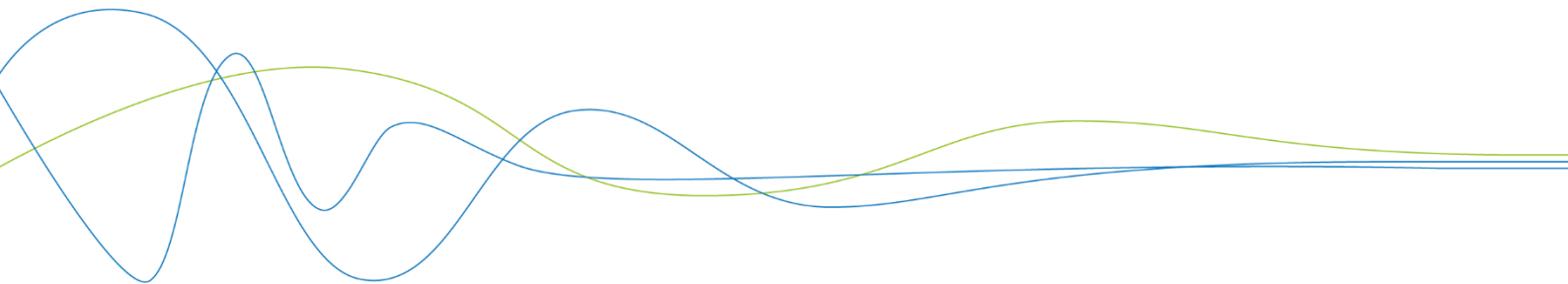




STACK 602

USER MANUAL



STACK 602

Particulate Measurement System

USER MANUAL

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1. Introduction

1.1 Purpose of this Manual

This manual contains all information necessary for the correct installation, setup, operation, and maintenance of the instrument. The procedures given in this manual must be carried out only by suitably trained and qualified personnel.

1.2 Product Safety

The following symbols are used throughout this manual to indicate procedures that, if not followed correctly, may result in personal injury or damage to the equipment.



WARNING!

Alerts the user to a procedure or practice that can result in personal injury or injury of others if not followed correctly.



CAUTION!

Alerts the user to a procedure or practice that can damage the system or ancillary equipment if not followed correctly.

NOTES are used to highlight important information that assists the user in carrying out a procedure or understanding the text.

In addition, the following symbols are used on the product:



WARNING! – ELECTRIC SHOCK



Protective Earth (GND) symbol

1.2.1 Danger from Process

The sensor may be installed in ducting that contains process particulate (and other flue gas constituents) hazardous to health.

This may take one or more of the following forms:

- Particulate which is flammable or explosive
- Particulate which is toxic or in some other way hazardous to health
- Particulate contained within high-temperature gas.

Take Precautionary Measures

Unless the process conditions are known to be entirely safe, suitable precautions, such as the use of breathing apparatus or duct purging/ detoxifying, must be employed before entry is made into the duct for installation or maintenance purposes. If in doubt, consult your local Safety Officer and/or local safety procedures.

1.3 Safety Procedures

Always observe the following safety precautions. Personnel installing, operating, or maintaining the equipment are responsible for their personal safety and the correct handling and use of the equipment in accordance with the safety procedures detailed in this manual.

Follow all warnings and instructions marked on the product and in this manual. These safety instructions must be followed to avoid possible personal injury, injury to others, and damage to the product.

If the equipment is used in a manner not specified in this manual, the protection provided by the equipment may be impaired. Retain these instructions in a safe and known place for future use.



WARNING!

Risk of personal injury or injury to others. All personnel must be fully trained and adhere to local and, where applicable, site-specific health and safety laws and guidelines. – *It is the responsibility of the local organisations to enforce safe working practices at all times.*



WARNING! – ELECTRIC SHOCK

Only connect to an earthed supply. The control unit is a Class 1 construction and must be connected to a protective earth connection (GND).



WARNING! – ELECTRIC SHOCK

This product must be connected to a power supply of the same voltage (V) and frequency (Hz) as indicated on the product rating plate and provided in the **Technical Data** section of this manual.

A supply cable with an adequate rating must be used. Temperature de-rating must be considered.



CAUTION!

Position the equipment to avoid excessive heat, vibration, humidity, and dust.



CAUTION!

Failure to service or maintain the product, fitting non-approved parts or carrying out non-approved alterations or servicing can be dangerous and could affect the product's safety. It may also invalidate the terms and conditions of the product warranty.

1.4 Intended Use

The STACK 602 particulate measurement sensor with *DynamicOpacity*[®] technology is suitable for measurement in non-condensing applications, such as electrostatic precipitators (ESPs), boilers, calciners, and large-diameter emission stacks where dust levels are typically above 10 mg/m³ (and up to 1,000 mg/m³), including processes that reach temperatures up to 600 °C (1,112 °F).

Limits of Use

To achieve optimum performance and safe operation, the equipment must be operated within the limits detailed in the **Technical Data** section of this manual. Operation outside these limits can result in damage to the equipment or failure to achieve the performance specified.

1.5 Additional Information

1.5.1 Product Serial Numbers

The serial number label can be found on the side of the sensor/control unit enclosure. The serial number on the instrument should match that on the Test Record Card, which is included with the product documentation.

1.5.2 List of Abbreviations

The following abbreviations and terms are used in this manual:

Abbreviation	Meaning
AIM	Auxiliary Input Module*
AOM	Analogue Output Module*
ESP	Electrostatic precipitator
l/min	Litres per minute (air purge flow rate)
OD	Outer diameter
PSU Repeater	Power supply unit*
ROM	Relay Output Module*
Rx	Receiver (sensor head)
Tx	Transmitter (sensor head)

*ENVEA net module (see **System Options** on page 16).

1.5.3 Related Documentation

The following literature may be consulted in conjunction with this manual as applicable. A *Reference Library* with supporting information for your instrument is included with the product documentation.

Included in the Reference Library

- ProController (Control Unit) User Manual (Publication Part Number (PPN): 492027)
- Standard Controller - Control Unit Manual (PPN: PC-000841-MA)
- Installation of Network Devices- User Manual (PPN: 492501)
- TN007 Network Cable Lengths (PPN: 491033)
- TN052 Air Purge Guide for *DynamicOpacity*® Sensors (PPN: 491022)
- PC-ME DUST TOOLS Quick Start Guide (PPN: 494003)

1.5.4 Product Parts and Options

For details of product options, software, accessories, and spares for your instrument or system, consult the STAC 602 datasheet and order information available on request and from the ENVEA website (see a reverse of this manual).

1.6 Certification

1.6.1 Conformance and related Standards

ENVEA UK Ltd hereby declares that this instrument – within the limits specified in this manual – conforms to the essential requirements and other provisions of the pursuant of the following:

1. European Union Directives: Low Voltage and EMC.
2. UK Regulation 2016: Low Voltage and EMC.

For details, refer to the relevant Declaration of Conformity (DoC) for this instrument or system supplied with your order.

2. Technical Data

2.1 Process and Application Conditions

Stack temperature range	-20 °C to 250 °C (-20 °F to 482 °F) Option: up to 600 °C (1,112 °F)
Stack diameter	Ø 1–15 m (3–50 ft., nom.)
Sensor – Key data	
Dust level response^A	<10–1000 mg/m ³
Certification range	0–150 mg/m ³ (TUV)
Response time^B	2 seconds
Environmental information	
Application conditions	Suitable for measurement in non-condensing flue gases. Note: not recommended for deployment in applications with water droplets or mist at monitoring point.
Inspection frequency	Every 6 months (see page 49)

2.2 Sensor Specification

STACK 602 Sensor		
Sensor variants	Standard sensor (Tx/Rx): 0–250 °C (up to 482 °F) High-temperature option: 0–600 °C (up to 1,112 °F)	
Enclosure	temperature range	-20 °C to +50 °C (-4°F to 122°F), ambient
	dimensions	W 147 x H 192 x D 106 mm (5.8 x 7.6 x 4.2") ^C
	protection rating	IP65
	material	Die-cast aluminium LM6M (epoxy coated)
Sensor body material	316 Stainless steel	
Weight	1.5 kg (3.3 lb) per sensor head	
Power requirements	24V DC (via control unit or network spur)	
Current consumption	170 mA	
Local outputs	RS-485 connection (to control unit)	

^A Application dependent

^B Sensor response to changes in dust concentration.

^C Excludes cable glands and hinges.

<p>Cable entries</p>	<p>Transmitter (Tx): 1x M20 cable glands Receiver (Rx): 3x M20 cable glands</p>
<p>Air purge requirements</p>	<p>Application dependent. (Recommended for positive pressure stacks or high dust loadings.) Requires optional air purge fitting and an external supply of 30–60 l/min of dry, clean (oil-free) instrument air.</p>

2.2.1 Dimensioned Drawings – Sensor Heads (Tx, Rx)

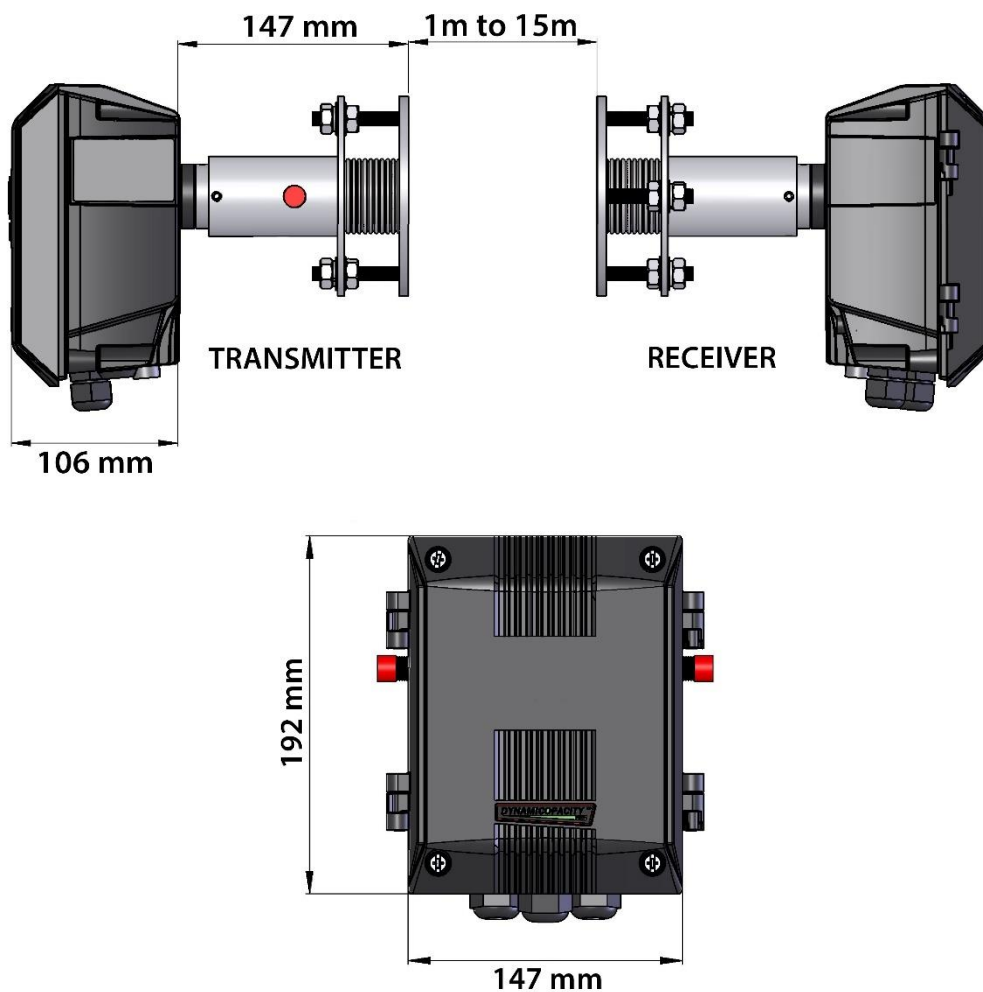


Figure 1: Dimensional drawing of STACK 602 sensor.

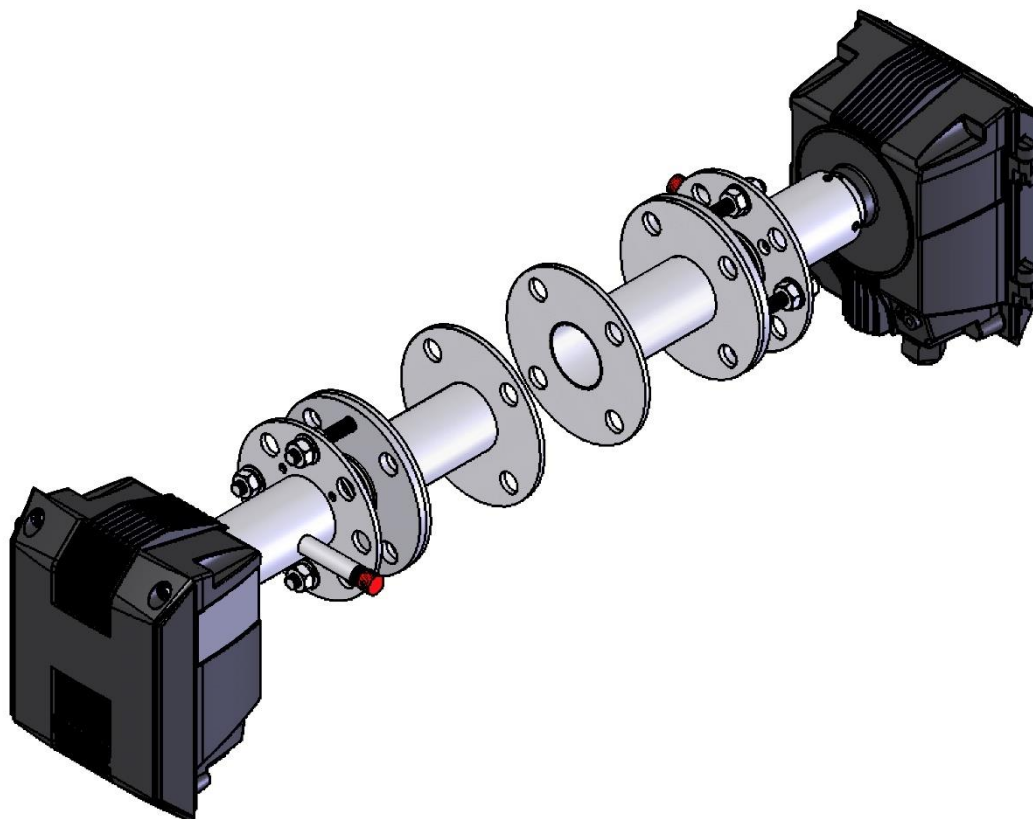


Figure 2: STACK 602 with 100 mm (4") mounting stubs for high-temperature applications.

