4500 MKIII

USER GUIDE

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Model 4500 MkIII

LAND
AMETEK®
PROCESS & ANALYTICAL INSTRUMENTS

QUALITY CUSTOMER SOLUTIONS

IMPORTANT INFORMATION - PLEASE READ

Health and Safety Information

Read all of the instructions in this booklet - including all the WARNINGS and CAUTIONS - *before* using this product. If there is any instruction which you do not understand, DO NOT USE THE PRODUCT.

Safety Signs

WARNING
Indicates a potentially hazardous situation which, if not avoided, could result in death or personal injury.

CAUTION
Indicates a potentially hazardous situation which, if not avoided, could result in minor or moderate injury to the user or users, or result in damage to the product or to property.

NOTE
Indicates a potentially hazardous situation which, if not avoided, could result in damage or loss of data.

Signs and Symbols used on equipment and Documentation


Caution, risk of electric shock.


Caution, attention to possibility of risk of damage to the product, process or surroundings. Refer to instruction manual.


Caution, hot surface.


Protective Conductor Terminal.


Observe precautions for handling electrostatic discharge sensitive devices.

Equipment Operation

Use of this instrument in a manner not specified by AMETEK Land may be hazardous. Read **and understand** the user documentation supplied **before** installing and operating the equipment.

The safety of any system incorporating this equipment is the responsibility of the assembler.

Protective Clothing, Face and Eye Protection

It is possible that this equipment is to be installed on, or near to, machinery or equipment operating at high temperatures and high pressures. Suitable protective clothing, along with face and eye protection must be worn. Refer to the health and safety guidelines for the machinery/equipment before installing this product. If in doubt, contact AMETEK Land.


Wear Protective Gloves


Wear Protective Clothing


Wear Eye Protection


Wear Ear Protection


Wear Safety Boots


Wear Face Protection

Electrical Power Supply

Before working on the electrical connections, all of the electrical power lines to the equipment must be isolated. All the electrical cables and signal cables must be connected exactly as indicated in these operating instructions. If in doubt, contact AMETEK Land.

Contact Us

UK - Dronfield
Land Instruments International
Tel: +44 (0) 1246 417691

USA - Pittsburgh
AMETEK Land, Inc.
Tel: +1 412 826 4444

China
AMETEK Land China Service
Tel: +86 21 5868 5111 ext 122

India
AMETEK Land India Service
Tel: +91 - 80 67823240

Email: land.enquiry@ametek.com

Web: www.ametek-land.com

For further details on all AMETEK Land offices, distributors and representatives, please visit our website.

Storage

The instrument should be stored in its packaging, in a dry sheltered area.

The maximum storage temperature is 10°C (18°F) higher than the maximum operating temperature.

The minimum storage temperature is 10°C (18°F) lower than the minimum operating temperature.

Refer to the Technical Specification for details of the operating temperature limits.

Unpacking

Check all packages for external signs of damage. Check the contents against the packing note.

Lifting Instructions

Where items are too heavy to be lifted manually, use suitably rated lifting equipment. Refer to the Technical Specification for weights. All lifting should be carried out in accordance with local and national regulations.

Return of Damaged Goods

IMPORTANT If any item has been damaged in transit, this should be reported to the carrier and to the supplier immediately. Damage caused in transit is the responsibility of the carrier not the supplier.

DO NOT RETURN a damaged instrument to the sender as the carrier will not then consider a claim. Save the packing with the damaged article for inspection by the carrier.

Return of Goods for Repair

If you need to return goods for repair please contact our Customer Service Department for details of the correct returns procedure.

Any item returned to AMETEK Land should be adequately packaged to prevent damage during transit.

You must include a written report of the problem together with your own name and contact information, address, telephone number, email address etc.

Design and Manufacturing Standards

The Quality Management System of Land Instruments International is approved to BS EN ISO 9001 for the design, manufacture and on-site servicing of combustion, environmental monitoring and non-contact temperature measuring instrumentation.

Registered ISO9001 Management System approvals apply in the USA.

UK Calibration Laboratory: UKAS 0034.

USA Calibration Laboratory: ANAB Accredited ISO/IEC 17025.

National Accreditation Board for Testing and Calibration Laboratories approvals apply in India.

Operation of radio transmitters, telephones or other electrical/electronic devices in close proximity to the equipment while the enclosure doors of the instrument or its peripherals are open, may cause interference and possible failure where the radiated emissions exceed the EMC directive.

The protection provided by this product may be invalidated if alterations or additions are made to the structural, electrical, mechanical, pneumatic, software or firmware components of this system. Such changes may also invalidate the standard terms of warranty.

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A

INTRODUCTION

A1 General Description

The AMETEK Land Instruments International Model 4500 MkIII Continuous Opacity Monitoring System (COMS) measures opacity by shining a light beam through flue gases.

An internal microprocessor calculates dust density and other parameters.

The Model 4500 MkIII is designed for continuous operation in all weather conditions. Maintenance requirements are minimal.

Transceiver	Containing all of the major electronic and electro–optic components.
Retro-Reflector	Containing a corner cube reflector.
Air Purge System	A continuous supply of purge air is essential to prevent dust and corrosive gases from affecting the optical system. Single and dual electric blowers or compressed-air driven devices are available to suit individual site requirements. Automatic fail–safe shutters can also be fitted for temporary protection in the event of a purge air failure.

Power Supply

The model 4500 MkIII operates from a 24 V d.c. supply.

Analogue Output

The Model 4500 MkIII Dust and Opacity Monitor has a current loop output that may be set to one of the four functions below:

Opacity	Dust
Constant Current	Optical Density

The output can be set to 'TRACK' or 'HOLD' the measurement signal during calibration routines. If 'TRACK' is set, the measurement signal will continue to be output during calibration. If 'HOLD' is set, the measurement signal will remain at the last recorded reading before calibration, until the calibration routine is complete.

Relay Outputs

Located on the key panel of the 4500 MkIII are three LEDs which light to indicate the operation of the following relay outputs:

SYSTEM OK
CALIBRATION
ALARMS

Computer Interface Operation

The Model 4500 MkIII Dust and Opacity Monitor may be connected to a computer or data acquisition system via its RS485 Modbus interface.

Auxiliary Function Unit and Power Supply (AFU-APS-I/O 4500 MkIII)

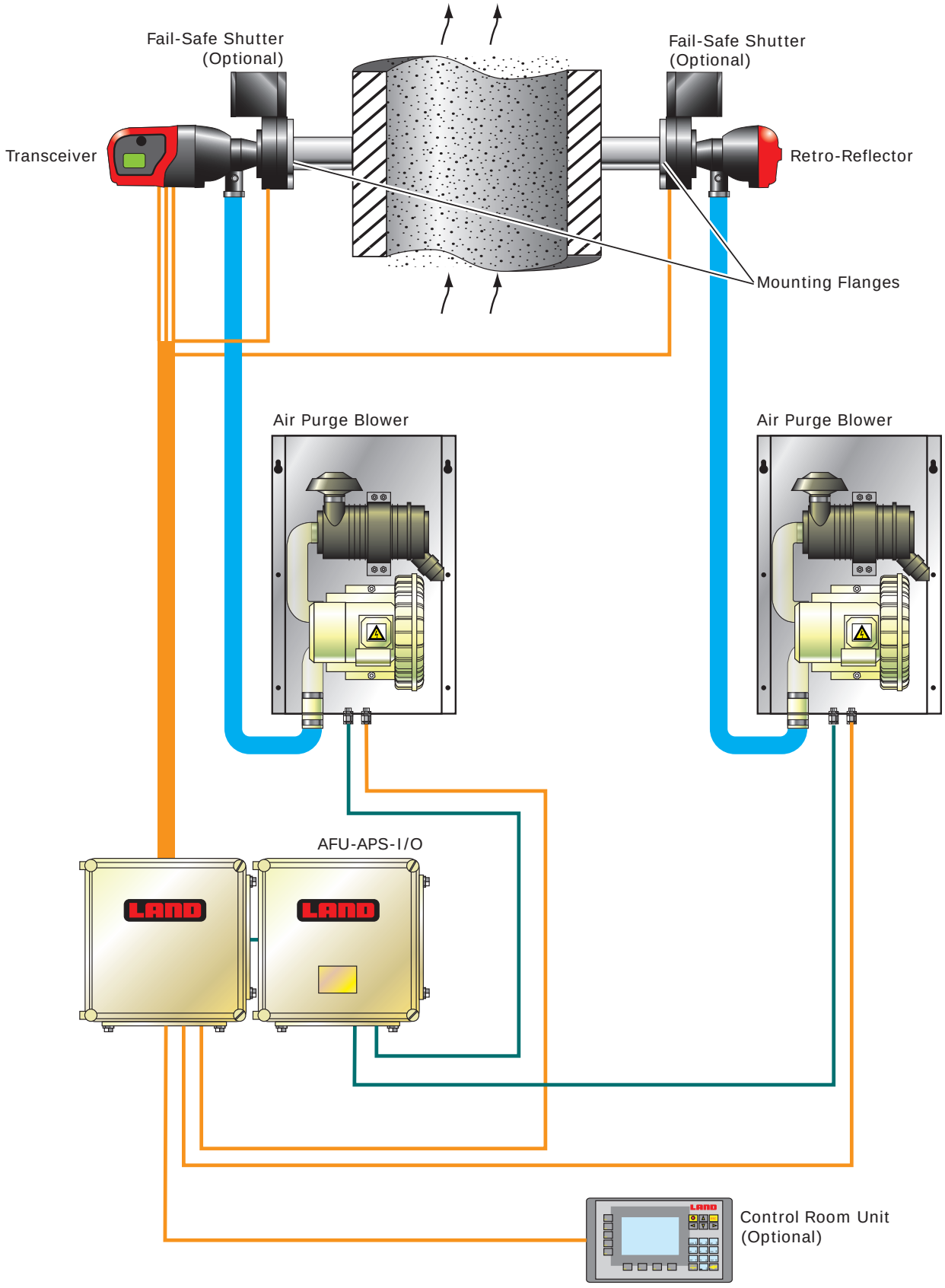
Optional external connection box which offers screw terminal connections plus enhanced input / output options, and an external mains-powered unit to provide 24 V d.c. power as well as power distribution for blowers, shutters and other mains-powered accessories.

Control Room Unit

Remote display and diagnostic terminal with touch-screen control.

A2 Installation Diagram

Typical Model 4500 MkIII Dust Opacity Monitoring System, showing all components installed.



A3 Installation Instructions

CAUTION

If the blower is **not** supplied through an APS (as described in Section A4), an external isolator, incorporating over-current protection, must be fitted to the blower supply.

CAUTION

The purge air supply must be connected and working before the Transceiver and the Retro-Reflector are installed.

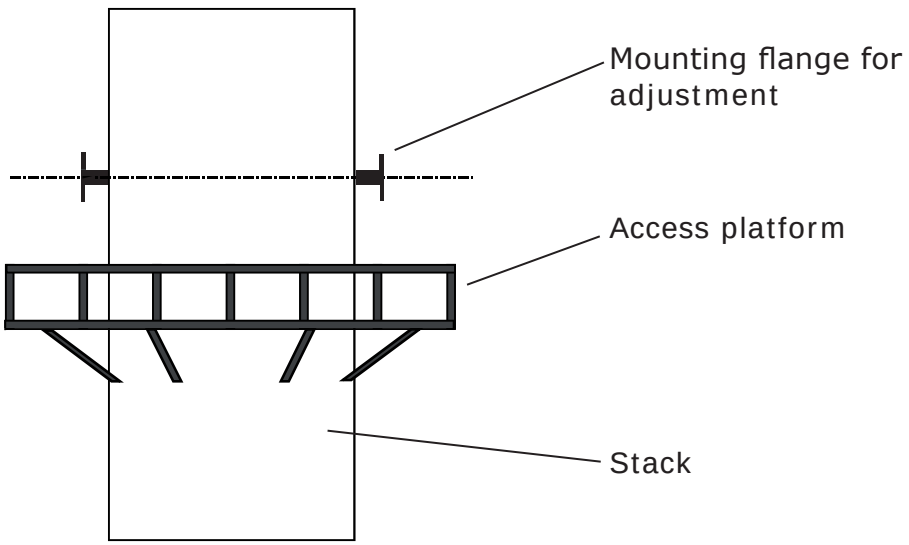
A3.1 Installation Checklist

1) Select the installation location.
2) Install the mounting flanges.
3) Install the Air Blower Unit(s) for the purge air supply. Consult the Air Blower Unit Instruction Manual for full details.
4) An external circuit breaker, incorporating over-current protection or a power isolator and fuse must be fitted to the blower supply.
5) Route all signal and power cables.
6) Connect the power supply to the Air Blower Unit(s).
7) Connect the electrical power supply and signals to the instruments, using the 5m (16 ft) pre-terminated cables supplied.
8) Power up the air purge system.
9) Install the Transceiver and Retro-reflector. Remember to connect the purge air supply from the Air Blower Unit(s) before mounting them on the flanges.
10) Power up the instrument and calibrate it.

A3.2 Selecting an Installation Location

The location of the mounting flanges may be affected by the type of Air Blower Unit(s) to be used. Please refer to the Air Blower Unit manual.

1) For new plants, the location of the Transmissometer should be planned during the design stages. For existing plants, it is critical that the best possible location be selected. The Transmissometer should be mounted so that it measures a representative concentration of dust across the stack or duct diameter.
2) If the monitor is to be used for US regulatory compliance the location should be determined by the EPA installation specifications detailed in 40 CFR 60, Appendix B, Performance Specification 1, or a location approved by the appropriate agency. In Europe the location should the determined in accordance with EN15259.
3) At the installation location, there should be as much negative pressure as possible, for example, a stack updraft.
4) The mounting area must have a safe walkway: if necessary, a sufficiently large and accessible platform should be constructed.
5) The ambient temperature at the mounting location must remain between -40°C and +55°C (-4°F and 131°F). If necessary, heating, ventilation, or a sun shield should be used to ensure this temperature range is not exceeded.
6) If the duct walls are too thin to support the weight of the instrument, additional reinforcement will be required.
7) The mounting flanges must be positioned such that the Transceiver and Retro-Reflector face each other across the centre of the stack or duct. Since most applications involve a vertical stack, the axis common to both flanges must be level and perpendicular to the direction of gas flow.



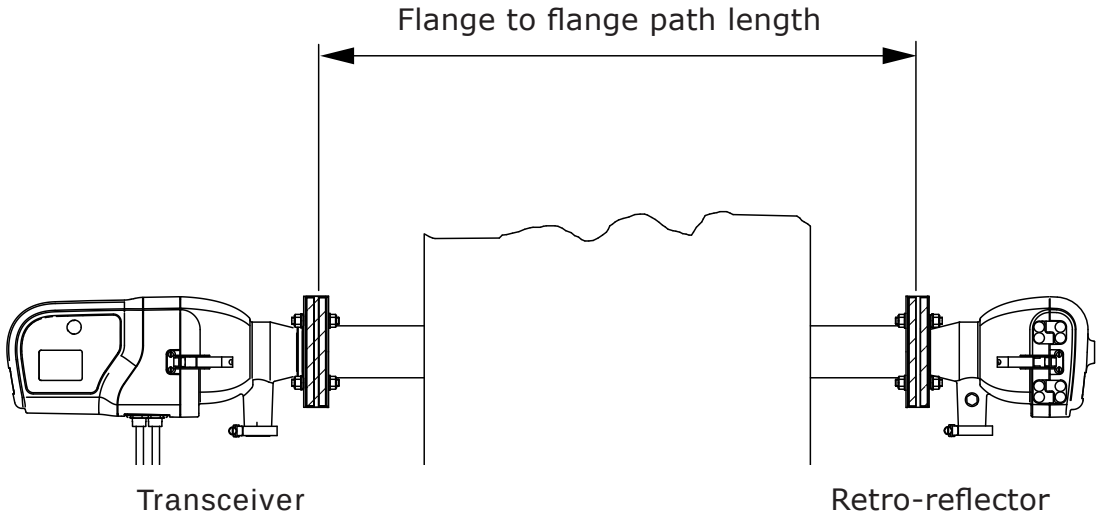
A3.3 Maintaining the path length during installation

The installation path length is defined as the distance between the outer faces of the mounting flanges of the transceiver and retroreflector. This is somewhat greater than the stack flange-to-flange path length, to allow for optical alignment. The length of accessories such as spoolpieces or fail-safe shutters also increases the installation path length relative to the stack flange-to-flange path length.

The installation path length must be specified at the time of order and the instrument is factory set for this path length.

The installation path length is indicated on the back of the Transceiver.

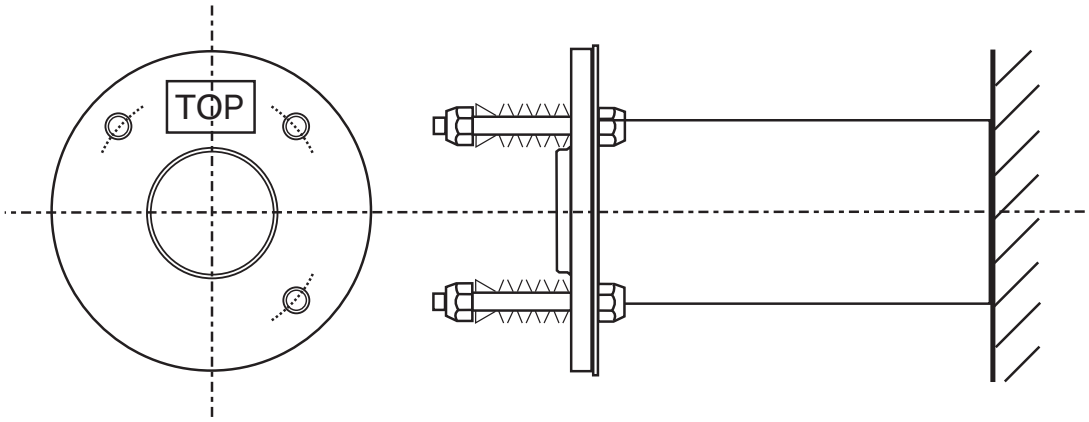
During the welding and alignment procedures the flange-to-flange measurement path must not change by more than ±1%, otherwise the accuracy of the measurement readings may be affected.



A3.4 Installing the Mounting Flanges

The Model 4500 MkIII is supplied with two mounting flanges with stand-offs (standpipes) used to mount the Transmissometer onto the stack or duct.

1) Each standpipe is 128mm (5.04in) long.
2) Accurately mark the centre of each mounting flange on the stack and punch a locating mark through the liner onto the inner stack plating.
3) On both sides of the stack, cut a hole from the liner large enough to allow welding of the mounting flange to the stack.
4) Where the Transceiver will be installed, cut a hole through the stack at the punched location mark.
5) Where the Retro-Reflector will be installed, make a 6mm to 12mm diameter pilot hole (0.25in to 0.50in)



6) Position the Transceiver mounting flange with the "TOP" label in the 12 o'clock position and tack weld the mounting flange in place.

   Accurate positioning of the flange at this stage is critical to the operation of the instrument. If the flange is not parallel to the stack wall it will be impossible to align the instrument correctly.

7) Cut a hole around the Retro-Reflector pilot hole, large enough to allow eventual welding of the outside of the flange stub to the stack wall. The mounting flange plate must be parallel to the stack wall.

8) If the measuring path is short (under 2m / 6.5ft) and easily accessible the flanges can be aligned using a straight piece of tube.

   a) Slide the tube through both flanges. Ensuring the specified flange-to-flange measuring path is maintained to within ±1%.

   b) Tack weld the Retro-Reflector mounting flange in place.

   c) Make any necessary adjustments to the Transceiver mounting flange to ensure alignment between the two flanges is maintained. Weld the flange permanently in place.

