



User Manual ShipCEMS Compact

Emission Monitoring for Ships



SHIP **CEMS**
COMPACT



User Manual

ShipCEMS Compact

The purpose of this user manual is to provide the descriptions and procedures required to operate and maintain the Analyser in a safe and efficient manner. this system is designed for analysis of ship emissions.

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Rev. 04	Corrections. Spare parts updated on sample probe.
Rev. 05	Section 8.1 spare parts items 13b, 14b, 19-22 added. Section 7.3.1 is added. HMI pictures added.

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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. Norsk Analyse 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
Backpurge	Purge air to probe to prevent raw uncleaned gas entering the system
CEMS	Continuous Emissions Monitoring System
CH ₄	Methane
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
DWG	Drawing
EGCS	Exhaust Gas Cleaning System
GA	General Arrangement (Drawing)
N ₂	Nitrogen
NO	Nitrogen Oxide
NO ₂	Nitrogen Dioxide
PFA	Perfluoroalkoxy alkane (plastic tube material)
PTFE	Polytetrafluoroethylene (plastic tube material)
PLC	Programmable Logic Controller
SO ₂	Sulphur dioxide
SP	Sample Probe
SCC	ShipCEMS Compact

Admonitions

Note	<i>Text set off in this manner presents clarifying information or specific instructions relevant to the immediate instruction.</i>
Caution	<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>
Warning	<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 Analyser System 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.

The standard analyser has one stream.

If a multiplexer is installed (for raw gas applications), up to four streams can be analysed. Refer to figure below.

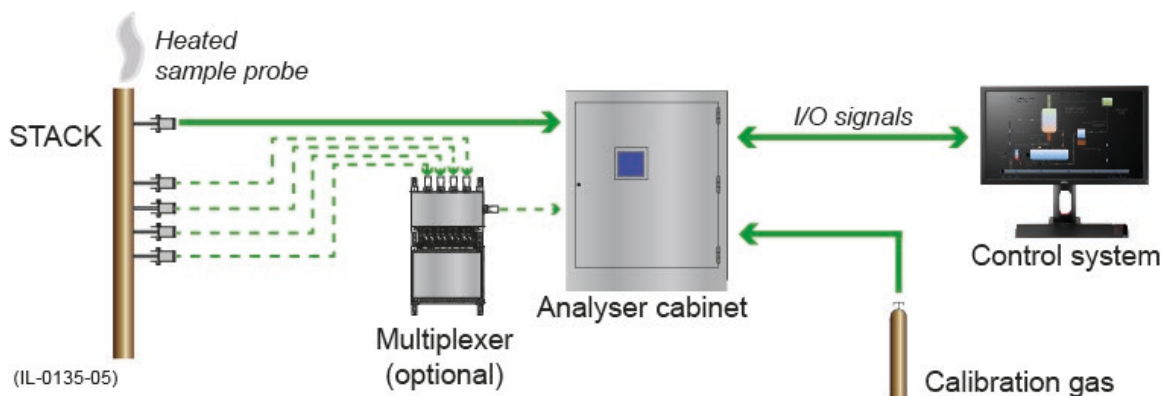


Figure 1 ShipCEMS main parts

1.2 Scope of supply

The Analyser System consists of the following main units:

The Analyser System consists of the following main components:

- Analyser Cabinet (AC)
- Analyser Module (AM)
- PLC
- Heated sample probe
- Heated sample line, 5 to 20 meters.
- Optional Equipment:
 - ShipCEMS multiplexer (for raw gas)
 - Zero Gas Regulator
 - Zero Gas
 - Cal Gas regulator
 - Air Filter Station
 - Air Dryer with Mounting Kit
 - ShipCEMS Connect

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

1.3 Contact details

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

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Fax: +47 3337 5149

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Service: service@norskanalyse.com

Spare parts: marine@norskanalyse.com

2 General safety rules

Safety precautions must always be followed 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 are heavy units. Do not open cabinet doors while in rough seas. Doors may suddenly swing open and cause damage or injury.

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

3 System description

3.1 Main purpose

The main purpose of the Analyser System is to analyse various exhaust gases with or without scrubber installed. For CEMS applications the system is made for 1-stream system. For raw gas applications and with a multiplexer installed, the system can handle up to four streams.

ShipCEMS Compact 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. Land based applications have the same design.

ShipCEMS Compact 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 will be displayed on the HMI, and an alarm signal is also sent to the client. If a potentially harmful fault occurs, appropriate actions will automatically be taken.

3.2 Analyser cabinet

This cabinet is made of stainless steel SS316L. 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 cabinet is supported on the rear of the wall frame by soft anti-vibration cushions to reduce the impact of horizontal and vertical vibrational movements.

The complete assembly is designed for mounting onto a support structure and either welded on the ship casing or free-standing frame for land-based applications. This support structure is prepared by the client and typically consists of two parallel angled steel bars.



The main components of the analyser cabinet are:

- Analyser Module (section 3.2.1)
- Analyser controller, HMI
- Cabinet cooler
- Solenoid valves for mode switching and validation/calibration
- Sample gas cooler
- Sample gas pump
- Flow controller for sample and calibration gas

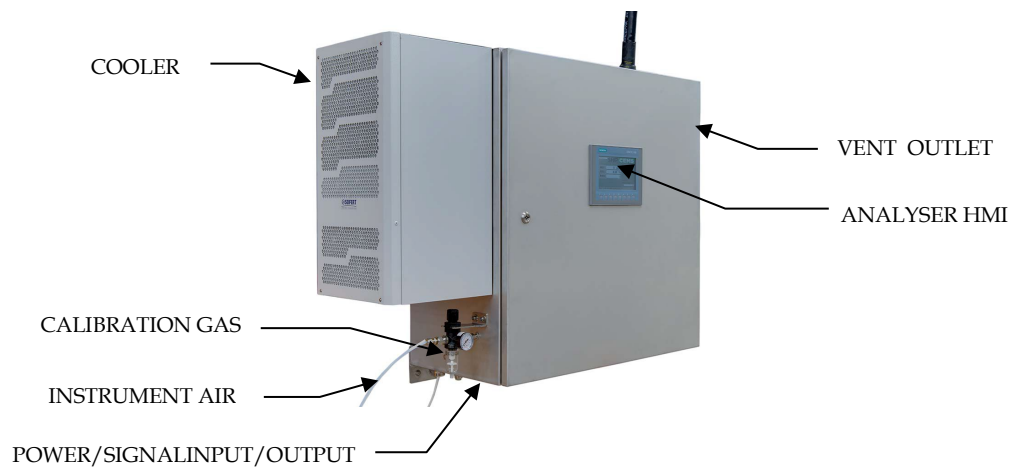


Figure 2 Analyser cabinet, main units

The cabinet door is equipped with HMI to enable local measurement readings and control of the system without opening the cabinet. The cabinet door allows access to the analyser, module and other units for service or filter change, etc.

The cabinet is equipped with a self-regulating cooling unit. The normal ambient temperature is defined as +5°C to +55°C. A cooling unit with 2700 BTU cooling capacity is used to reduce the inside cabinet temperature to maximum +40°C.

3.2.1 Analyser module

The analyser module is an enclosed unit that is mounted inside the analyser cabinet.

There are four versions. Refer to table below.



Figure 3 Analyser module

Analyser module	Measuring ranges
SCC-AM-SO2-CO2	SO2 0-200ppm CO2 0-15 %
SCC-AM-ALL	SO2 0-200ppm CO2 0-15 % NO 0-2000 ppm NO2 0-500 ppm CO 0-2000 ppm
SCC-AM-ALL+CH4	SO2 0-200ppm CO2 0-15 % NO 0-2000 ppm NO2 0-500 ppm CO 0-2000 ppm CH4 0-10 000 ppm
SCC-AM-ALL+COe	SCC-AM-ALL+COe SO2 0-200ppm CO2 0-15 % NO 0-2000 ppm NO2 0-500 ppm CO 0-2000 ppm COe 0-10 000 ppm

3.3 Multiplexer (optional for raw gas systems)

Refer to Figure 1.

This multiplexer is made of stainless steel SS316L.

To allow for multiple streams, the analyser can be equipped with a multiplexer. When a multiplexer is installed the streams from up to four stacks can be analysed.

3.4 Sample probe

The sample probe with its sample quill (the tube inserted into the exhaust stack) is installed to extract a representative sample from the exhaust gas of the ship engine.

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

The probe is fitted with calibration port and blow-back.

The probe has a flange to be fitted to the exhaust stack. The client must provide the counter flange welded to the exhaust stack.

The quill is attached to the probe and length of the quill determines where in the stack the sample is extracted from. Different types of quills are available. Refer to the spare part list in section 8.2 for an overview.

The probe is heated to make sure that the sample does not condense when it reaches the filter for separation of dust and other larger particles. The temperature is self-regulating with a low temperature alarm. The sample probe can be 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.*

3.5 Heated sample line

The heated sample line consists of a pre-assembled tube bundle with its own electrical self-regulating heat tracer cable. An aluminium 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 always be heated. This prevents condensation and any losses of trace components to be measured. It also avoids expensive and time-consuming maintenance.

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.

3.6 Calibration gas

Calibration gas is used for sensitivity verifications as well as calibration. The 10 litres gas cylinder is the normal use for approx. 12 months.

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

3.6.1 Zero gas

Instrument air is used for analysers only measuring CO₂ and SO₂
Nitrogen is used for all the other types of analysers.

3.6.2 Span gas

Span gas depends on analyser configuration. Refer to spare part list in section 8.
It is normally enough to have only one (1) calibration cylinder onboard.

3.7 Instrument air supply

The client must provide quality instrument air supply, with a water dew point of less than +3°C, and with no oil and no particulate contaminants.

This is vital for the 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: Dry, oil-free according to **ISO 8573-1:2010 [4: 3: 4]** (@ outlet instr. air).
ShipCEMS air filter [120404] is recommended in addition to the filter on the analyser.

3.8 Power supply

The client must provide a 110/230 VAC, 50/60 Hz two-phase continuous power supply. The cabinet is protected using a main two-pole automatic fuse.

The power consumption varies:

For a 230V system: 1480W + 66W/m for heated sample lines.

For multiplexer: additional 850W + 66W/m for multiplexer heated sample lines.

Note *Equipment start-up after blackout or restart is only 1-2 minutes, when the system is warm. A cold system requires approx. 30 minutes for the measurements to be stable.*

3.9 Network

Network depends on analyser configuration, e.g., TCP/IP.

3.10 Analyser controller

Analyser readings and system alarms are handled by the system analyser and are visible on the HMI in the front door of the analyser cabinet. The HMI has a touch screen. For operations refer to section 5.

3.11 Analyser interface

The intuitive HMI located in the front of the analyser cabinet. The touch screen is easy to use.



Figure 4 *HMI in front of the analyser cabinet*

4 Functional description

4.1 Overview

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

ShipCEMS Compact is designed to measure low values of gas components in wet and dry exhaust gases.

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.

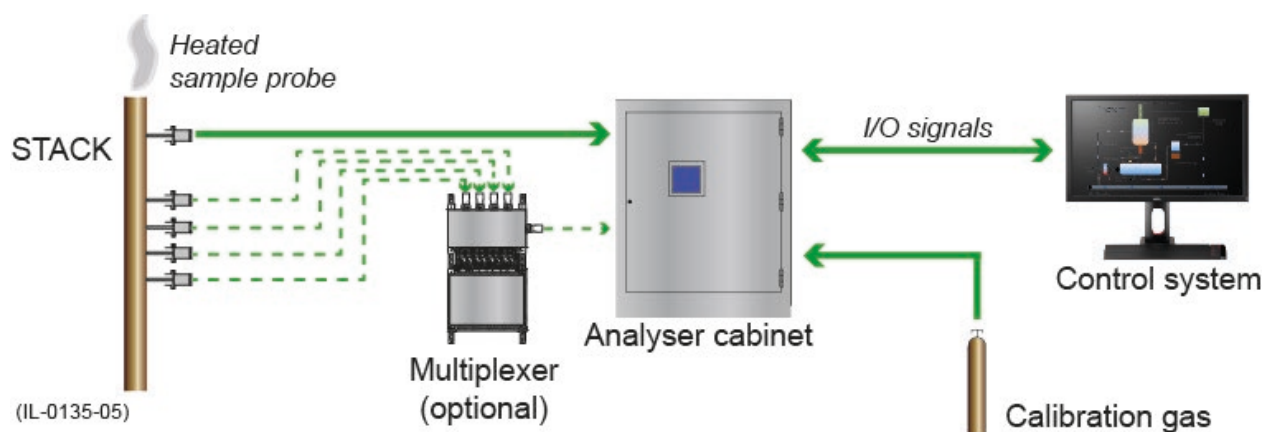


Figure 5 Block diagram for ShipCEMS Compact analyser system

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

- [50118-3001] – SYSTEM DIAGRAM ANALYSER CABINET
- [50118-5003] – TERMINATION DIAGRAM SIGNAL DISTRIBUTION /WITH MODBUS TCP/IP ANALYSER CABINET
- [50118-6001] – SYSTEM BLOCK DIAGRAM P&ID DISTRIBUTION OVERVIEW
- [50118-6002] – SYSTEM BLOCK DIAGRAM SIGNAL AND POWER DISTRIBUTION OVERVIEW

4.2 Sample probe and heated sample line

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

The heated sample line requires 110/230 VAC power supply. A self-regulating heat tracer cable is used to set temperature above dew point to avoid condensation and to keep the sample in a gas phase.

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 send to the analyser cabinet and the client automation system.*

4.3 Analyser System

A sample gas pump, placed inside the analyser cabinet, will draw the sample gas through the heated sample line into the sample gas cooler which remove the moisture from the gas. From the cooler the gas passes the flow controller and flow meter before entering the analyser. After being processed by the analyser module, the sample is released to ambient air through the atmospheric vent.

The sample flow will be adjusted automatically by flow controller and can be monitored on the HMI screen.



Figure 6 Analyser cabinet, interior view

The analyser cabinet includes HMI as a standard.

The analyser is supported by an anti-vibration frame inside the cabinet.

The measurements are based on the molecular-specific absorption of infrared radiation bands (absorption bands).

The analyser modules use a spectral range which includes different wave lengths.

4.4 Blowback

Blowback cleans only the probe but with a larger amount of instrument air. It is necessary on raw gas measurement or whenever probe is dirty.

Blowback of the system can be both automatic (set day and time) or manual. There is always an option to press the Trigger once now button to perform a blowback (10 seconds).

5 Operation

Note *The time from cold start-up to ready system is approx. 30 minutes.*

Note *Start-up after blackout (when the system is warm) is only 1-2 minutes.*

The different analyser modes are standby (idle), manual mode, service mode and calibration.

5.1 User interface

The operator can interact with ShipCEMS Compact using the following external systems and instruments. Updates on software may result in slightly different pictures in this section.

- Client automation system
- HMI
- PC workstation

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

The analyser is responsible for sending alarm and information messages to the client's automation system.

Contact Norsk Analyse for information about advanced functions in the analyser module.

5.2 Analyser interface

5.2.1 Main Screen

From the main page the following can be seen:

- F1 Main page
- F2 Diagnostics
- F3 Configuration
- F4 Calibration
- F5 Service
- F6 Reserved for future use
- F7 Reserved for future use
- F8 Alarms and logbook

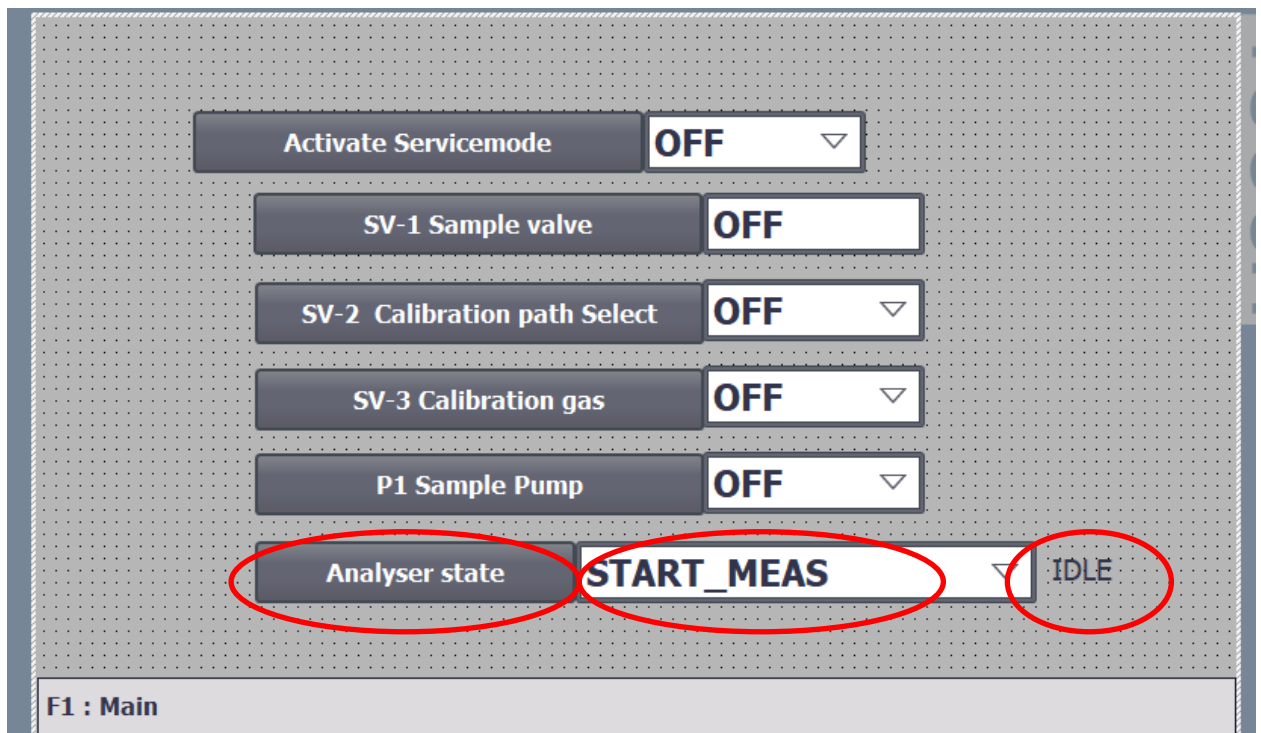


5.2.2 Information about HMI

The HMI picture is dynamic and may change or look different depending on configuration.