2.2.2 Quality Assurance and Control

Zero and Span Checks	Automatic and on demand Frequency: alternating every hour (on a 2-hour cycle)
-----------------------------	--

2.2.3 Sensor Options

Purge air options	<ul style="list-style-type: none"> ▪ Small Purge Blower (ACCAIR-B-Y) ▪ Air Filter Regulator ▪ Advanced Filter Regulator with flow control ▪ Air Filter Regulator with automatic flow control
Air purge fittings	1/4" fitting
Stack connections (flanges)	<ul style="list-style-type: none"> ▪ 1 1/2" 150lb ANSI ▪ DN40 PN6
Additional mounting options	<ul style="list-style-type: none"> ▪ Stack mounting stubs (pair, 100 mm/4") ▪ High-temperature standoffs (pair, 100 mm/4")^D ▪ Anti-fouling fittings (pair)

^D Required for high-temperature applications (refer to the drawing on page **Error! Bookmark not defined.** above).

Hazardous zone classification	<i>not available for this product</i>
--------------------------------------	---------------------------------------

2.3 System Options

Control Unit	<ul style="list-style-type: none"> ▪ Standard Module (for single-channel systems) ▪ ProController (for up to 32 sensors/channels)
Network Modules (for use with ENVEA control units only)	
Analogue Output Module (AOM)	8x 4-20mA (500Ω)
Auxiliary Input Module (AIM)	4x 4-20mA inputs or 4x Digital inputs
Network Spur	Divides a Modbus (RS-485) cable into two branches.
PSU Repeater	Provides power supply unit for voltage and signal boost for extended cabling runs with multiple sensors.
Relay Output Module (ROM)	8x Relays (1A @ 250V), user configurable

2.4 Cabling

All cabling should be rated for use up to at least +65 °C (149 °F) to allow for an ambient temperature of up to +50 °C (122 °F). For information on sensor cabling requirements and considerations, consult TN007 Network Cable Lengths (see **Related Documentation** on page 11).

Maximum cable lengths	<ul style="list-style-type: none"> ▪ RS-232: max. 15 m (50 ft.) ▪ RS-485: max. 1,000 m (3,280 ft.) <p><i>ProController only –</i></p> <ul style="list-style-type: none"> ▪ Ethernet (RJ45): up to 100 m (328 ft.) between active devices ▪ USB 2.0, type A: max. 2 m (6½ ft.)
------------------------------	---

2.4.1 Data Cable Specifications

The minimum requirements for sensor cabling are outlined in the following table. Cables supplied by ENVEA meet these requirements.

Sensor-to-Controller Cable

Cable type	4-core (2-pair) cable
Conductor size	Ø0.5 mm ² (16/0.2)
Current rating	1A r.m.s (per core), max.
Working voltage	440V r.m.s, max.
Cable shielding	Flame-retardant PVC outer sheath (Ø7.9 mm/0.3 in.), with overall tinned copper, braided, or foil screen.
Resistance	<40Ω/km (12.192 Ω/kft), recommended for long cable runs
Compliance	BS5308 part 2, type 1

ENVEA part no.	CAB004 (10 m/33 ft. supplied as standard)
-----------------------	---

Transmitter-to-Receiver Cable

Cable type	8-core, 7 strands (Ø 6.3 mm overall)
Conductor size	Ø 0.22 mm ²
Current rating	max. 1A r.m.s (per core)
Working voltage	max. 440V r.m.s
Cable shielding	PVC (sheath) with overall copper-braided screen
Resistance	92 Ω/km (28.042 Ω/kft)
Compliance	Defence standard 61.12, Part 4
ENVEA part no.	CAB008 (10 m/33 ft. supplied as standard)

2.5 PC Software Suite (PC-ME DUST TOOLS)

The minimum system specification (for desktop and laptop PCs) is set out in the below table. For information on hardware requirements, consult the PC-ME DUST TOOLS user manual (see **Related Documentation** on page **11** for details).

Operating system	Windows XP or higher
System memory	32 Mb RAM 20 Mb free hard disk space
Monitor	1024 x 768, high-colour graphics
Data communications	Serial port (for connection to one or more instruments) <i>ProController only</i> – <ul style="list-style-type: none"> ▪ Ethernet (RJ45; via Modbus TCP) ▪ USB 2.0 cable, standard type A-to-A, M:M
Optical disc drive (DVD/CD)	PC-ME DUST TOOLS is supplied on a software CD and is also available for download from the ENVEA website (www.envea.global/s/process-en/dahs-software/pc-me-dust-tools/).

3. Product Description

3.1 System Overview

The STACK 602 particulate monitoring system is a Modbus-based, cross-stack optical measuring system that uses a dynamic sensing technique to measure the rate of change of light using *DynamicOpacity*[®] ratiometric opacity technology as particulates pass through a modulated light beam. This proven optical technique, coupled with advanced design features, provides reliability and resolution advantages over traditional opacity monitors.

The STACK 602 is designed to be compliant with TUV approved standards. The instrument is comparable and has the identical quality of measurement to its predecessor, the SC600T, which achieved both TUV QAL1 and MCERTS approvals.

3.1.1 Sensor – *DynamicOpacity*[®] Transmitter/Receiver

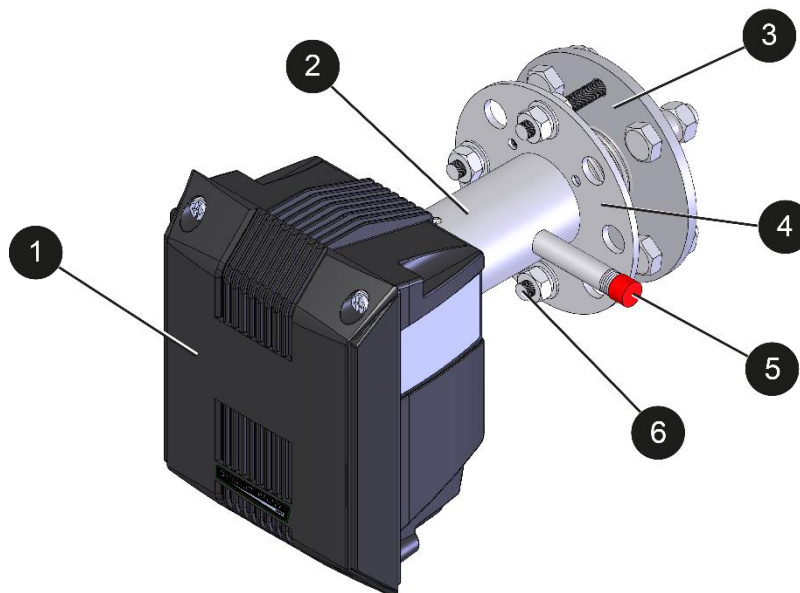


Figure 3: STACK 602 – *DynamicOpacity*[®] Transceiver/Receiver.

- 1 Sensor enclosure (with hinged lid)
- 2 Flanged sensor body (with air purge inlet)
- 3 Alignment aid (fixed)
- 4 Flange
- 5 Air purge inlet (with diffuser connector)
- 6 Alignment bolts (3 off)

The sensor heads (Transmitter and Receiver) use *DynamicOpacity*[®] technology, therefore requiring less maintenance and servicing time than standard opacity instruments. Dynamic Opacity ('Dust') mode means the STACK 602 uses a ratiometric measurement method with the significant advantage that this ratio is unaffected by lens contamination. This allows the instrument to operate even if the lens contamination exceeds 90%. Air purges should be connected to the sensor heads to provide a positive displacement of air away from the lens surfaces.

Automatic Self-Checks

The instrument has automatic opacity Zero and Span checks (the latter simulating and therefore, effectively checking for contamination). The automatic self-checks monitor the integrity of the instrument daily. These checks simulate the operation of the instrument and permit any internal instrument problems to be self-detected.

3.1.2 Control Unit

Two types of control units are available: the Standard Controller for a standard, single-channel system and the Ethernet-capable ProController for PRO systems, which provides up to 32 sensor channels via industry-standard Modbus.

The control units feature advanced graphical user interface (UI) screens and, with a raised multi-colour alarm (status) LED and intuitive user controls, allow the sensor heads to be set up quickly. As standard, they comprise alarm relays and 4-20mA outputs, alarm logging, and supply 24V DC power to the sensor.

3.2 Principle of Operation

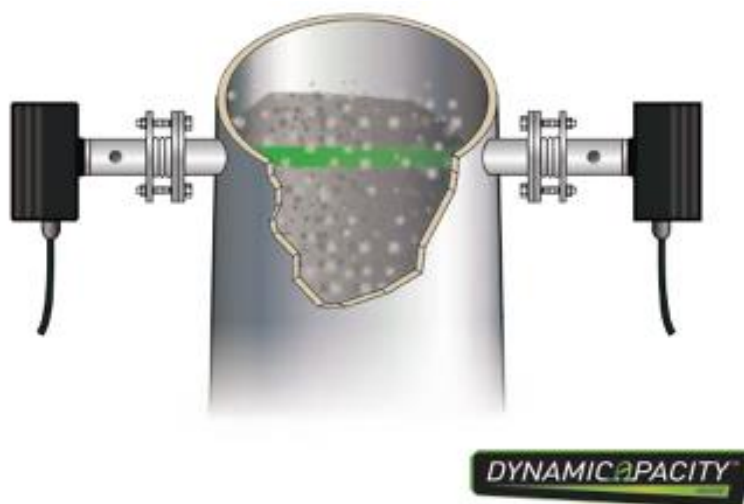


Figure 4: Principle of Operation – *DynamicOpacity*[®] sensors.

The STACK 602 measures the effect of particles on a light beam transmitted across the stack. The instrument measures the ratio of the temporal variation in intensity, unlike traditional opacity instruments, which simply measure the beam intensity. The variation in intensity derives from variations in the distribution of particles in the flue gas stream. A linear relationship between instrument output and dust concentration has been demonstrated in third-party, independent approvals, such as TUV. This permits the instrument to be calibrated in mg/m^3 by comparison to the standard reference method (SRM) of isokinetic sampling (refer to ISO 9096) for specific applications, such as fixed-load power plants and electrostatic precipitator (ESP) applications. The STACK 602 measures dust using dynamic opacity mode and provides concentration (mg/m^3) outputs.

What is Dynamic Opacity?

DynamicOpacity[®] technology measures the amount of variation in the light reaching the Receiver as a proportion of the total received light.

$$\text{dynamic opacity} = \text{light variation} / \text{total light intensity}$$

The advantage of dynamic opacity is that it is less affected by window contamination (accurate up to 90% window contamination). Window contamination will reduce the total light intensity showing up as an artificial opacity reading. However, the light variation due to dust moving in the stack should decrease by a similar amount, so the dynamic opacity ratio is unaffected.

4. Unpacking and Preparation

4.1 Unpacking and Inspection

Carefully unpack the units and retain the packaging to return equipment for servicing or repair. If the equipment is damaged in any way, return it to ENVEA or your local ENVEA representative (for more information, see the reverse of this manual) in its original packaging.

No responsibility for damage arising from the use of non-approved packaging will be accepted.

NOTE: Ensure that all items and accessories specified in the order information are present. If not, contact ENVEA or your local ENVEA representative.

4.2 Network Layouts

For more information on layouts and connection options, refer to the relevant control unit manual. For more information on network modules, refer to **System Options** on page 16. For overview and wiring diagrams, see **Related Documentation** on page 11.

Standard Systems

Connect a single sensor to the Standard Controller for a standard, single-channel system. For more information, refer to the relevant control unit manual (see page 11).

PRO Systems

Connect multiple sensors to the ProController either using network spurs or by daisy-chaining. For more information, refer to the relevant control unit manual (see page 11).

For medium to large systems, it is best to place the control unit(s) in the centre of the network to minimise voltage drop along cable runs. You may need to boost power using a PSU Repeater (see section 2.3 on page 16 for details).

4.3 Prerequisites and Guidelines

4.3.1 Location Requirements

When selecting a mounting location for the sensor, the following should be considered for optimum performance:

1. Mount in the longest, straightest, unrestricted duct available.
2. Ensure correct sensor grounding (see the section below).
3. Excess vibration will affect sensor readings. Avoid excessive vibration.
4. Ambient or radiating temperatures in the vicinity of the mounting location must not exceed +50 °C (122 °F).

For more information, refer to the general Installation Notes TN004 (see **Related Documentation** on page 11).

4.3.2 Cabling and Cable Routing

The cables between the sensor and net modules and control unit are of the same type (these comprise four cores with an overall screen). Sensor data cables are supplied as standard (see section 2.4.1 on page 16 for details).

For more information on available network modules, see **System Options** on page 16 and refer to the **Related Documentation** on page 11.

Guidelines for Routing Cables

1. Ensure the cable sheath fully penetrates the cable entry gland on the sensor.
2. Fit blanking plugs to unused cable entry glands.
3. Ensure cable entry glands are securely tightened to the cable.
4. Support cables at appropriate intervals.
5. Do NOT route cables where they may be at risk from lightning strikes (for example, overexposed roofs).
6. Leave sufficient length so the sensor can be removed from the stack/duct and laid on the ground or platform without disconnecting.

4.3.3 Grounding the Sensor

The sensor heads are electrically grounded to the ductwork by the mechanical connection made between each sensor and the socket/flange, and also by a grounding strap (supplied). Ensure the installation complies with the following guidelines:

- The sensor may only be fitted to a metal duct or stack. If the stack is not metallic or you are concerned that the stack may not provide a suitably earthed shield for the sensor, please contact ENVEA.
- It is recommended to use the grounding strap (or earth wire) to ensure the sensor body is firmly grounded to the metallic stack wall.

4.4 Supplying Purge Air – Purge Blower Unit

4.4.1 Mounting the Blower



WARNING! – ELECTRIC SHOCK

Only connect to an earthed supply. This unit is a Class 1 construction and must be connected to a Protective Earth connection (GND).



WARNING! – ELECTRIC SHOCK

This product must be connected to a power supply of the same voltage (V) and frequency (Hz) as indicated on the product rating plate and provided in the **Technical Data** section of the relevant product manual.



WARNING! – ELECTRIC SHOCK

Do NOT reverse Live (L) and Neutral (N)!

The Neutral line is not fused.^E



WARNING! – ELECTRIC SHOCK

Ensure that the mains isolator is clearly marked and easily accessible (within a 2m / 6½ft. radius) to allow the equipment to be switched OFF.



CAUTION!

The small purge air blower is supplied with 10 m (33 ft.) flexible tubing.

