Danfoss IXA - User Guide

MES 1001 MARPOL User Guide
In Situ Marine Emission Sensor

www.danfoss-ixa.com

Table of Contents

1. Safety

1.1. Safety Message Types

The following symbols are used in this manual.

Definitions

CAUTION

Indicates a potentially hazardous situation, which, if not avoided, could result in minor or moderate injury. It may also be used to alert against unsafe practices.

NOTICE

Indicates important information, including situations which may result in damage to equipment or property.

1.2. General Safety

CAUTION

This manual contains important instructions that must be followed during operation and maintenance of the MES 1001 MARPOL Marine Emission Sensor.

NOTICE

BEFORE INSTALLATION
Check for damage to equipment and packaging. If in doubt, contact the supplier before commencing installation.

CAUTION

Personnel conducting maintenance must be:

- Trained and authorized in general safety rules for work on electrical equipment.
- Familiar with local requirements, rules, and regulations for the installation.

NOTICE

When planning the installation site, ensure that the product label and warning labels remain visible.

NOTICE

Handle the MES 1001 MARPOL Marine Emission Sensor with care. Ensure safe mounting by lifting and moving MES 1001 MARPOL Marine Emission Sensor carefully. Lifting equipment can be necessary to carry the unit.

The weight of the components in the MES 1001 MARPOL Marine Emission Sensor are considerable and may cause injury if dropped. Wear safety boots.

1. Introduction

1.1. Purpose of the Manual

This manual provides information on operation and maintenance of the MES 1001 MARPOL Marine Emission Sensor. Descriptions of functional modes and display examples will enable the user to understand the different user interfaces. The Sensor Service Tool (SST) is a software tool, which provides easy monitoring of the marine emission sensor.

Other available resources:

- *MES 1001 MARPOL Data Sheet* (101222-DSH)
- *MES 1001 MARPOL Installation Guide* (101407-MAN)

These documents are available for download at the Danfoss IXA website, or from the supplier of the marine emission sensor.

NOTICE

This manual **only** includes instructions on **correct** operation, maintenance, troubleshooting and repair of the MES 1001 MARPOL sensor, hence any operation, maintenance, troubleshooting and repair of the MES 1001 MARPOL sensor not included in this manual is **not** intended use of the sensor and may cause the sensor to malfunction or to be damaged. Contact ixa.service@danfoss.com if information to solve a specific situation cannot be found in this manual.

1.2. Abbreviations and Definitions

Abbreviation	Description
ADU	Application Data Unit
CCD	Charged Coupled Device
DHCP	Dynamic Host Configuration Protocol
DOAS	Differential Optical Absorption Spectroscopy
GPS	Global Positioning System
LAN	Local Area Network
LCP	Local Control Panel
LED	Light Emitting Diode
MBAP	Modbus Application
NH3	Ammonia
NO	Nitric Oxide
NO2	Nitrogen Dioxide
NOx	A generic term for NO and NO2
NTP	Network Time Protocol
PDU	Protocol Data Unit
ppm	Parts Per Million
SO2	Sulfur Dioxide
SPE	Signal Processing Engine
SST	Sensor Service Tool
TCP	Transmission Control Protocol
UTC	Coordinated Universal Time
UV	Ultraviolet

Table 1: Abbreviations

Term	Description
Alarm	An alarm covers conditions where the sensor either malfunctions or exceeds the operational limits.
Heartbeat	The marine emission sensor provides a heartbeat signal on the control interface. A heartbeat signal is a periodic signal generated by the sensor to indicate that the sensor is running/measuring.
Modbus	Communication protocol.
Operational mode	The marine emission sensor has the following operational modes: • Standby Mode The marine emission sensor remains idle and does not perform any measurements. • Calibration Mode The marine emission sensor performs zero-point calibration. This process is automatic. • Sensing Mode The marine emission sensor performs measurement of all supported gases.
Warning	A warning covers conditions where the sensor is close to exceeding operational limits.

Table 2: Definitions

1.3. Product Description

The sensor is a marine emission sensor intended for measuring gases in various maritime applications. It is designed to withstand harsh environments. The ability of the marine emission sensor to operate in harsh environments with a low maintenance rate makes the marine emission sensor suitable for demanding applications. The marine emission sensor measures the content of these gases: NOx, SO_2 and NH_3 in the engine exhaust gas. The marine emission sensor is an in situ sensor, i.e. it performs the measurement directly in the exhaust gas. The sensor unit is mounted on the wall of the exhaust stack and measures the exhaust gas passing the sensor probe.

Illustration 1: Marine Emission Sensor

1.4. Measurement principle and functionality

The sensor works by the principle of DOAS (Differential Optical Absorption Spectroscopy). When mounted on the exhaust stack, the exhaust gas will pass through the probe. A UV (ultraviolet) light source emits light through an optical fiber into the probe where it is reflected and collected by another fiber, which is connected to the spectrometer. A CCD (Charged Coupled Device) in the spectrometer collects the incoming light and converts it into an electrical signal. The signal (spectrum) is then sampled and delivered to the Signal Processing Board.

The Signal Processing Board acquires the data from the spectrometer, and through an advanced algorithm combined with proprietary gas reference library, the gaseous concentrations are calculated. The signal processing compensates for the exhaust gas pressure and the exhaust gas temperature, which gives a more accurate measurement.

The marine emission sensor is automatically calibrated at specific intervals to compensate for various potential sources of error. This is achieved by applying compressed air into the probe. This way the exhaust gas in the measurement path is evacuated and only clean compressed air will be present. The Signal Processing Board calculates a new reference and compressed air is removed bringing the marine emission sensor back to normal operation.

The Signal Processing Board also controls the interfaces for external communication with the marine emission sensor. Interfaces like Ethernet and Analog Out, and discrete inputs/outputs are available and can be set up individually. The marine emission sensor can be operated locally through a display, but the user may also use a software-based service interface for remote access.

The Purge Air System is vital in the operation of the MES 1001 MARPOL. Purge air is always supplied to the probe of the sensor and it has three functionalities for the MES 1001 MARPOL. During Sensing Mode, the Purge Air System is a part of ensuring that the path length in the probe measuring chamber is correct hence the sensor is measuring correctly. Additionally, the Purge Air System constantly supplies compressed air to the optics in the probe which protects the optics from contamination with soot and other particles during operation. Finally, when the sensor enters Calibration Mode the Purge Air System provides compressed air to the measuring chamber for the zero-point calibration process.

1.5. Functional Features

The marine emission sensor is equipped with a control panel with a relevant button layout for local operation. The integrated control panel on the front of the marine emission sensor gives the user access to information about the system, the measured gases, and limited control.

Among available local control features and information are:

- ON/OFF control through a manually operated mechanical switch.
- Visual Power ON indication.
- Visual Warning indication.
- Visual Alarm indication.
- Control interface status of the sensor's operational modes.
- Control interface notifications in case of an error or warning.
- Menu for setting up the sensor.

1.6. Startup

Use the On/Off switch to turn on the marine emission sensor. The On/Off switch is positioned at the bottom of the marine emission sensor.

Illustration 2: On/Off Switch

NOTICE

Always keep the compressed air supply opened to the sensor while the engine is running even though the sensor is switched off. This is to protect the optics in the sensor from being contaminated.

Applying power
When power is applied to the marine emission sensor, the software starts booting. When the display is lit, the marine emission sensor is ready for operation. A zero-point calibration process is always initiated from standby mode and the marine emission sensor starts measuring after having received a command to do so.

The startup procedure works in the following way:

- The screen is illuminated and an IXA animation starts:

- All LEDs are turned on.
- When the animation is finished, the LEDs turn off, except On LED and Status LED.
- Warning LED will turn on if a warning is active.
- Alarm LED will flash if an alarm is active.

2. User Interfaces

2.1. First Time Setup

The sensor is initially configured with date and time at the time of its production, however during shipping the clock may have drifted. To ensure correct operation and logging, the sensor time must be set before it is taken into use. The sensor will continuously broadcast an alarm until the time is adjusted.

When the sensor is powered on for the first time, it will automatically enter the time setup menu on the local control panel from where the time can be set immediately. For manual setup of the sensor time, see 3.9 Service Page.

Also set up the appropriate signal interfaces applicable to the specific installation. For interface setup of the sensor time, see 3.8 Settings Pages.

2.2. Local Control Panel

NOTICE

The contrast level of the display can be altered by pressing and holding the Status button, and at the same time pressing the up and down buttons.

NOTICE

The backlight of the display can be turned off/on by pressing and holding the Status button and at the same time pressing the Back button.

2.2.1. LCP Layout

The LCP is divided into 4 functional groups (A-D), see Illustration 3.

Illustration 3: LCP Layout

A. Display area.

B. Display menu keys for changing the display to show status options and menu.

C. Navigation keys for programming functions and moving the display cursor. Also included are the status indicator lights.

D. Start/Stop Key.

2.2.2. Display Area (A)

The display is divided into 3 sections.

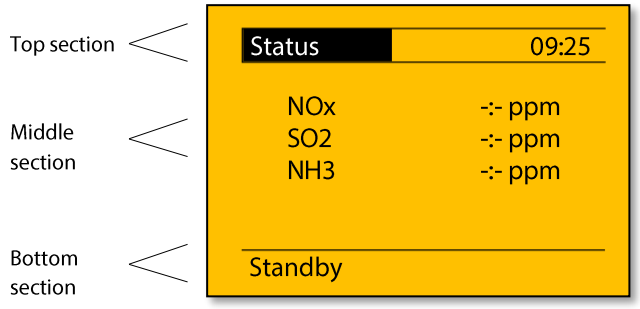


Illustration 4: Display Area

Top section	Heading.
Middle section	Displays information and values.
Bottom section	Shows current sensor mode and/or warning and alarm info.

Table 3: Legend to Illustration 4

2.2.3. Display Menu Keys (B)

The display menu keys are used for menu access for parameter setup, toggling through status display modes during normal operation, and viewing fault log data.

Illustration 5: Display Menu Keys

Key	Function
Status	Selects Status view (LED) Press to go to Status screen from any menu
Menu	Gives access to menus (LED) Press to go to the Main Menu from any other display view.

Table 4: Legend to Illustration 5

2.2.4. Navigation Keys (C)

Navigation keys are used for editing parameters, moving the display cursor, and selecting display views. Three status indicator lights are also located in this area.

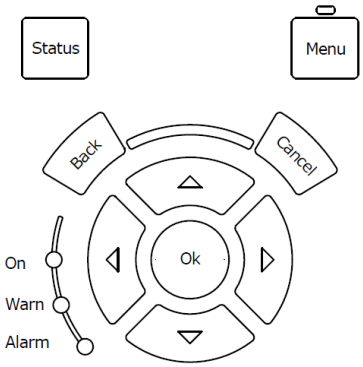


Illustration 6: Navigation Keys

Key	Function
Back	Return/deselect Go to the nearest higher level view/Menu. The top level view is the Status view.
Cancel	Cancels selection Cancels the last change or command as long as the display mode has not changed.
OK	Enter/select Use to access parameter groups or to enable a selection.
Navigation keys	Use the 4 navigation keys to move between items in the menu and toggle between Status views. ▲ Arrow up ▼ Arrow down ◄ Arrow left ► Arrow right

Table 5: Legend to Illustration 6

2.2.5. Indicator Lights (LEDs)

If certain threshold values are exceeded, the alarm and/or warning LED light up. A status and alarm text appears on the control panel. At the same time, the back light is on.

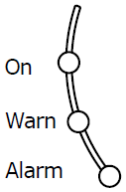


Illustration 7: Indicator Lights (LEDs)

LED	Function
On - green LED	Power on
Warn - yellow LED	On when a warning is active.
Alarm - red LED	Blinking when an alarm is active.

Table 6: Legend to Illustration 7
The following 3 symbols are used in the display and will be visible when one of the events is active:

Warning	Alarm	Maintenance
!		

Table 7: Icons Used by the Display

2.2.6. Start/Stop Key (D)

The Start/Stop key is located at the bottom of the LCP.

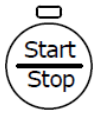


Illustration 8: Start/Stop Key

Key	Function
Start/Stop	Starts/stops measurements (LED)

Table 8: Legend to Illustration 8

The Start/Stop key starts the measurements; however, zero-point calibration is initialized automatically. When zero-point calibration is finished, it automatically enters sensing mode.

NOTICE

If the sensor operation is controlled by Digital Input, the Start/Stop key is ignored.

In Calibration mode, the Start/Stop LED flashes. In Sensing mode, the Start/Stop LED is lit continuously. When Stop is pressed again, the LED turns off and the sensor enters Standby mode.

NOTICE

Always keep the compressed air supply opened to the sensor while the engine is running even though the sensor is stopped. This is to protect the optics in the sensor from being contaminated.

2.2.7. Status

The following are examples of different status displays and readouts.

Illustration 9: Calibrating Mode and Concentration Status[1)]

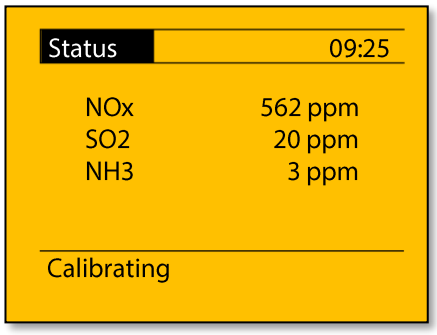
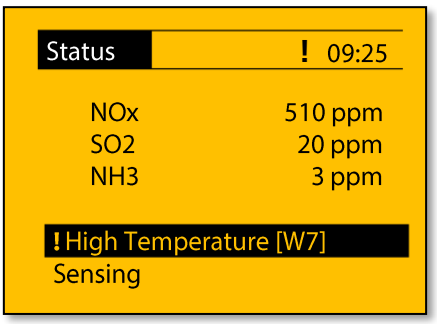


Illustration 10: Warning Situation[2)]



[1)] Only available gases are shown.
[2)] Refer to Appendix 2 - Event List for a list of event numbers and types. [W7] means Warning 7.

Illustration 11: Sensing Mode and Temperature Status

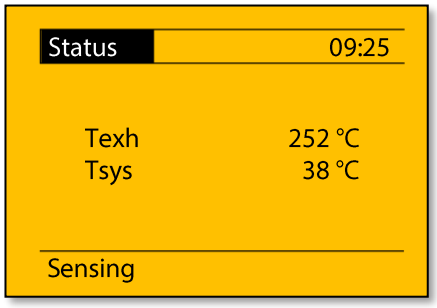


Illustration 12: GPS Coordinates

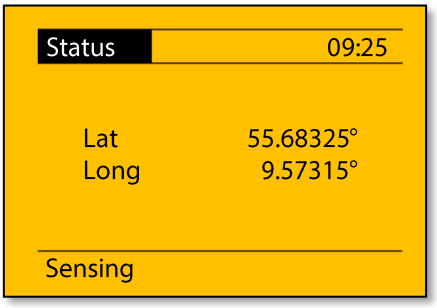
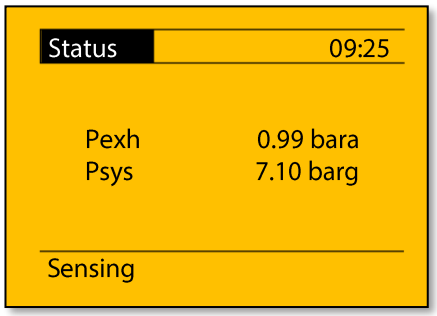


Illustration 13: Exhaust and System Pressure



2.2.8. Menu

All menus and parameters are numbered according to their category and tier with 3 digits. The leftmost digit designates the top-level menu, e.g. *3-** Interfaces*. The next tier contains submenus, e.g. *3-1* LAN Setup*, which contain the parameters, e.g. *3-11 LAN IP address*. See 2.3 Menu Structure or Appendices Appendix 1 – Parameter Overview for an overview of parameters.

Illustration 14: Main Menu with Scroll Bar

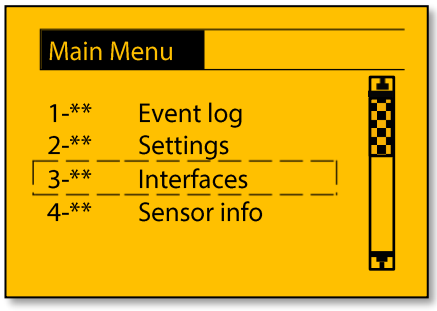


Illustration 15: Submenu 1, Reference to Main Menu Number

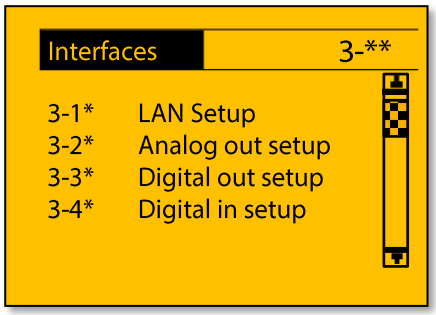


Illustration 16: Selection Screen

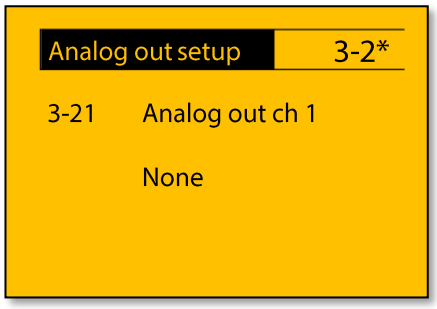


Illustration 17: Event Log Status Selection Menu

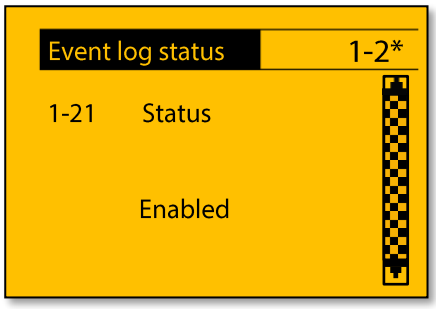


Illustration 18: Warning Levels with Range Indicator (Arrow) Showing MAX

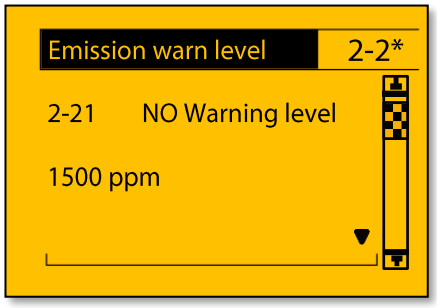
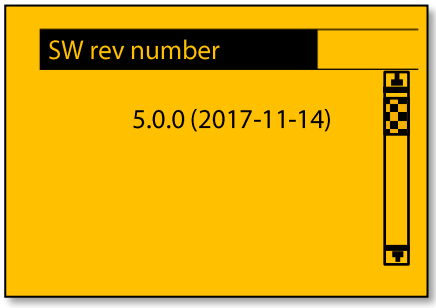


Illustration 19: Sensor Info



2.2.9. Editing Parameters

Changing Parameter Options

1. Enter the desired menu and use the Up (▲) and Down (▼) navigation keys to select a parameter.
2. Press OK to highlight options (for example Enabled/Disabled). Use the Up (▲) and Down (▼) navigation keys to view other options. Press Cancel to abort or press OK to confirm the new setting. The colors are now inverted.

Illustration 20: Step 1

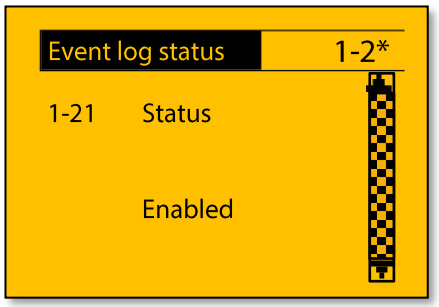
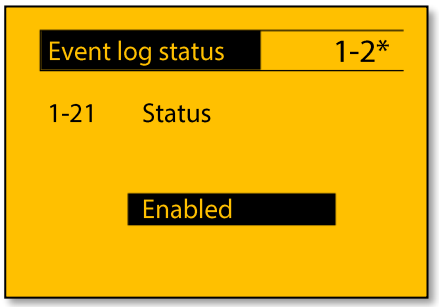


Illustration 21: Step 2



Changing Parameter Values

1. Enter the desired menu by using the navigation keys.
2. Press OK to enable editing of the value.
3. Move between digits by using the Left (◄) and Right (►) navigation keys. Digits can be highlighted individually and the value can be changed (as default, all digits are highlighted). The minimum and maximum values are those specified within range. The Up (▲) and Down (▼) navigation keys increase or decrease the value by 1 (default).
   – Press OK to confirm changes or cancel to discard changes.
4. The new value will now be applied to the parameter (e.g. 1200 ppm).

Illustration 22: Step 1

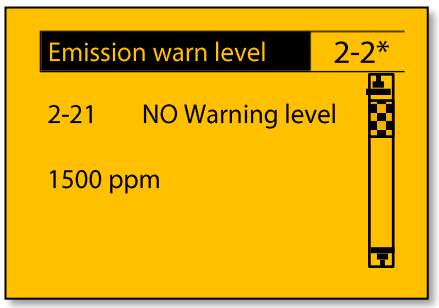


Illustration 23: Step 2

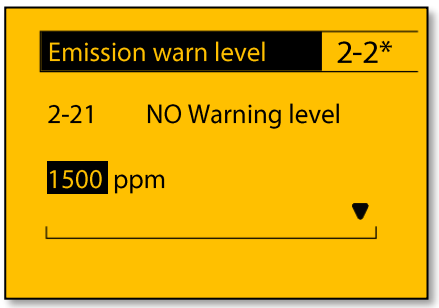


Illustration 24: Step 3

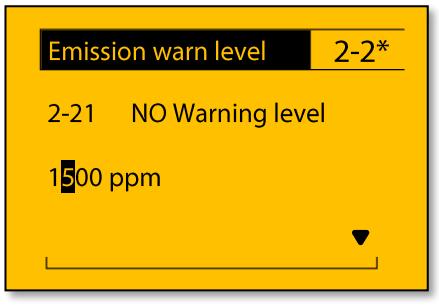
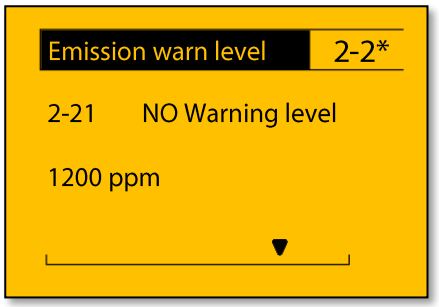


Illustration 25: Step 4



2.3. Menu Structure

See *Appendices*
Appendix 1 – Parameter Overview for default values and ranges.