In the example picture below:

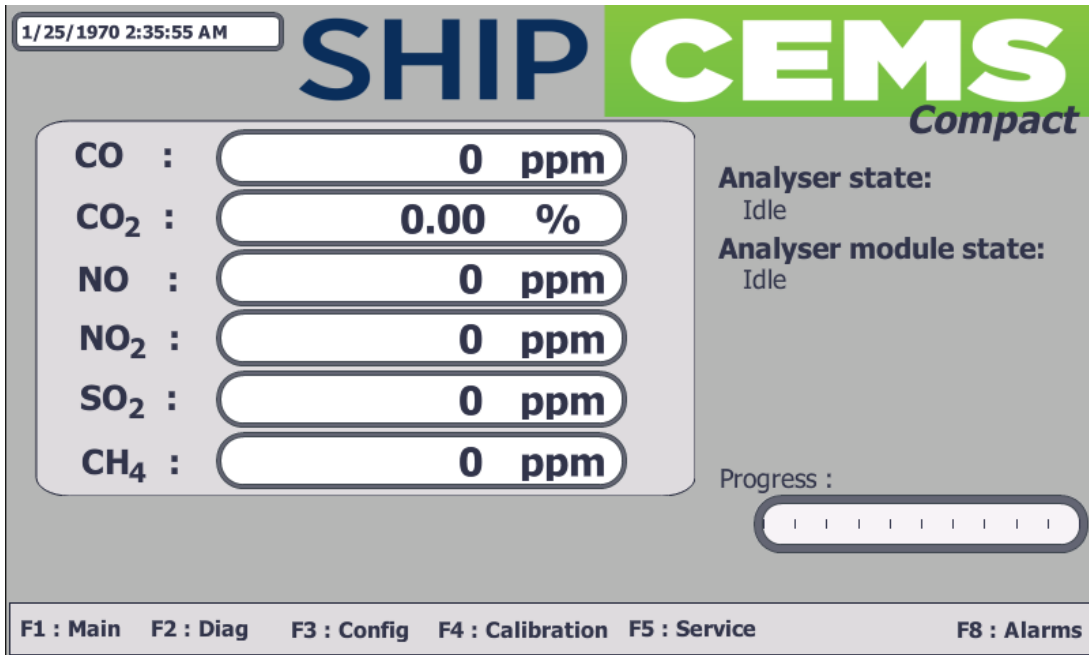
- **Analyser state** means parameter.
- **START_MEAS**: what is selected.
- **IDLE** is current state but will change to what is selected above (some seconds delay).



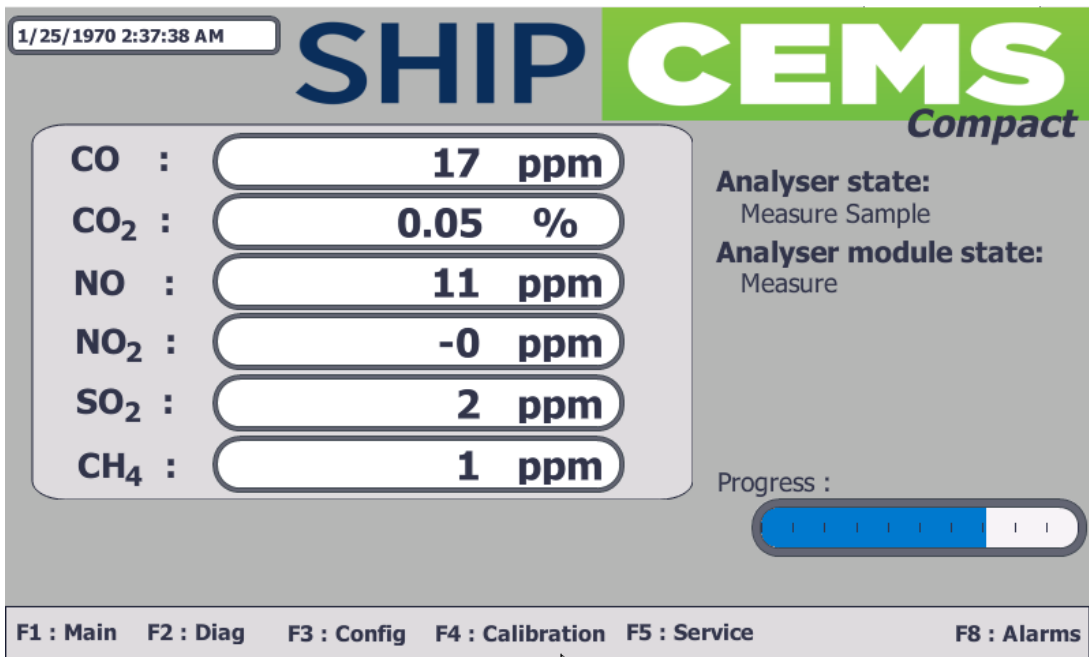
5.2.3 F1 - Main page

Main page is visible in the cabinet door when the system is running.

Depending on analyser module, AM configuration, some, or all the gases in the pictures below are visible.



When the analyser is running it shows the actual measurements and status of the measuring cycle. "Analyser state" reflects state/position of valves and pumps while "analyser module state" means what gas analyser is currently doing.



5.2.4 F2 - Diagnostics

The diagnostics pages give an overview of the status of the system. In general, the background colour indicates the health of parameter. "White" = Normal , "Orange" = slightly abnormal , "red" = alarm state.

5.2.4.1 Diagnostic page 1_1

The screenshot shows the 'Diagnostics page 1_1' interface. It features a 'System' button at the top left and two navigation buttons: 'Previous page' and 'Next page'. The main area displays several parameters with their values and units, each in a colored box: 'Sample H2O' (8933 ppm, white), 'Analyser sample pressure' (0.994 Bar Abs., white), 'Analyser sample temp' (28.2 Deg C, white), 'Sample flow' (32767 NI/min, red), 'Calibration port flow' (0 NI/min, orange), and 'Analyser abs. transmission' (89 %, white). A footer bar contains function keys: F1 : Main, F2 : Diag, F3 : Config, F4 : Calibration, F5 : Service, and F8 : Alarms.

Sample H2O:	8933	ppm
Analyser sample pressure:	0.994	Bar Abs.
Analyser sample temp:	28.2	Deg C
Sample flow:	32767	NI/min
Calibration port flow:	0	NI/min
Analyser abs. transmission:	89	%

5.2.4.2 Diagnostic page 1_2

The screenshot shows the 'Diagnostics page 1_2' interface. It features a 'System' button at the top left and two navigation buttons: 'Previous page' and 'Next Page'. The main area displays several parameters with their values and units, each in a white box: 'Analyser error code' (#####), 'Sample temp.:' (##### Deg C), 'PLC Cabinet temp.:' (30.0 Deg C), 'PLC Ambient temp.:' (20.8 Deg C), 'Multiplexer box temp.:' (##### Deg C), 'Multiplexer amb. temp.:' (##### Deg C), 'SCC PLC alive signal :' (30), and 'Evaluation unit alive signal :' (0). A footer bar contains function keys: F1 : Main, F2 : Diag, F3 : Config, F4 : Calibration, F5 : Service, and F8 : Alarms.

Analyser error code:	#####	
Sample temp.:	#####	Deg C
PLC Cabinet temp.:	30.0	Deg C
PLC Ambient temp.:	20.8	Deg C
Multiplexer box temp.:	#####	Deg C
Multiplexer amb. temp.:	#####	Deg C
SCC PLC alive signal :	30	
Evaluation unit alive signal :	0	

5.2.4.3 Diagnostic page 1_3

Diagnostics page 1_3

Analyser

Previous page

Next page

Raw values as read directly from gas analyser :

CO :	+0.000 ppm
CO ₂ :	-0.108 Vol. %
NO :	+0.000 ppm
NO ₂ :	+0.000 ppm
SO ₂ :	+13.284 ppm
CH ₄ :	+0.000 ppm
H ₂ O :	+5937.662 ppm

F1 : Main
F2 : Diag
F3 : Config
F4 : Calibration
F5 : Service
F8 : Alarms

5.2.4.4 Diagnostic page 1_4

Diagnostics page 1_4

Multiplexer

Previous page

Next page

Raw values as read directly from multiplexer:

Multiplexer installed : YES

Exhaust flow #1:	##### Nm...
Exhaust flow #1:	##### Nm...
Exhaust flow #1:	##### Nm...
Exhaust flow #1:	##### Nm...

SCM ambient temp: ##### D...

SCM hotbox temp: ##### D...

Multiplexer State: #

Alive : ###

* This page is diagnostics view only.
Change in config must be done from config menu

F1 : Main
F2 : Diag
F3 : Config
F4 : Calibration
F5 : Service
F8 : Alarms

5.2.4.5 Diagnostic page 2_1

Diagnostics page 2_1																	
PLC IO #1	<table border="1"> <tr> <td>PLC DI.1 - Cooler OK</td> <td>1</td> </tr> <tr> <td>PLC DI.2 - Sample probe OK</td> <td>1</td> </tr> <tr> <td>PLC DI.3 - Condensate tray alarm</td> <td>0</td> </tr> <tr> <td>PLC DI.4 - Spare</td> <td>0</td> </tr> <tr> <td>PLC AI.1 - Sample gas flow</td> <td>32767</td> </tr> <tr> <td>PLC AI.2 - O2 mA</td> <td>0</td> </tr> <tr> <td>PLC AI.3 - Calibration port flow</td> <td>32767</td> </tr> <tr> <td>PLC AI.4 - External exhaust flow sensor</td> <td>0</td> </tr> </table>	PLC DI.1 - Cooler OK	1	PLC DI.2 - Sample probe OK	1	PLC DI.3 - Condensate tray alarm	0	PLC DI.4 - Spare	0	PLC AI.1 - Sample gas flow	32767	PLC AI.2 - O2 mA	0	PLC AI.3 - Calibration port flow	32767	PLC AI.4 - External exhaust flow sensor	0
PLC DI.1 - Cooler OK	1																
PLC DI.2 - Sample probe OK	1																
PLC DI.3 - Condensate tray alarm	0																
PLC DI.4 - Spare	0																
PLC AI.1 - Sample gas flow	32767																
PLC AI.2 - O2 mA	0																
PLC AI.3 - Calibration port flow	32767																
PLC AI.4 - External exhaust flow sensor	0																
Previous page																	
Next page																	
F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms																	

5.2.4.6 Diagnostic page 2_2

Diagnostics page 2_2																									
PLC IO #2	<table border="1"> <tr> <td>PLC DO.1 - Sample pump start</td> <td>1</td> </tr> <tr> <td>PLC DO.2 - SV1 status</td> <td>0</td> </tr> <tr> <td>PLC DO.3 - SV2 status</td> <td>0</td> </tr> <tr> <td>PLC DO.4 - SV3 status</td> <td>0</td> </tr> <tr> <td>PLC DO.5 - Blowback start</td> <td>0</td> </tr> <tr> <td>PLC DO.6 - Spare</td> <td>0</td> </tr> <tr> <td>PLC DO.7 - Spare</td> <td>0</td> </tr> <tr> <td>PLC DO.8 - Spare</td> <td>0</td> </tr> <tr> <td>PLC Pt-100.1 - Cabinet temp</td> <td>26.6</td> </tr> <tr> <td>PLC Pt-100.2 - Spare</td> <td>850.0</td> </tr> <tr> <td>PLC Pt-100.3 - Spare</td> <td>850.0</td> </tr> <tr> <td>PLC Pt-100.4 - Ambient temp</td> <td>21.7</td> </tr> </table>	PLC DO.1 - Sample pump start	1	PLC DO.2 - SV1 status	0	PLC DO.3 - SV2 status	0	PLC DO.4 - SV3 status	0	PLC DO.5 - Blowback start	0	PLC DO.6 - Spare	0	PLC DO.7 - Spare	0	PLC DO.8 - Spare	0	PLC Pt-100.1 - Cabinet temp	26.6	PLC Pt-100.2 - Spare	850.0	PLC Pt-100.3 - Spare	850.0	PLC Pt-100.4 - Ambient temp	21.7
PLC DO.1 - Sample pump start	1																								
PLC DO.2 - SV1 status	0																								
PLC DO.3 - SV2 status	0																								
PLC DO.4 - SV3 status	0																								
PLC DO.5 - Blowback start	0																								
PLC DO.6 - Spare	0																								
PLC DO.7 - Spare	0																								
PLC DO.8 - Spare	0																								
PLC Pt-100.1 - Cabinet temp	26.6																								
PLC Pt-100.2 - Spare	850.0																								
PLC Pt-100.3 - Spare	850.0																								
PLC Pt-100.4 - Ambient temp	21.7																								
Previous page																									
Next page																									
F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms																									

5.2.4.7 Diagnostic page 3

Diagnostics page 3	
Information	
Analyser serial number:	TGA1000490
Analyser OS version:	1.4.4-1417
Analyser FW version:	1.4.4
PLC SW version:	1.460
Panel application version:	1.440
<p>Previous page</p> <p>Next page</p>	
<p>F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms</p>	

5.2.4.8 Diagnostic page 4

Diagnostics page 4	
Client connection	
Select engine 1:	0
Select engine 2:	0
Select engine 3:	0
Select engine 4:	0
Alive signal:	0
<p>Previous page</p> <p>Next page</p>	
<p>F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms</p>	

5.2.4.9 Diagnostic page 5_1

Diagnostics page 5_1

Ext. sensor SP1

Previous page

Next page

Flow rate:	0.00
Density:	0.0
Stack Temperature:	0.0
Velocity:	0.00
Total Flow:	0.000

Evaluation unit :

Stream #1 exhaust temperature :	0.0 Deg. C
Stream #1 exhaust pressure :	0.000 Bar.Abs
Stream #1 exhaust volume flow :	0 Nm3/hr

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

5.2.4.10 Diagnostic page 6

Diagnostics page 6

Calculations SP1

Previous page

Next page

Mass emission calculations:

0.000 kg/h
0.000 kg/h
0.000 kg/h
0.000 kg/h
0.000 kg/h
0.000 kg/h

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

5.2.4.11 Diagnostic page 7_1

Diagnostics page 7_1

Multiplexer

Exhaust flow Engine #1 : ##### Nm3/hr

Exhaust flow Engine #2 : ##### Nm3/hr

Exhaust flow Engine #3 : ##### Nm3/hr

Exhaust flow Engine #4 : ##### Nm3/hr

Alive: #####

Previous page

Next page

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

5.2.5 F3 - Configuration

The configuration has four pages.

5.2.5.1 Config. page 1

To enter new IP address or subnet mask, fill out the fields. Then select *Save to PLC*.

Config page 1

IP config

Read

Save to PLC

Previous page

Next page

Client ethernet configuration:

IP address:

In use: 193 . 169 . 1 . 0

NEW: 192 . 158 . 1 . 15

Subnet mask:

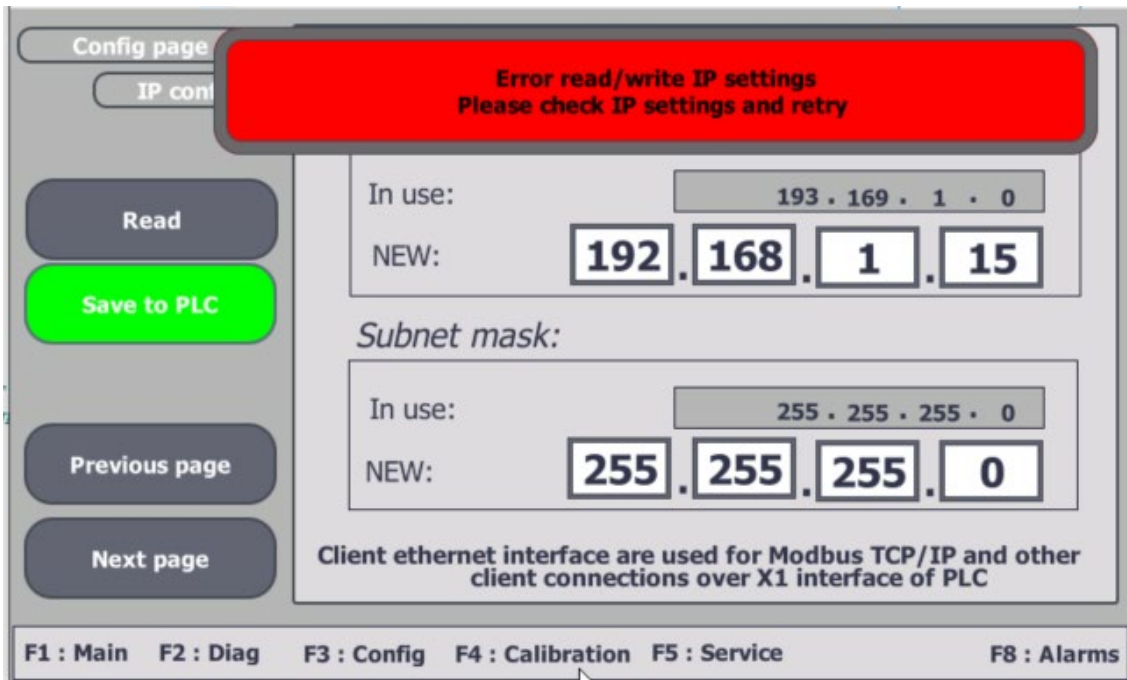
In use: 255 . 255 . 255 . 0

NEW: 255 . 255 . 255 . 0

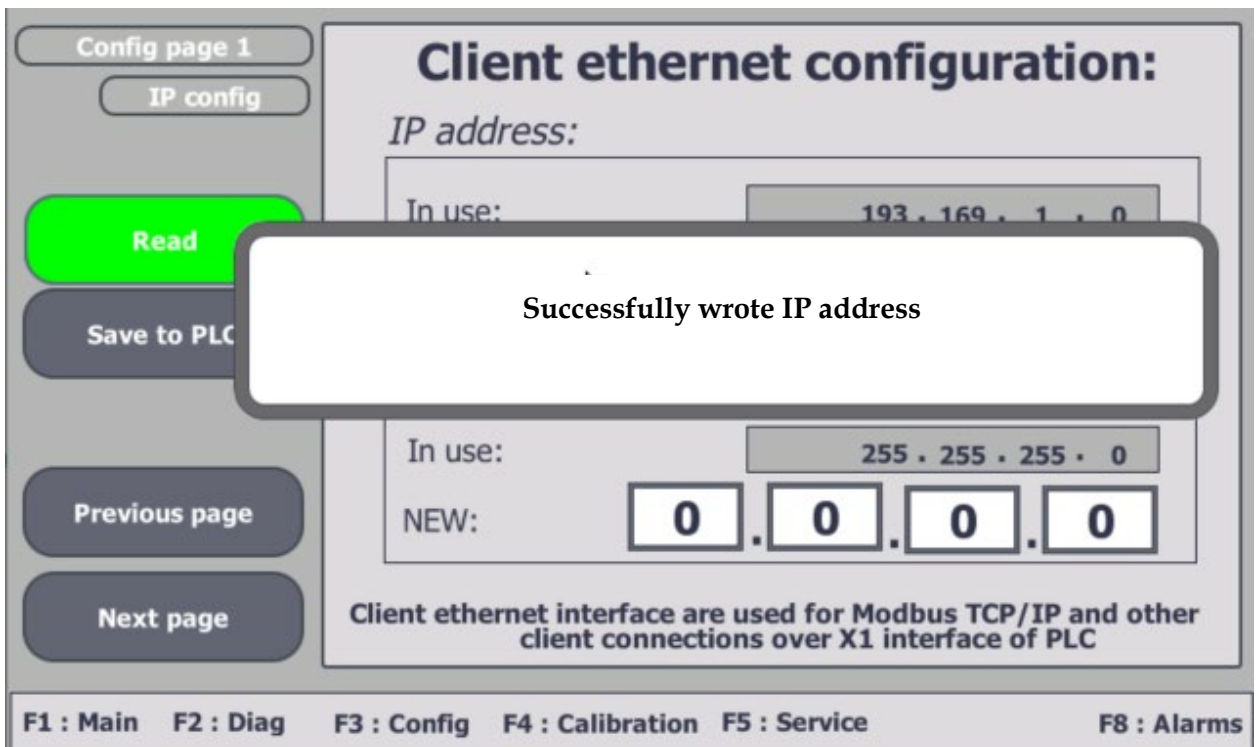
Client ethernet interface are used for Modbus TCP/IP and other client connections over X1 interface of PLC