Do NOT add any additional restrictions to the tubing, as this will reduce the air supply to the sensor heads.



CAUTION!

Ensure the enclosure lid of the purge blower is tightened fully (using ¼ - turn screws). This ensures the filter can operate fully to keep the air clean.

The small purge blower is designed to be wall-mounted with the air purge and power connections pointing downwards (see items 4 and 6, **Figure 5** below). Four mounting feet are supplied to enable easy fitting. Two 10m lengths of flexible blower hose are supplied as standard. Using the Y-splitter with ¼" BSP connections, the hoses attach directly to provide purge air to both the Tx and Rx. Ensure that the distance from the purge blower to the Tx/Rx is less than 10m to allow easy connection.

NOTE: Ensure the sensor heads can be removed from the stack and put on the ground or platform without disconnecting the flexible hoses or cabling.

The filter is a replaceable part. To remove the filter, slacken the screw on the filter bracket (see item 9, **Figure 5** below). For more information and technical data, consult the small blower unit manual (see page **11**).

^E All colour references are based on the standard ENVEA cables supplied.

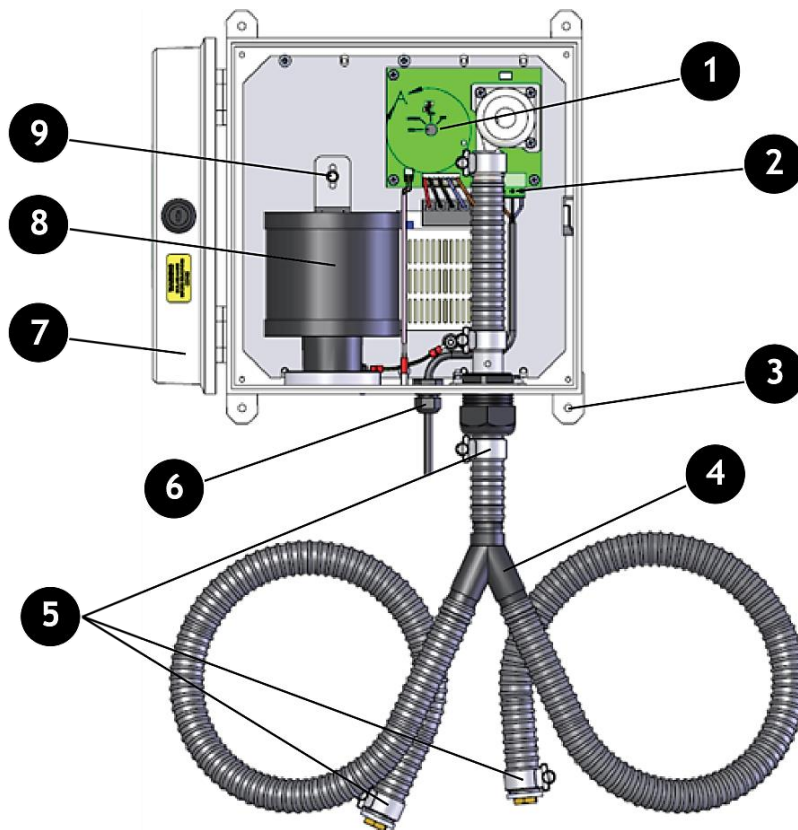


Figure 5: Wall-mounted Blower Unit (ACCAIR-B-Y).

- 1 Speed selection switch
- 2.....Mains power connector
- 3 Mounting feet/holes (4 off)
- 4Y-splitter piece (incl. 2x 10m flexible hoses)
- 5 Hose clips (2x to the sensor, 1x to blower w/ lock nut)
- 6M16 gland (for the mains power cable)
- 7 Hinged lid, lockable
- 8 Filter
- 9 Filter bracket (with screw)

4.4.2 Connecting the Purge Blower

1. Referring to **Figure 5** above, connect the purge blower to the sensor head by connecting the supplied straight tubing section (2x 72 mm/2.8”) to the air purge inlet on each of the sensor enclosures.
2. Referring to **Figure 6** below, connect the purge blower to the 3.15A mains isolation switch, then feed the cable through the gland at the bottom of the purge blower [6] and wire it to the power supply terminal block as shown.

Mains pin connections (L-R)		Wire colour*
N	Neutral	Blue
PE	Protective Earth (GND)	Green-Yellow
L	Live	Brown

**All colour references are based on the standard ENVEA cables supplied.*

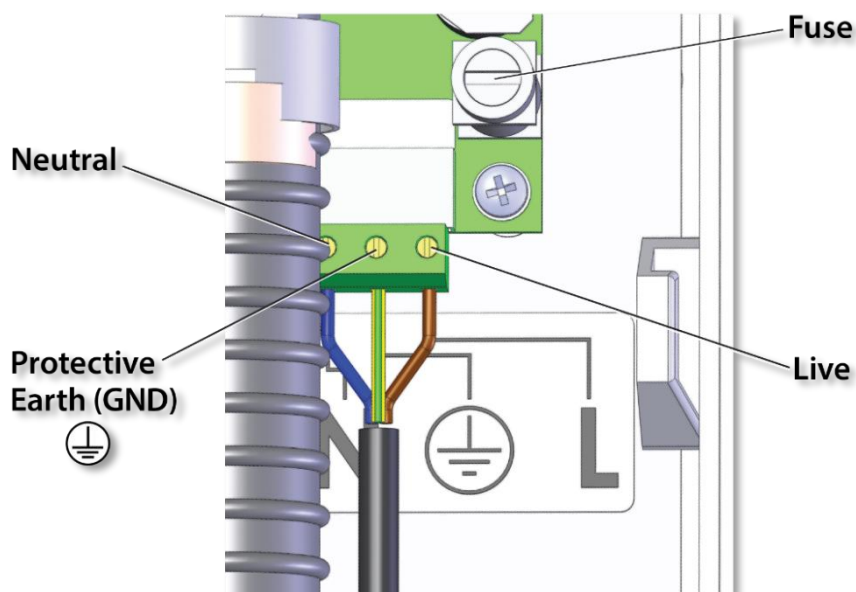


Figure 6: Purge blower wiring.

4.4.3 Adjusting the Speed

The small purge blower unit has three speed settings: HIGH, MEDIUM, and LOW. The typical amount of purge air required for *DynamicOpacity*[®] sensors is between 30 and 60 l/min under normal stack conditions (typically ± 10 mbarg) to both the Transmitter and Receiver.

This can be achieved by setting the switch selection to **HIGH** (Figure 7). The required speed is pre-set *ex-works*.

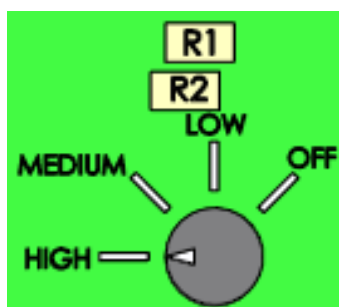


Figure 7: Speed selection for *DynamicOpacity*[®] sensors.

5. Sensor Installation

5.1 Safety Information



WARNING! – DANGER FROM PROCESS

It is possible that the sensors are to be installed in ducting containing process particulate that is hazardous to health.

Unless the process conditions are known to be entirely safe, suitable precautions such as the use of breathing apparatus or duct purging/detoxifying must be employed before any entry is made into the duct for installation or maintenance purposes.

If in doubt, consult the local Safety Officer and/or local or site-specific safety procedures.



CAUTION!

Do NOT try to rotate or adjust the sensor by twisting its enclosure, as this can damage the sensor.



CAUTION!

Non-metallic parts may be cleaned with a dry or lightly dampened cloth only. Do NOT use solvents or abrasives as this may damage the surfaces.

5.2 Mounting the Sensor

5.2.1 Transmitter and Receiver Heads

The Transmitter and Receiver heads are mounted on opposite sides of the stack, such that the light beam emitted by the Transmitter enters the Receiver. The sensor heads mount to the stack via a standard 1½"150lb ANSI flange.

Both sensor heads are fitted with an alignment aid to allow adjustment of the beam direction. The sensor heads are also fitted with an air purge with air filtration, see **Figure 8** below).

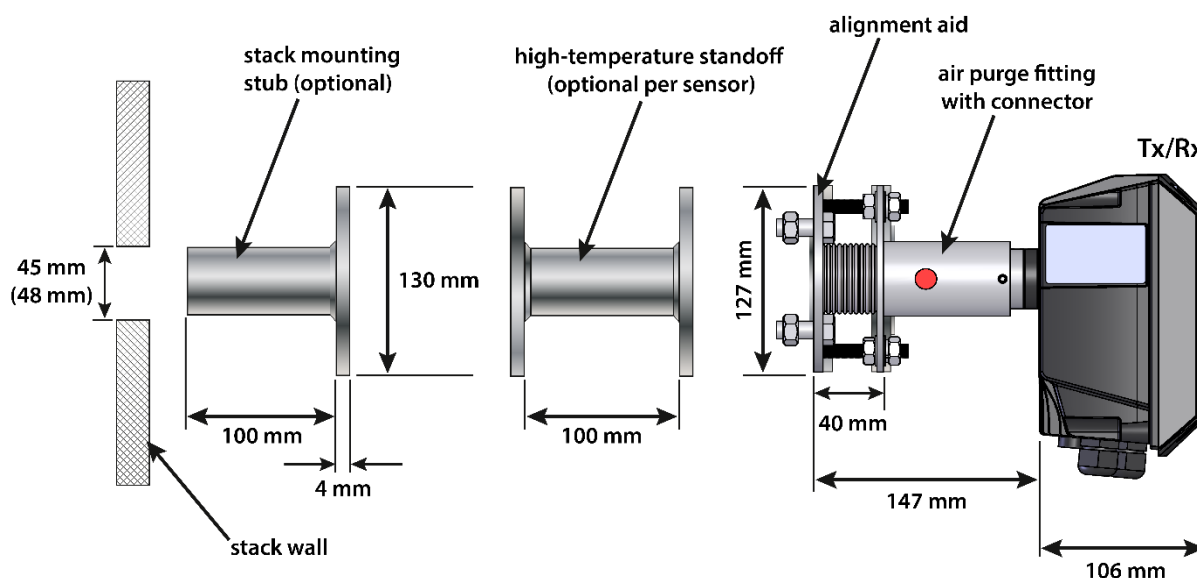


Figure 8: Installation diagram (for a sensor head).

5.2.2 Assembling the Head Mounting Components (Tx/Rx)

The STACK 602 is supplied with two stack mounting stubs (**Figure 9**). The stack mounting stubs must be welded onto the stack in the chosen position. Then the sensor body (incl. alignment aid and air purge with diffuser connector) is bolted on.

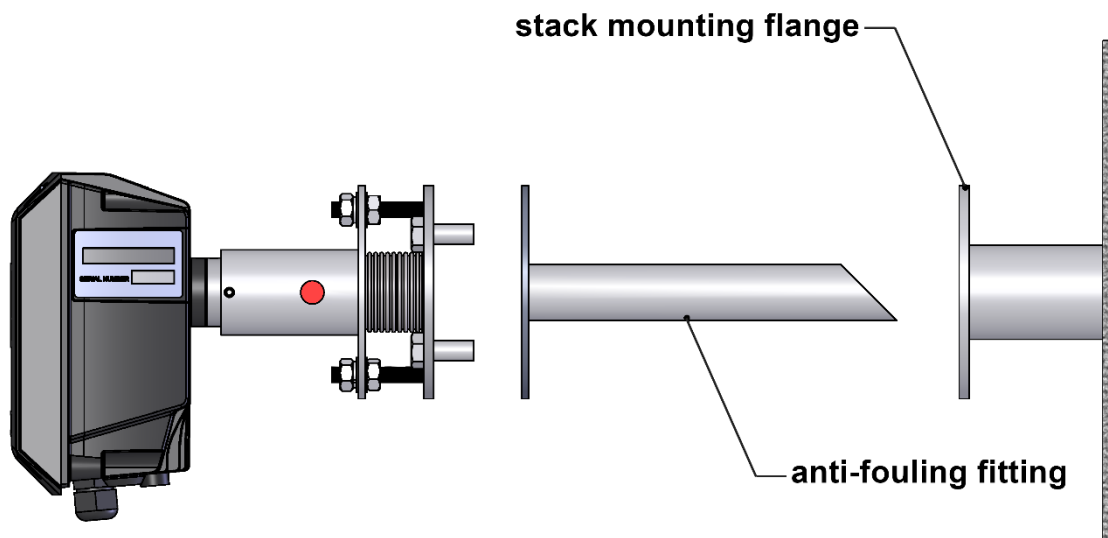


Figure 9: Installing anti-fouling fittings.

The flanged sensor body and stack mounting stubs are supplied with all fixings and the required hardware pre-assembled in the correct orientation. An optional anti-fouling fitting is available for installation between the sensor and the flanged stack mounting stub (see **Figure 9** above). For high-temperature applications, an additional high-temperature standoff should be fitted between the mounting stub and the alignment aid/sensor flange (see **Figure 8** on page 26).

The enclosure is then inserted into the body and attached using four grub screws (**Figure 10**). Note that once installed, the Receiver head requires aligning, which may include removal of the sensor enclosure (see

Appendix A on page 57).

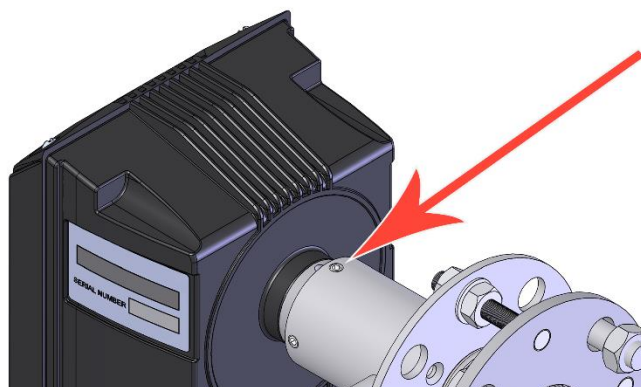


Figure 10: Attaching the sensor enclosure.

5.2.3 Fitting the Stack Mounting Stubs

NOTE: Ensure adequate access is provided by ladder or staging to both the Transmitter and Receiver units, and sampling ports.

When the stubs' optimum position has been decided, the stubs should be welded into position onto the stack. The objective in mounting the stubs is to optimise their alignment such that they are directly opposite each other.