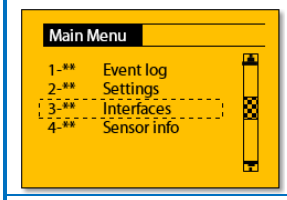
2.3.1. Menu Overview

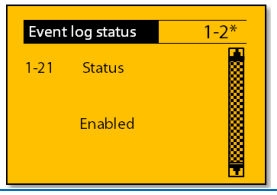
Main Menu

1. Event Log	2. Settings	3. Interfaces	4. Sensor info	5. Maintenance	6. Gas Calibration
1.1 Event Log Show 1.11 Event Log 1.2 Event Log Status 1.21 Status 1.3 Help	2.1 Calibration ACK 2.11 Cal Ack Mode 2.2 Emission warn level 2.21 NO warning level 2.22 NO2 warning level 2.23 NOx warning level 2.24 SO2 warning level 2.25 NH3 warning level 2.26 Warning level status 2.3 NO_X Readout 2.31 Status 2.4 Auto Start 2.41 Status 2.5 GPS 2.51 Status 2.6 Set Time and Date 2.61 Set Date	3.1 LAN Setup 3.11 LAN IP Address 3.12 LAN Gateway 3.13 LAN Network mask 3.14 Reboot 3.15 Sensor Hostname 3.16 DHCP 3.2 Analog out setup 3.21 Analog out ch 1 3.22 Analog out ch 2 3.23 Analog out ch 3 3.24 Analog out ch 4 3.3 Digital out setup 3.31 Digital out ch 1 3.32 Digital out ch 2 3.4 Digital in setup 3.41 Digital in ch 1 3.42 Digital in ch 2	4.1 Part number 4.11 Sensor Part number 4.2 Revision number 4.21 Sensor HW revision number 4.3 Serial number 4.31 Sensor Serial number 4.4 SW rev number 4.41 SW revision number 4.5 FW rev number 4.51 Sensor Firmware revision number 4.6 OS rev number 4.61 Operating Software revision number 4.7 SP serial number 4.71 SP serial number 4.8 Calibration Cert 4.9 Sensing Time	5.1 Lamp Replacement 5.2 Optics Cleaned 5.3 Reset Password 5.4 Diagnostics Report 5.5 Update Software 5.6 Save Setup 5.7 Restore Setup 5.8 Power on time	6.1 Gas Calibration

Illustration 26: Menu Overview

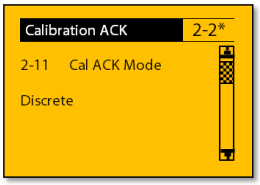
2.3.2. Menu Display Examples

Main Menu		
1-** Event 2-** Settings 3-** Interfaces 4-** Sensor info 5-** Maintenance 6-** Gas Calibration 		
See ***Appendices*** ***Appendix 1 – Parameter Overview.***		

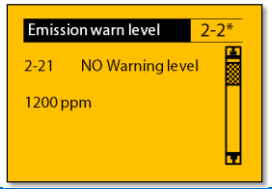
1- Event log**		
1-1* Event log show *(view only Event Details)* - select 1-11 Event log *(options List of Log IDs. If there are no Events, the list is empty.)* 	1-2* Event log status - select 1-21 Status *(options Enabled, Disabled)* 	1-3* Help 
See ***Appendices*** ***Appendix 1 – Parameter Overview.***		

2- Settings**

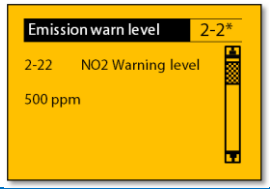
2-1* Calibration ACK
- select 2-11 Cal Ack Mode
(options Automatic, Discrete, LAN)



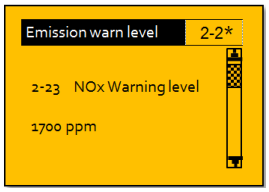
2-2* Emission warn level
- select 2-21 NO Warning level



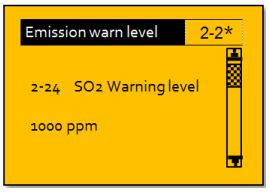
- select 2-22 NO2 Warning level



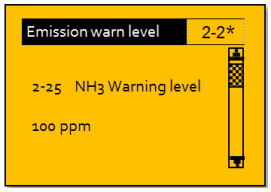
- select 2-23 NOx Warning level



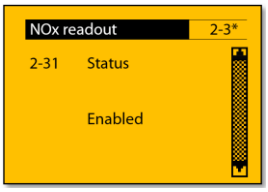
- select 2-24 SO_2 Warning level



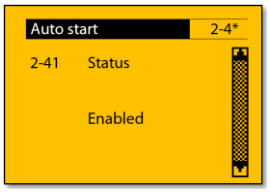
- select 2-25 NH_3 Warning level



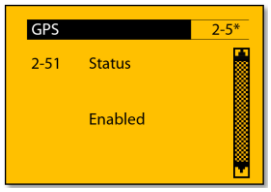
2-3* NOx readout
- select 2-31 NOx readout status



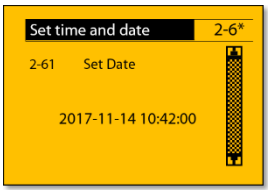
2-4* Auto start
- select 2-41 Auto start status



2-5* GPS
- select 2-51 GPS status



2-6* Set time and date
- select 2-61 Set Date

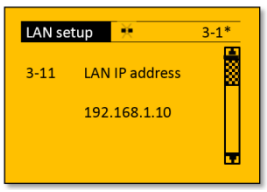


See ***Appendices***
Appendix 1 – Parameter Overview.

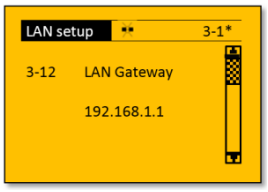
3- Interfaces**

Note: The symbol indicates a link connection.

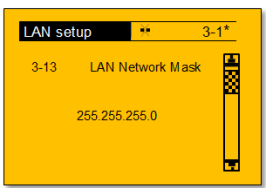
3-1* LAN setup
- select 3-11 LAN IP Address



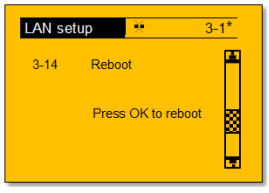
- select 3-12 LAN Gateway



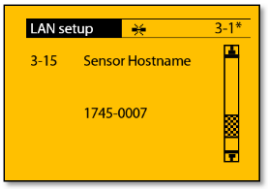
- select 3-13 LAN Network mask



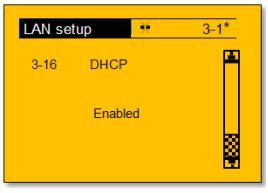
- select 3-14 Reboot



- select 3-15 Sensor Hostname



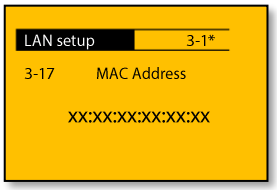
- select 3-16 DHCP



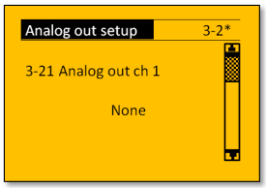
3- Interfaces continued**

Note: The symbol indicates a link connection.

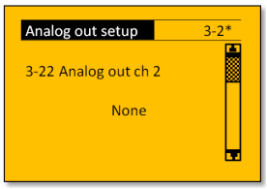
- select 3-16 MAC Address



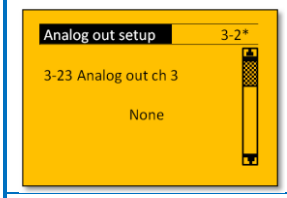
3-2* Analog out setup
- select 3-21 Analog out ch 1
(options None, Test, NO, NO2, NOx, SO2, NH3)



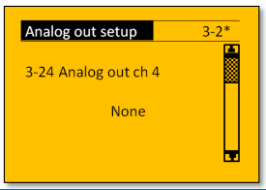
- select 3-22 Analog out ch 2
(options None, Test, NO, NO2, NOx, SO2, NH3)



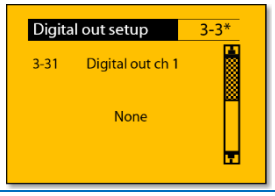
- select 3-23 Analog out ch 3
(options None, Test, NO, NO2, NOx, SO2, NH3)



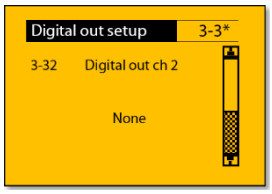
- select 3-24 Analog out ch 4
(options None, Test, NO, NO2, NOx, SO2, NH3)



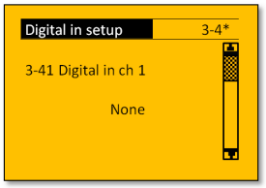
3-3* Digital out setup
- select 3-31 Digital out ch 1
(options None, Active Heartbeat, Alarms - off, Alarms – on, Warnings/Alarms – off, Warnings/Alarms – on, Heartbeat, Calibration Request)



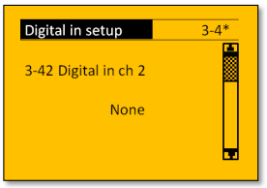
- select 3-32 Digital out ch 2
(options None, Active Heartbeat, Alarms - off, Alarms – on, Warnings/Alarms – off, Warnings/Alarms – on, Heartbeat, Calibration Request)



3-4* Digital in setup - select 3-41 Digital in ch 1
(options None, Start/Stop, Calibration ACK)



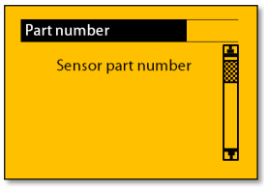
- select 3-42 Digital in ch 2 1
(options None, Start/Stop, Calibration ACK)



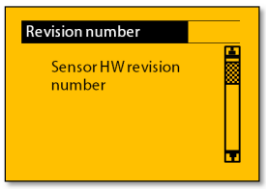
See ***Appendices***
Appendix 1 – Parameter Overview.

4- Sensor Info**

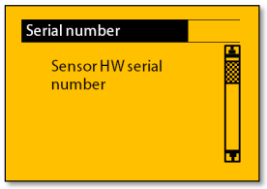
4-1* Part number
- read only Sensor part number



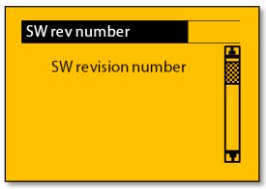
4-2* Revision number
- read only Sensor HW revision number



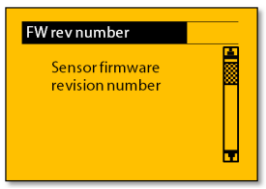
4-3* Serial number
- read only Sensor HW serial number



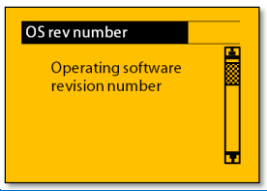
4-4* SW rev number
- read only SW revision number

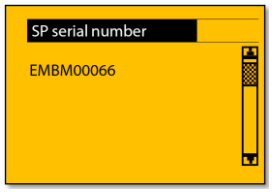
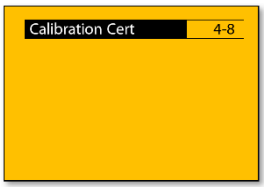
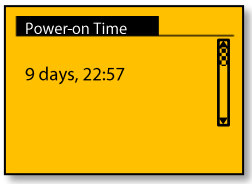


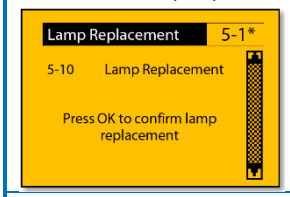
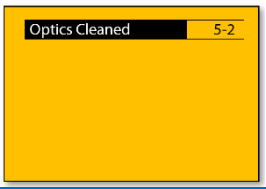
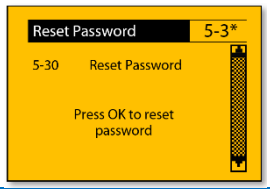
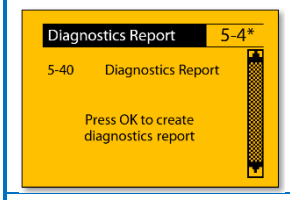
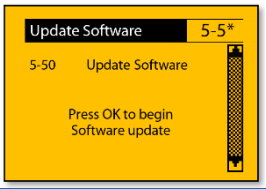
4-5* FW rev number
- read only Sensor firmware revision number

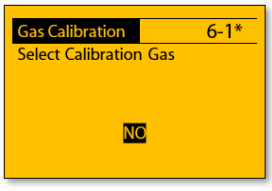


4-6* OS rev number
- read only Operating software revision number



4- Sensor Info continued**		
4-7* SP serial number *- read only Spectrometer serial number* 	4-8* Calibration Cert 	4-9* Power-on Time 
See ***Appendices*** ***Appendix 1 – Parameter Overview.***		

5- Maintenance**		
5-1* Lamp Replacement - select 5-10 Lamp Replacement 	5-2* Optics Cleaned 	5-3* Reset Password - select 5-30 Reset Password 
5-4* Diagnostics Report - select 5-40 Diagnostics Report 	5-5* Update Software - select 5-50 Update Software 	5-6* Save Setup 
5-7* Restore Setup 	5-8* Sensing Time 	
See ***Appendices*** ***Appendix 1 – Parameter Overview.***		

6- Gas Calibration**		
6-1* 		

2.4. USB Interface

The USB interface, located at the bottom of the marine emission sensor, can be used in combination with the local front panel and a USB drive to update the sensor software or extract a diagnostics report. The USB interface also includes the possibility to save/restore setup as well as enabling download of calibration certification in PDF format. The storage capacity of the USB drive must not exceed 32 GB.

2.4.1. Diagnostics Report

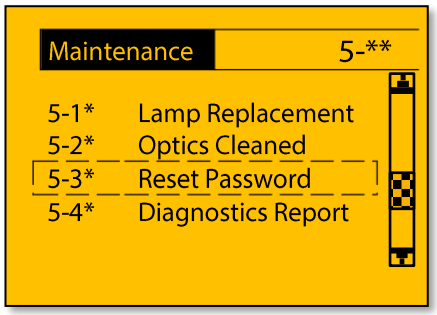
The diagnostics report is an important tool to help service personnel analyze the sensor's behavior. If a query regarding the sensor's performance is submitted a diagnostics report may be required to find the source of technical issues.

NOTICE

Ensure the USB drive is working and not full, before creating the diagnostics report.

To create a diagnostics report, insert a USB drive, navigate to the maintenance menu and select Diagnostics Report.

Illustration 27: Maintenance submenu



Follow the instructions on the screen and proceed by pressing OK.

Illustration 28: Step 1

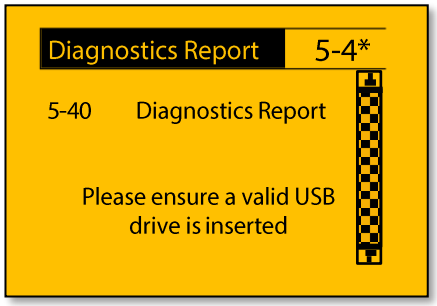


Illustration 29: Step 2

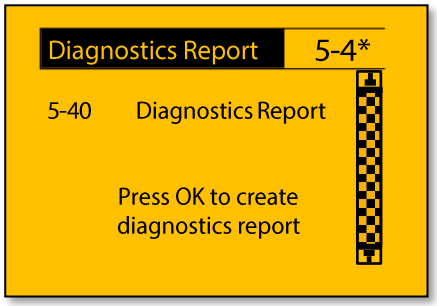


Illustration 30: Step 3

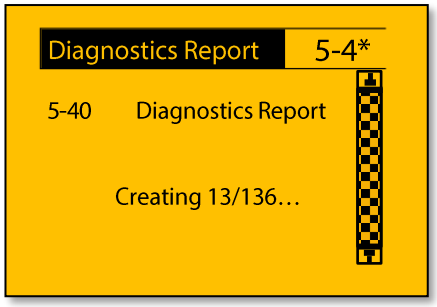
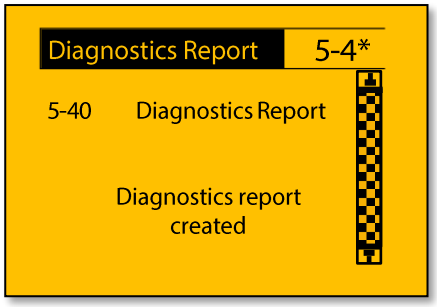


Illustration 31: Step 4



After successful completion, a directory named Diagnostics will be placed in the root folder of the USB drive.
If a USB device is not found, check or replace the USB drive, and start the sequence again by pressing OK.

2.4.2. Updating Software

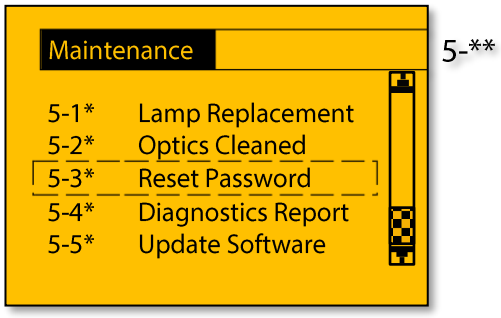
The software package obtained from Danfoss IXA consists of a directory with several files used for updating the software suite. The entire software directory must be placed on a USB drive before it is inserted into the sensor. Make sure that only 1 software folder exists on the USB drive, to ensure the intended version will be installed.

NOTICE

Do not turn the sensor off after beginning a software update, the sensor will automatically reboot when finished.

Insert the USB drive with the software suite in the sensor, navigate to the Maintenance submenu on the LCP and select Update Software.

Illustration 32: Maintenance submenu



Proceed through the guide by pressing OK, and if the directory is found, the software update will begin. The update will take several minutes. Wait for the sensor to reboot, the LCP screen may freeze during the update.

Illustration 33: Step 1

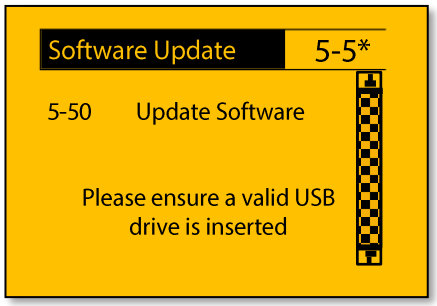


Illustration 34: Step 2

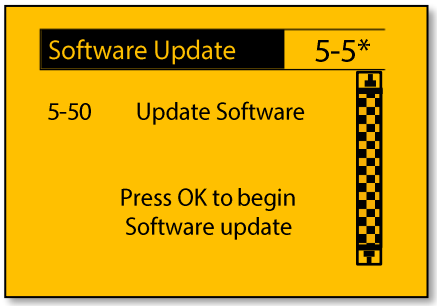


Illustration 35: Step 3

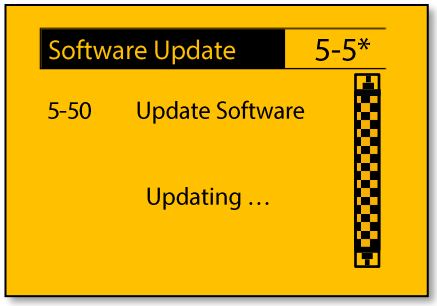
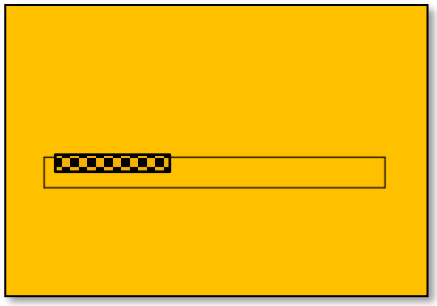


Illustration 36: Step 4



This step takes approx. 5 minutes and progress is indicated by the progress bar.

If a USB device with a valid software package is not found, the update will not start, and an error message will be displayed. Ensure that the complete directory is present on the device and try again. Press OK to restart the guide.

2.4.3. Optics Cleaned

The Optics Cleaned entry must be used when the optics of the sensor has been cleaned using the Probe Optics Cleaning Kit. It will reset and recompute the optics settings of the sensor (light intensity) by performing several zero-point calibrations. The duration of this operation is 1 to 2 minutes after which the sensor will return to its sensing state.

2.4.4. Save Setup

Insert USB stick → Maintenance → 5.6 Save Setup.

The Save Setup function saves the customizations of the sensor to a USB stick. The USB stick can later be used to restore the same or another sensor to an identical setup. The functionality can be used to create a backup of the sensor settings before changing some of the parameters available for customization in the LCP. The functionality is also able to carry customizations between several sensors that require identical setups.

2.4.5. Restore Setup

Insert USB stick → Maintenance → 5.7 Restore Setup.

The Restore Setup function restores the customizations of the sensor to those found on a USB stick. The functionality is also able to carry customizations between several sensors that require identical setups.

