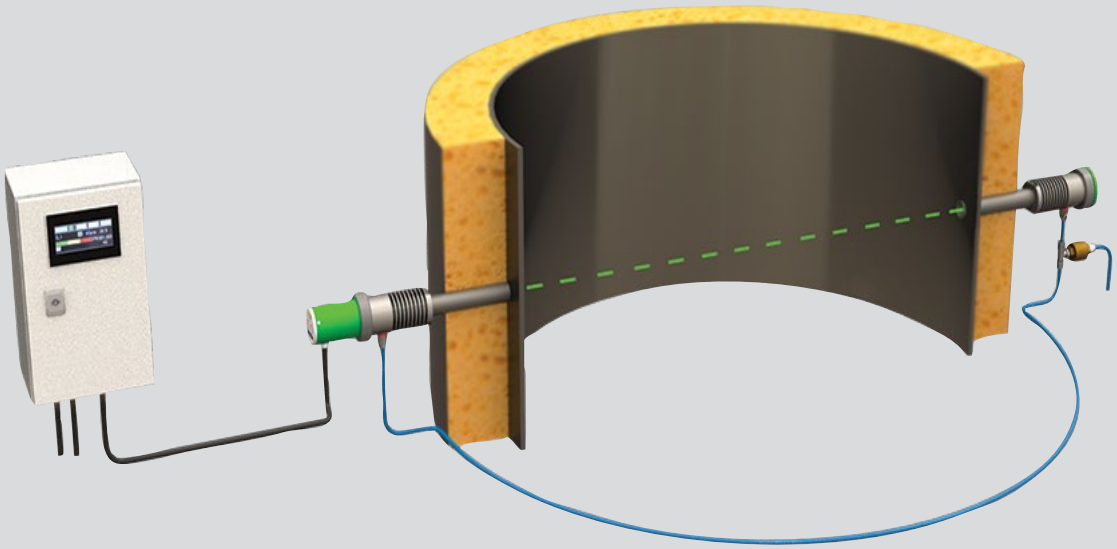
G16

Smoke Density Monitor

Instruction Manual



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Green Instruments

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1 Introduction

1.1 About this Manual

This manual contains data and instructions for the installation, operation, and maintenance of the G16 Smoke Density Monitor.

The instructions are given in general terms and do not take into consideration a specific installation. As such, the instruction manual is designed for the Opacity Monitor delivered by Green Instruments A/S.

Note that each Smoke Density Monitoring System is configured at the factory ac- cording to specifications. Therefore, it is important to study this manual and the Technical Drawings for each system in their entirety for the installation, operation and maintenance of the system.

The manual does not describe all possible situations, but only the most common and known situations. It cannot replace the necessary education and training of the personnel. Should situations not described in this manual occur that cannot be solved in accordance with normal known practice and good workmanship, the operator should contact Green Instruments A/S for instructions.

This manual does not claim to cover all details or variations in equipment or to provide for every possible contingency that may arise during installation, operation, or maintenance.

Green Instruments A/S reserves the right to minor alterations and improvements owing to developments without being obliged to enter the corresponding changes in this manual.

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Attention

Before operation read all instructions and warnings within this manual and associated documentation. 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 Inquiries and Feedback

All claims and inquiries for spares shall be addressed to Green Instruments A/S or our distributors. In all correspondence or when ordering spare parts, please carefully state the equipment type and serial number, which can be found on the label on the equipment.

Green Instruments A/S appreciates all feedback and suggestions for improvement. If any questions appear or any discrepancies can be found in this manual, kindly contact Green Instruments:

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1.3 About the System

1.3.1 System components

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

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.

Transceiver/Reflector Unit

- A G16 Smoke Density Monitor can be configured with up to 2 Transceiver/Reflector Units. Each transceiver/reflector unit consists of:
- A G16 transceiver module assembly, which contains the laser source, optical components, electronics, and data processing capacity. 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: (i) Avoiding soiling of the optical parts from the exhaust gases. (ii) 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 https://greeninstruments.com/

1.3.2 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 Audit targets
- Sealing air compressor with filter
- Extended monitoring system supporting up to 16 transceivers

2 Specifications

Control and Monitoring Unit	
Display	Opacity level [%]
Accuracy	Better than 2 % of full scale
Precision	Better than 2 % of full scale
Power supply Input	24 VDC – 2 A (optional: 100–240 VAC – 50/60 Hz – 1.4 A)
Communication	Modbus TCP/IP
Analog Output	2 x 4…20 mA max. 500 Ω - active & 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 mm² shielded cables Signal cable: 2 × 1.0 mm² twisted pair shielded cables Alarm cable: 4 × 1.0 mm² shielded cables Network cable: Cat5e

Transceiver incl. Air Module	
Measurements	Opacity
Measuring principle	Transmission dual pass
Measuring range	0 – 100% Opacity
Scanning distance	0.5 to 10.0 m
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	-500 to + 500 hPa

Ambient temperature	0°C – 55°C (Class A)
Vibration Class	B
EMC Class	A
Enclosure Class	B/IP 66
Dimensions & 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	-500 to + 500 hPa
Ambient temperature	0°C – 55°C (Class A)
Vibration Class	B
Enclosure Class	B/IP 66
Dimensions & weight	OD 75 mm, length 143 mm, 1500g
Optional Equipment	
Sealing/purge air compressor	
Support and alignment brack-ets	Support and alignment brackets
Audit module	Audit module
Audit targets	Audit targets
Visualization, recorder, and data logging	Visualization, recorder and data logging
Remote digital display for panel mounting	Remote digital display for panel mounting
Approvals and Certificates	
Download all product certificates at https://greeninstruments.com/	

Specifications are subject to changes without notice.

3 Safety Aspects

Before installing the system, please study the Installation Manual in its entirety.

WARNING

Follow the installation and operating instructions! Please read the instructions carefully in its entirety before working on the system.

Hazardous voltage!

Disconnect the power before installing or servicing the equipment. Ignoring this warning can result in severe personal injury or material damage. Read the instruction carefully to ensure correct connection of all power and signal leads.
Make sure that the correct 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.

Protective earth!

The system must be connected to protective earth.

Installation and fault finding!

Electrical installation and fault finding on the system should only be undertaken by a suitably trained and qualified engineer.

Warning Laser Hazard

Visible laser radiation. When the transceiver operates in pulsed mode, the laser is classified as Class 1, which is safe under all conditions of normal use. When it op- erates in the continuous mode (i.e. there is a steady light beam in the aligning mode), the laser is classified as Class 3R. Thus, please avoid eye exposure to direct or scattered radiation when the transceiver operates in the continuous mode.

Symbol Identification

Caution, risk of danger

Caution, risk of electrical shock

Warning Laser Hazard. Visible laser radiation! Avoid eye exposure to direct or scattered radiation

Protective earth

The CE mark proves the compliance of the instrument with the requirements of the relevant EU directives

Caution, hot surface

4 Control at Delivery

All products of Green Instruments A/S are individually checked throughout and carefully packed.

Check the equipment upon arrival, ensuring that the equipment has been transported properly.