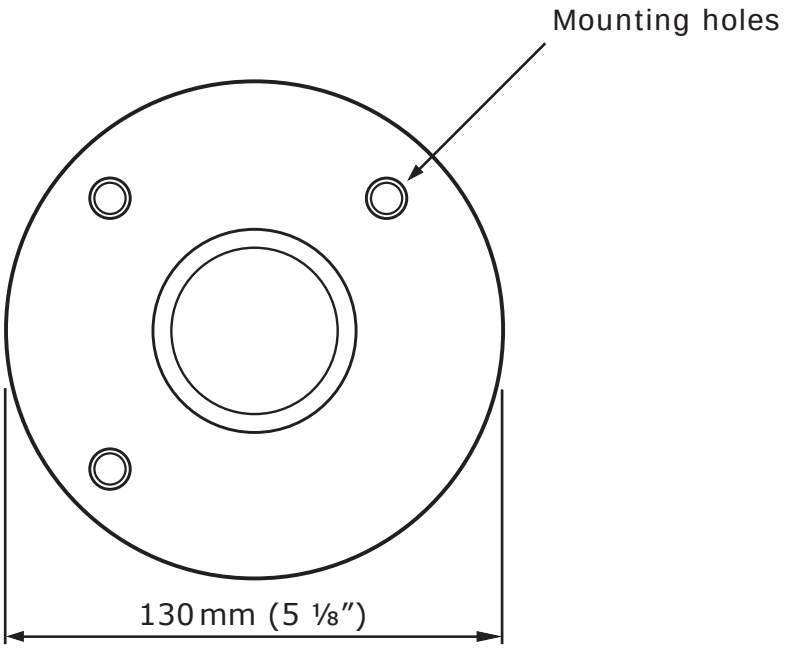
   d) Make any necessary adjustments and weld the Retro-Reflector mounting flange permanently in place.

An optical flange alignment tool (Part number 703.070) can be used to ensure the proper alignment of the flanges. Contact AMETEK Land Instruments for more information.

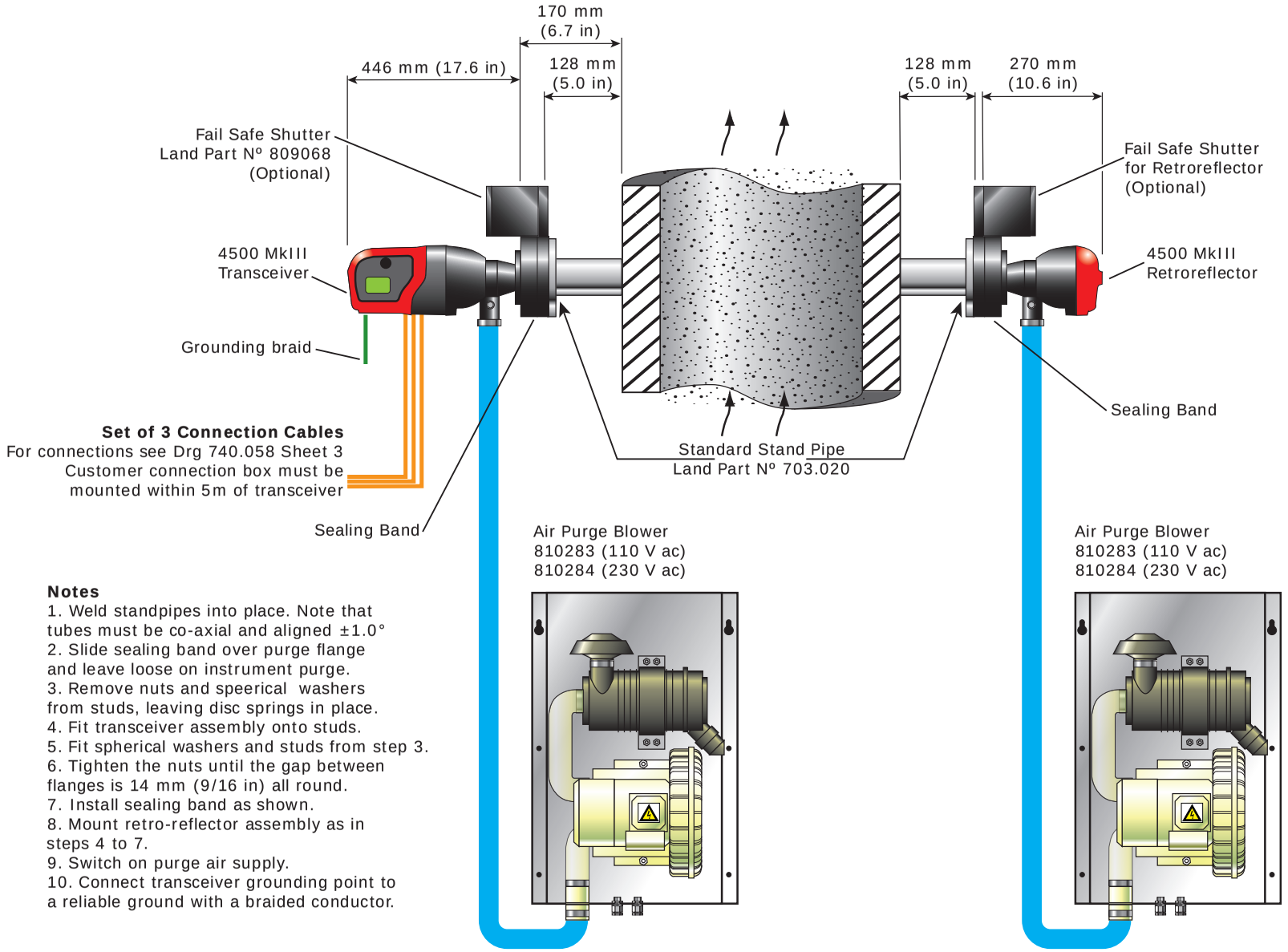
A3.5 Mounting Details

Air Purge Mounting Holes

The air purge unit must be fixed to the mounting flange. It has three mounting holes to accept the mounting studs from the Standpipe.



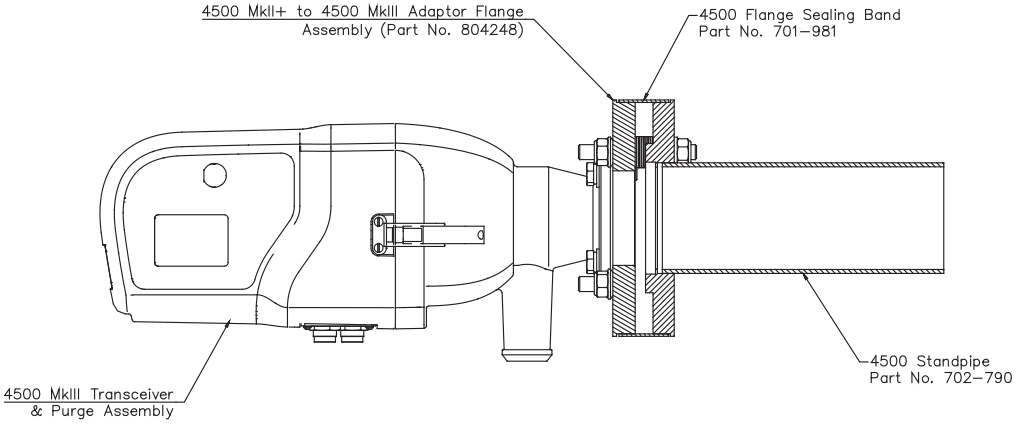
Front view of Air Purge showing mounting holes

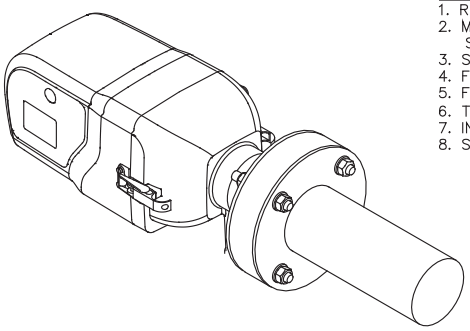


Notes

1. Weld standpipes into place. Note that tubes must be co-axial and aligned ±1.0°
2. Slide sealing band over purge flange and leave loose on instrument purge.
3. Remove nuts and speerical washers from studs, leaving disc springs in place.
4. Fit transceiver assembly onto studs.
5. Fit spherical washers and studs from step 3.
6. Tighten the nuts until the gap between flanges is 14 mm (9/16 in) all round.
7. Install sealing band as shown.
8. Mount retro-reflector assembly as in steps 4 to 7.
9. Switch on purge air supply.
10. Connect transceiver grounding point to a reliable ground with a braided conductor.

4500 MkIII System Installation Overview





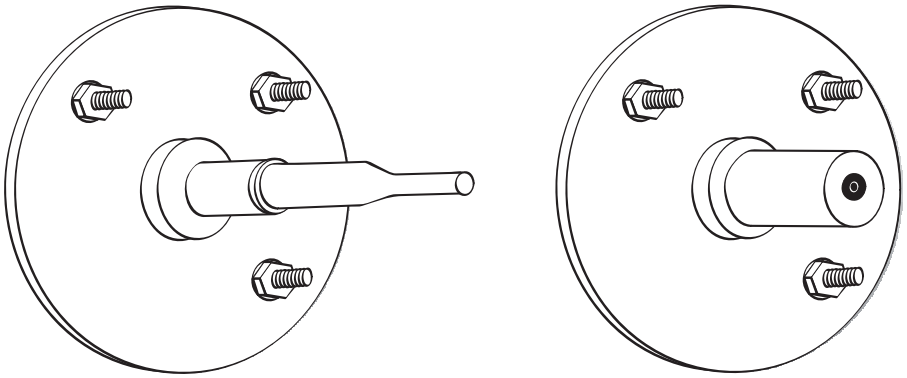
NOTES:
1. REMOVE EXISTING 4500 INSTRUMENT FROM STANDPIPE RETAINING THE NUTS & SPHERICAL WASHERS.
2. MOUNT 4500 MkIII INSTRUMENT to ADAPTOR FLANGE ASSEMBLY USING BOLTS, WASHERS & GASKET SUPPLIED WITH ADAPTOR FLANGE ASSEMBLY.
3. SLIDE SEALING BAND OVER STANDPIPE FLANGE & LEAVE LOOSE ON STANDPIPE.
4. FIT TRANSCEIVER ASSEMBLY ON TO STANDPIPE STUDS.
5. FIT SPHERICAL WASHERS & NUTS FROM STEP 1 to RETAIN.
6. TIGHTEN NUTS UNTIL THE GAP BETWEEN FLANGES IS 14mm (9/16") ALL ROUND.
7. INSTALL SEALING BAND AS SHOWN.
8. SWITCH ON AIR PURGE SUPPLY.

5. NOTE: CHECK THAT EACH MOUNTING STUD HAS SIX PAIRS OF SPRING WASHERS

Installing a 4500 MkIII on existing 4500 series mountings

A3.6 Using the Flange Alignment Tool

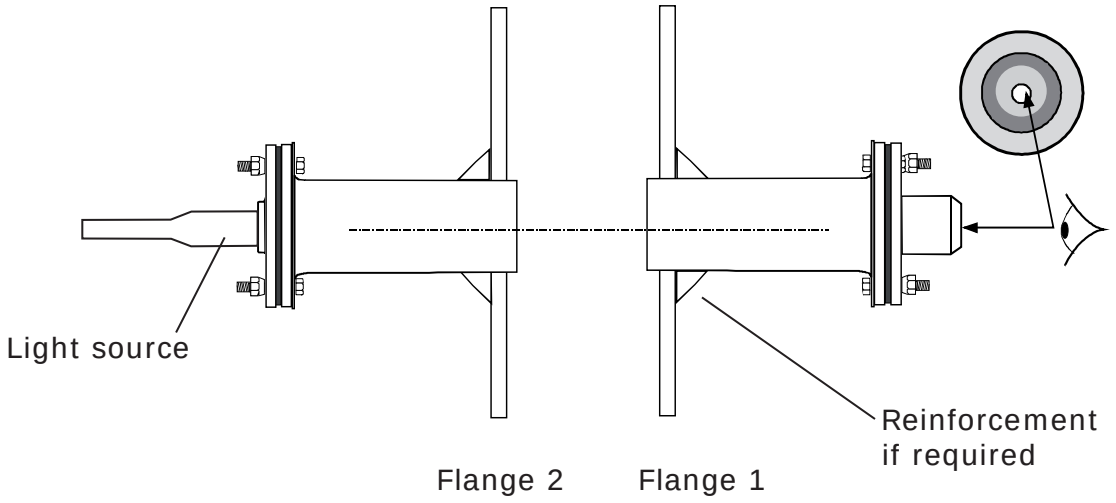
The flange alignment tool (part number 703.070) consists of two plates which are mounted on to the flanges. One plate supports a light source, the other a small telescope with a target in the centre. When the flanges are properly aligned, the light spot is located in the centre of this target.



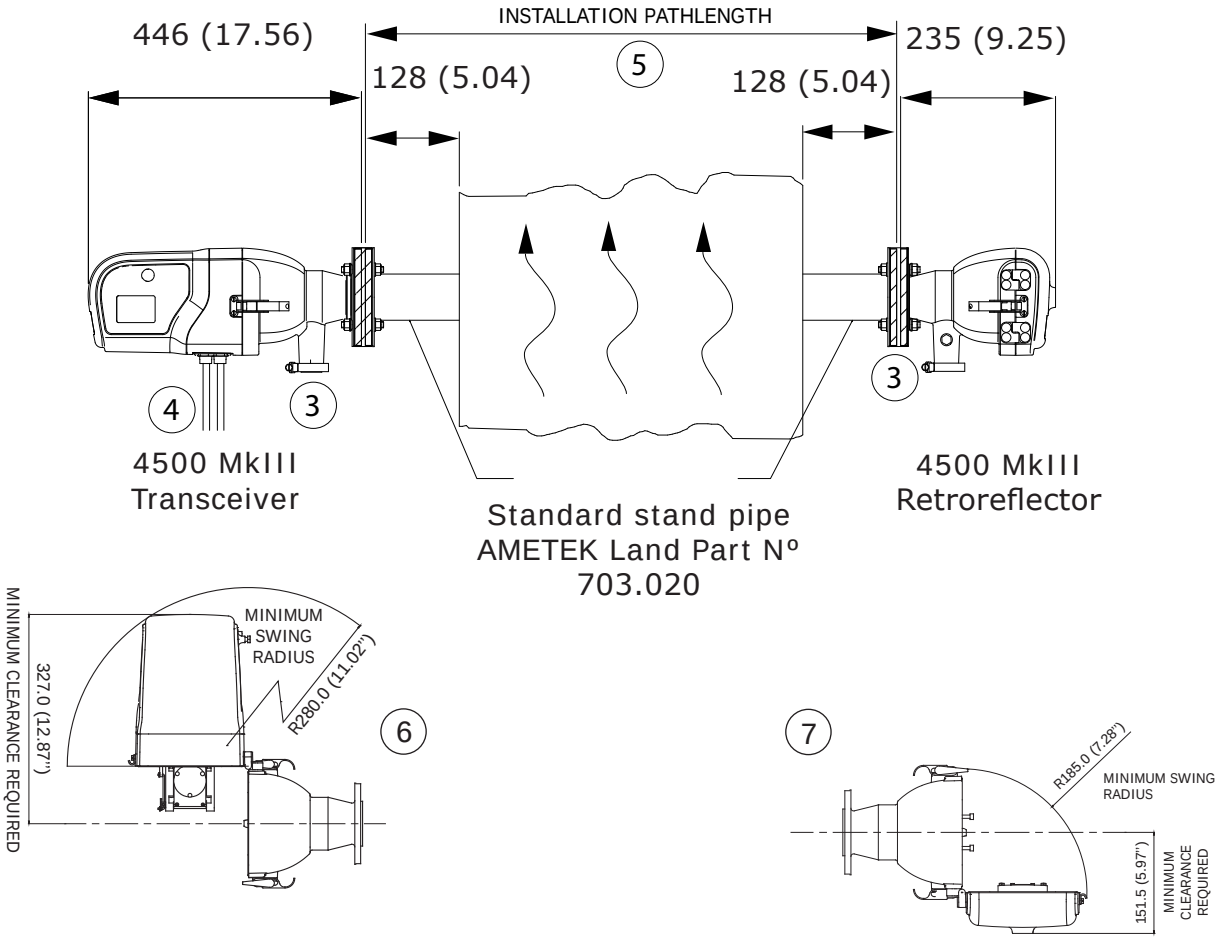
Light source Alignment circle

The flange alignment tool is used as follows:

1) Remove the washers from the mounting flanges. Retain these as they are essential to the correct installation of the instrument.
2) Tack weld the flanges in position.
3) Mount the flange alignment tool as shown below, with the light source attached to flange 2.
4) Align flange 1 and weld it into place.
5) Remove the alignment tool and refit it with the light source attached to flange 1.
6) Align flange 2 and weld it into place.
7) Replace the washers. See section A3.8.



A3.7 Important information for installing the transceiver and retro-reflector



1) Check the dimensions carefully before installation.
   a) Allow at least 1 m (3.3 ft) for mounting and removal procedures
   b) Allow a minimum of 200 mm (8 in) directly below the instrument for purge air (3) and electrical connections (4).
   c) Allow sufficient space to the side of each instrument to allow the hinges (6 and 7) to be opened.
   d) Check the Blower Unit Manual for additional installation requirements.
2) The air hose fitted between the air blower unit (see the diagram in section A2) and its two connections on the instrument (3) must not exceed 7m (23 ft).
3) The flange-to-flange path length (5) is factory set and must not be changed. It is given on the back of the Transceiver.
4) Pre-terminated 5 m power and data cables are supplied with this instrument.

A3.8 Mounting the Transceiver and Retro-Reflector

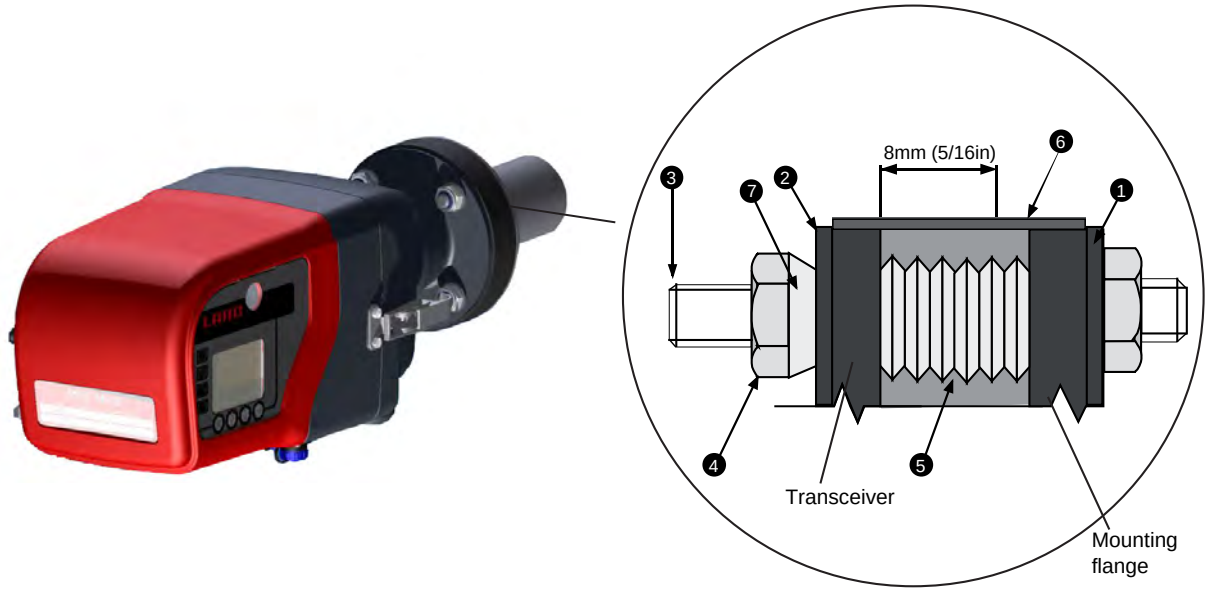
1) Ideally, the instrument should be installed when the process is not operating and the stack is cold.

