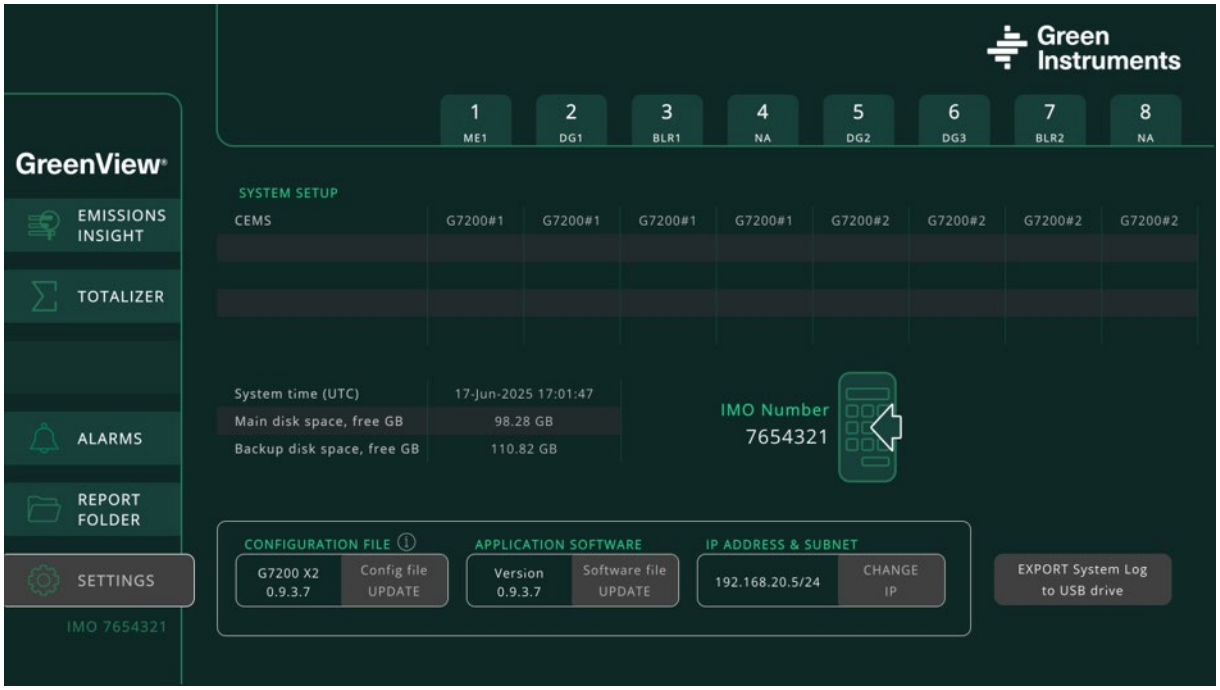



*Figure 3-6, Settings menu*

At the Settings' menu there is an overview of the system setup and system time which are preset and cannot be changed. You can see the available memory space, which is split into main disk and backup. There is a total space of 120GB for each of them.

The configuration file in use, as well as the application software and IP address are also visualized here underneath the system time.

On this page you can configure the vessel's IMO number. This is of special relevance when generating reports, for you to organize and distinguish between multiple reports from a fleet of vessels.

The data displayed under "System Setup" refers to system information. It depends on the application and input data from the configuration file.

The "System Time" is UTC time taken from the GreenView Panel PC system time.

### 3.6.1 Configuration file and application software updates

There are two different cases where the GreenView Panel PC will require an update:

1. Configuration file: when there is an update, you will receive a file from Green Instruments via email, which must be copied into the formatted USB, at the root (not saved into a folder). Refer to Figure 3-6. Then, insert the USB with the updated configuration file in the GreenView Panel PC. This will prompt a loss of connection, which will resolve once the update is complete.

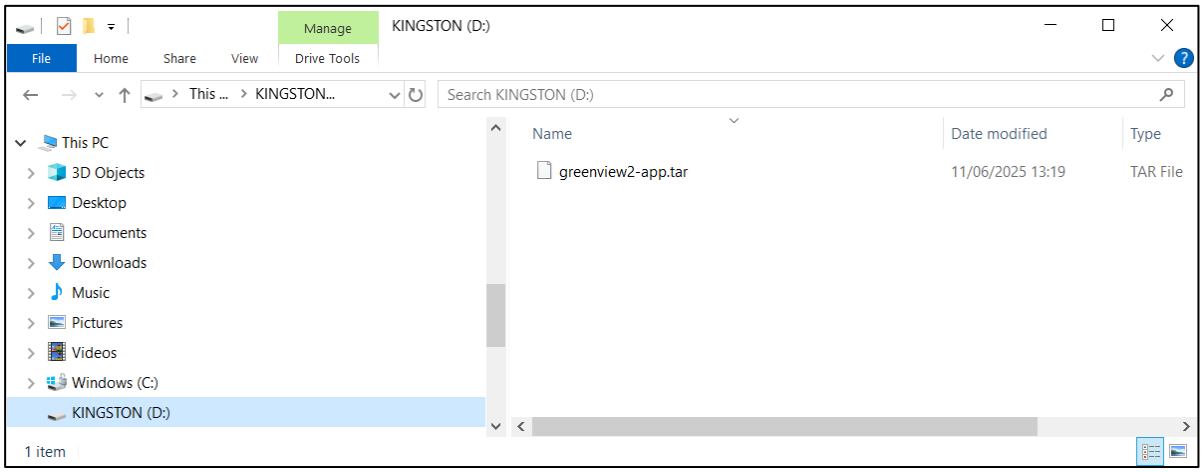



*Figure 3-7, configuration file update on a USB*

2. Application software: Green Instruments will provide the necessary files for a software update.
   Go to the Settings menu on the GreenView Panel PC, insert the USB with the received update file and on the screen, select “Software update”. Then, click on “Install new software”.
   If the update is not complete and the system fails, contact Green Instruments.

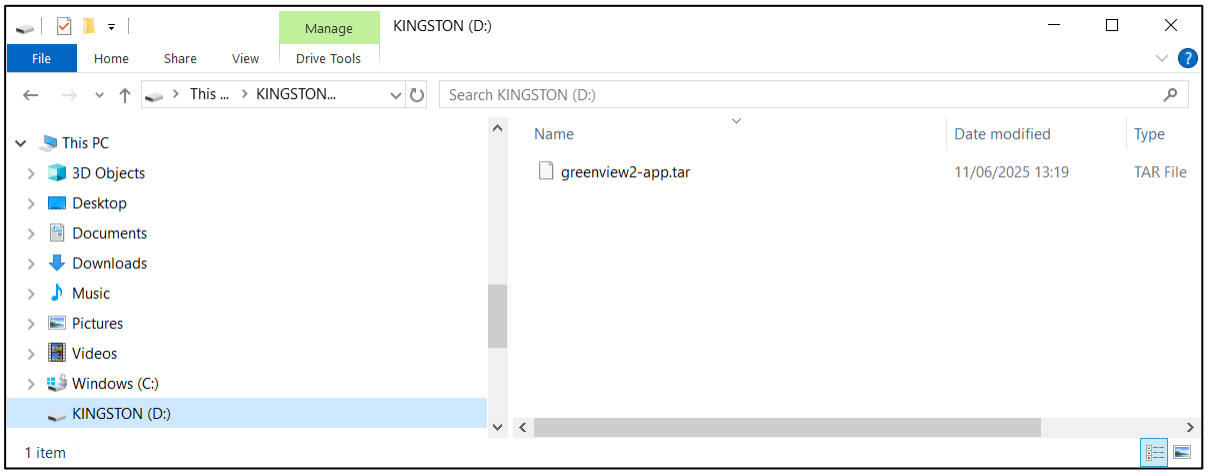



*Figure 3-8, application software update on USB*

# 4. Installation

**WARNING/ATTENTION**

Faulty operation/system failure hazard

Read this section carefully as it contains critical information regarding the installation of the system components. Incorrect or improper installation can lead to system failure or faulty operation. Failure to comply with the installation requirements can 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 2 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 and signal cables connections before operating the system enclosure.

**ATTENTION**

The following installation instructions are for general use only and are not concerned with specific installations.

**WARNING**

Electric shock hazard

Review the electrical drawings for each system component before proceeding with the electrical installation.

## 4.1 Terminals, Cables, and Wires Marking

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

**ATTENTION**

The GreenView Emissions Insight and assosiated modules are designed, developed, and rigorously tested to function efficiently and safely in demanding maritime applications. Failure to comply with service letters, and usage instructions can affect the function, lifetime and warranty.

## 4.2 Items received and placement

Upon receiving the GreenView Emissions Insight you will have:

For one G7200 system

- x1 kit with router
- x1 documentation package

For two G7200 systems

- x2 kits with router
- x1 documentation package

Note that the router kits are delivered along with the GreenView Panel PC. For more information on the contents of the router kits, go to section 4.3.5.

To visually understand the relation between the different modules, refer to section 4.4.2.

**ATTENTION**

If there are two G7200 systems installed on board, there will be two routers as well.
Router #1 is the main router and connected to the data inputs from G7200 CEMS #1 and G7990 Ambient Air Sensor Module. Router #2 is connected to the data inputs from G7200 CEMS #2 and transfers these data to the main router. Router #1 automatically denominates the probes connected to it 1-4, and the router #2 will thus see the probes connected to itself as probes 5-8.