Check for the absence of any damage. If these are noted, immediately make a note on the delivery document. Remove the packing and check for intrusive water or signs of humidity.

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

5 Installation

Read this chapter in its entirety before installing the system

5.1 In General

To avoid possible damage to the equipment or errors in the monitoring readings and alarm function, it is important to 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 oppo- site each other. Take consideration of the minimum distance between any walls or construction elements to the cabinet. Please 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.

5.2 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 5-1 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 4-5 a beam illustration when correctly installed.

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

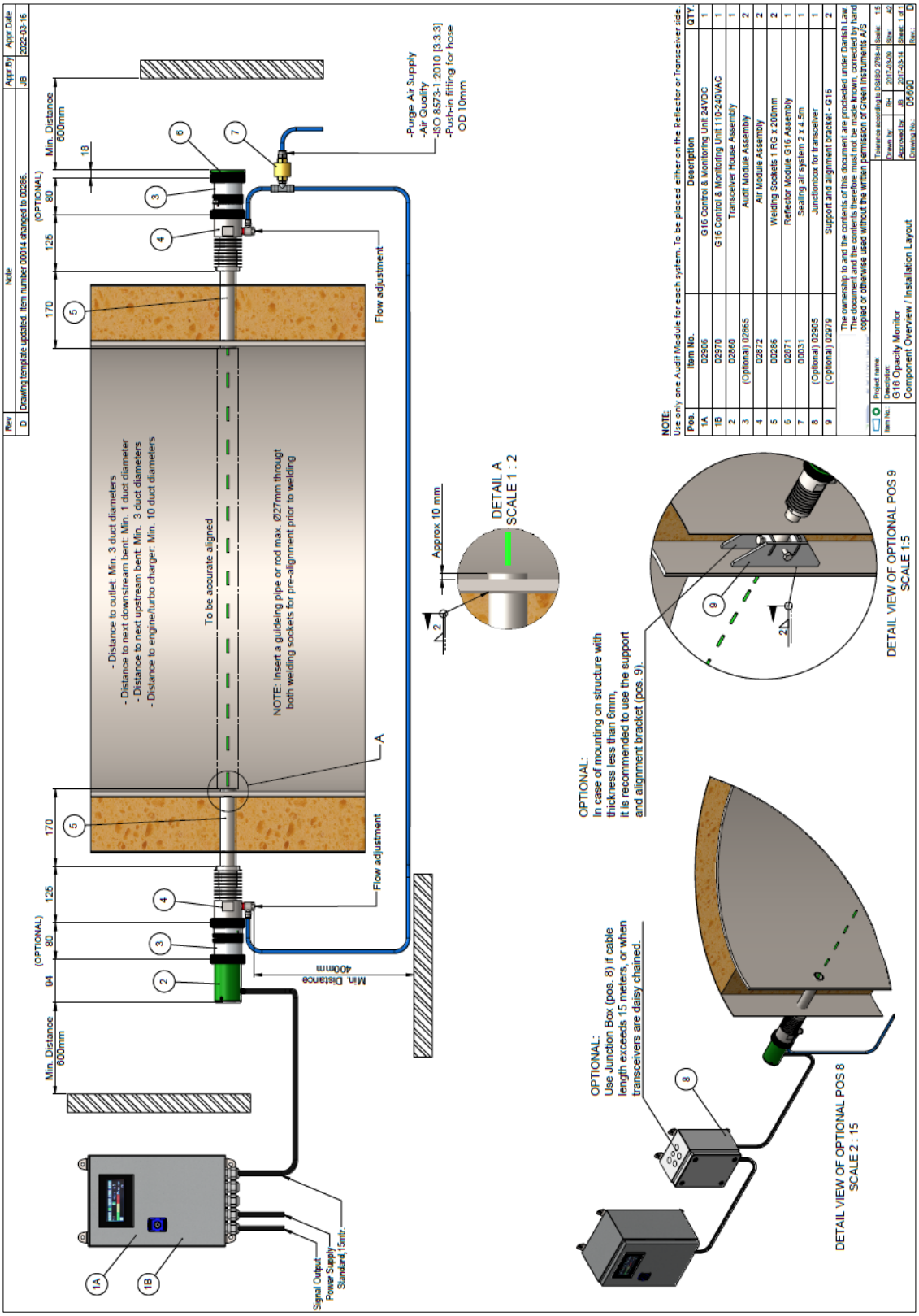


Figure 5-1: Installation of the G16 Smoke Density Monitor

5.2.1 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 5-1.

After spot welding the socket pipes, be sure to check for any misalignments. When this is ensured the welding procedure can be completed in accordance to Figure 5-1.

5.2.2 Support and Alignment Brackets (Optional)

In case of walls with thickness less than 6 mm, use the support and alignment brackets (part no. 02979). After completing the welding of both sockets, the guide pipe or rod can be removed, and the support and alignment brackets can be mounted and welded in position with the socket in center see both Figure 5-1 and Figure 5-2.

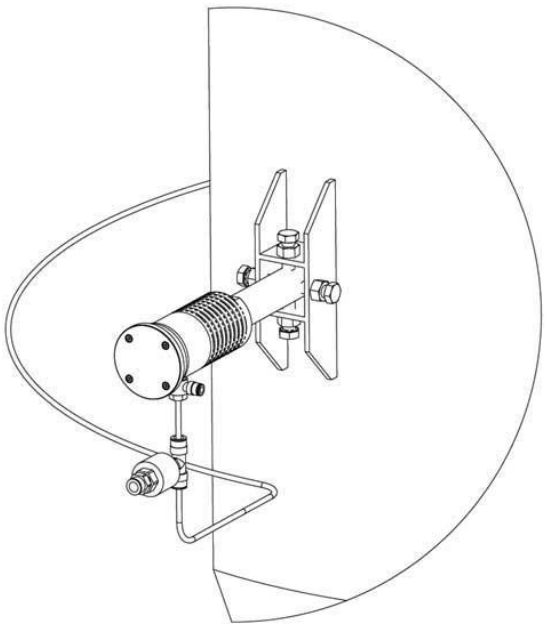


Figure 5-2: Mounting of a support and alignment bracket

5.2.3 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.

5.2.4 Audit Module

The audit module is an optional item that enables the user to validate the performance of the monitoring system 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 as shown on Figure 5-3 & Figure 5-4.