2.4.6. Calibration Cert

Insert USB stick → Sensor Info → 4.8 Calibration Cert.

The Calibration Cert functionality downloads the sensor's calibration certificate as a PDF file and stores it on the attached USB stick ("<serial number> Calibration Certificate.pdf"). This is an electronic copy of the printed calibration certificate shipped with the sensor.

3. Sensor Service Tool

3.1. Introduction

The Sensor Service Tool (SST) provides easy monitoring and control of the marine emission sensor. The SST is a software tool that interfaces with the marine emission sensor software.

The SST supports Windows® 7 and onwards.

The Sensor Service Tool is delivered together with the marine emission sensor, or it can be downloaded from www.danfoss-ixa.com.

The main functionalities of the tool are:

- Status
- Measurement Log
- Event Log
- Interfaces
- Service

3.2. Installation

Follow this procedure to install the SST:

1. Go to the specified download area and save the application file (approx. 32 MB), or run the file from USB.

2. Install via Windows Installer by clicking the file.

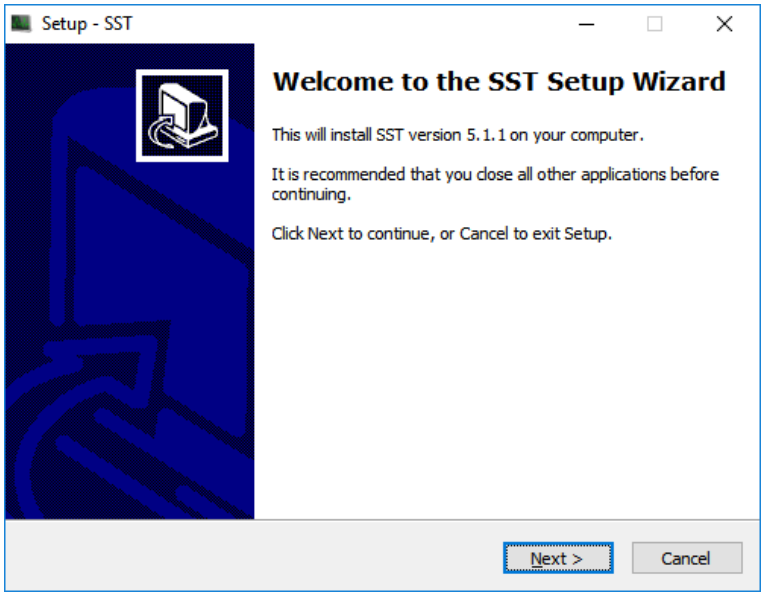


Illustration 37: SST Setup Wizard

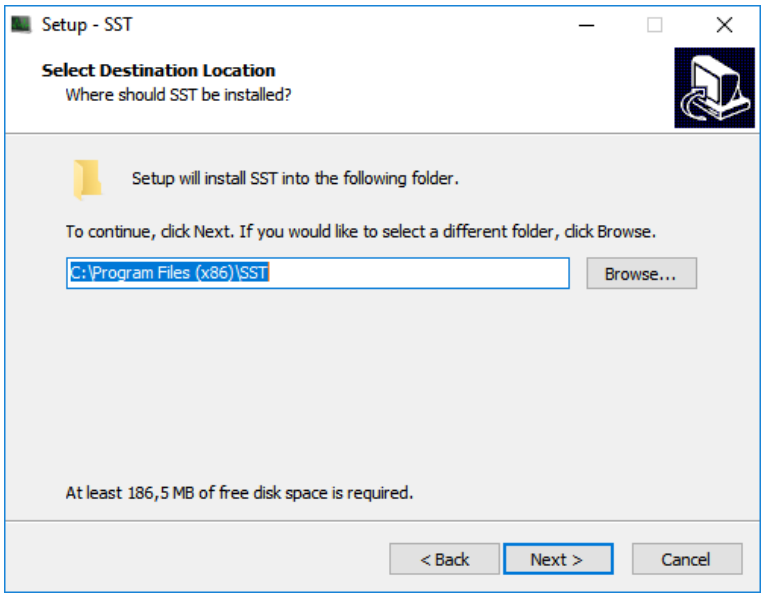


Illustration 38: Select Destination Location

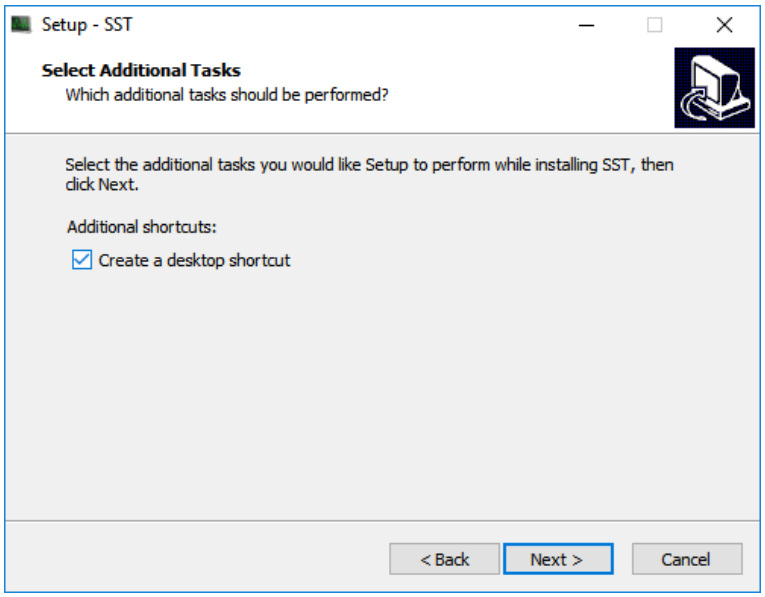


Illustration 39: Select Additional Tasks, Desktop Icon

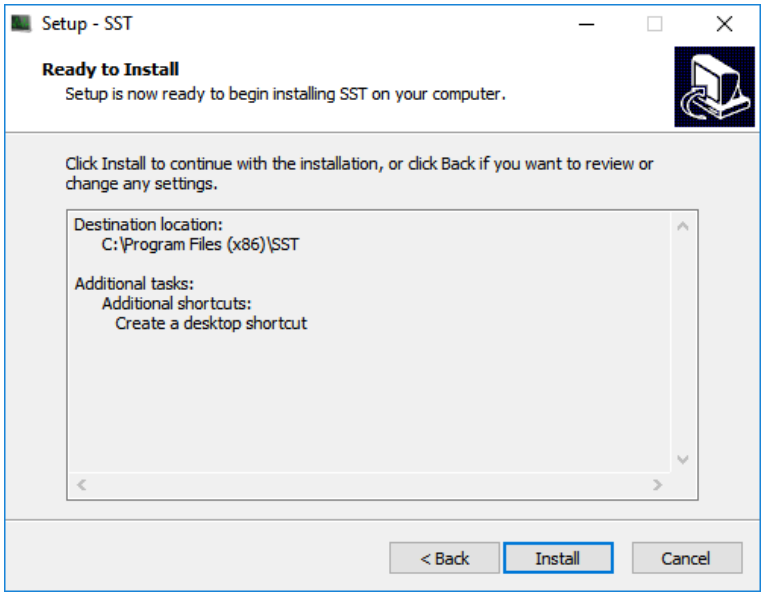


Illustration 40: Select Additional Tasks, Desktop Icon

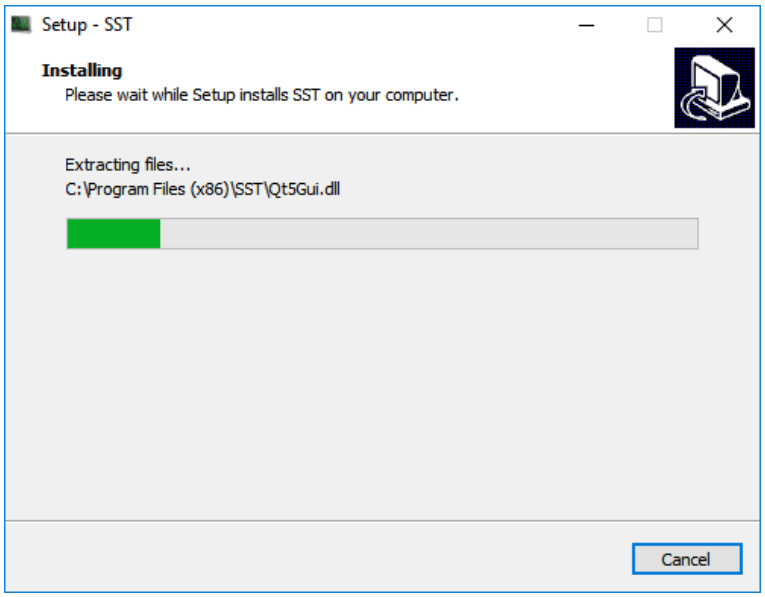


Illustration 41: Installing, Extracting Files

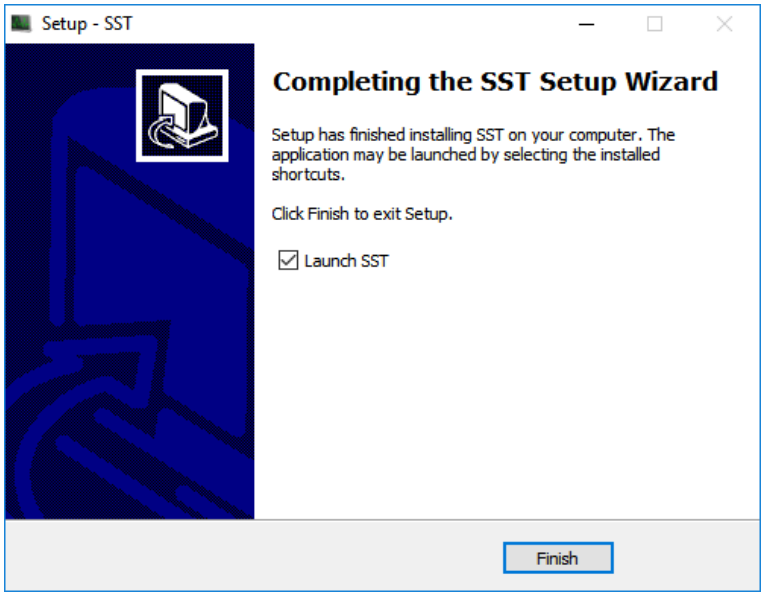


Illustration 42: Installation Completed, Launch SST

3. Launch tool on PC by clicking the desktop icon, if available, or from the start menu.

Once installed, the software is ready for use.

3.3. Connection

Establish connection by entering the Sensor IP address or hostname (default hostname is serial number) and press Connect. The standard username and password are admin/admin. Refer to 3.8 Settings Pages (Settings → Interfaces) to change the password.

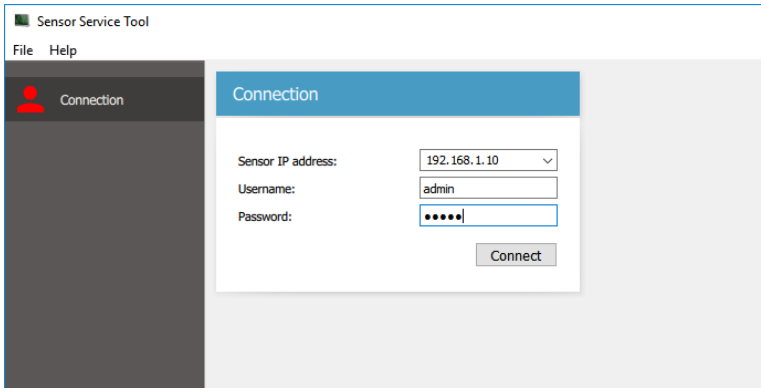


Illustration 43: Establish Connection

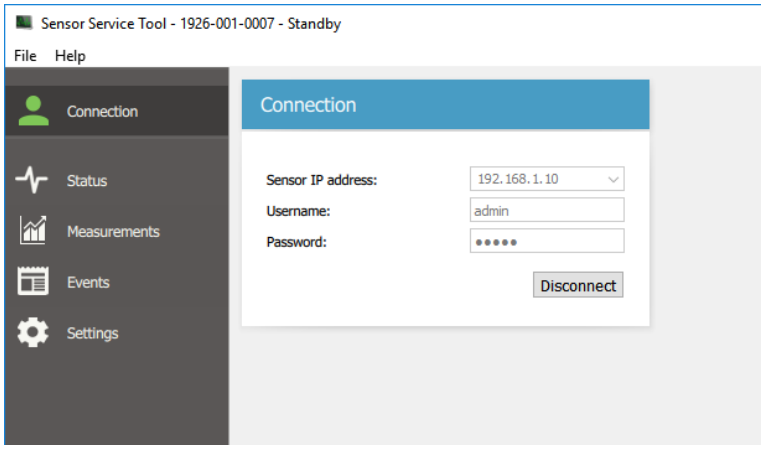


Illustration 44: Connection Established

Once connection is established, the Connection icon changes color from red to green.

The SST version can be read on the screen. The SST version is always available via the menu Help → About.

Illustration 45: SST Version

3.4. Overview

The menu is located on the left-hand side of the screen comprising:

- Status
- Measurements
- Events
- Settings

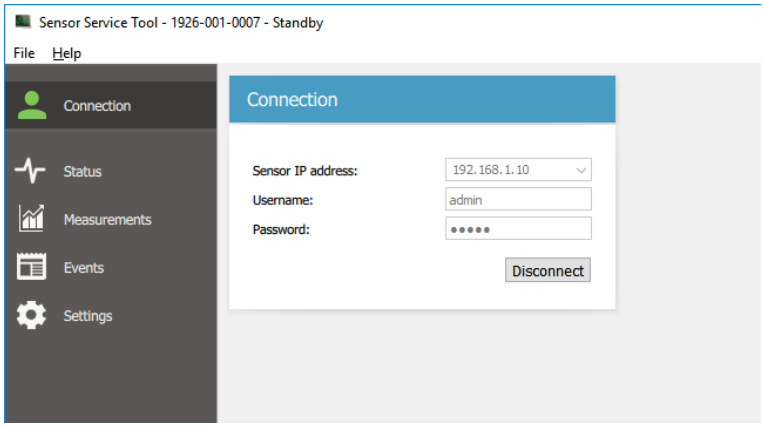


Illustration 46: SST Overview Page

3.5. Status Pages

Click on Status in the menu to view the following 3 sections, which appear automatically:

- Measurements
- Measurement Control
- Sensor status

Note that the following 3 illustrations indicate Standby, Calibrating and Sensing.

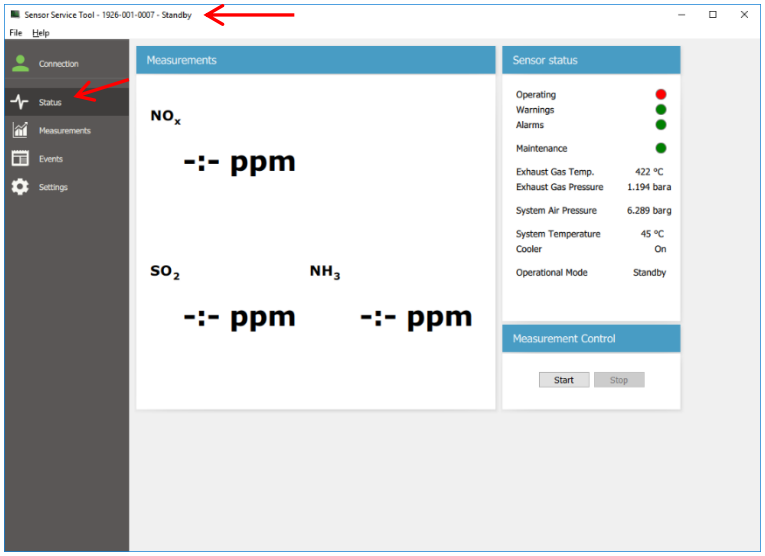


Illustration 47: Status Page 1, Standby

Symbol	Description
-:-	Indicates standby, no measurements

Symbol	Description
N/A	Indicates unsupported gases (not shown)

Table 9: Symbols

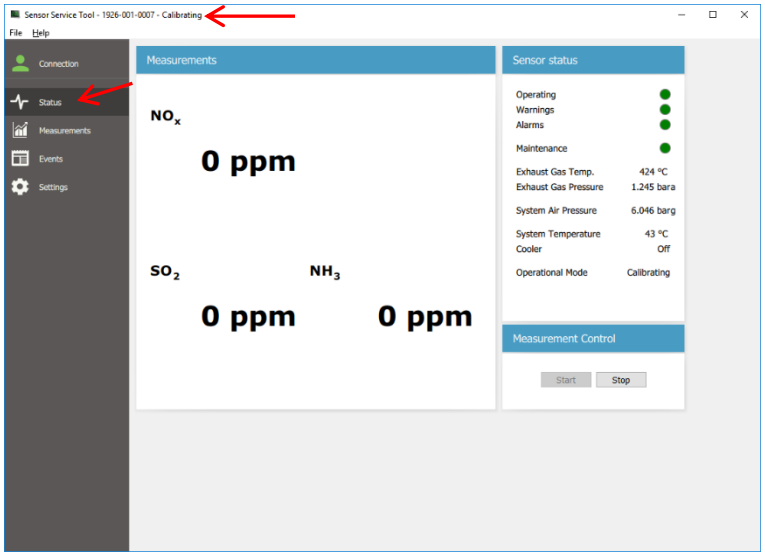


Illustration 48: Status Page 2, Calibrating

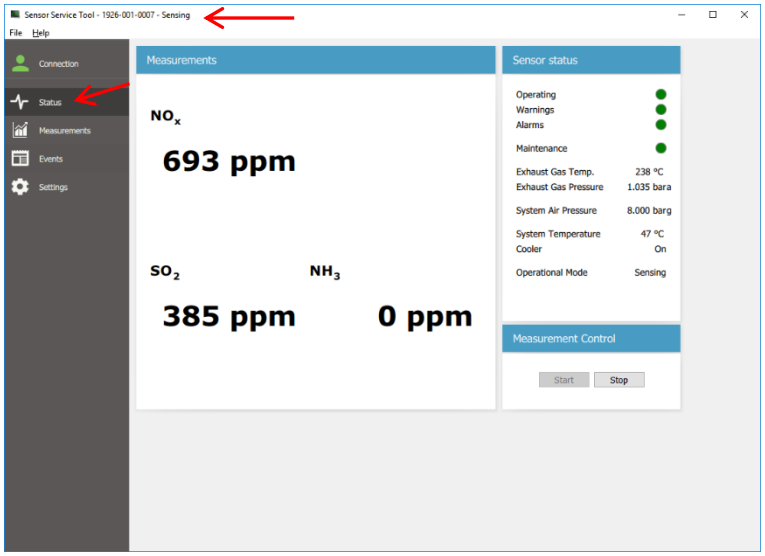
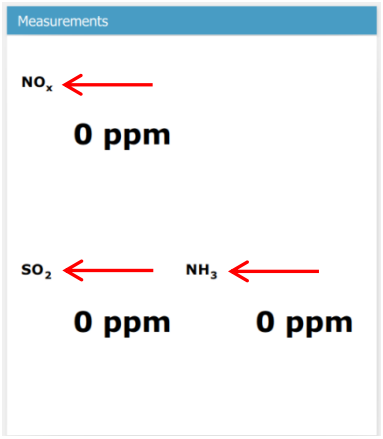
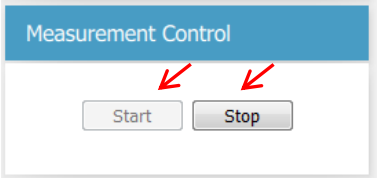


Illustration 49: Status Page 3, Sensing

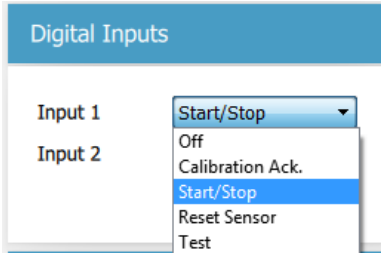
- **Measurements** show the current measured values of SO_2, NH_3, and NO + NO_2 or NO_x depending on the chosen setup.



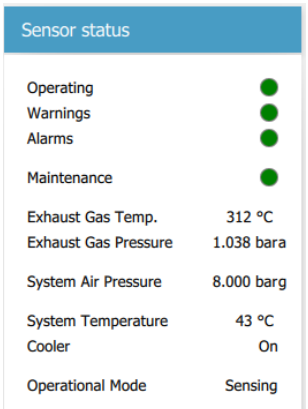
- **Measurement Control** has a Start button and a Stop button to start and stop measurement control.



- **Digital Input** - If the sensor operation is controlled by digital inputs the Start and Stop commands are disabled.



- **Sensor Status** provides a quick overview of the status and health of the marine emission sensor. The following information is available:



Sensor status	Description
Operating	The Operating indication operates as follows: • Green when Measurements are enabled. • Red when Measurements are disabled.
Warning	The Warning indication operates as follows: • Green when no warning is present. • Yellow when a warning is present.
Alarms	The Alarms indication operates as follows: • Green when no alarm is present. • Red when an alarm is present.
Maintenance	The Maintenance indication operates as follows: • Green when no maintenance is required. • Yellow when maintenance is required. • Red when maintenance is overdue.
Exhaust gas temperature	Shows exhaust gas temperature in the probe.
Exhaust gas pressure	The pressure is measured as absolute pressure.
Input air pressure	The pressure is measured as gauge pressure.

	Sensor status	Description
	System temperature	Shows the system temperature sensor.
	Cooler	Shows the actual status of the cooler. The following values are allowed: • ON • OFF
	Operational mode	Shows the actual status of the operational mode, which can be one of the following: • Standby • Sensing • Calibration • Over-temperature

Table 10: Sensor Status

3.6. Measurements Page

Click on Measurements in the menu to view the following 4 sections, which appear automatically:

- Live Measurements Graph
- Live Measurement Control
- Sensor Meas. Log
- Sensor Meas. Log Download

Please note: To enable NO_x, please see section 3.9 Service Page.