### 4.2.1 Choosing a Suitable Location

**ATTENTION**

For optimal operation and minimal maintenance, be aware of the following:

- It is advised that the GreenView Panel PC be installed in the ECR.
- The G7990 Ambient Air Sensor Module must be installed in a location where the air used for combustion passes through, such as the casing, engine room etc.
- The system modules must be installed indoors and protected from direct contact from salt, mist, water, dust, soot, and oil spills. Avoid high humidity levels (see the max. permitted ambient RH in the technical specifications section).
- The system modules must be mounted in a location and at a height that is easily accessible for operation and service.
- The ambient temperature must comply with the specification limits. The ambient location must be well-ventilated and not be near sources of radiant heating.
- The G7990 Ambient Air Sensor Module must be mounted vertically.
- The system modules must be mounted mechanically to structural beams, pillars, or other similar main structures to ensure minimal vibrations. It must not be mounted onto a thin-plated structure such as casing plates or similar because of the risk of vibrations.
- The system modules must be mounted according to the relevant installation layout drawing.
- There must be sufficient free space for access to the system modules. The system modules must be mounted in a location with correct circulation of air. Consult the installation layout in the technical drawings for more information and for the dimensions of the system enclosure.

### 4.2.2 Panel PC Installation

The GreenView Panel PC is recommended to be installed within the ECR, as illustrated in Figure 1-1. It is possible to mount the screen in a panel or onto a wall – refer to the installation layout in the product documentation.

As an additional feature of the GreenView Panel PC, you can purchase a Wall Mount Cover to be used for wall installation with a VESA 100 wall bracket. If instead you wish to install the screen incorporated into a panel (i.e. in the engine control room) you can follow the installation layout in the technical drawings delivered with this manual.

With the delivery of the screen there will be a USB extension to facilitate access to USB ports located at the back of the screen. This is of special relevance for panel mounting installations, where an additional hole in the panel must be made for the installation of the USB extender. Note that in all cases the communication and power cables must be fixed mechanically to avoid stress and damage. Below you will find how to secure a USB extension cable with a cable clamp:

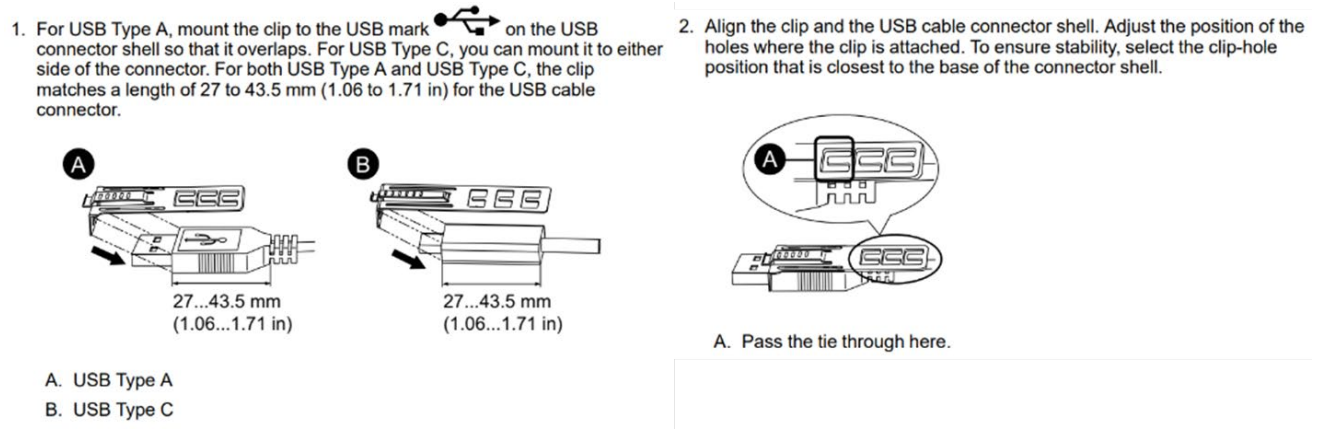



*Figure 4-1: USB cable clamp installation.*

### 4.2.3 G7990 Ambient Air Sensor Module Installation

The G7990 Ambient Air Sensor Module must be placed in a location where the air used for combustion passes through, such as the casing, engine room etc. to monitor the parameters related to the air consumed by the engines. The G7990 Ambient Air Sensor Module must be mounted by means of 4 bolts – refer to the installation layout.

### 4.2.4 CEMS module Installation

For the mounting of the G7200 Multi Gas Monitoring System, please refer to its manual.

All wirings should be made according to the electrical documentation provided with this manual.

### 4.2.5 Router Kit # 1 and 2 Installation

You will receive one router kit for each G7200 CEMS you install. Each of them must be connected to a router to join all the information inputs and then send them forward to the GreenView Panel PC. For the installation of either router, follow instructions delivered with Router Kit #1 or the G7200 electrical documentation.

Once you have performed the installation of the Router/s following the instructions received, the result should look like the pictures underneath.

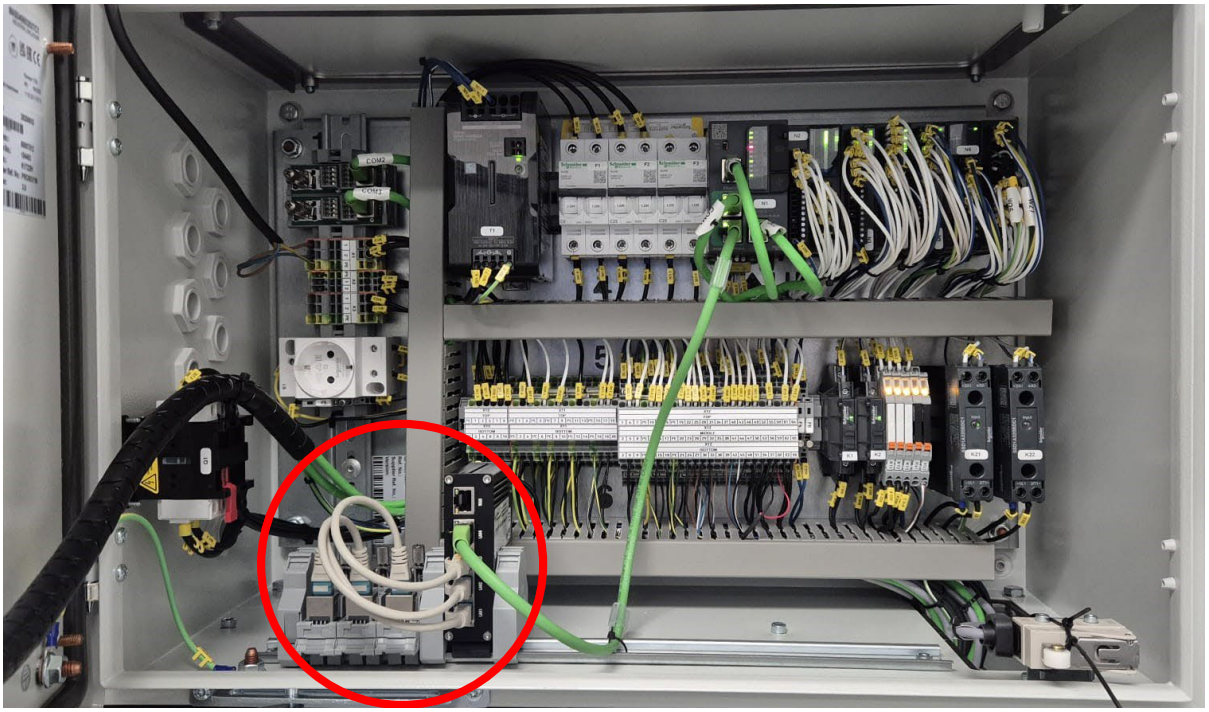


*Figure 4-2, Router Kit #1 mounted on G7200 CEMS*

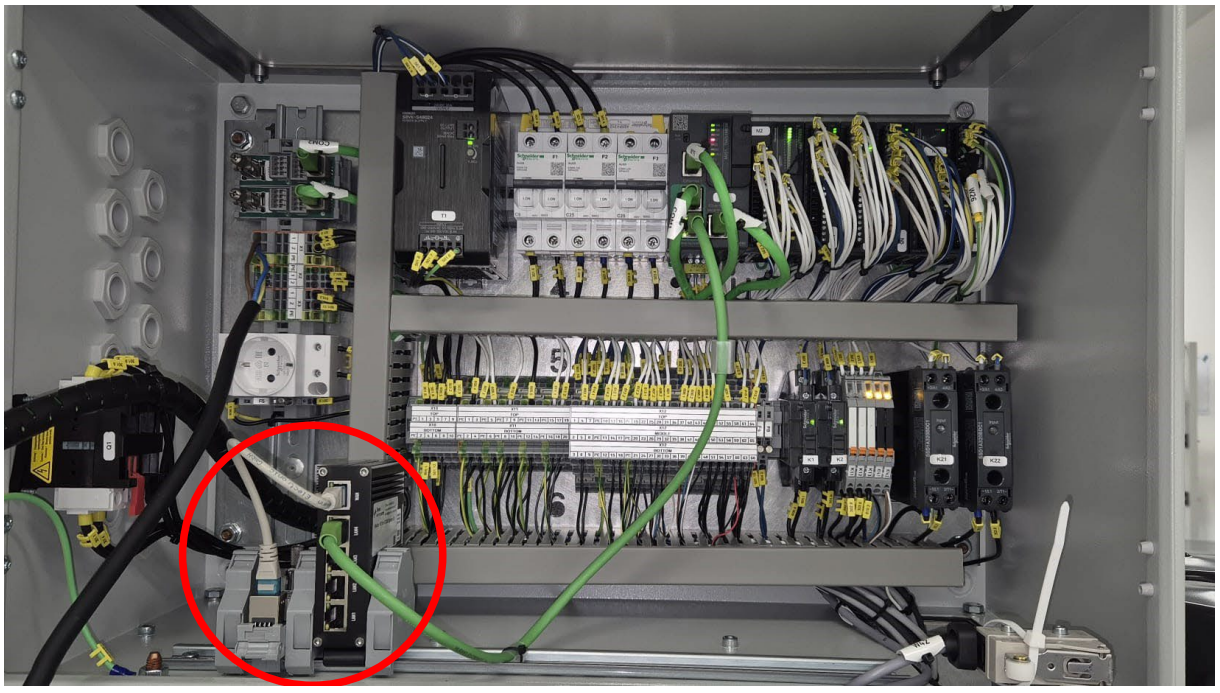


*Figure 4-3, Router Kit #2 mounted on G7200 CEMS*

# 4.3 Communication

## 4.3.1 Network Structure

This section will guide you through the process of linking the different modules and the ship's network to GreenView Panel PC's network.