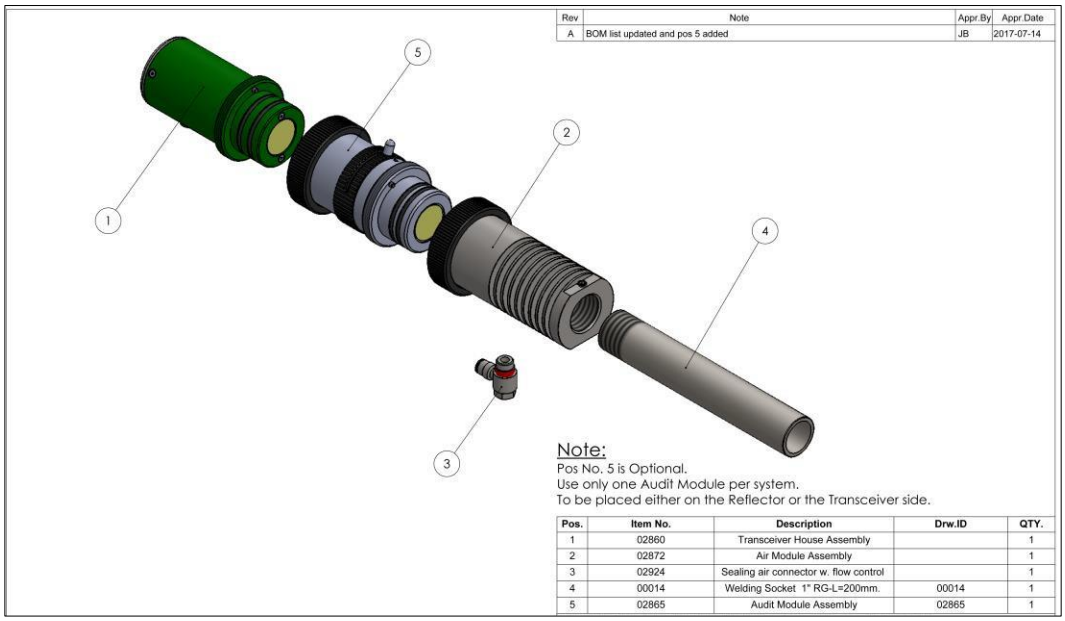


Figure 5-3: Mounting of Air Module, Audit Module (optional) and Transceiver

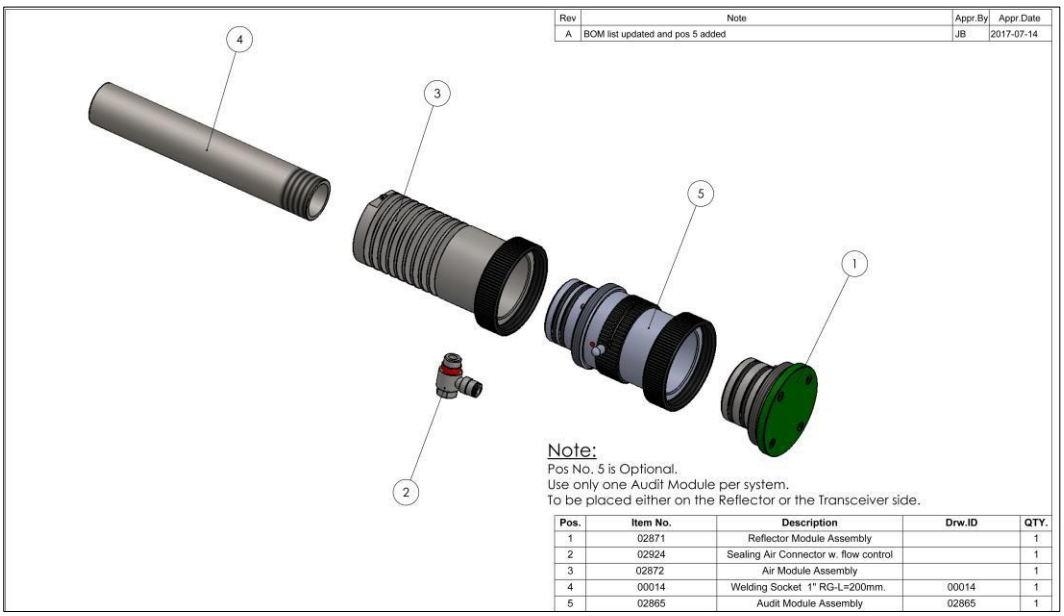


Figure 5-4: Mounting of Air Module and Reflector

5.2.5 Purge Air System

Purge air is connected via the non-return valve, air distributor, and hoses to both air modules. A sealing air kit (part no. 00031) includes the necessary parts.

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 be always used to even out variations in pressure.

As an alternative to instrument air an optional sealing air compressor can be provided (part no. 01259).

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.

We recommend the use of an optional flow meter (part no. 31022) to adjust the flow control screw at the purge air connection of the air modules. 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.

5.2.6 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 5-5.

5.2.7 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. The information of the junction box relevant for installation is provided in Figure 5-6.

