



User Manual

ShipCEMS Continuous Emission Measurement System



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User Manual

ShipCEMS Continuous Emission Measurement System

The purpose of this user manual is to provide the descriptions and procedures required to operate and maintain the ShipCEMS Continuous Emission Monitoring System in a safe and efficient manner. This system is designed for analysis of carbon and sulphur dioxides in wet marine exhaust gas.

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Rev. 02	Description of sample probe backflush added (see chapter 3.6).
Rev. 03	Rewritten chapter 3.6 (back purge mode) due to new system design. Added information in chapter 5.4 (heated sample line installation). Added chapter 6.3.4 (temperature controller settings). Added new drawing references in chapter 11. Other minor corrections of text and images.
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Rev. 06	Major revision of spare parts chapter. Updates in text and illustrations.
Rev. 07	General updates and clarifications, system explanation, maintenance, etc. Chapter 5.10: ISO 8573-1:2010 class 1.2.1. LOGO TDE (v8). Added maintenance procedures.
Rev. 08	Clarification standard quill/demister quill in chapter 7.3.11.

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Important

Before using the equipment, read all instructions thoroughly and follow all precautions and warnings contained within this document. Improper use may cause personal injury and/or damage to the equipment, and may void the warranty. Vimex AS disclaims any responsibility for damage or injury caused by improper installation, use or maintenance of the equipment.

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Acronyms and abbreviations

AC	Analyser Cabinet
ATU	Air Treatment Unit
Back flush	Refer to Back purge
Back purge	Cleaning of probe by flushing instrument air through
CEMS	Continuous Emissions Monitoring System
DCS	Distributed Control System
DWG	Drawing
EGCS	Exhaust Gas Cleaning System
GA	General Arrangement (Drawings)
IR	Infrared
PLC	Programmable Logic Controller
SCS	Sample Conditioning System
UPS	Uninterruptible Power Supply

Admonitions

<i>Note</i>	<i>Text set off in this manner presents clarifying information or specific instructions relevant to the immediate instruction.</i>
<i>Caution</i>	<i>Text set off in this manner provides a warning notice that failure to follow the directions in this caution can result in damage to equipment.</i>
<i>Warning</i>	<i>Text set off in this manner provides a warning notice that failure to follow the directions in this warning can result in bodily harm or loss of life and/or extensive damage to equipment.</i>
DANGER	TEXT SET OFF IN THIS MANNER PROVIDES A WARNING NOTICE THAT FAILURE TO FOLLOW THE DIRECTIONS IN THIS WARNING WILL RESULT IN BODILY HARM OR LOSS OF LIFE AND/OR EXTENSIVE DAMAGE TO EQUIPMENT.

1 Introduction

1.1 Purpose

The purpose of this user manual is to provide the descriptions and procedures required to operate and maintain the Continuous Emission Monitoring System (ShipCEMS) in a safe and efficient manner.

A thorough understanding of system functions and controls is necessary to optimise overall performance. Careful study of the information in this manual is highly recommended, preferably while exploring the system's various functions.

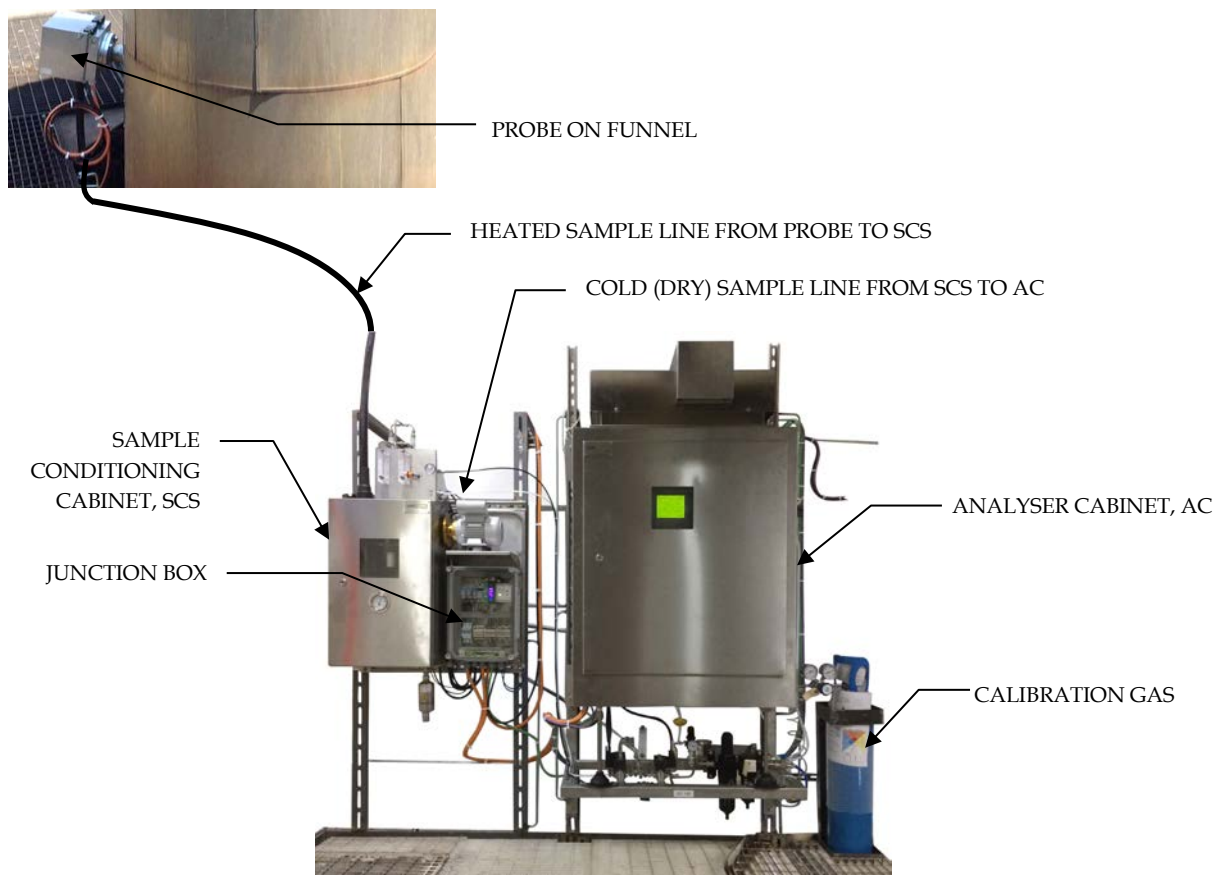


Figure 1 ShipCEMS main parts

1.2 Scope of supply

The ShipCEMS consists of the following main units:

- Analyser System cabinet
- Sample Conditioning System cabinet(s)
 - for 1 - 4 streams
- Heated sample probe(s)
- Heated sample line, approximately 10 metres (per sample probe)
 - for 1 - 4 streams
- Optional calibration gases
- Optional air dryer
- Optional air dryer mounting kit
- Optional air compressor

Note *Equipment provided locally by the installation contractor or by local dealers is not described in this manual.*

Note *Most of this manual is written as there is one SCS (singular), but there can be up to four SCS to every analyser cabinet (AC).*

1.3 Contact details

For enquiries related to sales, service, support, maintenance and spare parts, please contact us at:

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Service: service@vimex.no

Spare parts: spares@vimex.no

Other contacts: post@vimex.no

To assist us in making improvements to the product and to this manual, we welcome comments and constructive criticism at editor@vimex.no.

2 General safety rules

Safety precautions must be followed at all times during installation, operation and maintenance of the system.

Personnel shall be sufficiently qualified, and proper caution shall be taken to avoid injuries or damage to life, health, environment, equipment and property.

2.1 High voltage

Warning *ShipCEMS operates at a potentially lethal AC voltage.*

Always switch off all power before installation or maintenance. Adhere to safety precautions and instructions as directed by company policy.

For safety reasons during troubleshooting on the equipment with power ON, two persons must always be present.

Whenever installation or maintenance is carried out, it is essential that a first aid kit is available, and that personnel are familiar with the first aid instructions for electrical shock.

2.2 Hazardous components

The sample gas may contain trace amounts of hazardous components.

Warning *Many toxic gases are colourless, odourless and non-irritating, and may overcome exposed persons without notice.*

Personnel should have a thorough knowledge and understanding of the physical properties and safety precautions for the relevant gas samples before operating the system.

Gas inlets and outlets are hot in heated analyser systems. Skin contact may result in serious burns even for a long period after the equipment has been switched off.

2.3 Heavy equipment

The cabinets for the Analyser System and the Sample Conditioning System are heavy units.

Caution *During installation or replacement of larger units, appropriate safety clothing and certified lifting equipment must be used.*

Do not open cabinet doors while in rough seas. Doors may suddenly swing open and cause damage or injury.

3 System description

3.1 Main purpose

The main purpose of the ShipCEMS Continuous Emission Monitoring System is to analyse sulphur dioxide and carbon dioxide in wet marine exhaust gas.

ShipCEMS is designed and manufactured for the marine environment, hence ship movements, vibrations and temperature loadings are attended to during design of the system. The sample treatment technology selected is optimised for this specific trace analysis.

ShipCEMS is designed for unmonitored, continuous operation, but all system units may also be manually operated. The user interface is simple and intuitive, with a limited number of operations necessary to use the system.

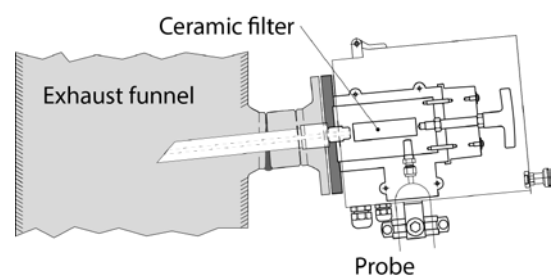
Self-test diagnosis of analyser maintenance, analyser faults and so on are run periodically. If any test should fail, an error message is sent to the local LOGO display (inside analyser cabinet) and a hardwired alarm signal is also sent to the customer. If a potentially harmful fault occurs, appropriate actions will automatically be taken, for example by shutting down the sample gas pump.

3.2 Sample probe

The sample probe with its sample quill (the tube inserted into the exhaust funnel) is installed to extract a representative sample from the exhaust gas of the ship engine. If several engines or combustion processes onboard are to be monitored, one sample probe must be installed per scrubber.

The sample probe is installed onto a connection flange mounted on the exhaust funnel.

It is equipped with a DIN flange DN 65, PN 6, but other sizes may be delivered if required (including ASTM). The customer must provide the counter flange welded to the exhaust funnel. The quill is attached to the probe and length of the quill determines where in the funnel the sample is extracted from. The quill is equipped with a demister to remove moisture from the sample gas.



The probe is heated to make sure that the sample does not condense when it reaches the 3 micron ceramic filter for separation of dust and other larger particles. The temperature is self-regulating with a low temperature alarm. The sample probe is equipped with a weather protection hood.

Caution *It is important that the sample probe is installed to prevent water traps in the heated sample line. Refer to Installation manual.*

3.3 Heated sample line

The heated sample line consists of a pre-assembled tube bundle with its own electrical heat tracer cable. An aluminum jacket holds the heat cable and the sample tube together. A high efficient insulation material is wound around the tracer and the sample tube, and a weather protective outer sheet covers the entire tube bundle. The tube bundle is designed for outdoor installations, but end seals must be used to avoid ingress of moisture.

The size of the tube bundle, the electrical heat tracer and the insulation thickness is based on ambient condition data and exhaust gas composition data.

The heated sample line must be heated at all times. This prevents condensation and any losses of trace components to be measured. It also avoids expensive and time consuming maintenance in cleaning the Sample Conditioning System downstream.

In the event of heated sample line power failure, the sample line will cool down. The sample then condensates, allowing heavy soot particles to form and stick to the inner walls of the sample line, as well as contaminating the Sample Conditioning System.

Refer to chapter *Installation procedures* in the installation manual.

3.4 Sample Conditioning System

The Sample Conditioning System, SCS, is enclosed by a specially designed cabinet. This cabinet is made of stainless steel SS316L and is mounted to a Unistrut wall frame.

The complete assembly is designed for mounting to a support welded on the ship casing. This support is prepared by the customer, and typically consists of two parallel angled steel bars.

There may be up to four SCS to every analyser cabinet. The main components of the Sample Conditioning System are:

- Heated cabinet
- Sample gas pump
- Sample gas filter
- Sample gas dryers
- Sensors for flow, temperature and moisture
- Junction box
- Flowmeters and regulator. Refer to Figure 8.