The GreenView Panel PC has an internal netork and an external network. On the external network the GreenView Panel PC is the modbus slave (server) and the ship's automation system is the modbus master (client). The network structure diagram illustrates this. You can use it as a starting point to understand how each module takes part into the whole setup.

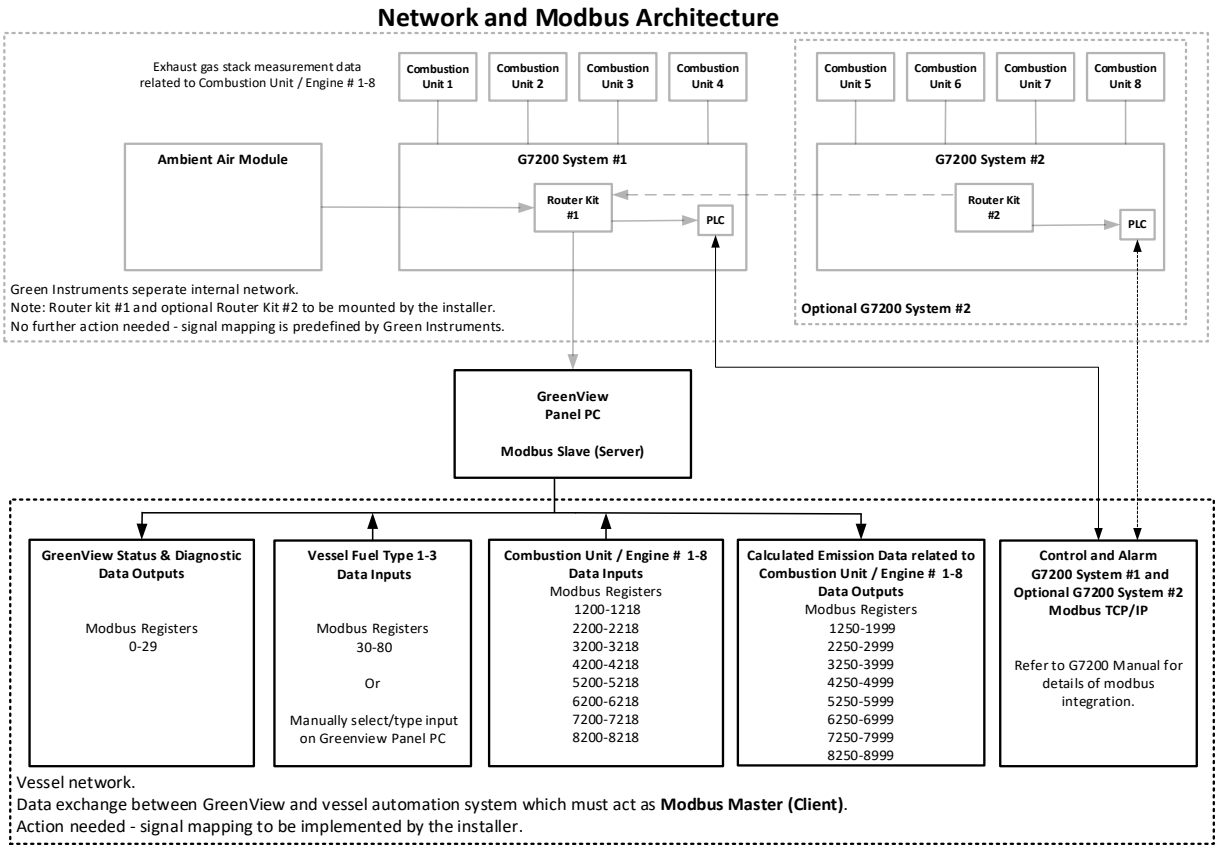



*Figure 4-4, Network and Modbus architecture diagram*

**ATTENTION**

You need to find where each data source is located in your ship's network, as well as the specific communication protocol in use. With this information, you can establish the communication to the GreenView Panel PC. Kindly note that GreenView Panel PC expects to receive updated data as a minimum every 20 seconds.

The data communication through the GreenView Panel PC (ETH port 2) has been predefined in regard to IP-addresses, data structure and format. This means that the GreenView Panel PC anticipates data on a fixed format from the G7990 Ambient Air Sensor Module and the G7200 system #1 as well as the optional G7200 system #2.

Modbus integration is needed to facilitate the data flow between the GreenView Panel PC and the ship's automation system. Kindly note that this data must be arranged according to the given modbus map, which is based on a fixed format with static assigned registers. It is not possible to modify this format. This means that the requested data must be assigned to the specific register as listed. Furthermore, the unit of the physical value must match the unit as defined in GreenView's modbus map. For instance, temperature is defined in degrees Celsius on the GreenView Panel PC, so in the calculations, the temperature values will be considered in Celsius. Thus, you must convert any other units different from Celsius before mapping the value to the required modbus register.

The IP address of the external (Vessel) network related to the GreenView Panel PC (ETH port 1) will need to be configured at the GreenView Panel PC. See the next section 4.4.2.

The data communication between each G7200 system and the ship's automation system is described separately in the G7200 User Manual. The purpose of this is to control the use of the G7200 system in regards to: enable sampling, and receiving notifications in the event of alarms.

### 4.3.2 Connecting data sources and G7200 systems

#### Configure GreenView IP address

The external IP address of the GreenView Emissions Insight is configured by you. On startup, you will need to specify this IP address in the Settings menu on the GreenView Panel PC.

Be aware that the IP ranges below are in use already, and therefore cannot be chosen.

| Device | IP Range |
|---|---|
| G7200 system #1 and G7990 Ambient Air Sensor Module | 192.168.12.0/24 |
| G7200 system #2 | 192.168.13.0/24 |
| Docker | 172.17.0.0/16 |
| Docker | 172.18.0.0/16 |

#### G7200 System 1

G7200 System 1 is defined as the CEMS which from a network perspective connects to the G7990 Ambient Air Sensor Module and the GreenView Panel PC. The probes connected to G7200 System 1 will automatically appear first on the GreenView Panel PC. Therefore, if you have two G7200 Multi Gas Monitoring systems, it is important that prior to connecting the different modules, you identify the relationship between the engines and the exhaust gas stacks from which the G7200 System measurements are taken.

Note that G7200 System 1 is directly related to GreenView engines 1-4 and thus, G7200 System 2 is related to engines 5-8.

#### Optional G7200 System 2

G7200 System 2 is defined as the CEMS which from a network perspective connects to G7200 System 1. G7200 CEMS #2 is connected to G7200 CEMS #1 via Router Kit #2. See Network Diagram.

## Example of relationship between G7200 sample points and modbus registers

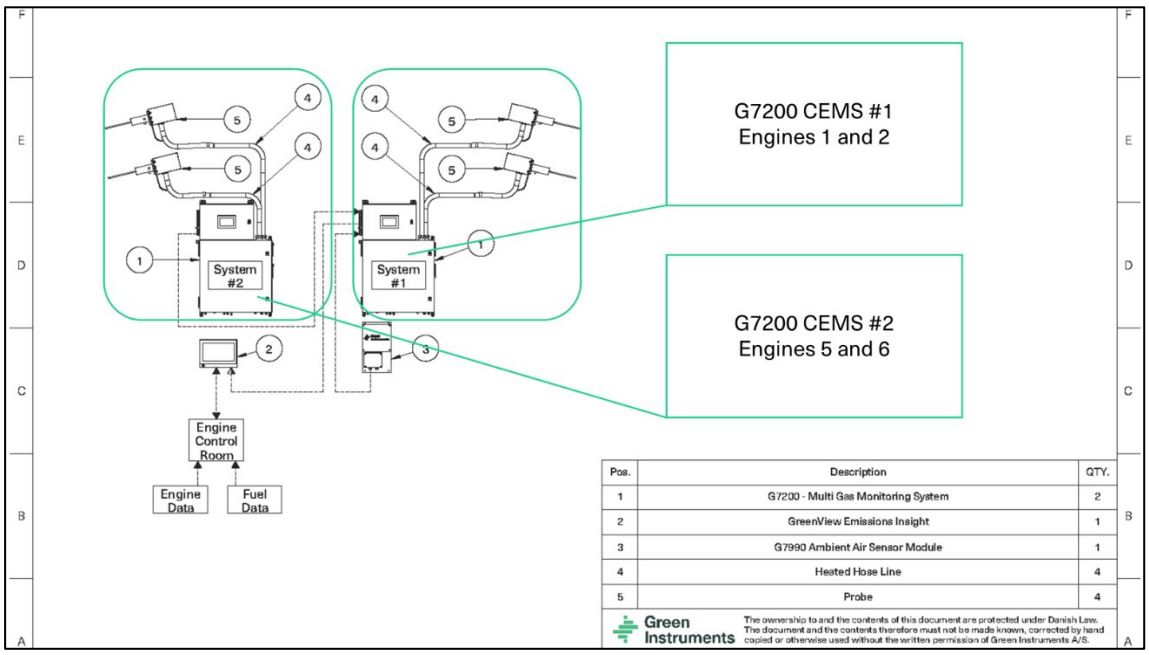



*Figure 4-5, Example of GreenView and G7200 CEMS relation*

On board a vessel, 2 pcs. G7200 CEMS are installed. CEMS #1 is configured for 2 stacks – meaning it has 2 sample gas probes. Probe 1 is installed on the exhaust gas stack related to Auxiliary Engine 2, while probe 2 is installed on the exhaust gas stack related to Main Engine 1.