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

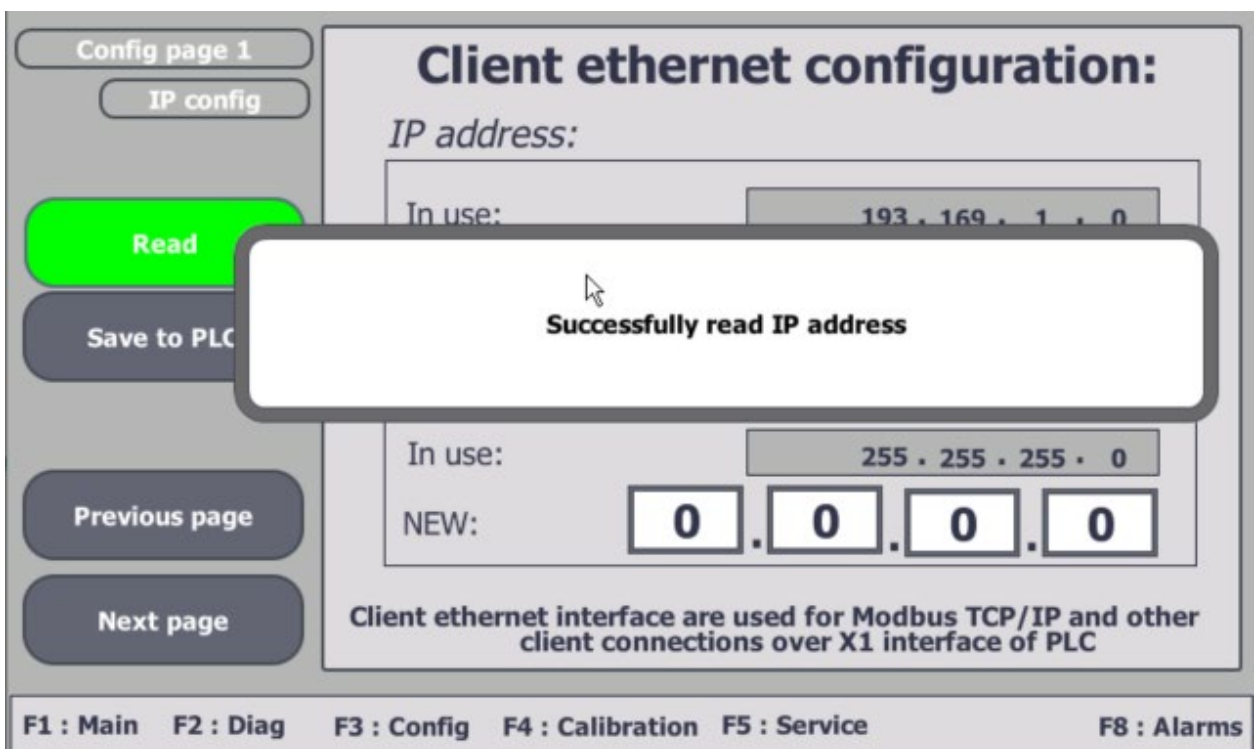
If IP settings are incorrect, the following screen appear after *Save to PLC*. is selected.



If values are correct, the following screen appears.



Note that the *In use* field does not update automatically until *Read* button is pressed.



5.2.5.2 Config. page 2

Choosing which analyser is installed and which type of flow sensor and O2 sensor.

Config page 2

System

Analyser module : CO-CO2-NO-NO2-SO2-CH4

Sample flow sensor: 4-20 mA

* Change on next PLC reboot

O2 sensor : 0-10 V

Previous page

Next page

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

5.2.5.3 Config. page 3

Trigger blowback once or set it to automatic.

Config page 3

Blowback

Blowback config:

Automatic : ON

Time of day (0..23): 6

Previous page

Next page

Trigger once now

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

5.2.5.4 Config. page 4

Select "yes" if h multiplexer is installed. Set setpoints according to application specifications.

Config page 4
Stream config

Multiplexer installed : YES

Maintain temp : 140 Deg. C

Sample time : 180 Seconds

Engine Select method : Automatic

Previous page
Next page

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

Config page 4
Stream config

Multiplexer installed : YES

Maintain temp : 140 Deg. C

Sample time : 180 Seconds

Engine Select method : Manual

Stream #1 Stream #2 Stream #3 Stream #4

Green = Qued for measurement
Red = NOT Qued for measurement

Previous page
Next page

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

5.2.5.5 Config. page 5

Chose type of exhaust gas flow sensor if any.

Config page 5
External sensors
Exhaust gas flow

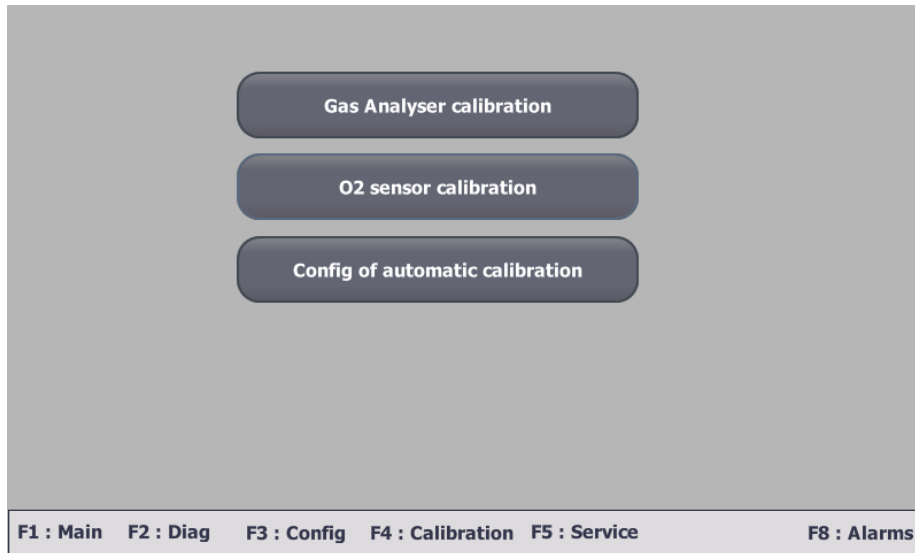
Exhaust gas flow sensor: Not installed

Not installed
mA type
Kurz

Previous page
Next page

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

5.2.6 F4 - Calibration



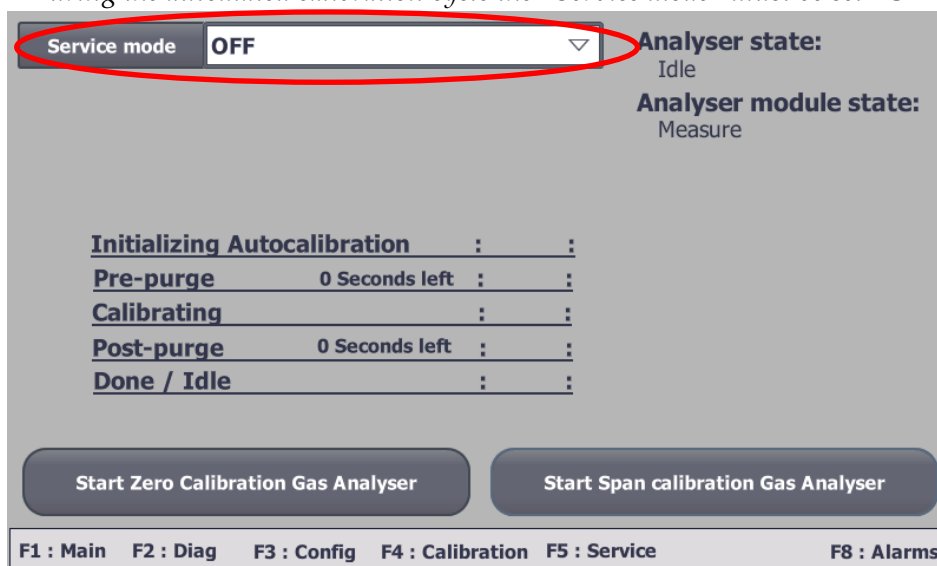
5.2.6.1 Gas Analyser Calibration

For flow adjustments and the use of calibration menu, refer to section 5.3.1, 5.3.2 and 5.3.3.

1. Flow adjustment, open bottle and preparations. Refer to section 5.3.1
2. ZERO calibration. Refer to 5.2.6.1.2
3. SPAN calibration Refer to 5.2.6.1.3
4. O2 sensor calibration. Refer to 5.2.6.1.4
5. Option: Config of automatic calibration menu. Refer to 5.2.6.1.5

Note Calibration is normally always done zero + span. System allows for them to be run individually but ZERO must always be performed before SPAN calibration.

Note During the automated calibration cycle the "Service mode" must be set "OFF".

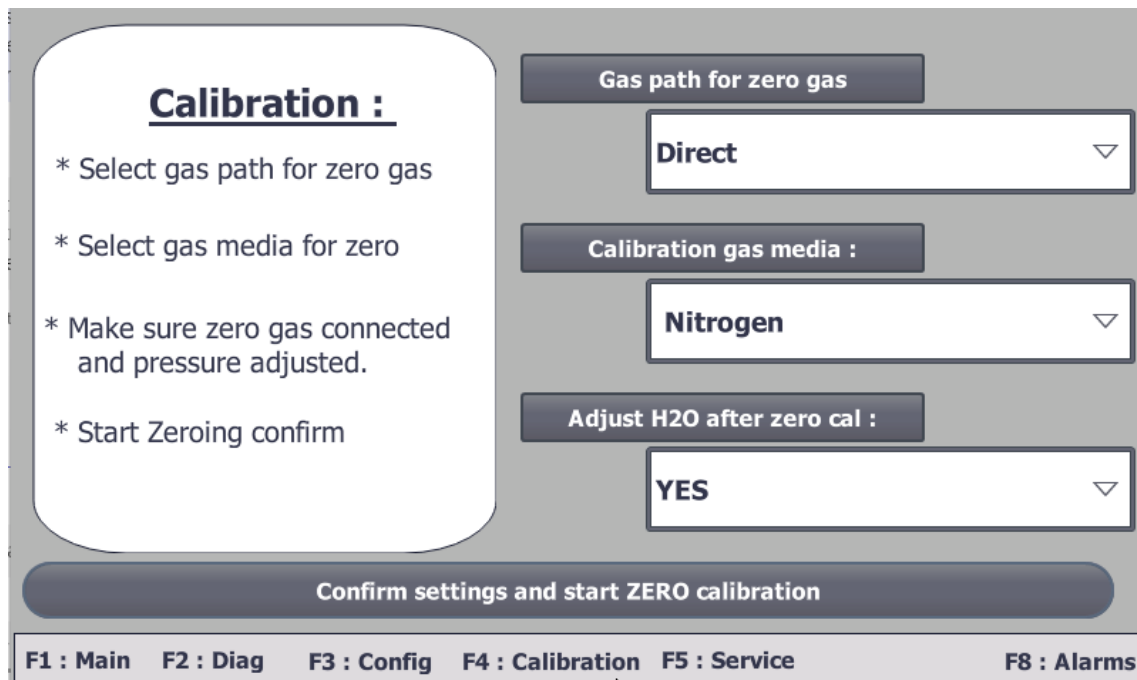


5.2.6.1.1 Flow adjustment

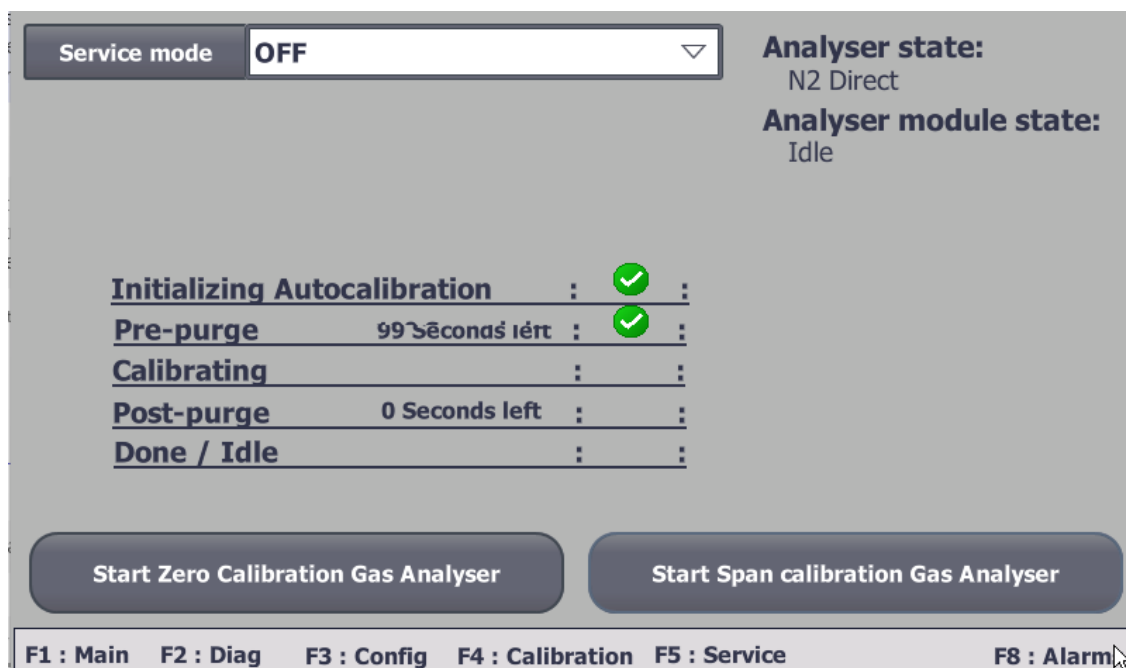
Refer to section 5.3.1

5.2.6.1.2 Zero calibration

Note Make sure "Service mode" must be set "OFF"



Make selections accordingly and press "confirm and start Zero calibration". The screen will go back to the main page and show status/progress:



System will go through the automated calibration cycle and switch valves at need. Once it reaches "DONE / IDLE" process is done and you can leave this screen or continue with SPAN calibration.

5.2.6.1.3 Span calibration

Calibration :

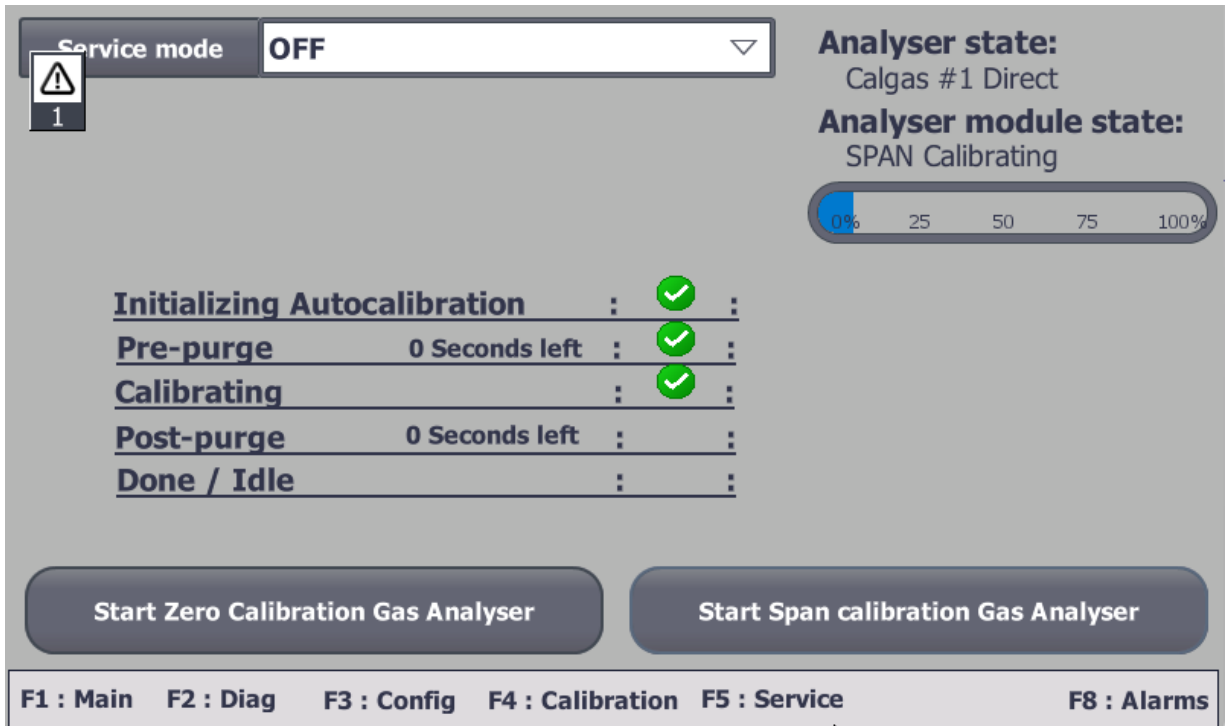
- * Select components to calibrate.
- * Set calibration gas actual value for each component.
- * Make sure gas media connected and pressure adjusted accordingly.
- * Start calibration by pressing button below.