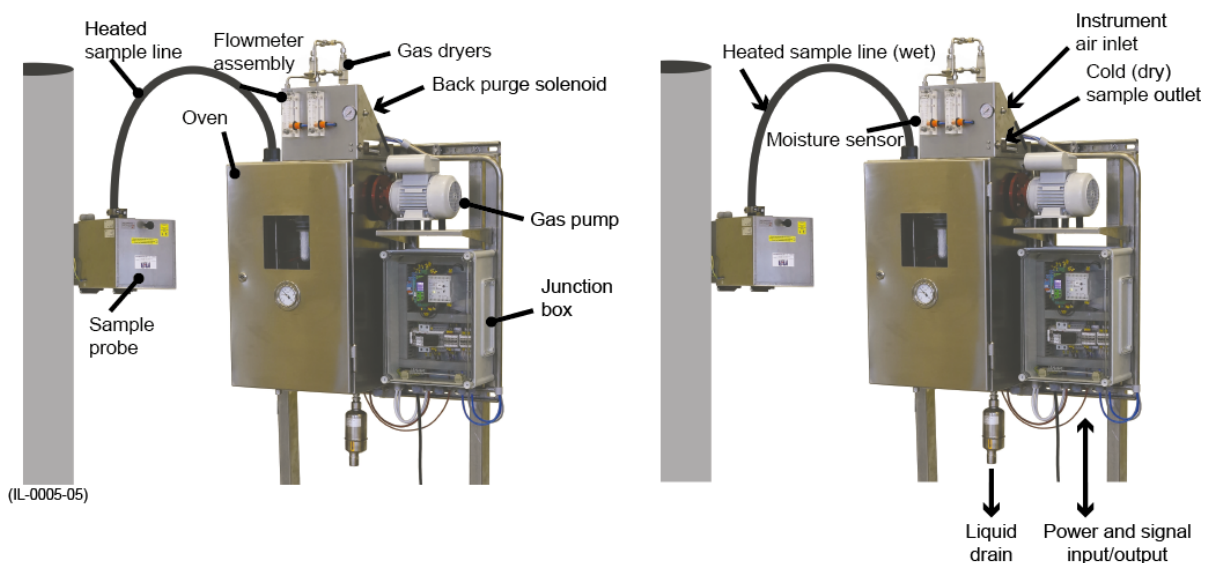


Figure 2 Sample Conditioning System, main units

The purpose of the Sample Conditioning System is to treat and dry the exhaust gas sample extracted by the sample probe via the heated sample line and send it to the analyser cabinet. This sample is wet when it enters, but the temperature is kept above dew point. The sample may contain corrosive components if condensing is allowed.

The gas pump unit provides a continuous sample flow from the exhaust funnel. The pump converts the sample from suction to pressure mode, and moves the sample through the gas tubes.

The permeation dryer tubes are used to remove moisture from the sample by a counter flowing stream of dry instrument air.

The heater ensures that the heated oven operates at $+60^{\circ}\text{C}$ ($+140^{\circ}\text{F}$) to keep the temperature above dew point at all times. The design temperature of the Sample Conditioning System allows using standard components such as filter elements and a pump head of PFA Teflon.

The junction box contains the temperature controller and the moisture alarm units, as well as a protection switch, fuses, change-over relays and the terminals for 230 VAC power and interfacing I/O signals. The junction box has a connection point to activate the back purge

locally (without signal from SC-IU or signal between analyser cabinet and sample conditioning cabinet). 24 VDC is required to activate the back purge locally.

SCS alarms are displayed on the LOGO display (located in the analyser cabinet) and it specifies in which SCS cabinet the alarm has occurred. Depending on system there may be up to four SCS cabinets connected to every analyser cabinet. Take action to stop the alarm in specified SCS cabinet. Refer to Figure 6 for location of LOGO unit.

It is important to adjust flow on recycle gas that goes in a loop through dryer tubes and to adjust flow for dryer air that removes moisture coming from inside the dryer tubes.

Caution *If sample is not properly dried and treated it can ruin the analyser!*

3.5 Sample line between cabinets

The dried sample is then transported from the Sample Conditioning System to the Analyser System. As the sample now contains little water, and the dew point temperature is lower than the ambient temperature, PFA/PTFE tubing can be used to interconnect the cabinets.

However, if the ambient temperature is expected to fall below +10°C (+50°F), it is recommended to use a heated sample line, for example the light heat traced version.

3.6 Analyser Cabinet

Caution *Before the sample enters the analyser cabinet it must be properly treated and dry. Poorly treated sample might cause damage to the analyser!*

The analyser cabinet, AC, is enclosed by a specially designed cabinet. This cabinet is made of stainless steel SS316L and is mounted to a Unistrut wall frame with a lower support bracket.

The cabinet is standing on top of two compression cushions to minimise the effects of high gravitational forces when the ship is moving into heavy seas. The cabinet is supported on the rear of the wall frame by soft anti-vibration cushions to reduce the impact of horizontal vibrational movements.

The complete assembly is designed for mounting to a support welded on the ship casing. This support is prepared by the customer, and typically consists of two parallel angled steel bars.

The cabinet is insulated with a high efficient, flame retardant and non-water absorbing synthetic foam to reduce incident heat radiation from ambient conditions and to avoid losing cooled air.

The main components of the analyser cabinet are:

- Online Analyser Module for analysis of SO₂ and CO₂
- LOGO PLC with display unit for alarm and auto calibration
- Peltier cabinet cooler system
- Solenoid valves for stream switching and validation and for analyser calibration
- 24 VDC power supply
- 48 VDC power supply (for Peltier cooler only)
- Terminals for power and signal interfaces
- Flowmeter and regulator
- Air filter station
- Optional interface unit (SC-IU)



Figure 3 Analyser System, main units

The cabinet door allows access to the analyser and the PLC unit. The door is equipped with an inspection window to enable local measurement readings without opening the cabinet.

The cabinet can be cooled if required by the ambient conditions. The normal ambient temperature is defined as +5°C to +55°C (+41 to +141°F). A Peltier element cooler with 195 W capacity is used to reduce the inside cabinet temperature to maximum +30°C (+86°F). If the ambient temperature is even higher, a larger Air Conditioning unit will be used.

The inner cabinet temperature is monitored by a temperature switch set at +30°C (+86°F). When activated, the temperature switch will power up the 48 VDC/6A power supply feeding the Peltier element. Circuit breaker is 10A. The normal current consumption after start-up <3 A. The current through the Peltier element will draw heat from the surface of one side and heat the opposite side. Both sides have heat exchanger fins mounted.

Both sides also have a separate fan installed. This will draw the internal hot air over the cooled fins for refrigeration and vice versa for the hot side of the element where ambient air is drawn by the hot fan to remove excess heat.

For multi-stream application only the flowmeter for stream # 1 is adjusted. This serves as an indication for the other streams as well as for calibration gas and instrument air. Refer to chapter 5.3.1 for more information.

3.7 Calibration gas

Calibration gas is used for sensitivity verifications as well as calibrations (Vimex part no: 501085). The 10 litres gas cylinder is the normal use for approx. 36 months.

Note *Other cylinders and gas mixtures can be ordered on request.*

The recommended calibration gas blend for SO₂/CO₂ scrubber systems is:

- 40 ppm SO₂
- 8 mol% CO₂
- Rest Nitrogen N₂

It is normally sufficient only to have one calibration cylinder onboard.

Note that instrument air supplied by the ship is used for zero calibration.

3.8 Power supply

The customer must provide a 230 VAC, 50/60 Hz two-phase continuous power supply, preferably using an Uninterrupted Power Supply (UPS). Each cabinet is protected using a main two-pole incoming fuse.

120 V can be provided as option.

Note *Equipment start-up after black out or restart is approx. 45 min.*

3.9 Instrument air supply

The customer must provide quality instrument air supply, with a water dew point of less than -17°C (-1.4°F), and with no oil and no particulate contaminants. This is vital for the Sample Conditioning System to function correctly. Also, low air quality cannot be used for zero gas verifications of the analyser. Absorbent chemical seals to avoid oil passing into the Analyser System, must also be included.

Air requirements:

- Lower than $+3^{\circ}\text{C}$ (37.4°F) dew point @ 8 barg minimum outlet pressure (lower than -17°C (1.4°F) dew point @ atmospheric pressure)
- Dry, oil-free according to ISO 8573-1:2010 class 1.2.1 (@ outlet compressed air).

If the instrument air on the vessel does not meet the requirements above, Vimex AS provides an optional, separate Air Dryer Unit. Refer to figure to the right. This unit filters the instrument air supply for particulate matter, and reduces the air inlet pressure to the required pressure level. It can feed the external Sample Conditioning Cabinet, as well as the internal consumers of the analyser cabinet. The Air Dryer Unit is a complete unit, including air filters, air dryers and air pressure regulators.



The Air Dryer Unit is either mounted behind the air filter unit as per picture or as a free standing unit next to the analyser cabinet.

3.10 External interfaces

Analyser readings of gas component values and system alarms generated by ShipCEMS are hardwired to the external customer monitoring and reporting systems.

Signal interfaces are located at the upper left hand corner of the analyser cabinet.

If the customer needs to control Multi Stream Switching for a multi-funnel application, there is a specific signal interface terminal for the LOGO PLC located at the upper right hand corner of the analyser cabinet.

3.10.1 Standard version

The following signal interfaces are available:

- Analogue outputs
 - 1 x 4 - 20 mA for CO₂ measurements
 - 1 x 4 - 20 mA for SO₂ measurements
- Digital outputs
 - SCS common alarm (general fault)
 - AC alarm
 - Measurement valid
 - Maintenance in progress

The analogue signals from ShipCEMS are active and isolated outputs.

The digital signals open or close relays in the LOGO PLC according to the table below.

Signal	Signal type	Open relay	Closed relay
SCS common alarm	Alarm	Alarm or power off	No fault
Analyser failure	Alarm	Alarm or power off	No alarm or maintenance request from analyser
Measurement valid	Information message	Not valid or power off	Valid measurement
Maintenance in progress	Information message	No maintenance or power off	Maintenance or calibration in progress true

3.10.2 For option with interface unit (SC-IU)

With the interface unit Fieldbus communication is used (such as Modbus, Profibus, Canbus etc.). Refer to the following drawing:

→ [9802] – *Field Bus Specification*

4 Functional description

4.1 Overview

This chapter gives a brief description of the functional design of the analyser system. The flow of the gas sample is described from the exhaust gas sample point until the processed readings are presented to the customer's workstation.

ShipCEMS is designed to measure low values of carbon and sulphur dioxide components in wet marine exhaust gas. The exhaust gases are also normally dirty, with a high content of soot. Trace components can easily be lost in the sample treatment system before arriving at the analyser instrument, resulting in improper readings. The ShipCEMS design is therefore based on heated sample treatment to avoid these defects, hence measuring the true gas composition.

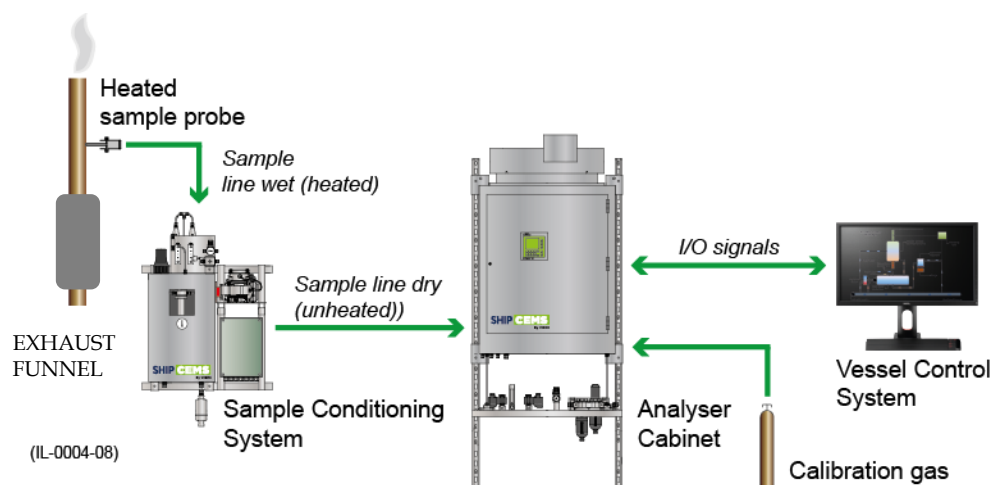


Figure 4 Block diagram for ShipCEMS analyser system

If the customer needs to control Multi Stream Switching for applications with several exhaust funnels, one sample probe is provided for each of the exhaust funnel with a belonging Sample Conditioning Cabinet and heated sample line. A maximum of four Sample Conditioning Cabinets can be supported by one analyser cabinet.

For a full understanding of this functional description chapter, please examine the following system drawings in parallel:

- [3001] – System Diagram, Analyser Cabinet, Stream Switching System, Emission Monitoring System
- [3003] – Analyser Cabinet, PLC & Signal Conditioning, Interface Unit – Option
- [3801] – System Diagram, Sample Conditioning System, Emission Monitoring, SO₂ – CO₂ Analysis In Flue Gas
- [6001] – System Block Diagram, Pipe and Gas, Distribution overview
- [6101] – Electrical Block Diagram, Signal and Power, Distribution overview, Interface Unit - Optional

Note that labelling of all individual components described, for example needle valve NV-1, conforms to labels in the corresponding system drawing.

Note *Tags like FI-01 and NV-01 exist in both analyser cabinet and SCS. Make sure to handle the correct unit.*

4.2 Sample probe and heated sample line

The sample probe (with quill) is installed to extract a representative sample from the exhaust gas.

The heated sample line requires 230 VAC power supply. A self-regulating heat tracer cable is used to set temperature above dew point to avoid condensation.

