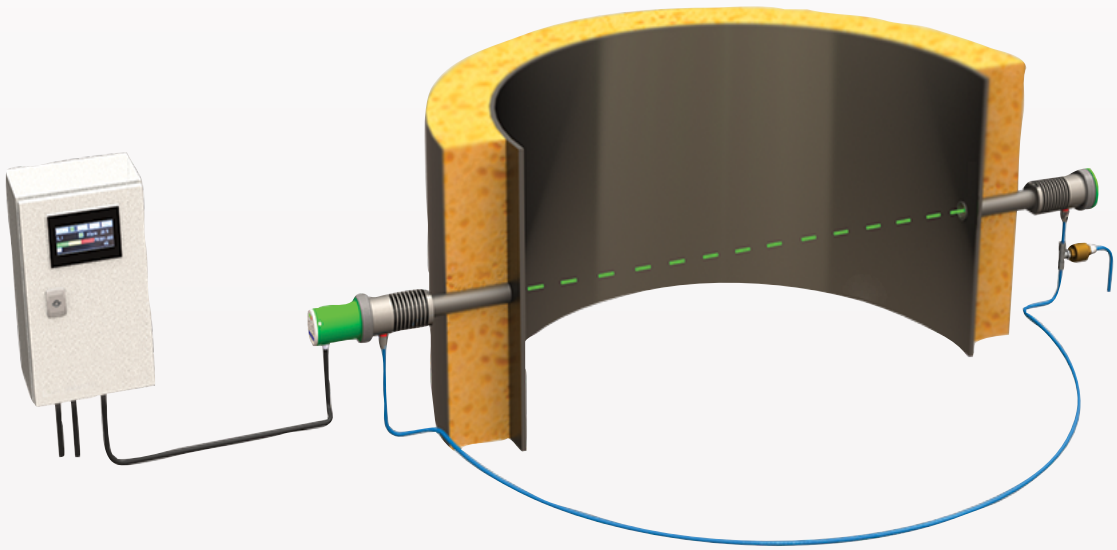
G16

Smoke Density Monitor



User Manual

Green Instruments

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For safe and proper use of the G16 Smoke Density Monitor, read this user manual carefully and keep it for future reference.

Green Instruments A/S reserves the right to adjust and improve its products and systems, and the user manual is subject to change without notice.

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

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

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

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Introduction

1.1 About this Manual

This manual contains information about the installation, operation, and maintenance of the G16 Smoke Density Monitor. For information about spare parts, refer to the G16 Spare Parts Catalog.

The user manual is designed for the Opacity Monitor delivered by Green Instruments A/S. Information is in general terms and do not take into consideration a specific installation or all possible scenarios.

Each Smoke Density Monitoring System is configured at the factory according to specifications.

The user manual cannot replace proper education and training of personnel. If any unforeseen situations arise that cannot be resolved using standar procedures, contact Green Instruments A/S.

ATTENTION

Before operation, read the user manual carefully. Improper use may cause personal injury and/or damage of equipment and may void the warranty.

Green Instruments A/S disclaims any responsibility for damage and/or injury caused by improper installation, use or maintenance of the equipment.

1.2 System Components

As a standard configuration, the G16 Smoke Density Monitor consists of the following standard elements:

1.2.1 Control and Monitoring Unit (HMI)

The control and monitoring unit is arranged with a touchscreen, connection terminals and cable glands. The control and monitoring unit can be configured to monitor up to 2 transceivers.

1.2.2 Transceiver/Reflector Unit

A G16 Smoke Density Monitor can be configured with up to two transceiver/reflector units. Each transceiver/reflector unit consists of:

- A G16.1 transceiver module assembly, which contains the laser source, optical components, and electronics. The transceiver controls and shapes the laser beam projected across the measuring area to the reflector assembly and measures the light attenuation when the light is reflected.
- An air module, which provides a purge air boundary between the process and the optical area and serves two main purposes: 1) Avoiding soiling of the optical parts from the exhaust gases. 2) Thermal protection of the instrument against exhaust gases.
- The air module is arranged with purge air supply connection and flow control valve for optimal airflow adjustment.
- A sealing air system including 9m purge air hose and a purge air distributor.
- A G16 reflector module assembly, which contains a precision reflector to direct the light beam back to the transceiver assembly.
- A connection cable of 15 m for connection between the transceiver and the control and monitoring unit.
- Two welding sockets 1” for the transceiver and the reflector assemblies.

Download the product certificates at www.greeninstruments.com/

1.2.3 Optional Components

- Junction box (JB): if the connection cable between the transceiver assembly and the control and monitoring unit is required to be more than 15 m, there shall be a junction box to support the connection between the transceiver and the control and monitoring unit.

- Audit Module Assembly with audit filters
- Sealing air compressor with filter
- Flow meter for sealing/purge air
- Filter regulator w. manometer
- Weld. and adj. brackets w/screws

1.3 Delivery Check

Check the equipment upon arrival to ensure it was transported properly.

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

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

1.4 Specifications

Specifications are subject to changes without notice.

Control and Monitoring Unit	
Display	Opacity level [%]
Accuracy	Better than 2 % of full scale
Precision	Better than 2 % of full scale
Power supply Input	100–240 VAC – 50/60 Hz – 1.4 A (optional:24 VDC – 2 A)
Communication	Modbus TCP/IP
Analog Output	2 x 4...20 mA max. 500 Ω - active and linearized
Alarm relay outputs	4 x alarm relays Potential free. I_{max} = 3A. U_{max} = 250VAC
Alarm levels	Alarm level is configurable Warning level is automatic set at 50% of the alarm level
Alarm delay	Default 0 s (programmable 0–1800 s)
Ambient temperature	0°C – 55°C
Dimensions/weight	H×W×D: 300 × 200 × 150 mm / 5.5 kg
Enclosure	IP 65 Steel box, AISI 1008, painted RAC 7035
Recommended minimum cable size	Power supply: 3 × 1.5 mm^2 shielded cables Signal cable: 2 × 1.0 mm^2 twisted pair shielded cables Alarm cable: 4 × 1.0 mm^2 shielded cables Network cable: Cat5e
Transceiver incl. Air Module	
Measurements	Opacity
Measuring principle	Transmission dual pass
Measuring range	0 – 100% Opacity
Scanning distance	0.5m to 6m
Power supply	24 VDC +/- 10%
Purge air supply	5-10 NLPM. Air quality to meet ISO 8573-1 Class 3
Flue gas temperature	Above dewpoint up to 460°C
Flue gas pressure	-50 to + 50 hPa
Ambient temperature	0°C – 55°C (Class A)
Vibration Class	B
EMC Class	A
Enclosure Class	B/IP 66
Dimensions and weight	OD 75 mm, length 220 mm, 1800g

Reflector incl. Air Module	
Purge air supply	5-10 NLPM. Air quality to meet ISO 8573-1 Class 3
Flue gas temperature	Above dewpoint up to 460°C
Flue gas pressure	-50 to + 50 hPa
Ambient temperature	0°C – 55°C (Class A)
Vibration Class	B
Enclosure Class	B/IP 66
Dimensions and weight	OD 75 mm, length 143 mm, 1500g
Optional Equipment	
Sealing/purge air compressor	
Multiple monitoring cabinet supporting up to 16 transceivers	
Visualization, recorder, and data logging (Green View)	
Remote digital display for panel mounting	
Approvals and Certificates	
Download all product certificates at www.greeninstruments.com	

1.5 Safety

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

1.6 Symbols and Warning Labels

This manual uses the following symbols to identify essential information related to the correct and safe operation of the G16 Smoke Density Monitor. Follow the safety warnings to minimize the risk of electrical shock, burns and equipment damage when operating the system.

Symbol identification			
	General warnings sign		Protective earth
	Electric shock hazard		

WARNING

- Failure to follow the instructions can lead to serious injury or death.
- Wear personal protective equipment. The system must only be installed in a safe, non-hazardous area. It must not be used with flammable media. This manual describes the most common and known situations. It does not describe every possible situation or circumstance relating to the installation of the system. This manual does not replace the specific training and education of personnel who will be installing the system.