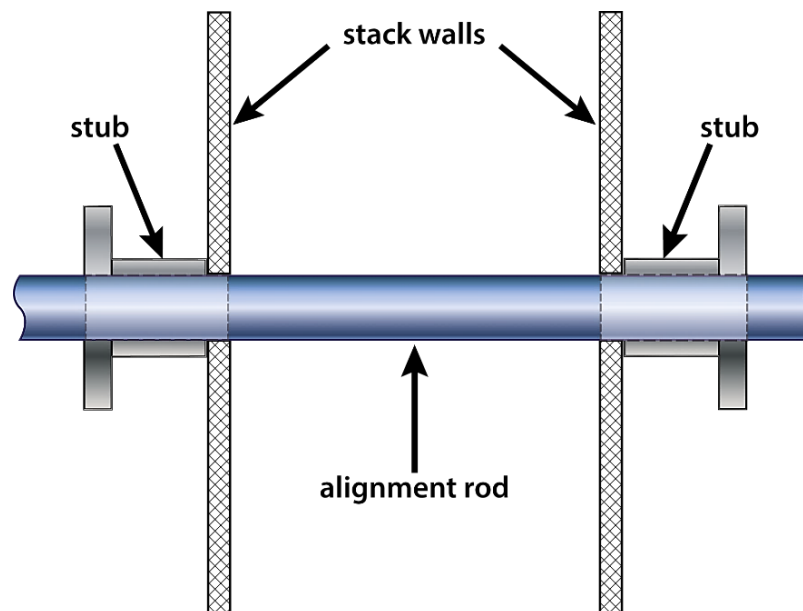


Figure 11: Fitting the stack mounting stubs.

1. Referring to **Figure 11**, cut a $\text{Ø}45 \text{ mm}$ ($1\frac{1}{2}''$) hole in one side of the stack/duct.
2. Measure or calculate the position for a hole directly opposite the first and cut a second $\text{Ø}45 \text{ mm}$ opening.
3. If required, fit the stack mounting stubs as follows:
 - 3a. For smaller stacks (up to $\text{Ø}2\frac{1}{2} \text{ m}$) and provided there is sufficient clearance at the mounting location, the most convenient method for aligning the stack mounting stubs is to source a rigid alignment tube or rod with a $\text{Ø}45 \text{ mm}$ OD and pass this from one side of the stack through to the other.
 The mounting stubs can then be simply slipped over the alignment tube or rod and tack welded in place.
 - 3b. For larger stacks, alignment will need to be performed by eye.
4. When the alignment is satisfactory, remove the alignment tube/rod (where used) and finish off by securely welding both mounting stubs in place.

5.2.4 Setting up the Air Purges

Air purges are normally fitted to the Transmitter and Receiver to minimise contamination of the lenses. These are supplied as a filter/regulator assembly correctly fitted to the Transmitter and Receiver units.

The air purges require a supply of dry, clean (oil-free) instrument-quality air, which should be set to deliver a flow rate of 30–60 l/min. Connection to the air purge is by a ¼" BSP fitting.

NOTE: It is recommended to adjust the air flow before fitting the sensors to the stack or ductwork.

5.3 Connecting the Transmitter (Tx)

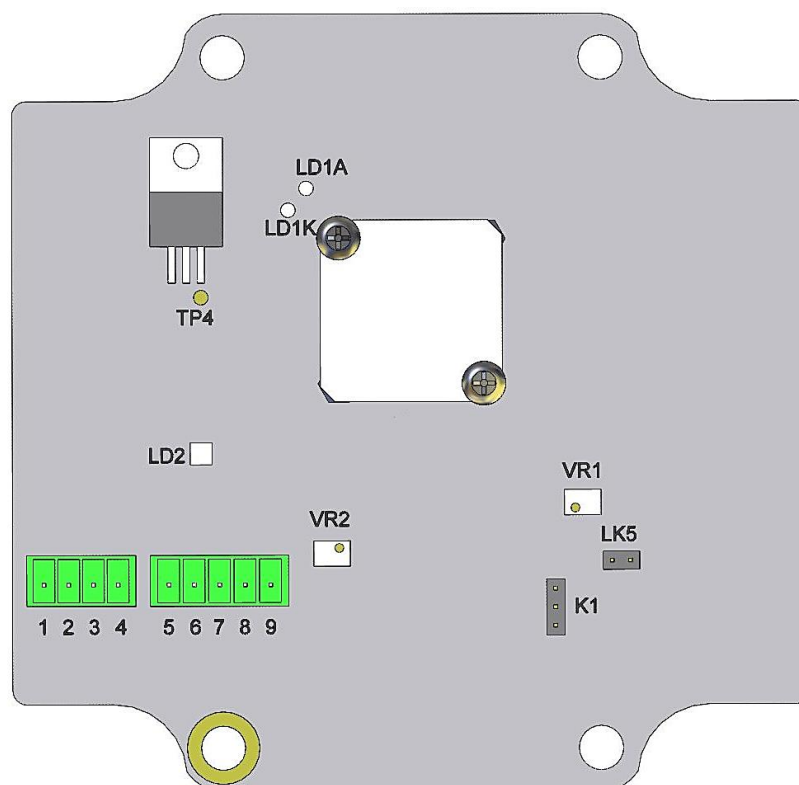


Figure 12: Transmitter (Tx) PCB connections.

5.3.1 Transmitter/Receiver Connections

The Transmitter is connected to the Receiver on the other side of the stack by a single 8-core (screened) cable. Make the connections from left to right as outlined in the below table. Refer to section 0 below for the location of the corresponding Receiver terminals.

Transmitter connector pins (L-R)	Receiver connector pins (top to bottom)	Wire colour ^F
1	SCR	(Cable) Screen
2	+8Vx	Brown
3	0Vx	White
4	-8Vx	Blue
5	TxTa	Black
6	ALDr	Red
7	DacD	Green
8	LedIm	Yellow
9	Fm1	Purple

5.3.2 Transmitter/Receiver Link Settings

The link connections must be set as outlined in the table below for the instrument to function correctly. See **Figure 12** above and **Figure 13** below, respectively, for the location of the links.

Receiver (Rx)		
LK1	Heater DISABLE	Link ON
LK200	Sample rate	Link in middle position
LK201	Reset	Link OFF
Transmitter (Tx)		
LK1	Brightness control ENABLE	Link pins 1 and 2
LK5	Heater DISABLE	Link ON

^F All colour references are based on the standard ENVEA cables supplied.

5.4 Connecting the Receiver (Rx)



CAUTION!

Ensure the cabling is not connected to the control unit power during wiring.

Refer to **Figure 13** below for the location of the terminals. After installation of the sensor, make the comms and power connections as described in the below sections. Connect the sensor heads by connecting the 8-core cable (supplied) as outlined in the table in section 0 above.

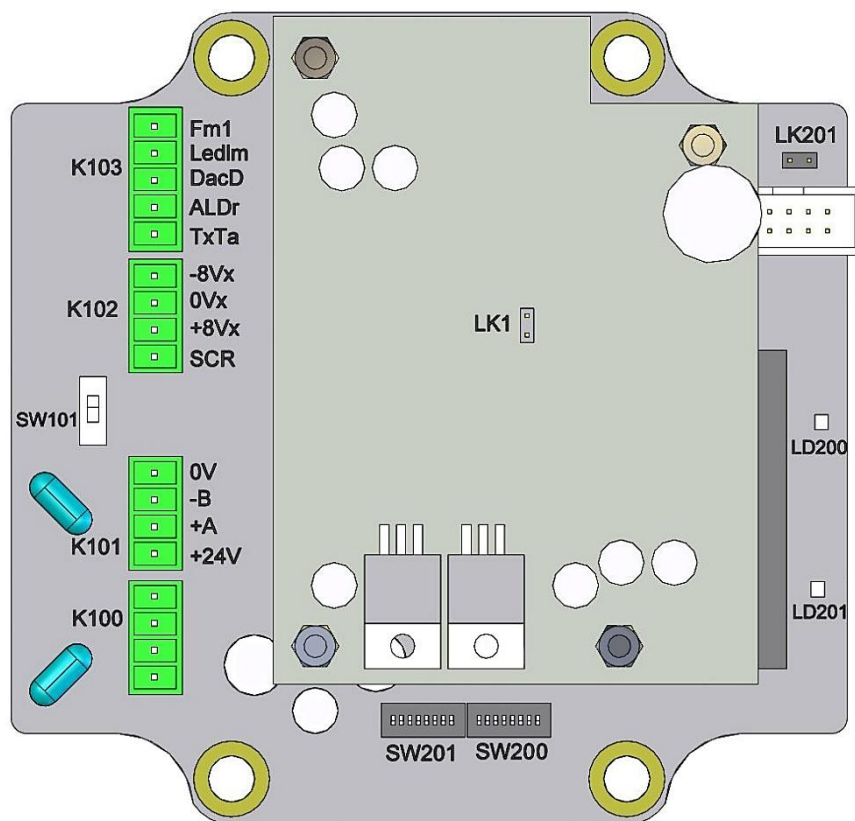


Figure 13: Receiver (Rx) PCB connections.

5.4.1 Data Cable Connection

Connecting daisy-chained Sensor Systems

Route the input cable through the cable gland nearest to the BUS IN terminals. Make the connections to the BUS IN terminals from top to bottom as follows.

Pin connection	Wire colour ^G	BUS IN TERMINAL (K100)^H
0V	Black	
Comms B	Blue	
Comms A	Green	
24V	Brown	

Connect the next sensor in the network to the BUS OUT terminals. Route the cable through the cable gland nearest to the BUS OUT terminals. Make the connections to the BUS OUT terminals from top to bottom as follows.

Pin connection	Wire colour ^H	BUS IN TERMINAL (K101)^I
0V	Black	
Comms B	Blue	
Comms A	Green	
24V	Brown	

Connecting spur-linked Sensor Systems

Route the input cable through the cable gland nearest to the BUS IN terminals. Make the connections to the BUS IN terminals from top to bottom as follows.

Pin connection	Wire colour ^H	BUS IN TERMINAL (K100)^I
0V	Black	
Comms B	Blue	
Comms A	Green	
24V	Brown	

The same connections are copied at the network spur. At the network spur, connect the cable screen to the terminal (SCREEN). Before refitting the cover, configure the Receiver as outlined in section 0 below.

^G All colour references are based on the standard ENVEA cables supplied.

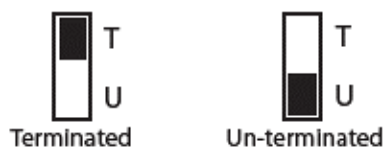
^H Connect the cable screen to the nearest earth stud.

^I Connect the cable screen to the nearest earth stud.

5.5 Setting up the Receiver

Refer to **Figure 13** above for the location of the setup switches. Check that the Tx/Rx link connections are set correctly. Refer to the table in section **5.3.2** above for details on links and **Figure 12** on page **29** and **Figure 13** above, resp., for the location of the links.

5.5.1 Bus Termination Switch (SW101)



The Bus Termination switch (SW101) setting is determined by the sensor's position in the network. Set the switch to **U** (unterminated) for all sensors connected in a chain ('daisy chain'), except the last sensor, which must be set to **T** (terminated). For spur-linked systems, all sensors should be set to **T** (terminated).

5.5.2 Set Address Switch (SW201)



Each sensor must have a unique address on the network. The address is set by means of the DIP switch (SW201). Only switch positions 1 to 6 are used, giving valid address settings from 1 to 64. The address switch uses binary coding to calculate the required address.

Example – To set address no. 5: set switch 1 (binary 1) ON and switch 3 (binary 4) ON ($4+1=5$). The above illustration shows address 5.

5.5.3 Set Comms Settings (SW200)

The sensor has two communications settings, ASCII and RTU. The default setting is ASCII: 19200 Baud, No Parity, 1 Stop Bit, ASCII mode (7-bit). RTU is a faster Comms protocol but is not available for all devices.

Set the address DIP switch as required (see the following table).

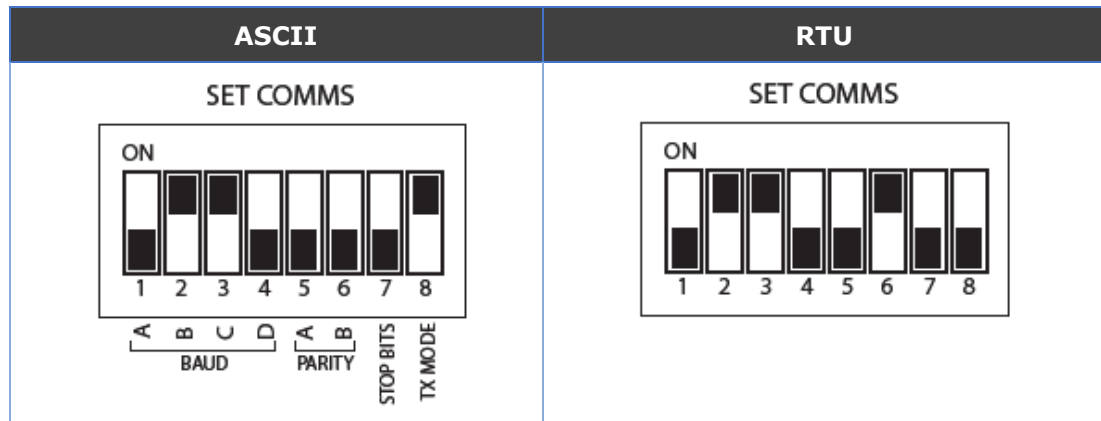


Figure 14: Basic setup – Communications settings.

The Comms mode is set by ENVEA prior to installation and should be checked during the system installation.

6. Basic System Setup

This section provides information on the initial setup and operation of the ENVEA control unit. The same procedure applies to both the Standard Controller (Standard systems) and ProController (PRO systems). For advanced configuration, refer to the relevant control unit manual (see **Related Documentation** on page 11).

This section provides an overview of the available user controls on the control units, their functionality and configurability.

6.1 User Controls and Functionality

6.1.1 The ProController UI

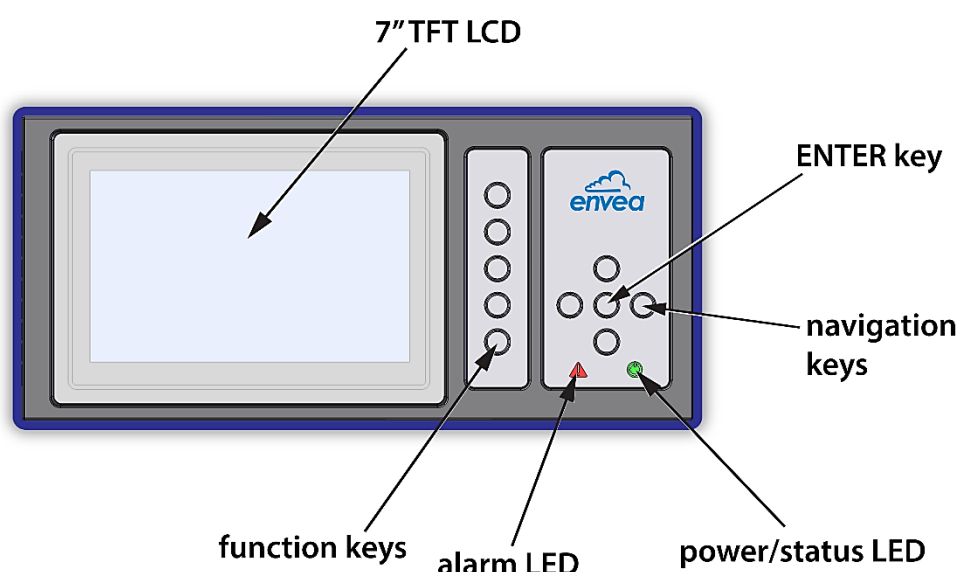


Figure 15: ProController – User interface with controls.