Note *In event of a power failure, the sample probe will cool down. If this occurs, a low temperature alarm output signal is generated and sent as an SCS Common Alarm to the analyser cabinet and the DCS.*

The alarm (visible on the LOGO display) will warn if wet and cold samples are extracted into the system. As a safety precaution, the sample gas pump is always stopped if the temperature is too low.

4.3 Sample Conditioning System

The gas sample from the exhaust funnel will now enter the heated oven of the Sample Conditioning System, first passing through the filter assembly for removal of particulate matters. To ensure a continuous sample flow, gas pump is needed.

The pump will convert the sample from suction to pressure mode and transport the sample through the gas dryer tubes.

Moisture is removed in the dryer tubes by a counter flowing stream of dry instrument air. (The air is harmless and is released in the SCS.)

The customer provides the instrument air inside the SCS for air circulation (according to ISO 8573-1:2010 class 1.2.1), which must have a low dew point and be free of oil. The necessary inlet air pressure of 1 barg is set by the pressure regulator, and the flow is set to approximately 10 l/min using needle valve NV-1 (in the SCS). The flow is monitored by flow indicator FI-02 (in the SCS).

Note *If the instrument air flow drops below set point, a low level flow alarm is generated. This alarm will also shut down the gas pump.*

The partial pressure of water in the sample on one side of the membrane will drive the water molecules through the membrane to the counter flowing stream of low partial pressure air. The membrane is chemically treated with Nafion for polar water transmission only. There are no other trace component losses in the permeation tube dryer, except for small losses of ammonia, if present.

The dry sample on the outlet of the membrane dryer will be recycled to the inlet of the Sample Conditioning System. The flow is set to approx. 3 NI/min. since the pump capacity is approx. 5 NI/min, the excessing 2 NI/min will be transferred to the analyser. This means that the analyser at all times has a fresh sample close to the analyser.

The dry sample on the outlet of the membrane dryer will be recycled to the inlet of the Sample Conditioning System. The flow is set to approximately 5 NI/min using needle valve NV-2. This reduces the dew point, and hence reduces the temperature requirement for the heated oven. The blend of incoming wet sample and the dried sample will allow the heated oven to be operated at +60°C (+140°F). The recycle flow is monitored by flow indicator FI-01 (in the SCS).

To protect the system against moisture, a moisture sensor is installed downstream the gas dryers.

Note *If a moisture alarm is generated, the sample shut off valve will close. This will also lead to a low flow alarm from the analyser cabinet side.*

The system will then close the SCS sample outlet and run the sample in recycle mode until all moisture is removed. In case of large errors, the system can be cleaned using instrument air by a manual operation.

Note *The temperature inside the heated oven is monitored. If the temperature drops below +55°C (+131°F), a low temperature alarm is generated and sent as a SCS Common Alarm to the analyser cabinet and the DCS. This alarm will also shut down the gas pump.*

All alarms will generate a common SCS alarm hardwired to the analyser cabinet. These common alarms are also displayed in the LOGO display.

4.4 Analyser System

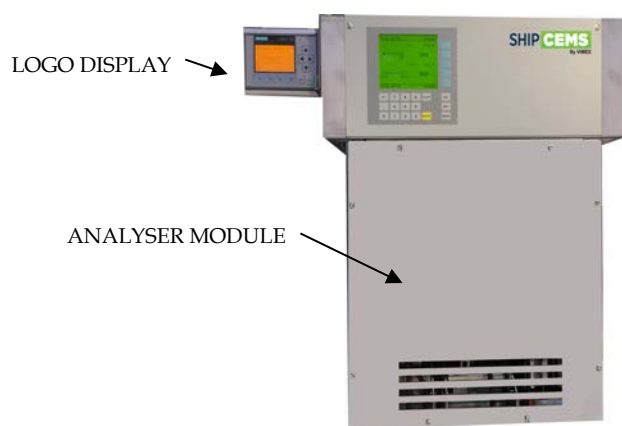
The dried gas sample will now enter the Analyser System. Needle valve NV-2 (located in the SCS) is used to set the sample flow to the analyser to approximately 1-1.5 NI/min.

This can be monitored by flow meter FI-01 in the AC.

Caution *Only adjust flow on the NV-2 in the SCS.
Do not use the NV-01 in the analyser cabinet.*

After being processed by the Analyser Module, the sample is released to ambient air through the atmospheric vent.

For a multi-funnel application, one of the stream-switching solenoid valves must be opened by the LOGO PLC to allow a sample to enter. Up to four streams may be handled by the system, but only one sample will be analysed at a time. This is set by the Select Engine #1 (or #2, #3 or #4) signals controlled by customer DCS. For a single stream system, only Select Engine #1 will be used.



The analyser cabinet includes both the Analyser Module and the LOGO PLC controller unit. Both instruments are supported by a specially designed bracket inside the cabinet.

The Analyser Module is a dual-channel analyser used to measure SO₂ and CO₂. The analyser operates according to the infrared two-beam alternating light principle with double-layer detector and optical coupler.

Figure 5 Analyser module and LOGO display (inside analyser cabinet)

The measuring principle is based on the molecule-specific absorption of bands of infrared radiation, as the absorbed wavelengths are characteristic to the individual gases. The detector layers will record the level of absorption, which then will be converted into an electric signal by a flow sensor. The values recorded are continuously presented to the

customer's external control and monitoring systems (DCS) by 4 - 20 mA analogue output signals for each gas component. For optional interface unit (SC-IU) the values recorded are presented by fieldbus communication.

The LOGO PLC is a simple programmable logic controller for control of stream valves, validation and calibration valves, as well as for calibration of the analyser. The unit will also warn if any alarm conditions occur, via its local display - the LOGO display - and remotely by hardwired signals to the customer DCS.

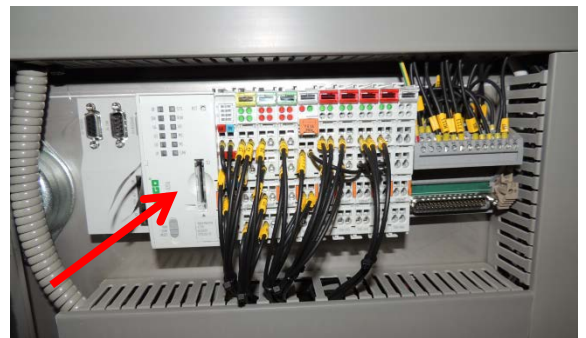
4.4.1 SC-IU (interface unit) (option)

Vimex part no: 501221

This is an option (PLC) for customers who require additional engineering and evaluation. The PLC is mounted in the analyser cabinet and takes care of communication to client through fieldbus communication.

With the interface unit back purge is automatic.

SC-IU option offers an intelligent control box for ShipCEMS system to facilitate system integration. SC-IU offers Profibus and Modbus as standard fieldbus connection, while others are available on request.



SC-IU will facilitate communication to/from control system as it will automatically separate measured values into RAW values and individual stream values. SC-IU also automatically calculates the ratio SO_2/CO_2 . This makes it much easier to generate emission reports directly from the ShipCEMS data.

Stream switching sequence for multi stream systems are controlled by SC-IU. Alarm signal will be transferred over fieldbus connection if IMO regulations cannot be met with respect to ratio limit and time limit for next sample.

SC-IU runs a webserver application which can be accessed by a standard internet browser. This is a very useful tool when troubleshooting the system. It can also easily connect to ship control system for real time status and system overview.

4.5 Back purge

Vimex part no: 501219

Back purge is installed on all systems. It is very important that back purge is activated when scrubber is off or in cleaning mode. The reason for this is to protect the analyser unit from raw gas from the exhaust funnel. Back purge can be either manual or automatic (SC-IU).

The back purge solenoid valve is located in the SCS cabinet.

Caution For these systems guarantee is not valid unless back purge is installed.

Note This is not applicable if the scrubber has bypass for exhaust gas while scrubber is out of operation or in cleaning mode.

Purging the line with air will reduce the need for maintenance of the probe as well as protect the system from raw gas. Instrument air is used as purge medium. The criteria for back purge are set by the customer. The ShipCEMS system is back purged automatically.

- **Standard (without SC-IU option):**

Without the interface option the back purge signal needs to be activated by customer's DCS system immediately-when scrubber is off or in cleaning mode. Back purge is activated in the SCS junction box, terminal X-1-115 and X-1-116.

- **SC-IU option:**

The signal for scrubber in operation from client is used by SC-IU to control this back purge solenoid valve. Sample collection is then stopped, but instrument air is now allowed to flow upstream through the sample probe into the exhaust funnel. The ShipCEMS system will activate back purge automatically when the select engine signal is deactivated when using the interface option.

4.5.1 When should back purge be activated?

- When scrubber is off (to prevent raw exhaust from entering the sample lines).
- When temperature inside the exhaust funnel (above the scrubber) exceeds 80°C (176°F).

Note Lower temperatures require less frequent filter change and maintenance in general.

- When scrubber is in cleaning mode/demisting.

Note Back purge signal must be de-activated before "Select engine signal" from scrubber in operation is activated. Sampling can now start.

5 Operation

Note *The time from start-up to ready system is approx. 45 minutes.*

5.1 User interface

The operator can interact with ShipCEMS using the following external systems and instruments:

- Customer's distributed control system (DCS)
- Analyser module
- LOGO unit
- SC-IU webserver application (expert users, optional)

ShipCEMS will send analyser readings, alarms and information messages for remote monitoring on the DCS. It is the responsibility of the customer to configure the DCS, as this control system is not a part of the ShipCEMS delivery.

The analyser and the LOGO instruments in the analyser cabinet are operated using front panel displays and control buttons.

The Analyser Module is used for reading of real-time measurements, whilst the LOGO display is used for menu operation when running manual maintenance and calibration operations. The LOGO PLC is also responsible for sending alarm and information messages to the DCS.

Contact Vimex for information about advanced functions in the analyser module.

5.2 Modes of operation

5.2.1 Automatic mode

Under normal conditions, the ShipCEMS is designed to operate fully automatic.

Sample analysis is performed continuously. The measured values of CO₂ (in mol %) and SO₂ (in ppm) are sent to the operator (DCS) as fieldbus variables.

Note *Automatic calibration in this context means that the system will control all solenoid valves and calibration cycle automatically. The automatic calibration cycle still needs to be started manually. See chapter 5.2.2 for details.*

During automatic calibration the digital signal (*Maintenance in progress*) is set high. This will notify the operator (DCS) that calibration is running.

Caution *Even though the system is in automatic mode, manual calibration is necessary to calibrate the analyser module. To be in compliance with the type approval certificate issued for this analyser, manual calibration needs to be performed every 30 days. Vimex recommends calibration every two weeks to make sure the analyser is accurate at all time.*

5.2.2 Manual mode





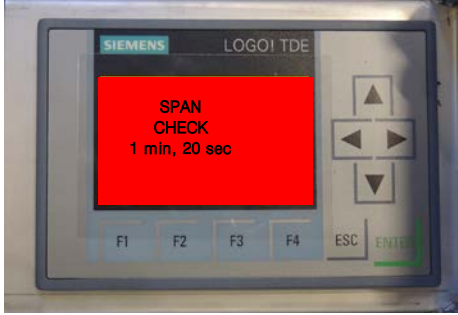



Figure 6 LOGO display

The LOGO unit holds four front panel control buttons; F1 to F4 for manual operation. Compared to the previous model LOGO TDE has a colour display; yellow to signal status and red to signal more serious matters or when it is necessary to take action.

5.2.2.1 LOGO display screen

Caution Take action when LOGO display is red. Negligence can affect the analysis.

Screen	Description
	<p>IDLE MODE - No stream selected</p> <p>This mode signals that either...</p> <ul style="list-style-type: none"> no stream has been selected for measurement. Select stream! "AC alarm" is suppressed or that scrubber is not running. In this case there is usually a communication error in the customer DCS.
	<p>MAINTENANCE MODE - F1</p> <ul style="list-style-type: none"> This mode signals that automatic calibration is running. PLC return automatically to "IDLE MODE". Manual maintenance procedures (e.g. filter change). The operator press F1 to start maintenance. Press F1 to exit and return to "IDLE MODE". <p>Also refer to Function buttons in chapter 5.2.2.2.</p>

Screen	Description
	<p>SPAN CHECK - F2</p> <p>Start span by opening the cal gas solenoid. Timer will display duration of span check. When analyser values are stable compare results with calibration gas certificate.</p> <p>Also refer to Function buttons in chapter 5.2.2.2.</p>
	<p>CALIBRATION MODE - F3</p> <p>Perform Flow adjustment according to 5.3.1 before AUTO CAL.</p> <p>Starts automatic calibration cycle. Once the calibration cycle is started it cannot be stopped.</p> <p>If calibration fails analyser fault is triggered. (Successful calibration is not reported.)</p> <p>Also refer to Function buttons in chapter 5.2.2.2.</p>
	<p>SERVICE MODE - F4</p> <p>Use to control the solenoids manually by pressing F4. Refer to text below.</p> <p>Also refer to Function buttons in chapter 5.2.2.2.</p>
	<p>ANALYSER FAULT</p> <p>This mode signals that the analyser is not working correctly.</p> <p>Refer to section 6.8.1 or contact Vimex.</p>

5.2.2.2 LOGO display function buttons

F1 - Maintenance mode

This button is used to send a message to the customer (DCS) that maintenance is performed on the system. In maintenance mode the Measurement valid signal will be suppressed. This will enable the operator to filter measurements when performing system maintenance.