2) The air blower unit should be operating and connected to the Transceiver and Retro-Reflector before the instrument is mounted on to the flanges.

3) Check that each mounting stud has the correct number of spring washers (5) arranged as shown - these may have been removed if the flange alignment tool was used. The standard flange 703.020 has four pairs of spring washers on each mounting stud.

NOTE

If the 4500 MkIII is replacing a 4500 MkII, a larger size of standpipe (702.790) is used. This requires six pairs of spring washers on each mounting stud.



4) Place a rubber sealing band over the mounting flanges for the Transceiver and Retro-Reflector. It cannot be fitted after the instrument is mounted on the flange.

5) Remove the three M10 nuts (4) and dome washers (2) from the mounting flange, and locate the Transceiver on to the studs (3).

6) Replace the Nyloc nuts (4) and dome washers (2) and tighten them, compressing the spring washers (5), until there is a gap of 8 mm (5/16 in) between the two flanges, all round. Pull the sealing band (6) into place over the gap. Anti-seize compound may be useful to prevent galling of the threads in extremely hot or corrosive environments such as coastal locations.

7) Install the Retro-Reflector following the same procedure.

CAUTION

If the instrument is being hoisted into position, the case clips must be covered or taped closed, to prevent them from opening accidentally.

A3.9 Electrical Connections

All switch cabinets, distribution boxes, fuses and other components for electrical installation must be provided by the customer, as must the mains power supply connections. Installation should be carried out by a competent person and cables should satisfy current carrying capacity and voltage rating.

Air Blower Unit Connections

Refer to the Instruction Manual supplied with the Air Blower Unit.

DC Supply

The 4500 MkIII requires a 24 V dc 3A supply.

Current consumption is 0.25 A at temperatures above -20 °C. Current increases to 3 A at lower temperatures, when the case heaters are operating.

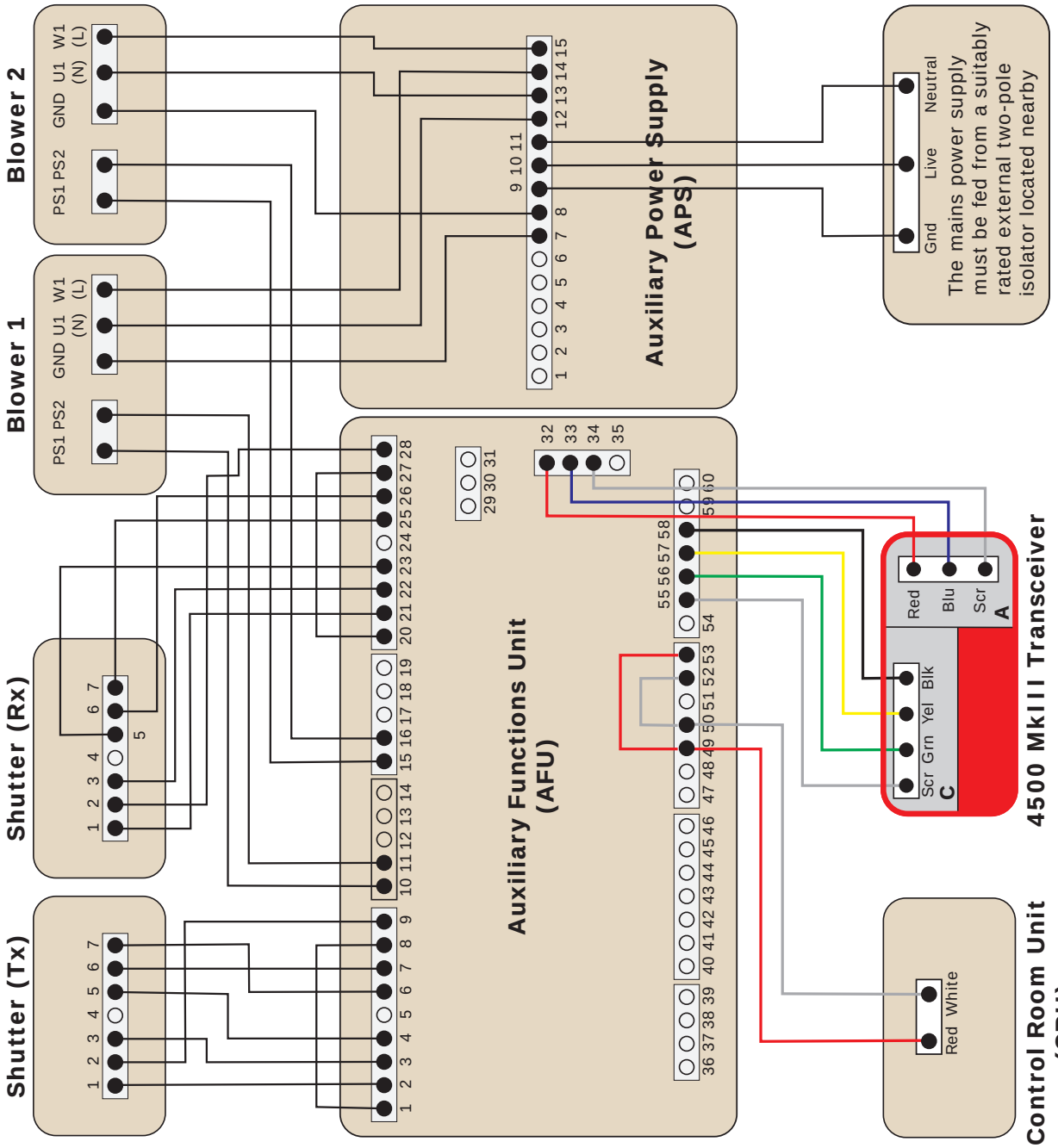
Signal Connections

Transceiver data cables (See diagrams in A3.10)

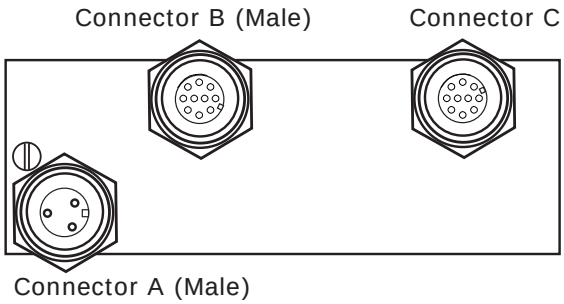
Lightning Protection

The 4500 MkIII opacity monitor is installed frequently in locations exposed to lightning strikes. The instrument's susceptibility to lightning-induced damage can be greatly reduced by connecting the grounding point to a reliable ground (earth) connection via a copper braid. The grounding point is shown in the photograph below.

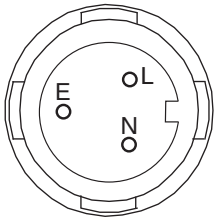
System Electrical Connections Overview



A3.10 Transceiver Connections

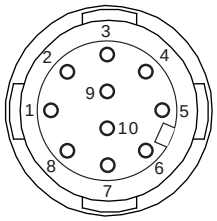


Connector A



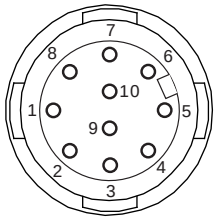
Pin Nº	Colour	Function
L	Red	+24 V dc
N	Blue	0 V
E	Screen	Screen

Connector B



Pin Nº	Colour	Function
1	Red	In Cal Relay NO
2	Blue	Alarm Relay COM
3	White	Alarm Relay NO
4	Yellow	4 to 20 mA O/P +
5	Green	4 to 20 mA O/P -
6	Screen	Screen
7	N/C	N/C
8	Black	In Cal Relay COM
9	Brown	Alarm Relay NC
10	Violet	In Cal Relay NC

Connector C



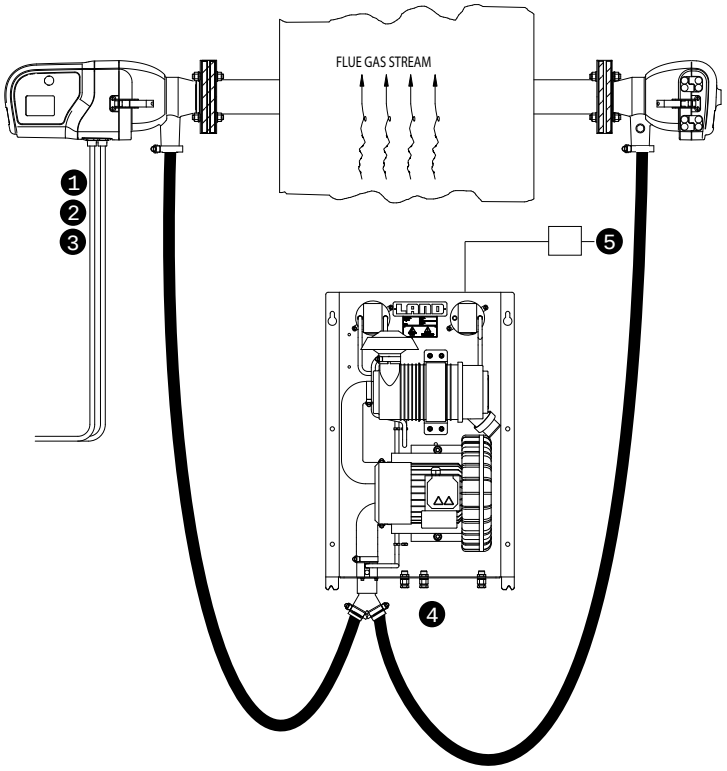
Pin Nº	Colour	Function
1	Screen	Screen
2	N/C	N/C
3	Red	Sys OK Relay COM
4	Blue	Sys OK Relay NO
5	Green	RS485 D1
6	Yellow	RS485 DØ
7	N/C	N/C
8	N/C	N/C
9	White	Sys OK Relay NC
10	Black	RS485 COM

A3.11 Cable Specification

Cable types recommended by AMETEK Land.

Electrical Connections Overview	Nº of Cores	Core Size mm^2	Core Size strands/ dia	Core Size awg	Diameter	Screened	Supplied by
1	3	0.5	16/0.2	22	6.5 mm	Yes	LAND
2	8	0.25	7/0.2	24	6.1 mm	Yes	LAND
3	8	0.25	7/0.2	24	6.1 mm	Yes	LAND
4	4	0.5 to 1.5	16/0.2 to 30/0.2	22 to 16		No	Customer
5	3	1.0	32/0.2	18		No	Customer

Cables 1, 2 and 3 are supplied in 5 m lengths.

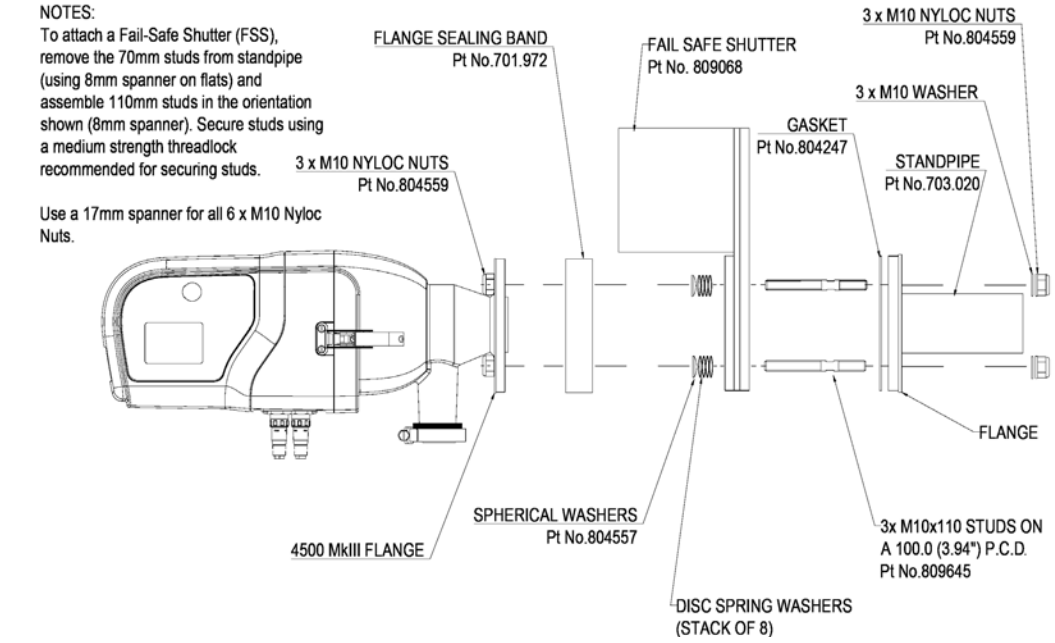


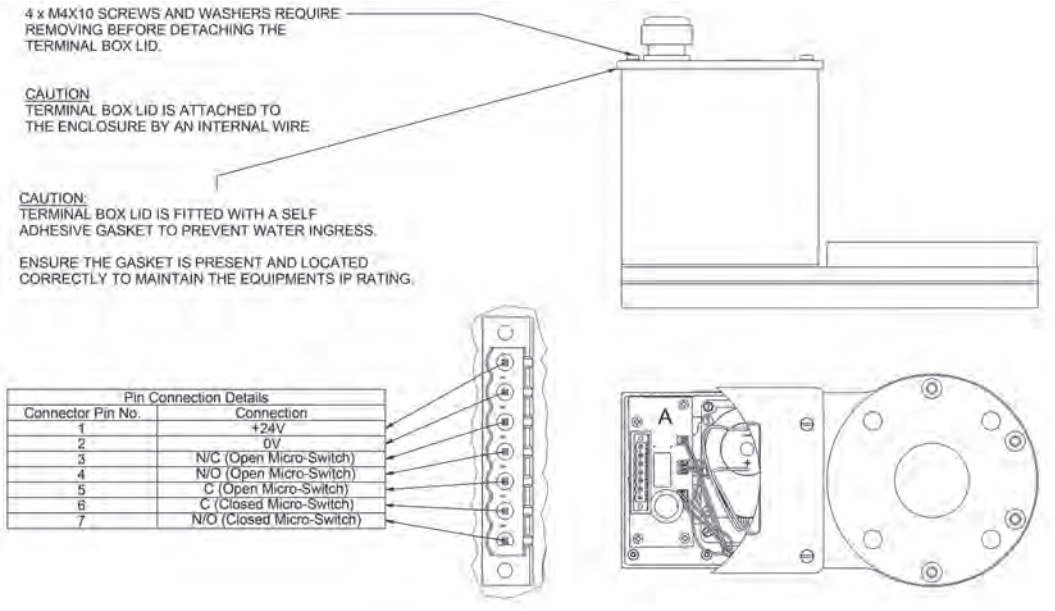
A3.12 Installation with a Fail-Safe Shutter (FSS)

The Fail-Safe Shutter provides protection to the optical system in the event of a short-term purge failure. It opens when power is applied and closes on loss of power, or if it receives a signal from the AFU. When used with a 4500 MkIII, the shutter closes each time the instrument performs an automatic zero calibration. This function reduces the risk that the shutter will jam in the open position and fail to close when needed. The instrument gives an error message if the shutter does not close and open as expected.

The shutter is not designed to withstand extended exposure to stack gases, and such exposure will cause permanent damage. Depending on the temperature and composition of the stack gases, damage will typically occur after a few days' exposure. After this time, the shutter may seize in the closed position, though it will continue to protect the instrument.

Each shutter is supplied with a 16 m (50 ft) length of 8.3 mm (0.33 inch) diameter cable which is used to connect it to the AFU.





Pin Connection Details	
Connector Pin No.	Connection
1	+24V
2	0V
3	N/C (Open Micro-Switch)
4	N/O (Open Micro-Switch)
5	C (Open Micro-Switch)
6	C (Closed Micro-Switch)
7	N/O (Closed Micro-Switch)

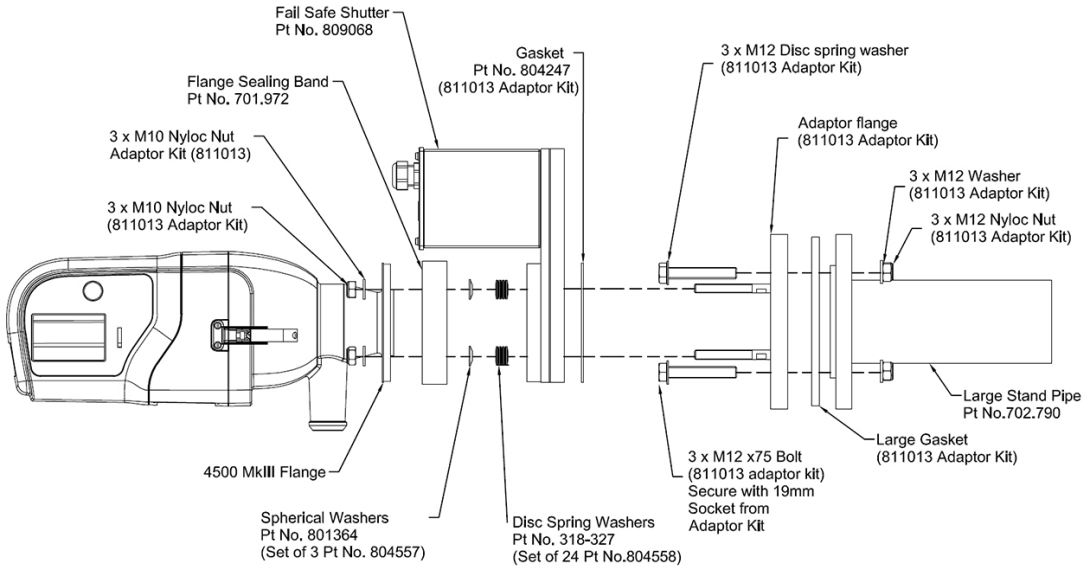
A3.13 Replacing a 4500 MKII or 4500 MkII+ incorporating a Fail-Safe Shutter

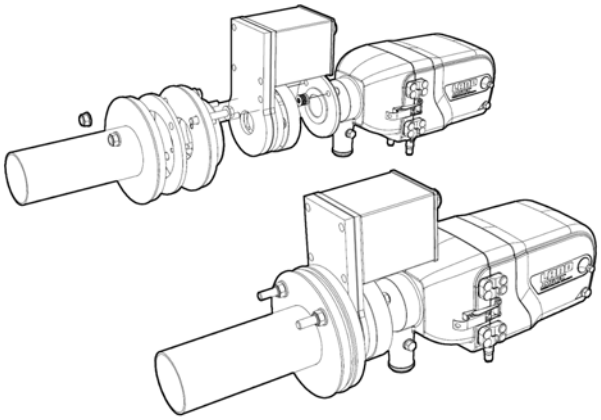
If the 4500 MkIII is replacing an older 4500 MkII or MkII+ and a fail-safe shutter is used, you will need to use a special Adaptor Kit (Part Nº 811013).

To complete the installation, refer to the instructions and illustrations below:

1) Remove the three M12 studs from the existing standpipe.
2) Place the silicone sponge gasket between the standpipe and the adaptor.
3) Fit the new adaptor flange to the standpipe using the three M12 bolts provided. Ensure the bolts go into the countersunk holes on the adaptor flange. A socket wrench is provided to assist with installation.
4) The M12 threads will protrude on the rear side of the standpipe flange. These can be used to mount a weather cover, if necessary. Three M12 nuts are provided to secure the weather cover in place.
5) Leave the fibre gasket on the adaptor but remove the nuts and washers from the studs
6) Slide the shutter onto the studs
7) Replace the spring washers
8) Fit the 4500 MkIII onto the studs
9) Fit the spherical washers and locking nuts onto the studs.

   Installation is now complete.





A3.14 Weather Covers

Weather covers provide additional protection against driving rain, intense sunlight and other severe weather conditions.