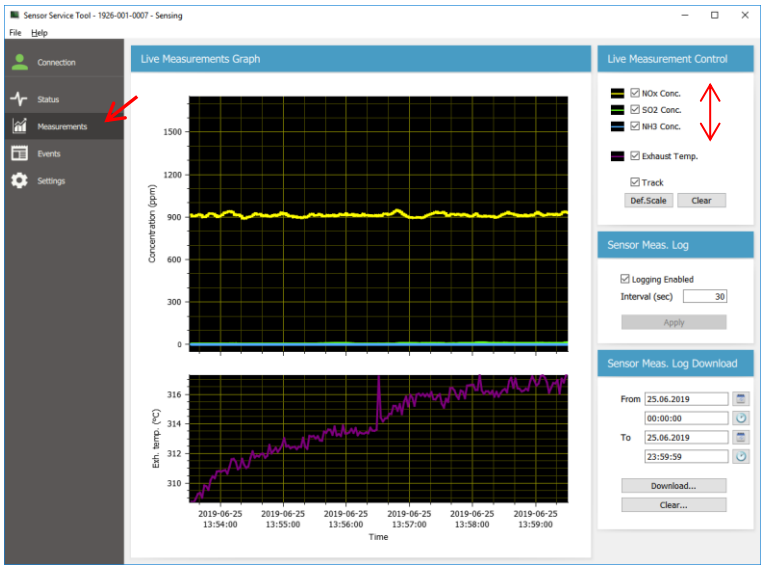
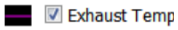


Illustration 50: Measurements Page NOx, SO2, and NH3

- **Live Measurements Graph.** The page supports 2 different graphs: a graph for concentrations and a graph for exhaust temperature.

  How to zoom and pan using the mouse:
  - Use the mouse wheel to zoom in and out on the graph. This function zooms on the x-axis only.
  - Left-click and hold to pan along the x-axis.
  - Right-click and drag to select a particular area of the graph
  - Def. Scale to reset zoom.

If the Exhaust temp. field is checked, the above functions will be reflected in this graph as well.



- **Live Measurement Control** offers the following functionality:

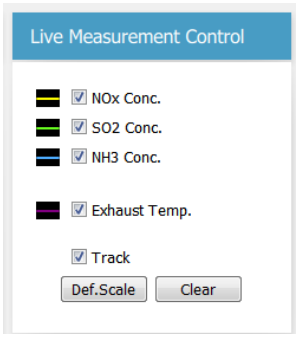
	Selection	Description
	NO_x Conc.	Enable/disable NO_x presentation.
	SO_2 Conc.	Enable/disable SO_2 presentation.
	NH_3 Conc.	Enable/disable NH_3 presentation.
	Exhaust temp.	Check or uncheck. When checked, a graph for exhaust temperature becomes visible. This graph follows the same time setting on the x-axis as the concentration graph. The y-axis is auto scaled.
	Track	Check the Track field to get a continuous live view of the measurements. If Track is unchecked, the view freezes.
	Def. Scale	Default scale.
	Clear	Clears the graph.

Table 11: Live Measurement Control, Exhaust Temp. Unchecked

- **Sensor Meas. Log** provides the following:

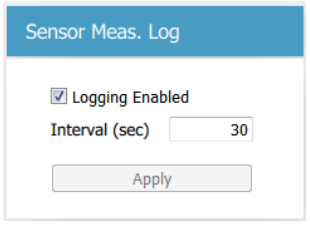
	Selection	Description
	Logging Enabled	Check to enable logging, or uncheck to disable logging.
	Interval (sec)	Select required logging interval
		The logging intervals are within the following range: 1 second – 60 minutes.

Table 12: Sensor Meas. Log

- **Sensor Meas. Log Download** provides the following:

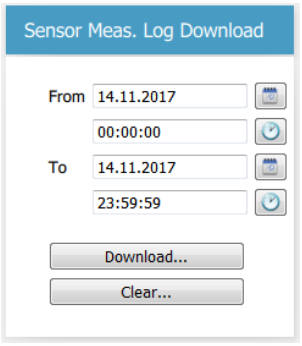
	Selection	Description
	From field	Select start date from drop-down calendar.*
	To field	Select end date from drop-down calendar.*
	Download button	Initiates download of the specified period.
	Clear button	Clears the log on the sensor. **NOTE:** The log file will be deleted permanently.
		The log is cleared by pressing the Clear button. ** Use the calendar to define the time period that holds the logging data to be downloaded. When Download is selected, a progress bar appears and a csv file is generated. See Chapter 4 Logging for more information.*

Table 13: Sensor Meas. Log Download

3.7. Events Page

Click on Events in the menu to view the following 3 sections, which appear automatically:

- List of Events
- Filter
- Sensor Event Log

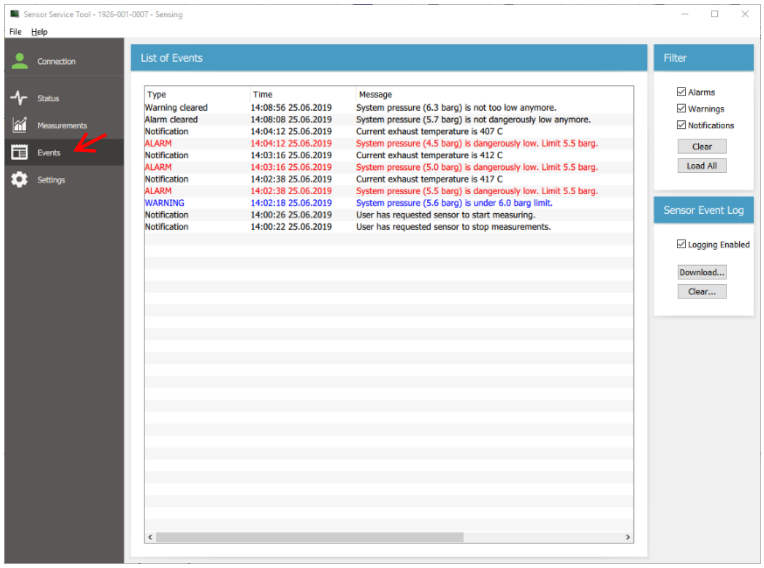


Illustration 51: Events Page

- **List of Events** shows Alarms, Warnings and Actions. It lists all events that occur using the following nomenclature for each event: hh:mm:ss dd-mm-yyyy

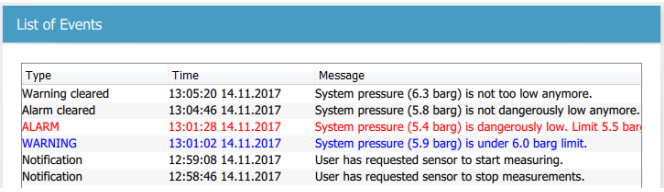


Illustration 52: List of Events

The list of events presents all events since the last opening of the SST.

- **Filter** provides the following options:

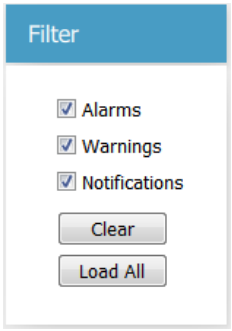
	Selection	Description
	Alarms	Enable/disable presentation of alarms.
	Warnings	Enable/disable presentation of warnings.
	Notifications	Enable/disable presentation of notifications.
	Clear button	Clears the List of Events in the SST (not the Event Log)
	Load All button	Loads all events recorded on the sensor since last software upgrade into the List of Events

Table 14: Filter

- **Sensor Event Log** consists of:

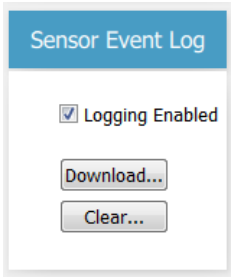
	Selection	Description
	Logging Enabled	Enable/disable event logging.
	Download button	Initiates download.
	Clear button	Clears the Event Log in the sensor.

Table 15: Sensor Event Log

3.8. Settings Pages

Click on Settings → Interfaces in the menu to view the following 5 sections, which appear automatically:

- Sensor IP Config.
- Analog Outputs
- Digital Inputs
- Digital Outputs
- Password Protection

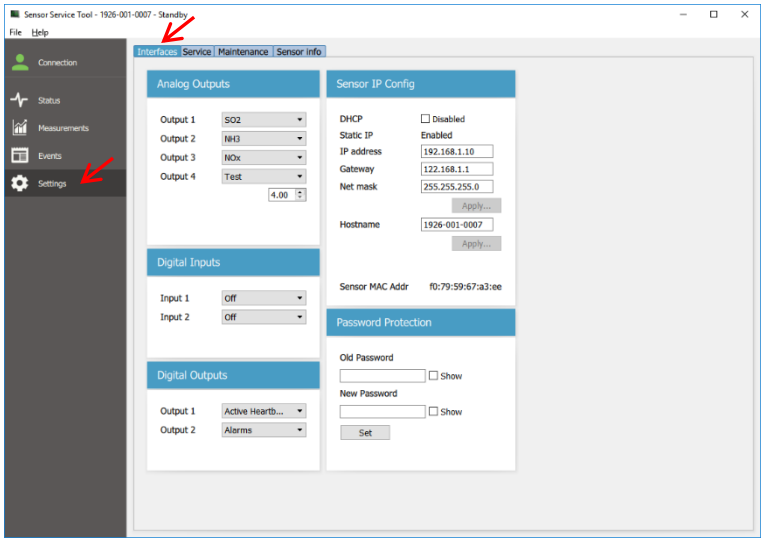


Illustration 53: Interfaces

- **Sensor IP Config** consists of:

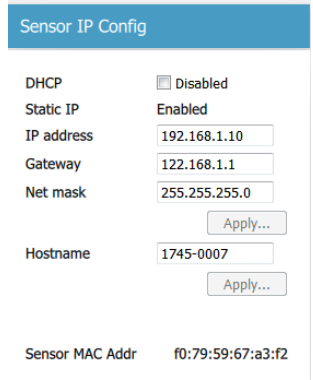
	Selection	Description
	DHCP enabled	Check to obtain IP address automatically via a DHCP server on the network. Uncheck to use manually entered static IP address, Gateway and Net mask.
	Static IP	Disabled if DHCP enabled – otherwise active.
	IP address	Enter IP address.
	Gateway	Enter gateway.
	Net mask	Enter Net mask.
	Apply button	Click to apply the changed values.
	Hostname	Enter Hostname.
	Apply button	Click to set the hostname of the sensor. The default hostname is the serial number of the sensor.

Table 16: Sensor IP Config

- **Analog Outputs** consists of:

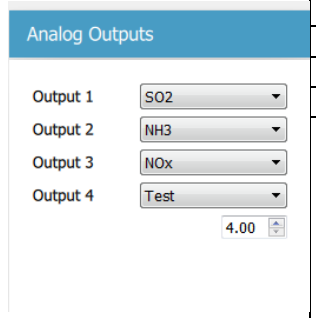
	Selection	Description
	Output 1	A drop-down box to select data on Output 1.
	Output 2	A drop-down box to select data on Output 2.
	Output 3	A drop-down box to select data on Output 3.
	Output 4	A drop-down box to select data on Output 4.
		Available data sources for Outputs 1-4 are Off, NO, NO_2, SO_2, NH_3, and NO_x, depending on sensor type and setup. *See 3.9 Service Page for activation of NO_x.* *See 0 for a description of Test.* *The sensor will use the output range 4 mA – 20 mA to represent the sensor's readings, covering the following ranges:* *NOx 0 to 2000 ppm* *SO2 0 to 1000 ppm* *NH3 0 to 100 ppm* *The sensor will output 3.2 mA shutdown or in case of alarm.*

Table 17: Analog Outputs

- **Digital Inputs** consists of:

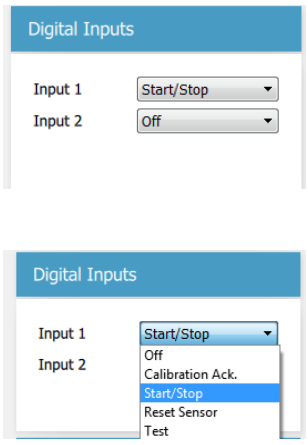
	Selection	Description
	Input 1	A drop-down box to select input signal type on Input 1.
	Input 2	A drop-down box to select input signal type on Input 2.
		Available input signal types on inputs 1-2 are: ***Start/Stop:*** *The sensor is in Sensing mode as long as the input is held high. The sensor is in Standby mode when the input is low.* ***Calibration Acknowledge:*** *Set the digital input high for 1 second to allow the sensor to calibrate after the sensor has requested this.*

Table 18: Digital Inputs

- **Digital Outputs** consists of:

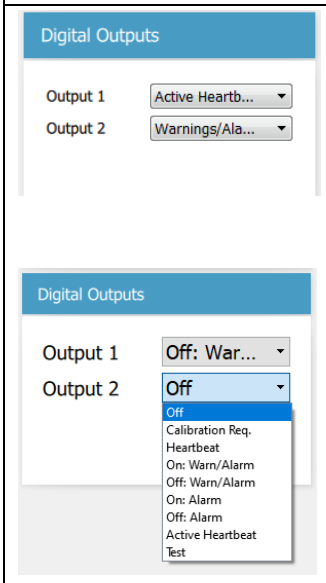
	Selection	Description
	Output 1	A drop-down box to select output signal type on Output 1.
	Output 2	A drop-down box to select output signal type on Output 2.
		Available input signal types on outputs 1-2 are ***Active Heartbeat:*** *The sensor toggles the output each 500 milliseconds (1 Hz) to indicate that the sensor is in Sensing state – otherwise the sensor is in Standby and the output is low. During zero-point calibration the sensor toggles the output at double speed (250 ms, 2 Hz).* ***On: Warn/Alarm:*** *The sensor sets the output **high** if warnings or errors need attention (use LCP or SST to solve the issues).* ***Off: Warn/Alarm:*** *The sensor sets the output **low** if warnings or errors need attention (use LCP or SST to solve the issues).* ***On: Alarm:*** *The sensor sets the output **high** if errors need attention (use LCP or SST to solve the issues).* ***Off: Alarm:*** *The sensor sets the output **low** if errors need attention (use LCP or SST to solve the issues).* ***Heartbeat:*** *The sensor toggles the output each 500 milliseconds (1 Hz) to indicate that the sensor is on.* ***Calibration Request:*** *The sensor sets the output high when an automatic zero-point calibration is required. Confirm the request by setting the proper Digital Input high. See 6.4.4 Digital Output.*

Table 19: Digital Outputs

- **Password Protection** consists of:

	Selection	Description
	Old Password	Enter old password.
	New Password	Enter new password.
	Set	Set new password.

	Selection	Description
	*Note that it is only possible to change the admin user password. If the password is forgotten, it can be reset in the LCP maintenance menu, parameter 5-20 Reset password.*	

Table 20: Password Protection

3.9. Service Page

Click on Settings → Service in the menu to view the following seven sections, which appear automatically:

- Calibration Acknowledge
- GPS Position Data
- Set Emission Warning Levels
- NO_x Readout
- Time
- Start-up

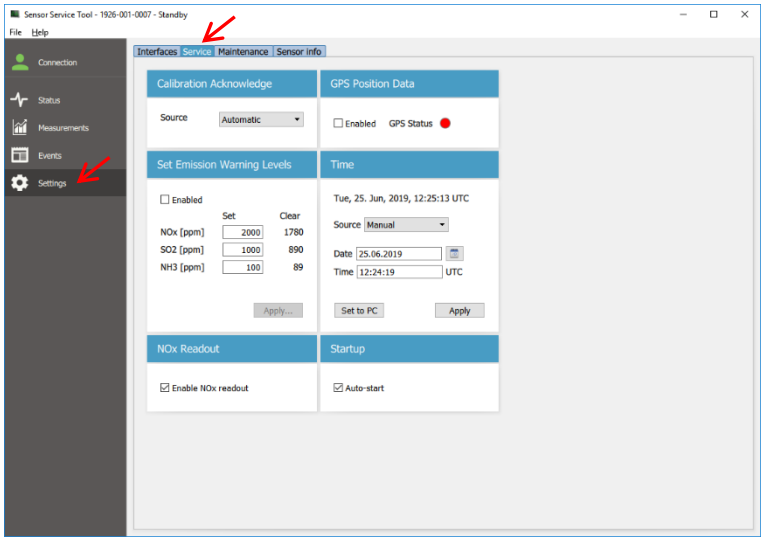
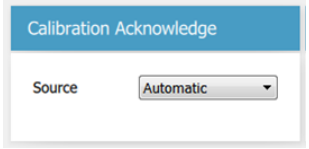


Illustration 54: Service

- **Calibration Acknowledge** consists of:

	Selection	Description
	Source	A drop-down box to select source. Options: Automatic, Discrete, LAN.
		Calibration Acknowledge takes place at predefined time intervals. The purpose of Calibration Acknowledge is to enable an external client or system to decide on zero-point calibration. The sensor sends a request 3 times at 1-minute intervals, which leads to a warning for the first 2 requests, and the third results in an alarm if zero-point calibration is not initiated. ***Automatic:*** *The sensor performs zero-point calibration automatically without user interaction.*

	Selection	Description
		Discrete: *Calibration Acknowledge is controlled by the discrete inputs and outputs. This requires setting of Digital Input (Calibration Ack.) and Digital Output (Calibration Req.)* ***LAN:*** *Not supported.*

Table 21: Calibration Acknowledge

- **GPS Position Data** consists of:

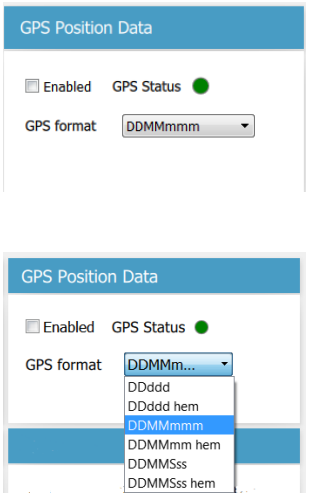
	Selection	Description
	Checkbox	A check box to enable/disable the reception of GPS data
		The reception of GPS data can be enabled or disabled by the user. *GPS data is expected to be in NMEA format containing GPRMC messages.* *Green light indicates GPS enabled, detected and proper position signal. Red light indicates bad GPS signal reception – possibly due to poor antenna conditions.* *If a GPS connection is available and the GPS is enabled, coordinates will be logged to the measurement log. If the box is unchecked, coordinates will not be logged in the measurement log.*

Table 22: GPS Position Data

- **Set Emission Warning Levels** consists of:

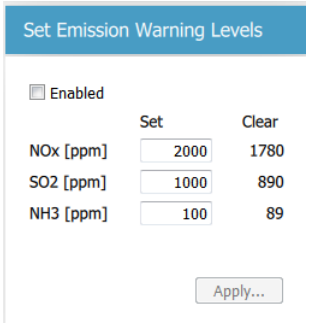
	Selection	Description
	Enabled	Check or uncheck.
	NO_x [ppm]	A field to set NOx warning level.
	SO_2 [ppm]	A field to set SO_2 warning level.
	NH_3 [ppm]	A field to set NH_3 warning level.
	Apply	Warning level changes are applied by pressing the Apply button.
		The warning levels are set by typing a value in the respective fields. *When Enabled is checked, the entered values are used.* *When Enabled is unchecked, the default values are used.*

Table 23: Set Emission Warning Levels

The clear criterion is based on a percentage of the maximum range (for example, for NO [ppm], the set range is 0-1500). Clear indicates when a warning is cleared at the given range. If an illegal value is entered, the font turns red:

- **NO_x Readout** can be enabled/disabled by checking or unchecking the check box. This will switch between NO/NO_2 and NO_x readout.

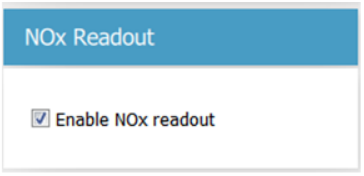


Illustration 55: NO_x Readout Control

- **Time** – Select the source for date and time input from the following: Manual, NTP, GPS. These options are shown individually in Table 24, Table 25 and Table 26. Time is always entered in UTC time.

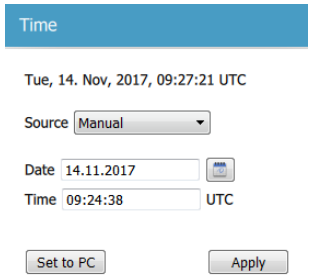
	Selection	Description
	Source	A drop-down box for selection of source.
	Date	A field to type in the new date (only visible when the source is set to Manual).
	Time	A field to type in the new time (only visible when the source is set to Manual).
	Set to PC	Time is set to PC time but adjusted to UTC.
	Apply	An Apply button to activate the changes made in this section.
		The clock can be changed manually if the source is set to Manual by typing hours, minutes, and seconds into the Time field. *The date can only be changed manually if the source is set to Manual by typing year, month, and day into the Date field.*

Table 24: Time, Manual

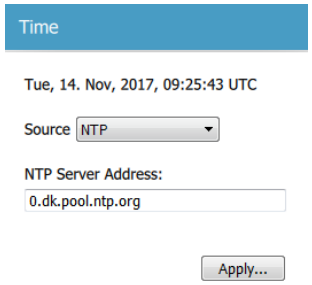
	Selection	Description
	Source	A drop-down box for selection of source.
	NTP Server Address	Field to enter the NTP server address.
	Apply	An Apply button to activate the changes made in this section.
		For NTP time setting, the user is able to set the NTP server address.