CO :	0	0 ppm	Ignored
CO₂ :	8.10	8.10 %	Calibrate
NO_x :	0	0 ppm	Ignored
SO₂ :	161	161 ppm	Calibrate
CH₄ :	0	0 ppm	Ignore

Confirm settings and start SPAN calibration

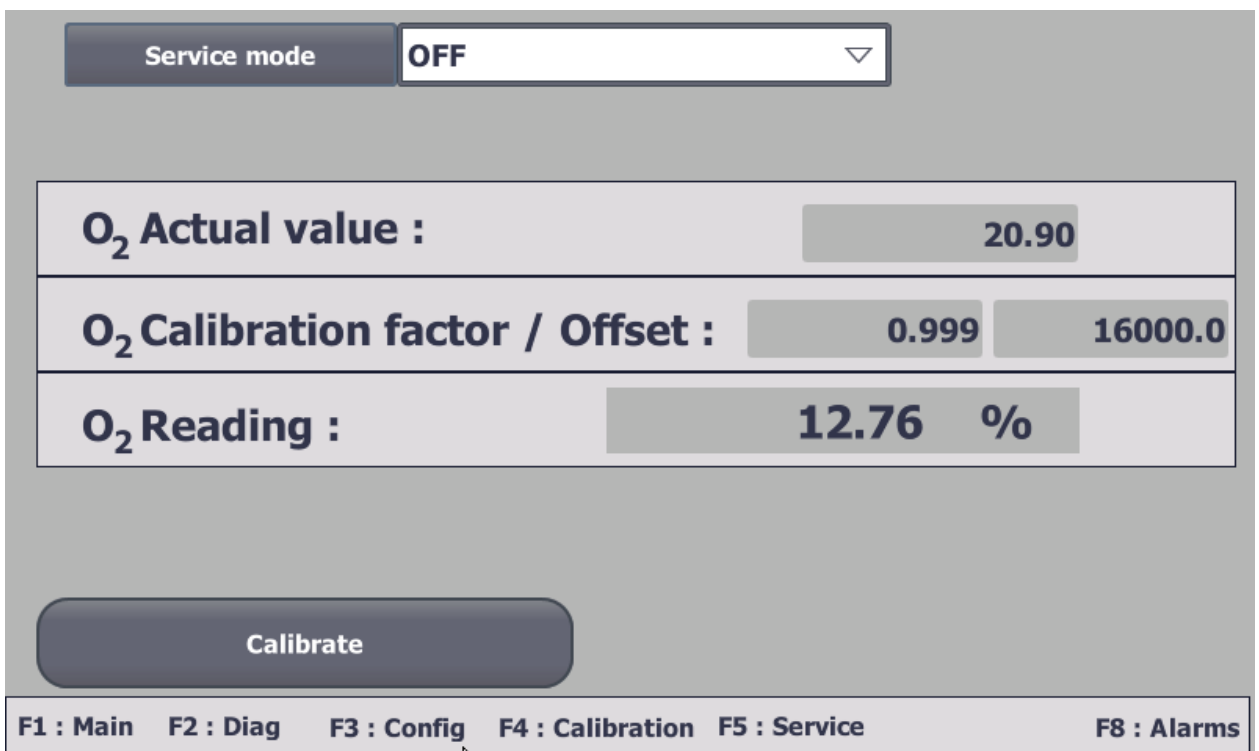
F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

Make selection accordingly. In the above example only SO2 and CO2 will be calibrated and the reference value for calibration gas is put in as setpoints. When ready press "Confirm settings and start SPAN calibration to continue and return to main screen:



When it gets to “DONE/IDLE” the calibration is performed, and you may exit this screen.

5.2.6.1.4 O2 sensor calibration menu



Make sure the O2 sensor gets instrument air and wait for stable readings. This means service mode must be set ON and you need to select system state “instrument air direct”

Service mode: ON

System state: Instrument air direct

O₂ Actual value : 20.90

O₂ Calibration factor / Offset : 0.999 16000.0

O₂ Reading : 11.51 %

Calibrate

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

Once stable and ready to calibrate press “Calibrate”.

Service mode: ON

System state: Instrument air direct

O₂ Actual value : 20.90

O₂ Calibration factor / Offset : 1.689 16000.0

O₂ Reading : 20.97 %

Calculating new value and factor: 20.90 % 1.689

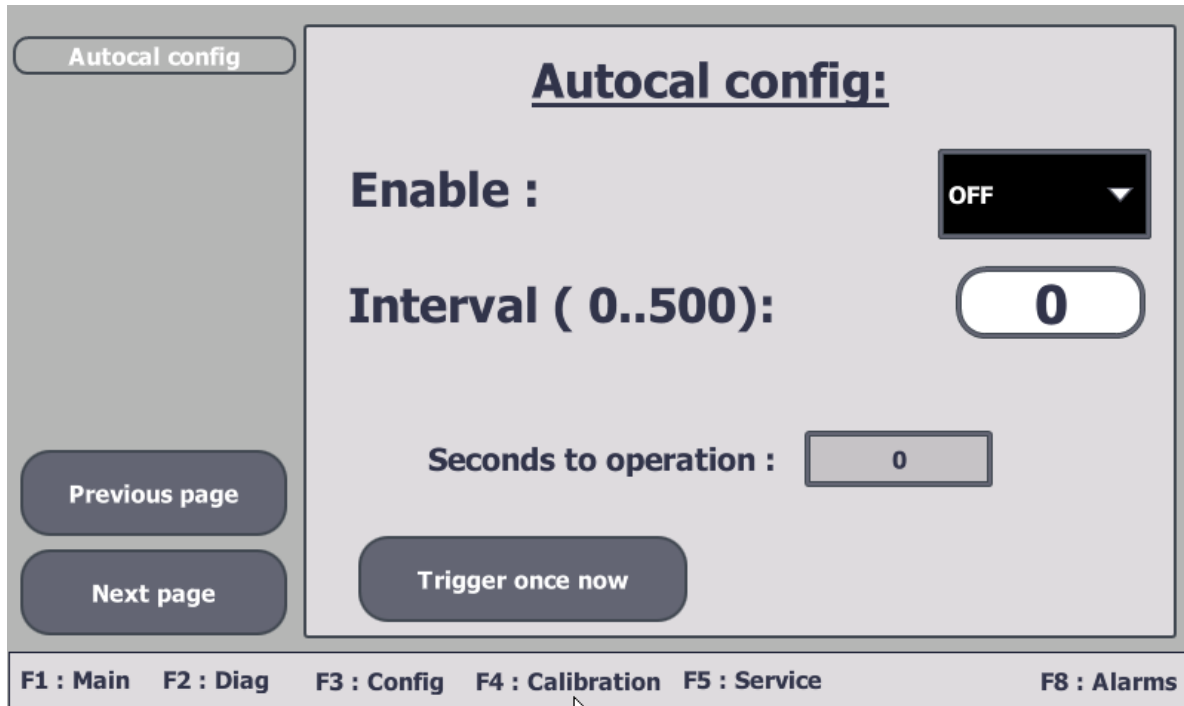
Accept calibration

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

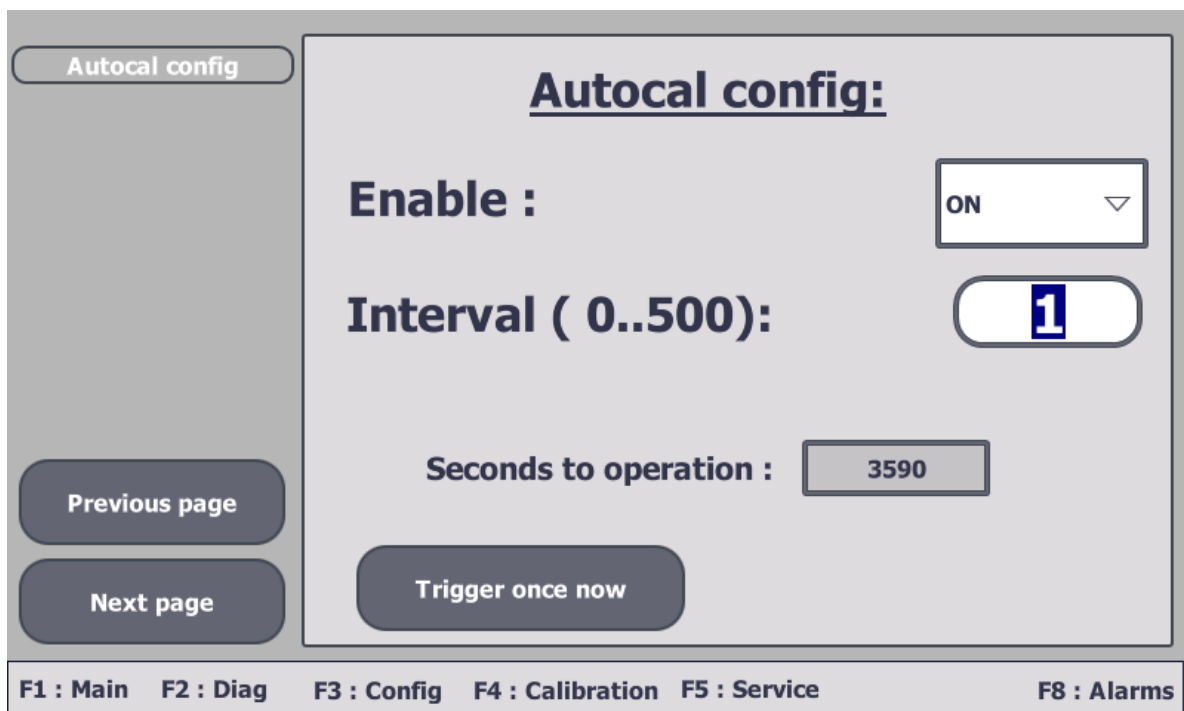
System will continue to calculate new factor and calibration until “Accept calibration” is pressed and ends the calibration taking into use the new factor.

5.2.6.1.5 Option: config of automatic calibration menu

From this menu it is possible to schedule automated start of zero calibration.



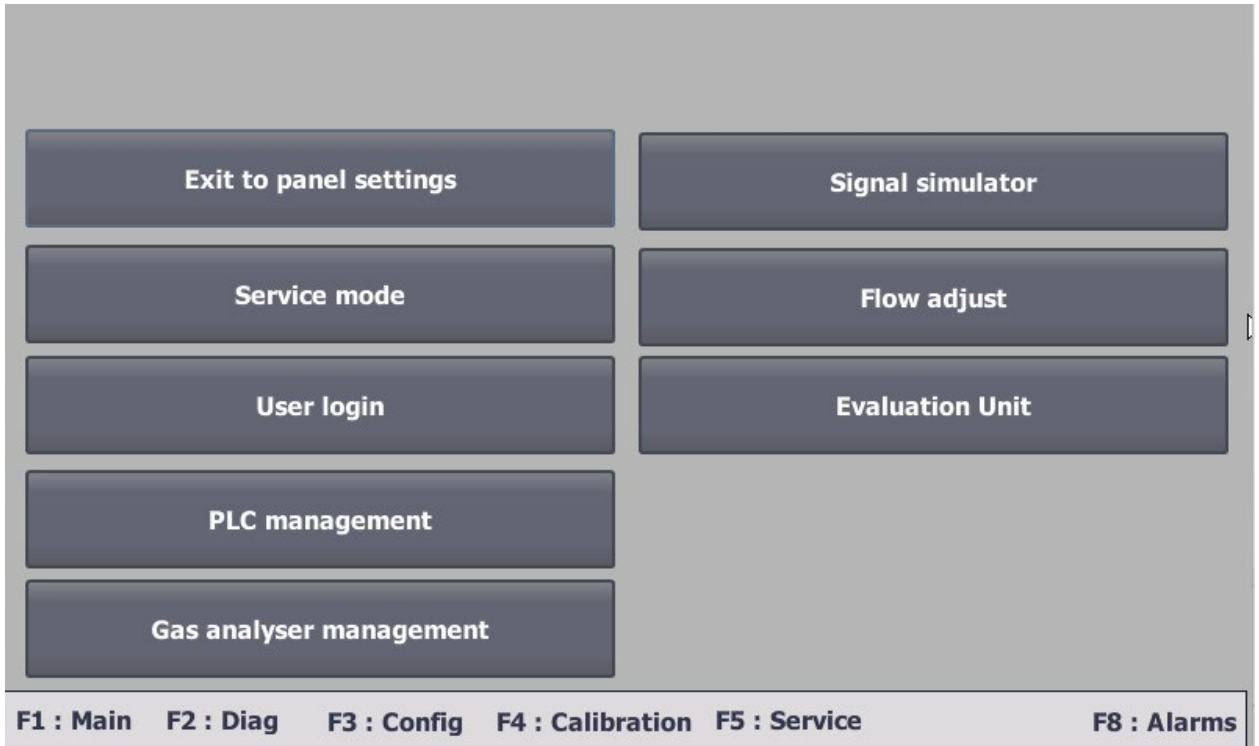
From this menu automated Zero calibration can be configured:



In the above example config 1 hour is selected for interval and the function is enabled. You can also see when seconds until the next automated zero calibration is started.

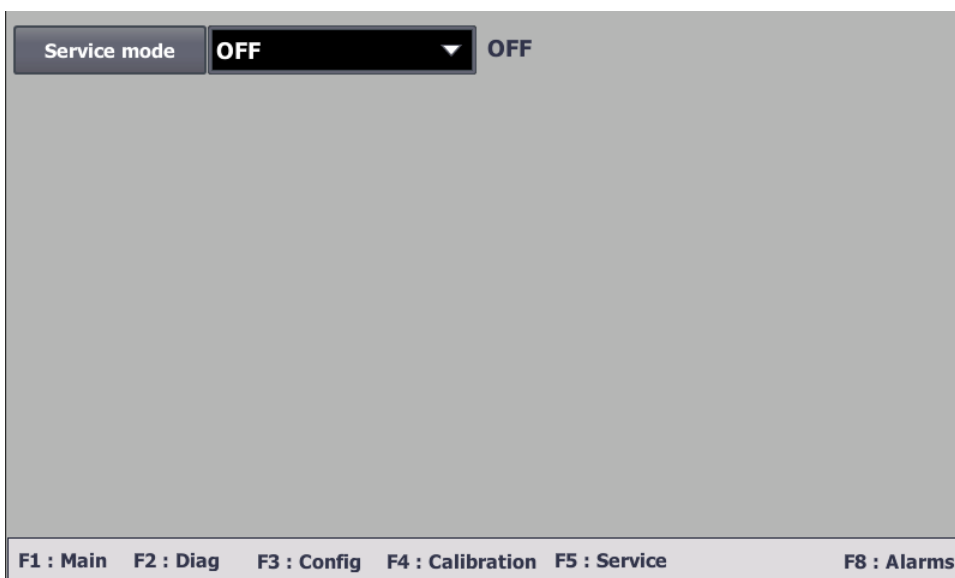
5.2.7 F5 - Service

Exit to panel setting is the manufacturer's factory settings for the HMI. There is normally no need to change anything here.

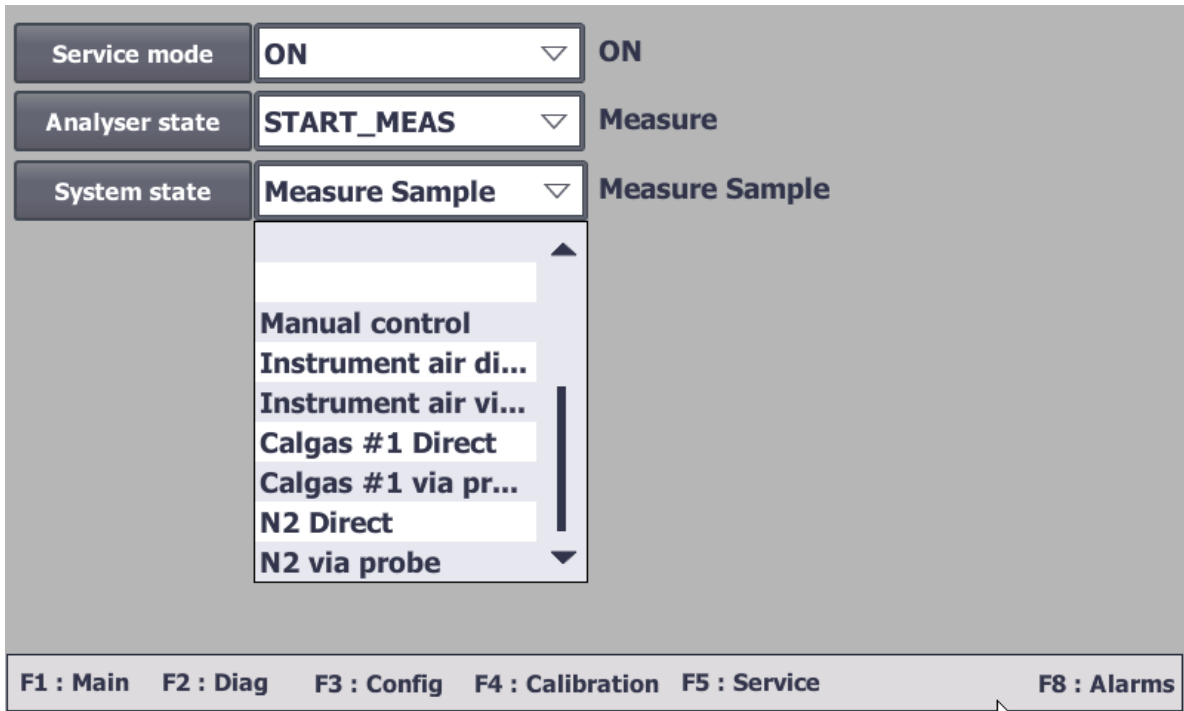


5.2.7.1 Service Mode

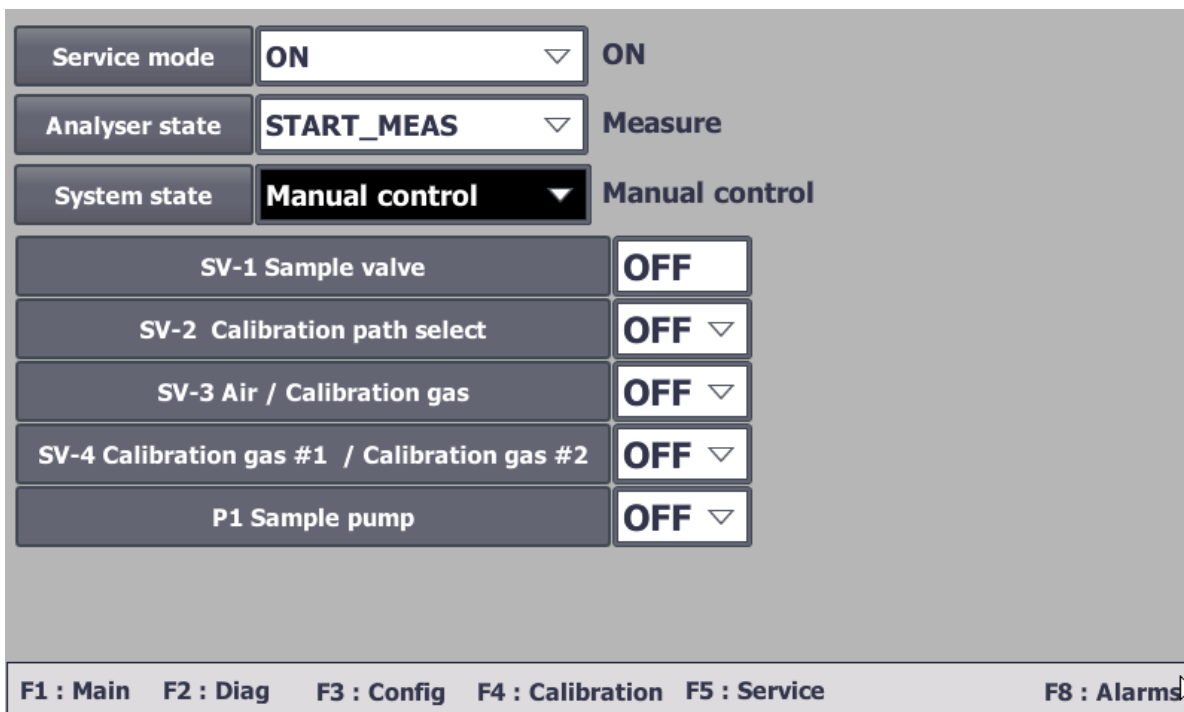
Select *Service mode* and the following display appears.