In another location on board the vessel CEMS #2 is installed. CEMS #2 is configured for 1 stack – meaning it has only 1 sample gas probe, which is installed on the exhaust gas stack related to Auxiliary Engine 1.

In this fictive example the GreenView Panel PC will automatically store the measurement data from CEMS #1 probe 1 to “Engine 1” which is given the alias “Aux. Eng 2”, while CEMS #1 probe 2 is stored to “Engine 2” which is given the alias “ME 1”. CEMS #2 probe 1 will be assigned to “Engine 5” and is given the alias “Aux. Eng 1”. Engine 3-4 and Engine 6-8 thus remains unused.

In this example the engine and fuel related data must be provided on the following registers:

| Engines on board | Related G7200 sample point | GreenView Engine Menu | Correctly associated Modbus register |
|---|---|---|---|
| Aux. Eng. 2 | G7200 CEMS #1, probe 1 | Engine 1 | 1xxx |
| ME 1 | G7200 CEMS #1, probe 2 | Engine 2 | 2xxx |
| N/A | N/A | Engine 3 | 3xxx |
| N/A | N/A | Engine 4 | 4xxx |
| Aux. Eng 1 | G7200 CEMS #2, probe 1 | Engine 5 | 5xxx |
| N/A | N/A | Engine 6 | 6xxx |
| N/A | N/A | Engine 7 | 7xxx |
| N/A | N/A | Engine 8 | 8xxx |

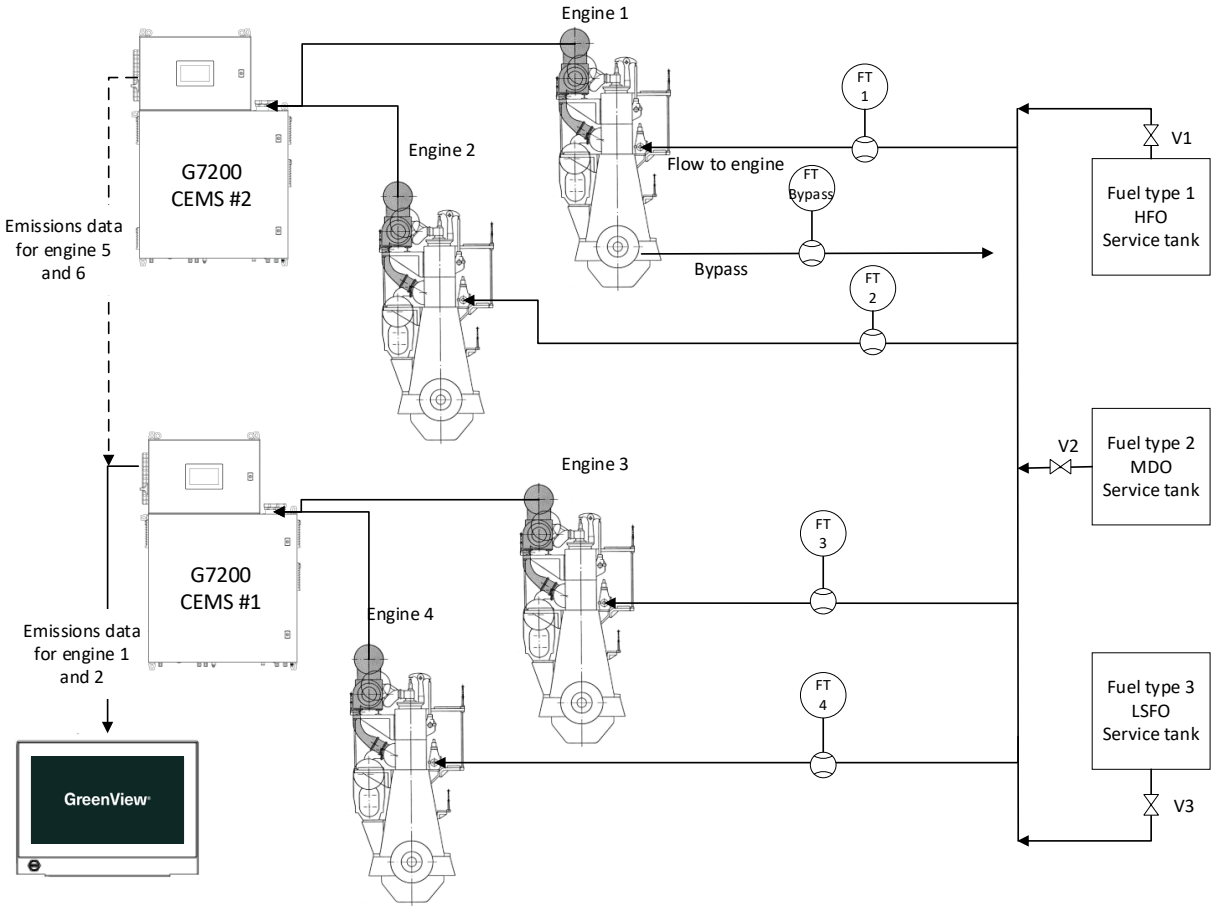



*Figure 4-6, G7200 CEMS and GreenView relationship*

## Alarms: status and diagnostics' outputs

The GreenView Panel PC shows the active alarms, where you can see which module it refers to, and refer to troubleshooting to solve it. If you wish to see active alarms on your ship's automation system, you need to integrate your network with the predefined GreenView Panel PC's modbus registers for that, which are registers 0-28.

## Fuel and engine data inputs

Fuel inputs: the fuels in use on board the vessel can be set on GreenView Panel PC as well as through the modbus. You can configure them at the modbus addresses from 30-70. Addresses 30, 50 and 70 correspond to fuel type 1, 2 and 3 respectively. Addresses 32-40 allow you to specify the chemical composition of fuel type 1. Note that to input the fuel type through the modbus, when using a custom fuel type, you must first set the fuel type at the modbus register to custom (0) and afterwards you can change the fuel composition (values for each element).

Engine data: you must always provide information for the required inputs, as the calculations by GreenView are dependent on this data. You can distinguish required from optional inputs by looking at the column "priority" on the modbus list.

Note that the charge/scavenge air pressure must be input as absolute pressure and not gauge pressure.

## Inputs – relevant case scenarios

In this section you can see examples of different case scenarios (non-exhaustive) that would require a special approach.

- Multiple fuel types but only one flow meter: If there are multiple fuel types but only one mass flow meter to measure the actual fuel flow, then additional logic needs to be implemented by the data integrator in order to differentiate the type of fuel which flows to the engine. In this case the signal from the single fuel flow meter should be correctly mapped to fuel input 1-2-3 depending on additional logic like engine mode (gas mode or oil mode) or the position of relevant valves in the fuel supply system. Looking at Figure 4-7, the case could be that Fuel type 1 is in use, and not Fuel type 2. One should consider which valve the flow passes through to account for the fuel correctly. In this case, Valve 1 is open, and Valve 2 closed. In this example the measured flow value should be mapped to fuel input 1.

- Multiple engines combined into a common exhaust: if multiple engines share a single exhaust system, it complicates the measurement of emissions. From a data input point of view the sum of engines should be regarded as one big engine. This means that the associated data inputs should be the sum of fuel for each fuel type and the sum of break power from all engines. Regarding the charge air pressure and temperature, these should be input as a weighted average in which the weighing should be based on the break power of each engine.

- Fuel flow bypass: in cases where a fuel bypass exists, fuel consumption might not be measured directly by means of a dedicated fuel flow meter in the supply line. In such cases the flow signal from either the fuel flow supply line or the fuel flow bypass line cannot be directly used. Additional logic must be implemented by the data integrator in order to reflect the actual fuel flow consumption. The case could be that the actual fuel consumption should be derived as follows:

$$Fuel_{consumed} = Fuel_{supply} - Fuel_{bypass}\ [kg/h]$$

With reference to Figure 4-, one must substract the fuel passing through flowmeter 2 (FT2) from the fuel supplied from the tank, passing through fuel flowmeter 1 (FT1) to calculate the fuel consumed.

$$Fuel_{consumed} = Flow_{TF1} - Flow_{FT2}\ [kg/h]$$

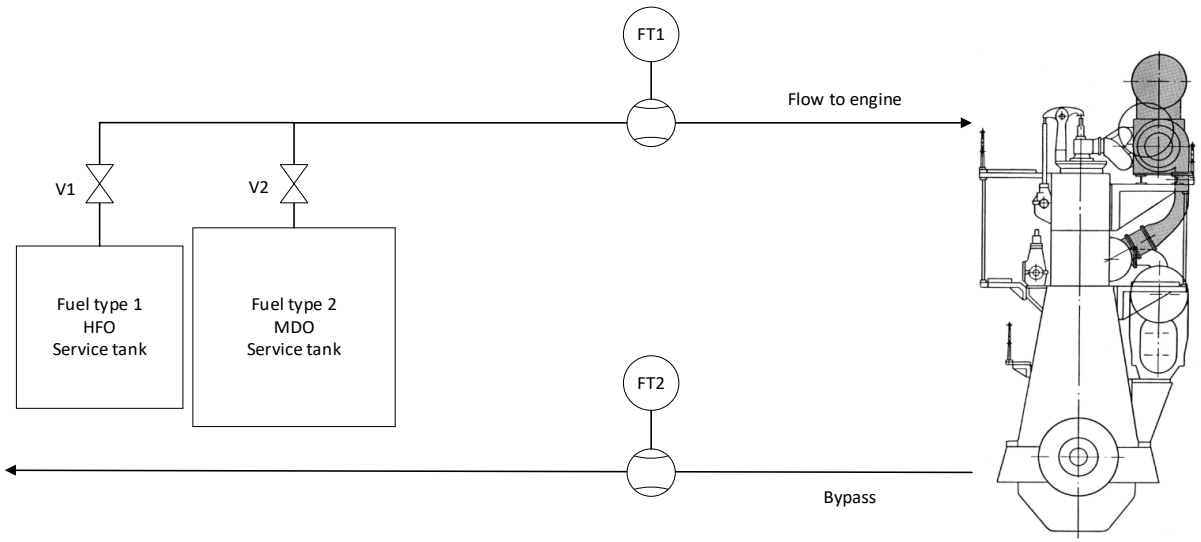



*Figure 4-7, Fuel flow scenarios*

### Calculated emissions data outputs

GreenView Panel PC uses the data from the connected engines to create calculated emission data for each engine. If you wish to see this data on the ship's automation system, use the predefined modbus registers shown on the modbus map.