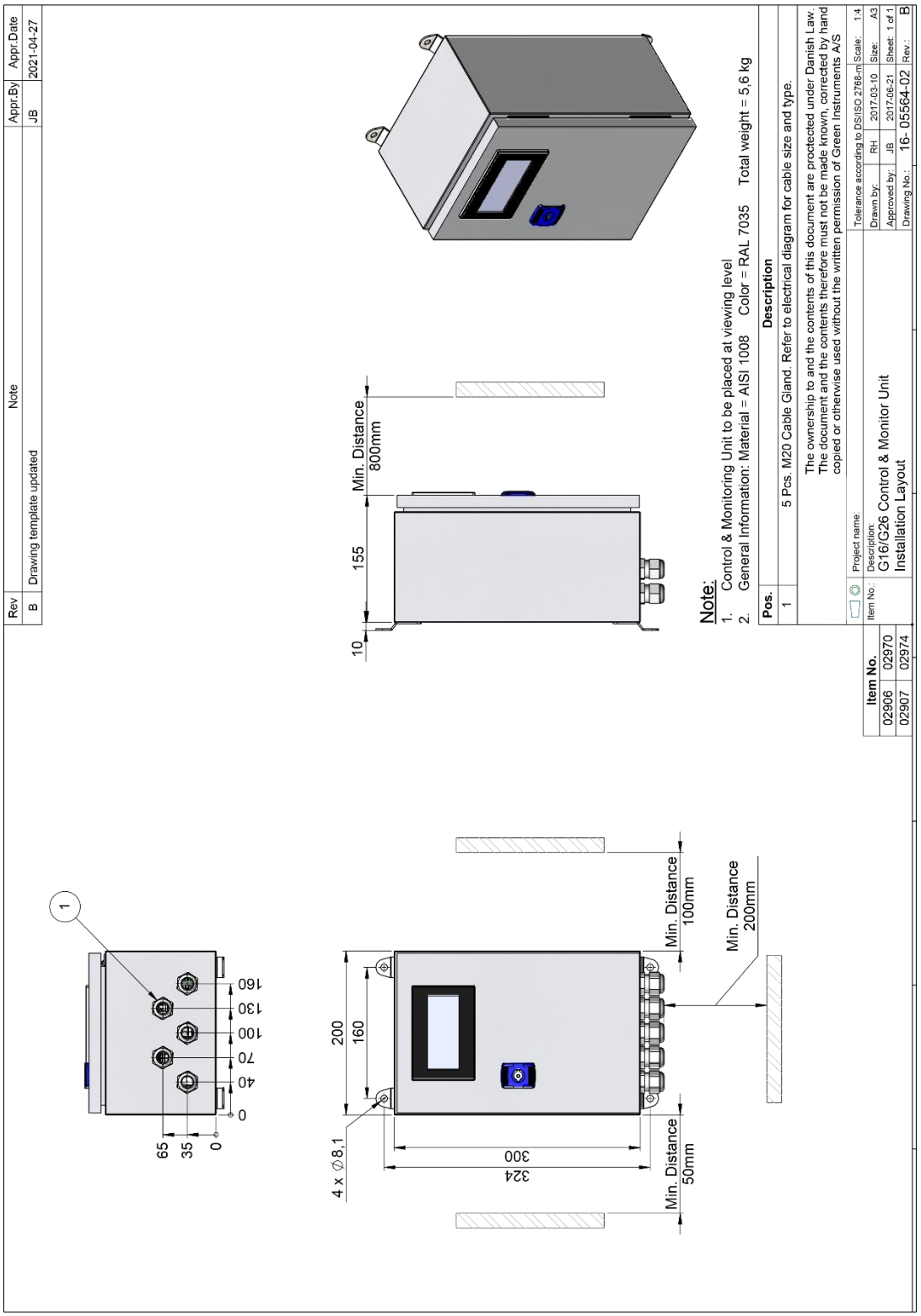


Figure 5-5: Installation of the control and monitoring unit

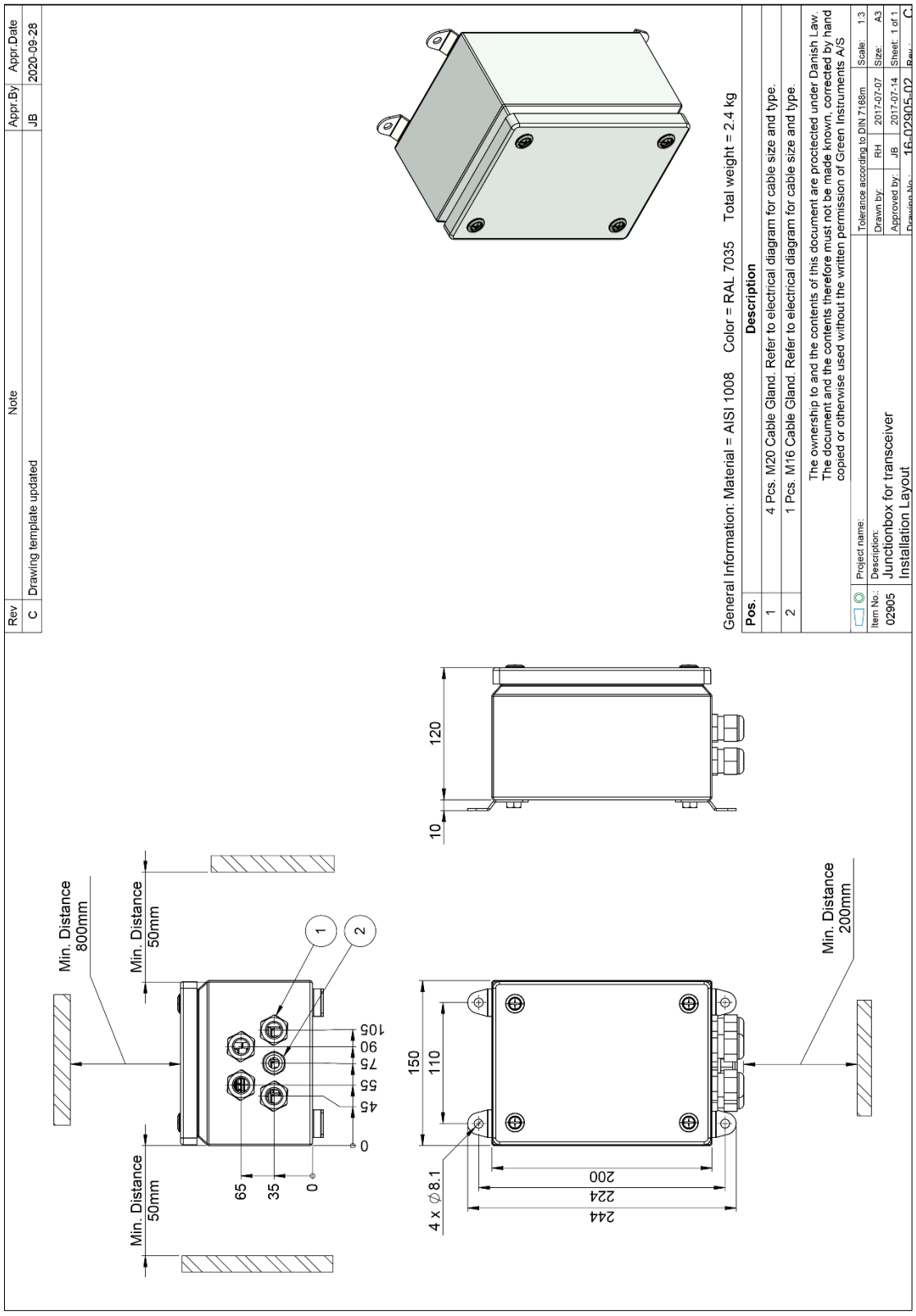


Figure 5-6: Installation of the Junction Box

5.3 Electrical Connections

5.3.1 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.

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

Please see the electrical drawings in section 10.2. The system can be prepared for functions not relevant for all installations. Only the functions to be used shall be connected.

Attention

The termination resistors 120 Ω - part no. 03261 provided with the control and monitoring unit and the optional junction box are to be installed according to the actual installation. Please refer to the electrical drawings for the details instructions.

5.3.2 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.

Please see the electrical drawings in section 10.2. The system can be prepared for functions not relevant for all installations. Only the functions to be used shall be connected.

5.3.3 Cable types

The recommended minimum cable sizes are as follows:

Power supply: 3 × 1.5 mm² shielded cable

Data cable: 2 × 1.0 mm² twisted pair shielded cable

Alarm cable: 4 × 1.0 mm² shielded cable

Analog Output 2 × 1.0 mm² twisted pair shielded cable

Network communication: Category 6e cable

6 Menu Structure & Configuration

6.1 Transceiver

6.1.1 Transceiver Button Function

Figure 6-1: Transceiver Interface

The transceiver user interface consists of a green power LED, a yellow warning LED and a red alarm LED, a zero and a span button, and 5 signal strength LEDs.

- Power: Green illuminating LED means power ON
- Warning: Yellow illuminating LED means Warning ON
- Alarm: Red illuminating LED means Alarm ON
- Signal Strength LEDs: Under normal operation, the signal strength LEDs indicate how strong the light beam is reflected back to the transceiver. When the first signal strength LED on the right illuminates, it indicates the transceiver is receiving very strong signal back, i.e. the section between the transceiver and the reflector is transparent with no obstructions to the light beam, and the transceiver lens and the reflector are clean. Please see Figure 4-2.

Figure 6-2: Illustration of strong signal, no obstructions to the light beam

- When the illumination changes to one of the LEDs on the left, it indicates that the reflecting beam becomes weaker, i.e. the beam is scattered or blocked, or the lenses become contaminated. When the illumination changes to the last LED to the left, it means the opacity level is just above the warning level. Thus, the signal strength illumination can give a quick indication on the opacity level and/or the contamination level of the transceiver lens and/or the reflector. Please see Figure 4-3.