Two options are available:

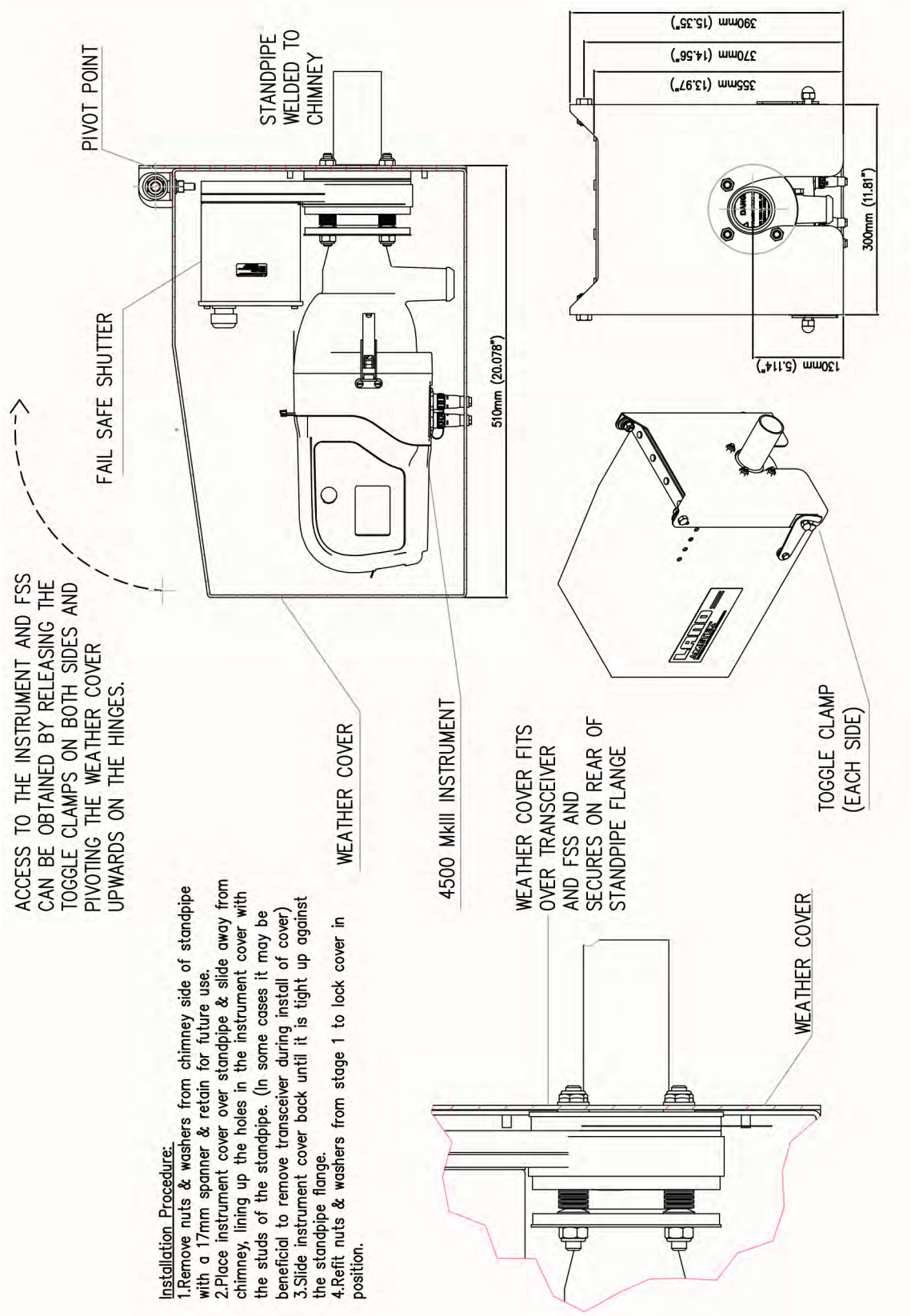
- Weather Cover 809881 mounts to the normal standpipe 703.020.
- A larger weather cover 807275 is required where the 4500 MkIII is replacing an older 4500 MkII, Premier or MkII+ using the existing, large standpipe.

In both cases, the weather cover mounts to the rear side of the standpipe using the three studs and their lock nuts.

To open the weather cover for maintenance, undo the clamps on either side and swing the cover upwards. To prevent accidental closing of the weather cover, place a 6 mm or ¼ inch screw in the holes on either side of the fixed part of the cover.

To prevent injury, always fit a locking screw in the weather cover before working on the Model 4500 MkIII.

A3.15 Installation with a Weather Cover (Part № 809881)



A4 AFU-APS-I/O Auxiliary Function Unit

A4.1 Description

The Auxiliary Functions Unit (AFU) side of the AFU-APS-I/O provides additional communications and control facilities for the Model 4500 MkIII:

- 2 isolated 4 - 20 mA current loop outputs
- 2 alarm relays
- 4 status and calibration relays
- 4 blower status inputs
- 4 fail-safe shutter status inputs
- 2 fail-safe shutter control outputs
- 4-wire Modbus port
- RS232 or RS485 diagnostic port
- 110 v or 230 V ac mains power supply (with APS)
- Circuit breakers and terminals for ac supply distribution (with APS)

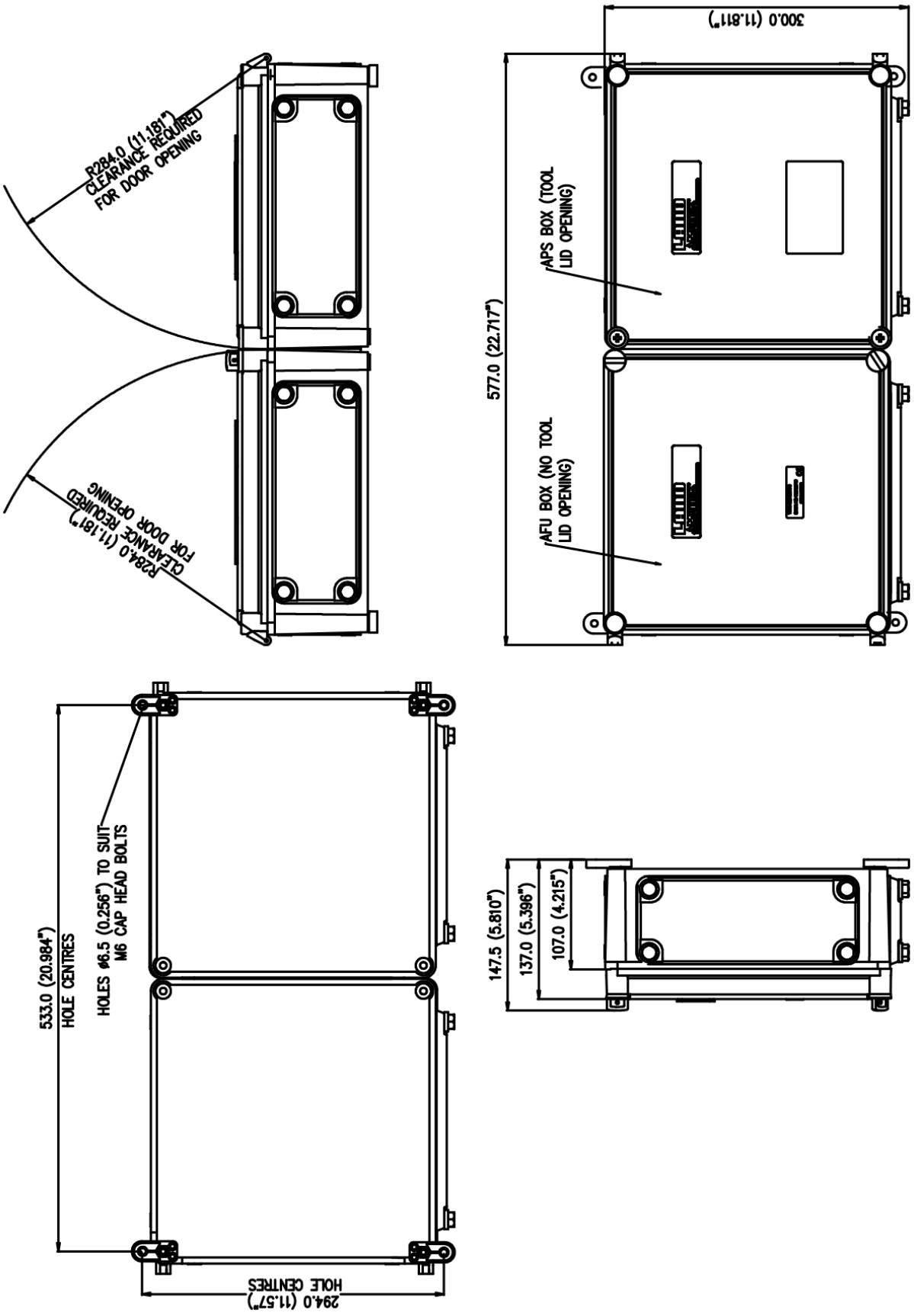
The AFU connects to the Transceiver via its RS485 Modbus port.

A4.2 Location

If the AFU is used to provide connections to Blowers and Fail-safe shutters, it must be located close to the 4500 MkIII Transceiver.

	4500 MkIII	AFU-APS-I/O
4 to 20mA output (x1)	•	•
2-wire RS485 Modbus	•	•
In Cal relay	•	•
Alarm relay	•	•
System OK relay	•	•
Mains power input		•
4-wire Modbus		•
Additional Modbus port		•
Shutter connections (24 V)		•
Pressure switch connections		•
Calibration trigger I/P		•
4 to 20 mA output (x2)		•
Zero and Span cal relays		•
Fuel Selection (for dust measurement)		•
Mains power to blowers		•
-40°C Operation	•	•

A4.3 Mounting the AFU-APS-I/O



A4.4 Connecting the Transceiver to the AFU

Only connectors A and C are needed to connect the Model 4500 MkIII transceiver to the AFU. All connections are made to the AFU main circuit board, not the daughter board. Customer connections can then be made directly to the AFU.

Connector A

Function	Colour	AFU Terminal
24 V dc	Red	32
0 V dc	Blue	33
Screen	Braided Screen	34

Connector B (Optional)

This connection is required only if a third 4 to 20 mA signal will be used.

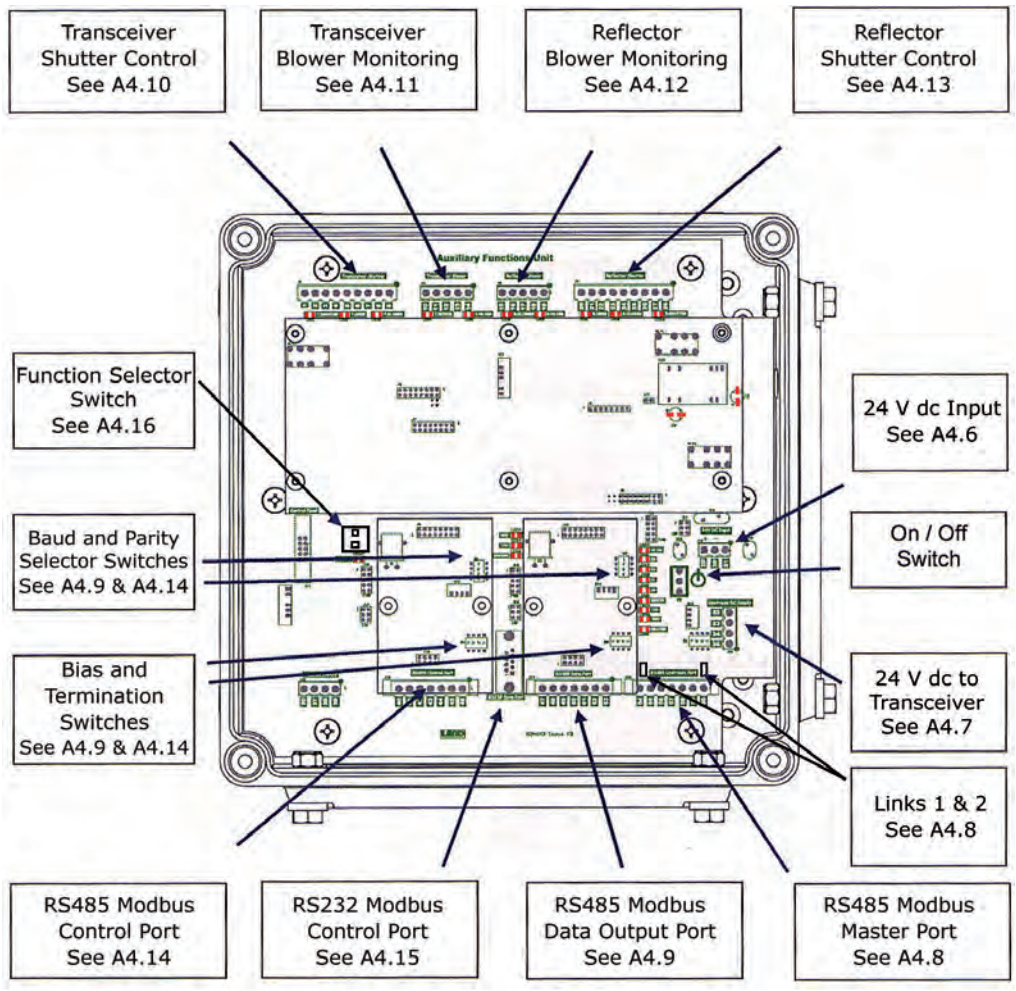
Function	Colour	AFU Terminal
4 to 20 mA +	Yellow	61
4 to 20 mA -	Green	62
Screen	Braided Screen	63

Connector C

Function	Colour	AFU Terminal
Screen	Braided Screen	55
Modbus D1	Green	56
Modbus D0	Yellow	57
Modbus Common	Black	58

A4.5 Connections

If an AFU is connested, the AFU icon will appear in the top left corner of the transceiver display, indicating that the AFU is communicating correctly. If the icon does not appear, follow the Troubleshooting for Error 11 in Section E1.



A4.6 24V DC Input (from APS or external supply)

Terminal	Function	APS Connection (if APS fitted)
29	+24V DC Supply Input	Red
30	0V DC Supply Input	Black
31	Cable Screen	Yellow/Green

A4.7 DC Supply to Transceiver

Terminal	Function	Transceiver Cable A
32	+24V DC Output	Red
33	24V DC Return	Blue
34	EARTH	Screen
35	EARTH	

A4.8 RS485 Modbus Master Port (To Transceiver)

Ensure links 1 and 2 are fitted for 2 wire operation.

Terminal	Function	Transceiver Cable C
54	Cable Screen	
55	Cable Screen	Screen
56	Modbus RXD1	Green
57	Modbus RXD0	Yellow
58	Modbus Common	Black
59	Modbus TXD0	
60	Modbus TXD1	

A4.9 RS485 Modbus Data Output Port

For 2 wire operation, connect 53 to 49 and 52 to 50.

Terminal	Function
47	Cable Screen
48	Cable Screen
49	Modbus TXD1
50	Modbus TXD0
51	Modbus Common
52	Modbus RXD0
53	Modbus RXD1

Baud and parity settings on S2

	S2-1	S2-2	S2-3	S2-4
19200, Even, 1 stop	**ON**	**OFF**	**OFF**	**OFF** (normal setting for Modbus)
9600, Even, 1 stop	ON	ON	OFF	OFF
9600, None, 1 stop	ON	ON	ON	ON

Termination and bias settings on S5 (See B4.9 for explanation):-

	S5-1	S5-2	S5-3	S5-4
Terminated	**OFF**	**OFF**	**ON**	**OFF** (normal setting)
Terminate and bias	ON	ON	ON	OFF
Un-terminated	OFF	OFF	OFF	OFF

A4.10 Transceiver Shutter Control

Terminal	Function	Shutter/AFU Terminal	Colour
1	Shutter Supply 0 V	AFU 8	-
2	Shutter Supply 24 V	1	Red
3	Shutter Open NC	3	Blue
4	Shutter Open COM	5	Green
5	Screen	-	Screen
6	Shutter Closed NO	7	Yellow
7	Shutter Closed COM	6	White
8	Open Shutter COM	AFU 1	-
9	Open Shutter	2	Black

Note: For correct operation, link AFU terminals 1 and 8.
Refer to Appendix A for connections of earlier AC-powered versions of the shutter.

A4.11 Transceiver Blower Monitoring

Terminal	Function	Pressure Switch
10	Blower Fail Input	2
11	Blower Fail Return	1
12	Cable Screen	
13	Blocked Filter Input	
14	Blocked Filter Return	

A4.12 Reflector Blower Monitoring

Terminal	Function	Pressure Switch
15	Blower Fail Input	2
16	Blower Fail Return	1
17	Cable Screen	
18	Blocked Filter Input	
19	Blocked Filter Return	

A4.13 Reflector Shutter Control

Terminal	Function	Shutter/AFU Terminal	Colour
20	Shutter Supply 0V	AFU 27	-
21	Shutter Supply +24V	1	Red
22	Shutter Open NC	3	Blue
23	Shutter Open COM	5	Green
24	Screen	-	Screen
25	Shutter Closed NO	7	Yellow
26	Shutter Closed COM	6	White
27	Open Shutter Common	AFU 20	-
28	Open Shutter	2	Black

Note: For correct operation, link AFU terminals 20 and 27.
Refer to Appendix A for connections of earlier AC-powered versions of the shutter.

A4.14 RS485 Modbus Control Port

For 2 wire operation, connect 46 to 42 and 45 to 43.

Terminal	Function
40	Cable Screen
41	Cable Screen
42	Modbus TXD1
43	Modbus TXD0
44	Modbus Common
45	Modbus RXD0
46	Modbus RXD1

Baud and parity settings on S1

	S1-1	S1-2	S1-3	S1-4
19200, Even, 1 stop	**ON**	**OFF**	**OFF**	**OFF** (normal setting for Modbus)
9600, Even, 1 stop	ON	ON	OFF	OFF
9600, None, 1 stop	ON	ON	ON	ON

Termination and bias settings on S4 (See B4.9 for explanation):

	S4-1	S4-2	S4-3	S4-4
Terminated	**OFF**	**OFF**	**ON**	**OFF** (normal setting)
Terminate and bias	ON	ON	ON	OFF
Un-terminated	OFF	OFF	ON	OFF

A4.15 RS232 Modbus Control Port

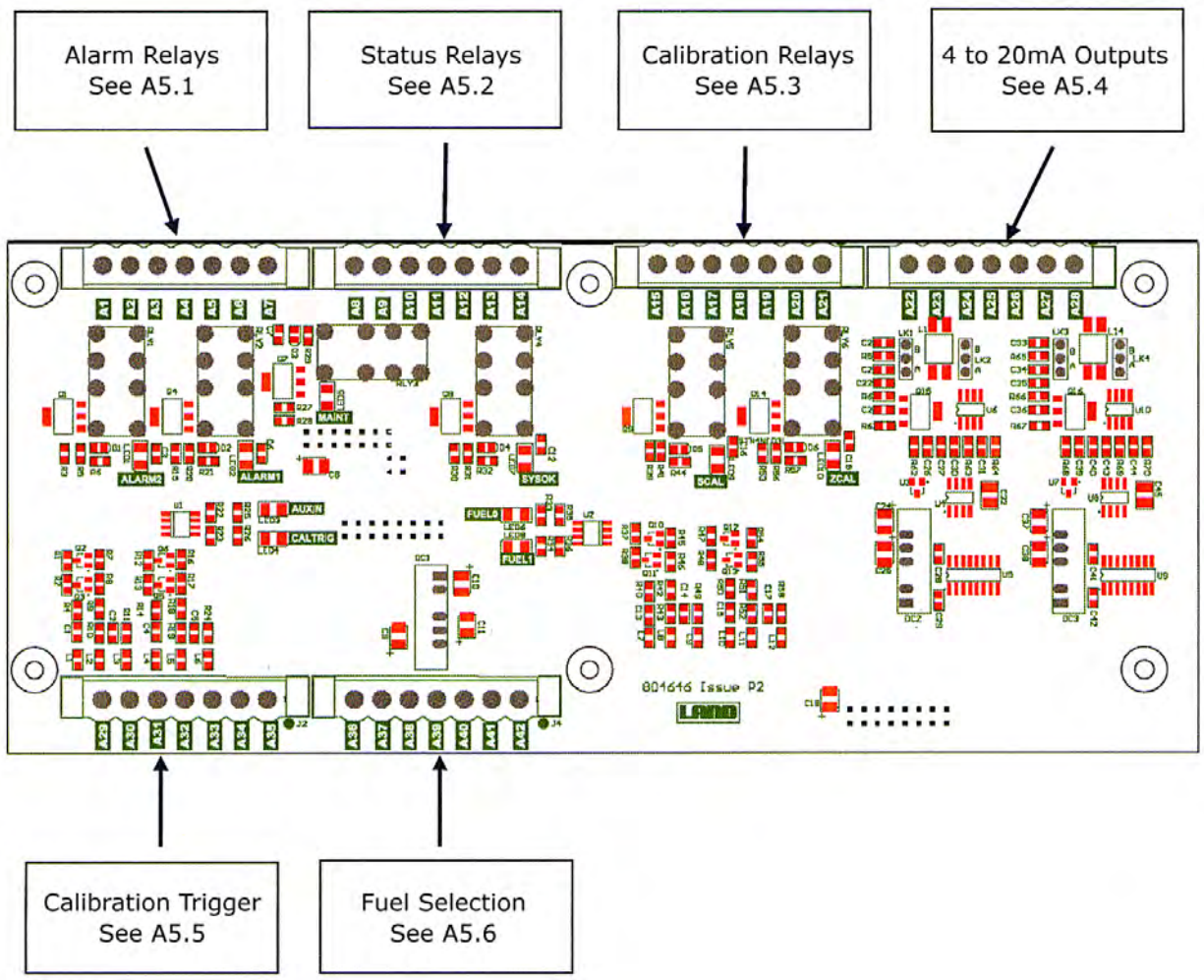
Terminal	Function
2	TXD
3	RXD
5	Common

A4.16 Function Selector Switch

All switches are set to ON at the factory.