Press F1 to set in maintenance mode.

Press F1 once more to turn off maintenance mode.

Note *Function F1 should only be used when troubleshooting or rectifying the system.*

F2 - Span check

This button is used to perform a span check of the Analyser Module.

Use the F4 button on the Logo display to check that flow is 1-1.5 l/min (F4) on span and air. If flow is not within range, perform flow adjustment according to chapter 5.3.1.

Press F2 to start span check. This will open for span gas to the analyser for two minutes.

Press F2 once more to stop span check. This can be done if the analyser reading stabilises before the two minute period has elapsed.

If the deviation between the analyser reading and the calibration cylinder certificate is larger than 5 %, a calibration of the analyser should be performed. Refer to chapter 5.3.2.

F3 - Calibration mode

Prior to using the F3 button on the Logo display, press the F4 button to check that flow is 1-1.5 l/min (F4) on span and air. If flow is not within range, perform flow adjustment according to chapter 5.3.1.

The F3 button is used to trigger automatic calibration. Once the button is pressed, the system will perform automatic calibration. When completed, the system will automatically return to its normal measuring mode.

F4 - Service mode

This button is used to control the solenoid valves manually. Press once to enter the service mode. Press F4 to toggle through the solenoid valves, opening them one by one. The complete cycle, ending with solenoid valve S6, must be toggled through before returning to the normal operational mode.

The following solenoid valves are available:

- S1 to S4 - Sample stream 1 to 4 to analyser system
- S5 - Calibration gas to analyser system
- S6 - Instrument air to analyser system

Note *Function F4 is dedicated to system testing, and should only be accessed by advanced users.*

5.3 Operational procedures

Note *Tags like FI-01 and NV-01 exist in both analyser cabinet and SCS. Make sure to handle the correct unit.*

As ShipCEMS is designed to operate fully automatic, only a limited number of procedures are applicable during normal system operation.

Caution *Do not access the Analyser Module menu for other purposes than listed in the following, as unskilled operation may result in system malfunction or equipment damage.*

5.3.1 Flow adjustment

Depends on scenario:

- A. If ShipCEMS system is not running and back purge is activated:
Follow first instructions in chapter 5.3.1.1 and then instructions in chapter 5.3.1.2.
- B. Is scrubber, ShipCEMS system is running and back purge is deactivated on all SCS?
Follow instructions in chapter 5.3.1.2 (skip chapter 5.3.1.1).

5.3.1.1 Flow adjustment with back purge activated

Verify scenario A in chapter 5.3.1.

Note *This start-up procedure is applicable when scrubber is off. This is to prevent false alarms and will set up the system to give correct measurement during analysing.*

When starting flow adjustment follow the steps below:

- 1) Make sure scrubbers are off and that back purge is activated.
- 2) Turn off the power for the Analyser cabinet and all SCS cabinets (two circuit breakers in the analyser cabinet and two circuit breakers SCS cabinet).
- 3) Disconnect the heated sample line from T-piece in all SCS cabinets. Refer to Figure 7.



Figure 7 *T-piece in the SCS cabinet*

- 4) Disconnect cable in SCS junction box from terminals X-1-115 and X-1-116 (back purge activation signal).
- 5) Isolate the cables from X-1-115 and X-1-116 using tape or other safe material. Make sure that they are separate.
- 6) Switch on the two circuit breakers in the analyser cabinet and two circuit breakers SCS cabinet.
- 7) Perform a flow adjustment for the entire system according to chapter 5.3.1.2.
- 8) Startup adjustment is now completed.
- 9) Turn off power for the Analyser cabinet and SCS cabinets in the junction box in the SCS (two circuit breakers for the analyser cabinet and two circuit breakers for SCS cabinet).
- 10) Reconnect the heated sample line to the T-piece in the SCS cabinet. Refer to Figure 7.
- 11) Reconnect the cable in SCS junction box to terminals X-1-115 and X-1-116 (back purge activation signal).
- 12) Turn on the system by switching on the two circuit breakers in the analyser cabinet and two circuit breakers SCS cabinet.
- 13) Wait for the system to warm up. It takes approx. 45 min to 1.5 hours depending on climate and surrounding cooling.
- 14) Perform calibration. Refer to chapter 5.3.2.
- 15) System is ready for use and scrubber can be started.

5.3.1.2 Flow adjustment

Verify scenario B in chapter 5.3.1.

It is important that the flow settings are correctly adjusted to prevent flow alarm and damaging the analyser.

Caution *Incorrect flow setting might damage the analyser.*

Flowmeters (refer to Figure 8 and Figure 9):

- On SCS: FI-01, Recycle gas: 3-4 l/min
- On SCS: FI-02, Dryer air: Min. 10 l/min
- On AC: FI-01 (under cabinet): 1-1.5 l/min

Regulators:

- On SCS: 1 barg
- On AC: 0.5-1 barg, depending on sample gas flow from SCS
- On Gas cylinder: 0.3-0.6 barg, depending on sample gas flow from SCS

Note *Tags like FI-01 and NV-01 exist in both analyser cabinet and SCS.
Make sure to handle the correct unit.*

Flow adjustment procedure:

- 1) AC (analyser cabinet): Turn on the circuit breaker (item 2 and 4 on dwg 1002)
- 2) AC: Open valve, BV-01, on air supply (under AC). Refer to Figure 9.
- 3) SCS (sample conditioning system): Adjust pressure regulator (for air supply) in Figure 8 to 1 barg.
- 4) SCS: Adjust flowmeter FI-02 Dryer air (right flowmeter) to minimum 10 l/min on all applicable SCS. Refer to Figure 8.
- 5) Wait for the system to warm up (approx. 30 min in room temperature).
- 6) AC: Press the F4 button on the Logo display (PLC, item 14 on dwg 1002) until stream 1 is selected.
- 7) SCS: Adjust flowmeter FI-01 Recycle gas (left flowmeter on picture) to 3 l/min on stream 1. Refer to Figure 8.



Figure 8 Flowmeters and regulator on SCS

- 8) AC: Make adjustment on flowmeter, FI-01, under AC to approx. 1.5 l/min when stream 1 is selected. Refer to Figure 9.

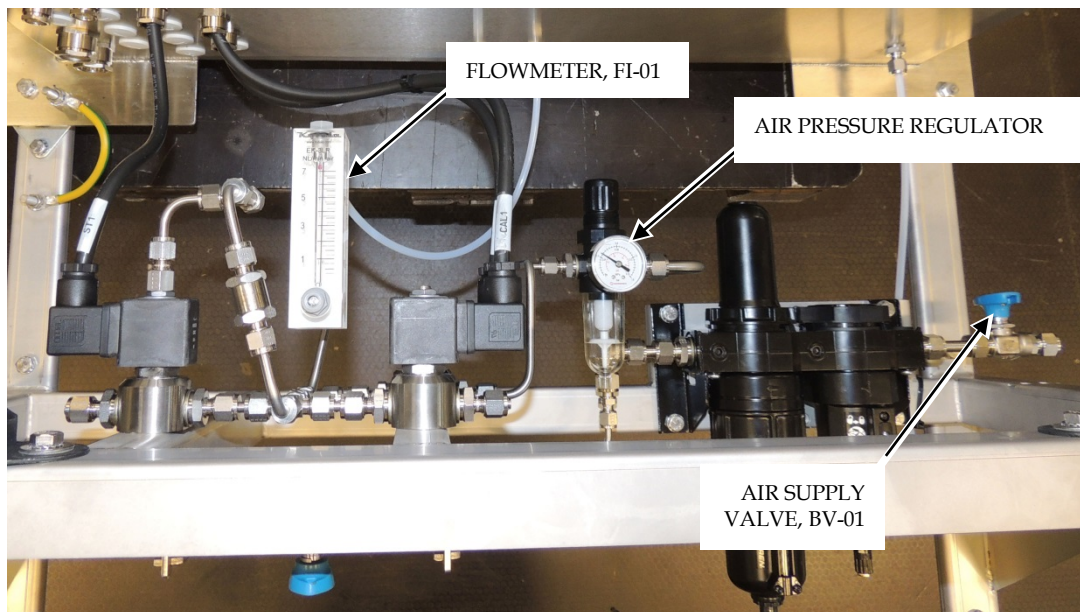


Figure 9 Flowmeter, regulator and air supply valve under AC

- 9) If stream 2 is installed:
Press the F4 on the Logo display until stream 2 is selected. Adjust the flowmeter **FI-01 (SCS)** on stream 2 so that flowmeter FI-01 (AC) is approx. 1.5 l/min.

Caution For streams 2-4 when installed:
Do not adjust flowmeter FI-01 under AC!
Adjust only the flowmeter FI-01 on the SCS.

- 10) If stream 3 is installed:
Press the F4 button on the Logo display until stream 3 is selected.
Adjust the flowmeter **FI-01 (SCS)** on stream 3 so that flowmeter FI-01 (AC) is approx. 1.5 l/min.
- 11) If stream 4 is installed:
Press the F4 button on the Logo display until stream 4 is selected.
Adjust the flowmeter **FI-01 (SCS)** on stream 4 so that flowmeter FI-01 (AC) is approx. 1.5 l/min.
- 12) AC: Press F4 button on the Logo display until Air inlet is selected.
- 13) AC: Adjust the air supply pressure regulator under AC (refer to Figure 9) until flowmeter, FI-01, under AC is 1.5 l/min.
- 14) Make sure the gas regulator (refer to Figure 10) is fully closed.
(Fully turned counterclockwise.)

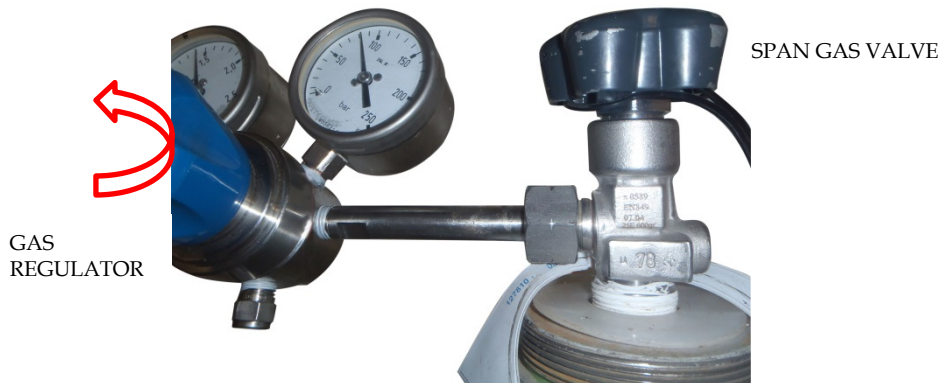


Figure 10 Valve and regulator on span gas cylinder

- 15) AC: Press F4 button until Span inlet is selected.
- 16) Open span gas valve on the cylinder and carefully open gas regulator (several turns clockwise) until flowmeter, FI-01, under AC (refer to Figure 10) shows 1.5 l/min.
- 17) Flow settings are completed.
- 18) Close both gas regulator and span gas valve.

5.3.2 Calibration

Caution Even if the system is in automatic mode, manual calibration is necessary to calibrate the analyser module. To be in compliance with the type approval certificate issued for this analyser, manual calibration needs to be performed every 30 days. Vimex recommends calibration every two weeks to make sure the analyser is accurate at all time.

The standard ShipCEMS system analyses SO₂ and CO₂. Over time the analyser may drift and subsequently present slightly incorrect values of SO₂ and CO₂ content. Therefore the analyser may need calibration.

ZERO CALIBRATION:

- During zero calibration for SO₂, a reference gas with no SO₂ (instrument air) is used to make a new zero reference for the analyser. (Enter 0ppm into the analyser.)
- During "zero" calibration for CO₂, a reference gas with only 0.04% CO₂ (instrument air) is used to make a new "zero" reference for the analyser. (Enter 0.04 into the analyser.)

The Analyser Module is zero calibrated using instrument air supplied through analyser cabinet inlet nozzle N12.

During calibration, the streaming solenoid valve will be closed and will stop sample gas, whilst simultaneously opening the zero solenoid valve. Both solenoid valves are controlled by the LOGO PLC. (Check the calibration gas blend on the cylinder and enter values into the PLC.)

SPAN CALIBRATION:

- During span calibration for SO₂ and CO₂, a reference gas with a mixture of SO₂ and CO₂ (calibration gas from the cylinder) is used to make a new span reference for the analyser. (Enter blend concentration from the calibration cylinder into the analyser.)

The Analyser Module is span calibrated using span gas supplied through analyser cabinet inlet nozzle N17. During calibration, the streaming solenoid valve will be closed, stopping sample gas, whilst simultaneously opening the span solenoid valve. Both solenoid valves are controlled by the LOGO PLC.