Figure 6-3: Illustration of weak signal, obstructions to the light beam

Beside the indication of signal strength, the blue LEDs are also used for indication in connection with the initial alignment and address settings.

- Zero and Span: The Zero and Span buttons are used for calibration and initial settings of light beam strength and transceiver address. Note that during initial setting of the light beam strength, the laser light will be steady providing good access for fine alignment of the beam against the reflector

6.1.2 Set Laser Aligning Function

Attention

Once you start laser aligning function (section 6.1.2), you need to continue with setting unit address (section 6.1.3) until you save the new settings (section 6.1.4).

Visible laser radiation. When the transceiver operates in pulsed mode, the laser is classified as Class 1, which is safe under all conditions of normal use. When it operates in the continuous mode (i.e. there is a steady light beam in the aligning mode), the laser is classified as Class 3R. Thus, please avoid eye exposure to direct or scattered radiation when the transceiver operates in the continuous mode.

During laser aligning step, all possible obstructions to the light beam (such as oil mist, smoke and dust) must be absent in the section between the transceiver and the reflector.

Press and hold SPAN and ZERO buttons simultaneously and wait approximately 5 seconds until all signal strength LEDs are ON, there will be a steady light beam sending from the transceiver. Then release SPAN and ZERO, you will see one of the signal strength LED remains ON and the Alarm and/or Warning LED might be ON.

The laser beam focus point on the reflector can now be fine adjusted by the sup- port and alignment bracket. For centring the laser beam, it is recommended to re- move the reflector and place a paper or a thin cardboard over the opening. The beam will be projected onto the backside of the paper or cardboard, and the position of the beam will be clearly indicated for fine adjustment to the centre. A cut shape off centre location indicates a poor alignment (see Figure 6-4). A circular shape at centre location indicates a good alignment (see Figure 6-4).

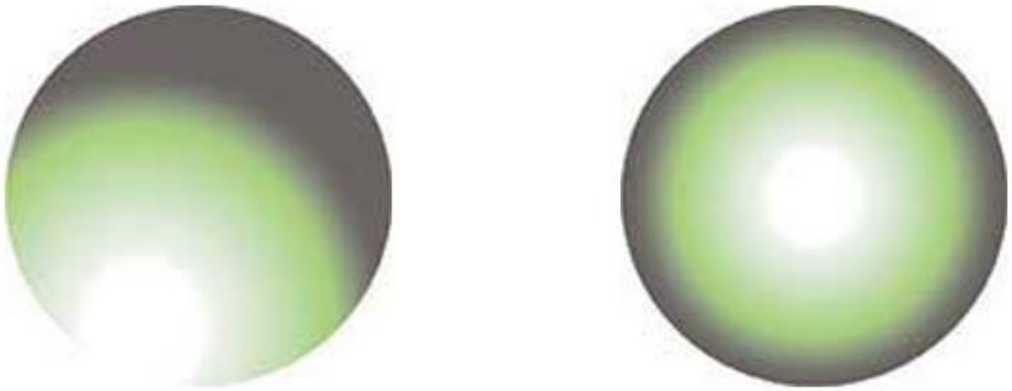


Figure 6-4: Illustration of poor and good alignment

After fine adjustment the beam to the centre of the reflector, tighten the counter nuts at the support and alignment brackets. Remove the paper or cardboard and mount the reflector back to the air module. Lock it with the ring nut. After the beam is central aligned, wait approximately 15 seconds until Alarm and/or Warn- ing LED(s) are OFF. Go to next step – set unit address.

6.1.3 Set Unit Address

Press and hold SPAN and ZERO buttons and wait approximately 5 seconds until all signal strength LEDs are ON and then release first ZERO followed by SPAN button. The unit address is now shown on the signal strength LEDs as described in Figure 6-5.

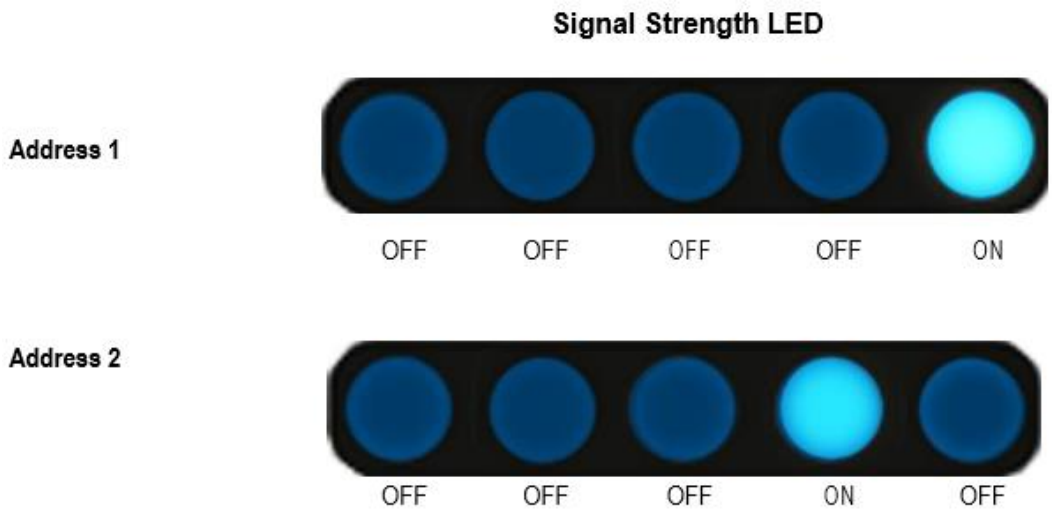


Figure 6-5: Transceiver Address Settings

Press ZERO button to change unit address to the desired one, e.g. address 1 and 2. Release ZERO button and check if the address is as wanted. When the address set- ting is correct, press and hold the SPAN button until all signal strength LEDs are ON.

All transceivers are set with address 1 at 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. Go to next step – save new settings.

Note

Unit address will always appear shortly when the transceiver is connected to power supply.

6.1.4 Save New Settings

To save the new address settings, first press and hold SPAN (see note below) and immediately after SPAN, press and hold ZERO buttons. Wait approximately 5 seconds until all signal strength LEDs are ON. Then release the buttons.

Note

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

6.1.5 Calibration

- **Zero calibration:** While there is no obstruction to the light beam, press and hold ZERO until all blue signal LEDs illuminate.
- **Automatic Span calibration:** After Zero calibration, the auto Span calibration will automatically be performed if the beam is blocked within 1 minute after Zero calibrating. The transceiver interface of an auto Span calibration shows on Figure 6-6.

Figure 6-6: The automatic Span Calibration active after Zero Calibration

Figure 6-7: Automatic Span calibration accepted

- **Span calibration:** You can carry out a manual Span calibration without Zero calibration.
- While the beam is blocked, press, and hold SPAN until all blue signal LEDs illuminate.

For calibration, please see section 7 for the full instruction of calibration.

6.2 Control and Monitoring Unit

The control and monitoring unit uses an HMI for the configuration, monitoring and visualization. The description of the menus and system configuration can be found in this section.