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

ELECTRIC SHOCK HAZARD

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

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

Circuit breaker

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

Overload protection

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

Installation and fault finding

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

PROTECTIVE EARTH

The system must be connected to protective earth.

LASER HAZARD WARNING

When the laser operates in the continuous mode (i.e. there is a steady light beam in the aligning mode), the laser is classified as Class 3R. Therefore, avoid eye exposure to direct or scattered radiation.

2. Installation

Read the entire chapter before installing the system

2.1 General

To avoid damage to the equipment or errors in the monitoring readings and alarm function, observe the following points carefully:

- The system is not to be used without purge air. Doing so might result in monitoring errors or equipment failure.
- The transceiver and reflector modules must be placed in areas with low vibration and with ambient temperatures below 55°C. The location must be suitable for service and cleaning.
- The transceiver and reflector with air modules are screwed on the welding sockets welded to the gas uptake in the selected location. The transceiver and reflector must be properly aligned and mounted firmly and stable direct opposite each other. Take consideration of the minimum distance between any walls or construction elements to the cabinet. Refer to the system installation layout in the technical drawings to see the allowed minimum distance.
- The transceiver and reflector must be protected against mechanical damage.

CAUTION

Installation and operation of the G16 Smoke Density Monitor and associated equipment must be carried out by skilled personnel. Green Instruments A/S does not take any responsibility of the operation of the system and associated equipment whatsoever.

The equipment must only be applied as specified by Green Instruments. If the equipment is used in a manner not specified by Green Instruments, the protection provided by the equipment may be impaired.

The successful and safe operation of this equipment is dependent upon proper handling, installation, operation, and maintenance.

2.2 Standard Installation

The Monitoring Unit can be configured with up to two sets of transceiver/reflector units. The installation of each monitoring point is similar to each other. Figure 2-1 illustrates the installation of a system with only one transceiver/reflector unit.

The transceiver and reflector are to be aligned opposite each other in such way that the light beam from the transceiver has an unrestricted path to the reflector. See Figure 2-1.

For accurate measurement, it is important to place the transceiver and the reflector at a straight section of the duct where the flow is laminar. This means that there should be a distance of at least three duct diameters to the nearest upstream bend and a distance of at least one duct diameter to the nearest downstream bend and minimum 10 duct diameters to the engine, turbocharger, or boiler

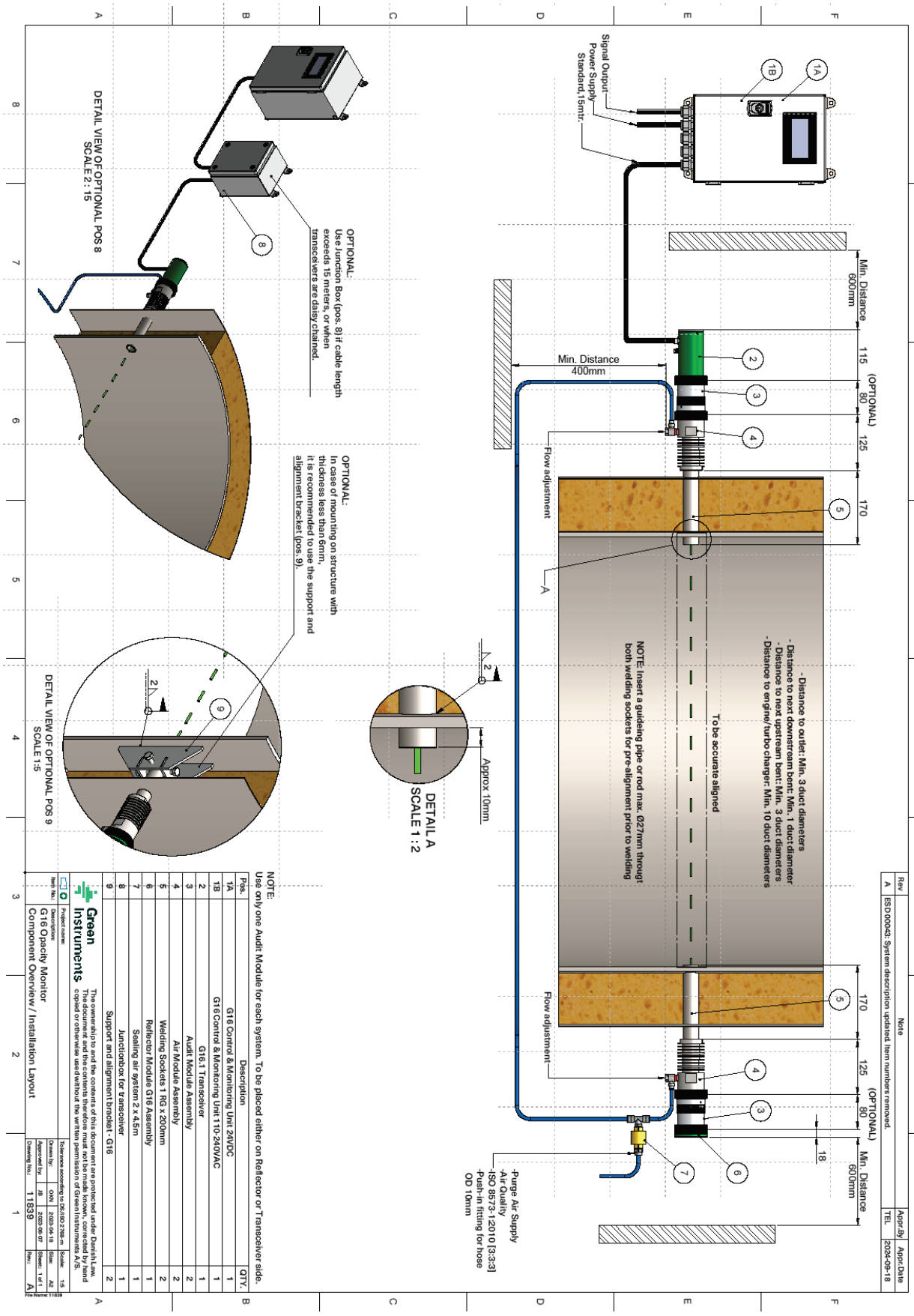

Figure 2-1: Installation of the G16 Smoke Density Monitor

2.2.1 Welding Sockets: Pre-alignment

The transceiver and reflector with air modules are installed on 200 mm long 1" socket pipes that are welded onto each side of the stack wall. It is recommended to shorten the welding sockets to match the thickness of the isolation to increase the stability of the installation. The welding sockets are of ordinary mild steel. Stability is best achieved by inserting the welding socket approximately 10 mm into the Ø35 mm hole made in the stack. This also helps preventing condensate from entering the socket pipe.

Special attention must be given to the alignment of the sockets, so that they are precisely aligned opposite each other. For pre-alignment, it is recommended to use a guiding pipe with maximally Ø27 mm outer diameter The guide pipe should be approximately 500 mm plus stack diameter. This is to be inserted through the 2 x Ø35 mm holes made for the welding sockets. The welding sockets are then slid onto the guiding pipe and then the sockets are welded to the stack/duct wall see Figure 2-1.

After spot welding the socket pipes, check that there are no misalignments. When you've verified this, you can complete the welding procedure in accordance with Figure 2-1.

2.2.2 Support and Alignment Brackets (Optional)

In case of walls with thickness less than 6 mm, use the support and alignment brackets (refer to the G16 Spare Parts Catalog). After completing the welding of both sockets, you can remove the guide pipe or rod, mount the support and alignment brackets and weld them in position with the socket in center. See Figure 2-1 and Figure 2-2.