Terminal	Function
S7-1	Ambient temperature monitoring
S7-2	Reserved
S7-3	Calibration trigger and fuel selector inputs
S7-4	Blower monitoring and shutter control

A5 AFU-APS-I/O: Process I/O Board



A5.1 Alarm Relays

Terminal	Function
A1	Alarm 2 Common
A2	Alarm 2 OK
A3	Alarm 2 Active
A4	Screen
A5	Alarm 1 Common
A6	Alarm 1 OK
A7	Alarm 1 Active

A5.2 Status Relays

Terminal	Function
A8	Maintenance (Data not Valid) Common
A9	Run (Data Valid)
A10	Maintenance (Data not Valid)
A11	Screen
A12	System OK Common
A13	Fault
A14	System OK

A5.3 Calibration Relays

Terminal	Function
A15	Upscale Calibration Common
A16	Normal Running
A17	Upscale Calibration in Progress
A18	Screen
A19	Zero Calibration Common
A20	Normal Running
A21	Zero Calibration in Progress

A5.4 4 to 20 mA Outputs

Output 1 Settings:

Active (Current Source) LK1 and LK2 in position B

Passive (Current Sink) LK1 and LK2 in position A

Output 2 Settings:

Active (Current Source) LK3 and LK4 in position B

Passive (Current Sink) LK3 and LK4 in position A

Terminal	Function
A22	Output 1 +
A23	Output 1 -
A24	
A25	Screen
A26	
A27	Output 2 +
A28	Output 2 -

A5.5 Calibration Trigger Input

Connect volt-free contacts between A30 and A31 to initiate calibration check.

Terminal	Function
A29	Calibration Trigger Common
A30	Calibration Trigger Input
A31	Calibration Trigger Supply
A32	Screen
A33	
A34	
A35	

A5.6 Fuel Selection Inputs

The Model 4500 Mk III can be configured to measure dust using two sets of dust parameters.
Connect volt-free contacts between A37 and A38 to Select Fuel 1.
Connect volt-free contacts between A41 and A42 to Select Fuel 2.

Make both connections to Select Fuel 3.

Terminal	Function
A36	Fuel Select 1 Common
A37	Fuel Select 1 Input
A38	Fuel Select 1 Supply
A39	Cable Screen
A40	Fuel Select 2 Common
A41	Fuel Select 2 Input
A42	Fuel Select 2 Supply

A5.7 Additional Connections

Terminals 61, 62 and 62 may be used to connect the 4 to 20 mA signal from the transceiver to the customer's data acquisition system.

Terminal	Function	Colour
61	4 to 20 mA +	Yellow
62	4 to 20 mA -	Green
63	Screen	Braided Screen

A6 AFU-APS-I/O: Auxiliary Power Supply (APS)

A6.1 Description

The Auxiliary Power Supply (APS) side of the AFU-APS-I/O contains a 24 V dc Power Unit for the AFU and/or Transceiver. It requires an ac mains input in the range 90 to 132 or 187 to 260 V ac, 50 to 60 Hz. The supply voltage range is selected automatically.

It also contains circuit breakers and terminals for supplying ac power to two blowers.

For specifications, see Section D.

The APS can be supplied as an integrated unit with an AFU, or as a standalone unit.

The standalone units can supply power to the AFU (and thus the 4500 MkIII) or to the 4500 MkIII directly.

CAUTION

Only AMETEK Land-supplied blowers may be connected safely to the APS. The connection of any other equipment to the shutter/blower terminals may be hazardous.

Approved blowers are listed in the table below:

Part N°	Description
099.471	Plate-Mounted Blower (230 V, 50 Hz)
099.472	Plate-Mounted Blower (220 V, 60 Hz)
099.473	Plate-Mounted Blower (110 V, 60 Hz)
803550	Blower Small, USA (220 V, 60 Hz)
803551	Blower Small, USA (110 V, 60 Hz)
806441	LC Economy Blower (110 V, 60 Hz)
806440	LC Economy Blower (230 V, 50 Hz)

CAUTION

Incorrect supply voltage/frequency can cause the motor to burn out, compromise performance or cause an explosion.

The connection of a blower restricts the allowable voltage range of the APS to that of the shutter/blower.

The blower supply voltage/frequency are detailed on the rating plate of the supplied motor. Check carefully.

Do not exceed the rated supply values. External wiring must be rated to >70°C / 158°F if the ambient temperature can rise above 50°C / 122°F.

A6.2 Standalone Auxiliary Power Supply (APS)

Terminal Connections

All terminals are rated for 10mm² (IEC) or 6 awg (UL. CSA) cables. Maximum cable size is 16mm².

Customer Terminations APS DIN Rail			
Number	Function	Number	Function
1	Red +24V (4500 MkIII)	10	Mains Live Input
2	Red +24V (Shutter 1)		
3	Red +24V (Shutter 2)	11	Mains Neutral Input
		12	Blower 1 Neutral
4	Black 0V (4500 MkIII)	13	Blower 2 Neutral
5	Black 0V (Shutter 1)		
6	Black 0V (Shutter 2)	14	Blower 1 Live
		15	Blower 2 Live
7	Blower 1 Earth		
8	Blower 2 Earth	16	Do not connect
9	Mains Earth Input	17	Do not connect

CAUTION

This unit **must only** be opened by personnel with electrical safety training.

The mains power supply to the APS must be fed from a suitably rated external two-pole isolator located nearby.

This unit **must** be earthed.

External wiring must be rated to >70°C / 158°F if the ambient temperature can rise above 50°C / 122°F.

Appendix A - Shutter Control Connections

Use these connections with earlier, mains-powered shutters.

AA.1 Transceiver Shutter Control

Terminal	Function	Shutter Terminals
1	Shutter Supply 0V	
2	Shutter Supply +24 V	
3	Shutter Open NC	14
4	Shutter Open COM	13
5	Cable Screen	Screen
6	Shutter Closed NO	17
7	Shutter Closed COM	16
8	Open Shutter Common	6
9	Open Shutter	7

Note: Shutters also require a link between shutter terminals 8 and 9

AA.2 Reflector Shutter Control

Terminal	Function	Shutter Terminal
20	Shutter Supply 0V	
21	Shutter Supply +24V	
22	Shutter Open NC	14
23	Shutter Open COM	13
24	Cable Screen	Screen
25	Shutter Closed NO	17
26	Shutter Closed COM	16
27	Open Shutter Common	6
28	Open Shutter	7

Note: Shutters also require a link between shutter terminals 8 and 9

END OF SECTION

B

GETTING STARTED

B1 The User Interface

The model 4500 MkIII is operated from the User Interface in the Transceiver. The User Interface has four function keys, and four illuminated indicators.

The liquid crystal display normally indicates the opacity measured by the instrument. Error messages and other parameters can also be displayed, as explained in a later section. The displayed opacity is corrected for Pathlength Correction Factor (PLCF). The PLCF is factory set and cannot be changed by the customer (see section C3).

1	Power on	4	Alarm Status
2	System status	5	LCD
3	Calibration in progress	6	Function keys

B2 Function Keys

The following function keys are located on the touch panel below the LCD display on the side of the Model 4500 MkIII Transceiver:

✕ Exit. Return to the previous menu level or cancel data entry.

⇧ Up. Change menu item or increase data value.

⇩ Down. Change menu item or decrease data value.

⏎ Enter. Select menu item or save data entry.

1. Displayed Value

When the LCD display is showing only the instrument reading, pressing the ⇧ or ⇩ arrows will change the value displayed. If the units are %, the value is Opacity, if the units are mg/m³, the value is Dust Density. If no units are shown, the value is Optical density.

2. Menu Selection

When the LCD display is showing only the instrument reading, press ✕ or ⏎ to go to the menu.

Use the ⇧ and ⇩ arrows to select the required menu item and press ⏎

To cancel a menu selection, press ✕

3. Data Entry

To change a data value, use the ⇧ arrow to increase the value and the ⇩ arrow to decrease it.

When the value is correct, wait for the ⏎ icon to appear, then press ⏎ to store it permanently.

To abandon the change and revert to the previous value, press ✕

The Model 4500 MkIII provides an accelerator facility for entering large numbers.

To increase the value, hold down the ⇧ arrow. The longer you hold down the key, the quicker the value increases. Initially, values increase in steps of 1, then steps of 10, then steps of 100, and so on. When you release the key, the highlight steps down the digits. You can press the up or down key again to make minor adjustments to the highlighted digit.

To store a value, wait until the highlight is on the last digit and the ⏎ symbol is present, and then press the ⏎ key.

Pressing ✕ leaves the original value unchanged. It is not possible to store a value which is out of limits.

Decreasing the value using the ⇩ arrow works in a similar manner.

Model 4500 MkIII Symbols

1 Enter

2 Exit

3 Up

4 Down

6 Unlock

7 Supervisor unlocked

8 Engineer unlocked

9 Lock

10 Locked

11 AFU present (or faulty if flashing)

12 Isokinetic average in progress

15 Calibrate

16 Settings

17 Parameters

18 Diagnostics

19 AFU settings

21 Cal check

22 Recalibrate

23 Cal Audit

24 Gravimetric test

25 Confirm abort

26 Fuel specific settings

27 Alarm type (Transceiver alarm)

271 Alarm type (AFU 1)

272 Alarm type (AFU 2)

31 Calibration check interval

32 Show negative

33 Alarm level (Transceiver alarm)

331 Alarm level (AFU 1)

332 Alarm level (AFU 2)

34 O/P type (Transceiver output)

341 O/P type (AFU 1)

342 O/P type (AFU 2)

35 O/P range (Transceiver output)

351 O/P range (AFU 1)

352 O/P range (AFU 2)

36 Constant current (Transceiver)

361 Constant current (AFU 1)

362 Constant current (AFU 2)

37 Dust settings

41 Parameter number

42 Parameter Scroll

45  List faults

46  Clear faults

51  Dust gain 1

52  Dust gain 2

53  Dust offset

54  Fuel 1 in use

541  Fuel 2 in use

542  Fuel 3 in use

55  Zero check

56  Upscale check

61  Confirm clear path

62  Confirm blocked path

63  Test filter opacity

65  Not averaged

66  Averaged

71  Start

72  Stop

73  Wait

75  No Negative Values

76  Show Negative Values

81  Opacity

82  Optical Density

83  Dust Density

85  Restore Previous Cal

86  Restore Last Cal

87  Restore Factory Cal

88  Confirm Restore Cal

89  Completed OK

91  C Constant

92  X Constant

93  B Constant

98  Internal Communication Error

99  Major Internal Fault

B3 Glossary of Terms

Op	Opacity
O.D.	Optical Density
Dust	Dust Density
Averaging	Time period used to calculate block average
Loop O/P	Current loop output reading in mA
Last Zero	Last zero calibration value
Last Upscale	Last upscale calibration value
Cal. Drift	Drift of signal between calibrations (range 0.1 to 1.0)
Version	Software Version Number
Blank	A blank line
So	Signal Detector Offset
Sf	Signal Detector Flood Value
Sm	Signal Detector Measurement Value
Ro	Reference Detector Offset
Rf	Reference Detector Flood Value
Rm	Reference Detector Measurement Value
C	Calibration Constant (slope)
X	Calibration constant (offset)
B	Balance correction
G	Gain correction factor
Q	Uncorrected transmission factor
Dust Gain	Constant relating Optical Density to Dust Density.
Dust Offset	Dust Density zero offset (usually zero)
Dust Gain 2	Quadratic term relating optical density to dust density (usually zero)
OP Damper	Low pass digital filter applied to output
PLCF	Pathlength Correction Factor
Last Cal.	Data stored from the latest calibration
Zero Comp.	Opacity compensation due to dust build on the lens
Gravimetric O.D	Average Optical Density calculated during gravimetric test
Running In	Positioning the zero reflector or upscale filter to an active position
Running Out	Positioning the zero reflector or upscale filter to an inactive position

B4 Using the Instrument for the First Time

Tools required:

- Flat-bladed electrician's screwdriver
- 17 mm spanner (11/16 in AF wrench)
- 19 mm spanner (3/4 in AF wrench): If using the 3 in Adaptor flanges.

> **Note**
>
> When entering numbers using the ⇧ and ⇩ arrows on the keypad, wait until the ⏎ symbol appears on the display before pressing the ⏎ key to confirm the value.

B4.1 Complete Installation

Ensure that the installation has been completed and that the purge air blowers are running.

B4.2 Check the Pathlength Correction Factor

If the Model 4500 MkIII is to be used to report Opacity, it is essential that the Pathlength Correction Factor (PLCF) is set correctly. PLCF is not relevant for Dust Density or Optical Density (Extinction) measurements.

To check that the PLCF is correct, press ⏎

Use the ⇧ and ⇩ arrows to select Parameters and press ⏎

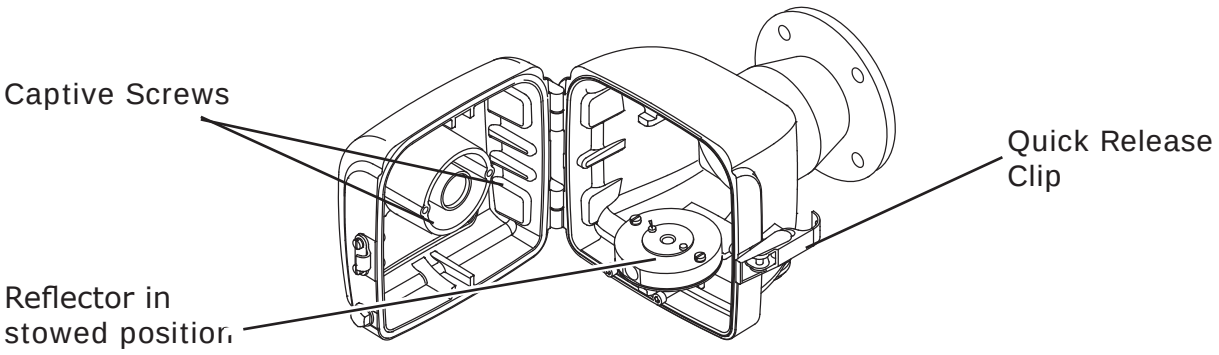
Use the ⇧ and ⇩ arrows to select Parameter Number and press ⏎

Use the ⇧ and ⇩ arrows to change the Parameter number to 137 and press ⏎

If the PLCF is correct press ✕ three times to return to the main screen.

If it is incorrect, the opacity monitor must be returned to AMETEK Land Instruments for reprogramming.

B4.3 Align the Retro-Reflector

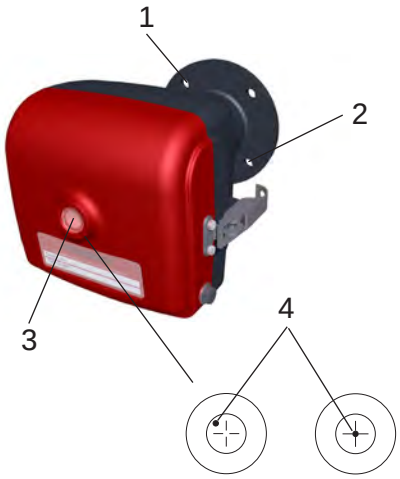


Opening the Retro-Reflector Case & Releasing the Reflector

1) Open the Retro-Reflector case by undoing the two quick-release clamps.
2) Release the Retro-Reflector Mount by unscrewing the two **captive screws** on either side of the Retro-Reflector Mount. Remove the reflector and stow in the purge housing.
3) Close the case and fasten the quick-release clamps.

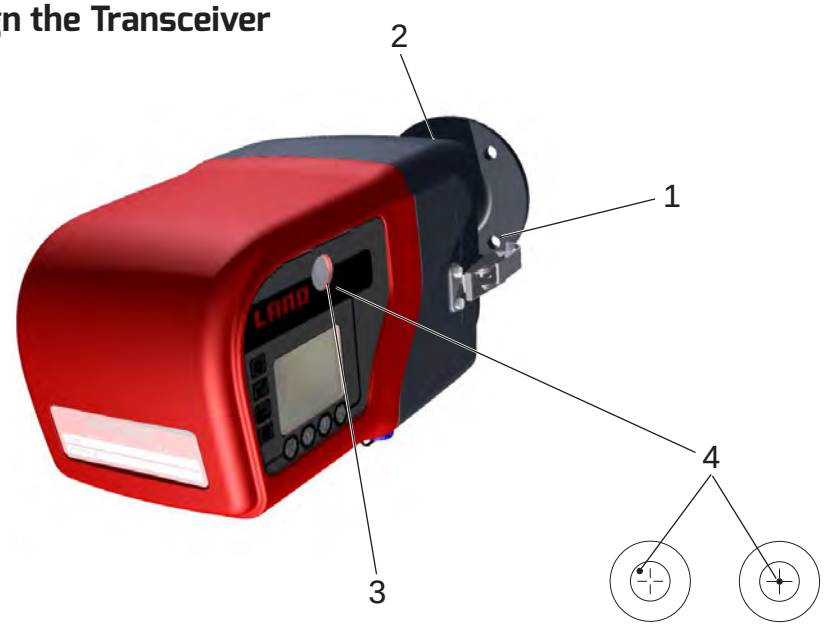
> **Warning**
>
> Eye and face protection must be worn when looking into hot gases.

4) Observe the alignment target through the window (3). A bright green spot (4) should be visible.
5) If the green spot is **not** visible undo the quick release clamp on the Retro-Reflector and look down the purge barrel. The bright green light from the Transceiver should be clearly visible. If not, then the Transceiver is either grossly misaligned or the instrument is malfunctioning.



6) To move the green spot horizontally adjust the M10 nut (1) on the air purge flange and to move it vertically, adjust the M10 nut (2), also on the air purge flange as illustrated above. Adjust these nuts until the green spot is central in the inner circle.
7) In bright sunshine the green spot on the alignment target may not be visible. In this case return to the transmissometer, undo the quick–release clamps and swing the instrument away from the purge. It should now be possible to adjust the Retro-Reflector until the bright circle of sunlight, visible through the transmissometer purge unit, is centred on the target.
8) Ensure that the 4 pairs of spring washers between the air purge flange and the mounting flange are under moderate compression. It is important that the instrument is firmly held in place to maintain optical alignment.
9) Open the Retro-Reflector case, re-fix the Retro-Reflector in position, and tighten the captive socket head screws. Close the Retro-Reflector case and fasten the two quick-release clamps.