From this page the service mode can be activated, and the system can manually be operated.

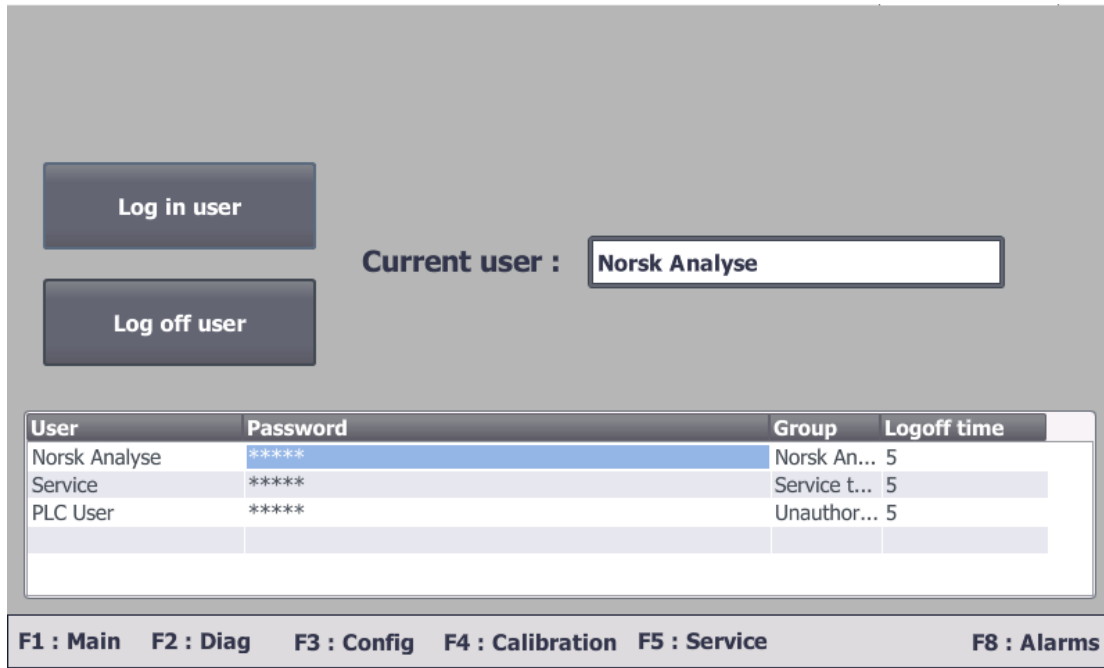


If "Manual control" is selected the valves can be set freely.



5.2.7.2 User Login

Select *User login* and the following display appears. There are three different levels of passwords. Service login: 1234.

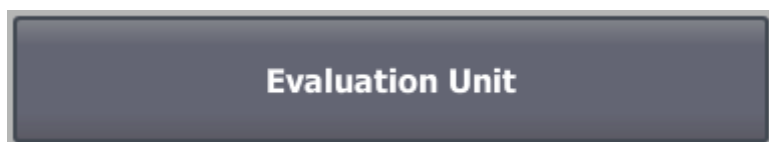


5.2.7.3 PLC & Gas analyser management

PLC management and *Gas analyser management* give access to advanced user functions/configuration of PLC/Analyser module. (Advanced password)



5.2.7.4 Evaluation Unit (option)



This is used for exhaust gas flow measurement option only and gives access to advanced config options for evaluation unit if installed.

5.2.7.5 Signal simulator

The signal simulator is for test and troubleshooting purposes only.

The Simulator interface is divided into two columns: 'Live values' and 'Fixed value'. The 'Live values' column contains eight rows, each with a gas name and an 'OFF' button. The 'Fixed value' column contains corresponding numerical values in a text box. To the right of these columns are two large toggle buttons: 'Activate simulator' and 'Simulate Multiplexer'. Below the main table are three buttons: 'Measure Values', 'Calibration constants & Config', and 'Alarm Configurator'. At the bottom left, a yellow bar displays 'PLC Softwareversion : V1.46'. At the bottom right is a 'DONE' button with a mouse cursor. The footer contains function keys: F1 : Main, F2 : Diag, F3 : Config, F4 : Calibration, F5 : Service, and F8 : Alarms.

Gas	Live values	Fixed value
CO _{co}	OFF	1200.45 ppm
CO ₂	OFF	5.12 Vol. %
NO	OFF	950.34 ppm
NO ₂	OFF	95.12 ppm
SO ₂	OFF	15.34 ppm
CH ₄	OFF	200.78 ppm
H ₂ O	OFF	5000.56 ppm
O ₂	OFF	4.89 Vol. %

5.2.7.6 Flow adjust

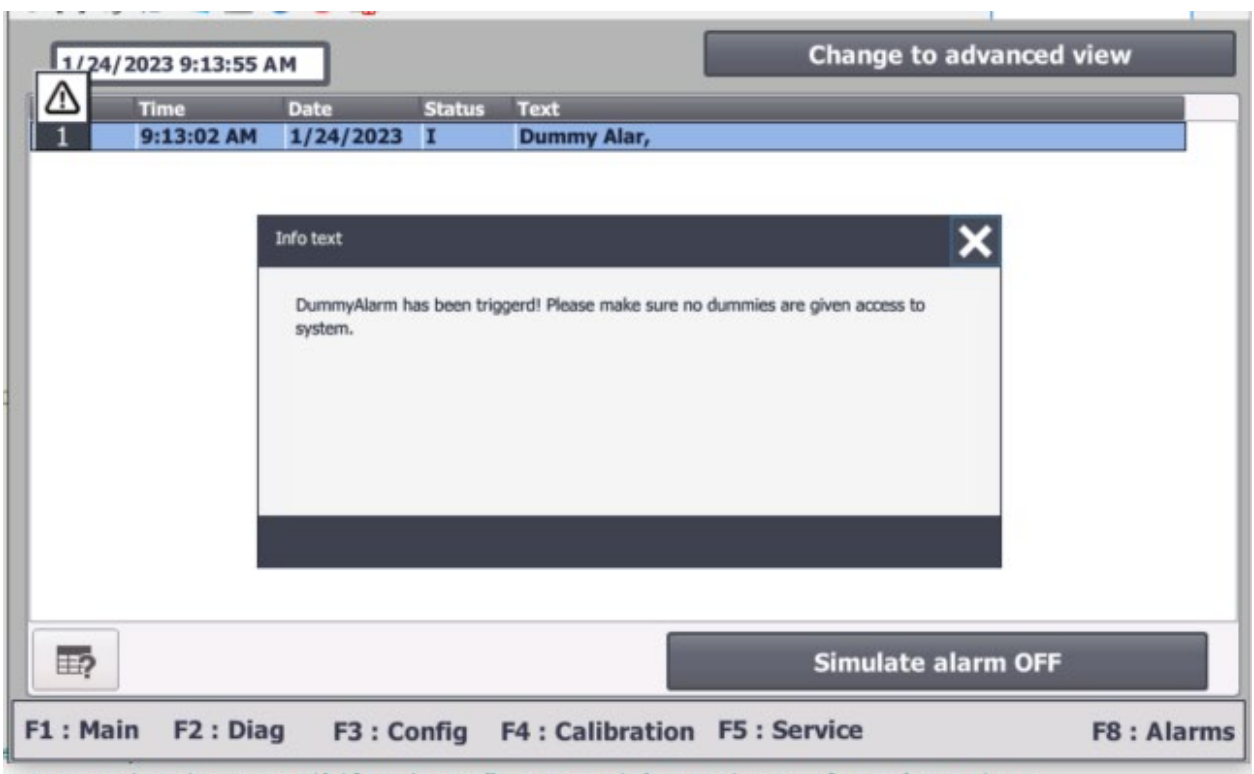
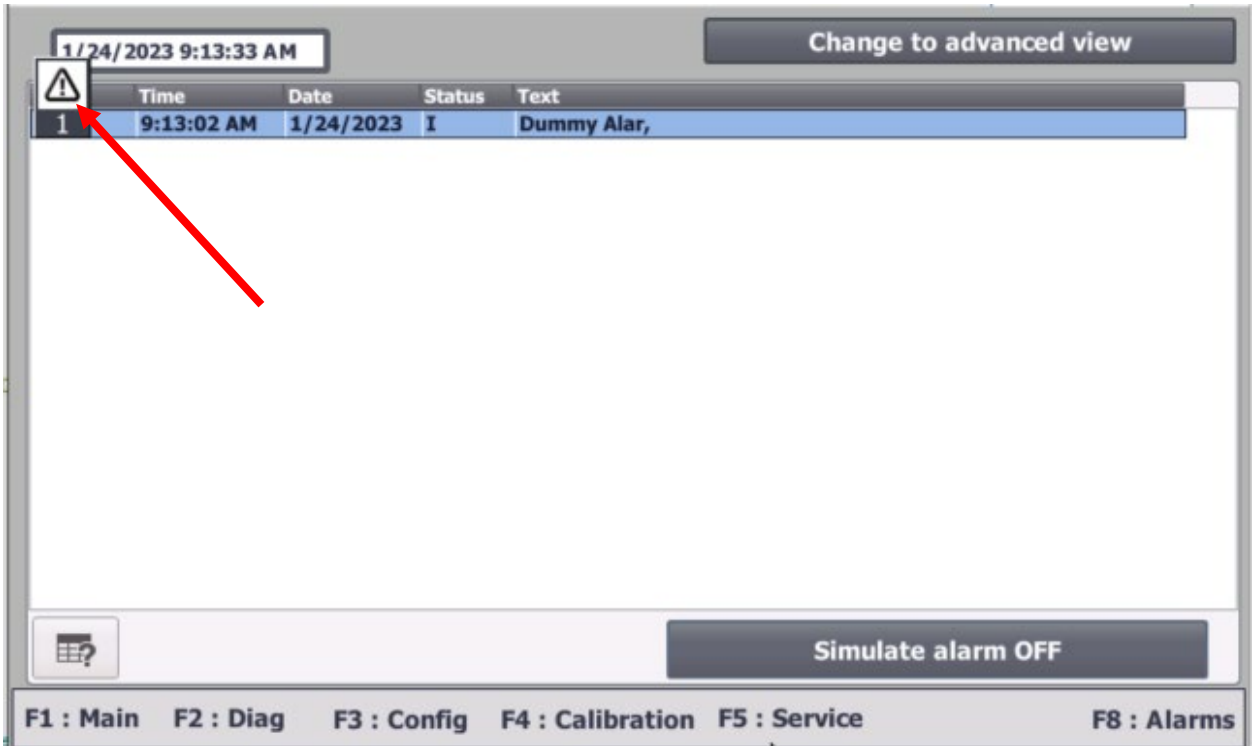
Setpoint for sample should be minimum 15dl/ min =1,5L/ min

Setpoint for calibration port should be minimum 200dl/ min =20L/ min

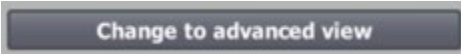
The Flow adjust interface features a 'Service mode' dropdown menu set to 'OFF'. Below this are two flow control sections. The first section, 'Sample flow (FCV-01)', shows a current value of 6096 and a slider ranging from 0 to 5 LPM, with a '0.0 LPM' button. The second section, 'Calibration port flow (FCV-02)', shows a current value of 236 and a slider ranging from 0 to 30 LPM, also with a '0.0 LPM' button. At the bottom, there are two setpoint controls: 'Sample flow setpoint' with a value of 15 dl/min and 'Calibration gas flow setpoint' with a value of 200 dl/min. The footer contains function keys: F1 : Main, F2 : Diag, F3 : Config, F4 : Calibration, F5 : Service, and F8 : Alarms.

5.2.8 F8 - Alarms

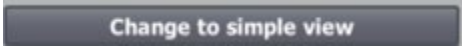
Simple view: Make sure that the clock is set correctly. If there are any active alarms, it is visible on the screen. They disappear automatically when alarm is inactive. The alarms will always be saved in the log (advanced view).



Advanced view: To get to this view, select

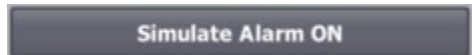


Go back to Simple view by selecting



The screenshot shows the 'Advanced view' of the ShipCEMS Compact interface. At the top left, a date and time stamp reads '1/24/2023 9:14:31 AM'. To the right is a 'Change to simple view' button. Below this is a table with the following columns: No., Time, Date, Status, and Text. The table contains 17 rows of alarm data. At the bottom of the table area is a 'Simulate Alarm ON' button. Below the table is a navigation bar with buttons for 'F1 : Main', 'F2 : Diag', 'F3 : Config', 'F4 : Calibration', 'F5 : Service', and 'F8 : Alarms'.

No.	Time	Date	Status	Text
4	9:14:26 AM	1/24/2023	IO	Dummy Alar,
4	9:13:02 AM	1/24/2023	I	Dummy Alar,
220006	9:11:28 AM	1/24/2023	I	Connection to PLC PFC100 (192.168.1.45) is established.
220007	9:10:30 AM	1/24/2023	I	Connection to PLC PFC100 (192.168.1.45) is interrupted.
260003	9:06:54 AM	1/24/2023	I	User logged off.
2	4:20:02 PM	1/23/2023	IO	Cooler fault
2	4:15:59 PM	1/23/2023	I	Cooler fault
220006	4:15:58 PM	1/23/2023	I	Connection to PLC PFC100 (192.168.1.45) is established.
190004	4:15:46 PM	1/23/2023	I	Tag __LifeBeat_T2500: PLC address error.
220006	4:15:46 PM	1/23/2023	I	Connection to PLC T2500 (192.168.1.31) is established.
220007	4:15:43 PM	1/23/2023	I	Connection to PLC PFC100 (192.168.1.45) is interrupted.
110001	4:15:43 PM	1/23/2023	I	Change to operating mode 'online'.
190004	1:12:35 PM	1/23/2023	I	Tag __LifeBeat_T2500: PLC address error.
220006	1:12:35 PM	1/23/2023	I	Connection to PLC PFC100 (192.168.1.45) is established.



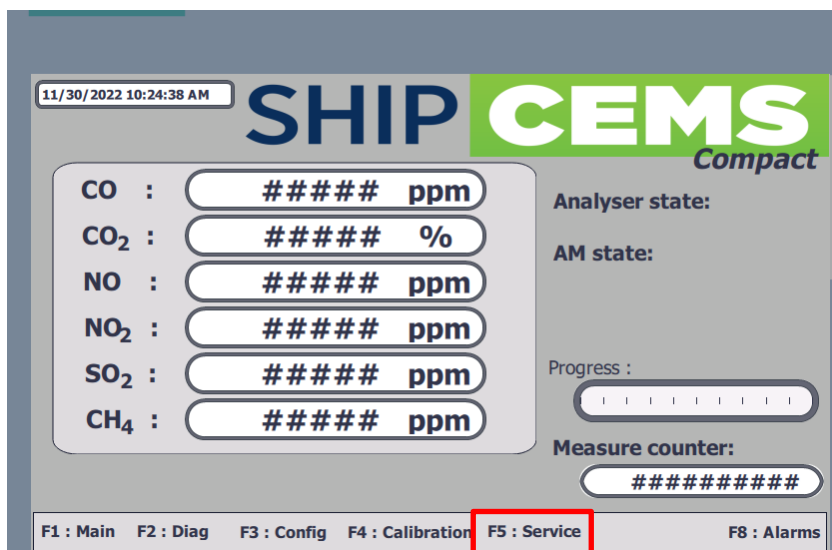
is a function to check if alarms are working and get registered as required.

5.2.9 System

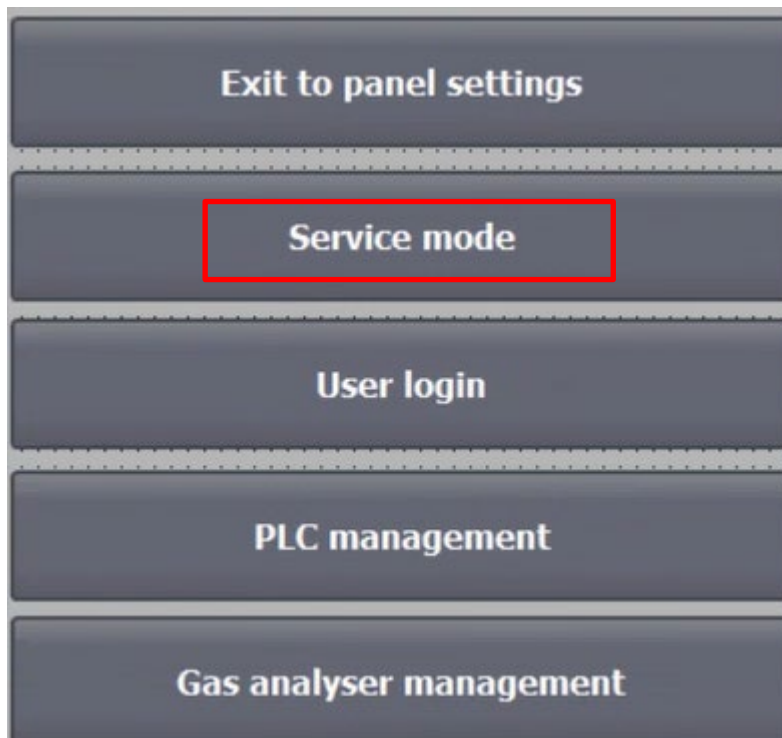
Automatic mode: By default, the system is in automatic mode which means the analyser module waits for a *start measure signal* from client automation system.

Manual control overrides the automatic mode. The analyser can be forced to e.g., measure and the system can manually be put in several manual states.