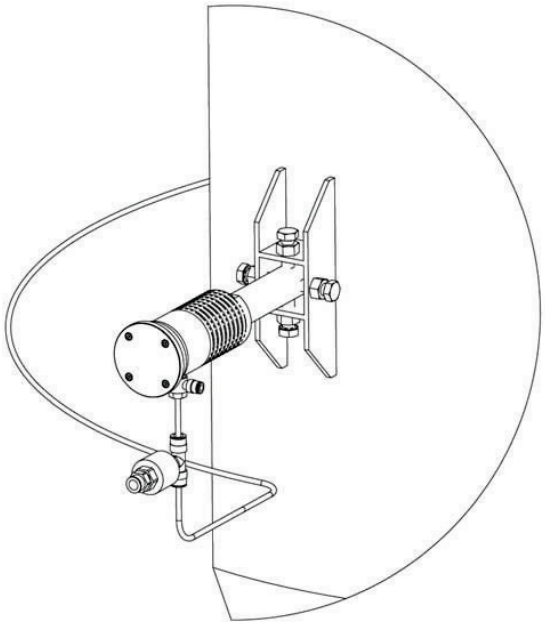

Figure 2-2: Mounting of a support and alignment bracket

2.2.3 Air modules, Transceiver and Reflector

After completing the welding of the sockets and the support and alignment brackets, the air modules can be mounted onto the welding sockets. To avoid gas leaks, it is recommended to use, e.g., Teflon thread tape in between. Fix the air module in position with the lock screw. Normally the best position is with the purge air supply connection facing down.

After completing the mounting of the air modules, the transceiver and reflector can be mounted on each side of the stack. The transceiver and reflector module are then secured by tightening the ring nut.

2.2.4 Audit Module (optional)

The audit module is an optional item that enables the user to validate the performance of the monitoring system and ease span calibration, e.g., in relation to demonstration of compliance requested by authorities. Only one audit module is needed for each set of transceiver/reflector. The audit module can either be mounted on the transceiver side or the reflector side, however it is important to have easily access to the audit module. The audit module is designed to fit in between the air module and the transceiver/reflector. See position 3 on Figure 2-1.

2.2.5 Purge Air System

Purge air is connected via the non-return valve, air distributor, and hoses to both air module.

The purge air consumption is approximately 10-20 NLPM for each set of transceiver/reflector. The purge air quality must meet ISO 8573-1 Class 3. Appropriate air cleaning and/or drying systems can be fitted to meet ISO 8573-1 Class3. When using instrument air, the optional air supply filter regulator (part no. 31021) must always be used to even out variations in pressure (refer to the G16 Spare Parts Catalog).

As an alternative to instrument air an optional sealing air compressor can be provided (refer to the G16 Spare Parts Catalog).

We recommend the use of an optional flow meter to adjust the flow control screw at the purge air connection of the air modules (refer to the G16 Spare Parts Catalog). Flow adjustment is essential since too much air flow will affect the effective light path length as it blows the flue gas out of the detection area. Too little air flow will lead to increased fouling of the lenses and could lead to intolerable temperature rises.

For stacks and ducts with a negative pressure at all loads, it is possible to use the passive air purge principle. This means that the purge air connection is simply connected to an air filter which allows the negative pressure inside the stack/duct to draw in a constant flow of ambient air and thus, providing a purging effect. However, make sure that the air still meets ISO 8573-1 Class 3. Otherwise, the lenses will be quickly fouled.

2.2.6 Control and Monitoring Unit

The control and monitoring unit handles up to two (2) sets of transceiver/reflector units. It is recommended to install the control and monitoring unit in an easily accessible location.

The information of the control and monitoring unit relevant for installation is provided in Figure 2-3.

2.2.7 Junction Box (Optional)

The junction box is an optional item used in cases where the cable between the Control and Monitor unit and the Transceiver exceeds 15 meters and/or in cases where multiple transceivers are daisy chained together. If the scope of supply includes a junction box, the junction box is pre-mounted with a connection cable for easy connection to the transceiver. See Figure 2-4 for information about junction box installation.