Use the navigation and ENTER keys to select the required menu screen. Five function keys are available for rapid menu access.

UI Element	Purpose	Description
FUNCTION KEYS	See section 6.2 below for details.	Five function keys are available for quick access and response. Two keys (F1 and F2) are user programmable.
NAVIGATION KEYS (arrow keys)	ENTER ↵	Press to select or confirm, or to adjust a value (incremental).
	UP/DOWN	Choose this menu option to modify. Select an entry value (for example, a digit for a password).
	RIGHT	Select a menu option. Confirm entry (applies and stores the chosen value).
	LEFT (CANCEL)	Abort change and return to the main menu or previous item.

POWER LED	Switch ON power. [Status]	Green = ON Off = No power
ALARM LED	Switch ON power. [Status]	Red (flashing) = alarm Off = no alarm

6.1.2 The Standard Controller UI

See below the UI layout of the Standard Controller showing the location of the user controls and Alarm/Power indicators. Use the navigation buttons and ENTER keys to select the required menu screen.

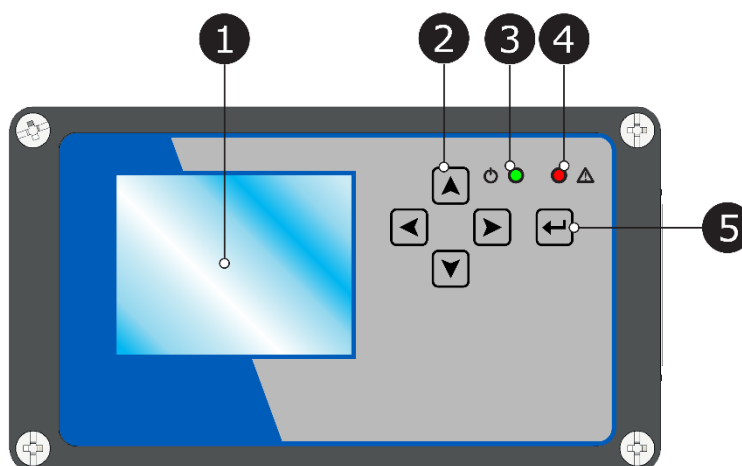







Figure 16: Standard Controller – User interface with controls.

UI Element	Purpose	Description
1 GRAPHICAL DISPLAY (320 x 240 pixels)	It illuminates when the power is being delivered. [Status]	Use to view processed data, alarms, graphs, bar charts, and overview screens.
2 Navigation buttons (arrow keys)	UP/DOWN	Use these buttons to modify values. Select an entry value (for example, a digit for a password).
	RIGHT	Select a menu option. Confirm entry (to apply and store the chosen value).
	LEFT (CANCEL)	Abort change and return to the main menu or go to the previous item.
3 Power/Comms LED	Switch ON power. [Status]	Green = ON Off = No power
4 Alarm LED	Sensor/system alarm. [Status]	Red (flashing) = alarm Off = no alarm
5 Navigation button	ENTER ↵	Press to select or confirm, or to adjust a value (incremental).





6.2 ProController – Function Keys and Setup





Refer to the table below for details on operating and setting the function keys for quick access to frequently viewed screens.

Symbol	Meaning	Action
	'BACK TO TOP'	Displays the current top-level menu icon (for example, Setup, as shown). Press the 'BACK TO TOP' button to return to the current top-level menu screen with a single click.
	FAVOURITE 1	<ul style="list-style-type: none"> Open the desired menu screen. Press and hold F1 + 'TOP' (the top-level menu icon, see above) to save the current screen as Favourite 1 (F1). The Power LED flashes GREEN to confirm the selection has been saved.
	FAVOURITE 2	<ul style="list-style-type: none"> Open the desired menu screen. Press and hold F2 + 'TOP' (the top-level menu icon, see above) to save the current screen as Favourite 2 (F2). The Power LED flashes GREEN to confirm the selection has been saved.
	SAVE / YES / OK	Press for a positive response or to CONFIRM (depending on the current screen).
	CANCEL / NO / BACK	Press for a negative response or to QUIT the page (depending on the current screen).

6.3 Main Menu Screens

The icon bar at the top of the screen is displayed on start-up. Select the required menu using the navigation (arrow) and ENTER keys:

Main menus	Screen	Description
	MULTIPLE DEVICES	Displays all available sensor/ device channels as bar graphs or as a list.
	BAR GRAPH	Displays (single) bar graph with emissions for a single stack; shows up to six channels, scalable.
	SYSTEM OVERVIEW	Provides a summary table and shows the current alarm status for each sensor on one screen.
	ALARM LOG	Select to view and scroll through the Event log; enables resetting of latched alarms.

Main menus	Screen	Description
	DATA GRAPH	Displays logged or real-time data per sensor as line graph; log type and time (span) are selectable.
	QUALITY ASSURANCE / SELF-TESTS	Provides access to self-check screens, calibration, maintenance, and enables running sensor checks manually.
	PASSWORD ENTRY	Set a password; with a locking option (to prevent unauthorised access/changes)
	SENSOR SETUP / SYSTEM SETUP	Main Setup screen; access other functions and sensor settings from this screen.
[Date]	<i>not selectable</i>	Display format: dd/mm/yy (set via main Setup screen)
[Time]	<i>not selectable</i>	Display format: hh:mm (set via main Setup screen)

6.3.1 Other Symbols

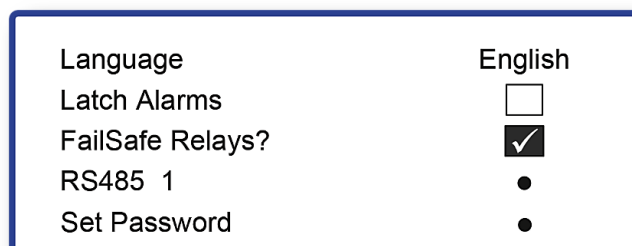


Figure 17: Screen elements (example).

Press ENTER to activate/deactivate ('tick') the checkboxes. Next, select a button (●) to display the detail screen for this function. Refer to the relevant section for further details and functionality.

7. Initial Setup

7.1 Introduction

This section provides information on the initial setup and operation of the control units. The same procedure applies to both the Standard Controller (for Standard Systems) and ProController (for PRO Systems).

For advanced configuration procedures, refer to the relevant control unit manual (see the **Related Documentation** on page 11).

7.2 Power-up Checks

Switch on the external power supply to the control unit. Check that the power LED is ON, and the graphical display is illuminated.

When using the control unit for the first time, communication must be established between the control unit and all connected devices in the network. If the control unit is being reconfigured, then all existing settings can be cleared by performing a Master Reset (refer to section 7.2.2 below for details).

7.2.1 Checking the Comms Mode

The Comms mode is set by ENVEA prior to installation and should have been checked during the system installation.

1. Open the main **Setup** menu screen.
2. Select **Other Functions | Advanced Functions**.
3. Select **Sensor Comms Mode** and note the settings, which should be as outlined in the following table.

Setting	Mode	Baud Rate	Parity
Standard	ASCII	19200	Odd
Optional	RTU	19200	None

The Comms mode is set by ENVEA prior to installation and should be checked during the system installation. If problems are encountered communicating with a sensor, check that the sensor communications setting is the same as the control unit Sensor Comms Mode setting (see section 0 on page 34).

7.2.2 Performing a Master Reset



CAUTION! – LOSS OF DATA

Performing a Master Reset deletes all settings and logged data!

Download the data using the ENVEA software tool before carrying out a system reset.

1. Open the main **Setup** menu screen.
2. Select **Other Functions | Reset Functions**.
3. Then select **Master Reset** to initiate the system reset.

7.3 Adding Sensors

Sensor channels can be added to the control unit manually or automatically by using the Autodetect functionality.

NOTE: The manual method should only be used to add sensors when manual control of the *order in which the devices are displayed* is required or only *specific* sensors are to be added. For details on how to add sensors manually, refer to the relevant manual.

7.3.1 Detecting Devices Automatically (Autodetect)

In Autodetect mode, the control unit scans all Modbus addresses to identify all sensors and devices in the network.

Select **Setup | Autodetect** to initiate the search. The menu sequence is shown below (see **Figure 18** below).

- The control unit will now attempt to configure all the sensors in the network with the default settings.
- When this is complete, the sensor data is displayed on the **Multiple Devices** screen. Open this screen from the icon bar, then use the **Bar/Text** button (on the left of the screen) to switch between views and the scroll bar (at the top left of the screen) to view all available channels and their values.

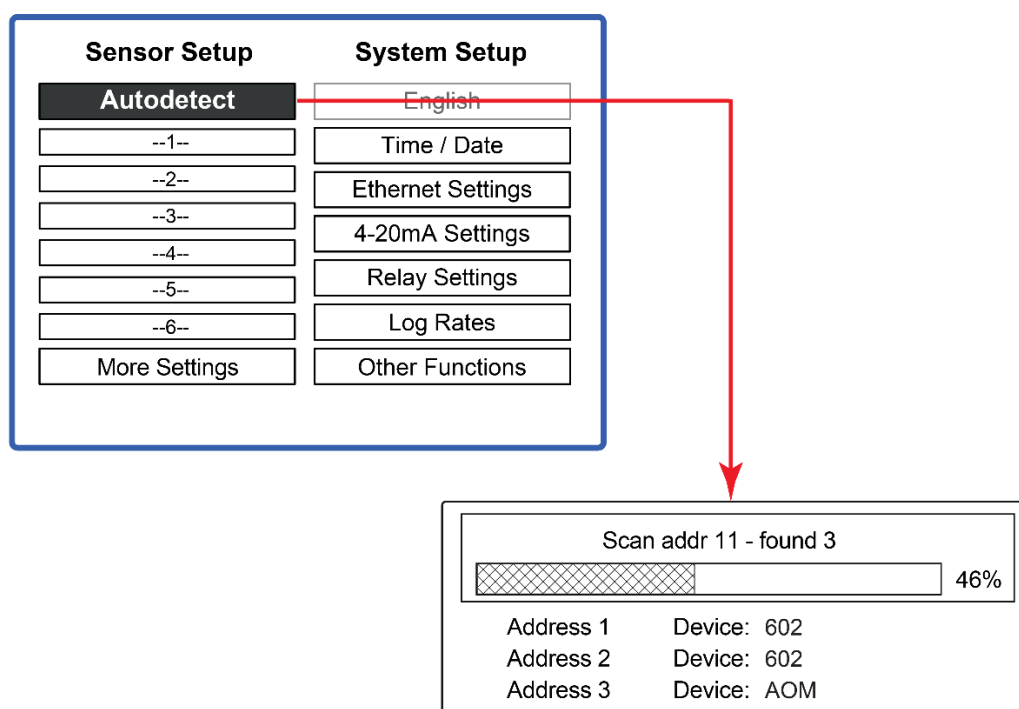


Figure 18: Running Autodetect (example).

7.4 Editing Basic Sensor Settings

When Autodetect is complete, a configuration button for each detected channel (up to six) is displayed on the **Sensor Setup** page.

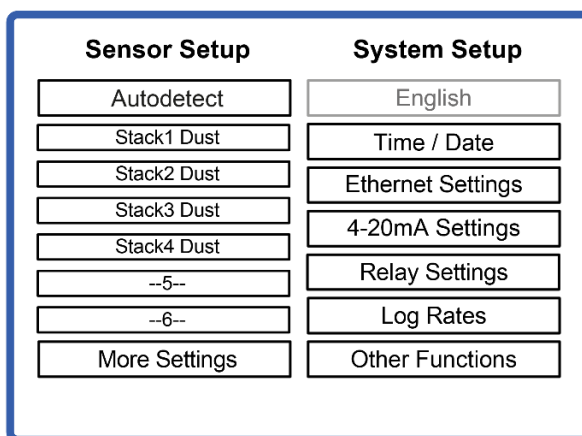


Figure 19: Main Setup screen.

- Advanced settings and additional sensors are accessed through the **More Settings** menu.
- To edit the basic settings for a channel, choose the required channel (for example, **Stack1 Dust**) and press ENTER to display the **Basic Settings** screen.

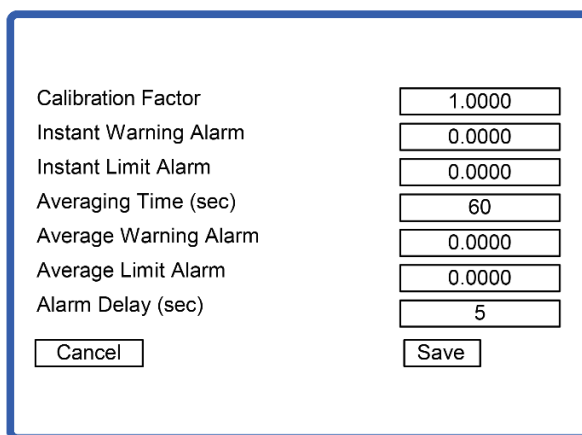


Figure 20: Basic settings – Sensor channel.

Refer to the control unit manual for more information and details on setting up the system (refer to the **Related Documentation** on page 11).

7.4.1 Sensor Channels

For each STACK 602 sensor, the following channels are added to the control unit automatically. Switch to the **Multiple Devices** screen to view these.

Channel	Description
1 Dust	Dynamic opacity reading (can be calibrated in mg/m ³)
2 Opacity	Opacity reading in % (0% = clear stack, 100% = obscured stack)
3 I	Total light intensity (diagnostic only)
4 SC	Scintillation count (diagnostic only)
5 Tx Temp	Transmitter PCB temperature (diagnostic only)
6 Rx Temp	Receiver PCB temperature (diagnostic only)

The STACK 602 optical sensor has two outputs: **Dynamic Opacity** mode and **Opacity** mode. The Dynamic Opacity mode is equivalent to a 'Dust' reading. If either mode (602 Dust / 602 Opacity) is not required, this can be deleted manually from the control unit.