CALIBRATION PROCEDURE:

- 1) Make sure flow adjustments are carried out according to 5.3.2.1.
- 2) Press the F3 button on LOGO display to start the auto-calibration procedure below:

Zero calibration:

- 3) **Prior to** zero calibration the solenoid valve for instrument air will open and the analyser will be purged with air for two minutes for stable reading. Purging is performed automatically.
- 4) When readings are stable the zero calibration is performed.
- 5) Solenoid valve for instrument air will close and span calibration will start.

Span calibration:

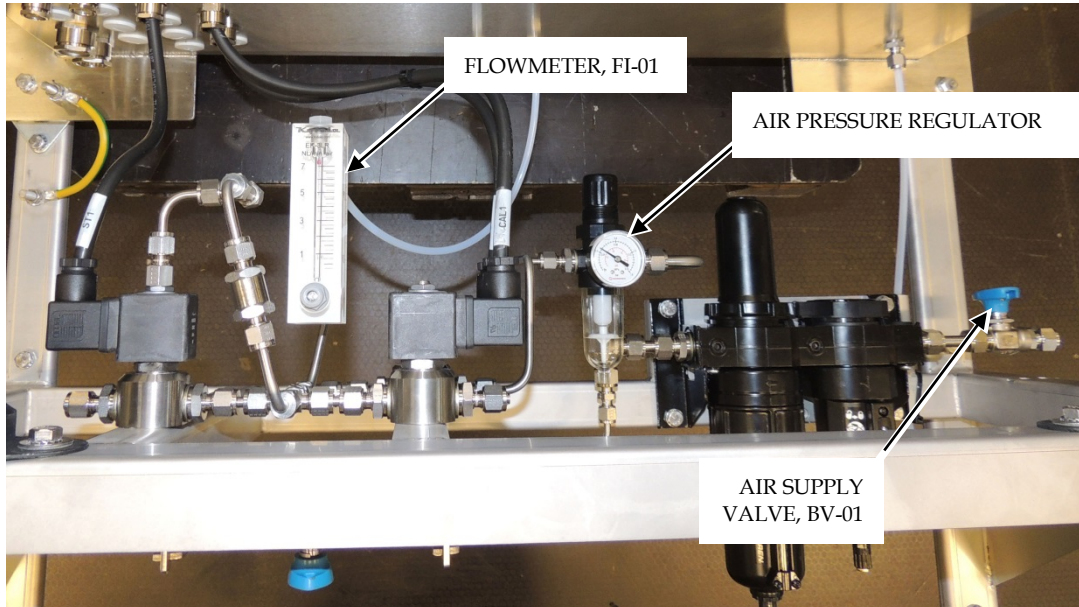
- 6) **Prior to** span calibration the solenoid valve for span gas will open and the analyser will be purged with span gas for two minutes for stable reading. Purging is performed automatically.
- 7) When readings are stable, the span calibration is performed.
- 8) After span calibration is performed the solenoid valve will close and the system goes automatically back to its prior mode (e.g. measuring or idle mode).

Note *Purging is performed to achieve stable measurements before calibration.
A complete calibration procedure takes approx. four minutes.*

The system is designed to operate fully automatic so the LOGO PLC will control the solenoid valves automatically. It is however possible to manually control the solenoid valves with function F4 service mode. Refer to chapter 5.2.2.

5.3.2.1 Flow adjustment for analyser calibration

- 1) AC: Press F4 button on the Logo display until *Air inlet* is selected.
- 2) AC: Adjust the air supply pressure regulator under AC until flowmeter, FI-01, under AC is 1.5 l/min.



- 3) AC: Press F4 button until Span inlet is selected.
- 4) Make sure the gas regulator (refer to figure below) is fully closed. (Fully turned counterclockwise.)



- 5) Open span gas valve on the cylinder and carefully open gas regulator (several turns clockwise) until flowmeter, FI-01, under AC (refer to figure above) shows 1.5 l/min.
- 6) Flow settings are completed.

5.3.3 Changing calibration interval on the Analyser Module

At delivery automatic start of calibration is switched off. It is easily activated, but Vimex recommends manual calibration. Contact Vimex for further guidance on how to activate this function.

Note *If automatic start of calibration cycle is activated, it is very important that calibration gas bottle is opened at all times. The system should be checked at least once a week to make sure all pressures are OK and that there is no leakage from calibration gas cylinder.*

5.3.4 Changing measuring range on the Analyser Module

Note *If range is changed from default setting it will require optional SC-IU to be programmed accordingly as well. Always consult Vimex before making any changes to the measuring range.*

ShipCEMS is delivered with a default measuring range for conversion of the gas components measured (in ppm or vol%) to 4-20mA signals that are transmitted by either analog or fieldbus communication to customer's DCS.

Note that when setting a higher range, the accuracy of the readings will be lower, and vice versa.

- 1) Enter function code 40 for SO₂ or CO₂ on the Analyser Module to change the range selection to correct measuring range.
If correct measuring range is not listed (MR1 - MR4) go to the next step.
- 2) Enter function code 41 to define measuring range (MR1 - MR4) for SO₂ or CO₂.
- 3) Enter the correct measuring range.

SO₂: Either 0-50 vpm or 0-100 vpm (same range for MR1 - MR4)

CO₂: 0 to 10% or 0 to 15% (same range for MR1 - MR4)

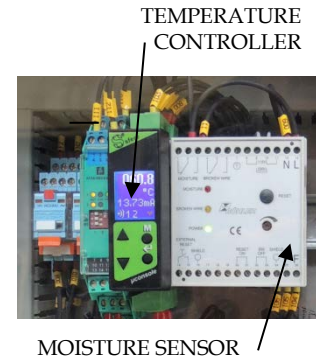


5.3.5 Changing Temperature Controller settings

The Temperature Controller is used to control both the heater relay (#1) and the gas pump relay (#2). It is mounted inside the SCS junction box (left of the moisture sensor).

The default relay temperature settings are as follows:

- Heater relay
 - Temperature set point SP1=60.0°C (140°F)
 - Hysteresis HYS1=1.0°C (34°F)
- Gas pump relay
 - Temperature set point SP2=55.0°C (131°F)
 - Hysteresis HYS2=1.0°C (34°F)



The Temperature Controller settings are programmed from Vimex and are normally not changed.

6 Troubleshooting

6.1 Troubleshooting philosophy

ShipCEMS is able to recognise system irregularities and will send messages accordingly. These messages can be sorted in two categories:

- Alarms
- Information messages

Caution *Alarms must be attended to immediately, as these indicate system faults that may be harmful to the equipment.*

Information messages need not influence the measuring ability of the analyser at the time they occur. It is however recommended to carry out remedial measures in order to guarantee reliable measurements.

All alarms and information messages are displayed on the screen of the LOGO display unit. Note that several messages may be present at a given time. The fault message of the highest priority order is then displayed on top. The LOGO UP/DOWN buttons must then be used to navigate to other messages present.

All messages will also be sent as a common digital alarm signal to the customer's external control system (DCS).

Individual error messages, possible causes and actions to be taken are described in tables in chapter 6.2.2, 6.3 and 6.4.

6.2 Signals

6.2.1 Output signals on standard ShipCEMS

Description	Type
AC ALARM	Digital alarm
SCS ALARM (COMMON)	Digital alarm
MAINTENANCE IN PROGRESS	Digital information message
MEASUREMENT VALID	Digital information message
CO ₂ VALUE	Analogue 4 - 20 mA
SO ₂ VALUE	Analogue 4 - 20 mA

6.2.2 Status signals on Interface unit (SC-IU) using fieldbus

Optional. Refer to the following drawing:

→ [9802] – Field Bus Specification

Description	Type	Meaning
AC Alarm	Alarm signal	1 = System Ok
SCS Alarm	Alarm Signal	1 = System OK
Maintenance in progress	Information signal	1 = Maintenance on system
Measurement valid	Information signal	1 = Measurement is currently valid
CO ₂ _RAW	Measured value	Actual measured value from system
SO ₂ _RAW	Measured value	Actual measured value from system
CO ₂ _Stream1..4	Measured value	Actual measured value from system
SO ₂ _Stream1..4	Measured value	Actual measured value from system

Note IF SC_IU is installed: Fieldbus variables "Gas component" _RAW values are always updated according to analyser readings.
 "Gas component" _STREAM1..4 values only updates for corresponding stream and when measurement is valid.

6.3 Alarms, LOGO unit

Refer to Figure 6 for location of LOGO unit inside the AC.

Display message	Possible cause	Action
FUNCTION CONTROL U6	Alarm message from Analyser Module (resulting from internal function control). Normally displayed when in warm-up mode or when analyser settings have been changed.	Check message on analyser display. Press the MEAS button to return to measurement mode. Contact Vimex AS for more information.
LOW FLOW U6	Alarm message from Analyser Module. There is no sample flow to the analyser. Note that a low flow alarm is activated when the scrubber is shut down and the system is automatically set to idle mode.	Check analyser's integrated flow meter. Perform visual check to locate the fault. If T-union is clogged rinse or replace T-union. Refer to chapter 7.3.5.
MAINTENANCE REQUEST U6	Maintenance request from Analyser Module. Possible fault with automatic calibration or other internal analyser processes.	Check request message on analyser display. Check filters in case these are contaminated. Refer to read log in section 6.8.1.1. Record analyser's error log and contact Vimex AS for further actions.
SCS ALARM #1 (#2, #3 and #4)	General alarm from sample conditioning system(s). Fault with sample conditioning system no. 1 to 4 respectively. This alarm will occur when SCS or probe is not heated to set point.	Access the relevant Sample Conditioning System cabinet (up to four cabinets for multi-funnel applications). Perform visual check, functional test and alarm test as required to locate the fault.

6.4 Information messages, LOGO unit

Refer to Figure 6 for location of LOGO unit inside the AC.

Display message	Possible cause
AIR INLET OPEN	Manual opening of solenoid valve for instrument air (function F4)
AUTO CALIBRATING	Calibration mode is entered (function F3)
CALIBRATION IN PROGRESS U6	Automatic calibration of Analyser Module is performed
MAINTENANCE MODE	Maintenance mode is entered (function F1)
MEASURING STREAM #1, #2, #3 and #4	Normal operation
SAMPLE #1, #2, #3 and #4 VALID	Normal operation
IDLE MODE	No stream is selected for measurement.
SERVICE MODE	Service mode is entered (function F4)
SPAN CHECK	Span check of Analyser Module is performed (function F2)
SPAN INLET OPEN	Manual opening of solenoid valve for calibration gas (function F4)
STREAM #1, #2, #3 and #4) OPEN	Manual opening of solenoid valve for sample from SCS (function F4)

6.5 Moisture alarms

The red moisture alarm indicator can lit up during the process, but is turned off once the sample is completely dry.

During moisture alarm the sample outlet valve is closed and the sample goes in a loop until the sample is dry.

If the alarm remains, perform the measures listed in the table below. If the alarm persists, contact Vimex AS.



MOISTURE SENSOR
ALARM INDICATOR

Display message	Possible cause	Action
Alarm indicator is lit up. Refer to figure above.	Visually check if there is water in the bottom of the sample gas filter element. Refer to 7.3.3 for pictures.	Refer to 7.3.3 to remove the glass cup and empty the water. Replace the glass cup. Check if the alarm is turned off after approx. 5 minutes.
Alarm indicator is lit up. Refer to figure above.	Dryer tubes could be worn and need replacement.	Refer to 7.3.6 to replace the dryer tubes. Contact Vimex for support.

6.7 General troubleshooting procedure

Troubleshooting may be complex and requires good knowledge of ShipCEMS. Onboard service personnel should therefore compile and update troubleshooting guidelines over time while gathering system experience.

The following procedure therefore indicates some check points that could be included in a troubleshooting routine when an alarm has been received.

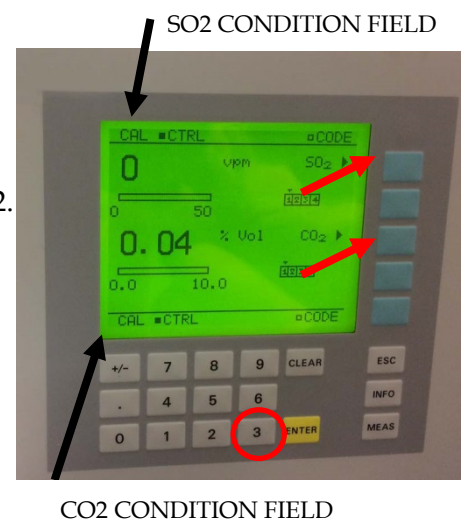
If necessary, contact Vimex AS for further advice or for service request.

6.8 Troubleshooting procedures

6.8.1 Analyser fault

6.8.1.1 Read log

- 1) Press function code 3 on the analyser module to read the log.
- 2) Select the channel to check the log for either SO₂ or CO₂.
- 3) Enter code 111 and press enter.
(The digits (111) are not visible on the screen.)
- 4) Scroll through the log pages to read the entire log and errors that have occurred.
- 5) Press ESC to exit.