6.2.1 Home Menu

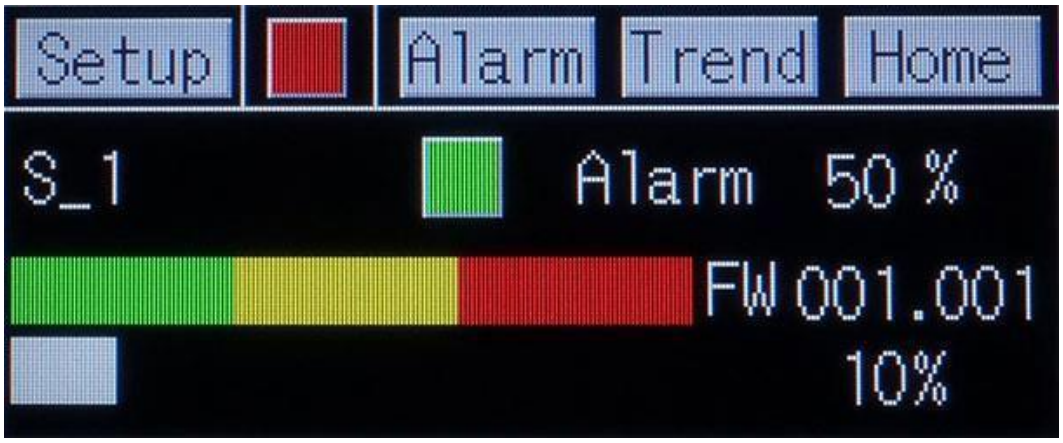


Figure 6-8: Home Menu with 1 configured sensor - Sensor menu

Home menu is the first screen when the system is turned on. The display depends on the number of transceiver/reflector units configured in the system.

If the system is configured with 1 transceiver/receiver unit, the home menu will be as shown in Figure 6-8. It will also be the sensor menu. See section 6.2.2 for more information.

Figure 6-9 shows the Home Menu with 2 configured sensors. To change the name of the sensor (e.g. from S_1 to Eng 1), please see the instruction in section 6.2.5.

Figure 6-9: Home Menu with 2 configured sensors

The light at each sensor box shows the alarm status at that sensor. Green light means no alarm and/or warning. Yellow means active warning and red means active alarm at that sensor. Black means the sensor is not configured or no data is yet received from the sensor.

6.2.2 Sensor Menu

If only one sensor is configured, the sensor menu will be the same as the home menu. If two sensors are configured, pressing the sensor name (e.g. S_1) will give the access to the sensor menu of that sensor (Figure 4-9). The sensor menu dis- plays the following information:

- Sensor name: S_1 as default setting for sensor 1 Global alarm condition (to the right of Setup):
- - Green light: No warning and alarm
- - Yellow light: Warning
- - Red light: Alarm
- Alarm condition of the selected sensor (to the right of the sensor name):
- - Green light: No warning and alarm
- - Yellow light: 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 001.001
- Current opacity level: e.g. 10%. When the current opacity level is within the green area, it means no alarm and/or warning. Yellow area means warning. Red area means alarm.

The sensor menu has also 4 functions buttons:

- Setup: to access the sensor setup menu
- Alarm: to access alarm list
- Trend: to access trend menu
- Home: to go back to the home menu

6.2.3 Alarm List Menu

By pressing Alarm on the Sensor Menu, the Alarm list menu as shown on Figure 6-10 will appear.

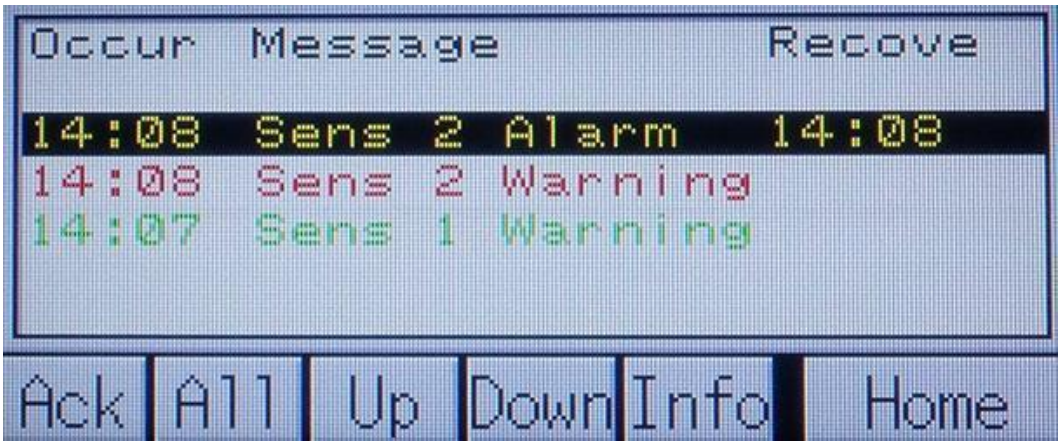


Figure 6-10: Alarm List Menu

The alarm list menu has 6 function buttons:

- Acknowledge the current selected alarm
- All: Acknowledge all alarms
- Up: Select alarm above
- Down: Select alarm below
- Info: Show info screen with description of the current selected alarm
- Home: to go back to the home menu

The red alarms mean the alarms are currently active. The green alarm means the alarm is currently active and acknowledged. When an alarm is recovered, the recovered time will be indicated at the Recove column on the screen.

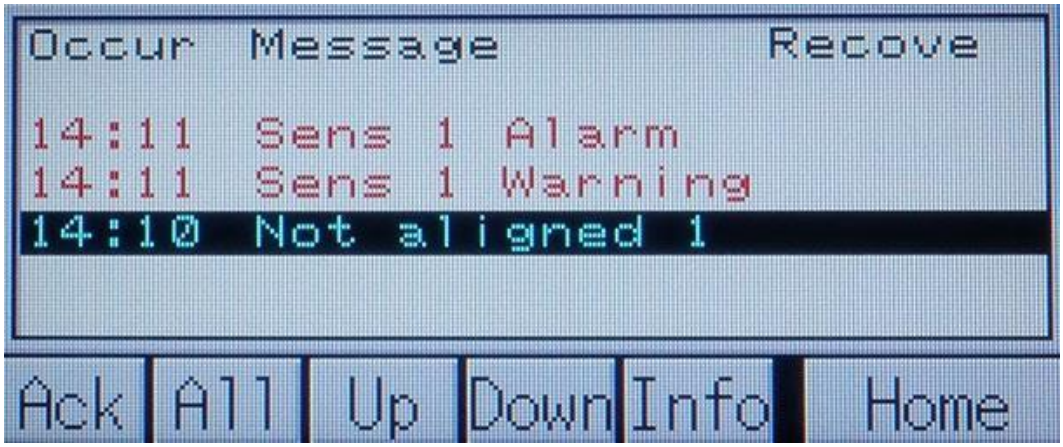


Figure 6-11: Select an Alarm in the alarm list menu

Select an alarm and press Info, an alarm info screen with information about the current selected alarm and suggestion to solve the alarm condition as shown on Figure 6-12 will appear.