### G7200 System Alarms and Control

The information about the status and alarms of the G7200 CEMS flows from the PLC connected to each Multi Gas Monitoring System to the ship's automation system independently from the GreenView Panel PC. To learn more on how to connect these networks, refer to G7200 Multi Gas Monitoring System User Manual.

## 4.3.3 Modbus map

- Only Modbus holding registers are used. The first holding register is address 0.
- Type: *Bit arrays* holds registers where individual bits are named with a function description. When a bit is 1 (true), the function is active.
- Type: *Real* uses two Modbus holding registers. Format is little-endian byte swap.

| Address (Holding register Function code 03) | Priority (Required /Optional) | Name | Function Description | Type (Read /Write) | Range or Unit |
|---|---|---|---|---|---|
| **System Data Optional features** | | | | | |
| 24 | Optional | GreenView system status | 0 = Not ready, 1 = Ready, 2 = Error | uint16 (Read) | Number (0-2) |
| 25 | Optional | GreenView system alarms | Bit 0: Database state (0=OK / 1=Error)<br>Bit 1: Calculation state (0=OK / 1=Error)<br>Bit 2: Disk #1 capacity remaining (0= > 20% / 1= < 20%)<br>Bit 3: Disk #2 capacity remaining (0= > 20% / 1= < 20%)<br>Bit 4: Modbus state (0=OK / 1=Error)<br>Bit 5: Backup state (0=OK / 1=Error)<br>Bit 6: CEMS state (0=OK / 1=Error)<br>Bit 7: G7990 Ambient Air Sensor Module state (0=OK / 1=Error)<br>Bit 8: Engine Data Error (0=OK / 1=Error) | uint16 (Read) | Bit array |
| 26-28 | Reserved | | | | |
| 29 | Optional | Fuel compositions valid | Bit 0: All fuel compositions (0=Valid / 1=Error)<br>Bit 1: Fuel 1 compositions (0=Valid / 1=Error)<br>Bit 2: Fuel 2 compositions (0=Valid / 1=Error)<br>Bit 3: Fuel 3 compositions (0=Valid / 1=Error) | uint16 (Read) | Bit array |

| Address (Holding register Function code 03) | Priority (Required /Optional) | Name | Function Description | Type (Read /Write) | Range or Unit |
|---|---|---|---|---|---|
| 30 | Optional | Fuel Type 1 | Optional: From Engine Data, Delivered by customer<br>This register will set predefined fuel composition values. See Manual Appendix A.<br>To define a custom fuel type this register must be set to 0 (Custom fuel type). Then it is possible to change the fuel composition via register 32 to 40. | uint16 (Read/Write) | N/A |
| 32 | Optional | Fuel 1 oxygen % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 34 | Optional | Fuel 1 hydrogen % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 36 | Optional | Fuel 1 carbon % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 38 | Optional | Fuel 1 nitrogen % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 40 | Optional | Fuel 1 sulfur % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 42-49 | Reserved | | | | |
| 50 | Optional | Fuel Type 2 | Optional: From Engine Data, Delivered by customer<br>This register will set predefined fuel composition values. See Manual Appendix A.<br>To define a custom fuel type this register must be set to 0 (Custom fuel type). Then it is possible to change the fuel composition via register 52 to 60. | uint16 (Read/Write) | N/A |
| 52 | Optional | Fuel 2 oxygen % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 54 | Optional | Fuel 2 hydrogen % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 56 | Optional | Fuel 2 carbon % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 58 | Optional | Fuel 2 nitrogen % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 60 | Optional | Fuel 2 sulfur % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 62-69 | Reserved | | | | |
| 70 | Optional | Fuel Type 3 | Optional: From Engine Data, Delivered by customer<br>This register will set predefined fuel | uint16 (Read/Write) | N/A |

| Address (Holding register Function code 03) | Priority (Required /Optional) | Name | Function Description | Type (Read /Write) | Range or Unit |
|---|---|---|---|---|---|
| | | | composition values. See Manual Appendix A.<br>To define a custom fuel type this register must be set to 0 (Custom fuel type). Then it is possible to change the fuel composition via register 72 to 80. | | |
| 72 | Optional | Fuel 3 oxygen % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 74 | Optional | Fuel 3 hydrogen % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 76 | Optional | Fuel 3 carbon % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 78 | Optional | Fuel 3 nitrogen % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 80 | Optional | Fuel 3 sulfur % m/m | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 82-999 | Reserved | | | | |
| **Engine 1 Data Inputs** | | | | | |
| 1200 | ⚠ Required | Fuel flow 1 (consumed flow) | From Engine Data, Delivered by customer | uint16 (Read/Write) | kg/hour |
| 1202 | ⚠ Required | Fuel flow 2 (consumed flow) | From Engine Data, Delivered by customer | uint16 (Read/Write) | kg/hour |
| 1204 | ⚠ Required | Fuel flow 3 (consumed flow) | From Engine Data, Delivered by customer | uint16 (Read/Write) | kg/hour |
| 1206 | ⚠ Required | Pressure of charge/scavenge air (absolute) | From Engine Data, Delivered by customer | uint16 (Read/Write) | kPa (abs) |
| 1208 | ⚠ Required | Temperature of charge air | From Engine Data, Delivered by customer | Real (Read/Write) | °C |
| 1210 | ⚠ Required | Brake Power | From Engine Data, Delivered by customer | | kW |
| 1212 | Optional | Engine RPM | From Engine Data, Delivered by customer (-100 = Disabled) | Real (Read/Write) | r/min |
| 1214 | ⚠ Required | Engine Load % | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| 1216 | ⚠ Required | Exhaust Gas Temperature | From Engine Data, Delivered by customer (-100 = Disabled) | Real (Read/Write) | °C |
| 1218 | ⚠ Required | Engine Data Error | From Engine Data, Delivered by customer (0=OK / 1=Error)<br>Customers must use this register to declare if the engine data is valid. | uint16 (Read/Write) | BOOL |
| 1220-1249 | Reserved | | | | |
| **Engine 1 Optional Data Outputs** | | | | | |
| 1000 | Optional | Data valid | Bit 0: G7990 Ambient Air Sensor | uint16 | Bit array |

| Address (Holding register Function code 03) | Priority (Required /Optional) | Name | Function Description | Type (Read /Write) | Range or Unit |
|---|---|---|---|---|---|
| | | | Module Data Error (0=OK/1=Error)<br>Bit 1: Engine Data Error (0=OK / 1=Error)<br>Bit 2: CEMS Error (0=OK / 1=Error) | (Read) | |
| 1004-1044 | Optional | G7200 data | Reserved | Real (Read) | N/A |
| 1250 | Optional | SO2 mass flow | | Real (Read) | kg/hour |
| 1252 | Optional | CO2 mass flow | | Real (Read) | kg/hour |
| 1254 | Optional | NO2 mass flow | | Real (Read) | kg/hour |
| 1256 | Optional | CH4 mass flow | | Real (Read) | kg/hour |
| 1258 | Optional | NO mass flow | | Real (Read) | kg/hour |
| 1260 | Optional | Exhaust mass flow | | Real (Read) | kg/hour |
| 1300 | Optional | SO2 Total | Accumulated sum of total mass emitted | Real (Read) | tons |
| 1302 | Optional | CO2 Total | | Real (Read) | tons |
| 1304 | Optional | NO2 Total | | Real (Read) | tons |
| 1306 | Optional | CH4 Total | | Real (Read) | tons |
| 1308 | Optional | NO Total | | Real (Read) | tons |
| 1310-1599 | Reserved | | | | |
| 1600 | Optional | Absolute humidity | | Real (Read) | g/kg |
| 1602 | Reserved | | | Real (Read) | N/A |
| 1604 | Optional | Absolute humidity of the charge air | | Real (Read) | g/kg |
| 1606 | Optional | Exhaust gas flow | | Real (Read) | Kg/h |
| 1608 | Optional | CH4 mass | | Real (Read) | Kg/h |
| 1610 | Optional | CH4 Specific | | Real (Read) | g/kWh |
| 1612 | Optional | CH4 TtW | | Real (Read) | g CH4 / g Fuel |
| 1614 | Optional | CH4 Slip | | Real (Read) | % |
| 1616 | Optional | CO2 Mass | | Real (Read) | Kg/h |
| 1618 | Optional | CO2 Specific | | Real (Read) | g/kWh |
| 1620 | Optional | CO2 TtW | | Real (Read) | g CO2 / g Fuel |
| 1622 | Optional | SO2 Mass | | Real (Read) | Kg/h |
| 1624 | Optional | SO2 Specific | | Real (Read) | g/kWh |
| 1626 | Optional | SO2 TtW | | Real (Read) | g SO2 / g Fuel |
| 1628 | Optional | NO Mass | | Real (Read) | Kg/h |
| 1630 | Optional | NO Specific | | Real (Read) | g/kWh |
| 1632 | Optional | NO TtW | | Real (Read) | g NO / g Fuel |
| 1634 | Optional | NO2 Mass | | Real (Read) | Kg/h |
| 1636 | Optional | NO2 Specific | | Real (Read) | g/kWh |
| 1638 | Optional | NO2 TtW | | Real (Read) | g NO2 / g Fuel |