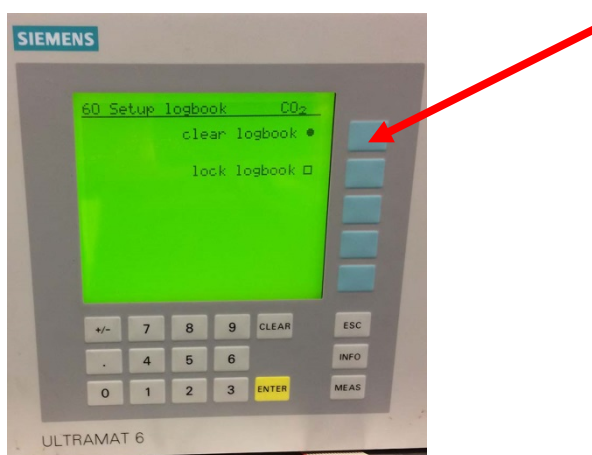


6.8.1.2 Delete log

For some specific alarms the analogue output will freeze and the analyser system stop working. To get operational again the log must be deleted.

*Caution Save all log pages! Use camera or write it down!
This is very important for support purposes.*

- 1) Take a picture of all the log pages.
- 2) Press function code 60 on the analyser unit.
- 3) Select the channel to delete, either SO2 or CO2.
- 4) For CO2: Enter code 111 and press enter (for SO2 no code is needed).
(The digits (111) are not visible on the screen.)
- 5) Press “clear logbook”



- 6) Press “MEAS” button once, wait 3 seconds and press “MEAS” button again.
- 7) Log is now deleted.

6.8.2 Visual check, Analyser System

- 1) Check that the atmospheric vent is connected and that it is not restricted.
- 2) Check electrical wiring. Inspect the internal terminals for loose wires.
- 3) Check for correct mounting of the Analyser Module inside its vibration rack.
- 4) Verify that all equipment is connected to its correct fuse.
- 5) Verify correct current rating for all fuses.
- 6) Check for loose fittings. Check tightness by hand.
- 7) Check the vibration mounting for non-tightened bolts.

6.8.3 Visual check, Sample Conditioning System

- 1) Check electrical wiring. Inspect the junction box terminals for loose wires.
- 2) Verify that all equipment is connected to its correct fuse.
- 3) Verify correct current rating for all fuses.
- 4) Check filter quality by inspecting the filter housing and filter element.
- 5) Check for loose fittings. Check tightness by hand.
- 6) Inspect the gas pump for any damage or for obstacles.

6.8.4 Functional test, Sample Conditioning System

- 1) Apply 230 VAC power to the cabinet.
- 2) Verify that the gas pump starts by manually activating relay R2.
- 3) Verify that the heater starts heating (up to maximum 60°C (140°F)).
- 4) Close the cabinet door. This will test that the pump auto starts (at 55°C (131°F)).
- 5) Verify that the heater stops heating when cabinet temperature reaches 60°C (140°F). Inspect at relay R1.

6.8.5 Alarm test, Sample Conditioning System

- 1) Moisture alarm: Generate a moisture alarm and verify that the sample shut off solenoid valve closes and that the flow to the Analyser System drops. The flow in recycle loop should increase. No alarm is sent to the Analyser System.
- 2) Temperature alarm: Open the cabinet door and verify that pump stops when the temperature drops below 55°C (131°F). An alarm shall be sent to the Analyser System and the error be reported in LOGO display.
- 3) Probe sample temperature alarm: Cut power supply to the probe and let the probe temperature drop below operating temperature. Verify that the gas pump stops. An alarm shall be sent to the Analyser System and the error be reported in LOGO display.
- 4) Dryer air flow alarm: Block for purge air. Verify that the gas pump stops. An alarm shall be sent to the Analyser System and the error be reported in LOGO display.

7 Maintenance

7.1 Maintenance philosophy

The maintenance philosophy recommended by Vimex AS is:

- Maintenance should be carried out by skilled personnel. The maintenance should include the following:
 - Calibrations and validations
 - Functional tests
- Replacement of faulty parts should be limited to the replaceable units recommended in the spare parts lists.

Whenever a faulty unit has been replaced, the unserviceable unit should be sent to Vimex AS, or an appointed dealer, for repair.

Note *Always follow the recommended maintenance of the different units. System performance and reliability may decline if these recommendations are not followed, and may also render the guarantee void.*

7.2 Maintenance schedule

Maintenance routines must be performed regularly as stated in the following tables to ensure optimal performance and a long operational life of the system and its components.

The preventive maintenance program shall by defined time intervals guide the ShipCEMS technician through an inspection, repair and replacement program. This will enable ShipCEMS to be operational, to reduce the number of expected alarms, to eliminate the number of unexpected alarms and to measure correctly.

The proposed maintenance schedule must be accommodated to authoritative legislation and actual operational conditions. The customer should thus work out a local maintenance plan.

Note *The maintenance schedule indicates the maximum recommended intervals between which the various routines should be performed.*

7.2.1 Daily routine

Unit	Remarks
Heated sample line	Check temperature by hand. Sample tube should be noticeably warm at probe outlet and cabinet inlet.
All instruments	Check instrument displays for fault messages.
Filters	Check filters in SCS and probe.

7.2.2 Weekly routine

Unit	Remarks
Cooler unit	Check that air inlet and outlet vents are free from sand, dust or other foreign matters.
Analyser Module	Check flow on span and air inlets by using the flowmeter mounted on lower support bracket of analyser cabinet. (LOGO Function F4). Normal flow is 1 to 1.5 l/min. Alarm if flow < 0.8 l/min.
	<i>Note</i> <i>Adjust flow using regulators - not the flowmeter!</i>
	Refer to <i>Flow adjustment</i> in chapter 5.3.1. Use span check (LOGO function F2). Carry out calibration procedure (LOGO function F3) if readings differ from value on calibration gas bottle carry out. Intervals for span check may be extended if deviations are insignificant.

7.2.3 Bi-weekly routine

Unit	Remarks
Calibration	Perform bi-weekly span check (LOGO function F3). If deviation is significant perform a calibration. Vimex recommends calibration every two weeks to make sure the analyser is accurate at all time. Intervals may be extended if the deviation is insignificant.

7.2.4 Monthly routine

Unit	Remarks
Cabinet and unit exterior	Clean all surfaces.
Calibration	MANDATORY MONTHLY! (but bi-weekly is recommended by Vimex) To be in compliance with the type approval certificate issued for this analyser, manual calibration must be performed every 30 days. Perform calibration (LOGO function F3).
Sample line inside cabinet	Check all tubing visually for condensation, contamination and leaks
Sample probe filter	Check for contamination and physical damage. Replace filter element if required. Vimex part no: 500840.
Sample gas filter	Visual check for contamination and physical damage. Replace as required. May be replaced earlier if flow is reduced to such a level that alarms are active or if filter is contaminated. Vimex part no: 500831.
Particle filter in Air Filter Unit	Check filter for contamination. Replace if required. Vimex part no: 500827.
Oil absorbing filter in Air Filter Unit	Check filter for contamination. Replace if required. Vimex part no: 500828.

7.2.5 Routine every six months

Unit	Remarks
Sample probe filter	Replace filter element. Vimex part no: 500840.
Sample gas filter	Replace filter element. May be replaced earlier if flow is reduced to such a level that alarms are active or if filter is contaminated. Vimex part no: 500831.
Calibration gas cylinder	Check expiration date on cylinder. Order new cylinder if pressure drops below 50 barg

7.2.6 Yearly routine

Unit	Remarks
Heated sample line	Check for moisture and contaminations. Clean as required. Refer to 0.
Gas pump membrane	Check physical condition. Replace if required (*). Vimex part no: 500838.
Solenoid valves	Perform functional test. Perform leakage test. Refer to 0.
Particle filter in Air Filter Unit	Replace filter. Vimex part no: 500827.
Oil absorbing filter in Air Filter Unit	Replace filter. Vimex part no: 500828.
Sample probe with demister	Replace filling on demister. Vimex part no: 501378
Analyser Condense trap	Replace condense trap. Refer to chapter 7.3.10. Vimex part no: 501288

7.2.7 Routine every three years

Unit	Remarks
Gas pump maintenance kit	Replace spare parts. Vimex part no: 500836
Calibration gas cylinder	Replace cylinder. Order from Vimex.
Dryer tubes (sample gas dryer)	Replace dryer tubes. Refer to chapter 7.3.6. Vimex part no: 500829

Note () – Membrane replacement shall be performed by personnel from Vimex AS, unless agreed otherwise between customer and Vimex.*

7.3 Maintenance procedures

7.3.1 Cleaning cabinet exterior and surfaces

- 1) Clean the exterior of cabinets and other surfaces with a sponge or cloth soaked in water contained cleansing agent.
- 2) Wipe down all surfaces afterward with a clean, damp cloth to remove the detergent.

Note *The surface of screen display areas must only be cleaned using a slight pressure to prevent damage to the thin foil.*

Note *Make sure that water does not enter the analyser or other units when cleaning.*

- 3) If necessary, dust may be removed from the interior of cabinets by carefully using a compressed air gun.

7.3.2 Replacing sample probe filter element

Vimex part no: 500840

The sample probe contains a filter element made of an inert ceramic material. The filter element is passive and does not add or absorb any of the trace components to be measured. It is not necessary to shut off power during filter replacement.

- 1) Open the protective shield to access the sample probe.
- 2) Turn the probe handle 90 degrees counterclockwise and pull the handle with the filter straight out.

Warning *Avoid touching hot parts of the sample probe, including the filter element.*



- 3) Replace filter according to steps below.
 - a) Replace filter if it is discoloured right through.
 - b) Lubricate and change O-rings.
 - c) Lubricate the internal O-ring on the filter with lubrication delivered with the filter.

Caution *Do not drop the filter to ground, as the unit is sensitive to shock loads.*

- 4) Reinsert the handle with the cleaned or replaced filter, and turn the handle 90 degrees clockwise to fasten.

7.3.3 Replacing sample gas filter element

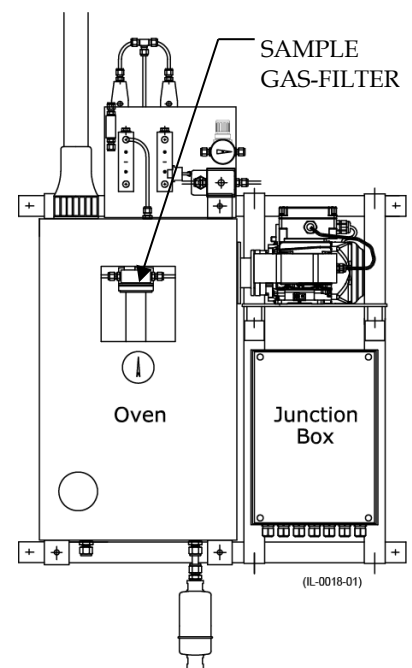
Refer to general arrangement drawings [1801].

Vimex part no: 500831

The Sample Conditioning System cabinet contains a filter element. The filter element is passive, and does not add or absorb any of the trace components to be measured.

If a moisture alarm has been activated, the filter must always be attended to.

- 1) Open the cabinet to access the filter.
- 2) Visually check for moisture or contamination in the glass container and surrounding tubing.
- 3) Wait until the pump has stopped to avoid pressure in plastic cup.
- 4) Open the filter housing by drawing out the plastic locking ring.
- 5) Pull the glass cup holding the filter straight down. It is only pushed up onto the element holder.



- 6) Replace the filter element.
- 7) Reassemble the sample gas filter unit.

It is not necessary to shut off power during filter replacement. The oven will reheat, and then the pump will restart when the cabinet temperature reaches +55°C (131°F).

7.3.4 Install or replace the calibration gas cylinder

Vimex part no: 501085

When the calibration gas cylinder is replaced, it is necessary to perform a recalibration of the Analyser Module afterwards.

- 1) Ensure that the solenoid valve controlling flow from the gas cylinder is closed. When the system is in normal operational mode, this valve will be closed. If not, use the LOGO to close the valve.
- 2) Ensure that the gas cylinder's outlet valve is firmly shut.
- 3) Unscrew the regulator fittings.
- 4) Remove all mechanical fasteners.

Caution *Never allow gas cylinders to fall.*

Caution *Keep caps on while moving gas cylinders.*

- 5) Replace the gas cylinder and ensure that the new cylinder is properly fastened.
 Use function number 22 on the Analyser Module to adjust correct set points for span and gas calibration. Refer to manufacturer's documentation for menu guidance.
 Pass code for Analyser Module (level 1): 111

Enter calibration cylinder values into the analyser:

For SO₂:

Insert Zero set point 0.00 vpm.

Insert MR1-MR4 set point according to values for SO₂ concentration found on the cylinder.

SO₂:

For CO₂:

Enter function code 22. Insert Zero set point 0.04 vpm.

Insert MR1-MR4 set point according to values for CO₂ concentration found on the cylinder.