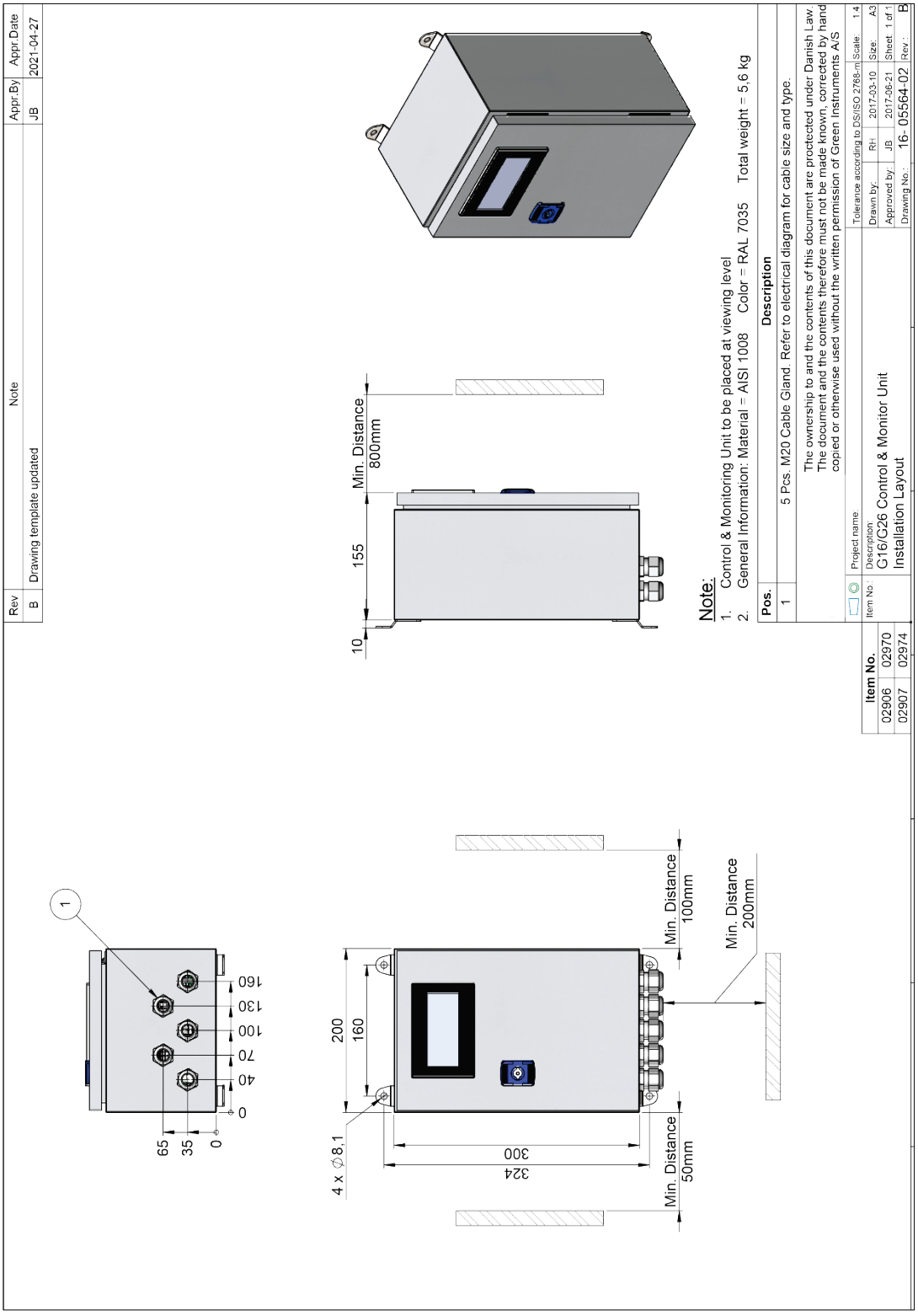

Figure 2-3: Installation of the control and monitoring unit

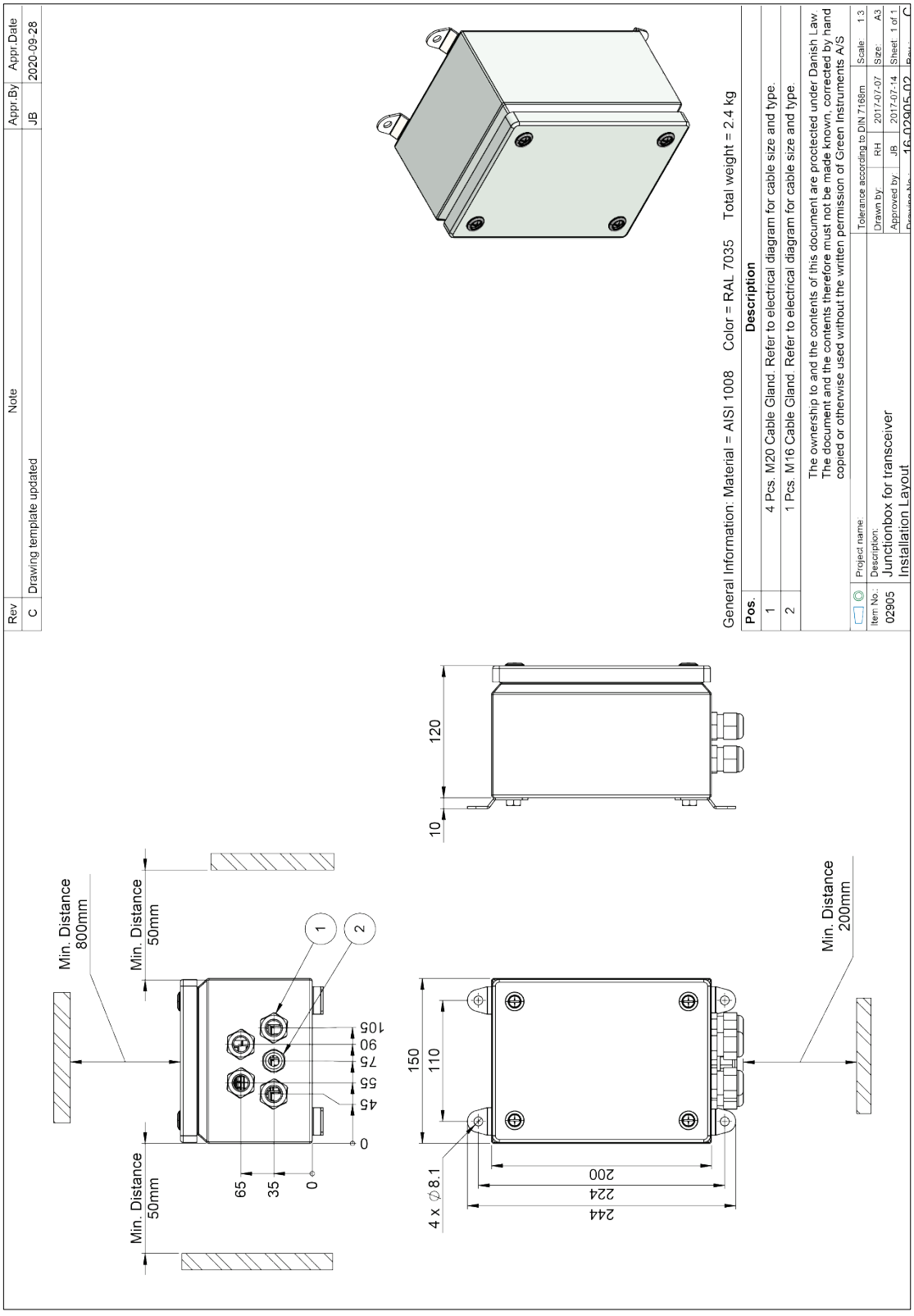

Figure 2-4: Installation of the Junction Box

2.3 Electrical Connections

2.3.1 Control and Monitoring Unit

The control and monitoring unit is arranged with touch screen and connection terminals inside the unit. Five (5) cable glands (M20) are arranged for incoming and outgoing power and data cables. The M20 cable glands are suitable for cables diameter between 7 mm to 13 mm. Refer to the connection diagram on the label located inside the control and monitoring unit.

Before connecting the power supply, make sure that the power supply rating for the control and monitoring unit corresponds with the power supply available.

The system can be prepared for functions not relevant for all installations. Only the functions to be used must be connected. Refer to the electrical drawings for detailed instructions. Contact Green Instruments A/S.

ATTENTION

Install the termination resistors 120 Ω provided with the control and monitoring unit and the optional junction box according to the actual installation. Refer to the electrical drawings for detailed instructions.

2.3.2 Junction Box (Optional)

The connection terminals are located in the junction box. Four (4) cable glands (M20) are arranged for incoming and outgoing power and data cables. The M20 cable glands are suitable for cables diameter between 7 mm to 13 mm. Refer to the connection diagram on the label located inside the control and monitoring unit.

The system can be prepared for functions not relevant for all installations. Only connect the functions to be used. Refer to the electrical drawings for detailed instructions. Contact Green Instruments A/S

2.3.3 Cable Types

The recommended minimum cable sizes are as follows:

- Power supply: 3×1.5 mm^2 shielded cable
- Data cable: 2×1.0 mm^2 twisted pair shielded cable
- Alarm cable: 4×1.0 mm^2 shielded cable
- Analog Output 2×1.0 mm^2 twisted pair shielded cable
- Network communication: Category 6e cable

The maximum cable size for 2 terminals is 4mm^2.

3. Menus and Configuration

3.1 Transceiver Button Functions

The transceiver user interface includes warning LEDs, a ZERO button, a SPAN button, and 5 signal strength LEDs.

Figure 3-1: Transceiver interface

3.1.1 Info LEDs:

- Power: Green LED means power ON
- Warning: Yellow LED means Warning ON
- Alarm: Red LED means Alarm ON

3.1.2 Signal Strength LEDs:

Under normal operation, the signal strength LEDs show how strongly the light beam is reflected back to the transceiver. When the first signal strength LED on the right lights up, it indicates that the transceiver is receiving a strong signal. This means the section between the transceiver and the reflector is clear without any obstructions to the light beam, and that both the transceiver lens and the reflector are clean.

Figure 3-2: Strong signal, no obstructions to the light beam

When one of the LEDs on the left lights up, it indicates a weaker reflecting beam. This could mean that the beam is scattered, blocked, or that the lenses are dirty. If the last LED to the left lights, the opacity level is just above the warning level. Thus, the signal strength LEDs can provide a quick indication of the opacity and/or contamination levels of the transceiver lens and/or the reflector.

Figure 3-3: Weak signal, obstructions to the light beam.

The blue LEDs are also used to indicate initial alignment and address setting. They flash at two different frequencies while the transceiver is in alignment and address setting mode.

3.1.3 ZERO and SPAN Buttons:

The **ZERO** and **SPAN** buttons are used for calibration and initial settings of light beam strength and transceiver address. During the initial light beam strength setting, the laser light is steady, allowing fine alignment of the beam against the reflector

3.2 Laser Aligning Function

ATTENTION

Once you start the laser aligning function, you must continue with setting the unit address until you save the new settings.

Visible laser radiation. When the laser operates in the continuous mode (i.e., there is a steady light beam in the aligning mode), the laser is classified as Class 3R. Therefore, avoid eye exposure to direct or scattered radiation when the transceiver operates in the continuous mode.

During the laser aligning step, ensure there are no obstructions to the light beam such as oil mist, smoke, and dust in the section between the transceiver and the reflector.

3.2.1 Set the Laser Aligning Function

1. Press and hold the **SPAN** and **ZERO** buttons simultaneously and wait approximately 5 seconds until all signal strength LEDs are **ON**. A steady light beam will be emitted from the transceiver.
2. Release **SPAN** and **ZERO**. One of the signal strength LED remains **ON** and the Alarm and/or Warning LED might be **ON**.
3. You can now finely adjust the laser beam focus point on the reflector by the support and alignment bracket. For centering the laser beam, we recommend you remove the reflector and place a piece of paper or thin cardboard over the opening. The beam will project onto the back of the paper or cardboard, indicating the beam's position for fine adjustment to the center. A cut shape off-center indicates poor alignment, while a circular shape at the center location indicates good alignment. See the following illustration:

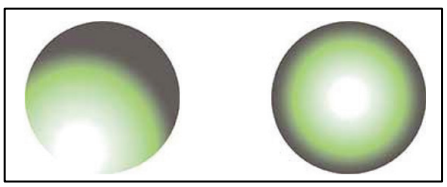

Figure 3-4: Poor versus precise alignment

4. After fine-tuning the beam to the center of the reflector, tighten the counter nuts on the support and alignment brackets. Remove the paper or cardboard and remount the reflector to the air module, locking it with the ring nut. Once the beam is centrally aligned, wait approximately 15 seconds until the alarm and/or warning LED(s) are OFF. Continue with setting the unit address.