B4.4 Align the Transceiver



Transceiver Alignment Target

1 Observe the alignment target through the window (3). A bright green spot (4) should be visible.

2 To move the green spot horizontally adjust M10 nut (1) on the air purge flange and to move it vertically, adjust the M10 nuts (2), also on the air purge flange as illustrated above. Adjust these nuts until the green spot is inside the inner circle.

3 In bright sunshine the green spot on the alignment target may not be visible. In this case return to the Retro-Reflector, undo the quick–release clamps and swing open the rear cover. It should now be possible to adjust the transmissometer until the bright circle of sunlight, visible through the Retro-Reflector purge unit is centred on the target. Close the Retro-Reflector again. If the green spot is visible, adjust the nuts until it is central in the inner circle.

4 Ensure that the spring washers between the air purge flange and the mounting flange are under moderate compression. If the compression becomes excessive, it is likely that the third nut has been over tightened or the mounting flange may not have been fitted accurately.

Note

If any of the settings are changed from their default values, the new values should be noted on the Calibration Report and Settings List supplied with the instrument.

B4.5 Setup Calibration Check Interval

1) From the instrument reading display, press ⏎
2) Unlock  is displayed, press ⏎
3) Use the ⇧ and ⇩ arrows until the Supervisor code (Default: 10) is displayed, wait for the ⏎ icon to appear and press ⏎
4) Use the ⇧ and ⇩ arrows to select Settings  and press ⏎
5) Use the ⇧ and ⇩ arrows to select Cal Check Interval  and press ⏎
6) Use the ⇧ and ⇩ arrows to change Cal Check Interval (in hours), wait for the ⏎ icon to appear and press ⏎
7) Press ✕ to return to Settings 

Note: Auxiliary Functions Unit (AFU)

If an AFU is fitted, the Transceiver outputs are not used, and there is no need to perform the settings described in sections 6, 7 and 8 below. AFU output setting instructions are given in sections 10, 11 and 12.

B4.6 Setup 4-20 mA Current Loop Output

The Model 4500 MkIII normally provides the power supply for the 4-20 mA current loop output. It is intended to be connected to a passive input device. To connect the 4-20 mA current loop output to an active device, option links inside the Transceiver must be changed. Switch off the power. Remove the rear cover from the Transceiver (see section E3) and locate Link 1 and Link 2 on the Main printed circuit board.

The Model 4500 MkIII is shipped set for Active output with the Links in the following positions:

Link 1: A
Link 2: B

For Passive output, set the Links in the following positions:

Link 1: B
Link 2: A

To configure the 4-20 mA current loop output:

1) From Settings, press ⏎

2) Use the ⇧ and ⇩ arrows to select Output Type and press ⏎

3) Use the ⇧ and ⇩ arrows to select Opacity, Optical Density, Dust Density, Constant Current, Calibration Drift or Pathlength Correction Factor and press ⏎

4) Press ✕ to return to Output Type.

5) Use the ⇧ and ⇩ arrows to select Output Range and press ⏎

6) Use the ⇧ and ⇩ arrows to change the output value corresponding to 20mA and press ⏎

7) Press ✕ to return to Output Range.

8) Use the ⇧ and ⇩ arrows to select Show Negative Values and press ⏎

9) Use the ⇧ and ⇩ arrows to select Show Negative Values or No Negative Values and press ⏎

10) Press ✕ to return to Show Negative Values

If required, the current loop output can be set to deliver a constant current for test purposes.

11) Use the ⇧ and ⇩ arrows to select Output Current and press ⏎

12) Use the ⇧ and ⇩ arrows to change the output current and press ⏎

13) When the test is complete, press ✕ to switch back to normal operation.

14) Press ✕ to return to Settings

Track and hold

The 4-20 mA current loop output can be set to track or hold during calibration. This function is controlled using the following system parameters

Register 188 - transceiver output

Register 338 - AFU output 1

Register 351 - AFU output 2

Setting the register value = 1 allows the current loop to track during the calibration check. This option is required for compliance applications so that the calibration value can be recorded by the data acquisition system.

Setting the register value = 2 freezes the 4-20 mA current loop during calibration, with the output held to the last valid measurement. This option is appropriate where the signal is being used as part of a process control system where the calibration reading could affect the operation of the controller.

B4.7 Setup Alarm

1) From Settings  , press ⏎
2) Use the ⇧ and ⇩ arrows to select Alarm Type  and press ⏎
3) Use the ⇧ and ⇩ arrows to select Opacity  , Optical Density  or Dust Density  and press ⏎
4) Use the ⇧ and ⇩ arrows to select Alarm  and press ⏎
5) Use the ⇧ and ⇩ arrows to change the Alarm Level and press ⏎
6) Press ✕ to return to Settings  .

B4.8 Modbus Interface

Modbus communications, based on the RS485 duplex hardware standard, provide direct access to the Model 4500 MkIII system data. Details of the Modbus protocol are available from the Modbus website www.modbus.org. The Model 4500 MkIII implements Functions: 1 (Read Coil), 3 (Read Holding Register), 5 (Force Single Coil), 6 (Pre-set Single Register) and 10 (Pre-set Multiple Registers).

The transceiver has one Modbus and the AFU has three Modbus ports. They can be used as follows:

Port	Main Use	Alternate use	Max baud rate
Transceiver Connector C	Connect to AFU	Customer data	57600
AFU Modbus Master	Connect to transceiver	None	57600
AFU Modbus Data O/P	Connect to CRU	Customer data	19200
AFU Modbus Control	Customer data	Spare port	19200

Each Modbus must have one termination resistor at each end and one bias network somewhere on the bus. The Model 4500 MkIII can provide a termination resistor and a bias network. As supplied, the termination resistor is switched on, and the bias network is switched off.

Port	Baud select	Bias & Termination	Max baud rate
Transceiver	Register 2	Transceiver S1	57600
AFU Modbus Data O/P	AFU S2	AFU S5	19200
AFU Modbus Control	AFU S1	AFU S4	19200

If you need to change the transceiver termination and bias settings, remove the rear cover from the Transceiver (see section E3) and locate switch S1 on the Main printed circuit board. The four sections of S1 have the following functions:

1 and 2 (both must be the same)	Bias network ON or OFF
3	Always ON
4	Termination resistor ON or OFF

The Model 4500 MkIII is shipped with the following default communications settings:

Baud rate:	57600
Parity:	Even
Data bits:	8
Stop bits:	1
Slave Address:	7

Refer to sections A4.9 and A4.14 for the AFU switch settings.

The Baud rate, Parity and Slave Address can be changed as follows:

1) Press ⏎
2) Use the ⇧ and ⇩ arrows to select Parameters and press ⏎
3) Use the ⇧ and ⇩ arrows to select Parameter Number and press ⏎
4) Use the ⇧ and ⇩ arrows to change the Parameter number to 1 and press ⏎
5) Use the ⇧ and ⇩ arrows to change the Slave Address to the desired number in the range 1 to 247 and press ⏎
6) Use the ⇧ and ⇩ arrows to change the Parameter number to 2 and press ⏎
7) Use the ⇧ and ⇩ arrows to change the Baud Rate to 9600, 19200, 38400, or 57600 and press ⏎
8) Use the ⇧ and ⇩ arrows to change the Parameter number to 3 and press ⏎
9) Use the ⇧ and ⇩ arrows to change the Parity to 0 (None), 1 (Even), or 2 (Odd) and press ⏎
10) When the communication settings are correct press ✕ twice to return to the main screen.

Any writeable Modbus register can be changed using the Transceiver Control panel as follows:

1) Press ⏎
2) Use the ⇧ and ⇩ arrows to select Parameters and press ⏎

3) Use the ⇧ and ⇩ arrows to select Parameter Number  and press ⏎
4) Use the ⇧ and ⇩ arrows to select the required Parameter (register) number, then press ⏎
5) Use the ⇧ and ⇩ arrows to change the parameter value to the desired value and press ⏎
6) Press ✕ twice to return to the main screen.

B4.9 Modbus Registers

A brief list of the most useful Registers is given below. A full list is included on the CD-ROM.

> Note
>
> The definition of Register Numbers given in the Modbus standard can cause confusion. For historical reasons, Registers are given decimal numbers beginning at 1, but Register 1 is located at Address Offset 0. Register numbers are always one greater than their associated bus addresses. The Table below uses Register Numbers.

Scaling

In the following table, the value in the Modbus register must be divided by the scaling factor to obtain the actual value.

Read-Only Registers

Modbus Register	*Data Value*	*Description*	*Range*	*Scaling*
127	Opacity	Calculated opacity	-25% - 100%	x100
128	Optical density	Calculated optical density	-1 - 3	x1000
129	Dust density	Calculated dust density	0 - 9999	x1
130	Dust density fractional	Fractional part of the dust density (Reg 503)	0 - 99	x100
131	Average optical density	Average optical density during gravimetric test	-1 - 3	x1000
132	Stored Average Optical Density	Stored average optical density	-1 - 3	x1000
133	Held opacity	Calculated opacity not updated during a cal audit or a cal check	-25% - 100%	x100
134	Held optical density	Calculated optical density not updated during a cal audit or a cal check	-1 - 3	x1000
135	Held dust density	Calculated dust density not updated during a cal audit or a cal check	0 - 9999	x1
136	Held dust density fractional	Fractional part of the held dust density (Reg 506)	0 - 99	x100
73	Alarm status	Transceiver alarm	0 = Inactive 1 = Active	NA
51	Number of faults	Indicates the number of faults currently present (regardless of mask states)	0 - 32	NA
52	Error Flags	Error flags	Bit 0 = Zero motor jammed Bit 1 = Upscale motor jammed Bit 2 = Source LED fail Bit 3 = Flood Led fail Bit 4 = ADC over-range Bit 5 = ADC fault Bit 6 = Tx shutter fault Bit 7 = Retro shutter fault Bit 8 = Tx blower fault Bit 9 = Retro blower fault Bit 10 = AFU fault Bit 12 = Negative opacity Bit 13 = Checksum error Bit 14 = Lens contamination limit Bit 15 = Failure during calibration	NA

Read-Write Registers

Modbus Register	Data Value	Description	Range	Scaling
201	Average during audit		0 = Off 1 = On	NA
202	Initiate Calibration		Bit 0 = Cal check Bit 1 = Cal audit	NA
95	Cal check interval	In hours (Default = 24)	0 - 1000	NA
96	Time to next cal	Time to next cal in minutes	0 - 65535	NA

Note

A Read operation on an unassigned Register will return a zero, rather than an exception.

Some status conditions can also be accessed as Modbus coils. Refer to the Model 4500 MkIII Modbus guide for more details

B4.10 Setup AFU 4 to 20mA Current Loop Outputs

There are two 4 to 20mA current loop outputs from the AFU; they can be set up independently. If there is more than one AFU connected, they will all use the same settings.

The Model 4500 MkIII AFU normally provides the power supply for the 4 to 20mA current loop output. It is intended to be connected to a passive input device. To connect the current loop output to an active device, the links LK1 and LK2 in the AFU must be moved to position A, as described in section A5.4.

To configure the 4 to 20mA current loop output:

1) Use the ⇧ and ⇩ arrows to select AFU Settings and press ⏎
2) Use the ⇧ and ⇩ arrows to select Output 1 Type and press ⏎
3) Use the ⇧ and ⇩ arrows to select Opacity, Optical Density, Dust Density, Constant Current, Calibration Drift or Pathlength Correction Factor and press ⏎
4) Use the ⇧ and ⇩ arrows to select Output 1 Range and press ⏎
5) Use the ⇧ and ⇩ arrows to change the output value corresponding to 20 mA and press ⏎

Set up Output 2 in a similar manner.

If required, the 4 to 20mA current loop output can be set to deliver a constant current for test purposes.

1) Use the ⇧ and ⇩ arrows to select Output 1 Current or Output 2 Current and press ⏎
2) Use the ⇧ and ⇩ arrows to change the output current and press ⏎
3) When the test is complete, press ✕ to switch back to normal operation.

The current loop outputs can be set to represent negative values, using currents below 4mA, if required.

1) Press ✕ to return to AFU Settings.
2) Use the ⇧ and ⇩ arrows to select Settings
3) Use the ⇧ and ⇩ arrows to select Show Negative Values and press ⏎
4) Use the ⇧ and ⇩ arrows to select Show Negative Values or No Negative Values and press ⏎
5) Press ✕ to return to Settings

Track and hold

The 4-20 mA current loop output can be set to track or hold during calibration. This function is controlled using the following system parameters

Register 188 - transceiver output

Register 336 - AFU output 1

Register 340 - AFU output 2

Setting the register value = 1 allows the 4-20 mA current loop to track during the calibration check. This option is required for compliance applications so that the calibration value can be recorded by the data acquisition system.

Setting the register value = 2 freezes the 4-20 mA current loop during calibration, with the output held to the last valid measurement. This option is appropriate where the signal is being used as part of a process control system where the calibration reading could affect the operation of the controller.

Averaging

The 4-20 mA current loop outputs are factory set for instantaneous response. Averaged outputs can be configured by setting the foillowing Register values

Register 189 - Transceiver Output Averaging enable

Register 339 - AFU Output 1 Averaging enable

Register 352 - AFU Output 1 Averaging enable

Setting parameter value = 0 disables averaging

Setting parameter value = 1 enables averaging

Register 190 - Transceiver Output Averaging time in minutes

Register 340 - AFU Output 1 Averaging time

Register 353 - AFU Output 1 Averaging time

To set AFU output for 6-minute averaging, set parameter 352 to value 1 and set parameter 353 to value 6.

Note that the averaging function uses block averages. Therefore, the instrument measures the opacity for the first averaging period, then it outputs that value during the second averaging period

B4.11 Setup AFU Alarms

1) Use the ⇧ and ⇩ arrows to select AFU AFU Settings and press ⏎
2) Use the ⇧ and ⇩ arrows to select Alarm 1 Type 1 and press ⏎
3) Use the ⇧ and ⇩ arrows to select Opacity, Optical Density log10 or Dust Density and press ⏎
4) Use the ⇧ and ⇩ arrows to select Alarm 1 Level 1 and press ⏎
5) Use the ⇧ and ⇩ arrows to change the Alarm Level and press ⏎
6) Set up Alarm 2 in a similar manner.
7) Press ✕ to return to Settings

B4.12 AFU Modbus Interface

Modbus communications, based on the RS485 hardware standard, provide direct access to the Model 4500 MkIII system data. Details of the Modbus protocol are available from the Modbus website www.modbus.org. The Model 4500 MkIII implements Functions: 3 (Read Holding Register), 6 (Pre-set Single Register) and 10 (Pre-set Multiple Registers). Modbus Register numbers are given in Section 9.

Each AFU has three Modbus output ports called the Data Output Port, the Master Port, and the Control Port.

The Data Output Port is a Modbus slave. It can be connected to a Data Acquisition System for continuous monitoring of Opacity or Dust Density measurements. It can also be used to receive commands, such as Calibration Check, from a Plant DCS. The Data Port uses RS 485 communications

The Master Port is normally connected to the 4500 MkIII Transceiver, however if additional AFUs are needed, the Master Port of the second AFU is connected to the Data Output Port of the first AFU, and so on, up to a maximum of four AFUs connected to one Transceiver.

The Control Port is a Modbus slave. It can be used to monitor the operation of the 4500 MkIII, and to change the settings, without interrupting normal operation. RS485 and RS232 connections are provided for this port. They should not be used simultaneously. The Control Port can also be used as a second Data Output port.

RS485 networks connected to the Data Output and Control ports must have one termination resistor at each end and one bias network somewhere on the bus. The Model 4500 MkIII AFU can provide a termination resistor and a bias network. As supplied, the termination resistor is switched on, and the bias network is switched off. To change the switch settings, See section A4.4.

AFUs are shipped with the Data Output and Control Ports set as follows:

Baud rate:	19200
Parity:	Even
Data bits:	8
Stop bits:	1

The Baud rate and Parity are controlled by switch settings as described in section A4.4.

The Slave Address for both slave ports is set in the Transceiver, and its default value is 7.

The Slave Address can be changed using the Transceiver Control panel as follows:

1) Press ⏎
2) Use the ⇧ and ⇩ arrows to select Parameters  and press ⏎
3) Use the ⇧ and ⇩ arrows to select Parameter Number  and press ⏎
4) Use the ⇧ and ⇩ arrows to change the Parameter number to 1 and press ⏎
5) Use the ⇧ and ⇩ arrows to change the Slave Address to the desired number in the range 1 to 247 and press ⏎
6) Press ✕ twice to return to the main screen.

B4.13 AFU Blower status and Shutter Control

The AFU is designed to control the fail-safe shutters which protect the transceiver and retroreflector in the event of a short-term failure of the purge air system. The shutters close automatically if any of the following conditions occurs:

- Loss of power to the AFU
- Loss of purge air flow, as sensed by the optional flow sensor in the blower. The flow switch is designed to be open-circuit in normal operation and closes if flow is lost. Two flow sensor inputs are provided in the AFU, so that either one or two blowers can be monitored. The shutters will close if either sensor detects loss of purge flow

To minimize the risk that the shutters will become stuck in the open position, the shutters also close during the zero portion of the daily calibration check. The 4500 MkIII will indicate a fault if the shutters are not fully closed during a calibration check, or if they do not open fully afterwards.

Each shutter has sensors which detect whether the shutter is fully open or fully closed. LEDs on the AFU circuit board indicate the shutter status.

ID	Label	On	Off	Normal Operation
LED1	T SHUTTER	Shutter power on	Shutter power off	ON
LED2	T OPEN	Shutter not fully open	Shutter fully open	-
LED3	T CLOSED	Shutter fully closed	Shutter not fully closed	-
LED4	T BLOWER	Blower 1 fault	Blower 1 OK	-
LED5	T FILTER	Not used	Not used	-
LED6	R BLOWER	Blower 2 fault	Blower 2 OK	-
LED7	R FILTER	Not used	Not used	-
LED8	R OPEN	Shutter not fully open	Shutter fully open	-
LED9	R CLOSED	Shutter fully closed	Shutter not fully closed	-
LED10	R SHUTTER	Shutter power on	Shutter power off	ON

LED1 and LED10 are lit during normal operation, with both shutters open.

LED 2, LED3, LED8 and LED9 are all lit when shutters are fully closed. Except for a brief period while the shutters are opening, all four LEDs should be on, or all four should be off. A single LED on or off indicates a stuck shutter. Refer to Section E (Maintenance) for more information.

If LED4 or LED6 is lit, there is a blower flow fault.