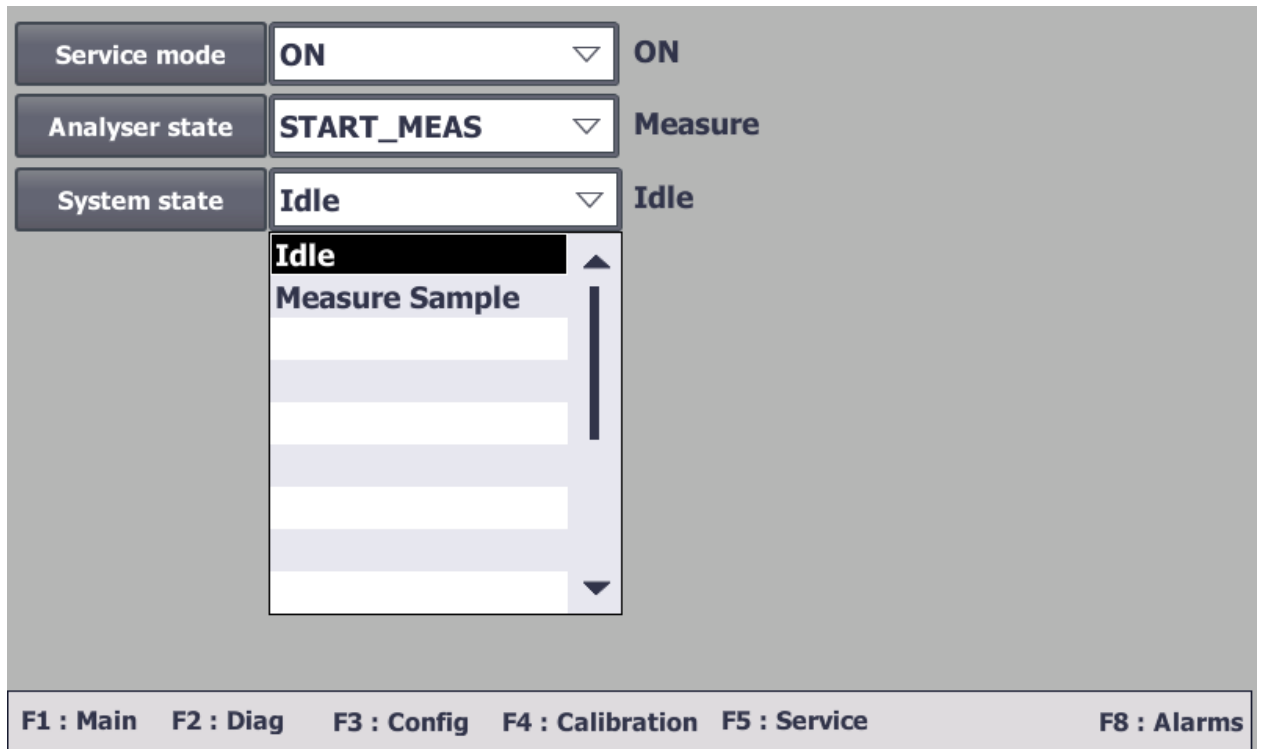
- 1) Select F5 "Service" to enter Service menu.



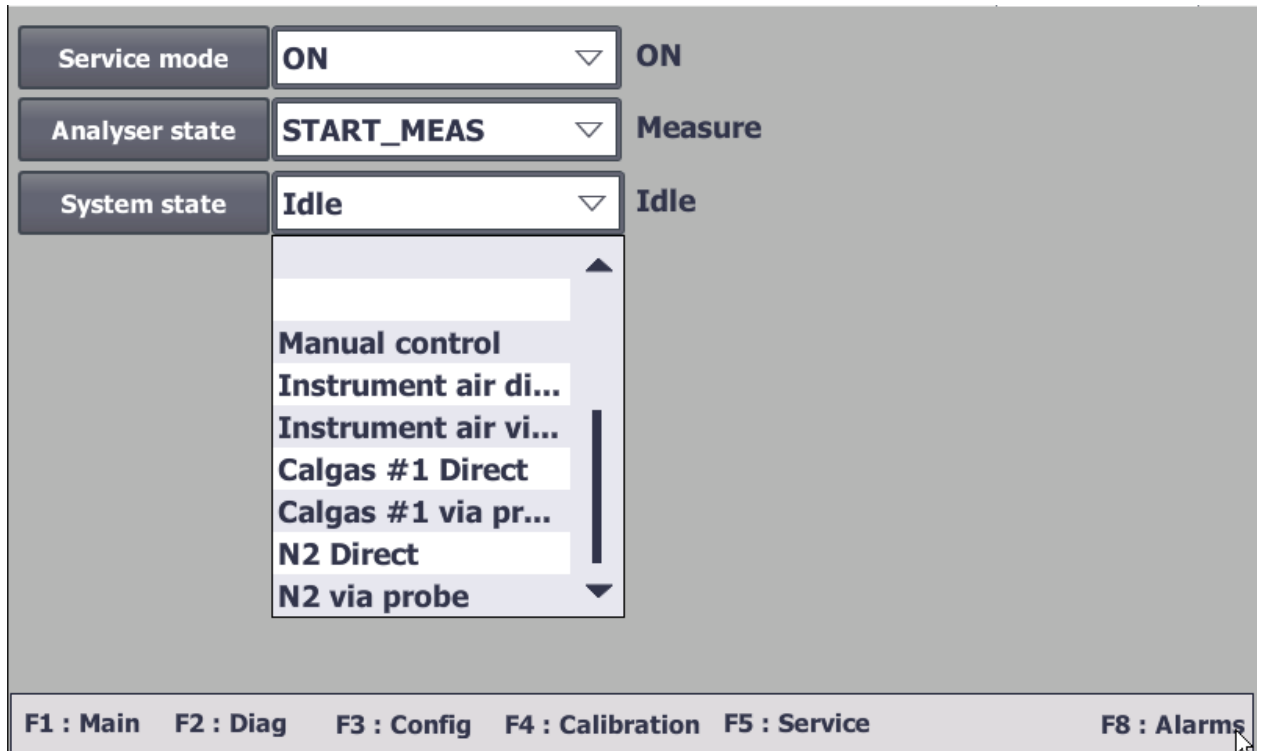
- 2) From the Service menu select "Service mode"



- 3) Press the drop-down menu and select the system state to get dropdown menu intended e.g.:
- Measure Engine 1
 - Backpurge Mode
 - Validation (in Service mode)
 - Zero Calibration
 - Span Calibration



6.



5.3 Operational procedures

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

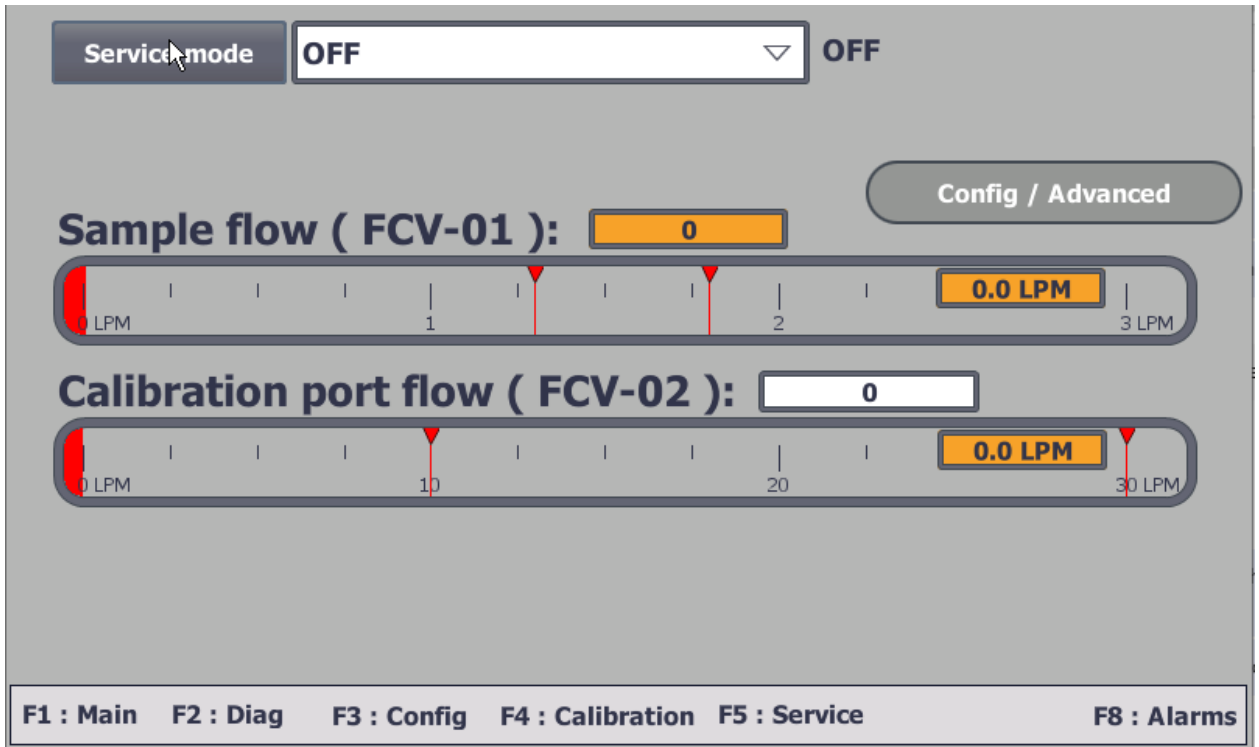
5.3.1 Flow adjustment

Flow adjustment must be preceded by pressure adjustment. The flow controller will adjust flow to correct setpoint. For sample flow or direct calibration, the setpoint is 1,5L/min. For calibration through the probe, the flow setpoint is 20 L/min.

Check always if the flow is correct at the "flow adjust" page in the service menu.

See pressure settings in next section.

The sample gas pump must be set at full sample flow, meaning the adjustments screw must be all the way in (clockwise)



5.3.1.1 Pressure adjustment

The system will automatically adjust the flow required for the calibration but before starting a calibration, it is essential to check and adjust the pressure for span- and zero gas.

Zero gas (instrument air or nitrogen), and for Span gas

The pressure must be set to 1 Barg

The pressure regulator is placed on the left side of the cabinet or at the bottle.



5.3.2 Validation

A validation is to check if last calibration is still valid. If it is valid there is no action but if it varies a calibration must be performed.

An alarm will be activated if the validation differs more than a set percentage deviation from calibration gas reference value or full scale value. Defined in the *Config menu*.

5.3.2.1 For Zero validation with Nitrogen

- 1) Open Nitrogen cylinder and set pressure to 1 barg on connection N7
- 2) Go to Service menu, F5.
- 3) Select *Service mode*.
- 4) Select Service mode *ON*
- 5) Set analyser state to Measure (*START_MEAS*).
- 6) Go to system state in dropdown menu and choose *N2 DIRECT (for nitrogen)*
- 7) Make sure the flow is according to 5.3.1 and wait a couple of minutes until measurement values are stable.
- 8) Compare the measurements once it is stable

5.3.2.2 For Zero validation with instrument air

(only for CO₂ & SO₂ analyser)

- 1) Set pressure to 1 barg on connection N2 (instrument air)
- 2) Go to Service menu, F5.
- 3) Select *Service mode*.
- 4) Select Service mode *ON*
- 5) Set analyser state to Measure (*START_MEAS*).
- 6) Go to system state in dropdown menu and choose *INSTRUMENT VIA PROBE*
- 7) Make sure the flow is according to 5.3.1 and wait a couple of minutes until measurement values are stable.
- 8) Compare the measurements once it is stable

5.3.2.3 For Span validation:

- 1) Open span gas cylinder (must be connected to nozzle N4).
- 2) Go to Service menu, F5.
- 3) Select *Service mode*.
- 4) Select Service mode *ON*
- 5) Set analyser state to Measure (*START_MEAS*).
- 6) Go to system state in dropdown menu and choose *CAL GAS #1 DIRECT*.
- 7) Make sure the flow is according to 5.3.1 and wait a couple of minutes until measurement values are stable.
- 8) Compare the measurements once it is stable and compare with calgas values on the cylinder.

Note *No values will be adjusted or saved.*

5.3.3 Calibration

Always perform zero calibration before span calibration.

For analyser measuring only CO₂ and SO₂ it is required always to perform span calibration after a zero calibration. For all other analysers the span calibration is only performed when needed.

5.3.3.1 Pressure adjustment for calibration

The system will automatically adjust the flow required for the calibration but before starting a calibration, it is essential to check and adjust the pressure for span- and zero gas.

For system without automatic flow adjustment make sure the flow is according to 5.3.1

Zero gas (instrument air or nitrogen):

The pressure regulator is placed on the left side of the cabinet. Or on the Nitrogen bottle.

Adjust the pressure to 1.0 barg.



Span gas:

- 1) Open the calibration gas cylinder's main valve and perform leak test.
- 2) Adjust the pressure using the blue handle to 1.0 barg.



5.3.3.2 Calibration

Caution Even if the system is in automatic mode, manual calibration is necessary to calibrate the analyser module.

Norsk Analyse recommends span validation every week to make sure the analyser is accurate at all times.

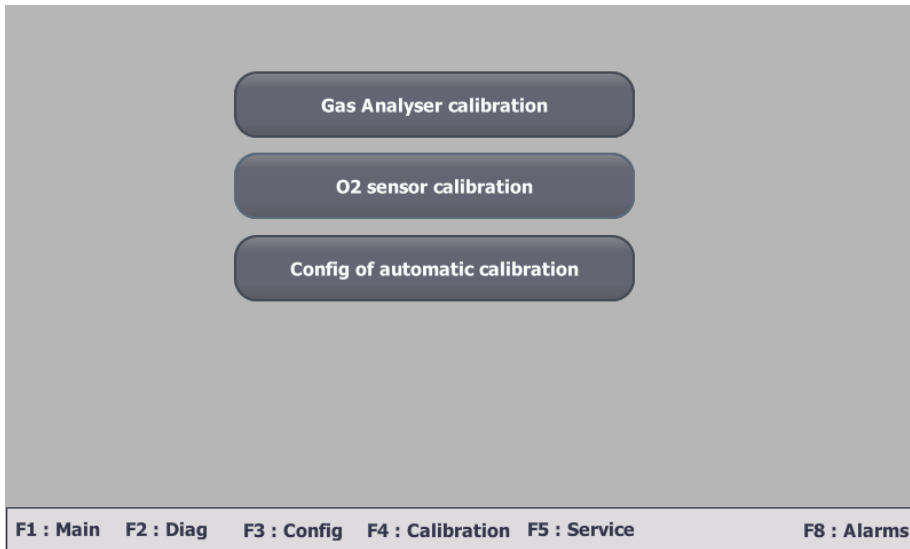
The analyser may drift over time and subsequently present slightly incorrect values. Therefore, the analyser may need calibration.

SEQUENCE

The analyser needs to be calibrated in two steps. Each step needs to be initiated manually in the right sequence. Each step takes approx. 5 minutes (the analyser purge for 2 minutes before each calibration).

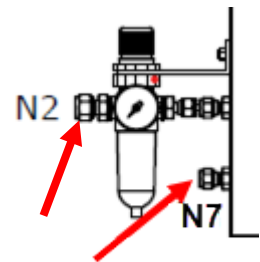
- a. Zero calibration
- b. Span calibration

Select "Gas Analyser Calibration" (see picture on next page).



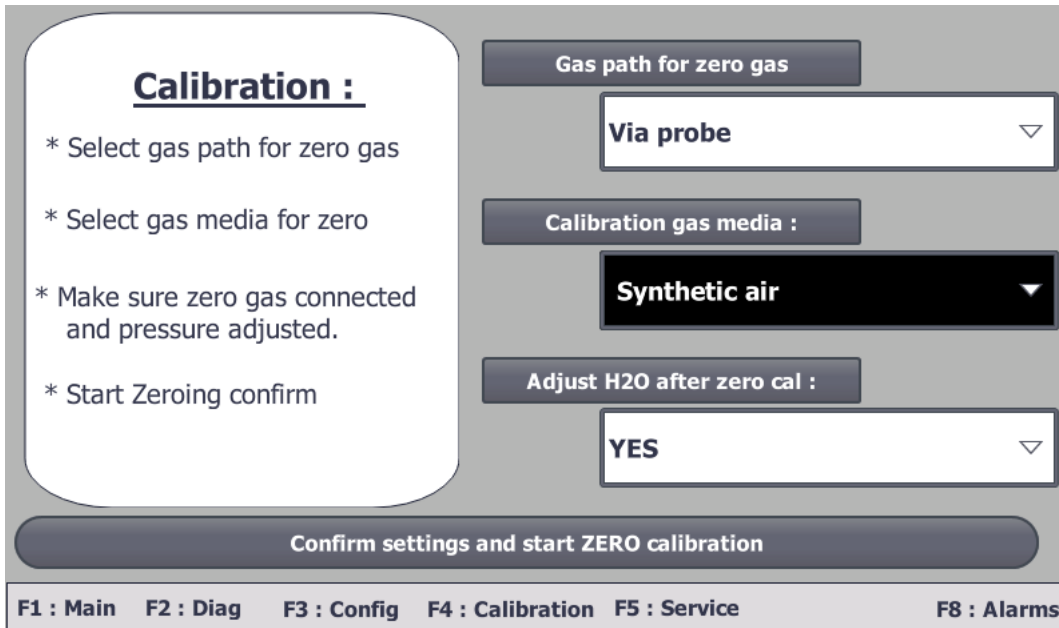
5.3.3.2.1 ZERO CALIBRATION

Select "Start Zero Calibration Gas Analyser"



CO₂/SO₂ analyser:

The zero calibration is to be performed through the calibration port in the probe and can be done with both Nitrogen and instrument/Synthetic air. Select yes to "adjust H₂O after zero cal". This will enable the H₂O zero calibration using calibration gas when the span calibration is performed.

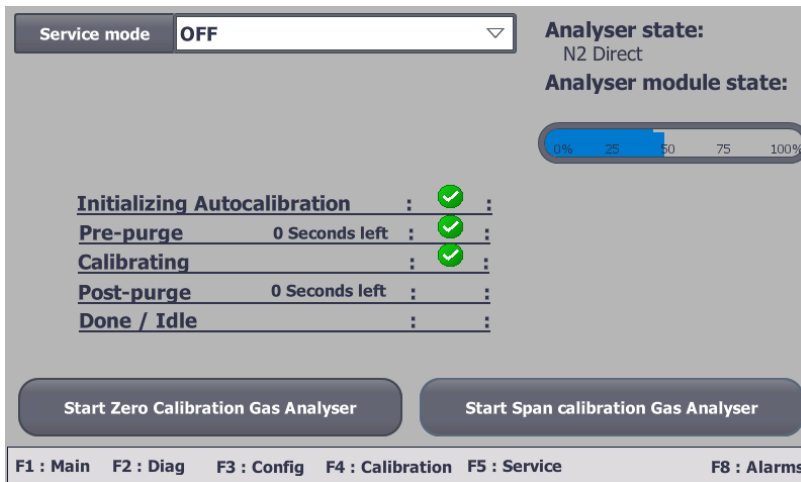


After settings are confirmed, the calibration will start. The valves will be set automatically.

All other analysers:

Select nitrogen as zero calibration gas and press start.

Before starting, make sure the gas flow is according to section 5.3.1.



When the calibration is started, it will automatically run through the sequence.

5.3.3.2.2 SPAN CALIBRATION

For all types of analysers, the procedure for calibration is the same.

Press “Start Span Calibration Gas Analyser” and add the values from the calibration bottle certificate.

Press Calibrate on the components that have to be calibrated, and press ignore on the others. When the box is green the component is included.