3.3 Set the Unit Address

1. Press and hold the **SPAN** and **ZERO** buttons and wait approximately 5 seconds until all signal strength LEDs are **ON**. Then release the **ZERO** button first, followed by the **SPAN** button. The unit address is now shown on the signal strength LEDs as illustrated in the following figure.

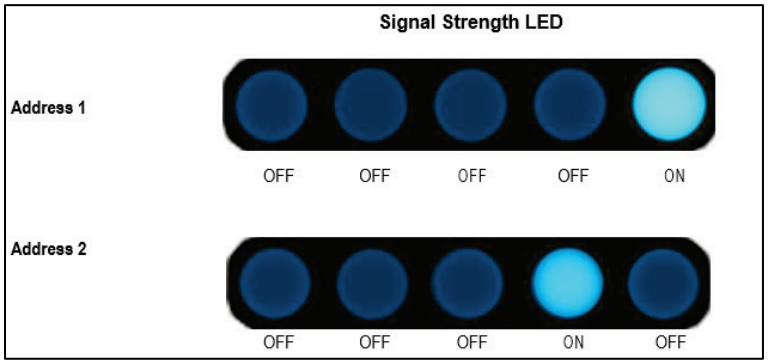

Figure 3-5: Transceiver address settings

2. Press the **ZERO** button to change the unit address to the desired address.
3. Release the **ZERO** button and verify that the address is correct.
4. Press and hold the **SPAN** button until all signal strength LEDs are **ON**.

All transceivers are set to address 1 at the factory. If the system is configured with 2 transceiver/reflector units, one of the transceivers must be set to address 2. Address 3-15 are currently not in use. Continue with saving the new settings.

Note: The unit address briefly appears when the transceiver is connected to power supply.

3.4 Save New Settings

To save the new address settings, press and hold **SPAN** and then immediately press and hold the **ZERO** button. Wait 5 seconds until all signal strength LEDs are **ON**, and then release the buttons.

NOTE: There is a risk that the transceiver counts at the address if you press SPAN and ZERO buttons simultaneously.

3.5 Calibration

- **Zero calibration:** Ensure there's no obstruction to the light beam, and then press and hold **ZERO** until all blue signal LEDs light up.
- **Automatic Span calibration:** After Zero calibration, the auto Span calibration will automatically be performed if the beam is blocked within 1 minute.

Figure 3-6: Automatic span calibration active after zero calibration

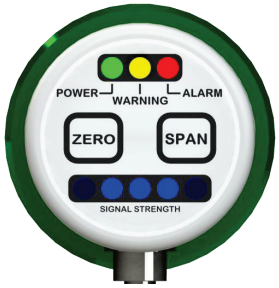

Figure 3-7: Automatic span calibration accepted

- **Manual Span calibration**: You can manually perform a Span calibration without Zero calibration. While the beam is blocked, press, and hold SPAN until all blue signal LEDs light up.
  For calibration details, see chapter 4.

3.6 Control and Monitoring Unit

The control and monitoring unit uses an HMI for configuration, monitoring, and visualization.

3.6.1 Home Menu

The Home Menu is the first screen displayed when you turn on the system. The display varies depending on the number of transceiver/reflector units configured in the system.

If the system is configured with 1 transceiver/receiver unit, the Home Menu is also the Sensor Menu. The sensor ligths show the alarm status of the sensor:

- Green light: no alarm and/or warning.
- Yellow: active warning
- Red: alarm

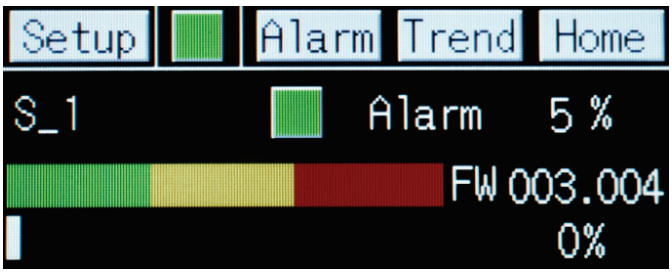

Figure 3-8: Home Menu with 1 configured sensor

Figure 3-9: Home Menu with 2 configured sensors

The light at each sensor box shows the alarm status at that sensor as described in the following.

3.6.2 Sensor Menu

If two sensors are configured, press the sensor name (e.g., S_2) to access to the sensor menu. The sensor menu displays the following information:

- Sensor name: S_1 – the default setting for sensor 1
- Global alarm condition (to the right of Setup):
  Green light: no warning and/or alarm
  Yellow light: active warning
  Red light: alarm
- Alarm condition of the selected sensor (to the right of the sensor name):
  Green light: no warning and/or alarm
  Yellow light: active warning
  Red light: alarm
  Black: Sensor not configured, or no data received.
- Alarm level: 2% opacity as default setting
- Software version of the transceiver: e.g., FW 003.004
- Current opacity level: e.g., 10%.
  Green: no alarm and/or warning.
  Yellow: active warning.
  Red: alarm.

The sensor menu has also 4 functions buttons:

- **Setup:** Access the sensor setup menu
- **Alarm**: Access alarm list
- **Trend**: Access trend menu
- **Home**: Return to the home menu

3.6.3 Alarm List Menu

Press **Alarm** on the **Sensor Menu** to acess the **Alarm list** menu.

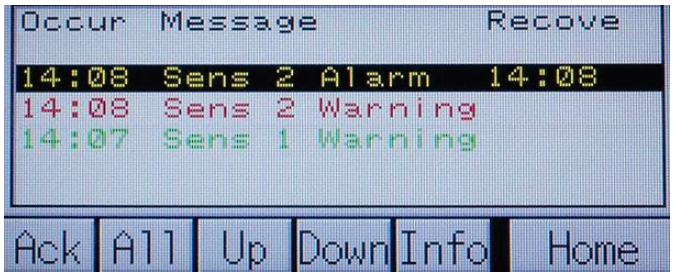

Figure 3-10: Alarm List Menu

The A**larm** list menu has 6 function buttons:

- **Ack**: Acknowledge the current selected alarm .
- **All**: Acknowledge all alarms.
- **Up**: Select the alarm above.
- **Down**: Select the alarm below.
- I**nfo**: Show info screen with description of the currently selected alarm.
- **Home**: Return to the home menu.

Alarm colors:

Selected alarm – black bar:

- Turquoise: active alarm
- Magenta: acknowledged alarm
- Yellow: recovered alarm

Other alarms:

- Red: active alarm
- Green: acknowledged alarm
- Blue: recovered alarm

Figure 3-11: Select an alarm in the alarm list menu

Select an alarm and press **Info**, to display an alarm info screen with information about the current selected alarm and suggestions to solve the alarm condition.

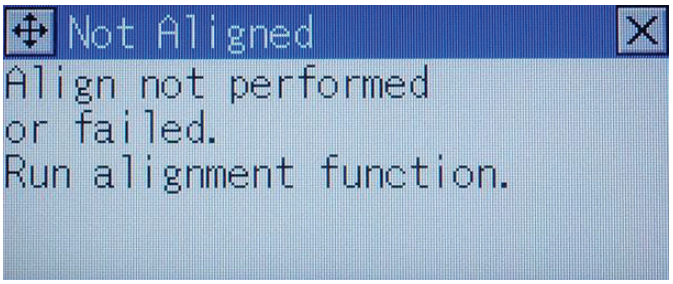

Figure 3-12: Alarm info screen

3.6.4 Complete Alarm List

Alarm	Description	Information
Sens 1 Error	Error at Sensor 1	General error on sensor. Check if a more specific error is present on the same sensor. If not replace the sensor.
Sens 1 Warning	Warning at Sensor 1	Opacity warning level threshold reached. Note this alarm will be set as soon as the sensor detect the high level.
Sens 1 Alarm	Alarm at Sensor 1	Opacity alarm level threshold reached. Note this alarm will be set as soon as the sensor detects the high level.
Ret 1 L Warning	Warning for Low Returned Light Intensity	Returned light low. Run align function again and make sure the beam is aligned with the reflector. Reduce the distance to the reflector if possible.
Ret 1 L Alarm	Alarm for Low Returned Light Intensity	Returned light to low. Run align function again and make sure the beam is aligned with reflector. Reduce distance to reflector if possible.