CO₂:

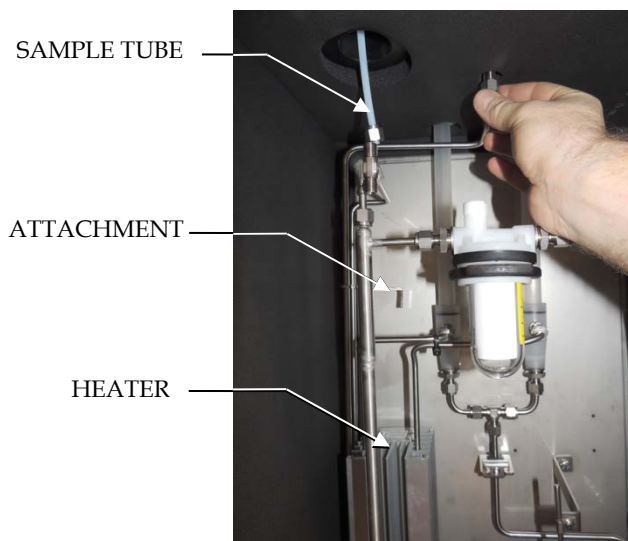


Adjust the regulator on the new gas cylinder for correct flow to the analyser system.

- Press F4 on the LOGO to open span inlet (in order to adjust regulator on gas cylinder).
- Perform flow adjustment according to chapter 5.3.1.
- Use the LOGO to enter Calibration mode (F3 button). Activate the necessary solenoid valves to allow instrument air and calibration gas to flow through the system.

7.3.5 Cleaning T-union

A clogged T-union can reduce the sample flow.



- 1) Disconnect the sample tube from the T-union.
- 2) Use adjustable spanner and combination spanner 14 mm and disconnect the T-union.
- 3) Check for trail of oil and water.
- 4) Clean the T-union.
- 5) Connect the T-union and the sample tube.

7.3.6 Replacing dryer tubes (sample gas dryer)



Caution Dryer tubes are modified to fit ShipCEMS. Always order dryer tubes from Vimex.

Vimex part no: 500829

- 1) Moisture alarm can also be activated, when dryer tubes are worn.
- 2) Replace dryer tubes by disconnecting fittings on upper and lower dryer tube holder.
- 3) Refer to GA drawing [1802] and figure below to remove the set screw on the lower dryer tube holder. Turn the holder if the set screw is difficult to reach.

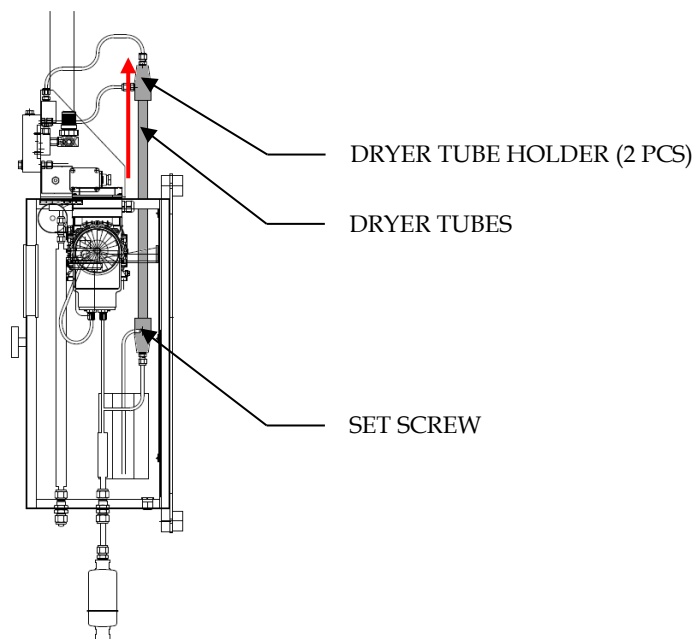


Figure 11 ShipCEMS sample gas dryer (dryer tubes)

- 4) Separate the dryer tubes from the lower dryer tube holder and pull the dryer tubes up from the opening.
- 5) Remove the lower dryer tube holder.
- 6) Install the new dryer tubes in reverse order.

7.3.7 Replacing internal parts in the Analyser Module

The Analyser Module is a sensitive device. Replacing serviceable parts inside the unit should therefore be only performed by service personnel authorised by Vimex.

7.3.8 Particle filter in Air Filter Unit

Vimex part no: 500827

The filter is mounted under the analyser cabinet. Refer to Figure 12.

Refer to chapter 7.2 for maintenance schedule.

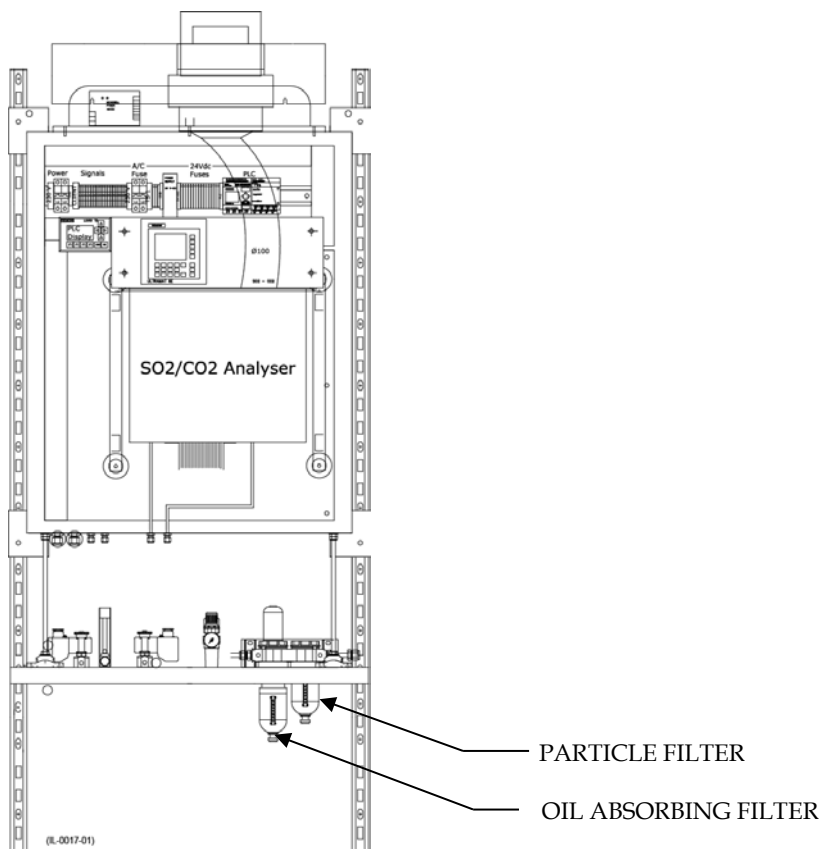


Figure 12 Particle and oil absorbing filter on filter unit

7.3.9 Oil absorbing filter in Air Filter Unit

Vimex part no: 500828

The filter is mounted under the analyser cabinet. Refer to Figure 12.

Refer to chapter 7.2 for maintenance schedule.

7.3.10 Replace condense trap

Vimex part no: 501288

The condense trap is located under the analyser cabinet.
The function of the trap is to protect the analyser from moisture by removing any moisture that might have passed the sample conditioning phase.



ANALYSER CABINET

1) Press F4 on LOGO display and select "Air inlet open".

2) Assemble the filter unit and tighten the connections.

For later maintenance:
Write current date on the yellow label.
Leave the label on the filter.



3) Make sure the yellow label on the filter unit is facing upwards.

Install the filter unit, starting with the top.



4) Tighten the connections and make sure that the filter unit is somewhat vertical.

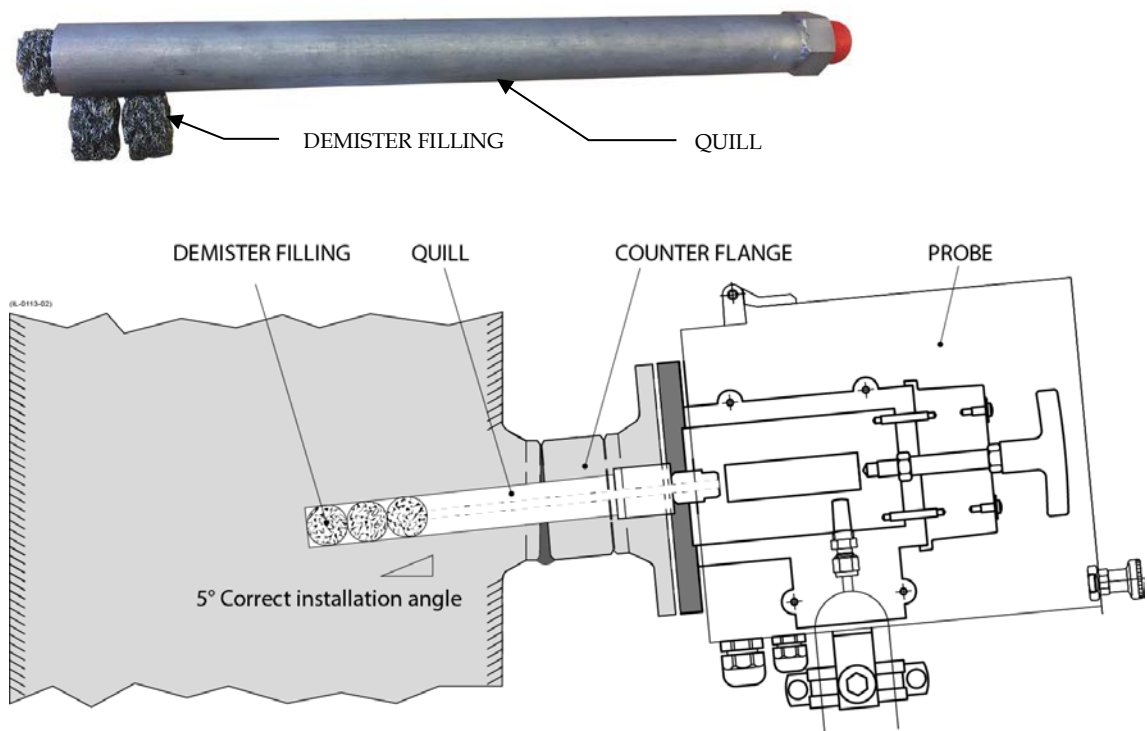
5) Perform a flow adjustment according to chapter 5.3.1 before any sampling or calibration.

7.3.11 Replace demister filling - only demister quills

Vimex part no: 501378

This is only applicable if a demister quill is installed. The standard probe normally has a quill with a pointed tip and does not need refilling. Refer to figure in chapter 3.2.

After a year approximately the demister filling is used up. Replace more often if there is no filling at all left when replacing.



- 1) Detach the heated sample line from the probe.
- 2) Disconnect the probe from the flange using the four screws.
- 3) Pull the probe and the whole quill from the funnel.
- 4) Replace/insert new demister filling, one or all three "cushions". The filling should be in the tip of the quill and no distance between.
- 5) Remount the probe and heated sample line in reverse order.

7.3.12 Cleaning heated sample line

The tube inside the heated sample line can get dirty. If a flow alarm occurs and the sample line is clogged, there are two ways to solve the problem:

- Clean the sample tube that is connected.
- Connect to the spare sample tube.

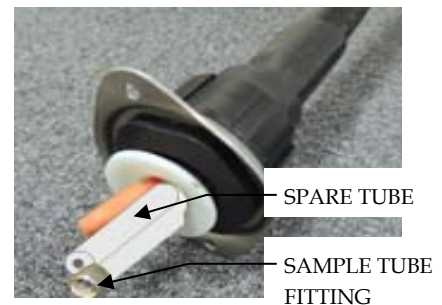
7.3.12.1 Clean the sample tube

- 1) Disconnect the sample line in the T-piece in the SCS. Refer to Figure 7 on 34.
- 2) Remove the mounting bracket on probe.
- 3) Disconnect sample tube from the sample outlet of the probe at the fitting.
- 4) Start from the SCS and use compressed air to clean the tube.
- 5) Connect sample line in both ends.

7.3.12.2 Connect to the spare sample tube

Note *Make sure fittings are available.*

- 1) Refer to installation manual chapter *Installation procedures*.
- 2) Remove the mounting bracket on probe.
- 3) Disconnect the sample tube from the sample outlet of the probe at the fitting.
- 4) Seal the old sample tube in both ends.
- 5) Connect spare sample tube to the sample outlet of the probe using new fitting.
- 6) Mount the mounting bracket.
- 7) In the SCS; switch to the spare sample tube using new fitting.



7.3.13 Leak test

7.3.13.1 Entire sample line

Note Perform test on each stream. Contact Vimex for further instructions.

Note We recommend Vimex personnel to perform leak test during annual service.

7.3.13.2 SCS

Note Perform test on each SCS.

- 1) Block sample outlet on the SCS.
- 2) Make sure that back purge solenoid valve is closed (deactivated).
- 3) Read and print down the set flow:
..... (l/min)
- 4) Adjust flowmeter for recycle air to maximum flow.
Read and print down the recirculated flow:
..... (>4.0 l/min)
- 5) This is a measure of pump capacity in correlation to what it should be and that there is no leakage on the push side of the pump.
- 6) Reset the flow to value in step 3).

7.3.14 Cleaning of analyser module

Exterior:

The front panels and doors can be washed. Clean using a sponge or cloth soaked in water contained cleansing agent. The surface of the display area in particular must only be cleaned using a slight pressure to prevent damage to the thin foil. Make sure that no water enters the analyser when cleaning.