7.5 Adjust Sensor Brightness and Sensitivity

To set up the STACK 602, the brightness and sensitivity settings must be adjusted, so an appropriate Received Light signal is being detected at the Receiver.



CAUTION!

Adjustments to the sensor sensitivity and/or brightness affect the Dust calibration.

Neither sensitivity nor brightness settings should be changed once the STACK 602 has been calibrated. The settings should be noted during the calibration procedure (see section 7.6 on page 44).

1. Referring to **Figure 21** below, select the **QA/Self Tests** icon to display this screen.
2. From the **Device** list, select **Stackn Opacity**.
3. Select the **Set Up** button (top right) and press ENTER to display this screen.

NOTES: Sensitivity and brightness settings can be set automatically or manually. It is recommended to set the brightness and sensitivity automatically using the AUTOSET function (see below).

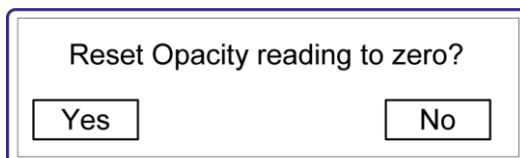
7.5.1 Adjusting Sensitivity/Brightness Automatically (Autoset)

1. Referring to **Figure 21** below, select the **Autoset** button and press ENTER.
2. Select the **Sensitivity** button and press ENTER to increase the setting from **Low** to **Medium / High** until a sufficiently large Received Light signal is reached (>**12.5**, on the bar chart).

3. Repeat the process for brightness: use the **^ / v** (Up/Down) controls to increase the **Brightness %** from 50% up to 100% until a reading of **80** is displayed (on the bar chart).
4. When finished, a confirmation message is displayed (**Setup Complete**).
5. Select **OK** to confirm and close the message. Then press the **Exit** button.

Resetting Opacity to Zero

When setting sensitivity/brightness up from the Opacity menu – on exiting the Set Up screen, a confirmation dialogue (**Reset Opacity to Zero?**) is displayed.



Select **Yes** to set the current Received Light level to 0% (clean stack). Changes in opacity are then measured from this base level. Otherwise, select **No**.

NOTE: It is recommended to set up Opacity under process OFF / clean stack conditions so that 0% Opacity corresponds to Zero dust.

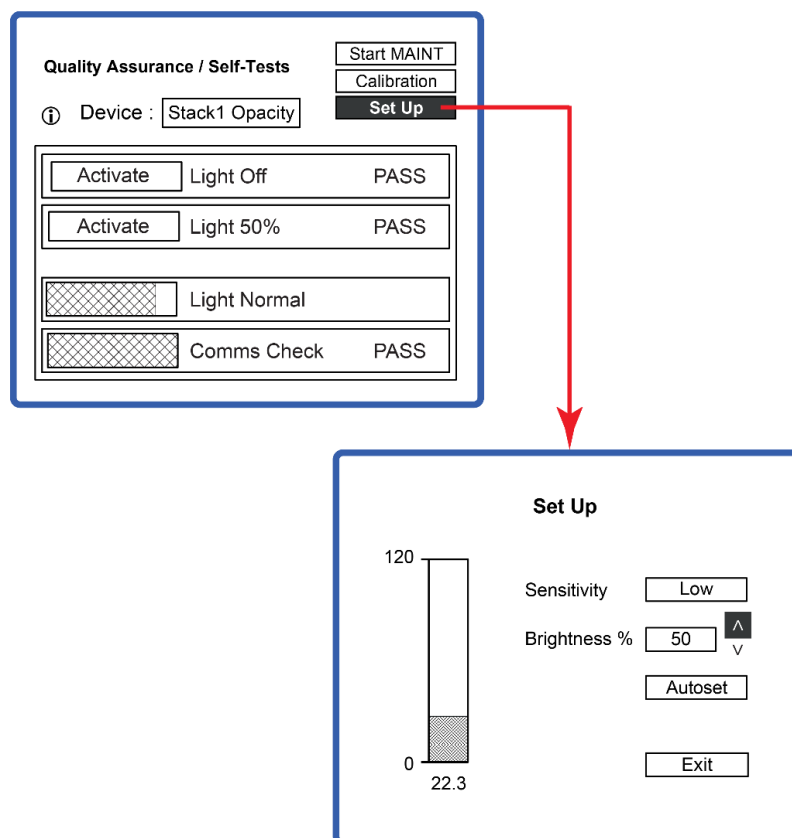


Figure 21: Adjusting brightness and sensitivity.

7.5.2 Adjusting Brightness and Sensitivity Manually

To manually set your brightness and sensitivity, the recommended procedure is:

1. Referring to **Figure 21** above, set **Sensitivity = Low** and **Brightness % = 50**.

2. Increase the **Sensitivity** from **Low** → **Medium** → **High**, until a signal **>12.5** is reached. Each sensitivity change will increase the reading by a factor of 8.
3. Increase the **Brightness %** from 50% (up to max. 100%), ideally to reach a level of between **80** and **100**. If this level cannot be reached, increase the level to 100%.

NOTES:

- (i) If settings are at maximum level (for example, High sensitivity and 100% brightness) and the signal still reads <25, then check the alignment of the sensor heads to improve the signal level.
 - (ii) If the **Set Up** screen shows a fixed maximum level (reaching 118 on the bar chart), the Receiver has become saturated. To correct this, lower the sensitivity and brightness until the level drops.
 - (iii) It is recommended not to run with a brightness level of less than 50% because this increases the level of Transmitter noise.
-

7.6 Calibration Factor (Cal Factor)

The Cal Factor is used to scale the raw dust reading to provide a mg/m³ reading within the instrument. Alternatively, the raw dust reading can be output to your own system (using analogue or Modbus outputs) and calibrated within that system.

The Cal Factor scales the raw reading as follows:

$$\text{Dust Reading (mg/m}^3\text{)} = \text{raw instrument reading} \times \text{Calibration Factor}$$

The Cal Factor is applied to:

- The Multiple Device menu screen
- Logged data within the instrument (short term, via PC-ME DUST TOOLS only)
- Analogue (4-20mA) outputs
- Modbus RS-485 output values.

The default Cal Factor is 1.00. The procedure to calculate the correct Cal Factor is described in **Appendix B** on page **61**.

NOTE: When the Cal Factor is adjusted, the new Cal Factor is only applied to newly logged data. Existing logged data remains calibrated to the old Cal Factor. The control unit maintains a history of Cal Factor changes for use by the PC-ME DUST TOOLS software.

7.6.1 Advanced Settings

For information on more advanced sensor/device settings, refer to the relevant control unit manual (see **Related Documentation** on page **11**).

8. Quality Assurance and Self-Tests

8.1 Available Sensor Tests

The control unit provides the maintenance and testing functions outlined below.

Function	Purpose
Maintenance Mode (Start/Stop)	Puts the sensor heads in maintenance mode, allowing cleaning and maintenance of the sensor.
Sensor Self-tests (Zero/Span checks)	Automatic internal opacity sensor self-tests to check the validity of measurements.
Comms Check	Checks communications between the control unit and sensor.
Calibration	To carry out calibration using results from isokinetic sampling (see Appendix B on page 61).
Set Up	To configure brightness and sensitivity.

8.1.1 Performing Sensor Self-Tests

The QA/Self-Tests screen allows the status of self-checks to be reviewed for each device. These can be set to run automatically and can also be forced manually (for example, during installation or maintenance).

Frequency: Span checks for the CEM are implemented automatically and are performed by varying the light intensity in the Transmitter head. The Zero check involves measuring the variation with no Transmitter light present. The automatic sensor self-tests are performed alternating every hour (Zero test = Light OFF, Dynamic Opacity Span test = Light 50%).

Sensor self-tests can also be activated manually (on demand) from the **QA/Self-Tests** menu screen. To perform a test, press the **Activate** button next to the required test. For each test, the display alternates between PASS and FAIL, and the numerical result of the test; the meaning of these numbers is explained below.

8.1.2 Sensor Test Pass Levels

Sensor Test	Minimum Pass Level	Optimum Pass Level	Maximum Pass Level
Opacity Light OFF (ZERO)	–	0%	5%
Opacity Light 50% (SPAN)	40%	50%	60%
Dynamic Opacity (Dust) Light OFF (ZERO)	–	–	–
Dynamic Opacity (Dust) Light 50% (SPAN)	–	–	–

8.2 Opacity Self-Tests

8.2.1 Viewing Opacity Self-Tests

1. Open the **QA/Self-Tests** menu screen, then select **Device | Stackn Opacity** to display the self-test results for a sensor (see **Figure 22** below):

- 1a. **Light Normal**: displays the current level of scintillation at the Receiver. This should be the same as the light level set up initially on the Set-Up screen. A typical value is between 50 and 100 (see section 0 on page 42).

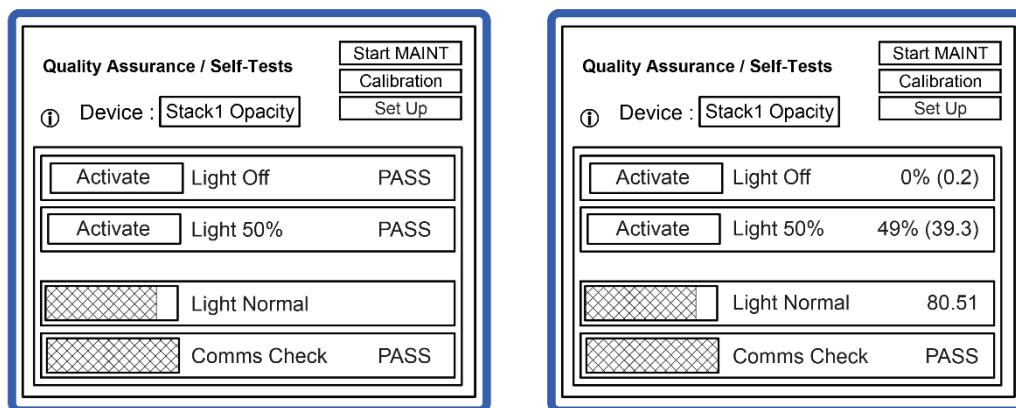


Figure 22: Opacity sensor test results (alternating).

- 1b. **Comms Check**: verifies the control unit is reading opacity values correctly from the sensor.
- 1c. **Opacity Light Off (ZERO) check**: this check turns the Transmitter brightness down to zero and checks the scintillation also drops close to zero.

Example: the results show a Light Normal scintillation count of 80.51 just before the test, which is reduced to 0.2 (0%) during the test. The display now alternates between showing PASS and the numerical result.
- 1d. **Opacity Light 50% (SPAN) check**: the aim of this test is to simulate an opacity reading electronically by oscillating the Transmitter brightness between 100% and 50% (its original setup level) at a frequency within the measurement band of the instrument. An expected reading from this test is around 200,000.

Example: the results show the Light Normal level of 80.51 before the test reduced to 39.3 (49%) during the test. The display now alternates between showing PASS and the numerical result. However, if the result is significantly different from 50%, the instrument generates an Opacity Span alarm (see note below).

2. Repeat the procedure for additional sensors as required.

NOTE: If an Opacity self-test is outside tolerance levels or generates an alarm, refer to the troubleshooting section **9.5.7** on page **54**.

8.3 Dynamic Opacity (Dust) Self-Tests

8.3.1 About *DynamicOpacity*[®] Self-Tests

The numerical values displayed on the 'Dust' (Dynamic Opacity) QA/Self Tests page (see **Figure 23** below) are all measures of raw scintillation counts. Raw scintillation is the *amount of light signal variation* seen at the Receiver due to the dust flow.

Dynamic Opacity is calculated as follows:

$$\text{Dynamic opacity} = \text{scintillation (SC diagnostic channel)} / \text{received intensity (I diagnostic channel)} \times 100,000$$

Example: if SC=200 and I=800,000, then

$$\text{Dynamic Opacity} = 200/800,000 \times 100,000 = 25.$$

8.3.2 Viewing Dynamic Opacity Self-Tests

1. Open the **QA/Self-Tests** menu screen, then select **Device | Stackn Dust** to display the self-test results for a sensor (**Figure 23**).

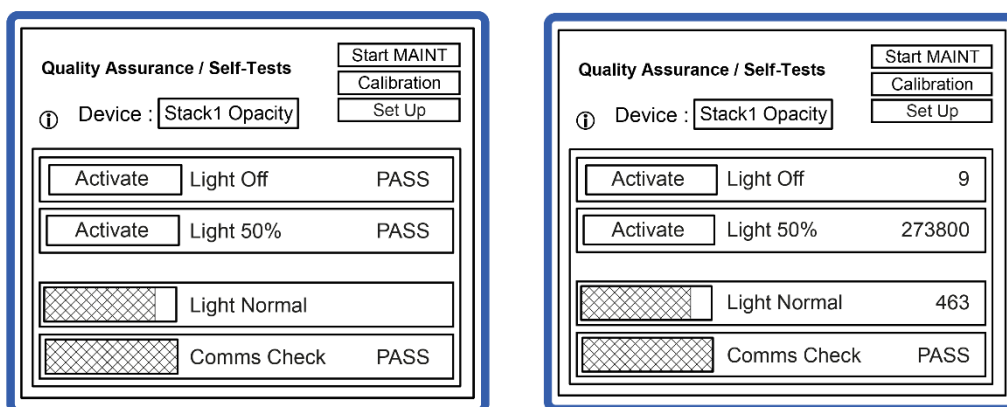


Figure 23: Dynamic Opacity sensor test results (alternating).

- 1a. Light Normal:** displays the current level of scintillation at the Receiver. This should be the same as the light level set up initially on the Set-Up screen. A typical value is between 10 and 1,000 (see section 0 on page 42).
- 1b. Comms Check:** verifies the control unit is reading dynamic opacity values correctly from the sensor.
- 1c. Dynamic Opacity Light Off (ZERO) check:** this check turns the Transmitter brightness down to zero and checks the scintillation also drops close to zero.

Example: referring to **Figure 23** above, the result shows a Light Normal scintillation count of 463 just before the test which is reduced to 9 during the test.
- 1d. Dynamic Opacity Light 50% (SPAN) check:** the aim of this test is to simulate a dynamic opacity reading electronically by oscillating the Transmitter brightness between 100% and 50% (its original setup level)

at a frequency within the measurement band of the instrument. An expected reading from this test is around 200,000.

Example: referring to **Figure 23** above, the result shows a Light Normal scintillation count of 463 just before the test, which increases to 273,800 during the test.

2. Repeat the procedure for additional sensors as required.

8.4 Setting Sensor Tests and Alarms

8.4.1 Enabling/disabling Self-Tests

1. Open the **Setup** screen, then select **More Settings | Edit an Existing Device**.
2. Select the device to edit from the list, then set **Self Tests Active** to **Yes** (or **No**).