| Address (Holding register Function code 03) | Priority (Required /Optional) | Name | Function Description | Type (Read /Write) | Range or Unit |
|---|---|---|---|---|---|
| 1640 | Optional | NOx Mass | | Real (Read) | Kg/h |
| 1642 | Optional | NOx Specific | | Real (Read) | g/kWh |
| 1644 | Optional | NOx TtW | | Real (Read) | g NOx / g Fuel |
| 1646 | Optional | Break Specific Fuel Consumption (BSFC) | | Real (Read) | g Fuel / kWh |
| 1648 | Optional | Raw exhaust gas mass density | | Real (Read) | Kg/m3 |
| 1650 | Reserved | | | Real (Read) | |
| 1652 | Reserved | | | Real (Read) | |
| 1654 | Reserved | | | Real (Read) | |
| 1656 | Optional | Combustion Efficiency (CH4 / CO2) | | Real (Read) | N/A |
| 1658-1999 | Reserved | | | | |
| **Engine X (2-8) Data Inputs** | | | | | |
| x200 | ⚠ Required | Fuel flow 1 (consumed flow) | From Engine Data, Delivered by customer | uint16 (Read/Write) | kg/hour |
| x202 | ⚠ Required | Fuel flow 2 (consumed flow) | From Engine Data, Delivered by customer | uint16 (Read/Write) | kg/hour |
| x204 | ⚠ Required | Fuel flow 3 (consumed flow) | From Engine Data, Delivered by customer | uint16 (Read/Write) | kg/hour |
| x206 | ⚠ Required | Pressure of charge/scavenge air (absolute) | From Engine Data, Delivered by customer | uint16 (Read/Write) | kPa (abs) |
| x208 | ⚠ Required | Temperature of charge air | From Engine Data, Delivered by customer | Real (Read/Write) | °C |
| x210 | ⚠ Required | Brake Power | From Engine Data, Delivered by customer | | kW |
| x212 | Optional | Engine RPM | From Engine Data, Delivered by customer (-100 = Disabled) | Real (Read/Write) | r/min |
| x214 | ⚠ Required | Engine Load % | From Engine Data, Delivered by customer | Real (Read/Write) | % |
| x216 | ⚠ Required | Exhaust Gas Temperature | From Engine Data, Delivered by customer (-100 = Disabled) | Real (Read/Write) | °C |
| x218 | ⚠ Required | Engine Data Error | From Engine Data, Delivered by customer (0=OK / 1=Error)<br>Customers must use this register to declare if the engine data is valid. | uint16 (Read/Write) | BOOL |
| x220-x249 | Reserved | | | | |
| **Engine X (2-8) Optional Data Outputs** | | | | | |
| x000 | Optional | Data valid | Bit 0: G7990 Ambient Air Sensor Module Data Error (0=OK/1=Error)<br>Bit 1: Engine Data Error (0=OK / | uint16 (Read) | Bit array |

| Address (Holding register Function code 03) | Priority (Required /Optional) | Name | Function Description | Type (Read /Write) | Range or Unit |
|---|---|---|---|---|---|
| | | | 1=Error)<br>Bit 2: CEMS Error (0=OK / 1=Error) | | |
| x004-x044 | Optional | G7200 data | Reserved | Real (Read) | N/A |
| x250 | Optional | SO2 mass flow | | Real (Read) | kg/hour |
| x252 | Optional | CO2 mass flow | | Real (Read) | kg/hour |
| x254 | Optional | NO2 mass flow | | Real (Read) | kg/hour |
| x256 | Optional | CH4 mass flow | | Real (Read) | kg/hour |
| x258 | Optional | NO mass flow | | Real (Read) | kg/hour |
| x260 | Optional | Exhaust mass flow | | Real (Read) | kg/hour |
| x300 | Optional | SO2 Total | Accumulated sum of total mass emitted | Real (Read) | tons |
| x302 | Optional | CO2 Total | | Real (Read) | tons |
| x304 | Optional | NO2 Total | | Real (Read) | tons |
| x306 | Optional | CH4 Total | | Real (Read) | tons |
| x308 | Optional | NO Total | | Real (Read) | tons |
| x310-x599 | Reserved | | | | |
| x600 | Optional | Absolute humidity | | Real (Read) | g/kg |
| x602 | Reserved | | | Real (Read) | N/A |
| x604 | Optional | Absolute humidity of the charge air | | Real (Read) | g/kg |
| x606 | Optional | Exhaust gas flow | | Real (Read) | Kg/h |
| x608 | Optional | CH4 mass | | Real (Read) | Kg/h |
| x610 | Optional | CH4 Specific | | Real (Read) | g/kWh |
| x612 | Optional | CH4 TtW | | Real (Read) | g CH4 / g Fuel |
| x614 | Optional | CH4 Slip | | Real (Read) | % |
| x616 | Optional | CO2 Mass | | Real (Read) | Kg/h |
| x618 | Optional | CO2 Specific | | Real (Read) | g/kWh |
| x620 | Optional | CO2 TtW | | Real (Read) | g CO2 / g Fuel |
| x622 | Optional | SO2 Mass | | Real (Read) | Kg/h |
| x624 | Optional | SO2 Specific | | Real (Read) | g/kWh |
| x626 | Optional | SO2 TtW | | Real (Read) | g SO2 / g Fuel |
| x628 | Optional | NO Mass | | Real (Read) | Kg/h |
| x630 | Optional | NO Specific | | Real (Read) | g/kWh |
| x632 | Optional | NO TtW | | Real (Read) | g NO / g Fuel |
| x634 | Optional | NO2 Mass | | Real (Read) | Kg/h |
| x636 | Optional | NO2 Specific | | Real (Read) | g/kWh |
| x638 | Optional | NO2 TtW | | Real (Read) | g NO2 / g Fuel |
| x640 | Optional | NOx Mass | | Real (Read) | Kg/h |
| x642 | Optional | NOx Specific | | Real (Read) | g/kWh |

| Address (Holding register Function code 03) | Priority (Required /Optional) | Name | Function Description | Type (Read /Write) | Range or Unit |
|---|---|---|---|---|---|
| x644 | Optional | NOx TtW | | Real (Read) | g NOx / g Fuel |
| x646 | Optional | Break Specific Fuel Consumption (BSFC) | | Real (Read) | g Fuel / kWh |
| x648 | Optional | Raw exhaust gas mass density | | Real (Read) | Kg/m3 |
| x650 | Reserved | | | Real (Read) | |
| x652 | Reserved | | | Real (Read) | |
| x654 | Reserved | | | Real (Read) | |
| x656 | Optional | Combustion Efficiency (CH4 / CO2) | | Real (Read) | N/A |

## 4.4 Commission

**ATTENTION**

You must verify that all G7200 Systems have been installed correctly according to the G7200 User Manual.

After completing the system installation and before bringing GreenView Emissions Insight into operation, verify the setup by ensuring all connections are made according to the installation instructions. Refer to the relevant sections in this chapter to verify correct installation of all units. Note that the commissioning checklist is not exhaustive as it only lists the typical acceptance criteria.

### 4.4.1 Data input verification

In order to verify that the GreenView Panel PC data inputs are correctly established, you must use the following method:

1) Compare the ECR data with the data shown on the Greenvlew Panel PC for each engine.
2) Compare the G7200 measurement data with the data shown on the Greenvlew Panel PC for each engine.

Through this, you can see if the parameters on GreenView Panel PC relate to the correct engine and that the values and units are correct. This is important in order to verify that the data inputs are correct and that there is no mixup with respect to the relationship between data, emissions and engines. Then you will know if the signal integration has been made correctly.

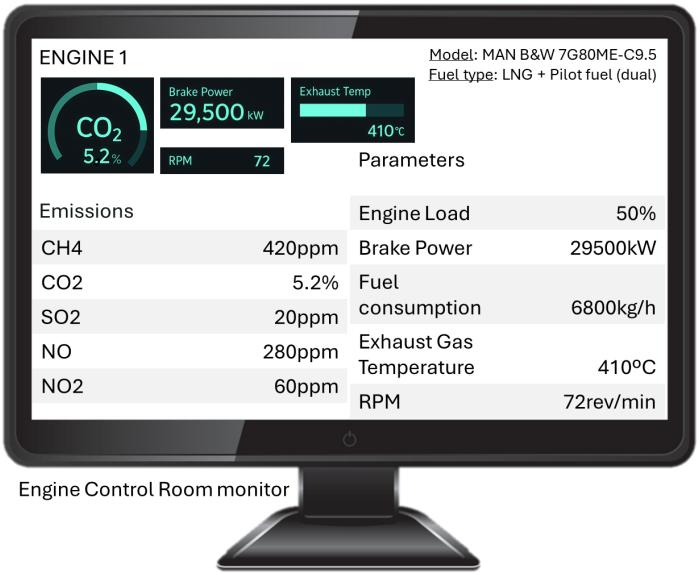



*Figure 4-8, Example of ship automation monitor showing measured parameters of Engine 1*


*Figure 4-9, Example of measured parameters at Engine 1 on GreenView Panel PC*

## ATTENTION

Be aware that at the initial start-up of the GreenView Panel PC, the “Database backup state” alarm will activate automatically, as the system will detect that there has been no backup yet. This is normal procedure, and it will solve itself after 24 hours, therefore no action is needed.