Alarm	Description	Information
Ret 1 H Warning	Warning for High Returned Light Intensity	Returned light high. Run align function again. Increase reflector distance or use filter.
Ret 1 H Alarm	Alarm for High Returned Light Intensity	Returned light to high. Run align function again. Increase reflector distance or use filter.
Ref 1 L Warning	Warning for Low Reference Light Intensity	Reference light low. Run align function. Increase reflector distance.
Ref 1 L Alarm	Alarm for Low Reference Light Intensity	Reference light to low. Run align function. Increase reflector distance. Replace the sensor.
Ref 1 H Warning	Warning for Low Reference Light Intensity	Reference light high. Run align function.
Ref 1 H Alarm	Alarm for Low Reference Light Intensity	Reference light to high. Run align function. Replace sensor.
Neg Opa 1 Warn	Negative Opacity Warning	< -2.5% negative opacity measured. Calibrate sensor. Note it's very important that calibration is done without smoke / oil / dust present.
Neg Opa 1 Alarm	Negative Opacity Alarm	< -5.0% negative opacity measured. Calibrate sensor. Note it's very important that calibration is done without smoke / oil / dust present.
Not aligned 1	Transceiver and reflector not aligned	Align not performed or failed. Run alignment function.
Zero 1 cal Err	Zero Calibration Error	Zero calibration not performed or failed. Press ZERO to calibrate. Note: Smoke / oil / dust must not be present.
Span 1 cal Err	Span Calibration Error	Span calibration not performed or failed. Press SPAN to calibrate. Note: Beam must be blocked during SPAN calibration.

3.6.5 Trend Menu

Press **Trend** on the Sensor **Menu**, to display the opacity trends of all sensors.

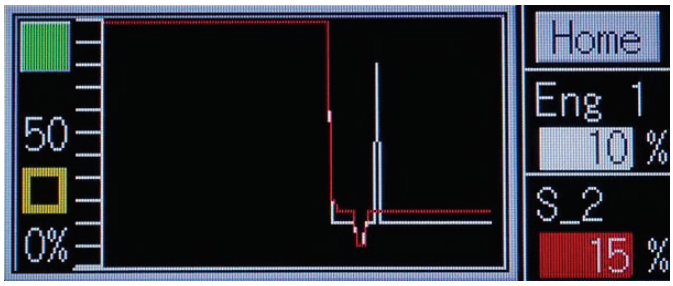

Figure 3-13: Trend Menu

The vertical axis shows opacity values from -10% to100% opacity from, and the horizontal shows a time scale of the last 30 minutes.

To log data, use a FAT32-formatted USB flash drive with a maximum capacity of 32 GB. In the Trend menu, a small green square appears on the left. If there's a USB error, an orange or redframe will indicate the issue (e.g. red for wrong format like NTFS) along with a message saying, "This USB isn't available."

Figure 3-14 USB error

3.6.6 Sensor Setup

1. Press **Setup** on the **Sensor Menu**.
2. Find the password on the Test and Configuration Sheet delivered with each system. Use the popup keyboard to enter the password.
3. Press **OK** by using up/down/right/left buttons on the keyboard, and then press **ENT**.

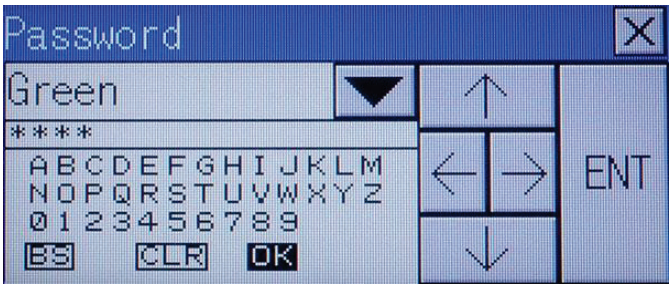

Figure 3-15: Password popup window

The **Sensor Setup Menu** appears.

The **Sensor Setup Menu** has two function buttons:

- **System**: Access the general **System Setup** menu
- **Home**: Return to the home menu

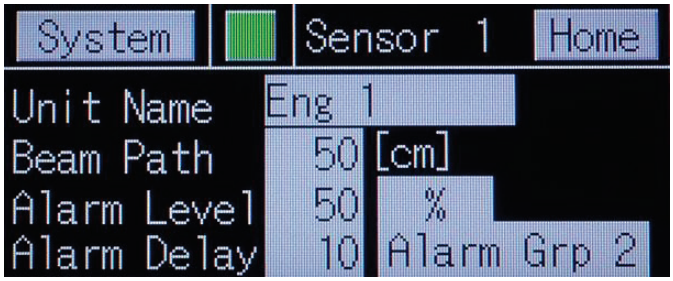

Figure 3-16: Sensor setup

The light at top of the screen shows the global alarm status:

- Green light: no warning and/or alarm
- Yellow light: warning
- Red light: alarm

You can configure the following sensor parameters for each sensor in the Sensor Setup Menu:

- **Unit Name:** The default names set at the factory are S_1 and S_2. However, you can change the name of each sensor for better clarity (e.g., S_1 can be changed to Eng_1 (i.e., sensor 1 monitors the exhaust gas from the main engine), S_2 to Incr (i.e., sensor 2 monitors the exhaust gas from the incinerator).

To change the name of the unit, press the grey box next to **Unit Name**. Use the popup keyboard to enter the new name.

- **Beam Path**: The beam path is the distance between the transceiver and the reflector in cm. The value is currently not in use.
- **Alarm Level**: You can configure the alarm level based on the requirements of each application. Note that the monitor and control unit always provide a warning at 50% of the alarm level, which can be used as lens-cleaningwarning
- **Alarm Delay**: The delay time in seconds for the alarm to activate.
- **Alarm group:** The system has two alarm groups: Group 1 and Group 2. The alarm outputs are configured as follows:

Alarm Output	Alarm Group	Alarm level
Alarm relay 1	Alarm Grp 1	Warning level
Alarm relay 2	Alarm Grp 1	Alarm level
Alarm relay 3	Alarm Grp 2	Warning level
Alarm relay 4	Alarm Grp 2	Alarm level

By setting the Alarm Group for each sensor, you can configure which alarm outputs are connected to that sensor.

3.6.7 System Setup

Press **System** on the **Sensor Setup Menu** of any sensor to access the general **System Setup Menu**.

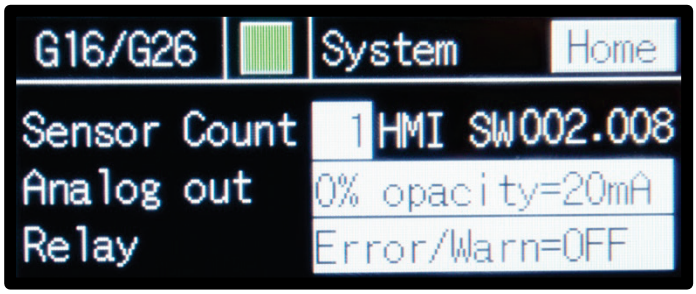

Figure 3-17: System setup

This menu displays the software version of the control and monitoring unit. It also has **Home** button to return to the **Home Menu**.