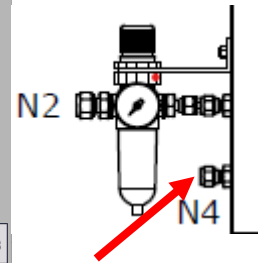
Calibration :

- * Select components to calibrate.
- * Set calibration gas actual value for each component.
- * Make sure gas media connected and pressure adjusted accordingly.
- * Start calibration by pressing button below.

CO :	1740	1740 ppm	Calibrate
CO₂ :	9.40	9.40 %	Calibrate
NO_x :	1790	1790 ppm	Calibrate
SO₂ :	225	225 ppm	Calibrate
CH₄ :	9740	9740 ppm	Calibrate

Confirm settings and start SPAN calibration

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service
F8 : Alarms



When Pressing Confirm, the autocalibration will start its sequence.

5.3.3.2.3 AUTO ZERO CALIBRATION

For the multi gas analysers it is an option to activate an auto zero calibration.

Note that the nitrogen bottle must be left open and with proper pressure adjusted.

Set the Enable to ON and set timer.

The timer is hours between auto zero calibration.

Autocal config

Autocal config:

Enable : ON ▾

Interval (0..500): 24

Seconds to operation : 86389

Previous page

Next page

Trigger once now

F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms

5.3.3.2.4 O2 SENSOR CALIBRATION

Set Service mode on and select "instrument air direct". Let the system purge until the values are stable.

Press "Calibrate" and "accept calibration".

Service mode	ON
System state	Instrument air direct
O ₂ Actual value :	20.90
O ₂ Calibration factor :	1.057
O ₂ Reading :	21.00 %
Calibrate	
F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms	

Service mode	ON
System state	Instrument air direct
O ₂ Actual value :	20.90
O ₂ Calibration factor :	1.059
O ₂ Reading :	20.90 %
Calculating new value and factor: 20.90 % 1.059	
Accept calibration	
F1 : Main F2 : Diag F3 : Config F4 : Calibration F5 : Service F8 : Alarms	

5.4 Controlled Shutdown

If the system is to be left off for a longer period, it is possible to shut down the entire system.

Following the procedure for shutdown of system:

- 1) Remove the sample probe filter.
- 2) Disconnect the sample line at the gas cooler inlet.
- 3) Blow the sample line clean for 5 min. with compressed air.
- 4) Disconnect the sample probe from the stack (stack)
- 5) Blind the counter flange on the stack.
- 6) Power off system.
- 7) Close the air supply to system.

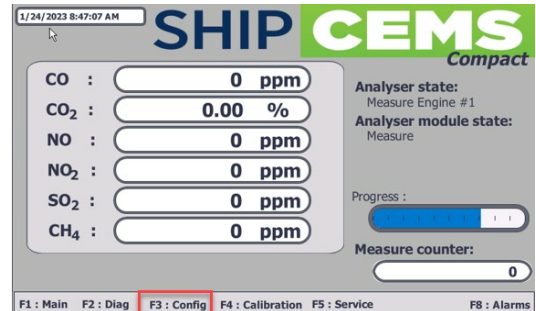
5.4.1 Start-up after controlled shutdown

- 1) Mount the probe to the flange.
- 2) Open air supply.
- 3) Power up system.
- 4) Perform a full calibration after approx. 1 hour.

5.5 Change IP address

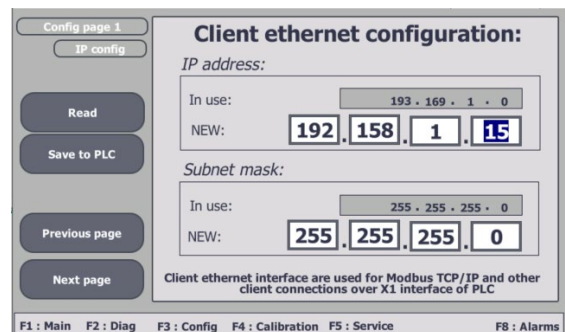
Changing the IP address to establish communication with the system can be done directly on the HMI.

- 1) Locate the F3 button on the main screen to enter the Configuration menu.



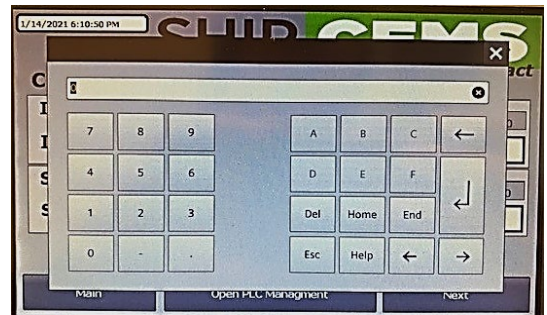
- 2) The first page in the configuration menu is the "Client Ethernet configuration".

Touch the screen at the address line.
Refer to pictures in 5.2.5 on how to write and save.



- 3) A keypad will pop-up.

Enter the IP address intended, and press enter.
The new IP address is now stored.
Finish setup by pressing "Main".



- 4) Insert the Ethernet cable to port X1.
If correct setup has been performed, communication will now be established.

If client is using alive signal, this can be verified. At page 4 in the diagnostic menu.



6 Troubleshooting

6.1 Troubleshooting philosophy

ShipCEMS Compact can 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 to guarantee reliable measurements.

All alarms and information messages are displayed on the HMI. Note that several messages may be present at a given time. The fault message of the highest priority order is then displayed on top. Individual error messages, possible causes and actions to be taken are described in the table in section 6.4.

6.2 Remote troubleshooting

Optional the system can be incorporated with ShipCEMS Connect, which allows Norsk Analyse to remotely connect for advanced troubleshooting purposes.

Contact sales for further information.

6.3 Signals

6.3.1 Modbus TCP/IP

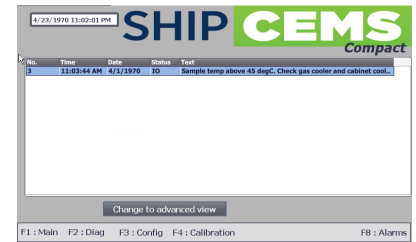
Refer to the following document:

→ *50118-D212 Signal Exchange List*

6.4 Alarm history

Active alarms have status "I" (Incoming = active).

Old and cleared alarms are showed as status IO.



Note Only the most recent events are shown in alarm table.

Display message	Possible cause	Action
SP1 Fault	Sample probe Low temp alarm	<ul style="list-style-type: none"> • Check if power is missing to the probe. • Check if heating elements are working properly.
Cooler fault	Cooler fault	<ul style="list-style-type: none"> • Check power to sample gas cooler. • Check cooler temperature.
Sample Gas Temp	Sample Gas Temp above 45 degC.	<ul style="list-style-type: none"> • Check sample gas cooler. • Check cabinet cooler.
Flow sensor	Flow sensor bad signal	<ul style="list-style-type: none"> • Check cable and connections to sensor
Low Sample Flow	Sample flow below 0.5l/ min during measuring	<ul style="list-style-type: none"> • Check filters. • Check heated sample line for blockage.
Sample Humidity high	Sample humidity > 12.000 ppm	<ul style="list-style-type: none"> • Check sample gas cooler
Analyser Fault	Gas analyser fault	<ul style="list-style-type: none"> • Contact Norsk Analyse
Calibration Fault	Calibration failed	<ul style="list-style-type: none"> • Check air and span gas pressure. • Perform new calibration.
Communication Fault PLC	No Communication to PLC	<ul style="list-style-type: none"> • Check cables to PLC. • Check power to PLC.
Communication Fault Analyser	No communication to Analyser	<ul style="list-style-type: none"> • Check cables to analyser. • Check power to analyser.
O2 sensor Fault	O2 sensor signal bad	<ul style="list-style-type: none"> • Check cable and connections to sensor.

Display message	Possible cause	Action
Leak test failed sampling	O2 above 10% during sampling	<ul style="list-style-type: none"> • Locate and repair leak.
Leak test failed calibration	O2 above 1% during calibration / Calibration Check	<ul style="list-style-type: none"> • Locate and repair leak.
Calibration check failed	Tolerance (4%) exceeded	<ul style="list-style-type: none"> • Perform calibration.

6.5 General troubleshooting procedure

Troubleshooting may be complex and requires good knowledge of ShipCEMS Compact.

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 Norsk Analyse service department for further advice or for service request.

Support: contact support@norskanalyse.com

Service: contact service@norskanalyse.com

Spare parts: contact marine@analyse.com

7 Maintenance

7.1 Maintenance philosophy

The maintenance philosophy recommended by Norsk Analyse 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 Norsk Analyse.

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 warranty 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 Compact 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 client 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	<p>Check sample gas filter. Replace filter element if required.</p> <p>Replace when element is discoloured!</p> 

7.2.2 Weekly routine

Unit	Remarks
Gas Cooling unit	Check that the peristaltic pump is running
Air conditioner unit on analyser cabinet	Check inside fan is running and temperature on display is less than 40°C.
Filters	Check sample gas filter.

7.2.3 Every second week

Unit	Remarks
Probe filter	<p>Check for contamination and physical damage. Replace filter element if required. Part no: 141581.</p> 

7.2.4 Monthly routine

Unit	Remarks
Cabinet and unit exterior	Clean all surfaces.
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. Part no: 141581.
Sample gas filter	Replace filter element. Part no: 133615
Analyser module Perform calibration check	Check pressure on calibration gas inlets. Refer to adjustment in section 5.3.3.1. Use calibration check. Section 5.3.3 Carry out calibration procedure if readings differ >4% from value on calibration gas cylinder.

7.2.5 Routine every six months

Unit	Remarks
Sample probe filter	Replace filter element. Part no: 141581.
Sample gas filter	Visual check for contamination and physical damage. Replace as required. Part no filter 133585. Part no filter element 133615.
Calibration gas cylinder	Check expiration date on cylinder. Order new cylinder if pressure drops below 50 barg
Air conditioner unit	Check both internal and external fans. check inlet filter for blockage

7.2.6 Yearly routine

Unit	Remarks
Cabinet and units	Check bolts. Tighten if necessary.
Heated sample line	Check for moisture and contaminations. Clean as required.
Sample probe	Replace filter element. Part no: 141581. Use PTFE paste. Part no: 141582.
Gas pump membrane	Check physical condition. Replace if required (*). Part no: 138705
Calibration	To be in compliance with the type approval certificate issued for this system, manual calibration must be performed once a year.
Solenoid valves	Perform functional test.
Sample probe with demister	If applicable, replace filling on demister.
Gas Cooling unit	Check the hoses inside the peristaltic pump, replace if any signs of damage
O2 sensor (only for item 13b, refer to spare part list section 8.1)	Replace sensor. Part no: 144285

7.2.7 Routine every three years

Unit	Remarks
Gas pump maintenance kit	Replace spare parts. Part no: 138706 (P1.1)
Calibration gas cylinder	Replace the cylinder. Order from Norsk Analyse. Refer to spare part list in section 8.3.

7.3 Maintenance procedures

Note *The single most efficient maintenance measure to protect the analyser is to replace probe and sample gas filter element when discoloured!*

7.3.1 Replacing or dismantling of internal parts in the analyser module

The analyser module is a sensitive device. Replacing or dismantling serviceable parts inside the unit can only be performed by service personnel authorised by Norsk Analyse.

Caution *If this is not followed, the warranty will no longer be valid.*

7.3.2 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.

7.3.3 Replacing sample probe filter element

Part no: Kit 141581

Part no: Paste 141582

Filter elements, O-rings and gaskets are consumables and must be replaced regularly, at least once a year. Ensure that sealing surfaces are clean and unhurt.

Turning off the heater at ambient temperatures below -25 °C (~-13 °F) may destroy the sealing materials of the gas sample probe.

The filter element is passive and does not add or absorb any of the trace components to be measured.

Note *The ceramic filter elements are very fragile by their nature. Handle those elements with care and avoid dropping them.*

Caution *Use heat resistant gloves.*

Caution *The housing of the probe may get very hot! Take care, in case of process over pressure, explosive and/or toxic gas emanation is possible. To avoid accidents, take care for necessary safety precautions in case of service and maintenance.*

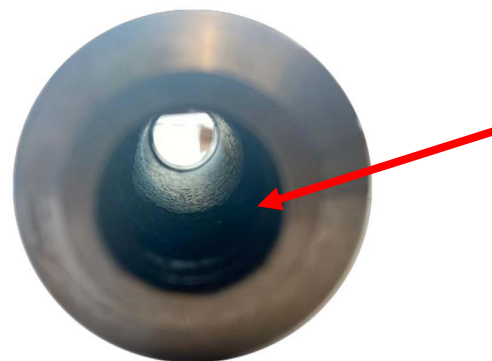
Caution *Protect the analyser by replacing probe filter element when dirty!*
Example of overdue filters:



Very dirty filter element!



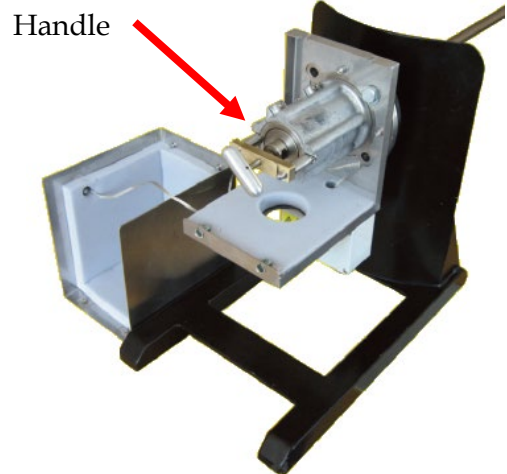
Time to replace!



This element has a glossy inside.

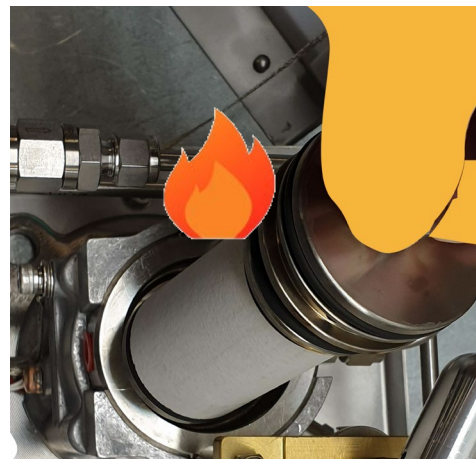
For cleaning or replacing following steps should be done:

- 1) Switch off the power supply and wait for cooling down of the probe.
- 2) Remove the weather protection housing.
Turn the two wing nuts to open the protective shield.



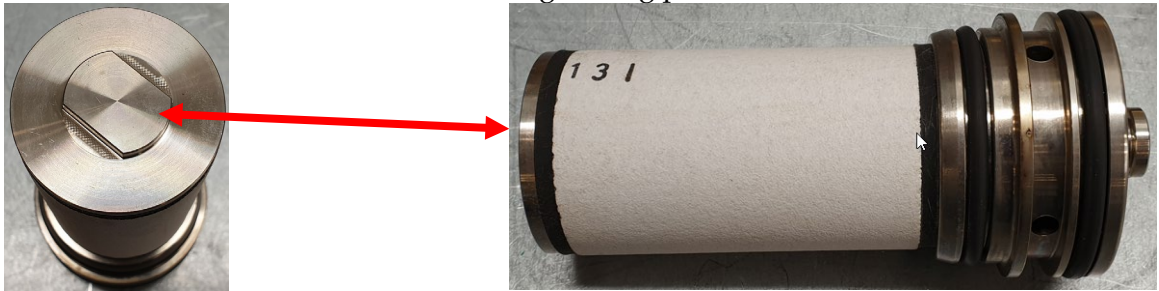
Caution Do not use earthing cable to hold weight of housing cover.

- 3) Turn away the handle for pulling out the filter element. Swing the pivoting lever (yellow) sideways and pull out the support tube with the filter element.

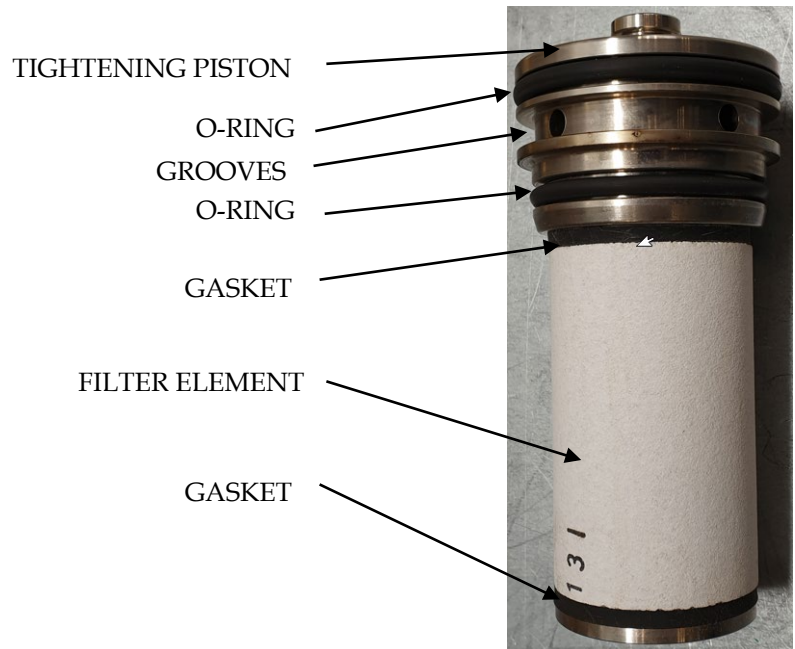


Caution If not cooled down, the support tube is very hot - 180°C.
Use gloves or pliers to pull the knob.

- 4) Unscrew the screw on the bottom of the tightening piston.



- 5) Replace filter element and/or gaskets. Clean grooves on tightening piston of filter retainer and remove O-rings with a non-metallic tool (wood or plastic wedge).



- 6) Apply a thin wetting of PTFE paste on O-rings and pull them on.
- 7) Remount gaskets and filter element.
- 8) Fasten the filter element-and gaskets to the tightening piston with the screw.
- 9) Clean the sealing surfaces in sample probe.
- 10) Mount all other parts in vice versa sequence.



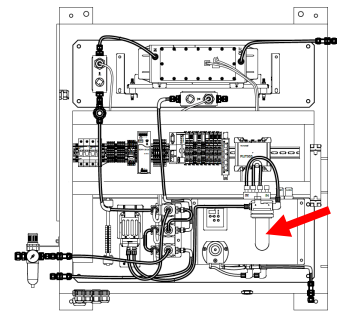
Recycling: The unit contains elements which are suitable for recycling, and components which need special disposal. Make sure that the unit will be recycled by the end of its service life.

7.3.4 Replacing sample gas filter element

Refer to general arrangement drawings [1003].