### 4.4.2 Commissioning Checklist

Signature by Installation Contractor: The installation contractor must sign the commissioning checklist once all the checks have been completed.

### Submission to Green Instruments A/S

A scanned copy of the commissioning checklist along with the results and any remarks must be sent to Green Instruments A/S.

**NOTE:** The commissioning checklist is also included in the documentation package so that you can easily copy and scan it.

- Send the scanned document to: service@greeninstruments.com
- Add the following information in the subject field: *GreenView checklist, IMO no., System Serial no.*

| Action | Observed criteria | Evaluation | Note |
|---|---|---|---|
| The installation and commissioning of G7200 MGMS has been completed. | ▪ Refer to the commissioning checklist found in the manual of the G7200 MGMS. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to chapter 4 Installation. |
| The GreenView Panel PC has been installed. | ▪ The GreenView Panel PC is installed on a wall or in a panel.<br>▪ The USB interface is established and accessible. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to chapter 4 Installation. |
| Connection of power cable to the GreenView Panel PC. | ▪ Power voltage has been verified with multimeter.<br>▪ Power is ready to be switched on.<br>▪ Cable is mechanically fixed. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to chapter 4 Installation. |
| Check the essential manual inputs to the GreenView Panel PC. | ▪ Fuel types 1-3 and % content have been defined.<br>▪ Alias for all engines are defined.<br>▪ Check that date and time corresponds to UTC.<br>▪ Type in the IMO number<br>▪ IP address for port 2 has been configured to match the vessel network. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to chapter 3 GreenView and 4.4.2. |
| Check installation of the router kit #1 in the G7200 System #1.<br>Check the installation of the optional Router kit #2 in G7200 System #2. | ▪ The router kit(s) have been installed following the enclosed guide. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to chapter 4 Installation. |

| Action | Observed criteria | Evaluation | Note |
|---|---|---|---|
| Verify the connection of the ethernet cable from the router #1 to the GreenView Panel PC port 2. | ▪ Connection has been tested with a cable tester or by “pinging” system.<br>▪ Cable is mechanically fixed. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to chapter 4 Installation and 4.4.2. |
| The G7990 Ambient Air Sensor Module has been installed. | ▪ The G7990 Ambient Air Sensor Module is installed in a location where the air used for combustion passes through, such as the casing, engine room etc. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to chapter 4 Installation. |
| The connection of the power cable to the G7990 Ambient Air Sensor Module is correct. | ▪ Power voltage has been verified with multimeter.<br>▪ Power is ready to be switched on. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to chapter 4 Installation. |
| Check the connection of the ethernet cable from router #1 to the G7990 Ambient Air Sensor Module. | ▪ Connection has been tested with a cable tester or by “pinging” system. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to chapter 4 Installation and 4.4.2. |
| The network has been completed by establishing an ethernet cable from the vessel data network to the GreenView Panel PC port 1. | ▪ Connection has been tested with a cable tester or by “pinging” system. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to chapter 4 Installation, and section 4.4.2. |
| Communication protocol is correctly implemented via MODBUS TCP/IP. | ▪ The required engine data has been mapped to the GreenView modbus registers as described. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to section 4.4. |
| Data input verification: Verify correct connection of G7200 CEMS probes to engine exhaust.<br>Verify the engine data inputs. | ▪ For each individual engine, compare that all data shown on the GreenView Panel PC corresponds to the information for that specific engine parameter shown on the automation system of the ship.<br>▪ For each individual engine compare that all data shown on the GreenView Panel PC corresponds to the information for that specific engine emission | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to section 4.5.4. and 4.3.4 CEMS module Installation. |

| Action | Observed criteria | Evaluation | Note |
|---|---|---|---|
| | measurement data as shown on the HMI on the relevant CEMS. | | |
| Test that alarm cases are changing the status on the alarm page. | ▪ Disconnect the ethernet connection from each module (CEMS #1, CEMS #2, G7990 Ambient Air Sensor Module, Engine data) one at a time and observe:<br>▪ The associated CEMS alarm status on the GreenView alarm page.<br>▪ The associated G7990 Ambient Air Sensor Module alarm status on the GreenView alarm page.<br>▪ The associated Engine and fuel data alarm status on the GreenView alarm page.<br>▪ The associated Modbus alarm status on the GreenView alarm page. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to section 3.4 Alarms menu. |
| Inform if relevant systems on board are ready for operation e.g., engines, boilers, etc. | Necessary systems must be operational if relevant to the MGMS. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to vessel machinery and their manufacturer's technical documentation. |
| Perform a sea trial for all engines | ▪ Fuel types and % content have been defined and correspond to the bunkered fuel.<br>▪ Alias for all engines<br>▪ Submit emission report to Green Instruments covering at least 7 days of operation to verify system performance and integration. | ☐ Accepted<br>☐ Not accepted<br>☐ Not done | Refer to vessel machinery and their manufacturer's technical documentation. |
| GreenView Emissions Insight serial number. | | | |
| Installation contractor | | | |
| Ship name / hull no. / IMO no. | | | |
| Ship owner | | | |
| Checks performed by (date / sign) | | | |
| Checks verified by (date / sign) | | | |

# 5. Operations

Installation, operation, and maintenance must follow best practices and the latest version of the user manual and must respect the limitations of the product type approval. Failure to comply with service letters can also affect lifetime and warranty.

The information provided about the lifetime of the product shall in no case be interpreted as a guarantee of the product's condition or quality.

**ATTENTION**

Update fuel in use as often as necessary to ensure having valid data. Remember to adjust the parameters of the fuel composition to ensure that the GreenView Panel PC has the correct inputs. The data of reports expedited by the GreenView Emissions Insight depend on the fuel composition selected. See section 3.2 to see the fuel selection procedure. It is imperative to keep this updated, so that each engine connected to the GreenView has the corresponding fuel values to the actual fuel in use.

## 5.1 Fuel type selection

### 5.1.1 Conversion from bunker delivery note to fuel mass percentage

In order to have valid reports, fuel data needs to reflect the composition of the fuel in use. The GreenView Panel PC considers the mass percentage of each component in the fuel to calculate the emissions. As you can see on the engine menu at the GreenView Panel PC, there are predefined fuels with predefined mass percentage of each component. When these options do not fit the fuel on board your ship, you will need to select "Custom" and calculate each component.

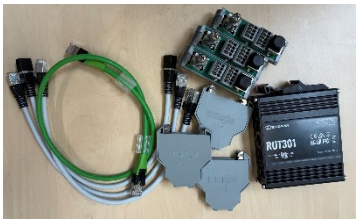
In Appendix A to this manual, you will find relevant information to use when selecting the fuel.

# 6. Services

With assistance from our global service network, we offer a wide range of customer services and support. To find out more about our service offerings, contact our service department at service@greeninstruments.com.

## 6.1 Spare Parts

Place your original spare parts order directly with Green Instruments. Our dedicated spare parts team ensures effective handling of your order, and we offer fast worldwide delivery to stock or directly to vessels. Contact spares@greeninstruments.com.

| Part No. | Part Description | Image |
|---|---|---|
| 105493 | GreenView Wall Mount Cover |  |
| 105052 | G7990 Ambient Air Sensor Module |  |
| GI-G7200-105486 | Router Kit |  |
| GI-G7200-02237 | Power Supply 24V |  |

## 6.2 Commissioning

Our service team offers supervision of your Green Instruments equipment installation. We offer startup assistance, checkpoint functionality as well as surveyor assistance, sea trial support, and training of onboard crew before final delivery.

## 6.3 Field Service

Our skilled and certified service engineers offer the best service on board and provide authorized service for installed Green Instruments equipment. Services include calibration, troubleshooting, inspections, technical advice, and maintenance.

## 6.4 Support

- Our skilled instructors facilitate training both online and in-person. Training is product specific and ensures that end users and onboard crew become familiar with system operation and maintenance in a controlled environment.
- We offer full technical support for all our products throughout their entire lifetime. Our dedicated experts provide 24-hour service support to ensure timely assistance.
- Our remote services are designed to assist you quickly and accurately with basic requests and to prepare technicians for on-site visits.

## 6.5 Service Agreements

Our transparent service agreements are tailored to the needs of your organization and offer a predictable yearly cost. A service agreement includes relevant spare parts, training, as well as remote and onsite assistance.

## 6.6 Return of Equipment

You must contact Green Instruments to coordinate equipment return. You will then receive a Return Form that you must fill out and return along with the equipment.

Use a secure transport container suitable for the equipment that you are returning. Carefully clean the equipment prior to return to ensure that it is free of any hazardous substances (acids, alkalis, solvents, etc.).

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

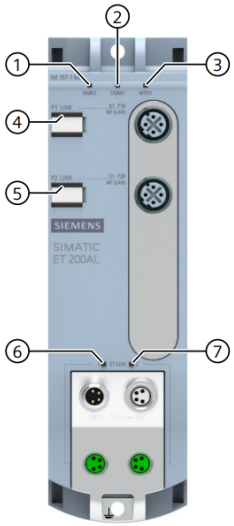
# 7. Troubleshooting

For troubleshooting of the system, refer to the PI diagram of each system. Troubleshooting must always be carried out by trained professional personnel. Carry out the suggested actions for each issue in the listed prioritized order.