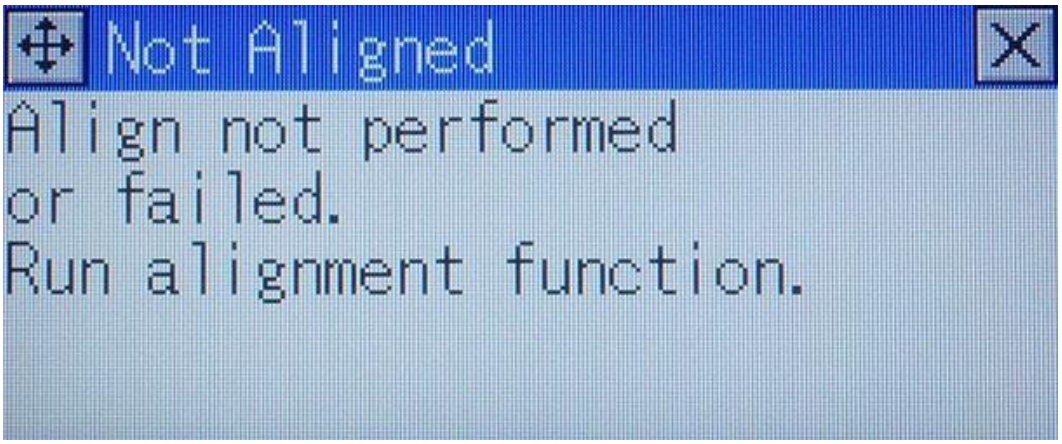


Figure 6-12: Alarm Info Screen - e.g, Not aligned Alarm

The full alarm list is as follow:

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 detect 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 reflector. Reduce distance to 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.

6.2.4 Trend Menu

Press Trend on the Sensor Menu, the opacity trends of all sensors will be dis- played Figure 6-13.

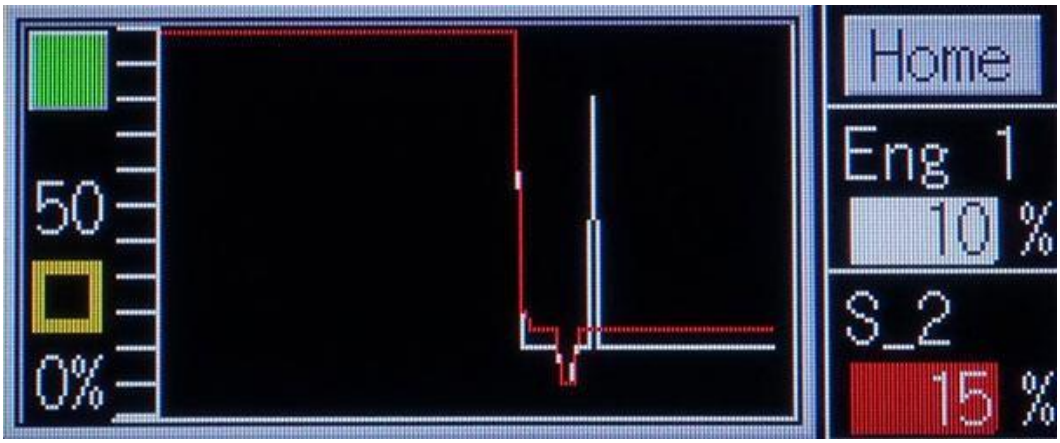


Figure 6-13: Trend Menu

The opacity values (vertical axis) are shown on a time scale (horizontal axis). The scale of vertical axis is -10% - 100% opacity. The scale of the horizontal axis is the last 30 minutes.

6.2.5 Sensor Setup

Press Setup on the Sensor Menu to access its Sensor Setup Menu.

It will require a password to enter the menu (see Figure 6-14). The password can be found on the Test and Configuration Sheet delivered to each system. Use the popup keyboard to enter the password. Choose OK by using up/down/right/left buttons on the keyboard then press ENT. The Setup Menu shown on Figure 6-15 will appear.

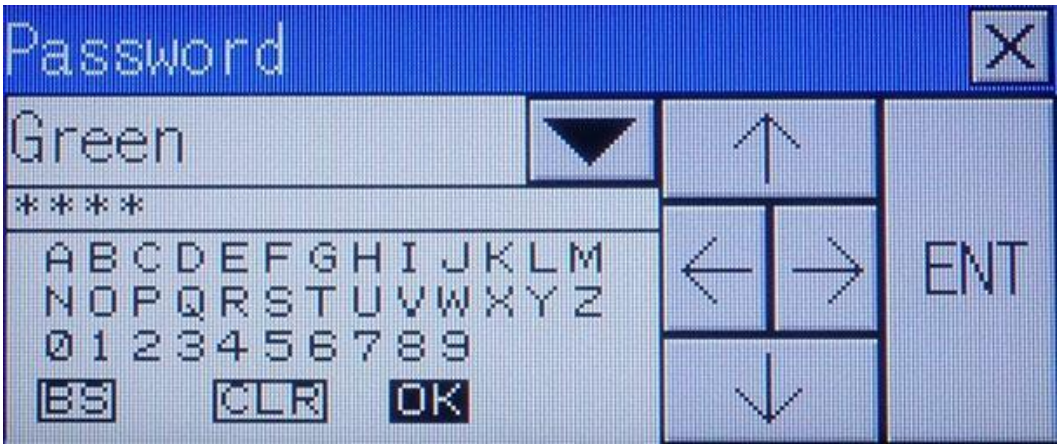


Figure 6-14: Password Popup window

The Sensor Setup Menu has two function buttons:

- System: to access the general System Setup menu
- Home: to go back to the home menu

Figure 6-15: Sensor Setup

The light on top of the screen shows the global alarm status. Green/Yellow/Red light means no alarm and/or warning/active warning/active alarm.

Besides, the following parameters of each sensor can be configured in its sensor menu:

Unit Name

The default names set up at the factory is S_1 and S_2. However, the name of each sensor can be changed if it gives more meaning for the operator, e.g. S_1 can be changed to Eng_1 (i.e. sensor 1 monitors the exhaust gas from the main en- gine), S_2 to Incr (i.e. sensor 2 monitors the exhaust gas from the incinerator).

To change the name of the unit, press on the grey box beside Unit Name, a pop-up keyboard will appear for you to enter the designed texts and numbers.

Beam path

The beam path is the distance between the transceiver and the reflector in cm. Value is currently not in use.

Alarm level

The alarm level can be freely configured upon the requirement of each applica- tion. Note that the monitor and control unit will always provide a warning which is 50% of the Alarm level. This warning can be used as lens-cleaning warning

Alarm delay

Alarm delay is the delay time in second for the alarm to be activated.

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

Thus, by setting Alarm Group for each sensor, you configure which alarm outputs are connected to that sensor.

6.2.6 System Setup

By pressing System on the Sensor Setup Menu of any sensor, the general System Setup Menu shown on Figure 6-16 will appear.