Table 25: Time, NTP

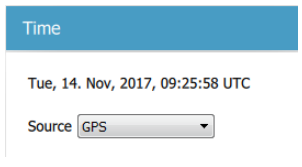
	Selection	Description
	Source	A drop-down box for selection of source.
		If GPS is selected, the time indication will be updated immediately to show the new time. This selection only works if the sensor is connected to a GPS.

Table 26: Time, GPS

- **Start-up** consists of:

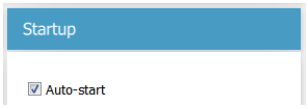
	Selection	Description
	Auto-start	Enable/disable auto-start.
		Check this box to enable automatic start of Sensing on the sensor. When the sensor is turned on or restarted, it enters Standby mode. If Auto-start is enabled, the sensor immediately starts Sensing mode.

Table 27: Update SW

3.10. Maintenance Page

Click on Settings → Maintenance in the menu to view this section, which appears automatically:

- Lamp Replacement
- Optics
- Sensor Diagnostics
- Sensor Configuration (Save… / Restore…)
- Update SW

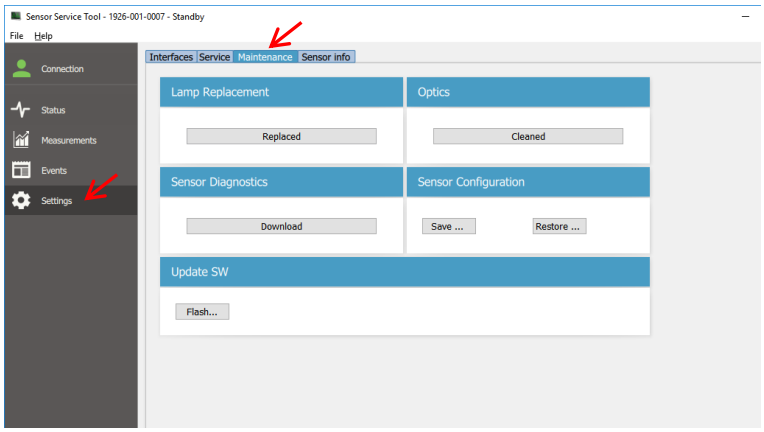


Illustration 56: Maintenance Page

- **Lamp Replacement** consists of:

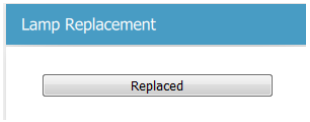
	Selection	Description
	Replaced	Press button to indicate that the lamp has been replaced. Resets the Sensor Lightsource Log. The Replaced button must be applied after successful lamp replacement. Access this function either from SST or the LCP. Please refer to 6.2.4 Lamp Replacement for detailed instructions on how to replace the lamp.

Table 28: Lamp Replacement

- **Optics** consists of:

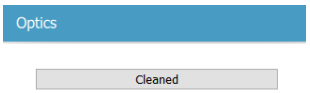
	Selection	Description
	Cleaned	Press button to indicate that the optics has been cleaned. Resets the optics performance of the sensor by performing a series of zero-point calibrations. The Cleaned button must be applied after successful cleaning of the optics. Access this function either from SST or the LCP. Please refer to the Probe Optics Cleaning Guide included in the Probe Optics Cleaning Kit (part no. 930071). The Optics Cleaning Guide can be downloaded at https://danfoss-ixa.com/services-and-support.

Table 29: Optics

- **Sensor Configuration** consists of:

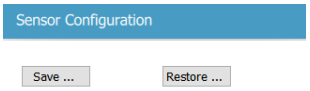
	Selection	Description
	Save …	Saves sensor configuration customizations. *The Save button saves data about the sensor setup customizations. The SST saves the customization setting in a file in the chosen location on the PC. The corresponding LCP function (parameter 5-60) saves the customized settings in a file in the root of the USB drive in the sensor.*
	Restore …	Resets sensor configuration to factory settings and applies saved customizations. *The Restore button restores the sensor setup to factory settings and applies the customizations from a saved setup. The SST restores from a file in the chosen location on the PC. The corresponding LCP function (parameter 5-70) applies the customizations from a file in the root of the USB drive in the sensor.* *The file is named Customized.txt*

Table 30: Sensor Configuration

- **Sensor Diagnostics** consists of:

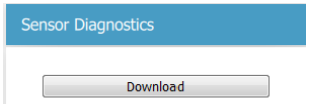
	Selection	Description
	Download	Downloads sensor diagnostics. *The Download button retrieves data about the sensor setup and other log files, which can be forwarded to Danfoss IXA for further analysis to establish the cause of the problem. The SST saves the diagnostics files in the chosen location on the PC. The corresponding LCP function (parameter 5-30) places the diagnostics file in /Diagnostics/ in the root of the USB drive in the sensor.*

Table 31: Sensor Diagnostics

- **Update SW** consists of:

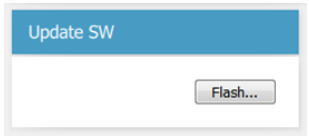
	Selection	Description
	Flash	When pressing the Flash button, a file browser pops up giving access to the folder where the flash file is stored.
		This function enables software updates on the sensor. You will have received a complete directory structure from Danfoss IXA. Navigate to the folder and select the DataImage-xxxx.jffs2 file. This installs new software on the sensor. Do NOT disconnect the power on the sensor during the upgrade! The sensor will automatically restart when the upgrade finishes.

Table 32: Update SW

- **Step 1: Updating Software, Progress Bar**

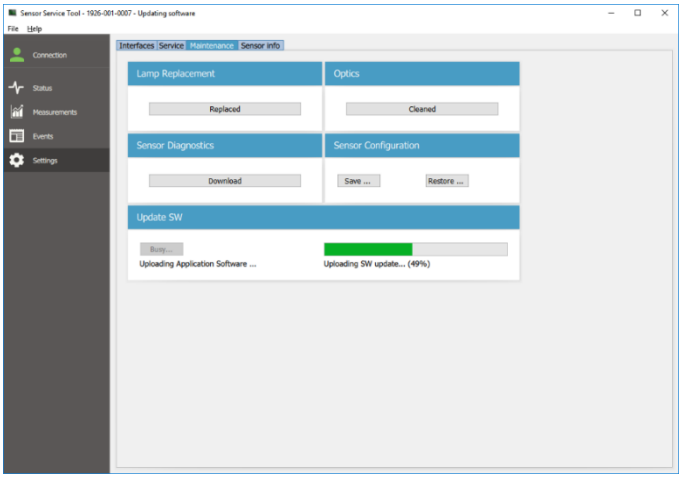


Illustration 57: Updating Software, Progress Bar

- **Step 2: Updating Application Software**

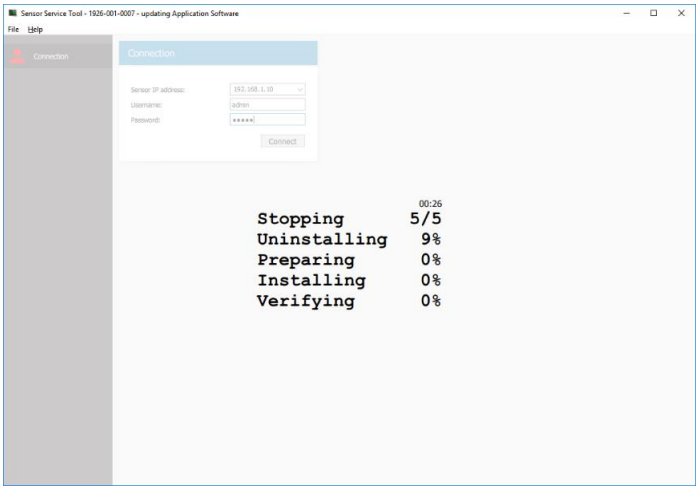


Illustration 58: Updating Application Software

– **Step 3: Completing Software Update**

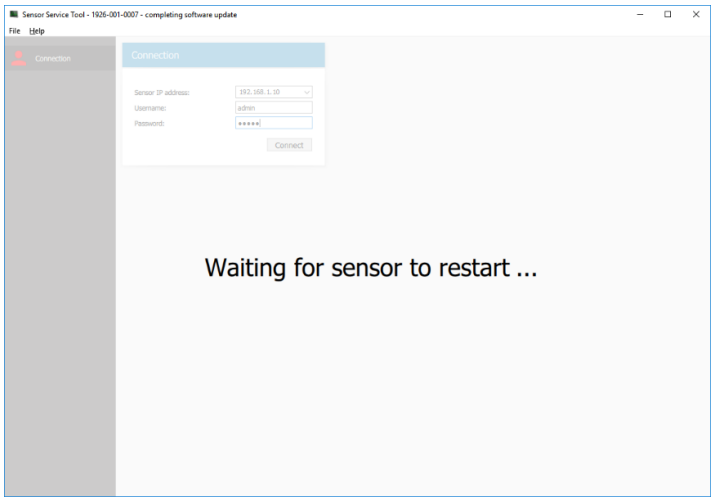


Illustration 59: Completing Software Update

3.11. Sensor Info Page

Click on Settings → Sensor Info in the menu to view this section, which appears automatically:

- Sensor Information
- Sensor Lightsource Log

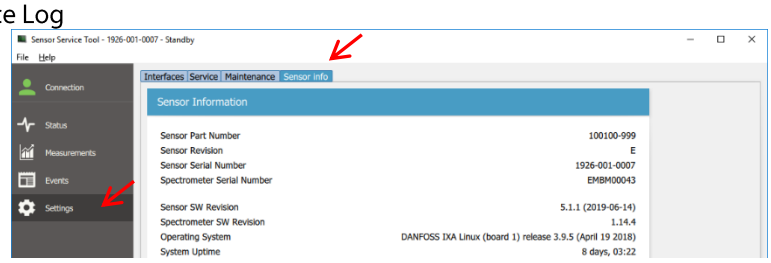


Illustration 60: Sensor Info

- **Sensor Information** consists of:

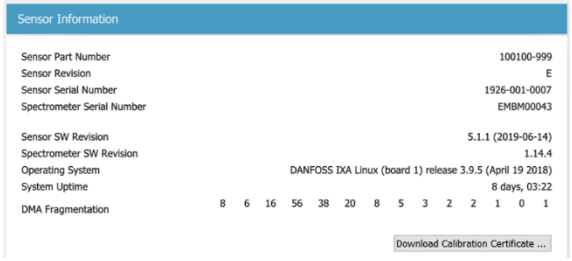
	Selection	Description
	Sensor Part Number	The sensor part number is of the form 100100-xyz where xyz identifies the capabilities of the sensor (gases measured).
	Revision	Revision is the hardware revision of the sensor.
	Sensor Serial Number	The serial number consists of the production year and week, the weekly running number, and may contain a sensor total running number.
	Spectrometer Serial Number	Serial number of the spectrometer.
	Sensor SW Revision	The sensor SW is the software version.
	Spectrometer SW Revision	Spectrometer is the spectrometer software version.
	Operating system	The operating system is the basic sensor control software.
	System Uptime	System uptime is the time since the sensor was last restarted.
	DMA fragmentation	DMA fragmentation is valuable information about the memory conditions on the sensor, used in support situations.
	Download Calibration Certificate	Download calibration certificate in pdf format.

Table 33: Sensor Information

Sensor Lightsource Log consists of**:**

	Selection	Description
	Sensing Time	The period the sensor has been operating (Sensing) since last lamp replacement.
	Estimated pulses	The number of pulses issued by the lamp since last replacement – wear indicator for the light source.

Table 34: Sensor Lightsource Log

4. Logging

The sensor logs measurements, events, warnings and alarms. As a minimum, each line in the log is given a time-stamped starting date, hours, minutes, seconds and a description of the measurement/event/warning/ alarm. The log is available for at least the last 18 months, depending on logging intervals. It is possible to request the log through LAN. See Table 13: Sensor Meas. Log regarding download of the Sensor Measurement Log.

4.1. Example of Measurement Log

The data in Table 35 is the result of an SST-generated file (csv file). Ensure correct conversion of data.

Date	Time	Latitude	Longitude	Speed	Direction	NO	NO_2	SO_2	NH_3	NO_x	Pressure system	Pressure exhaust	Tempera-ture system	Tempera-ture exhaust	Cooler	State
2015.06.18	14:02:12	5541	934.399	0.21	151.9	621	78	240	15	699	7.15579	1.01125	37.5606	250.9839	0	3
2015.06.18	14:02:15	5541	934.399	0.14	151.9	621	78	240	15	699	7.15579	1.01125	37.5606	250.9839	0	3
2015.06.18	14:02:19	5541	934.399	0.21	151.9	621	79	240	15	700	7.15585	1.01123	37.5611	250.9855	0	3
2015.06.18	14:02:23	5541	934.399	0.22	151.9	621	79	240	15	700	7.15560	1.01122	37.5586	250.6981	0	3
2015.06.18	14:02:27	5541	934.399	0.55	151.9	621	78	240	15	699	7.15580	1.01128	37.5601	250.1459	0	3

Table 35: Example of Measurement Log

Column name	Description
Date	Measurement date
Time	Measurement time
Latitude	Latitude coordinates
Longitude	Longitude coordinates
Speed	Speed data are in knots
Direction	Definition of direction
NO	Measured values for NO
NO_2	Measured values for NO_2
SO_2	Measured values for SO_2
NH_3	Measured values for NH_3
NO_x	Measured values for NO_x
Pressure system	System air pressure in Barg
Pressure exhaust	Exhaust gas pressure in Bara
Temperature system	System temperature in °C
Temperature exhaust	Exhaust temperature in °C
Cooler	Indicates cooler activity: 0 = Off 1 = On
State	Indicates operational mode: 0 = Standby 1 = Confirming 2 = Calibration 3 = Sensing 4 (Reserved) 5 = Over-temperature 6 = SPE disconnected 7 = Configuring 8 (Reserved) 9 = Hardware Error 10 = Updating software 11 (Reserved)

Table 36: Legend to Table 35

5. IXA Modbus TCP/IP

5.1. Introduction

This chapter explains how to establish and configure communication between the marine emission sensor and a controller using the Modbus TCP/IP protocol.

5.2. Example

Port number 502 and 1502 on sensor
The supported protocol is Modbus TCP/IP ADU consisting of a MBAP header and a PDU, which is the standard default format.

ModBus RECV:	**00 01 00 00 00 06** *00* 01 <u>00 00 00 05</u>
ModBus SEND:	**00 01 00 00 00 04** *00* <u>01 01 00</u>

Table 37

Bold	**MBAP header**	2 bytes for MBAP transaction id – usually increasing 2 bytes for MBAP protocol – 00 00 2 bytes for data to follow
Italic	*Unit id*	Not used in Modbus TCP/IP
<u>Underlined</u>	<u>PDU</u>	In the above example: RECV: Read Coils (01), starting addr 0 (00 00), 5 coils (00 05) SEND: Read Coils (01), coil values is 01 00

Table 38

5.3. Exception Answers

If parameters are out of range, not allowed, or unsupported functions are used, then an exception is returned as defined by the Modbus standard. The standard defines that the Modbus function is returned with the high bit set followed by an exception code. For example, an exception on the Modbus function 0x5 will return 0x85.
Example: Attempting to enter Standby mode on a sensor already in Standby mode:

REQ:	**00 05 00 00 00 06** *00* <u>05 00 00 00 00</u>	Write coil (5), address 00 00, value 00 00
RESP:	**00 05 00 00 00 03** *00* <u>85 03</u>	Exception on write coil (85) – invalid parameter (03)

Table 39

5.4. Supported Functions

5.4.1. Read Coils (Modbus Function 1)

Supports 47 coils – on/off values (1 bit each, addr 0, 46 coils)

Coil 0	Operating state	ON when sensing, otherwise OFF
Coil 1	Cooler state	ON when cooling, otherwise OFF
Coil 2	Standby state	ON when SPE active without measuring, otherwise OFF
Coil 3	Alarms state	ON when alarms active, OFF when no alarms
Coil 4	Warnings state	ON when warnings active, OFF when no alarms
Coil 5	Calibrating state	ON when calibrating, otherwise OFF
Coil 6	Calibration Acknowledge Required	ON when the sensor requires acknowledge to calibrate and Calibration Acknowledge (Settings -> Service) is set to LAN. See Write Single Coil for confirmation
Coil 7	Low System Pressure Alarm	ON if a Low System Pressure Alarm is active, otherwise OFF
Coil 8	High System Pressure Alarm	ON if a High System Pressure Alarm is active, otherwise OFF
Coil 9	High System Temperature Alarm	ON if a High System Temperature Alarm is active, otherwise OFF
Coil 10	High Probe Temperature Alarm	ON if a High Probe Temperature Alarm is active, otherwise OFF
Coil 11	Calibration Acknowledge Timeout Alarm	ON if a Calibration Acknowledge Alarm is active, otherwise OFF
Coil 12	Light Source Intensity Alarm	ON if a Light Source Intensity Alarm is active, otherwise OFF
Coil 13	System Temperature sensor Alarm	ON if an Internal Hardware Error is active, otherwise OFF
Coil 14	Probe Temperature Sensor Alarm	ON if an Internal Hardware Error is active, otherwise OFF
Coil 15	System Pressure Sensor Alarm	ON if an Internal Hardware Error is active, otherwise OFF
Coil 16	Probe Pressure Sensor Alarm	ON if an Internal Hardware Error is active, otherwise OFF
Coil 17	Internal Server Error Alarm	ON if an Interval Hardware Error is active, otherwise OFF
Coil 18	Missing SD Card Alarm	ON if a Missing SD Card alarm is active, otherwise OFF
Coil 19	Low UV Count Alarm	ON if a LOW UV Count Alarm is active, otherwise OFF
Coil 20	Memory Fragmentation Alarm	ON if a Memory Fragmentation Alarm is active, otherwise OFF
Coil 21	LCP disconnected alarm	ON if a LCP disconnect alarm is active, otherwise OFF
Coil 22	Spectrometer missing Alarm	ON if a Spectrometer Missing Alarm is active, otherwise OFF
Coil 23	Low System Pressure Warning	ON if a Low System Pressure Warning is active, otherwise OFF
Coil 24	High System Pressure Warning	ON if a High System Pressure Warning is active, otherwise OFF
Coil 25	Low System Temperature Warning	ON if a Low System Temperature Warning is active, otherwise OFF
Coil 26	High System Temperature Warning	ON if a High System Temperature Warning is active, otherwise OFF
Coil 27	High Probe Temperature Warning	ON if a High Probe Temperature Warning is active, otherwise OFF
Coil 28	Calibration Acknowledge Timeout Warning	ON if a Calibration Acknowledge Timeout Warning is active, otherwise OFF
Coil 29	Light Source Intensity Warning	ON if a Light Source Intensity Warning is active, otherwise OFF
Coil 30	NO High Warning	ON if a High NO Warning is active, otherwise OFF
Coil 31	NO2 High Warning	ON if a High NO_2 Warning is active, otherwise OFF
Coil 32	SO2 High Warning	ON if a High SO_2 Warning is active, otherwise OFF
Coil 33	NH3 High Warning	ON if a High NH_3 Warning is active, otherwise OFF
Coil 34	NOx High Warning	ON if a High NO_x Warning is active, otherwise OFF
Coil 35	NO Out of Bounds Warning	ON if a NO Out of Bounds Warning is active, otherwise OFF

Coil 36	NO2 Out of Bounds Warning	ON if a NO_2 Out of Bounds Warning is active, otherwise OFF
Coil 37	SO2 Out of Bounds Warning	ON if a SO_2 Out of Bounds Warning is active, otherwise OFF
Coil 38	NH3 Out of Bounds	ON if a NH_3 Out of Bounds Warning is active, otherwise OFF
Coil 39	NOx NO Out of Bounds Warning	ON if a NO_X-NO Out of Bounds Warning is active, otherwise OFF
Coil 40	NOx NO2 Out of Bounds Warning	ON if a NO_X-NO_2 Out of Bounds Warning is active, otherwise OFF
Coil 41	NO in Lamp Warning	ON if a NO in Lamp Warning is active, otherwise OFF
Coil 42	NO2 in Lamp Warning	ON if a NO_2 in Lamp Warning is active, otherwise OFF
Coil 43	SO2 in Lamp Warning	ON if a SO_2 in Lamp Warning is active, otherwise OFF
Coil 44	NH3 in Lamp Warning	ON if a NH_3 in Lamp Warning is active, otherwise OFF
Coil 45	NO GPS signal Warning	ON if a NO GPS Signal Warning is active, otherwise OFF
Coil 46	Invalid Sensor Configuration	ON if the sensor contains an incorrect gas configuration, otherwise OFF
Coil 47	Lamp must be replaced Alarm	ON if the light source is worn out and must be replaced, otherwise OFF
Coil 48	Lamp is wearing out warning	ON when the expected lifetime of the light source is less than one month, otherwise OFF
Coil 49	Time must be setup on sensor	ON when the time has not been setup properly on the sensor, otherwise OFF

Table 40

5.4.2. Read Holding Registers (Modbus Function 3)

Supports 19 registers – each 2 bytes: AB
Supports 5 strings registers – each spanning 50 Offsets (100 bytes)