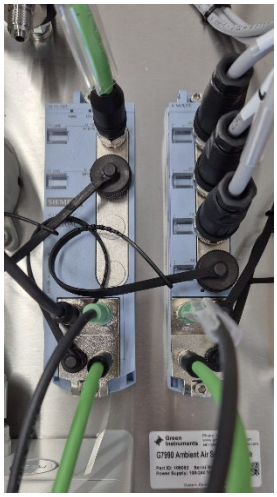
| Issue | Possible Causes | Action | Severity |
|---|---|---|---|
| G7200 Data | Missing inputs. Exhaust gas data is missing.<br>Mismatch between engine data and/or probe relation to engine. | See the G7200 System manual.<br>Check that the enabled gases are the ones shown on GreenView Panel PC at the engine menu.<br>Check engine relationship by observing that the reported emissions are 0 when engine is stopped and >0 when engine is running. | Critical |
| Ambient air data | Out of range due to temperature, pressure or humidity sensor failing.<br>Sensor end of life. | See following section for trouble shooting of the G7990 Ambient Air Sensor Module. | Low |
| Engine data | Wrong value, wrong signal mapping or incorrect unit.<br>Missing communication to the vessel network (check cable and IP address). | Check engine status.<br>Validate data on GreenView panel pc by comparison with data in ECR. | Moderate |
| Fuel | Wrong input flow of fuel, e.g.: in case of unaccounted bypass.<br>Wrong fuel type selected. | Check the flowmeters.<br>At GreenView engine menu, validate inputs and compare with data shown in the engine control room.<br>Review and edit fuel composition to match actual fuel in use. | Critical |
| Modbus | Missing communication to the vessel network (check cable and IP address).<br>Broken or missing com cable, or wrong cabling.<br>Missing router kit or missing power to router.<br>Wrong IP address on CEMS or G7990 Ambient Air Sensor Module. | Check the network connection of the different modules. | Critical |
| Database | No connection: data is not being recorded. | Restart the system. | Critical |
| | Calculation error | Check the CEMS and consult CEMS manual.<br>Check engine data. | Dependent on type of input error. |

| Issue | Possible Causes | Action | Severity |
|---|---|---|---|
| | | See following section for trouble shooting of the G7990 Ambient Air Sensor Module.<br>Do a sanity check of the data to see if a sensor has end of life. | |
| | | Check fuel data.<br>Restart system. | |
| | Unit error | Convert unit to match required format. | Dependent on type of input error. |
| | Missing daily backup | Contact Green Instruments | Low |
| | Lack of disk space | Contact Green Instruments | Low |

## G7990 Ambient Air Sensor Module alarm troubleshooting




| | | |
|---|---|---|
| ① | RN/NS | Green/red |
| ② | ER/MS | Green/red |
| ③ | MT/IO | Green/red/yellow |
| ④ | P1 LINK | Green |
| ⑤ | P2 LINK | Green |
| ⑥ | ET-CON1 | Green |
| ⑦ | ET-CON2 | Green |



| Interrupts/diagnostics/status information | |
|---|---|
| Diagnostics function | Yes |
| **Alarms** | |
| • Diagnostic alarm | Yes |
| **Diagnostics indication LED** | |
| • RUN LED | Yes; green LED |
| • ERROR LED | Yes; red LED |
| • MAINT LED | Yes; Yellow LED |
| • NS LED | Yes; green/red LED |
| • MS LED | Yes; green/red LED |
| • IO LED | Yes; red/green/yellow LEDs |
| • Connection display LINK TX/RX | Yes; 2x green LED |

# APPENDIX A

First, you will see an example of a calculation and the input information needed for it. This is the mass percentage values for each element in the typical fuels, and the atomic weights. Furthermore, you will find a table with the modbus registers that are defined for GreenView, in case you configure your fuel and the composition through the modbus. Note that to input the fuel type through the modbus, when using a custom fuel type, you must first set the fuel type at the modbus register to custom (0) and afterwards you can change the fuel composition (values for each element).

## Fuel composition calculation example:

Here you will find how to calculate the composition of the fuel in use from a chemical formula to mass percentage of each component.

1. Taking HFO 3.5 as an example, the chemical formula may look like:

   $C_{25}H_{50}S_{0.4}O_{0.1}N_{0.1}$

2. Having your chemical formula, you need to calculate the molar mass of the molecular formula. For this, you will need to consider the weight of each atom. You can take the Elemental Atomic Weight table (number 3) as reference.

   $(25_{C\ atoms} \times C_{wt}) + (50_{H\ atoms} \times H_{wt}) + (0.4_{S\ atoms} \times S_{wt}) + (0.1_{O\ atoms} \times O_{wt}) + (0.1_{N\ atoms} \times N_{wt}) =$

   fuel molar mass g/mol

   ---

   (25 x 12.011) + (50 x 1.008) + (0.4 x 32.065) + (0.1 x 15.999) + (0.1 x 14.007) =

   300.275 + 50.4 + 12.826 + 1.5999 + 1.4007 = 366.502 g/mol

In this case, 366.502 g/mol is the molar mass of the fuel.

3. Now you can proceed to calculate the mass percent of each element in the fuel.
   The formula to apply is the following:

$$\%Element = \left(\frac{Total\ Mass\ of\ Element}{Molar\ Mass\ of\ Fuel}\right) x100$$

In our example you will get:

| | |
|---|---|
| Carbon (C) | $\%C = \left(\frac{300.275}{366.502}\right) x100 = 81.93\%$ |
| Hydrogen (H) | $\%H = \left(\frac{50.4}{366.502}\right) x100 = 13.75\%$ |
| Sulfur (S) | $\%S = \left(\frac{12.826}{366.502}\right) x100 = 3.5\%$ |
| Oxygen (O) | $\%N = \left(\frac{1.5999}{366.502}\right) x100 = 0.44\%$ |
| Nitrogen (N) | $\%O = \left(\frac{1.4007}{366.502}\right) x100 = 0.38\%$ |

## 1. Typical mass percentage values by fuel type

| Mass percentage of each element | | | | | |
|---|---|---|---|---|---|
| Fuel type | % Carbon | % Hydrogen | % Sulfur | % Oxygen | % Nitrogen |
| N/A | 0.00 | 0.00 | 0.00 | 0.00 | 100.00 |
| HFO 3.5 | 81.93 | 13.75 | 3.50 | 0.44 | 0.38 |
| HFO 2.5 | 82.78 | 13.90 | 2.50 | 0.44 | 0.39 |
| HFO 1.5 | 83.63 | 14.04 | 1.50 | 0.45 | 0.39 |
| IFO 380 | 82.35 | 13.82 | 3.00 | 0.44 | 0.38 |
| IFO 180 | 83.20 | 13.97 | 2.00 | 0.44 | 0.39 |
| MGO | 83.94 | 15.10 | 0.10 | 0.80 | 0.07 |
| MDO | 83.18 | 14.96 | 1.00 | 0.79 | 0.07 |
| VLSFO | 83.60 | 14.74 | 0.50 | 1.11 | 0.05 |
| ULSFO | 83.94 | 14.79 | 0.10 | 1.12 | 0.05 |
| LNG | 74.87 | 25.13 | 0.00 | 0.00 | 0.00 |
| LPG | 81.71 | 18.29 | 0.00 | 0.00 | 0.00 |
| Methanol | 37.48 | 12.58 | 0.00 | 49.93 | 0.00 |
| Ethanol | 52.14 | 13.13 | 0.00 | 34.73 | 0.00 |
| CNG | 74.87 | 25.13 | 0.00 | 0.00 | 0.00 |
| FAME (Biodiesel - Methyl Oleate) | 76.97 | 12.24 | 0.00 | 10.79 | 0.00 |
| HVO | 84.95 | 15.05 | 0.00 | 0.00 | 0.00 |
| Ammonia | 0.00 | 17.75 | 0.00 | 0.00 | 82.25 |
| Hydrogen | 0.00 | 100.00 | 0.00 | 0.00 | 0.00 |

## 2. Atomic weights of the elements

| Elemental Atomic Weight | |
|---|---|
| Carbon (C) | 12.011g/mol |
| Hydrogen (H) | 1.008 g/mol |
| Sulfur (S) | 32.065 g/mol |
| Oxygen (O) | 15.999 g/mol |
| Nitrogen (N) | 14.007 g/mol |

## 3. Reference to chemical formulas per fuel type

Here you can see a list of fuel types and their corresponding modbus registers.

| Fuel Type Index | Fuel name | Typical chemical formula |
|---|---|---|
| 0 | Custom Alias | Custom Fuel specific composition |
| 1 | N/A (Fuel type not in use) | $N_2$ |
| 2 | HFO 3.5 | $C_{25}H_{50}S_{0.4}O_{0.1}N_{0.1}$ |
| 3 | HFO 2.5 | $C_{25}H_{50}S_{0.28}O_{0.1}N_{0.1}$ |
| 4 | HFO 1.5 | $C_{25}H_{50}S_{0.17}O_{0.1}N_{0.1}$ |
| 5 | IFO 380 | $C_{25}H_{50}S_{0.34}O_{0.1}N_{0.1}$ |
| 6 | IFO 180 | $C_{25}H_{50}S_{0.22}O_{0.1}N_{0.1}$ |
| 7 | MGO | $C_{14}H_{30}S_{0.006}O_{0.1}N_{0.01}$ |
| 8 | MDO | $C_{14}H_{30}S_{0.063}O_{0.1}N_{0.01}$ |
| 9 | VLSFO | $C_{20}H_{42}S_{0.045}O_{0.2}N_{0.01}$ |
| 10 | ULSFO | $C_{20}H_{42}S_{0.009}O_{0.2}N_{0.01}$ |
| 11 | LNG | $CH_4$ |
| 12 | LPG | $C_3H_8$ |
| 13 | Methanol | $CH_4O$ |
| 14 | Ethanol | $C_2H_6O$ |
| 15 | CNG | $CH_4$ |
| 16 | FAME (Biodiesel - Methyl Oleate) | $C_{19}H_{36}O_2$ |
| 17 | HVO | $C_{18}H_{38}$ |
| 18 | Ammonia | $NH_3$ |
| 19 | Hydrogen | $H_2$ |
| 20-99 | Reserved for future fuels | |

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