8.4.2 Enabling/disabling Self-Test Alarms

1. Open the **Setup** screen and select **More Settings | Edit an Existing Device**.
2. Select the device to edit from the list, then set **Zero/Span Alarm** to **Yes** (or **No**).

9. Maintenance

9.1 Safety Information

**CAUTION!**

Refer all servicing or maintenance to qualified service personnel.

**WARNING! – HAZARDOUS VOLTAGES****This equipment contains lethal voltages!**

Always switch OFF and isolate the unit from the power supply before removing the front cover.

**WARNING! – HAZARDOUS VOLTAGES**

Hazardous voltages are still present when the main power supply fuse has failed.

**CAUTION!**

Non-metallic parts may be cleaned with a dry or lightly dampened cloth only. Do not use solvents or abrasives as these may damage the surfaces. For sensor parts, follow the advice given in the instructions.

9.2 Maintenance Mode

Maintenance mode allows sensors to be disabled for routine maintenance. There are three ways of disabling a sensor:

- **Power OFF the control unit:** this removes power from all sensors in the network. A 'Power Interruption' alarm will be recorded in the Event log indicating the maintenance period. A gap will appear in the emission logs.
- **Disconnect the sensor from the network:** if the sensors are connected into the network using spurs, it is possible to physically disconnect the sensor from the network without affecting polling to the other sensors. A 'No Response' alarm will be generated in the control unit for that channel during the maintenance period.
- **Maintenance mode menu in the control unit:** sensors placed in Maintenance mode will be re-enabled automatically after eight hours.

9.2.1 Placing a Sensor in Maintenance Mode

1. Select **Setup | Other Functions | Maintenance Mode** to display the following screen.

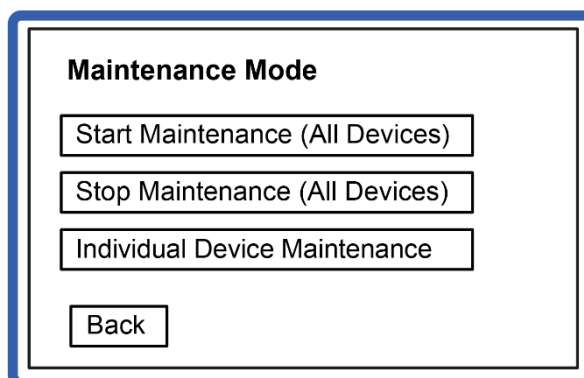


Figure 24: Maintenance Mode screen.

- 1a. To put all sensors into Maintenance mode: select **Start Maintenance (All Devices)**.
- 1b. To re-enable all sensors: select **Stop Maintenance (All Devices)**.
- 1c. To place individual sensors in Maintenance mode: select **Individual Device Maintenance**.

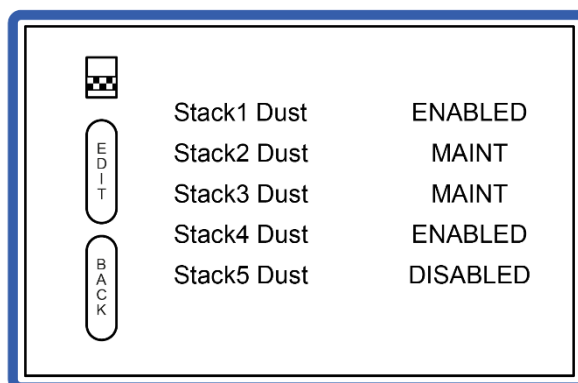


Figure 25: Placing sensor in Maintenance mode.

Use the scrollbar to move the cursor to the required channel.

- 1d. Press **Edit** to change the sensor's status to Maintenance mode.

Sensor Status

The below table details the status of various functions according to sensor status.

Function	Sensor Status		
	ENABLED	MAINT	DISABLED
Emission Alarms (control unit relays)	Active	Inactive	Inactive
Comms and Self-test Alarms	Active	Active	Inactive
4-20mA	Active	Set to 0	Set to 0
Logging	Active	Active (labelled MAINT) ^J	Inactive
Alarm Log	---	Maintenance alarm	---

9.3 Service Messages

The control unit generates service messages at various points in the life of the sensors to ensure the sensors are correctly maintained. Three types of Service messages are created whose purpose is outlined in the table below.

Message	Time after installation	Action required
Inspection due	6 months	Remove the sensor from the stack for inspection and cleaning.
Service due	12 months	Arrange service visit by an ENVEA Service Engineer or an authorised ENVEA representative.
Major Service due	4 years	Recommended return to ENVEA for testing and refurbishment if required.

Messages advising inspection are displayed one month prior to the due date. If messages are not cleared within a month, 'Overdue' messages will occur, and the control unit LED will flash RED.

Clearing Service Messages

All active service messages can be cleared by entering Maintenance mode (see page 49), performing the required actions, and then returning the sensor to normal operation.

^J This data is only available in PC-ME DUST TOOLS and may be excluded from reports.

9.4 Inspecting and Cleaning Procedures

The nature of many processes is such that a build-up of particulate may develop on the sensor windows. This build-up will normally not affect the instrument's performance, but it is recommended that the build-up is periodically removed. Put the sensor in Maintenance mode (see page 50). This will force 4-20mA outputs to 4mA and disable relays.

9.4.1 Cleaning the Sensor Window (Rx and Tx)

1. Undo the grub screws (4 off) connecting the sensor to the alignment fitting.
2. Clean the sensor window, then refit to the sensor and tighten the grub screws.
3. Perform any other maintenance required at the sensor.
4. Ensure that the sealed connectors are secure and undamaged.
5. Inspect the connecting cables (where possible), ensure that they are not damaged or stressed.
6. Check that no moisture or foreign bodies have entered the sensor unit enclosure. Ensure that the cover lid is securely refitted.

9.5 Troubleshooting



WARNING! – HAZARDOUS VOLTAGES

The control unit contains lethal voltages!

Always switch OFF and isolate the unit from the power supply before removing the front cover.



WARNING! – ELECTRIC SHOCK

Ensure that the mains isolator is easily accessible (within a 2 m/6½ ft. radius) to allow the control unit to be switched off.

9.5.1 Comms Failure

The control unit can support many sensors and devices that may be spread over a wide area of a plant. It is, therefore, essential to be methodical in the approach to locating the cause of communications problems. If you cannot get the complete network to communicate, it is best to disconnect some of the sensors and add them in one by one to see where the problem occurs.

Diagnostics

1. On the control unit, check that the Sensor Comms Mode is set correctly (see section 7.2.1 on page 39)
2. Run **Autodetect** and note which devices fail to be detected.
3. If existing devices have stopped communicating, this will show up as:
 - 3a. A 'No Response' message at the bottom of the screen
 - 3b. A flashing red LED
 - 3c. On the **QA/Self-Tests** screen: Comms Check = 'No Response'.

Solution: if the problem exists with one or two devices, visit those devices and check:

4. Cable connections
5. Comms DIP switch settings
6. Network address DIP switch settings
7. Bus termination setting.

NOTE: To prevent bus conflicts, each sensor/device must have a unique address. Devices must not use address '0'.

9.5.2 Checking Spurs

Where network spurs are used, the internal yellow and green LED's may be used as a service guide. The devices communicate by a set of query-response cycles. If either LED is stuck on, this indicates a wiring error or possibly an incorrectly set bus termination switch at some point in the network.

9.5.3 Sensor Power Check

Each sensor has a green LED located in the Receiver (LD200) that flashes at approx. 1Hz (with equal spacing: 0.5s ON, 0.5s OFF). When power is correctly applied to the sensor (before the control unit is ready to communicate with the sensor).

If the LED is OFF, check the connections to the sensor and measure the network supply voltage (between the black and red cores).

9.5.4 Sensor Communications Check

When the control unit communicates with the sensor, and the sensor has accepted the control unit data and decided that it is a valid command, the operation of the red LED changes: it flashes briefly (approx. 50-100ms) every time it receives a valid command from the control unit. If the control unit commands cease, the sensor waits 4 seconds (LED OFF), then reverts to the 0.5s ON/OFF mode of operation.

9.5.5 Power Loss

The sensors are powered from the control unit (24V DC). With long cable runs, there will be voltage drop along the cable. If the voltage drop is too large (<18V), the sensor will not communicate correctly. Check the voltage at each sensor with a multimeter between the 24V and 0V pins.

NOTE: Voltage drop – if the voltage is too low at any sensor in the network, this may cause comms problems throughout the network. Correct voltage problems by adding a PSU Repeater to the network. If you are already using a PSU Repeater, check that it has not been powered OFF.

9.5.6 Frozen Readings

If a sensor reading is not updating, this could have several causes.

1. If there is also a 'No Response' alarm, this could be due to:
 - 1a. A communication problem that must be fixed (see sections above)
 - 1b. A faulty sensor PCB, which needs to be replaced.
2. If there is no such alarm, then:
 - 2a. The sensor may be running a self-test (go to **QA/Self Tests** to check this).
 - 2b. The sensor may have been disabled (select **Sensor Setup | More Settings | Edit an Existing Device** and check the **Enabled** setting).
 - 2c. The sensor may be in Plant Stop mode. The word 'STOP' will be displayed underneath the sensor reading.
 - 2d. The control unit may be too busy reading other sensors. To solve this, power the control unit OFF and back ON; the control unit will restart sharing its time between all sensors on the network.

9.5.7 Troubleshooting Opacity

Symptom	Cause and Solution
'Light Normal' level has dropped significantly below the setup level	See section 9.5.8 below for likely cause (Step 2b) and instructions on how to resolve this issue. If this does not resolve the problem, please contact ENVEA or your local ENVEA representative.
'Light Normal' has reached a fixed, saturated level (118)	See section 9.5.8 below for likely cause (Step 2a) and instructions on how to resolve this issue. If this does not resolve the problem, please contact ENVEA or your local ENVEA representative.
Opacity Light OFF = FAIL (Opacity alarm is shown)	Please contact ENVEA or your local ENVEA representative for assistance.
Opacity Light 50% = FAIL (Opacity alarm is shown)	

9.5.8 Sensor Reading too Low or too High

The control unit gets the reading from the sensor using digital Modbus communication, which has error checking. Therefore, if a reading is being displayed at the control unit without any 'No Response' message (and not frozen – see section above), you can be confident this is a genuine reading from the sensor.

If it is not the reading you expect, consider the following:

1. Run the sensor self-checks manually and follow the troubleshooting advice given in section **9.5.7** above.
2. Check the main **Setup** screen. The sensor must be set up with the Receiver light level within the instrument range. Two common problems can occur:

- 2a. The Received Light level is saturating the Rx (level fixed at 118): in this case, no scintillation (SC) signal will be generated, and so the dust reading is zero.
- 2b. The sensor has become misaligned, and the Received Light level at the Rx is very low (level fixed at <1): in this case, the 'Dust' reading may be very large but will be a noise reading not representative of the actual dust level.
3. The following checks and adjustments commonly resolve the above issues:
 - 3a. If you suspect a problem with the setup, repeat the alignment procedure detailed in
 - 3b. **Appendix A** (see page **57** for instructions).
 - 3c. Excessive stack vibration can generate false high readings.
 - 3d. An insufficiently grounded sensor can produce false high readings.
 - 3e. Visible moisture and heat haze can generate false high readings.
 - 3f. [If used for measuring dust concentration] Adjust the Cal Factor to scale the sensor reading. Dust monitors do not provide a reading pre-calibrated to mg/m³. See **Appendix B** (page **61**) for further information and instructions.

NOTE: The grounding of the sensor heads is not usually an issue for this measurement technique.

Appendix A – Alignment

Principles of Alignment

Transmitter (Tx)

The STACK 602 has a diffused transmitter, which emits light at various angles (see **Figure 26**). The highest light intensity occurs in the forward direction.

Therefore, if the Transmitter is misaligned (for example, the Transmitter is not pointing directly at the Receiver), the light level at the Receiver will be reduced.

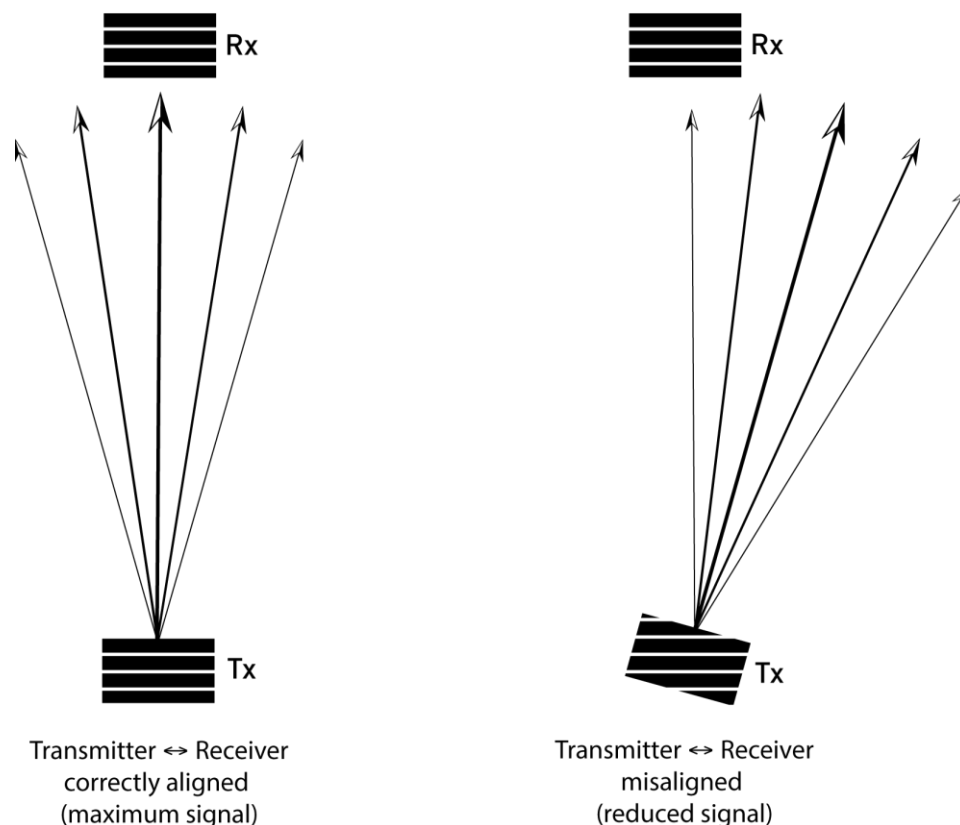


Figure 26: Alignment principles – Transmitter.