Floating point offsets (4 bytes)		
Offset 0 + Offset 1	NO level	float value AB_0AB_1
Offset 2 + Offset 3	NO_2 level	float value AB_2AB_3
Offset 4 + Offset 5	SO_2 level	float value AB_4AB_5
Offset 6 + Offset 7	NH_3 level	float value AB_6AB_7
Offset 8 + Offset 9	System pressure	float value AB_8AB_9
Offset 10 + Offset 11	Exhaust pressure	float value $AB_{10}AB_{11}$
Offset 12 + Offset 13	System temperature	float value $AB_{12}AB_{13}$
Offset 14 + Offset 15	Exhaust temperature	float value $AB_{14}AB_{15}$
Offset 50 + Offset 51	NO_x level	float value $AB_{50}AB_{51}$
Offset 52 + Offset 53	GPS latitude	float value $AB_{52}AB_{53}$ As reported in NMEA GPRMC sentence
Offset 54 + Offset 55	GPS longitude	float value $AB_{54}AB_{55}$ As reported in NMEA GPRMC sentence
Offset 56 + Offset 57	GPS speed over ground	float value $AB_{56}AB_{57}$ As reported in NMEA GPRMC sentence
Offset 58 + Offset 59	GPS heading	float value $AB_{58}AB_{59}$ As reported in NMEA GPRMC sentence
Offset 60 + Offset 61	Detector temperature	float value float value $AB_{60}AB_{61}$
Offset 62 + Offset 63	CPU temperature	float value float value $AB_{62}AB_{63}$
Offset 64 + Offset 65	Not used	float value float value $AB_{64}AB_{65}$
Offset 66 + Offset 67	Not used	float value float value $AB_{66}AB_{67}$
Unsigned offsets (2 bytes)		
Offset 16	Sensor state	AB unsigned value 0 (standby) 1 (confirming) 2 (calibrating) 3 (sensing) 4 Reserved 5 (Over-temperature)

		6 (SPE Disconnected) 7 (configuring) 8 Reserved 9 (hardware error) 10 (updating software) 11 Reserved
Offset 68	NO level scaled by **10**	AB unsigned value
Offset 69	NO_2 level scaled by **10**	AB unsigned value
Offset 70	SO_2 level scaled by **10**	AB unsigned value
Offset 71	NH_3 level scaled by **100**	AB unsigned value
Offset 72	NOX level scaled by **10**	AB unsigned value
Offset 73	Not used	AB unsigned value
Offset 74	Not used	AB unsigned value
Offset 75	System pressure scaled by **1000**	AB unsigned value
Offset 76	Exhaust pressure scaled by **1000**	AB unsigned value
Offset 77	System temperature scaled by **100**	AB unsigned value
Offset 78	Exhaust temperature scaled by **100**	AB unsigned value
Offset 100	Coil 0 -15 as bitfield	AB unsigned value – 0x0 to 0xFFFF
Offset 101	Coil 16 – 31 as bitfield	AB unsigned value – 0x0 to 0xFFFF
Offset 102	Coil 32 – 47 as bitfield	AB unsigned value – 0x0 to 0xFFFF
Offset 103	Coil 48 - 63 as bitfield	AB unsigned value – 0x0 to 0xFFFF
String offsets (100 bytes, UTF8 encoding)		
Offset 1000 – Offset 1049	Sensor part number string	e.g. "1234" represented as $12_{1000}34_{1001}$
Offset 1050 – Offset 1099	Sensor revision number string	e.g. "1234" represented as $12_{1050}34_{1051}$
Offset 1100 – Offset 1149	Sensor serial number string	e.g. "1234" represented as $12_{1100}34_{1101}$
Offset 1150 – Offset 1199	Sensor software revision string	e.g. "2.2.0" represented as $2._{1150}2._{1151}0_{1152}$
Offset 1200 – Offset 1249	Spectrometer firmware version string	e.g. "1234" represented as $12_{1200}34_{1201}$
Offset 1250 – Offset 1299	Sensor OS version string	e.g. "Linux" represented as $Li_{1250}nu_{1251}x_{1252}$

Table 41

All offsets are filled with zeros when requesting more offsets than the string represents, e.g. if the sensor part number is "1234" and offset 1000 – 1002 (3 registers of 2 bytes) is requested, then

Offsets	High byte	Low byte
1000	'1'	'2'
1001	'3'	'4'
1002	0	0

Table 42

5.4.3. Write Single Coil (Modbus function 5)

Supports 3 coils

Coil 0	Operating state	When set to 0xFF00 start measuring. When set to 0x0000 stop measuring. Any other value returns exception.
Coil 5	Calibration	When set to 0xFF00 the sensor will do zero-point calibration
Coil 6	Calibration Acknowledge	If the sensor requires acknowledge to do zero-point calibration (see read coil 6) the sensor may be granted zero-point calibration by setting coil 6 to a value of 0x0000. Any other value returns exception

5.4.4. Write Holding Registers (Modbus function 16)

Supports 1 address – 2 bytes

Address	Writable coils	

100	0,5,6	0 Operating state 5 Calibrating state 6 Calibration Acknowledge

6. Service and maintenance

6.1. General

The MES 1001 MARPOL sensors are designed for minimum maintenance and no special training or service technicians required. Replacement and installation of all planned maintenance and consumables can be performed easily by crew by following the following section which describes the service and maintenance procedures for the MES 1001 MARPOL sensors.

⚠ CAUTION

The lamp generates ultraviolet light which can cause serious damage to the eyes if exposed to the ultraviolet light. Always ensure to switch of the power for the MES 1001 MARPOL sensor before removing the cabinet for maintenance of the sensor.

6.2. Maintenance

The marine emission sensor is a low-maintenance product. Maintenance and inspection conducted by personnel onboard shall be carried out according to the table below.

NOTICE

Read the following sections carefully prior to performing any service or maintenance on the MES 1001 MARPOL sensors.

⚠ CAUTION

Personnel conducting maintenance must be:

- Trained and authorized in general safety rules for work on electrical equipment.
- Familiar with local requirements, rules, and regulations for the installation.

NOTICE

Do not disassemble the Probe from the Back-end since this will result in damaging vital components of the sensor and the sensor requires to be returned to Danfoss IXA for repair, readjustment and recalibration. Disassembling the Probe from the Back-end will result in loss of warranty on the sensor. Illustration 61 below shows:

1. Back-end
2. Probe

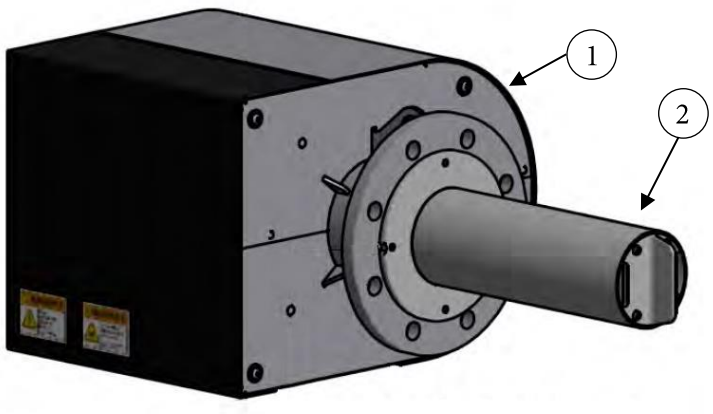


Illustration 61: Back-end and Probe of MES 1001 MARPOL sensor

6.2.1. Maintenance Tasks

Avoid unexpected maintenance costs with timely maintenance of your emission MES 1001 MARPOL sensors.

Maintenance task	Frequency	Who	What (how)
Check LCP for warnings & alarms	Weekly, optionally by electronic signal	Crew	Go to sensor and check display on sensor
Visual inspection	Biweekly	Crew	Go to sensor and: • Check for mechanical damage • Check flange, bolts, screw fittings, etc.
Check purge air supply	Biweekly	Crew	Go to sensor and check indicators on filters
Replace lamp, see 6.2.4 Lamp Replacement	*Every 24 months	Crew	Remove cabinet and replace lamp as instructed in user guide
Clean probe optics	Every 6 months or before if required	Crew	Clean the probe optics using the Probe Optics Cleaning Kit
Replace filter cores	Every 6 months or before if required	Crew	As instructed in filter product guideline
On-site Gas Calibration	Every 12 months or before if required	Crew	As instructed in section 6.3 On-site calibration

* Based on sensor in *Sensing mode* for approximately 182,5 days per year.

Table 43: Maintenance Tasks

Checking the purge air supply. This description applies to the Danfoss IXA supplied unit.

- The condensate level is visible in the metal bowls liquid level indicator lenses. Condensate will be drained out automatically.
- Replace filter elements when required. Use only new filter elements.

6.2.2. Spare parts

The Spare Parts and Accessories Catalogue and Spare Parts Flyer can be downloaded at https://danfoss-ixa.com/services-and-support for an overview of available spare parts.

Spare parts can be ordered at ixa@danfoss.com.

6.2.3. Service Interface

The marine emission sensor can be controlled, monitored and configured by a dedicated service interface through LAN. The service interface can be accessed through LAN regardless of the selected control interface.
New software can be uploaded to the marine emission sensor through the service interface.

6.2.4. Lamp Replacement

The marine emission sensor is equipped with a lamp that will need replacement. Expected lamp lifetime is approximately 12 months if the sensor is used continuously in *Sensing mode* as a CEMS, hence the frequency for replacement of the lamp will be reduced equal to the time the sensor is in *Standby mode*. A warning signal from the sensor will appear when the sensor is close to requiring a replacement, and an alarm will appear when the lamp requires replacement. The lamp is easily replaced, and the marine emission sensor does not need to be demounted. A new lamp must be purchased through the supplier of the sensor.

⚠ CAUTION

Ensure that power has been switched off before replacing the lamp. The marine emission sensor must still receive a supply of compressed air.

CAUTION

HOT SURFACE!

The exhaust pipe and the flange may become hot during operation. Do not touch hot surfaces unnecessarily.

Remove Cabinet

To remove the cabinet follow these steps:

1. Remove the 4 screws and washers. Removing the screws will not destabilize the sensor.
2. Remove the cover carefully.

Step 1 – Remove the 4 screws and washers.

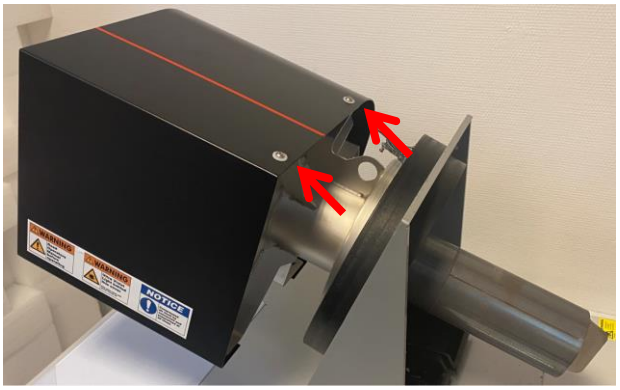


Illustration 62

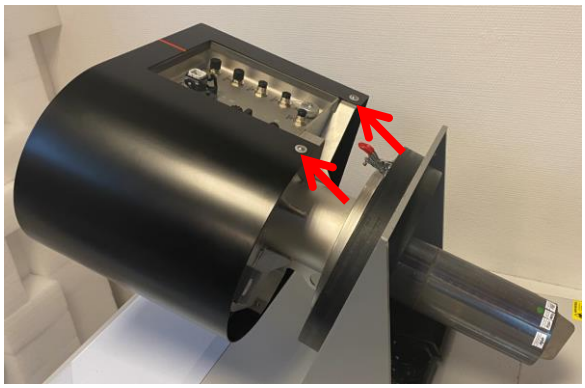


Illustration 63

Illustration 64

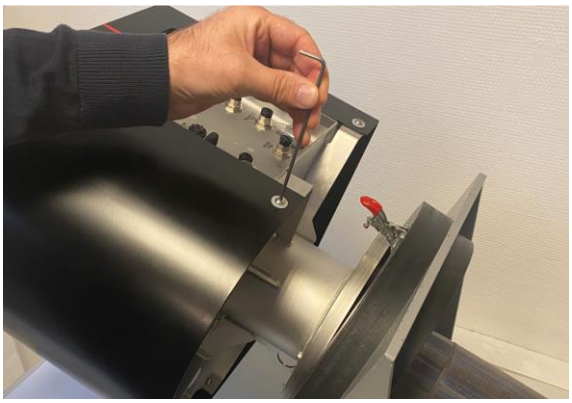


Illustration 65

Step 2 – Remove the cover carefully.	

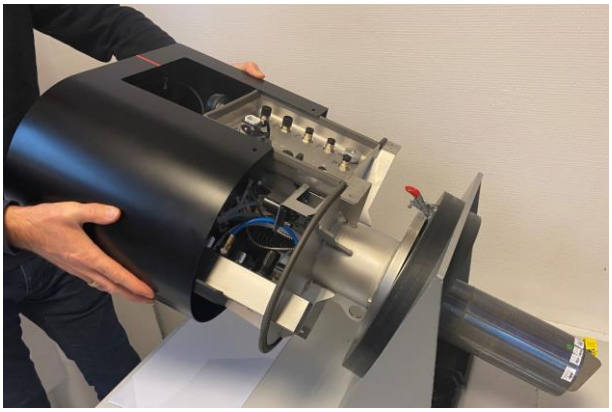
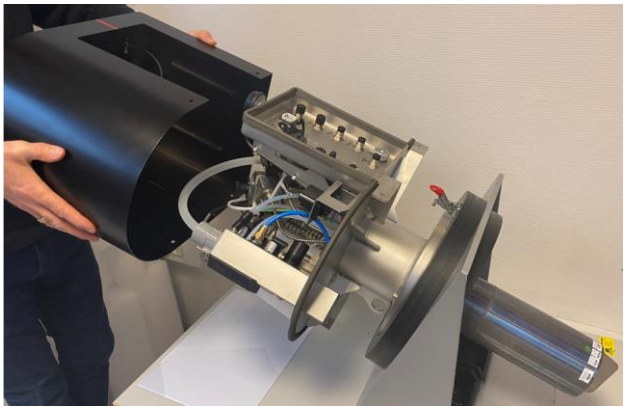

	

Illustration 66	**Illustration 67**

CAUTION

The sensor is an electrostatic sensitive device. Use proper grounding techniques to prevent equipment damage.

NOTICE

Do not disassemble or touch the Optical Fiber. Disassembling or touching the Optical Fiber could result in a damaged Optical Fiber, the sensor malfunctioning or the sensor requiring recalibration.

Replace the Lamp

Follow these steps to replace the lamp:

1. Unscrew the connector and detach the lamp cable from the circuit board.
2. Release and open the lamp cover by pulling the latch.
   Notice: Do not touch the protective glass of the new lamp, since this will damage the lamp.
3. Remove the lamp and replace it.
4. Remount the cover and tighten the 4 screws. Tightening torque is 7 Nm. Repeat steps 1-2 in reverse order to reassemble the marine emission sensor.
5. Reset the lamp log in Maintenance, see 3.10 Maintenance Page, Table 28.

Step 1 – Unscrew the connector and detach the lamp cable from the circuit board.

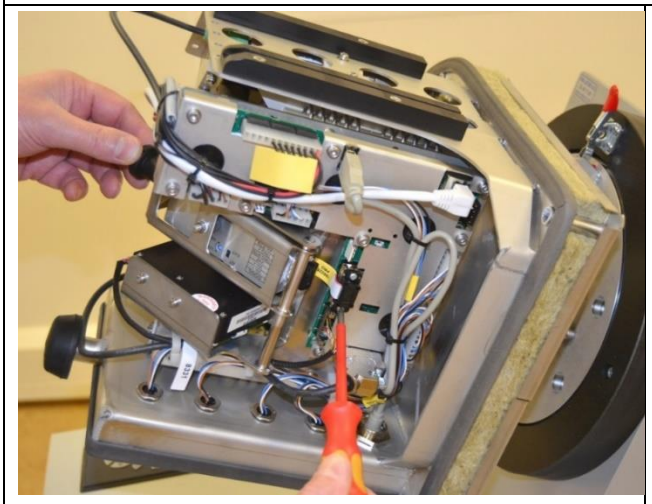


Illustration 68: Unscrew the connector

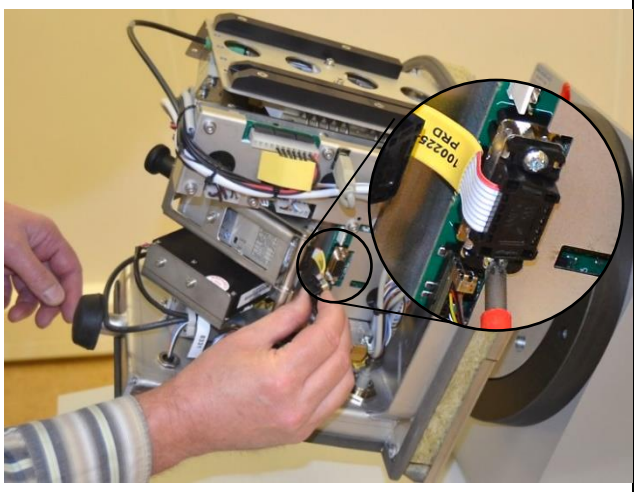


Illustration 69: Remove the Cable

Step 2 – Release and open the lamp cover by pulling the latch.

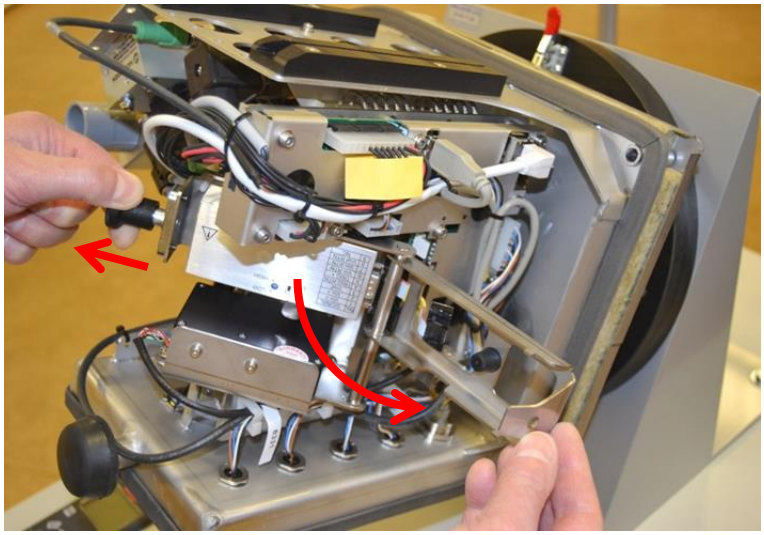
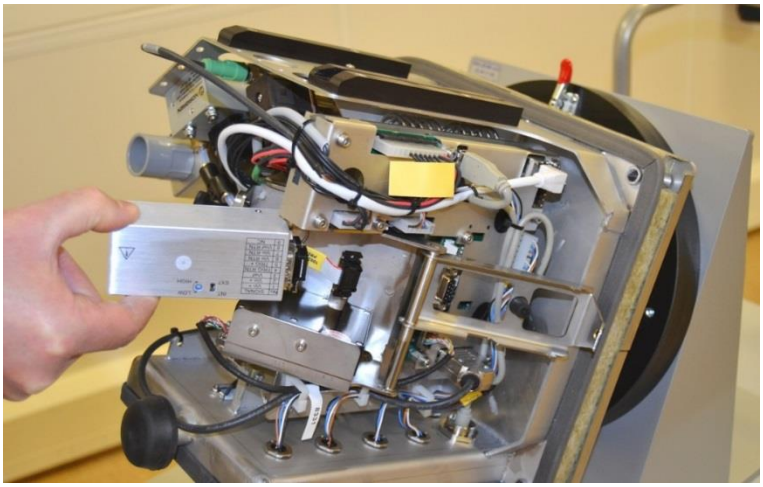


Illustration 70: Release the Lamp cover

Step 3 – Remove the lamp and replace it.
 **Illustration 71: Remove the Lamp and Replace It**
Step 4 – Remount the cover and tighten the 4 screws. Tightening torque is 7 Nm. Repeat steps 1-2 in reverse order to reassemble the marine emission sensor.
Step 5 – Reset the lamp log in Maintenance, see 3.10 Maintenance Page, Table 28.

6.2.5. Replacement of High-Grade Filter Element Set

This section describes how to replace the High-Grade Filter Elements in the standard filter units.

NOTICE

Danfoss IXA provides a compressed air supply filter for special applications protecting sensor against excessive oil and water in the compressed air. Contact sales at ixa@danfoss.com for further information.

	
Step 1 - Disconnect supply of compressed air. Push in the right bowl, turn counter clockwise and retract bowl. Caution, bowl may contain liquids. Empty bowl for liquids while keeping floating device inside bowl in place with a finger.	**Step 2** - Unscrew the filter insert and discard used filter insert. Mount new filter insert by hand. Note, no use of tools! Mount bowl again by positioning bowl at same orientation, push on bowl and turn clockwise.

	
Step 3 - Disassemble left bowl in the same way as the right bowl. Empty bowl for liquids, keeping the floating device inside bowl.	**Step** 4 - Unscrew white plastic nut at the end of the filter insert. Discard used filter insert.
	
Step 5 - Mount new filter insert and put on white plastic nut by hand. Note, no use of tools! Put on bowl again.	**Step** 6 - Pull outwards on both bowls to ensure that they are both fully secured. Turn on compressed air supply again! Check for leaks. Make a note on the date of filter replacement.

6.2.6. Probe Optics Cleaning Kit

The optics in the probe of the sensor needs cleaning every six months or if necessary more frequent as mentioned in 6.2.1 Maintenance Tasks. The cleaning kit is used for cleaning the measuring chamber of the probe, the lens and the reflector. It is important that the optics are cleaned with the MES 1001 Probe Optics Cleaning Kit following the included instructions guide. There are no other alternatives to clean the optics hence it is important only to use the MES 1001 Probe Optics Cleaning Kit.

NOTICE

Do not use any alternatives to clean the optics than the MES 1001 Probe Optics Cleaning Kit. It will risk damaging the optics which results in the sensor not able to measure.

Illustration 72: Probe Optics Cleaning Kit for MES 1001

The optics cleaning guide which describes the procedure for using the cleaning kit can be downloaded at https://danfoss-ixa.com/services-and-support and a refill kit for the MES 1001 Probe Optics Cleaning Kit can be ordered at ixa@danfoss.com.