Part no: 133615

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

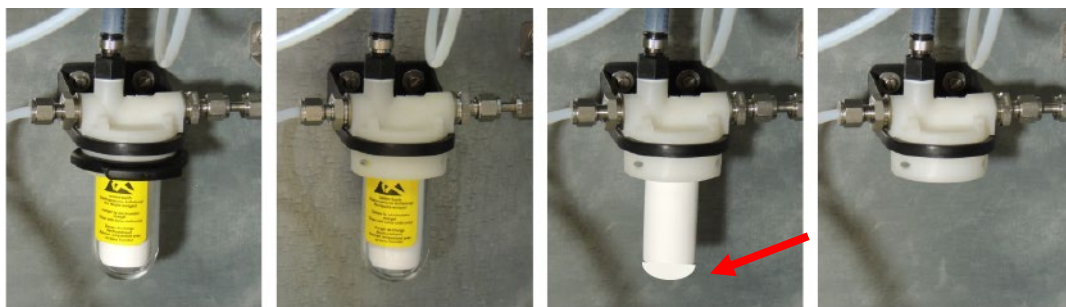


Caution *Protect the analyser by replacing sample gas filter element when dirty!*
Example of overdue filters:



Time to replace!

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



- 5) Unscrew the spacer pin (red arrow) and replace the filter element.
- 6) Make sure that the top of the filter element seals in the top.
- 7) Reassemble the sample gas filter unit.

It is not necessary to shut off power during filter replacement.

7.3.5 Install or replace the calibration gas cylinder

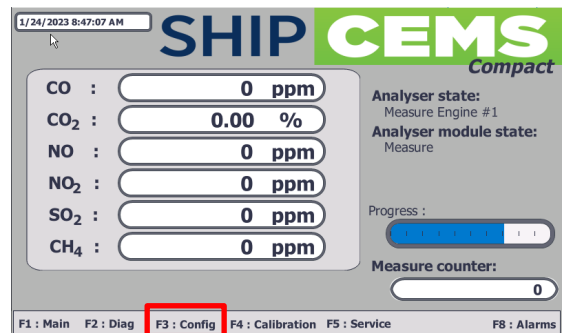
Part no: Refer to spare part list in section 8.3.

When the calibration gas cylinder is replaced, it is necessary to change the calibration gas values in the analyser and perform a recalibration of the module.

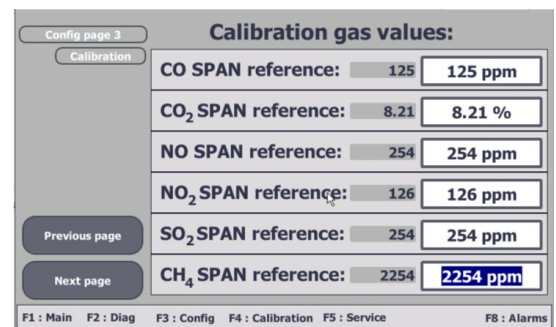
Replace the gas cylinder and ensure that the new cylinder is properly fastened.

7.3.5.1 Change calibration gas values

1) From the main page use F3 "Config"



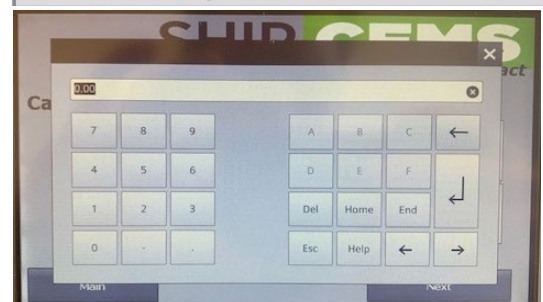
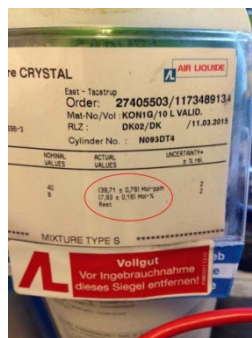
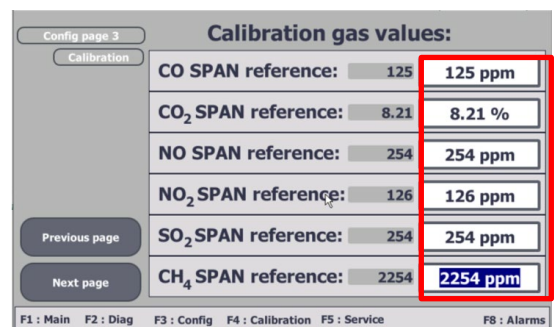
2) Navigate to the 3rd page "Calibration gas values".



3) Use the finger touch to open the keypad.

4) Enter values matching the gas cylinder certificate. Press enter.

5) Press Main to exit setup.



6) Perform now new calibration according to section 5.3.3 Calibration.

7.3.6 Replace O2 sensor

Only applicable for item 13b. Refer to spare part list section 8.1.

If F-series flow controller [141975] is used, the O2 sensor must be replaced yearly. The sensor is ageing and should be ordered prior to replacement.

7.3.7 Cleaning heated sample line

The tube inside the heated sample line can get dirty. If a flow alarm occurs, the sample line is can be cleaned to solve the problem.

7.3.7.1 Clean the sample tube

- 1) Disconnect the sample line at the cooling unit.
- 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 cabinet and use compressed air to clean the tube.
- 5) Connect sample line in both ends.

7.3.8 Leak test

Leak test is a function based on measured O2 values.

7.3.8.1 Leak test during validation/calibration

When performing a calibration, the O2 sensor monitors the level of oxygen in the gas. As the calibration gas has 0% of O2, a measure of 1% O2 or greater, an alarm will be triggered.

7.3.8.2 Leak test during sampling

During sampling, the O2 sensor will continuously observe the oxygen level in the sample gas. If the level exceeds 10% or greater an alarm will occur.

7.3.9 Cleaning of analyser surfaces

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 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 the analyser.

7.3.10 HOT SWAP - quick change of analyser module

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

Contact repair@norskanalyse.com

7.3.11 Wire dampers and dampers

It is vital for the system that the vibrations from the vessel are reduced. Check that the dampers are intact. Replace if necessary.

In the Analyser cabinets there are four different dampers and in the sample conditioning cabinet only 4 pcs. under the pump.




Refer to drawing 50118-1003:



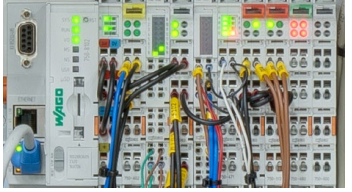
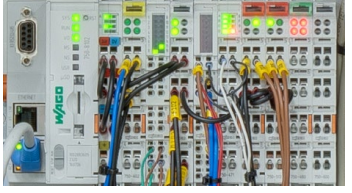
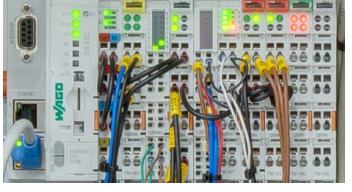

Item	Amount	P/N	Description
17	1 kit	125698	Damper Kit - Analyser Module & Pump
9	1 kit	138707	ShipCEMS Compact Pump Vibration Damper Kit
18	1 kit	138710	ShipCEMS Compact Wire Damper Kit

8 Spare parts lists





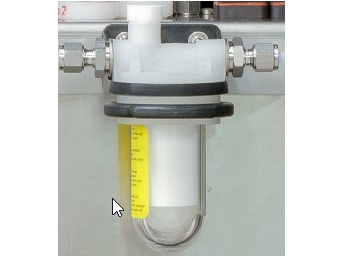

8.1 Analyser System

Note that item numbers refer to general arrangement drawing [1003].






Item no.	Description	Part no.	
1	ShipCEMS Compact- analyser module Models are listed below		
	SCC-AM-SO2-CO2	141632	
	SCC-AM-ALL	141633	
	SCC-AM-ALL+CH4	141634	
	SCC-AM-ALL+COe	141635	
2	ShipCEMS AC Main Automatic fuse 10A (230V)	125198	
3	ShipCEMS Relay (R3) 5A 24VDC (option: Backpurge)	125847	

Item no.	Description	Part no.	
4	ShipCEMS - Logo Power supply (24vDC)	123526	
5	ShipCEMS Compact - A/C Unit	138693	
6	ShipCEMS Compact PLC (Complete)	138696	
6b	ShipCEMS Compact PLC (CPU)	138697	
6c	ShipCEMS Compact PLC (I/O)	138698	
7	ShipCEMS Compact - Air Regulator	138694	

Item no.	Description	Part no.	
8	ShipCEMS - Stream select solenoid valve 3/2-24VDC	122230	
9	Sample Gas Pump (SCC)	138704	
	Bypass Valve for Sample Gas Pump (SCC)	142386	
9b	Pump Bellow (SCC)	138705	
9c	Pump Connection Rod (SCC)	138706	


Item no.	Description	Part no.	
9d	Pump Vibration Damper Kit (SCC)	138707	
9e	Pump Inlet/Outlet valves (2 pcs) (SCC)	138708	
10	ShipCEMS Compact - HMI	138695	
11	ShipCEMS - Switch 5-port (132879 is included)	137525	
12	ShipCEMS - Sample Gas Filter Unit (II-Type) incl. Element	133585	
12	ShipCEMS - Sample Gas Filter Element (II-Type) - 5ea (Part of 133585)	133615	

Item no.	Description	Part no.	
13	For sample: ShipCEMS Compact Flow Controller (C-series - embedded unit) 0-3 l/min	138702	A black, rectangular, embedded flow controller unit with various ports and a white cable connected to the side.
13	For sample: F-series Flow Controller (F-series - modular unit. See modules below) 0-3 l/min	141975	A modular flow controller unit with a yellow cable, a small white box, and a metal component.
13b	Only for F-series ShipCEMS Compact - O2 Sensor (combined with F-series flow sensor)	144285	A white, cylindrical oxygen sensor with a yellow label that reads "OXYGEN SENSOR" and "668903 11".
13c	Only for F-series FC-1 Amplifier	141977	A cylindrical, metallic amplifier component with a small metal bracket attached to the side.
13d	Only for F-series FC-1 Control Valve	141980	A small, cylindrical control valve with a white cable and a metal component.

Item no.	Description	Part no.	
13e	<p style="text-align: center;">Only for F-series FC-1 Mass Flow Sensor (complete)</p>	141787	
14	<p>For calibration: ShipCEMS Compact Flow Controller (C-series) 0-30 l/min</p>	138703	
14	<p>For calibration: F-series Flow Controller (F-series - modular unit. See modules below) 0-30 l/min</p>	141976	
14b	<p style="text-align: center;">Only for F-series FC-2 Amplifier</p>	141978	
14c	<p style="text-align: center;">Only for F-series FC-2 Control Valve</p>	141981	

Item no.	Description	Part no.	
14d	Only for F-series FC-2 Mass Flow Sensor (complete)	141788	
15	ShipCEMS - Low Profile Power Connection Kit	133627	
16	ShipCEMS Compact Gas Cooler	138699	
16b	ShipCEMS Compact - Gas Cooler (Heat Exchanger) 1pcs (2x)	139113	
16c	ShipCEMS Compact Peristaltic Pump - (Complete)	138700	


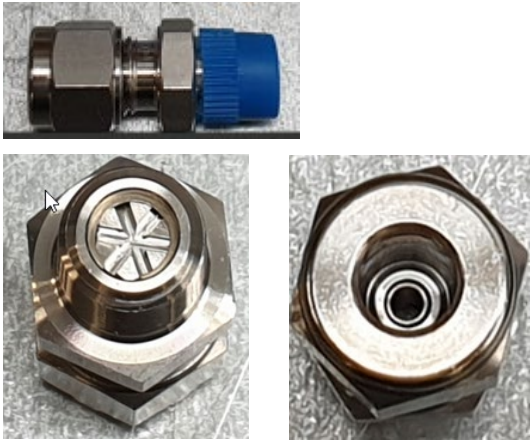



Item no.	Description	Part no.	
16d	ShipCEMS Compact Peristaltic Pump - Hose Kit	138701	
16e	ShipCEMS Compact Perist. Pump - (Cover)	139112	
17	ShipCEMS - Damper Kit - Analyser Module & Pump (4 pcs.)	125698	
18	ShipCEMS Compact Wire Damper Kit	138710	
20	PoE Adapter Module	141973	
	Sample Flow indicator 0,4-2,6 NI/m	144907	

Item no.	Description	Part no.	
	ShipCEMS - Analyser condense trap w/adapters	128732	
N/A	ShipCEMS (AC) fuse 2A - 250 V (10ea)	123572	
N/A	ShipCEMS - 6 mm Nuts & Ferrule Connect. (10 ea.)	123512	
N/A	ShipCEMS - 10mm Nuts & Ferrule Connect. (5 ea.)	123513	
N/A	ShipCEMS Relay (R3) 5A 24VDC (Backpurge) For sample gas pump	125847	

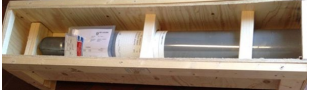



8.2 Sample probe

Refer to general arrangement drawing [1202].

Item no.	Description	Part no.	
	ShipCEMS Compact - Consumable parts kit: 1 x O-ring A and B, 1 x filter element ceramic 0,2 μ , 2 x gaskets Viton®	141581	
	PTFE paste (for O-rings in 141581)	141582	
	ShipCEMS Compact - Mounting clamp for heated line (d35-50 mm) to sampling probe ShipCEMS Compact - Mounting clamp probe/HSL	139726	
	ShipCEMS Compact - Heater element for probe	141623	
	ShipCEMS Compact - T-handle assembly kit for probe	141624	
A	ShipCEMS Compact-Probe Quill SS316, 1000 mm	141724	
	ShipCEMS Compact-Probe Quill Hastelloy C, 1000 mm	141726	
	ShipCEMS Compact-Probe Quill SS316, 500 mm	141964	
	ShipCEMS Compact-Probe Quill Hastelloy C, 500 mm	141967	

Item no.	Description	Part no.	
N/A	ShipCEMS - Flange Gasket	131989	
	<p>Pressure Reduction Valve for Probe (SCC)</p> 	142473	
	<p>Non-return Valve for Probe (SCC)</p> 	142475	

8.3 Calibration gas

System	Description	Part no.	
SCC-AM-SO2-CO2	Cal. gas SO2 160ppm/CO2 8% in N2, 10L 36M - ShipCEMS (SC-CAL05 160/8)	135030	
SCC-AM-ALL	Cal. Gas 160 SO2, 8% CO2, 1600 ppm NO/CO (SC-CAL SO2/CO2/CO/NO)	138271	
SCC-AM-ALL+CH4	ShipCEMS Compact -Cal. Gas Special Mix, B10 (SCC-CAL Mix)	140421	
SCC-AM-ALL+COe	ShipCEMS Analyser Module - ALL+Coe	141635	

9 Technical specifications

9.1 Environmental requirements

ShipCEMS is designed to comply with:

- IMO Resolution MEPC.340(77) - Guidelines for Exhaust Gas Cleaning Systems.
- IMO Marpol Annex VI MEPC 177 (58) NTC 2008.

9.2 Type approvals

Lloyds Register: LR21500752TA

DNV: TAA0000378

9.3 Measuring range

Item	Specification
SO ₂	0-200 ppm to 0-1000 ppm 0.1% Sulphur cap: 0-50 ppm 0.5% Sulphur cap: 0-200 ppm
CO ₂	0-5 % to 0-15 % 0.1 and 0.5%: 0-10%
Others on request	

9.4 Physical dimensions

Item	Specification
Analyser cabinet Dimensions (WxDxH) Weight	1100 x 380 x 800 mm 120 kg (265 lbs)
Heated sample probe Probe length Quill length standard Quill length option Flange diameter Weight	254 mm 500 mm 1000 mm DIN DN65-PN6 10 kg
Sample probe counter flange Dimensions	DIN DN65, PN 6 (or client specific)
Heated sample line (wet) Diameter Weight Length	50 mm (2") 1.2 kg/m (0.4 lbs/ft) 5-10 or 25 m

9.5 Materials

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

9.6 Ingress protection

- IP44

9.7 Power supply

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

9.8 Power consumption

Item	Specification
Analyser cabinet incl. Probe	1480W
Heated sample line (wet)	66W/m
Sample line (dry)	15 W/m if ambient temperature < +5°C Non heated if ambient temperature > +5°C

9.9 Zero gas (nitrogen)

100% nitrogen.

9.10 Calibration gas (span)

Item	Specification
Gas composition <i>Standard specifications. Other gas compositions may be ordered on request.</i>	160 ppm SO ₂ 8 mol% CO ₂ Rest Nitrogen N ₂
Cylinder size	10 litres (typical)
Cylinder pressure	> 100 barg (> 1500 psig)
Consumption	5 litre / min / calibration

9.11 Instrument air

Item	Specification
Quality	Dry, oil-free according to ISO 8573-1:2010 class 4.3.4 Dew point: $\leq -17^{\circ}\text{C}$ Particles per m^3 (1-5 μm): ≤ 10 Total oil: $0.01 \text{ mg}/\text{m}^3$
Consumption for each connected SCS (1 to max 4)	Minimum 15 Nl/min (0.9 Nm^3/hour) @ atmospheric pressure
Pressure range	6 to 8 barg (90 to 120 psi)
Dew point	$<+3^{\circ}\text{C}$ @ 8 barg minimum outlet pressure (lower than -17°C @ atmospheric pressure)

10 Drawing references

10.1 Drawings

The ShipCEMS drawings below are sent as separate files, prior to delivery.

DWG	Description	230V	120V
Mechanical drawings:			
50118-1001	GENERAL ARRANGEMENT DRAWING ANALYSER CABINET EXTERNAL VIEW - STANDARD	X	
50118-1003	GENERAL ARRANGEMENT DRAWING ANALYSER CABINET INTERNAL VIEW - STANDARD	X	
System drawings:			
50118-3001	SYSTEM DIAGRAM ANALYSER CABINET GAS FLOW	X	
Electrical drawings:			
50118-5001	TERMINATION DRAWING - OVERVIEW SYSTEM 230VAC STANDARD	X	X
50118-5002	TERMINATION DIAGRAM 230/120VAC & 24VDC POWER DISTRIBUTION ANALYSER CABINET	X	X
50118-5003.1	TERMINATION DIAGRAM SIGNAL PLC/ WITH MODBUS TCP/IP ANALYSER CABINET	X	X
50118-5005	TERMINATION DIAGRAM SAMPLE PROBE	X	
Block diagrams:			
50118-6001.1	SYSTEM BLOCK DIAGRAM P&ID DISTRIBUTION OVERVIEW	X	X
50118-6002.1	SYSTEM BLOCK DIAGRAM SIGNAL AND POWER DISTRIBUTION OVERVIEW	X	X
Network map			
50118-8201	NETWORK MAP, ShipCEMS Compact	X	X

10.2 Documents

DWG	DESCRIPTION	230V	120V
50118-D22	SHIPCEMS COMPACT INSTALLATION MANUAL	X	X
50118-D204	SHIPCEMS COMPACT FIELDBUS COMMUNICATION	X	X

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