In this menu, you can configure the following system parameters:

- **Sensor Count**: The sensor count is the total number of the transceiver/reflector units to be controlled.
- **Analog out**: Analog output signals can be configured as follows:

Range	Setting
0% opacity = 4 mA 100% opacity = 20 mA	0% opacity=4 mA
0% opacity = 20 mA 100% opacity = 4 mA	0% opacity=20 mA (default)

Digital out

The alarm digital output signals can be configured as follows:

Output Signal at Active Warning or Alarm	Setting
Alarm active = Relay not energized Alarm inactive = Relay energized	Error/Warn=OFF (default)
Alarm active = Relay energized Alarm inactive = Relay not energized	Error/Warn=ON

3.6.8 Setting the System Clock

The timestamps in the alarm log and log files are based on the system clock settings, so it's important that the setting is correct.

1. Press System on the **Sensor Setup Menu** to access the general System Setup Menu.
2. Press and hold G16 to access the system menu.

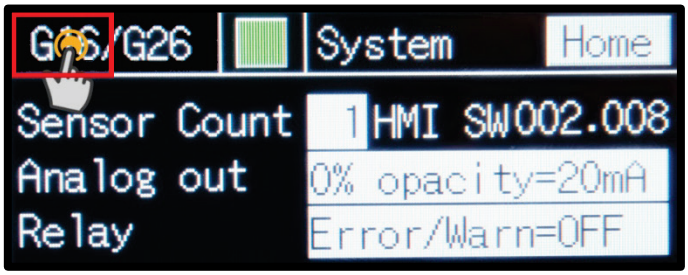

Figure 3-18: Set clock

3. Press **System Mode**. When prompted, enter the default password: aaaa.

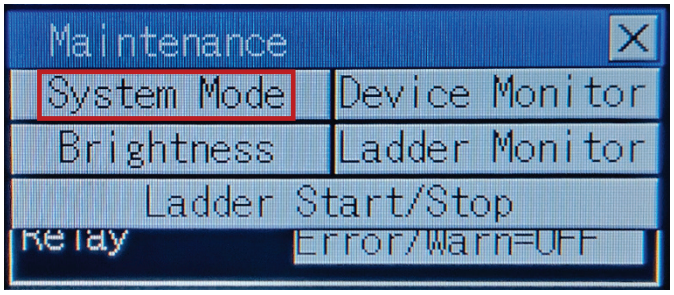

Figure 3-19: Set clock - system mode

4. Press **Main Menu**.

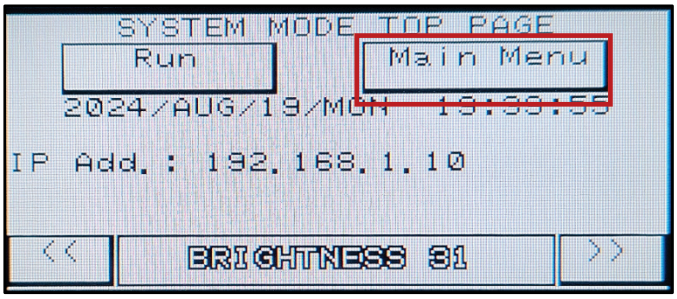

Figure 3-20: Set clock - Main Menu

5. Press **Clock Setting**.

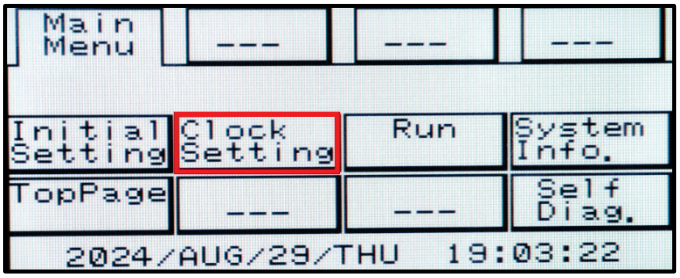

Figure 3-21: Set clock - select

6. Adjust the time and date as needed. Use the left and right arrows to navigate between year (YYYY), month (MM), and date (DD) and between hour (HH), minutes(MM) and seconds (SS).

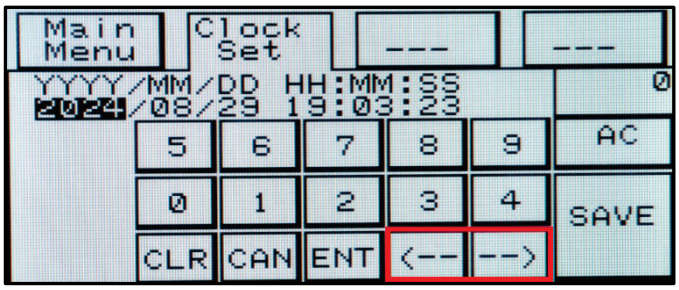

Figure 3-22: Set clock - arrows

7. Press **Main Menu** to exit the menu.
8. Press **RUN** to exit the System Setup Menu.

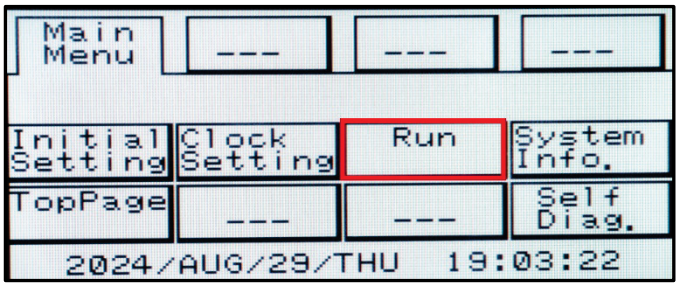

Figure 3-23: Set clock - Run

3.7 Updating the HMI Application

To update the HMI application, you need a FAT32-formatted USB flash drive with the HMI software and with a maximum capacity of 32 GB. The USB should contain the hgauto.ini file in the root folder and the project file in the ..\HGDATA01\NVDATA folder.

1. Insert the USB flash drive that contains the HMI software into the USB slot.

Figure 3-24: Updating HMI – USB

2. Follow the on-screen instructions to initiate the update. When prompted, select Install Rx.x.

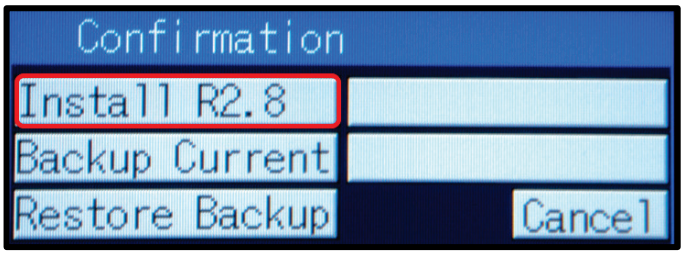

Figure 3-25: Updating HMI - install

3. When prompted, enter the default admin code: aaaa.
4. The transfer begins.
   When the transfer has completed, the following message appears.

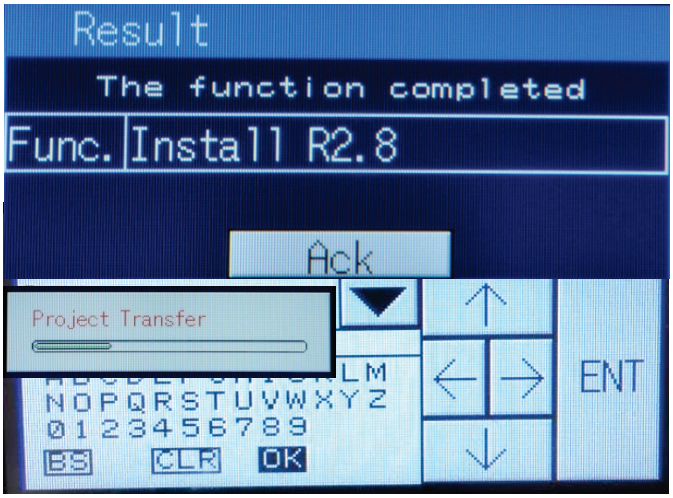

Figure 3-26: Updating HMI - transfer complete

5. When the software has finished downloading, remove the USB flash drive from the system, and then press the **Ack** button to restart the system.
6. Set up the relevant parameters again such as Sensor Count, Analog out, and Relay.