6.2.7. Cleaning Probe inlet and outlet

Please see below picture with green marking of inlet and outlet port. In order to ensure there are no clogging issues please insert a metal rod app. Ø 2-3 mm app. 15 cm and do circular motions. Repeat this in both ports. Reinstall the sensor and press start. The sensor will start in Zero-calibration and the soot residues are ejected automatically.

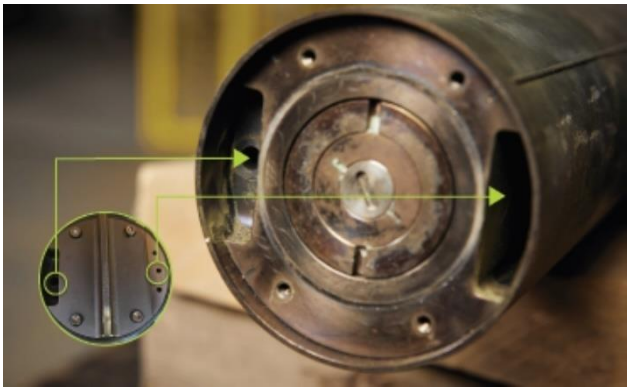


Illustration 73: Inlet and outlet on the probe of MES 1001 MARPOL sensors

6.3. On-site calibration

Following section describes the procedure for performing the on-site gas calibration of the MES 1001 MARPOL sensors.

⚠ CAUTION

The gases used for Gas Calibration are toxic – It is strongly recommended to perform the calibration of the MES 1001 MARPOL sensor when it is installed at the installation point to avoid inhalation of the toxic gases.

An On-site Calibration Guide, which summarizes the steps of the on-site calibration procedure in one page, can be downloaded at https://danfoss-ixa.com/services-and-support. Gas Calibration Kit and Calibration Gas can be ordered at ixa@danfoss.com.

6.3.1. Preparation

Calibration gases are used when performing the Gas Calibration of the MES 1001 MARPOL sensor. Table 44 shows the acceptable Calibration Gas Concentrations used for Gas Calibration.

Gas	Operational range	Acceptable Calibration Gas Concentration
NO	0 – 1500 ppm	263 – 329 ppm

Table 44 Acceptable Calibration Gas Concentrations

Acceptable calibration gas concentrations must be between 80-100% of equivalent full scale (= 1500 ppm * 9.45/43.1 = 329 ppm). This is ensured by using calibration gas supplied by Danfoss IXA.

Typical calibration gas usage per calibration per sensor:

- 2.5 l/min
- Duration: < 10 min
- Usage: < 25 liter (@ 1 bar)

Tools needed for Gas calibration:

- Gas Calibration Kit (part no. 930090), which contains:
  - Carry case for gas cylinders and tools
  - Fixed flow regulator with valve
  - Tubing and fitting to connect calibration gas cylinder to sensor
  - Cylinder recycling tool
- Calibration Gas (part no. 930091)

Ensure the following conditions are in order prior to performing the Gas Calibration:

- Sensor is warmed up (should be turned on for minimum 30 minutes before initiating calibration)
- Engine is not in operation
- Check that sensor is installed correctly
- Sensor is in Standby Mode (refer to 2.2.6 Start/Stop Key (D) for instructions to enter standby mode)

NOTICE

Check that the expiry date of the calibration gas certificate is not exceeded.

6.3.2. Connect calibration gas to sensor

NOTICE

Ensure that the valve on the fixed flow regulator is closed before connecting the regulator to the calibration gas cylinder.

Illustration 74: Fixed flow regulator with valve connected to calibration gas cylinder

- Connect the fixed flow regulator to the calibration gas cylinder as shown in the illustration above.
- Check that there is sufficient gas in the calibration gas cylinder (at least 250 psi = 17 bar)
- Connect the tube to the Calibration gas connection point on the MES 1001 MARPOL sensor (marked with a red arrow on the illustration below)

NOTICE

Do not open the valve on the fixed flow regulator until instructed during the following section 6.3.3 Calibrate via wizard on display.

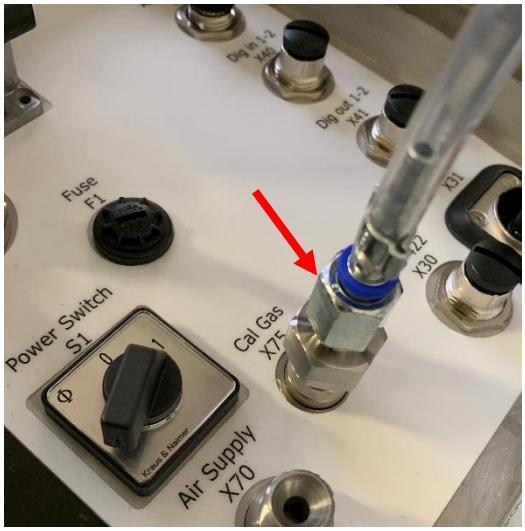
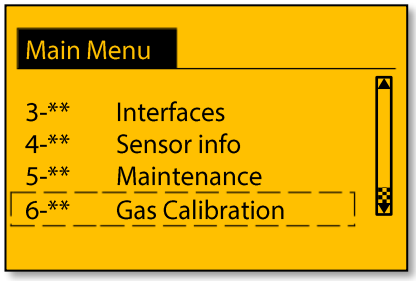


Illustration 75: Connect the tube from the calibration gas cylinder

6.3.3. Calibrate via wizard on display

To perform the Gas Calibration, go to the Gas Calibration menu 6-**. The following illustrations shows the LCP displays when performing the Gas Calibration via the Calibration Wizard.

Illustration 76: Gas Calibration Menu

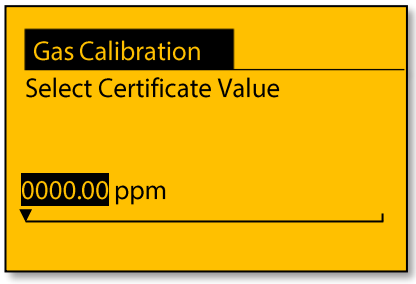


Go to menu 6-** Gas Calibration and press OK to enter the menu.

Illustration 77: Select Calibration Gas

Press OK and OK again to select NO as calibration gas.

Illustration 78: Enter the Calibration Gas Certificate Value



Press OK to enable editing the Calibration Gas Certificate Value. Toggle the digits by moving the cursor up, down, left, and right.

Illustration 79: Enter the Calibration Gas Certificate Value

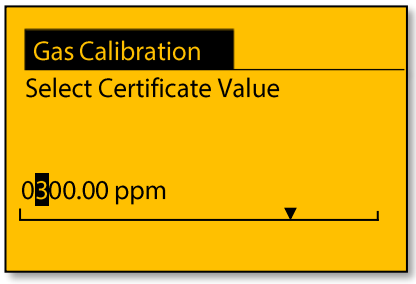


Illustration 80: Enter the Calibration Gas Certificate Value

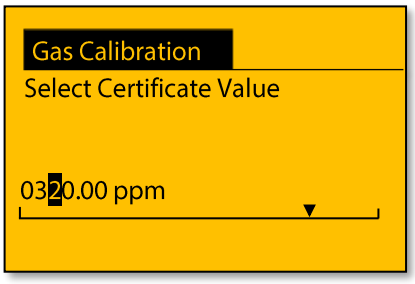


Illustration 81: Enter the Calibration Gas Certificate Value

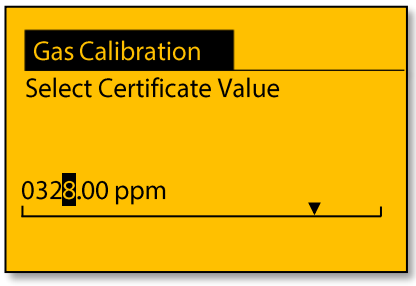
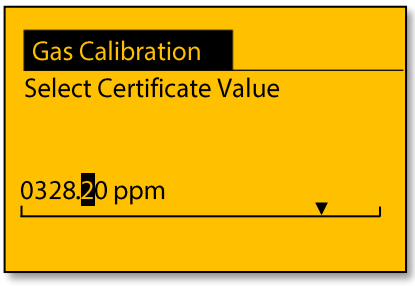


Illustration 82: Enter the Calibration Gas Certificate Value

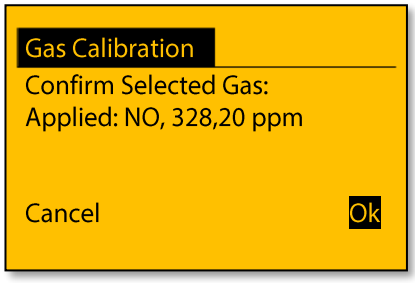


Press OK when the Calibration Gas Concentration Value is entered.

NOTICE

Open the regulator valve before confirming the Calibration Gas Certificate Value.

Illustration 83: Confirmation of entered Calibration Gas Certificate Value



Check the entered Calibration Gas Certificate Value and press ok to confirm. If the entered concentration is wrong, use the Back button to go back and correct it.

Illustration 84: Checking engine

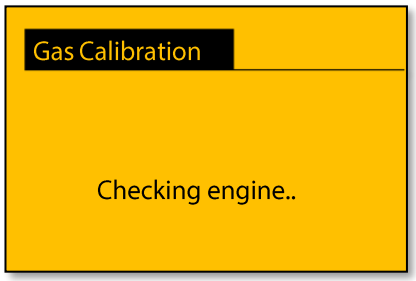
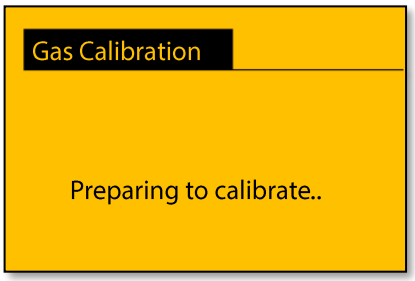


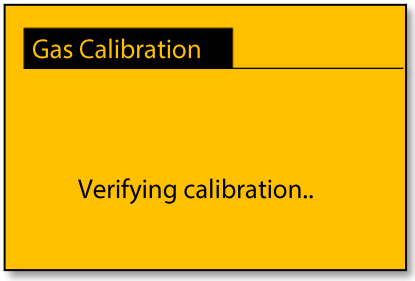
Illustration 85: Preparing to Calibrate



Wait while the sensor ensures that the engine is not in operation and for the sensor to perform a Zero-point Calibration to prepare for the Gas Calibration.

Illustration 86: Gas Calibration of sensor

Illustration 87: Verification of calibration

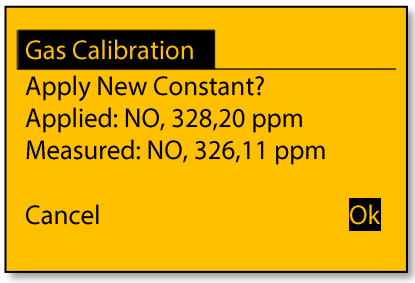


Wait while the sensor performs and verifies the Gas Calibration.

NOTICE

These four steps may take up to 10 minutes in total.

Illustration 88: Saving the calibration



The sensor has completed and passed the Gas Calibration. Press OK to save the calibration.

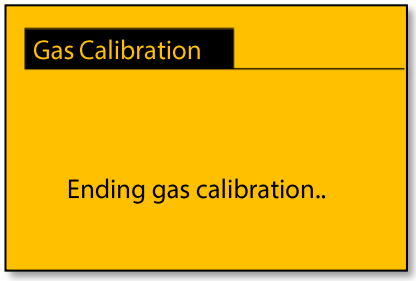
NOTICE

The calibration can only be applied when the sensor has passed the calibration. Section 6.3.4 Possible errors describes what happens if the sensor fails during the calibration.

Illustration 89: Disconnect the Calibration Gas

When prompted to disconnect the gas, close valve on the fixed flow regulator. Subsequently, the tube can be disconnected from the sensor (see Illustration 75: Connect the tube from the calibration gas cylinder).

Illustration 90: Ending the Gas Calibration

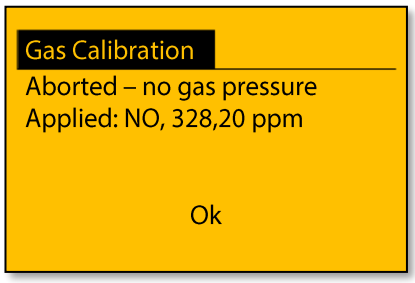


When the calibration gas is disconnected, the sensor ends the Calibration Wizard and the calibration has now been successfully completed.

6.3.4. Possible errors

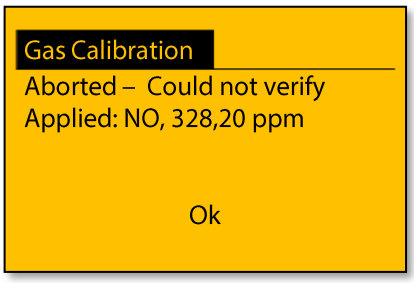
Should an error occur while performing the calibration the LCP on the sensor will display a message which describes the error causing the aborted calibration. Following illustrations are examples of the error messages which can occur.

Illustration 91: No gas pressure



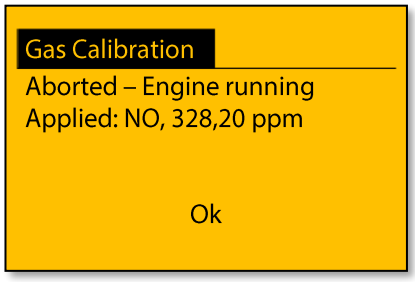
Error message occurs when no gas pressure is detected.

Illustration 92: Could not verify



Error message occurs when the sensor could not verify the calibration, e.g., due to offset more than 4 % or not stable measurements.

Illustration 93: Engine is running



Error message occurs if the sensor detects any indications on the engine is running.

6.3.5. Cylinder recycling tool

When the calibration gas cylinder is empty, it shall be depressurized before disposal. This is done with the gas cylinder recycling tool shown in for the illustration below.

Illustration 94: Gas cylinder recycling tool

The following steps describe how to use the gas cylinder recycling tool:

1. Empty any residual gas from the calibration gas cylinder using the fixed flow regulator (see Illustration 74: Fixed flow regulator with valve connected to calibration gas cylinder
2. **⚠ CAUTION**
   Emptying of the calibration gas cylinder shall be done outdoors or in otherwise adequately ventilated area.
3. Close the valve and remove the fixed flow regulator.

4. Mount the head of the recycling tool on the threaded interface of the calibration gas cylinder.
5. Rotate the handle of recycling tool until you hear a distinct sound (the pin of the cylinder interface being ejected).
6. Demount the recycling tool from the calibration gas cylinder.
7. The calibration gas cylinder may now be disposed as scrap metal.

⚠ CAUTION

The gas cylinder recycling tool is ONLY to be used with non-flammable, non-toxic, and non-oxidizing gasses.

6.4. Troubleshooting

Technical support and customer service can be contacted to resolve any technical issues that may arise in relation to usage of the sensor.

By phone: +45 7488 8500
By e-mail: ixa.service@danfoss.com

Before contacting service, check the following.

6.4.1. Warnings and Alarms

The MES 1001 MARPOL sensor can provide a digital output signal when a warning and/or an alarm appears. The difference between warnings and alarms is the severity. Warnings indicate that a possible upcoming issue requires attention to prevent the sensor from stopping, but the sensor can continue operation while having a warning. An alarm appears when the sensor cannot continue operation until the reason for the alarm has been corrected. In Appendix 2 - Event List all shows all possible alarms and warnings for the MES 1001 MARPOL.

6.4.2. Troubleshooting Guide

Problem	Possible cause	Solution
No signal on SCR panel	Loop power lost on analog output	The analog outputs on MES 1001 MARPOL requires 24 VDC supply. Check the loop power for analog outputs and/or refer to 6.4.3 Test of Analog Outputs for guidance
Low PPM Readings	Clogged inlet and outlet of probe	Clean the probe inlet and outlet, refer to 6.2.7 Cleaning Probe inlet and outlet for guidance.
		Check that the compressed air supply is opened and within required range while engines are running.
		Check the condition of the compressed air filter unit. Replace the High-Grade Filter Elements if required. Refer to 6.2.5 Replacement of High-Grade Filter Element Set for guidance.
Alarm [A33] – Optics may be contaminated, please clean & Alarm [A102] – UV Low	Probe optics are contaminated	Clean the Probe Optics using the MES 1001 MARPOL Probe Optics Cleaning Kit. Refer to 6.2.6 Probe

Problem	Possible cause	Solution
		Optics Cleaning Kit for further information.
		Check that the compressed air supply is opened and within required range while engines are running.
		Check the condition of the compressed air filter unit. Replace the High-Grade Filter Elements if required. Refer to 6.2.5 Replacement of High-Grade Filter Element Set for guidance.
		If above is does not solve the problem, then replace the Advanced High-Power UV Light Source. Refer to 6.2.4 Lamp Replacement for guidance.
Warning [W122] & Alarm [A124]	Limited or no pulses from Advanced High-Power UV Light Source.	Replace the Advanced High-Power UV Light Source. Refer to 6.2.4 Lamp Replacement for guidance.
Warnings and Alarms related to compressed air: [W1], [W3], [W13], [W89], [W91], [W93], [W95], [A23] and [A25]	Compressed air supply pressure not within specifications.	Check that the compressed air supply is opened and within required range while engines are running.
		Check the condition of the compressed air filter unit. Replace the High-Grade Filter Elements if required. Refer to 6.2.5 Replacement of High-Grade Filter Element Set for guidance.

Table 45: Troubleshooting

To assist in troubleshooting technical issues, a diagnostics report can be generated. See 2.4.1 Diagnostics Report or 3.10 Maintenance Page, Sensor Diagnostics, for further information.

6.4.3. Test of Analog Outputs

Loop power refers to the analog outputs. It is possible to test the interfaces to confirm the presence of loop power. Analog outputs can be put in test from LCP and from SST. From LCP it is in LCP menu 3-2* Analog out setup. When tested from the LCP the analog output signals are fixed to a specific mA output current as shown in below Table 46.

Analog output channel	Analog output value
Analog output ch 1	6 mA
Analog output ch 2	8 mA
Analog output ch 3	12 mA
Analog output ch 4	18 mA

Table 46: Analog outputs values when tested from LCP

From SST it is under Settings → Interfaces, select 'Test' instead of a gas type in the 'Analog Outputs' dialog box. The selection of 'Test' makes a field appear, which enables the simulation of outputs between 4 mA and 20 mA. If the connection is established correctly, the results can be read from the analog outputs.

NOTICE

You MUST press the return key on the keyboard for the value to be applied!

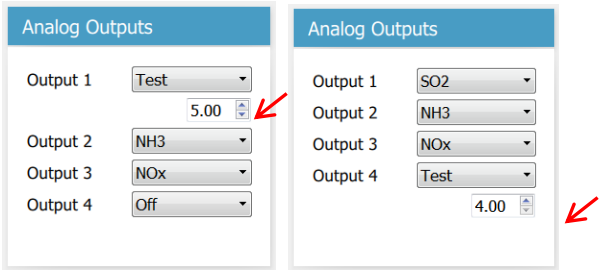


Illustration 95: Examples of Loop Power Simulation on Analog Output Interfaces

The signals that appear are standard values:

Standby	4 mA
Alarm or sensor shutdown	3.2 mA
When measuring/testing	4-20 mA

Table 47: Standard Values for Loop Power Simulation

6.4.4. Digital Output/Input

It is possible to test the interfaces to confirm the presence of the connections. From SST it is under *Settings → Interfaces*, select 'Test' in the 'Digital Outputs' or 'Digital Inputs' dialog box.