Interior:

If necessary, the inside can be carefully blown out using a compressed air gun after opening up the analyser.

7.3.14.1 HOTSWAP - quick change of analyser module

In case of defect analyser module, Vimex has a hotswap program to minimise the down period. Contact Vimex service department. A new analyser module together with a step-by-step instruction will be sent within days. The old analyser is then returned to Vimex.

8 Spare parts lists

8.1 Analyser System

Note that item numbers refer to general arrangement drawing [1002] and [1802].

Item no.	Description	Vimex part no.
Drawings [1002]		
1	ShipCEMS - Analyser hotswap 110VAC	501284
	ShipCEMS - Analyser hotswap 230VAC	501285
	<ul style="list-style-type: none"> ShipCEMS AM 230V fuse, 1A - 250 V (10ea) (120V) 	500818 (500819)
2	ShipCEMS AC Main Automatic fuse 10A	501018
4	ShipCEMS Automatic fuse A/C 6A	501017
5	ShipCEMS LOGO Power supply (24V) (same for LOGO TD and LOGO TDE)	500962
6	ShipCEMS Cooler Power supply (48V)	500961
7	ShipCEMS Cooler Unit	501069
8	ShipCEMS LOGO8 TDE complete with firmware	501416
9	ShipCEMS Clean Air Filter	501000
	<ul style="list-style-type: none"> ShipCEMS AF Particle Filter Kit 	500827
	<ul style="list-style-type: none"> ShipCEMS AF Oil Absorber Filter Kit 	500828
10	ShipCEMS Air Reduction Regulator	501036
11	ShipCEMS sample /calibration solenoid valve 2/2-24V	500826
12	ShipCEMS sample flow indicator	500825
13	ShipCEMS stream select solenoid valve 3/2-24V	500824
15	ShipCEMS (AC) fuse 2A - 250 V (10ea)	500966
Option	ShipCEMS Interface Unit	501221

Item no.	Description	Vimex part no.
N/A	ShipCEMS Back purge kit	501219
N/A	Analyser condense trap	501288

8.2 Sample Conditioning System

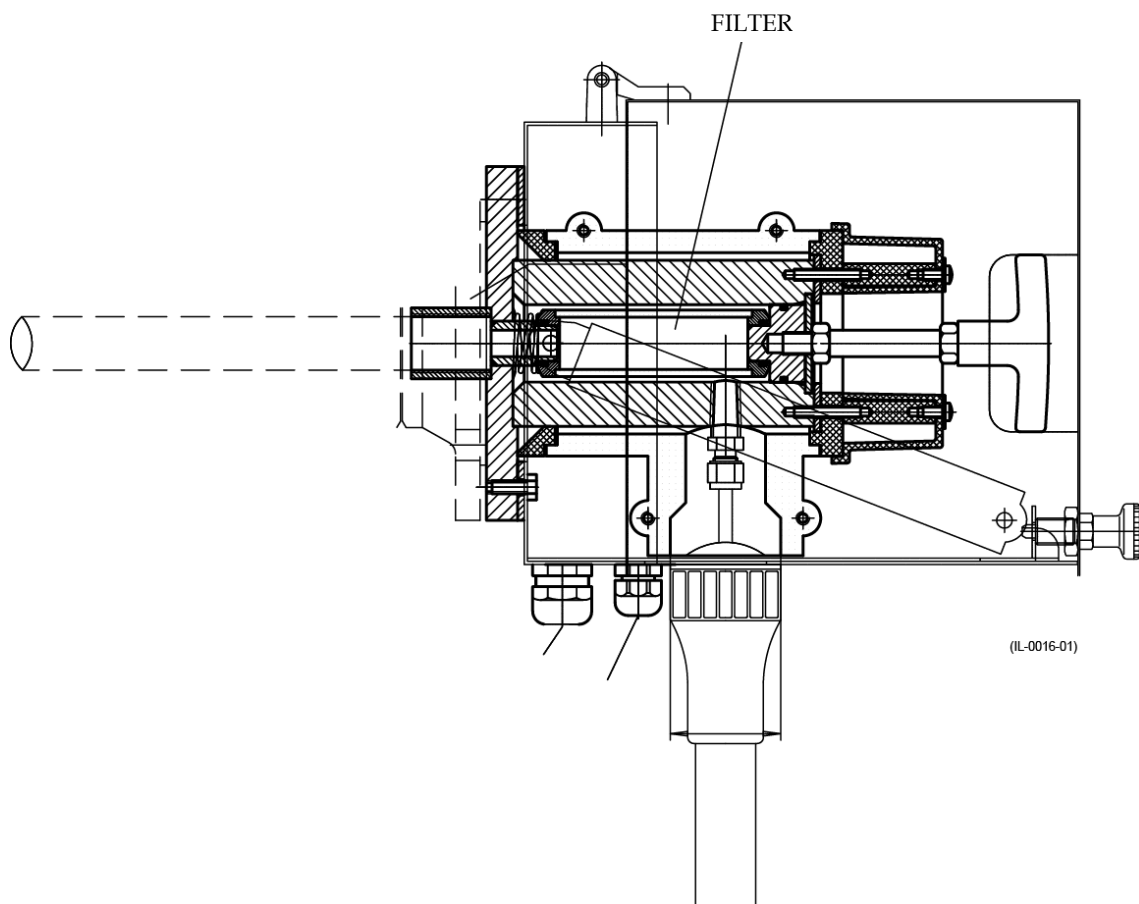
Note that item numbers refer to general arrangement drawings [1801], [1802] or [1805].

Item no.	Description	Vimex part no.
Drawings [1801, 1802]		
15	ShipCEMS sample gas dryer	500829
16	ShipCEMS sample shut off solenoid valve 2/2-230V (120V)	500830 (501227)
17	ShipCEMS sample gas filter, package (5ea)	500831
18	ShipCEMS Sample pump 230V (120V)	500984 (500983)
19	ShipCEMS sample flow indicator with alarm	500832
20	ShipCEMS Temp. Gauge door	501090
21	ShipCEMS Pressure regulator dry air	501091
22	ShipCEMS bypass flow indicator	500833
Drawings [1805]		
13	ShipCEMS Relay 5A (R1 / R2) 230 V (120V)	500835 (501228)

8.3 Sample probe

Refer to general arrangement drawing [1202].

Item no.	Description	Vimex part no.
N/A	ShipCEMS sample probe filter element	500840
N/A	ShipCEMS - Filling 500mm demister 3 pcs.	501378



9 Technical specifications

9.1 Environmental requirements

ShipCEMS is designed to comply with:

- IACS E10 - Test Specification for Type Approval
- IEC 60945 - Maritime navigation and radio communication equipment and systems – General requirements – Methods of testing and required test results
- IEC 60529 - Degrees of Protection Provided by Enclosures (IP Code)

9.2 Type approvals

ShipCEMS is designed in accordance with the requirements of:

- DNV GL (Certificate no. A-13672)
- Lloyd’s Register (Certificate no. 13/70009)
- ABS (Certificate no. 15-HS1356772)
- Bureau Veritas (Certificate no. 42658/A0 BV)
- Rina Services (Certificate no. MAC 085816XG)

9.3 Measuring range

Item	Specification
SO ₂	0-50 ppm (min) 0-1000 ppm (max)
CO ₂	0-5 % (min) 0-15 % (max)
Others on request	

9.4 Physical dimensions

Item	Specification
Analyser System cabinet Dimensions (WxDxH) Weight	800 x 400 x 1000 mm (31 1/2" x 15 3/4" x 39 1/2") 143 kg (315 lbs)
Sample Conditioning System cabinet Dimensions (WxDxH) Weight	400 x 300 x 700 mm (15 3/4" x 12" x 27 1/2") 52 kg (115 lbs)
Heated sample probe Probe length Quill length Flange diameter Weight	254 mm (10") 1 m (40") 160 mm (DIN DN 65 PN 6) 10 kg (22 lbs)
Sample probe counter flange Dimensions	DIN DN65, PN 6 (or customer specific)
Heated sample line (wet) Diameter Weight	50 mm (2") 1.2 kg/m (0.4 lbs/ft)

9.5 Materials

Item	Specification
Cabinets	SS316L
Tubing	PFA/PTFE
Fittings	SS316L
Heated sample probe quill	SS316L
Heated sample probe counter flange	SS316L (or customer specific)

9.6 Ingress protection

- IP44

9.7 Power supply

Item	Specification
Power from ship switchboard	230V, 2-phase, 50/60 Hz Option: 110V, 2-phase, 50/60 Hz
Power cable specifications	230V: 2 x 2.5 mm ² + PE 110V: 2 x 4 mm ² + PE

9.8 Power consumption

Item	Specification
Analyser Cabinet	590 W
Sample Conditioning System	490 W
Heated sample probe	350 W
Heated sample line (wet)	67 W/m
Sample line (dry)	15 W/m if ambient temperature < +10°C (+50°F) Non heated if ambient temperature > +10°C (+50°F)

9.9 Calibration gas (span)

Item	Specification
Gas composition <i>Standard specifications. Other gas compositions may be ordered on request.</i>	40 ppm SO ₂ 8 mol% CO ₂ Rest Nitrogen N ₂
Cylinder size	10 litre (typical)
Cylinder pressure	> 100 barg (> 1500 psig)
Consumption	5 litre / min / calibration

9.10 Instrument air

Item	Specification
Quality	Dry, oil-free according to ISO 8573-1:2010 class 1.2.1 Dew point: ≤ -40°C (-40°F) Particles per m ³ (1-5µm): ≤ 10 Total oil: 0.01 mg/m ³
Consumption for each connected SCS (1 to max 4)	Minimum 15 NI/min (0.9 Nm ³ /hour) @ atmospheric pressure
Pressure range	6 to 8 barg (90 to 120 psig)
Dew point	<+3°C (37.4°F) @ 8 barg minimum outlet pressure (lower than -17°C (1.4°F) @ atmospheric pressure)

10 Drawing references

The ShipCEMS drawings given below are enclosed as separate files.

Note that [nnnn] is used as number identification for standard product drawings, but this is subject to change when specified by contract.

DWG	Description	ShipCEMS standard (230V)	Other options	120V
Mechanical drawings:				
1001	General Arrangement Drawing, Analyser Cabinet, External View	X		X
1002	General Arrangement Drawing, Analyser Cabinet, Interior, Hook-up Locations	X		X
1003	General Arrangement Drawing, Analyser Cabinet, Interior, Interface Unit - Optional	X		X
1005	General Arrangement Drawing, Analyser Cabinet, Hook-up / Wall Mounting, External View	X		X
1202	General Arrangement Drawing, Heated Sample Probe, Flange DN65 - PN6, 230 VAC Electric Heated	X		X
1801	General Arrangement Drawing, Sample Conditioning System, External View, Hook-up Details	X		X
1802	General Arrangement Drawing, Sample Conditioning System, Interior	X		X
1804	General Arrangement Drawing, Sample Conditioning Cabinet, Hook-up / Wall Mounting, External View	X		X

DWG	Description	ShipCEMS standard (230V)	Other options	120V
1805	General Arrangement Drawing, Sample Conditioning System, Junction Box Layout	X		X
1901	General Arrangement Drawing, Emergency Stop, Option		X	
System drawings:				
3001	System Diagram, Analyser Cabinet, Stream Switching System	X		X
3002	System Diagram, Analyser Cabinet, PLC & Signal Conditioning	X		X
3003	System Diagram, Analyser Cabinet, PLC & Signal Conditioning, Interface Unit	X		
3801	System Diagram, Sample Conditioning System	X		X
Electrical drawings:				
5001	Termination Diagram - Power, Analyser Cabinet - Interface	X		X
5002	Termination Diagram, PLC, Analyser Cabinet	X		X
5101	Termination Diagram, Sample Conditioning System, Heater & Flow Control Logic, Junction Box	X		X
5102	Termination Diagram, Sample Conditioning System, Backflush Option, Junction Box	X		X
5201	Termination Diagram - Signal, Analyser Cabinet - Interface, Emission Monitoring System	X		X
5202	Termination Diagram - Signal, Analyser Cabinet - Interface, Emission Monitoring System, Interface Unit, Option	X		X
5301	Termination Diagram, Heated Sample Probe, Model 222.15 / 222.17, Plug Connections	X		X

DWG	Description	ShipCEMS standard (230V)	Other options	120V
5401	Termination Diagram, Cabinet Cooler System, 194 Watt Peltier Element, Analyser Cabinet	X		X
5501	Termination Diagram, Signal SO ₂ /CO ₂ Analyser D-SUB pinout	X		X
5502	Termination Diagram, Signal SO ₂ /CO ₂ Analyser D-SUB pinout	X		X
5601	Termination Diagram, Emergency Power Switch, SCS/Analyser Cabinet		X	
5701	Termination Diagram, Emergency Power Switch, System Layout - Loop		X	
5802	Termination Diagram, Signal Emission Monitoring System, Interface Unit - Option	X		X
9802	Field Bus Specification	X		X
Block diagrams:				
6001	System Block Diagram, Pipe and Gas, Distribution overview	X		X
6101	Electrical Block Diagram, Signal and Power, Distribution Overview, Interface unit - Optional	X		X

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