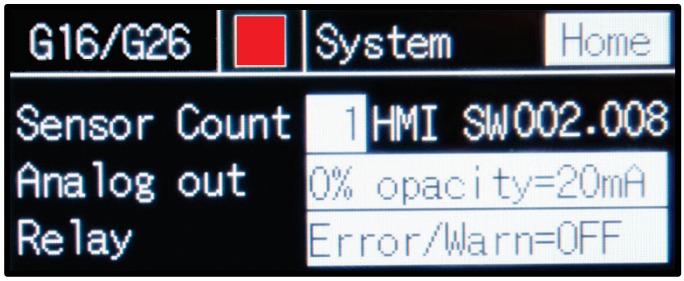

Figure 3-27: Updating HMI - set parameters

3.8 Viewing and Exporting Log Files

To export log files, you need a FAT32-formatted USB flash with a maximum capacity of 32 GB.

1. Insert the USB flash drive into the HMI. The system automatically logs data to the USB flash drive at a 15-second interval.

2. Press the small green square in the upper left corner of the HMI to safely remove the USB flash drive.

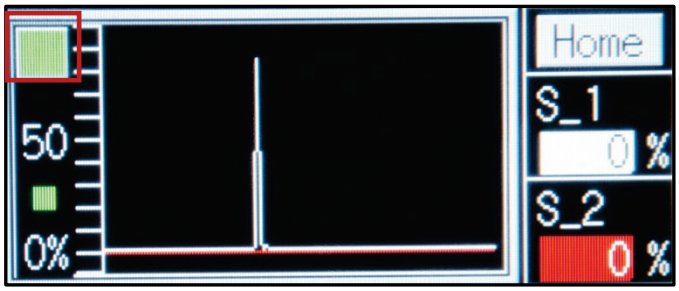

Figure 3-28: Export log - remove USB

3. A message appears saying “Stopping external memory”.

4. Remove the USB flash drive.
5. Insert the USB flash drive into a computer.
6. Open the HGDATA01\DATALOG folder on the USB flash drive.

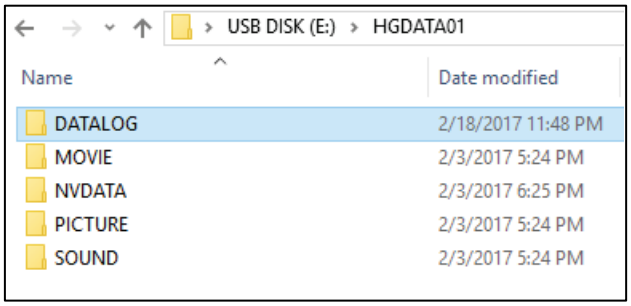

Figure 3-29 :Export log - datalog folder

7. The folder contains two log files in CSV format. Copy these files from the USB flash drive to your computer.

New log files will automatically be created on the USB flash drive when you reinsert it into the HMI.

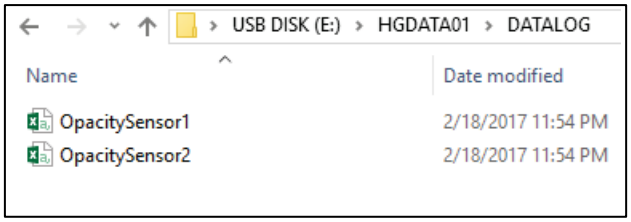

Figure 3-30: Export log -new files

4. Calibration

NOTE:

ZERO: 0% Opacity = 100% Transmission = All light reflected

SPAN: 100% Opacity = 0% Transmission = No light reflected

4.1 Zero Calibration

1. Ensure there are no obstructions to the light beam such as oil mist, smoke, or dust in the section between the transceiver and the reflector
2. Press and hold **ZERO** until all blue signal LEDs light up. Release **ZERO**.
3. Press and hold **ZERO** again until all blue signal LEDs turn OFF. Alternatively, start Auto Span calibration by blocking the beam for a minute.

4.2 Auto Span Calibration

The transceiver interface of an Auto Span calibration will indicate this in the following way.

- Alarm and Warning LEDS will turn ON.
- After the light beam is unblocked, a few seconds will pass until the beam returns to normal operation.

Refer to section 3.5 Calibration for more information.

4.3 Span Calibration

You can perform a manual Span calibration as an alternative to Auto Span calibration. Follow these steps:

1. Block the light beam by either unmounting the transceiver and using your hand to block the beam, or by setting the **SPAN Target** to the **Audit Module** if you have it. **Alarm** and **Warning** LEDs will turn **ON** when the beam is blocked.
2. Press and hold **SPAN** until all blue signal LEDs light up.
3. Release **SPAN**. The first signal strength LED on the left will turn **ON** and the Warning and Alarm LED will remain **ON**.
4. When the transceiver is mounted back to the Air Module, orThe SPAN Target is removed from the audit module, the light changes to the first signal strength LED on the right and the Warning and Alarm LED will turn **OFF**

   If the alarm and/or warning LEDs remain **ON** after you remount the transceiver or remove the SPAN Target, the unit has not been calibrated successfully. Check the **Alarm List** for the reason and recalibrate.

5. Commissioning

Before starting the system for the first time after installation, verify that all parts are installed correctly according to the instructions, that all connections are secured, and that there are no leaks. Verify that all electrical connections are correct according to the instructions.

5.1 Starting the System

Switch on the power supply, configure, and align the transceiver/reflector.

To configure each transceiver:

- Align the transceiver and reflector: refer to section 3.2.
- Set unit address: refer to section 3.3.
- Save new settings: refer to section 3.4.

5.2 Calibrating the System

Calibrate the system following the instructions in chapter 4 Calibration.

5.3 Setting Alarm Levels

Set the alarm level according to the requirements of each application. To configure the alarm level for each transceiver, follow the instructions in section 3.6.6 Sensor Setup.

5.4 Setting Signal Outputs

Signal outputs (analog and digital) shall be set up following the requirement of each application. Follow the instruction to configure signal output for the system in section 3.6.7 System Setup.

6. Maintenance

Besides normal cleaning of the lenses, the system does not require any maintenance.

ATTENTION

The lenses can only be cleaned when the boilers/engines stop and there is no exhaust gas in the stack.

If you remove the transceiver or the reflector while there is exhaust gas in the stack, exhaust gas may escape from the transceiver/reflector unit's holes.

We recommend turning on the purge air system while you are cleaning the transceiver and the reflector.

6.1 Cleaning the Transceiver Lens and Reflector

1. Loosen the ring nut and pull either the transceiver or the reflector toward yourself.
2. Clean the transceiver lens/reflector with the cleaning pad (refer to the G16 Spare Parts Catalog).
3. Reattach the transceiver and the reflector to the air module/audit module. Refer to section 2.2.3 Air modules, Transceiver and Reflector.

We strongly recommended that you calibrate the system after cleaning. Ensure there is no exhaust gas (smoke/dust/mist) between the optic heads during calibration. You must turn off the process that is being monitored.

Cleaning intervals depend on the amount of soot particles that contaminate the lenses. Accumulated dirt on the lenses will result in higher opacity readings and might cause false alarms. Make sure to set sufficient cleaning intervals.

Troubleshooting

Troubleshooting must always be carried out by trained and certified personnel.

ELECTRIC SHOCK HAZARD

The G16 Smoke Density Monitor is connected to hazardous electric voltages that can cause personal injury if not handled correctly.

Issue	Possible cause and action
No display at all	Check the power supply – the power supply needs to be connected to the correct voltage.
Incorrect indication of opacity level	The alignment has changed (e.g., due to vibration or some impact) →realign the transceiver and the reflector. Check by removing the lenses and looking through the duct.
Incorrect alarm level	Incorrect alarm level settings →change settings at the control and monitoring Unit.
No alarm despite opacity between the lenses	Incorrect alarm level settings → change settings at the control and monitoring Unit.
Incorrect alarm level	Incorrect alarm level settings →change settings at the control and monitoring Unit.

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