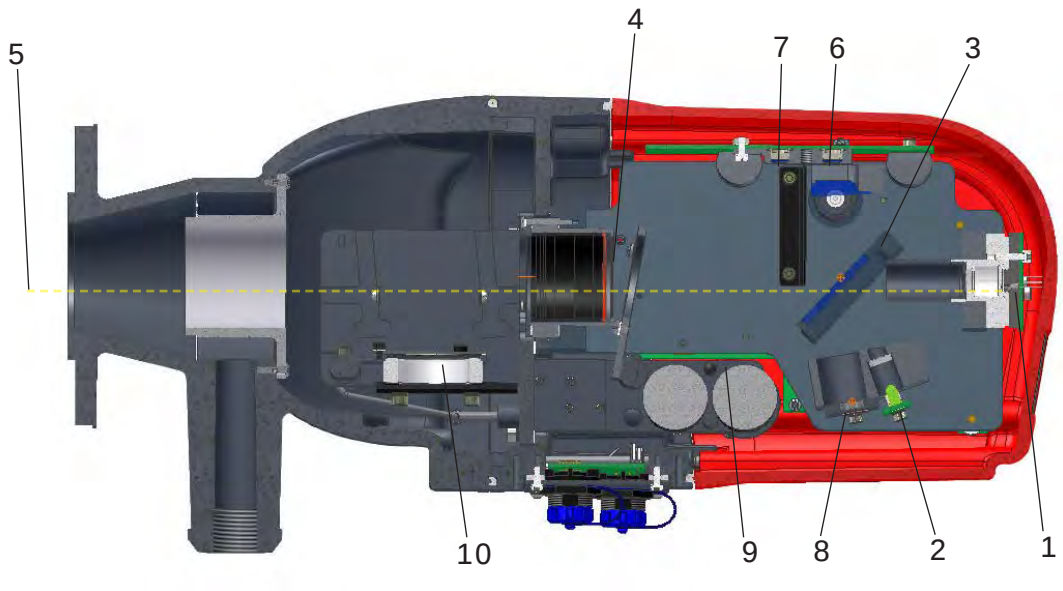
B4.14 AFU Communications Checks

The AFU communicates with the transceiver via a Modbus link, with wiring between Connector C and AFU terminals 55 to 58.

If the AFU is communicating successfully with the transceiver, LED23 (Tx) and LED24 (Rx) will flicker rapidly and the "AFU" icon will appear on the transceiver display. If no communications are detected, LED23 will flicker dimly approximately once per second.

B5 Periodic Modes of Operation

B5.1 Calibration Check



Transceiver

1	LED light source	6	Measurement Detector
2	Flood LED	7	Reference Detector
3	50/50 Beam Splitter	8	Concave Mirror
4	Collimating Lens	9	Upscale Filter
5	Collimated Beam	10	Zero Point Reflector

The transmissometer periodically performs a two step calibration check. In the first step, a zero-point reflector (10), mounted within the air purge of the Transceiver is placed into the optical axis. In the second step, the upscale filter (9) is also placed in the light path. The monitor reads the difference in light between the current zero–point and the zero–point established during the last clear stack calibration, and notes this value as the amount of drift and optical dust build-up. The opacity value of the upscale filter (9) is shown on the calibration certificate which accompanies the instrument.

As required by ASTM D6216-07, the model 4500 MkIII indicates the PLCF value on the current loop output for 90 s at the end of each calibration check. The value is scaled 0.0 to 10.0. For example PLCF = 1.2; the output value will be 4 + (1.2/10) x 16 = 5.92 mA. This function can be disabled by setting the output to hold during calibration (parameter 188=1).

If fail-safe shutters are fitted, the shutters close during the zero phase of the calibration check. This demonstrates that the shutters are functioning correctly and ensures that they cannot become stuck in the open position. During this time, the purge air will escape around the edge of the rubber sealing ring.

CAUTION

Do not attempt to move the zero point reflector by hand. The precision gearbox will be damaged beyond repair.

1) From the instrument reading display, press ⏎
2) Unlock  is displayed, press ⏎
3) Use the ⇧ and ⇩ arrows until the Supervisor code (Default: 10) is displayed, wait for the ⏎ icon to appear and press ⏎
4) Use the ⇧ and ⇩ arrows to select Settings  and press ⏎
5) Use the ⇧ and ⇩ arrows to select Calibration  and press ⏎
6) Use the ⇧ and ⇩ arrows to select Cal Check  and press ⏎
7) Start  is displayed, press ⏎ to Start the Cal Check.
8) The hourglass  is displayed while the Cal Check is in progress.
   It disappears when the Cal Check is finished.
9) Press ✕ twice to return to the main display.

The Model 4500 MkIII is now ready for use.

B5.2 Calibration Audit (Non EPA-compliant)

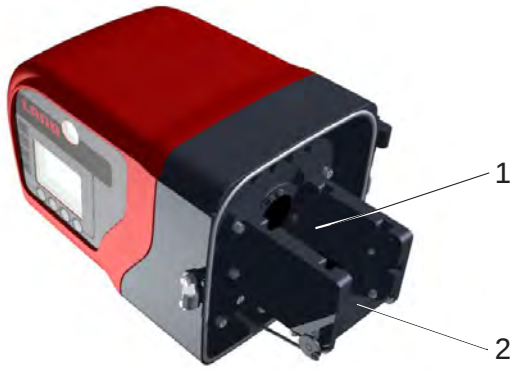
A convenient Calibration Audit facility is provided, for carrying out Calibration Audit tests.

Note that the simple calibration audit does NOT comply with the requirements of US EPA Procedure 3. Refer to B5.9 for a calibration audit method which complies with Procedure 3.

Calibration Error Checks

1) Press ⏎
2) Unlock  is displayed, press ⏎
3) Use the ⇧ and ⇩ arrows until the Supervisor code (Default: 10) is displayed and press ⏎
4) Use the ⇧ and ⇩ arrows to select Calibration  and press ⏎
5) Use the ⇧ and ⇩ arrows to select Cal Audit  and press ⏎
6) Fast Response  is displayed, press ⏎

The Zero Reflector is driven into its working position, and opacity is displayed; it should be 0.0%. Release the clips on both sides of the Transceiver housing. Swing the instrument open on its hinges.



CAUTION

Do not attempt to move the zero point reflector by hand. The precision gearbox will be damaged beyond repair.

7) Insert a calibrated neutral density filter into slot 1, taking care not to touch the glass. Read and record the displayed opacity value.

8) Note that this value is path-length corrected. If the PLCF is set to 1.0, the displayed value should match the filter opacity. If the PLCF is not 1.0, use the following formula to calculate the expected instrument reading:

Calculate the PLCF-corrected opacity using the opacity value on the calibration certificate.

$$OD = -log_{10}(1 - Opacity)$$

$$Corrected\ Opacity = 1 - 10^{-PLCF \times OD}$$

9) The operating wavelength of the Model 4500 MkIII is 525 nm. All audit filters will be calibrated at this wavelength.

10) Remove the filter, insert the next filter and record the reading.

Exit from Audit Mode

Use the ⇧ and ⇩ arrows to select Stop and press ⏎
The Zero Reflector is retracted and the instrument resumes normal operation.
Press ✕ twice to return to the main screen.

B5.3 Recalibration (Also known as Zero Alignment or Clear Stack Calibration)

A Recalibration must only be performed when there is no smoke or dust in the beam of the opacity monitor. To comply with US EPA Procedure 3, the instrument must be removed and attached to test stands for calibration.

Using the Calibration Stand Kit (AMETEK Land Part Nº 809807)

1) Undo the clips from the transceiver and retro-reflector purges. Remove them and take them to a clean workshop.
2) Mount the transceiver and retro-reflector into a stand calibration stand. Use the clips to secure each unit into its stand.
3) Determine the correct spacing for the stands. The distance between the stands should be equal to the installation pathlength given on the Manufacturer's Certificate of Conformity (MCOC) plus 252 mm (9.9 in).
4) Connect the power supply to the transceiver.
5) Align the transceiver and the retro-reflector using the alignment targets. You will need to remove the retro element to see the green spot on the target (Refer to Section B4.3 and B4.4 of this User Guide).
6) Go to the Calibration menu (password is **10**) and do a recalibration (See Section 5.4 below).

B5.4 Recalibration procedure

Ensure that the pathlength is correct and that the surfaces of the main lens and retro-reflector elements are clean and dust free. Align the instrument as described in B 1.4 paragraph 3.

1) Press ⏎
2) Unlock  is displayed, press ⏎
3) Use the ⇧ and ⇩ arrows until the Supervisor code (Default: 10) is displayed and press ⏎
4) Use the ⇧ and ⇩ arrows to select Calibrate  and press ⏎
5) Use the ⇧ and ⇩ arrows to select Recalibrate  and press ⏎
6) Start  is displayed. When ready, press ⏎
7) Confirm clear path  is displayed. Check that the optical path is clear and that the opacity reading is stable. Press ⏎

   The hourglass  is displayed while the instrument waits an additional 10 seconds for the readings to settle.
8) Confirm blocked path  is displayed. The simplest way to achieve a blocked path is to release the clips on the side of the Transceiver and swing it open on its hinges until the beam is pointing into free space. Alternatively, to calibrate the instrument at an opacity other than 100%, insert a filter into the slot in the calibration unit, close the Transceiver on its hinges and apply the clips.

9) When the reading is stable, press ⏎. The hourglass  is displayed while the instrument waits an additional 10 seconds for the readings to settle.

10) Filter Opacity  is displayed and the value is pre-set to 100%. If the Transceiver was pointed into free space, or if the beam was completely blocked, press ⏎. If a calibrated filter was used, set the opacity of the filter with the ⇧ and ⇩ arrows and press ⏎

11) Zero Check  is displayed while the instrument deploys and checks the Zero Reflector.

12) Upscale Check  is displayed while the instrument deploys and checks the Upscale Filter. During this time, the values of the calibration constants X and C are displayed, for use by Service Engineers.

13) The hourglass  is displayed while the instrument retracts the Zero Reflector and the Upscale Filter.

When the hourglass disappears, the Clear Stack Calibration is complete.

14) If you have an optional External Zero Device (EZD), it must be recalibrated after performing a Clear Stack Calibration. Refer to Section B5.9.

B5.5 Gravimetric Calibration (Isokinetic Calibration)

The Model 4500 MkIII measures the opacity of dust and smoke emissions. As explained in the Reference section of the manual, this may be converted to Dust Density using calibration constants. To determine these calibration constants it is necessary to collect and weigh samples of the particulate matter from the flue gases. This procedure must be carried out in accordance with relevant USEPA Methods or CEN or ISO Standards. It is generally known as Gravimetric or Isokinetic Sampling.

Model 4500 MkIII provides a facility to simplify collection of readings during Gravimetric Calibration.

To record the Average Optical Density during a Gravimetric Test:

1) Press ⏎

2) Unlock  is displayed, press ⏎

3) Use the ⇧ and ⇩ arrows until the Supervisor code (Default: 10) is displayed and press ⏎

4) Use the ⇧ and ⇩ arrows to select Calibrate  and press ⏎

5) Use the ⇧ and ⇩ arrows to select Gravimetric Test  and press ⏎

6) Start  is displayed. When the Gravimetric Test is started, press ⏎
The display will show the Average Optical Density since the start of the test.

7) Stop  is displayed. When the Gravimetric Test is complete, press ⏎
The Average Optical Density during the last test is shown. Record the value.

Note

Do not press ✕ while the Gravimetric Test is running as this has the same effect as pressing ⏎. The test is terminated and the current Average Optical Density is stored.

8) Start  is displayed. To start a new test (and lose the saved value) press ⏎
9) To leave the Gravimetric Test menu, press ✕
10) Press ✕ twice to return to the main display.

To calculate calibration constants from the results of a series of Gravimetric Tests:

The procedures for formally calculating the calibration constants are given in USEPA Performance Specification 11, or CEN Standards EN 13284-2 and EN 14181. A simplified procedure using Microsoft Office Excel is given below:

1) For each measurement point, determine the Dust Density at the reporting conditions from the Gravimetric Test procedure, and the average Optical Density indicated by the Model 4500 MkIII during the test.
2) Plot a Scatter Chart of Dust Density (Y axis) against Optical Density (X Axis). Add a Linear Trendline through the origin (0,0) and show the equation of the Trendline on the chart. The slope of the Trendline is the Dust Gain calibration constant. Dust Offset and Dust Gain 2 are zero.
3) If the Trendline is not a good fit to the data, try removing the constraint for the Trendline to go through the origin. The Trendline offset is the Dust Offset calibration constant. Dust Gain 2 is zero.
4) If the data points form a marked curve rather than a straight line, change the Trendline to a Polynomial of order 2. The coefficient of the x^2 term is the Dust Gain 2 calibration constant.

To enter the calibration constants into the analyser:

Model 4500 MkIII can record up to three sets of calibration constants. Each set is associated with a "Fuel Number" because they are intended to facilitate changes of fuel. They could equally be used for different load or operating conditions by assigning "Fuel Numbers" to these, as required. The "Current Fuel" described below refers to the set of calibration constants which the analyser is currently using to calculate Dust Density in mg/m^3.

1) To enter the Dust Gain and Offset values into the Model 4500 MkIII, press ⏎
2) Unlock  is displayed, press ⏎
3) Use the ⇧ and ⇩ arrows until the Supervisor code (Default: 10) is displayed and press ⏎
4) Use the ⇧ and ⇩ arrows to select Settings  and press ⏎ ⏎

To change the Current Fuel and its settings:

1) Use the ⇧ and ⇩ arrows to select Dust Settings  and press ⏎
2) Fuel in Use, either  ,  , or  is displayed.
3) To change the current fuel selection, press ⏎
4) Use the ⇧ and ⇩ arrows to change the Fuel number as required and press ⏎

To change the settings for the Current Fuel:

1) Use the ⇧ and ⇩ arrows to select Dust Gain  and press ⏎
2) Use the ⇧ and ⇩ arrows to change the Dust Gain value as required and press ⏎
3) Use the ⇧ and ⇩ arrows to select Dust Gain 2  and press ⏎
4) Use the ⇧ and ⇩ arrows to change the Dust Gain 2 value as required and press ⏎
5) Use the ⇧ and ⇩ arrows to select Dust Offset  and press ⏎
6) Use the ⇧ and ⇩ arrows to change the Dust Offset value as required and press ⏎
7) Press ✕ three times to return to the main display.

B5.6 Restoring Previous Calibration Values

If the Model 4500 MkIII is mis-calibrated, it is possible to recover the situation by replacing the erroneous calibration constants. The Previous constants, and the constants determined during Factory testing are stored in the instrument.

To replace the Current Calibration constants with the Previous constants:

1) Press ⏎
2) Unlock  is displayed, press ⏎
3) Use the ⇧ and ⇩ arrows until the Supervisor code (Default: 10) is displayed and press ⏎
4) Use the ⇧ and ⇩ arrows to select Calibration  and press ⏎
5) Use the ⇧ and ⇩ arrows to select Previous Cal  and press ⏎
6) Use the ⇧ and ⇩ arrows to select Restore Last Cal  and press ⏎
7) Confirm  is displayed. Press ⏎
8) The Previous Calibration constants are copied into the Current Calibration constants.
9) The Tick ✓ in the top left corner of the display indicates that the operation was successful.
10) Press ✕ three times to return to the main display.

To replace the Current Calibration constants with the Factory constants:

1) Press ⏎
2) Unlock  is displayed, press ⏎
3) Use the ⇧ and ⇩ arrows until the Supervisor code (Default: 10) is displayed and press ⏎
4) Use the ⇧ and ⇩ arrows to select Calibration  and press ⏎
5) Use the ⇧ and ⇩ arrows to select Previous Cal  and press ⏎
6) Use the ⇧ and ⇩ arrows to select Restore Factory Cal  and press ⏎
7) Confirm  is displayed. Press ⏎
   The Factory Calibration constants are copied into the Current Calibration constants.
8) The Tick ✓ in the top left corner of the display indicates that the operation was successful.
9) Press ✕ three times to return to the main display.

B5.7 Setting Calibration Constants Manually

In the event of a major malfunction resulting in loss of the calibration data, the Model 4500 MkIII provides a facility for entering the calibration constants manually. The original calibration data determined during factory testing are recorded on the Calibration Report. This may also show calibration data determined during later clear-stack calibrations. To enter the calibration constants, C, X and B:

1) Press ⏎
2) Unlock  is displayed, press ⏎
3) Use the ⇧ and ⇩ arrows until the Engineer code is displayed and press ⏎
4) Use the ⇧ and ⇩ arrows to select Calibration  and press ⏎
5) Use the ⇧ and ⇩ arrows to select the C Constant  and press ⏎
6) Use the ⇧ and ⇩ arrows to change the displayed value as required and press ⏎
7) Use the ⇧ and ⇩ arrows to select the X Constant  and press ⏎
8) Use the ⇧ and ⇩ arrows to change the displayed value as required and press ⏎
9) Use the ⇧ and ⇩ arrows to select the B Constant  and press ⏎
10) Use the ⇧ and ⇩ arrows to change the displayed value as required and press ⏎
11) Press ✕ three times to return to the main display.

B5.8 Using the External Zero Device (EZD)

The External Zero Device (EZD) allows the operator to check the zero point stability, perform a calibration audit, or to perform a recalibration in accordance with CFR 60 Appendix F Procedure 3, while the process is running and a clear path is not available. The EZD is configured for a specific instrument, and it should be used only with the instrument whose serial number is shown on the case.

For continued accuracy, it is essential that the EZD is adjusted each time the instrument is recalibrated in the laboratory or under clear path conditions.

External Zero Device

The instrument serial number and pathlength are printed on the carry case label. It is important that the EZD is only used with the instrument it has been calibrated with. Please ensure the plant installation location (i.e. Stack 1) is written on the carry case label before placing the clear self-adhesive label (Provided by AMETEK Land Instruments International) over the top of the carry case label for protection.

External Zero Device Carry Case Label

The External Zero Device (EZD) is used during the Re-calibration routine when true clear stack conditions are unobtainable.

Follow the steps outlined in Section 5.4, being careful NOT to move the sliding adjusting plate on the back of the EZD.

Before step 7 (Confirm Clear Path), fit the EZD (with the arrow pointing upwards) as shown in the photograph below. Tighten the clamping screw to hold the EZD securely. Remove the EZD before continuing to Step 8 (Confirm Blocked Path)

External Zero Device fitted to Model 4500 Mk III

B5.9 Recalibrating the External Zero Device (EZD)

All instruments are shipped out from the factory configured to customers' requirements. Re-calibration of the EZD is required immediately after re-calibration of the instrument. It is recommended that re-calibration is performed every three years or if a Calibration Audit shows the instrument to be outside of acceptable limits. Please ensure that all optical surfaces are clean and the optical path is not obstructed before performing any calibration.

If the flange to flange path length is altered (i.e. due to relocation of the instrument) contact AMETEK Land Instruments International customer services for instrument pathlength setup advice.

IMPORTANT

Re-calibration should be carried out under clear stack conditions or in a laboratory with the Transceiver set to the correct flange-to-flange path length.

The EZD should be re-calibrated following a genuine recalibration of the instrument only (recommended every three years).

If in any doubt about these instructions, please contact AMETEK Land Instruments International Customer Services Department before proceeding. Take care when handling the reflective surfaces as they can easily be scratched or made dirty.

Immediately after a genuine clear stack re-calibration perform the following steps for re-calibration of the EZD.

1) Fit the EZD as shown in the photo.
2) Ensure that the instrument is set to display negative values and then observe the measurement reading.
3) Loosen the locking nut on the sliding adjusting plate and slide the plate until the instrument is measuring zero.

If the instrument cannot be set to measure zero opacity by adjusting the sliding adjuster on the back of the EZD, it is necessary to change the aperture and grating that cover the reflective surface.

If the black wedge shape on the front of the sliding adjuster on the EZD completely covers the reflective surface then replace the current aperture plate and grating with the ones corresponding to the next highest 'B' value (i.e. Next highest 'B' value 0.97 corresponding aperture plate C and grating 2). Refer to Table B1 opposite.

If the black wedge shape on the front of the sliding adjuster on the EZD cannot be seen then replace the current aperture plate and grating with the ones corresponding to the next lowest 'B' value (i.e. Next lowest 'B' value 0.91 corresponding aperture plate E and grating 2).

4) Lock the sliding adjusting plate in place.

IMPORTANT

Once calibrated to an instrument, the EZD should not be adjusted unless undergoing another re-calibration.

5) Remove the EZD. Store the EZD in the carry case provided until required for Re-calibration.
6) Close the Transceiver casing.

The instrument is now ready for normal operation.