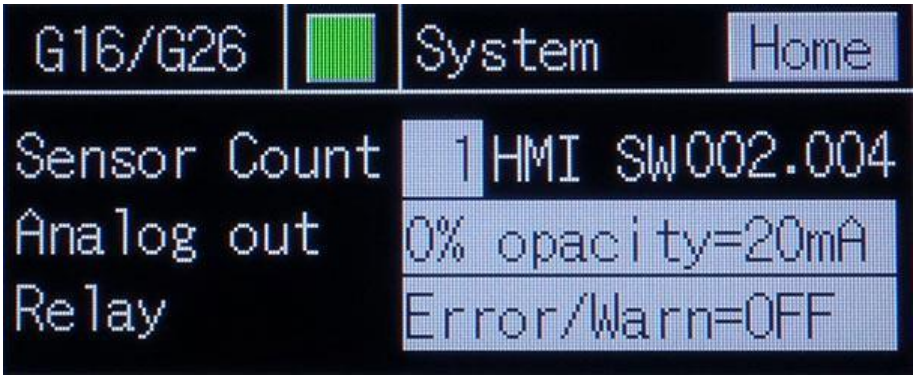


Figure 6-16: System Setup

The menu displays the software version of the control and monitoring unit. It also has Home button to go back to the home menu.

The following parameters of the system can be configured in this menu:

Sensor Count

The sensor count is the total number of the transceiver/reflector units to be con- trolled.

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 in- active = Relay not energized	Error/Warn=ON

7 Calibration

Note

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

During ZERO calibration, all possible obstructions to the light beam (such as oil mist, smoke or dust) must be absent in the section between the transceiver and the reflector.

7.1 Zero calibration

- First ensure no obstruction to the light beam
- Then press and hold ZERO until all blue signal LEDs illuminate. Release ZERO, then:

7.2 Auto Span calibration

- After Zero calibration, the auto Span calibration will automatically be performed within 1 minute if the beam is blocked. The transceiver interface of an auto Span calibration will indicate as Figure 4-7.
- Alarm and Warning LEDS becomes ON as Figure 4-8.
- After the light beam is unblocked, it will endure a few second as the Figure 4-7 before the beam becomes to the normal operation as Figure 4-2.

7.3 Span calibration

A manual Span calibration might be considered as another possibility beside an auto Span calibration. You can carry out a manual Span calibration as following

First block the light beam by either

- Unmount the transceiver and use a hand to block the beam, or
- Set the SPAN Target to the Audit Module if you have the Audit module Alarm and Warning LEDs become ON when the beam is blocked.
- Then press and hold SPAN until all blue signal LEDs illuminate.

- Release SPAN, the first signal strength LED on the left becomes ON and the Warning and Alarm LED remain ON.
- The illumination changes to the first signal strength LED on the right and the Warning and Alarm LED become OFF when
- The transceiver is mounted back to the Air Module, or The SPAN Target is removed from the audit module

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

8 Commissioning

Before starting the system for the first time after completing the installation, please check and confirm that all parts an installed correctly are installed according to the instructions, and that all the connections are secured and no leaking. Check and confirm all the electrical connections are correct according to the instructions.

8.1 Start of the system

Now you can switch on the power supply, configure, and finally align the transceiver/reflector.

Following actions should be carried out to configure each transceiver:

Align the transceiver and reflector: refer to section 6.1.2

Set unit address: refer to section 6.1.3

Save new settings: refer to section 6.1.4

8.2 Calibration

Now you can calibrate the system following the instructions in chapter 7.

8.3 Setting of Alarm Levels

Alarm level shall be set up following the requirement of each application. Please follow the instruction to configure alarm level for each transceiver in section 4.2.5 Sensor Setup.

8.4 Setting of Signal outputs

Signal outputs (analog and digital) shall be set up following the requirement of each application. Please follow the instruction to configure signal output for the system in section 6.2.6 System Setup

9 Maintenance

Besides normal cleaning of the lenses, the system does not require any maintenance. Please follow the instruction to clean the lenses in section 9.1 maintenance instruction.

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, there is a risk that the exhaust gas will come out from the transceiver/reflector unit's holes.

We recommend that the purge air system is turned on while you are cleaning the transceiver and the reflector.

For cleaning the transceiver's lens or reflector, please do the following steps:

- Loose the ring nut and pull either the transceiver or the reflector toward your- self.
- Clean the transceiver's lens/reflector with the cleaning pad (part no. 02398).
- Plug the transceiver and the reflector back onto the air module/audit module. See section 5.2.3 for detailed instructions.
- It is strongly recommended to calibrate the system after cleaning (see chapter 7). However, exhaust gas (smoke/dust/mist) must not be present in the section between the optic heads during calibration, i.e. the process to be monitored must be turned off.

Cleaning intervals depend on the amount of soot particles that contaminate the lenses. The accumulation of dirt on the lenses will result in higher opacity readings and might therefore give false alarms. Please make sure to set sufficiently cleaning intervals.

10 Troubleshooting

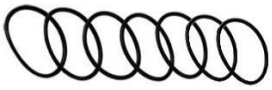
Trouble shooting should always be carried out by trained and certified personnel. The G16 Smoke Density Monitor is connected to hazardous electric voltages, which can cause personal injury if not handled correctly.

Trouble	Possible Cause →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 im- pact) →realign the transceiver and the reflector – this can be checked by removing the lenses and looking through the duct. Lens contaminated with dirt →clean lenses (using a cleaning pad part no. 02398). The transceiver might have been damaged →replace transceiver- er Zero and/or span have drifted →recalibrate. Scanning range out of range →Please see the system specification
Incorrect alarm level	Incorrect alarm level settings →change at the control and monitoring Unit (see section 4.2.5).
No alarm despite opacity between the lenses	Incorrect alarm level settings → change at the control and monitoring Unit (see section 4.2.5). Damaged/faulty parts →replace the respective part.
False alarm	Opacity is not only caused by smoke but also by dust and mist.

11 Spare Parts

Spare parts are not included in the standard delivery. Spare parts can be ordered when necessary. When ordering spare parts, please mention the serial number of the equipment, which you can find on the label of the equipment.

Part No.	Part Description	The specific appearance of the parts list is sub- ject change without notice; the function however will not change
00286	Welding socket 1” x 200 mm	
00031	Sealing air kit incl.: purge air hose 9m (part no.00027) purge air distributor (part no. 00525)	
00027	Purge air hose – 10/8 mm (ordered per meter)	
00525	Purge air distributor	
02924	Sealing air with flow control	
02872	Air Module Assembly	
02820	Ring Nut	
02860	G16 Transceiver House Assembly	

Part No.	Part Description	The specific appearance of the parts list is sub- ject change without notice; the function however will not change
02871	G16 Reflector Module Assembly	
02906	G16 Control & Monitoring Unit - 24 VDC	
02970	G16 Control & Monitoring Unit - 110-240 VAC	
02905	Junction box	
02939	Cable with multi-connector length 2m	
03163	Cable with multi-connector length 15m	
00493	Fuse (pkg of 10 pcs)	
03195	O-ring kit (6 pcs)	
03261	Termination register	
02891	G16 Smoke Density Monitor Instruction Manual	

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