7. Appendices

7.1. Appendix 1 – Parameter Overview

Par. No.	Parameter description	Default value	Range
1- Event log**			
1-1*	Event log Show		
1-11	Event log	Empty	List of Log ID's; If there are no Events, the list is empty.
1-2*	Event log Status		
1-21	Status	Enabled	Enabled, Disabled
1-3	Help		
2- Settings**			
2-1*	Calibration ACK		
2-11	Cal Ack Mode	Automatic	Automatic, Discrete, LAN
2-2*	Emission warn level		
2-21	NO Warning level	1500	25-1500 ppm
2-22	NO2 Warning level	500	10-500 ppm
2-23	NOx Warning level	2000	35-2000 ppm
2-24	SO2 Warning level	1000	20-1000 ppm
2-25	NH3 Warning level	100	2-100 ppm
2-26	Warning level status	Disabled	Enabled, Disabled
2-3*	NOx readout		
2-31	Status	Disabled	Enabled, Disabled
2-4*	Auto start		
2-41	Status	Disabled	Enabled, Disabled
2-5*	GPS		
2-51	Status	Disabled	Enabled, Disabled
2-6*	Set time and date		
2-61	Set Date	None	yyyy-mm-dd HH:MM:SS
3- Interfaces**			
3-1*	LAN setup		
3-11	LAN IP Address	192.168.1.10	
3-12	LAN Gateway	192.168.1.1	
3-13	LAN Network mask	255.255.255.0	
3-14	Reboot		
3-15	Sensor Hostname		Letters (a - z) case insensitive and Numbers (0 - 9) + hyphen (-). Max 63 characters long.
3-16	DHCP	Disabled	Enabled, Disabled
3-17	MAC Address	None	XX:XX:XX:XX:XX:XX
3-2*	Analog out setup		
3-21	Analog out ch 1	None	None; NO2; NO; NOx; SO2; NH3; Test
3-22	Analog out ch 2		
3-23	Analog out ch 3		
3-24	Analog out ch 4		
3-3*	Digital out setup		
3-31	Digital out ch 1	None	None, Active Heartbeat, Alarms – off, Alarms - on, Warnings/Alarms – off, Warnings/Alarms - on, Heartbeat, Calibration Request, Test
3-32	Digital out ch 2		
3-4*	Digital in setup		
3-41	Digital in ch 1	None	None, Start/Stop, Calibration ACK, Test, Reset (restarts the sensor)
3-42	Digital in ch 2		

Par. No.	Parameter description	Default value	Range
4- Sensor Info**			
4-1*	Part number		
4-11	Part number	Sensor Part number	
4-2*	Revision number		
4-21	Revision number	Sensor HW Revision number	
4-3*	Serial number		
4-31	Serial number	Sensor HW Serial number	
4-4*	SW rev number		
4-41	SW rev number	SW revision number	
4-5*	FW rev number		
4-51	FW rev number	Sensor Firmware revision number	
4-6*	OS rev number		
4-61	OS rev number	Operating Software revision number	
4-7*	SP serial number		
4-71	SP serial number	Spectrometer serial number	
4-8	Calibration Cert		
4-9	Powe-on Time		
5- Maintenance**			
5-1	Lamp Replacement		
5-2	Optics Cleaned		
5-3	Reset Password		
5-4	Diagnostics Report		
5-5	Update Software		
5-6	Save Setup		
5-7	Restore Setup		
5-8	Sensing time		

Table 48: Parameter Overview

7.2. Appendix 2 - Event List

Table 49 provides a list of events (Alarms, Warnings, Notifications). The indication 'xx' is a placeholder for the value actually shown. W = Warning, A = Alarm, N = Notification

Event no.	Type	Event	Text in event log and Sensor Service Tool (SST)	Text in LCP status screen
1	W	WarningSet	Compressed air pressure (xx barg) is under xx barg limit.	Compressed Air Pressure
2	W	WarningCleared	Compressed air pressure (xx barg) is not too low anymore.	Compressed Air Pressure
3	W	WarningSet	Compressed air pressure (xx barg) is above xx barg limit.	Compressed Air Pressure
4	W	WarningCleared	Compressed air pressure (xx barg) is not too high anymore.	Compressed Air Pressure
5	W	WarningSet	System temperature (xx C) is under xx C limit.	System Temperature
6	W	WarningCleared	System temperature (xx C) is not too low anymore.	System Temperature
7	W	WarningSet	System temperature (xx C) is above xx C limit.	System Temperature
8	W	WarningCleared	System temperature (xx C) is not too high anymore.	System Temperature
9	W	WarningSet	Probe temperature (xx C) is above xx C limit.	Probe Temperature
10	W	WarningCleared	Probe temperature (xx C) is not too high anymore.	Probe Temperature
11	W	WarningSet	Calibration acknowledgment not received.	Calibration Ack
12	W	WarningCleared	Calibration acknowledgment timeout warning cleared.	Calibration Ack
13	W	WarningSet	Contamination during calibration. Check air supply.	Calibration Contamination
14	W	WarningCleared	Contamination cleared.	Calibration Contamination
15	W	WarningSet	NO level (xx ppm) is above xx ppm limit.	NO Level
16	W	WarningCleared	NO level (xx ppm) is back within limits.	NO Level
17	W	WarningSet	NO2 level (xx ppm) is above xx ppm limit.	NO2 Level
18	W	WarningCleared	NO2 level (xx ppm) is back within limits.	NO2 Level
19	W	WarningSet	SO2 level (xx ppm) is above xx ppm limit.	SO2 Level
20	W	WarningCleared	SO2 level (xx ppm) is back within limits.	SO2 Level
21	W	WarningSet	NH3 level (xx ppm) is above xx ppm limit.	NH3 Level
22	W	WarningCleared	NH3 level (xx ppm) is back within limits.	NH3 Level
23	A	AlarmSet	Compressed air pressure (xx barg) is dangerously low. Limit xx barg.	Compressed air pressure
24	A	AlarmCleared	Compressed air pressure (xx barg) is not dangerously low anymore.	Compressed air pressure
25	A	AlarmSet	Compressed air pressure (xx barg) is dangerously high. Limit xx barg.	Compressed air pressure
26	A	AlarmCleared	Compressed air pressure (xx barg) is not dangerously high anymore.	Compressed air pressure
27	A	AlarmSet	System temperature (xx C) is dangerously high, limit xx C. Spectrometer shut down.	System Temperature
28	A	AlarmCleared	System temperature (xx C) is not dangerously high anymore. Turning on spectrometer.	System Temperature
29	A	AlarmSet	Probe temperature (xx C) is dangerously high, limit xx C.	Probe Temperature
30	A	AlarmCleared	Probe temperature (xx C) is not dangerously high anymore.	Probe Temperature
31	A	AlarmSet	Calibration could not be performed. Acknowledgment not received xx times.	Calibration Ack
32	A	AlarmCleared	Calibration acknowledgment timeout alarm cleared.	Calibration Ack
33	A	AlarmSet	Optics may be contaminated, please clean.	Optics Contamination
34	A	AlarmCleared	Optics not contaminated anymore.	Optics Contamination
35	N	Notification	Event Log started. History available from ID #xx, count xx.	Event Log Start
36	N	Notification	User has requested sensor to stop measurements.	Sensor Stop
37	N	Notification	Sensor time adjusted: xx seconds.	Time adjusted
38	N	Notification	User has requested sensor to calibrate.	Sensor Calibrate
39	N	Notification	Sensor needs to calibrate because measuring conditions have changed.	Sensor Calibrate
42	N	Notification	User has requested sensor to start measuring.	Sensor Start
44	N	Notification	Event Log erased by user's request.	Event Log Erased
45	N	Notification	Measurement Log started. History available from ID #xx, count xx.	Data Log Start
46	N	Notification	Measurement Log erased by user's request.	Data Log Erased
47	W	WarningSet	NO level (xx ppm) is above of sensor capability (1500).	NO Capability
48	W	WarningCleared	NO level (xx ppm) is back within sensor capability range.	NO Capability
49	W	WarningSet	NO2 level (xx ppm) is above of sensor capability (500).	NO2 Capability
50	W	WarningCleared	NO2 level (xx ppm) is back within sensor capability range.	NO2 Capability
51	W	WarningSet	SO2 level (xx ppm) is above of sensor capability (1000).	SO2 Capability
52	W	WarningCleared	SO2 level (xx ppm) is back within sensor capability range.	SO2 Capability
53	W	WarningSet	NH3 level (xx ppm) is above of sensor capability (xx).	NH3 Capability
54	W	WarningCleared	NH3 level (xx ppm) is back within sensor capability range.	NH3 Capability
55	N	Notification	LightSource Log started. History available from ID #xx, count xx.	Lamp Log Start
56	N	Notification	LightSource Log erased by user's request.	Lamp Log Erased
59	W	WarningSet	NOx level (xx ppm) is above xx ppm limit.	NOx Level
60	W	WarningCleared	NOx level (xx ppm) is back within limits.	NOx Level

61	W	WarningSet	NOx measurement error, NO component (xx ppm) is above sensor limitation (1500).	NOx - NO component invalid
62	W	WarningCleared	NOx measurement NO component (xx ppm) is back within range (1500).	NOx - NO component valid
63	W	WarningSet	NOx measurement error, NO2 component (xx ppm) is above sensor limitation (500).	NOx - NO2 component invalid
64	W	WarningCleared	NOx measurement NO2 component (xx ppm) is back within range (500).	NOx - NO2 component valid
65	A	AlarmSet	Probe Pressure Error	Probe Pressure Error
66	A	AlarmCleared	Probe Pressure Error cleared	Probe Pressure Error
75	N	Notification	Sensor requested to perform gas calibration.	Gas Calibrate Begin
76	N	Notification	Sensor requested to end gas calibration.	Gas Calibrate End
77	N	Notification	Heartbeat on digital xx too slow - xx secs delay.	Heartbeat slow
78	N	Notification	Loop power lost on analog output xx.	Power lost AO
79	N	Notification	Loop power detected on analog output xx.	Power detected
80	A	AlarmSet	SD card NOT detected - limited storage of measurement data.	NO SD card!
81	N	Notification	NO verification (xx ppm certificate) xx ppm measured.	NO Verified
82	N	Notification	NO2 verification (xx ppm certificate) xx ppm measured.	NO2 Verified
83	N	Notification	NH3 verification (xx ppm certificate) xx ppm measured.	NH3 Verified
84	N	Notification	SO2 verification (xx ppm certificate) xx ppm measured.	SO2 Verified
85	N	Notification	NO calibration changed (xx) xx.	NO Calibration
86	N	Notification	NO2 calibration changed (xx) xx.	NO2 Calibration
87	N	Notification	NH3 calibration changed (xx) xx.	NH3 Calibration
88	N	Notification	SO2 calibration changed (xx) xx.	SO2 Calibration
89	W	WarningSet	NO contamination during calibration (xx ppm)	NO Contamination
90	W	WarningCleared	NO contamination has been flushed.	NO Flushed
91	W	WarningSet	NO2 contamination during calibration (xx ppm)	NO2 Contamination
92	W	WarningCleared	NO2 contamination has been flushed.	NO2 Flushed
93	W	WarningSet	SO2 contamination during calibration (xx ppm)	SO2 Contamination
94	W	WarningCleared	SO2 contamination has been flushed.	SO2 Flushed
95	W	WarningSet	NH3 contamination during calibration (xx ppm)	NH3 Contamination
96	W	WarningCleared	NH3 contamination has been flushed.	NH3 Flushed
97	W	WarningSet	GPS signal has been lost.	GPS signal lost
98	W	WarningCleared	GPS signal has been regained.	GPS signal regained
99	N	Notification	Sensor restarted due to changed settings.	Restart - settings
100	N	Notification	Sensor restarted due to software installation.	Restart - SW installation
101	W	WarningCleared	GPS was disabled.	GPS was disabled
106	N	Notification	Sensor rebooting due to memory fragmentation	Reboot - memory fragmentation
107	N	Notification	Sensor rebooting on reset request	Reboot - reset request
108	A	AlarmSet	Spectrometer not found. Unable to proceed	SPECTROMETER NOT FOUND
109	A	AlarmSet	Connection to the LCP could not be established	LCP disconnected
110	A	AlarmCleared	Established connection to the LCP	LCP connected
111	A	AlarmSet	The sensor gas configuration has been tampered with	Gas configuration tampered
112	A	AlarmCleared	Sensor gas configuration is valid	Gas configuration valid
113	A	AlarmSet	Sensor time and date setup required	Time and date required
114	A	AlarmCleared	Sensor time has been set	Time and date set
115	A	AlarmSet	Sensor serial number is INVALID	Serial number is INVALID
116	A	AlarmCleared	Sensor serial number validated	Serial number validated
117	N	Notification	Sensor configuration restored	Sensor configuration restored
119	N	Notification	Probe temperature is xx C	Temperature
120	N	Notification	Optics cleaned by user	Optics cleaned
121	N	Notification	Optics performance reset and recalculated	Optics performance reset
122	W	WarningSet	Light Source has limited lifetime	Light Source lifetime limited
123	W	WarningCleared	Light Source lifetime back within expected time	Light Source lifetime OK
124	A	AlarmSet	Light Source replacement required	Replace Light Source
125	A	AlarmCleared	Light Source lifetime OK	Light Source lifetime OK

Table 49: Event List

7.3. Appendix 3 - LAN Settings

Step 1: On a computer (Windows 7 and above OS only), install SST software from the USB stick, which is supplied with the shipped sensor.

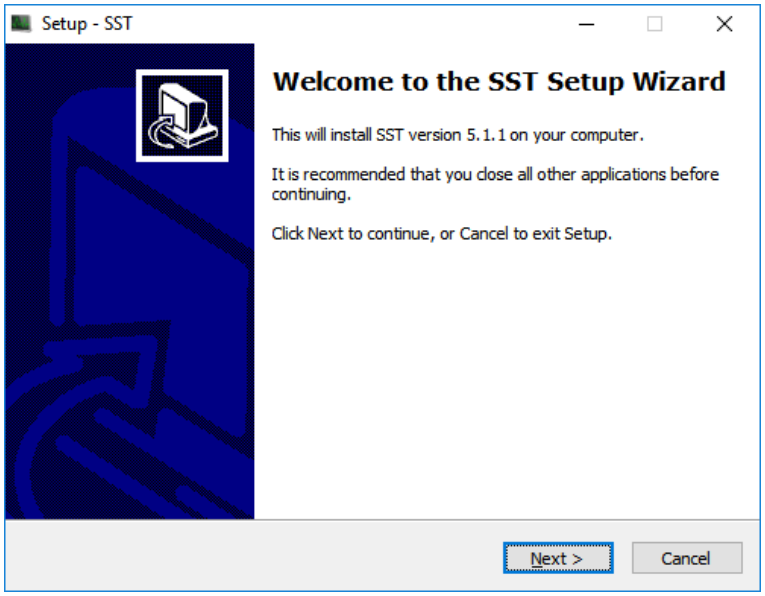


Illustration 96: Appendix 1 - SST Setup, Step 1

Step 2: Connect a LAN cable from the sensor to the LAN port of the computer with SST installed.
Step 3: On the computer, go to Control Panel\Network and Internet\Network Connections.

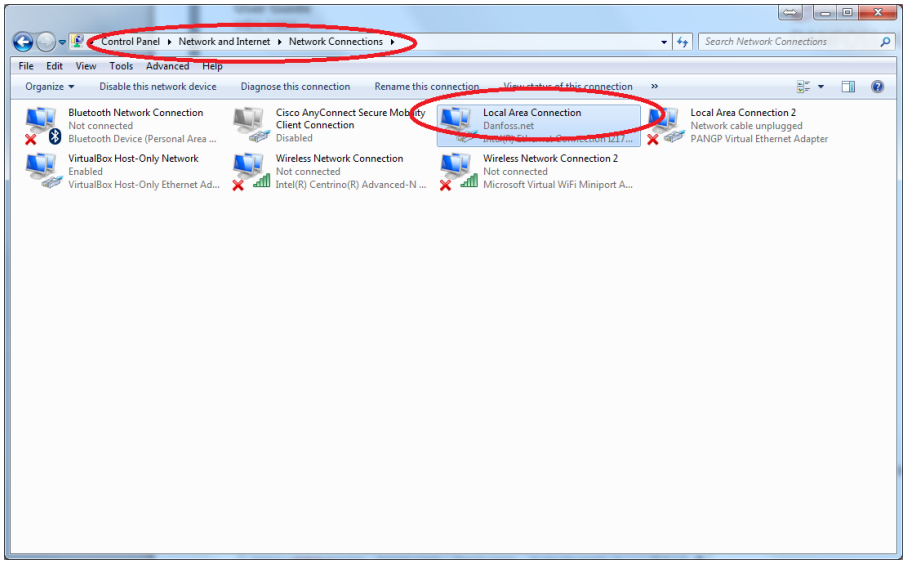


Illustration 97: Appendix 1 - SST Setup, Step 3

Step 4: Right-click on Local Area Connection and go to the Properties of the Local area connection for the cable plugged into the computer. The computer will request an administrator password to make changes, which must be entered before proceeding.

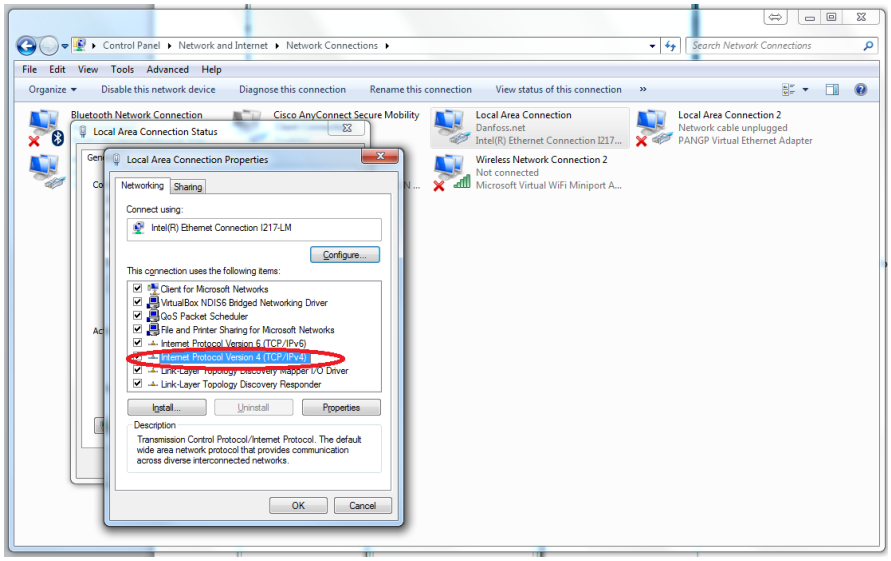


Illustration 98: Appendix 1 - SST Setup, Step 4

Step 5: In the Internet Protocol version 4 window, activate the "Use the following IP address:"

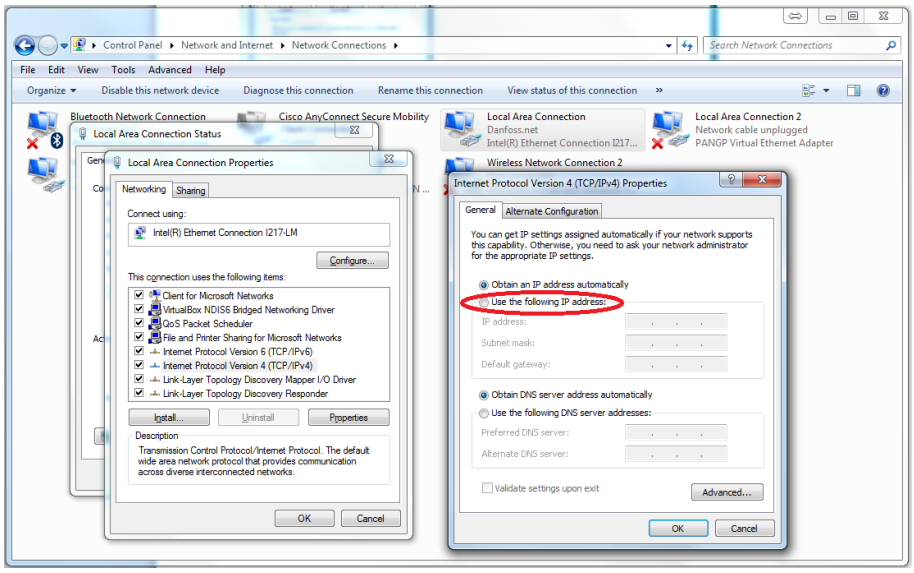


Illustration 99: Appendix 1 - SST Setup, Step 5

Step 6: Type 192.168. 1.100 in the "IP address:" field as shown below and press enter.
If the subnet mask does not appear automatically, then please type 255.255.255.0 and press enter.

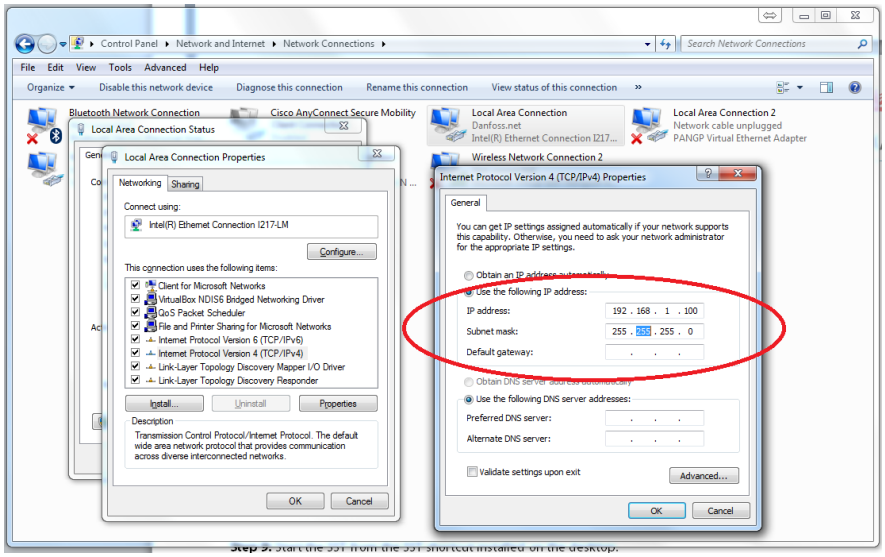


Illustration 100: Appendix 1 - SST Setup, Step 6

Step 7: Press OK and exit the "Local Area Connection Properties" dialog box.
Step 8: Start the SST from the SST shortcut installed on the desktop.

Illustration 101: Appendix 1 - SST Setup, Step 8

Step 9: The default IP address on the sensor is 192.168.1.10. You may confirm this on the LCP panel (Interfaces → LAN Setup).
On the Sensor Service Tool dialog box, type 192.168.1.10 as shown below and press Connect.

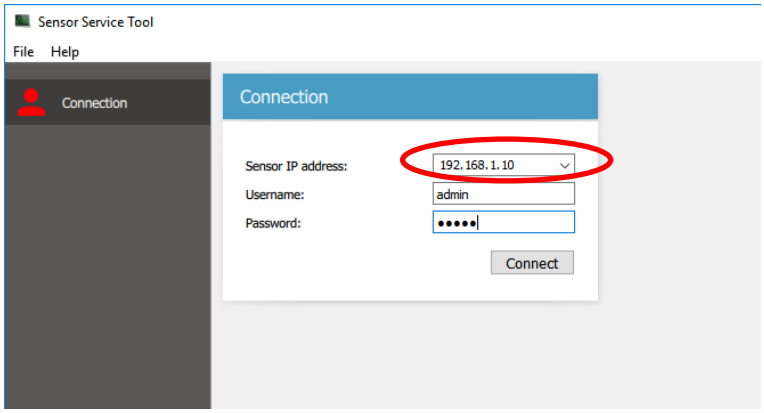


Illustration 102: Appendix 1 - SST Setup, Step 9

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