Receiver (Rx)

The STACK 602 Receiver consists of a lens that focuses the received light onto a small Receiver diode (see **Figure 27** below).

The Receiver must be aligned correctly, so the lens focuses light onto the centre of the Receiver diode. If the Receiver becomes misaligned, the beam may miss the Receiver diode completely. Therefore, correct Receiver alignment is *critical* for the instrument to function.

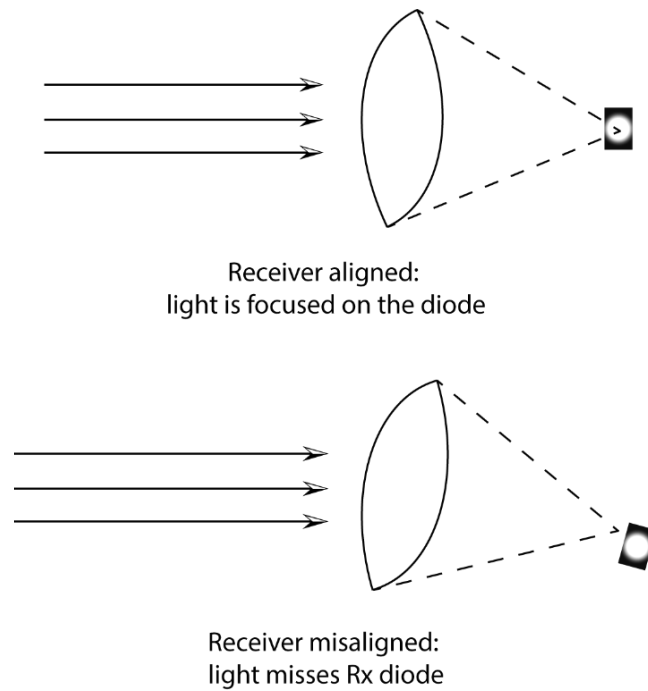


Figure 27: Alignment principles – Receiver.

Alignment Procedure

Aligning the Sensor Heads using the Alignment Tool

An alignment tool (**Figure 28**) is provided that simulates the effect of the lens and Receiver diode.

1. Power up the Receiver. Check the Transmitter is ON (producing a green light source), then install the Receiver (accurate alignment of the sensor head is not essential at this stage).
2. Install the alignment tool into the Receiver mounting as follows:
 - 2a. Undo the grub screws behind the Receiver enclosure (refer to **Figure 10** on page **27**) and remove the complete enclosure from the sensor body.
 - 2b. Insert the alignment tool with the wide end first into the sensor body.

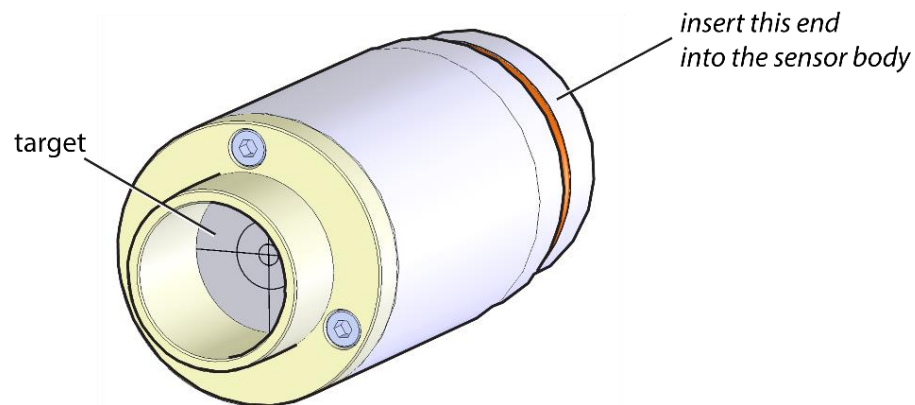


Figure 28: Alignment tool.

Observe the target to align the Receiver: the target centre represents the location of the Receiver diode.

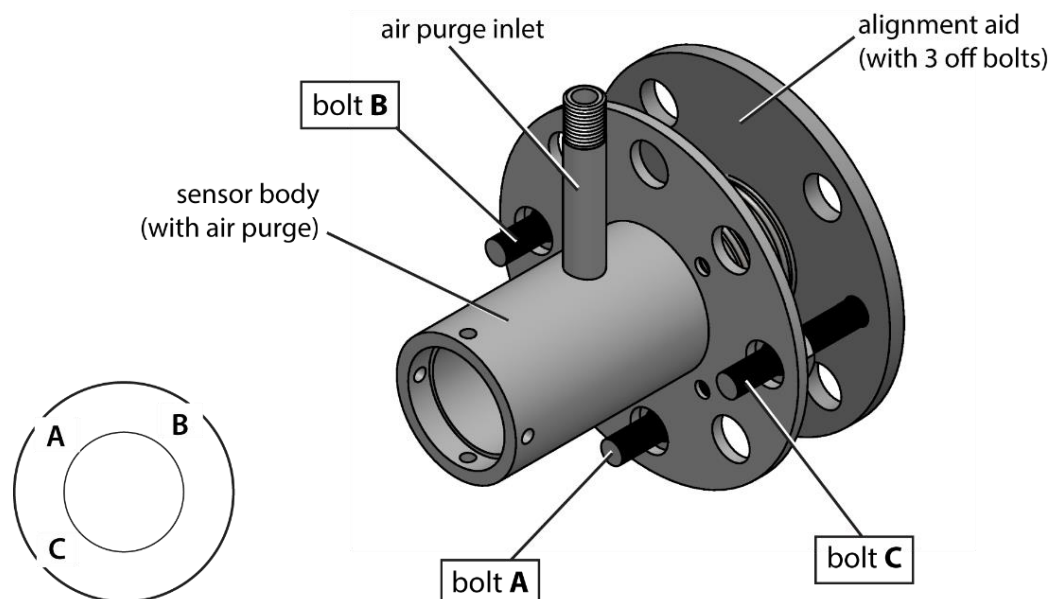


Figure 29: Aligning the Receiver (rotated view).

1. Referring to **Figure 28**, adjust the bolts on the flange to get an image on the target as follows:
 - 1a. Tighten bolt **A** moderately.
 - 1b. Fully slacken bolts **B** and **C**.
 - 1c. Adjust the Receiver assembly by hand until a green light image appears on the target, then tighten the nut on bolt **A**. (If no image appears, check that the Transmitter is working correctly.)
2. Using a spanner fine-tune bolts **B** and **C** on the flange to fix the green image exactly at the centre of the target. (Bolts B and C provide horizontal and vertical adjustment, resp.)
3. Securely tighten all three bolts (tighten bolts **B** and **C** at the same rate).
4. Replace the alignment tool with the Receiver enclosure and tighten the grub screws.

Aligning the Sensor Heads using the Control Unit

A more precise alignment is possible if you have visual access to the control unit display during alignment. The aim is to adjust the alignment bolts on the Receiver and the Transmitter flange to obtain the maximum reading.

1. Select **QA/Self-Tests** and set the required channel from the **Device** list.
2. Press the **Set Up** button at the top right to display this screen.
3. Observe the Received Light level while adjusting the tension of the bolts:
 - 3a. Referring to **Figure 28** above, loosely tighten bolt **A**.
 - 3b. Slacken bolts **B** and **C**.

4. Adjust the reading by manually turning bolts **B** and **C** slowly clockwise until the maximum possible reading is reached. (Note that the reading will go up when turning the bolts clockwise; however, turning them too far will cause the reading to go down again.)

This procedure may be applied on both the Receiver and the Transmitter and should be carried out during the **Initial Setup** of the control unit (see page **35**).

Appendix B – Calibration

Introduction

STACK 602 sensors attached to the control unit can be calibrated in mg/m³ in certain applications. Calibration is carried out with reference to an isokinetic sample (manual stack method). The isokinetic sample should be carried out to the relevant standards as defined by your local environmental authority or government agency.

NOTE: Calibration of each sensor is necessary on at least an annual basis and should be carried out either by ENVEA or an authorised ENVEA representative.

At its simplest level, the calibration procedure is carried out to calculate a calibration (or scaling) factor that is used to scale up the raw sensor readings into a true dust concentration value, which is displayed in mg/m³. The use of a simple calibration (or scaling) factor is possible since the response of the instrument is directly proportional to the dust concentration over a predefined range.

Calculating the Calibration Factor

The basic method to calculate a new Cal Factor a sensor uses the following formula:

New Cal Factor =

Current Cal Factor x (Test Result/Sensor Average)

- The Test Result is the result obtained from a single sample of the stack.
- The Current Cal Factor is the calibration factor entered into the instrument at the time of sampling. (NB, the default Cal Factor setting is 1.0.)
- The Sensor Average is the average of the readings displayed in your control unit using the current calibration (scaling) factor.

Example:

- Sampling test result = 50 mg/m³
- Current Cal factor setting = 2.5
- Instrument average = 20 units
- New Cal factor = $2.5 \times (50 / 20) = 6.25$

Calibration Procedure

1. Ensure that the sensors and control unit are running properly and that the plant is running normally for representative conditions.
2. Carry out an isokinetic test.
3. Calculate the average sensor response displayed in your control unit (Sensor Average) and record the sensor settings.
4. Obtain the isokinetic sampling results (Test Result).
5. Calculate the new Cal Factor (as outlined above).

6. Enter the New Cal Factor (as described below).

Entering a new Cal Factor

1. Select **Setup | More Settings | Edit an Existing Device**.
2. Select the **Device** to be edited and enter the **Cal Factor** value.
3. Select **Save** to store the settings and return to the main menu.

Setting the Units to mg/m³

1. Select **Setup | More Settings | Edit an Existing Device**.
2. Select the device and change the **Units Name** using the navigation keys.
3. Select **Save** to store the settings and return to the main menu.

Using the Calibration Tool

The control unit software contains a calibration tool to aid the calibration (or scaling) procedure. The calibration tool can be used to carry out a simple calibration with a single sample or to obtain sensor averages for sample runs to send to ENVEA.

1. Select the **Quality Assurance / Self-Tests** menu screen and select the required **Device** from the list.
2. Select **Calibration** to display the following screen (**Figure 30**).

	D	M	Y	h	m
Start Time	14	02	18	10	32
Duration				00	45
Max. Reading	7.3200			Short Term	
Sensor Average	5.6315				
Test Result	17.95			Calc	Exit

Figure 30: Calibration tool screen (Edit mode).

3. Set the **Start Time** using the LEFT/RIGHT navigation keys to move between fields (see the dashed line for direction) and the UP/DOWN keys to adjust the values.

The control unit will now search the logs and calculate and display the **Sensor Average**. A **Max Reading** is also displayed. Comparing the maximum reading to the sensor average makes it possible to judge if the sensor readings were steady during the period.

The control unit uses the short-term (ST) log to calculate the average. If this log is not available, an approximate average will be calculated from the LT log. The log used for the calculation is displayed on the right-hand side of the screen.

Calculating the Calibration Factor: Manual Method

The Calibration (Cal) Factor can then be calculated manually or automatically using the control unit calibration tool.

Calculate the Calibration Factor manually

1. Record the **Sensor Average**.
2. Obtain the isokinetic sampling test result.
3. Calculate the Cal Factor (see **Calculating the Calibration Factor** above).

Update the new Calibration Factor in the Control Unit

1. Select **Setup | More Settings | Edit an Existing Device**.
2. Select the required device to edit and enter the Cal Factor.
3. Select **Save** to store the settings and return to the main menu.

Calculating the Calibration Factor: Automatic Method

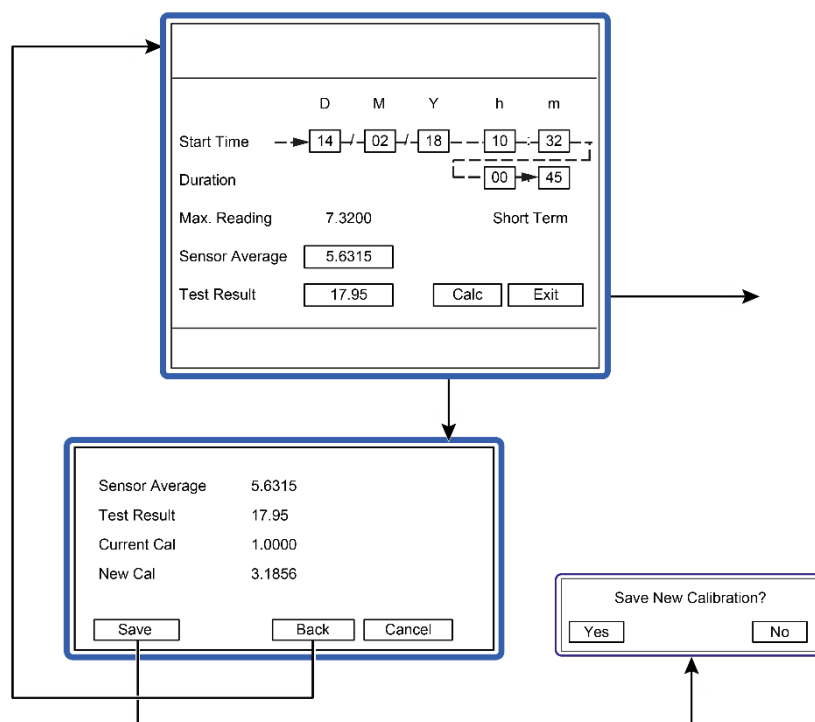


Figure 31: Calculating the calibration factor automatically.

1. Obtain and enter the isokinetic sampling test result.
2. Select **Calc** to perform the calculation and display the new calibration factor, **New Cal** (see **Figure 31** above).
 - 2a. If the new Cal Factor is acceptable, select **Save** and **Yes** to update this automatically in the sensor configuration and return to the QA menu screen.
 - 2b. If the new Cal Factor is not acceptable, select **Back** to return the calculation screen and repeat the calculation procedure, or select **Cancel** to return to the QA menu screen.

General Notices

List of Materials

The following tables provide a list of materials used in the construction of this product.

Material	Where used
Standard sensors (0–250 °C)	
316 Stainless Steel	Sensor rod and body
Aluminium alloy	Enclosure
Electronic components	Sensor electronics
Fibreglass	PCB
PTFE	Insulator
High-temperature sensors (0–600 °C)	
Alumina	Insulator
PEEK	Insulator
Sialon	Insulator

Recycling and Disposal of Electrical and Electronic Equipment

In many countries separate collection systems have been set up to handle the disposal and recycling of electrical and electronic waste. Disposing of this product correctly helps prevent potentially negative consequences for the environment and human health. The recycling of materials helps conserve natural resources.

Dispose of this product at a collection point for the recycling of electrical and electronic equipment according to your local government regulations.

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