B5.10 Calibration Audit complying with US EPA Procedure 3

US EPA Procedure 3 - Quality Assurance Requirements for Continuous Opacity Monitoring Systems at Stationary Sources - requires all compliance opacity monitors to undergo a three-point calibration error test every calendar quarter. This test must use an External Zero Device (EZD) and three calibrated neutral density filters. The following procedure meets the requirements

1) Select low-, mid- and high-range calibration audit filters according to ASTM D6216 paragraph 7.5. This table is summarized below.
2) Verify that the calibration certificate for the filters is valid
3) Calculate the PLCF-corrected filter value using the equations below
4) Fit the EZD to the Model 4500 MkIII as shown in B5.9.
5) Verify that the Model 4500 MkIII indicates 0.0% +/- 1.0% opacity.
6) One at a time, place the audit filters in the slot between the EZD and the main lens. Ensure the filter is fully inserted into the slot. After each insertion, wait at least twice the shortest recording interval on the COMS data recorder so that the reading can be registered by the data recorder.
7) Make at least three nonconsecutive readings with each filter; five readings are recommended. It is useful to note the filter reading on the Model 4500 MkIII display, but this reading must not be used for the audit calculations
8) Take the filter test data from the COMS permanent data recorder and calculate the calibration error as the sum of the absolute value of the mean difference and the 95 % confidence coefficient for each of the three test attenuators using the method given in PS-1 para 8.1 (3)(ii).
9) At the end of the calibration error test, remove the EZD and keep it in its storage case until it is needed.

Select calibration attenuators that will provide an opacity monitor response corrected to single-pass opacity values for the emission outlet pathlength in accordance the following table.

	ELV < 20% opacity	ELV ≥ 20% opacity
Low	5% to 10%	10% to 20%
Mid	10% to 20%	20% to 30%
High	20% to 40%	30% to 60%

To calculate the PLCF-corrected opacity using the opacity value on the calibration certificate.

$$OD = -log_{10}(1 - Opacity)$$

$$Corrected\ Opacity = 1 - 10^{-PLCF \times OD}$$

Table B1 : Automatic Zero Point Reflector Aperture and Grating Selection

Aperture Plate	B Value					
	Grating A	Grating 1	Grating 2	Grating 3	Grating 4	Grating 5
B	1.80	1.25	0.90	0.64	0.46	0.35
C	1.76	1.22	0.88	0.60	0.44	0.34
D	1.71	1.19	0.84	0.59	0.43	0.33
E	1.65	1.15	0.82	0.57	0.42	0.32
F	1.60	1.11	0.79	0.56	0.41	0.31
G	1.54	1.07	0.77	0.54	0.40	0.31
H	1.49	1.04	0.74	0.53	0.39	0.30
I	1.43	1.00	0.72	0.52	0.38	0.29
J	1.38	0.97	0.71	0.50	0.37	0.29
K	1.33	0.94	0.68	0.49	0.36	0.28

Select the Aperture Plate (horizontally) and the Grating (vertically) that relate to the 'B' value observed after recalibration.

END OF SECTION

C THEORY OF OPERATION AND APPLICATION

C1 General Outline

When a beam of light crosses a medium containing smoke or dust particles, some of the light is transmitted and some is lost due to scattering. The fraction which is transmitted is called the transmittance and the fraction which is lost is the opacity.

In the early days of emissions measurement, the opacity of the smoke leaving a stack was measured by the Ringelmann method in which a trained observer makes a visual estimate of its appearance.

Modern methods for opacity measurement are far more sophisticated than the Ringelmann method, but many of the specifications relate back to the way the human eye sees smoke emissions. The wavelength response of an opacity monitor must mimic that of the human eye. An instrument must have a nearly photopic response. The AMETEK Land Model 4500 MkIII uses a high-intensity green LED light source to achieve this.

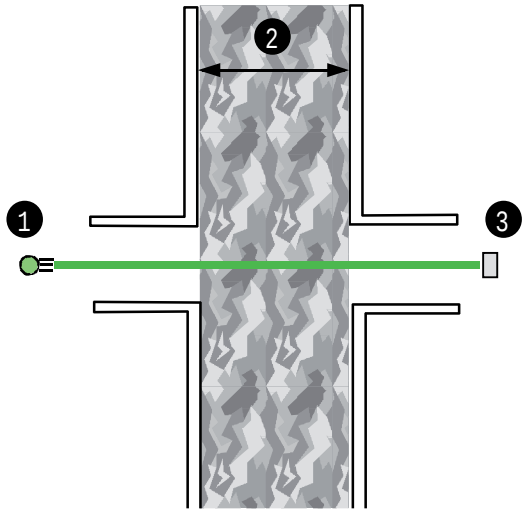
C2 Beer-Lambert's Law

The mathematical relationship between the light transmitted by a medium and the quantity of pollutant present is known as the Beer-Lambert Law and may be written;

$$\tau = \frac{I}{I_o} = e^{-acL}$$

where:

τ	=	Transmittance
I_o	=	Intensity of light into the medium (see 1 below)
I	=	Intensity of light out of the medium (see 3 below)
a	=	Attenuation Coefficient
c	=	Concentration of Pollutant
L	=	Distance light beam travels through the medium (see 2 below)



Since opacity (Op) = 1 - τ , the above equation becomes:

$$(1 - Op) = e^{-acL} \quad \text{or} \quad Op = 1 - e^{-acL}$$

Note that the quantity c is the amount of dust in the optical path. Optical Density (or extinction) is defined as;

$$OD = -\log_{10}\tau = -acL/2.303$$

$$c = k \times OD \quad \text{where } k = \frac{-2.303}{aL}$$

By comparing a series of optical density measurements with gravimetric dust measurements taken at the same time, it is possible to determine the value of k.

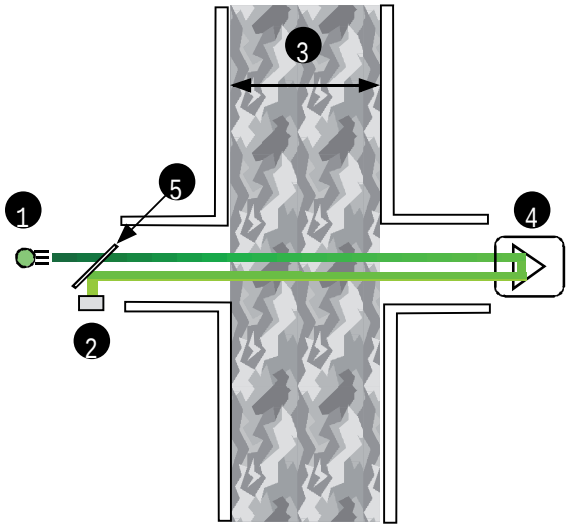
C3 Pathlength Correction Factor (PLCF)

The last item that we need to address is the fact that opacity monitors may not always be mounted at the exit of a stack. Since the Ringelmann observer always views opacity at the exit of a stack, we must also introduce a factor to correct for the change in pathlengths between the measurement and exit diameters of the stack. It should also be pointed out at this time that the AMETEK Land Model 4500 MkIII Dust and Opacity Monitor is a double pass instrument. This means that the light beam crosses the medium twice and hence experiences twice the amount of absorption as illustrated below. This must also be corrected in our system.

The Pathlength Correction Factor (PLCF) is only relevant for Opacity measurements. It is the ratio between the diameter of the stack exit and the diameter of the stack at the point where the instrument is installed. For a parallel stack, the PLCF is 1.0. For a tapering stack which is narrower at the exit than the base, the PLCF is less than 1.0.

The Optical Pathlength Ratio (OPLR) is the ratio between the diameter of the stack exit and the distance travelled through the stack gases by the beam. For a double-pass instrument like the Model 4500 Premier, the OPLR is equal to half the PLCF i.e.

$$OPLR = \frac{PLCF}{2}$$



Key

1. Light source I_o
2. Detector
3. Distance light beam passes through medium (L)
4. Reflector
5. Beam Splitter

Double Pass System

We can use the previous equations to calculate the opacity at the stack exit, if we define the pathlength correction factor (PLCF);

$$PLCF = \frac{L_e}{L_m}$$

where: L_e = the exit pathlength
L_m = the measurement pathlength

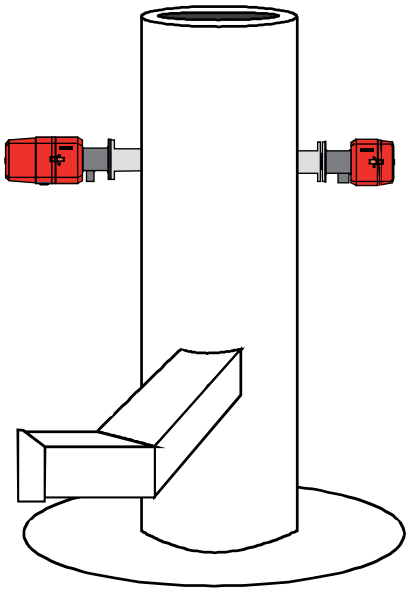
$$OPLR = \frac{PLCF}{2}$$

$$Op_e = 1 - 10^{PLCF \times \log(1-Op_m)}$$

Note:

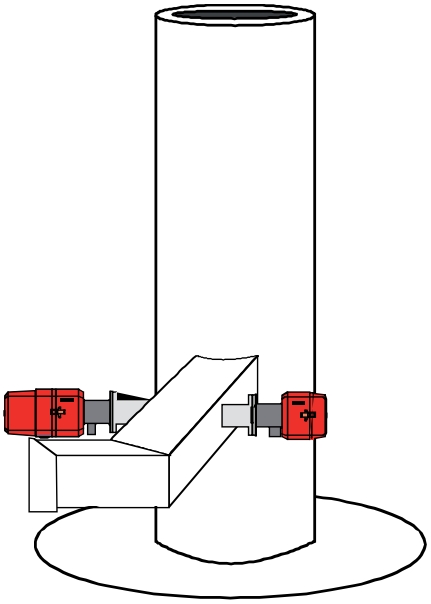
The Model 4500 MkIII applies the PLCF correction only to the measured opacity. Optical density is shown as the double-pass value.

C4 Examples of Different Pathlength Correction Factors (PLCF)



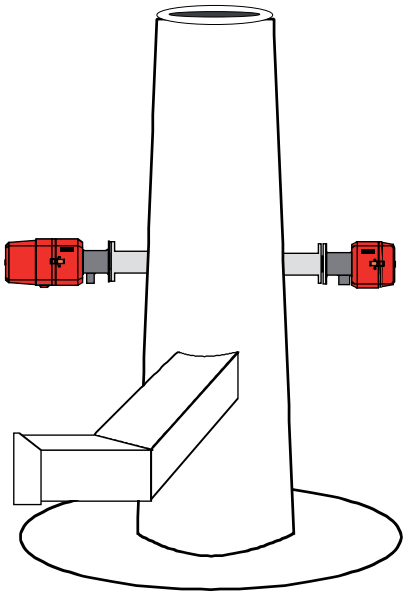
Straight stack.
Measurement pathlength and exit pathlength are equal.
PLCF = 1.00

Example 1



Straight stack, monitor on narrow duct.
Measurement pathlength is less than exit pathlength.
PLCF > 1.00

Example 2



Stack narrows towards exit.
Measurement pathlength is greater than exit pathlength.
PLCF < 1.00

Example 3

C5 Requirements for Environmental Legislation

USA

When used to measure opacity, the Model 4500 MkIII meets or exceeds the requirements of ASTM Standard Practice D6216.

The Model 4500 MkIII measures dust density (particulate matter concentration) in accordance with US 40CFR60 AppB PS-11.

It is therefore suitable for compliance measurements in accordance with 40 CFR 60 Appendix B Performance Standard 1.

Europe

The Model 4500 MkIII has QAL1 approval according to EN 15267 under both the UK MCERTS and German TUV / UBA schemes.

C6 Physical Principles

C6.1 General Description

The AMETEK Land Instruments International Model 4500 MkIII Continuous Opacity Monitoring System (COMS) measures opacity by shining a light beam through flue gases. An internal microprocessor calculates opacity, dust density and other parameters. The instrument comprises the following parts. The Transceiver which contains all of the optical and electro–optic components; the Retro-Reflector containing a glass reflector and the air purge system.

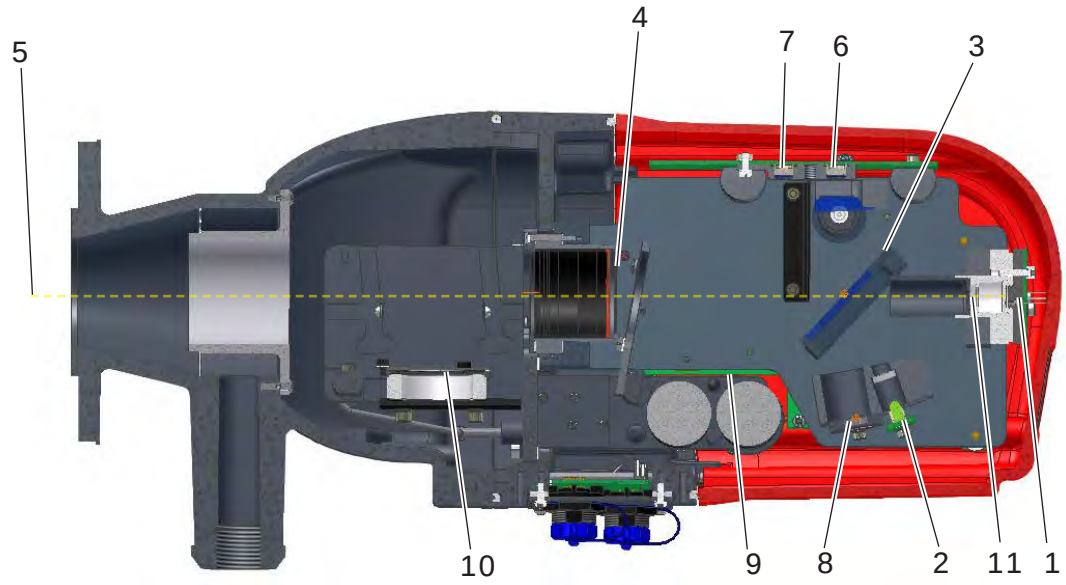
The air purge system can take several forms depending upon individual site requirements. Single and dual electric blowers are available, as are compressed-air driven devices. Continuous purge air supply is essential to prevent dust and corrosive gases from affecting the optical system. Automatic fail–safe shutters can also be fitted for temporary protection in the event of a purge air failure.

The entire system is designed for continuous operation in all weather conditions, with minimal maintenance.

C6.2 Principle of Operation

The AMETEK Land Model 4500 MkIII has been developed from the highly successful AMETEK Land Model 4500 MkII+, which already has a well-deserved reputation for reliability and accuracy. The main light source uses three green LEDs in a special configuration (patent pending) to ensure homogeneity over the entire transmitted light beam. The light source is modulated at a frequency of 1 kHz, to reduce electrical noise and eliminate errors due to ambient light. A second light source, the (patented) "Flood LED" is used to reduce the effect of temperature drift in the detectors to an almost immeasurable low level.

Electronic modulation eliminates the need for a mechanical chopper and so the only moving parts are the motors used in the calibration system. These



motors have a very low duty cycle and are very reliable.

Transmissometer

Key

1. LED light source
2. Flood LED
3. 50/50 Beam Splitter
4. Collimating Lens
5. Collimated Beam
6. Measurement Detector
7. Reference Detector
8. Concave Mirror
9. Upscale Filter
10. Zero Reflector
11. Diffuser

The Transceiver is illustrated above. Light from source LED1 (1) passes through the diffuser (11) and on to the 50/50 beamsplitter (3). The transmitted portion passes on to the lens (4) which projects a well-defined, collimated beam (5) across the measuring path to the distant Retro-Reflector. Light returned from the retro-reflector is focused by the lens (4) onto measurement detector (6). The portion of light originally reflected by the beamsplitter (3) falls on the concave mirror (8) which focuses it on to reference detector (7). The opacity value can be calculated from the ratio of

the signals from the two detectors.

This is true only as long as long as the responsivity of the detectors (6 and 7) and the gain of their associated electronics remains constant. In practice, temperature variations and ageing of the components means that this cannot be guaranteed. The Model 4500 MkIII uses a novel method to compensate for such changes by using Flood LED (2) to illuminate both detectors (6 and 7). Because it uses no focusing optics, there is no possibility of misalignment and so any relative change in sensitivity between the detectors (6) and (7) will lead to a change in the ratio of signals from the Flood LED (2). By alternating light sources (1) and (2), the normalisation procedure is then continuous.

The microprocessor performs the calculations required to perform the normalisation and to convert the opacity measurement into optical density or dust density as required.

Calibration Check

The transceiver periodically performs a two step calibration check. In the first step, a zero reflector (10), mounted on the outside of the Transceiver is placed into the optical beam. In the second step, the upscale filter (9) is also placed in the light path. The monitor reads the difference in signal level between the current value and that established during the last clear stack calibration and makes a correction for any contamination on the lens. The opacity value of the upscale filter (9) is shown on the calibration certificate which accompanies the instrument.

At the end of a calibration check, the Model 4500 MkIII outputs the PLCF value (scaled 0-10) for 90 seconds, in accordance with ASTM D6216-07.

END OF SECTION

D SYSTEM SPECIFICATION

D1 4500 MkIII Dust and Opacity Monitor

Measuring

Technique:	Double pass transmissometry
Operating Wavelength:	520 ± 20 nm
Light Source:	Pulse High Intensity LED
Range:	Opacity: 0 to 10 % to 0 to 100 %
	Optical Density: 0 to 0.1 to 0 to 3.0
	Dust Density: 0 to 15 to 0 to 1000 mg/m^3 (at 5 m pathlength)
	User Selectable
Calibration Error:	1.5 % Opacity
Drift:	<0.3 % Opacity per month
Thermal Stability:	0.6 % Opacity / 22 °C change
Angle of Projection:	2°
Angle of View:	2°
Response Time:	<10 seconds to 95 % of final value
Averaging:	Selectable from 10 seconds to 24 hours (in 1 sec steps)
Pathlength:	0.5 to 10 m / 20 in to 32 ft (extended pathlengths to 15 m / 50 ft available
Calibration:	Automatic zero and upscale check
	(Selectable interval 1 to 24 hours in 1 hour steps)
Zero Correction:	Automatic correction for zero drift

Control Panel

Display:	128 x 64 pixel reflective backlit LCD
Keypad:	4 keys for data input
Indicators:	Power, System OK, Calibration, Alarm

Environmental

Operating temperature:	-40 to 55 °C / -40 to 131 °F
Maximum Flue Gas temp:	600 °C / 1112 °F
Maximum Flange temp:	200 °C / 392 °F
Flue Gas Water Content	Not sensitive to water vapor. Condensed water must not be present in the measurement path
Electrical Safety:	IEC / EN 61010-2
EMC:	EN50 081 & EN50 082
Sealing:	IP65 / NEMA4X
Approvals:	EN15267-1, EN15267-2, EN15267-3, EN13284-2
Performance Specifications:	QAL1, US EPA PS-1, ASTM D6216, US EPA Procedure 3

Outputs

Modbus Interface:	RS485. Opacity, Optical Density, Dust Density, and Status Information available
Analog Outputs:	Isolated 4-20 mA current output. Configurable as Opacity, Optical Density, Dust Density. Maximum impedance 500 Ω
Relay Outputs:	System OK, Calibration, Alarm
Relay Rating:	1 A @ 24 V dc

Electrical

Power Supply:	24 V dc nominal (18 to 30 V dc)
Current Consumption:	3 A maximum

Mechanical Data

Dimensions (H x W x D)

Transceiver:	191 x 201 x 413 mm / 7.5 x 7.9 x 16.3 in
Retro-Reflector:	191 x 201 x 237 mm / 7.5 x 7.9 x 9.3 in
Long Pathlength Retro:	320 x 220 x 220 mm / 13 x 13 x 9 in

Weight

Transceiver:	6 kg / 13.2 lb
Retro-Reflector:	3 kg / 6.6 lb
Long Pathlength Retro:	8 kg / 17.6 lb

Enclosure

Transceiver / Retro-Reflector:	Cast Aluminium, epoxy coated

Protective Purge

Purge air required:	30 m^3 / hr / 18 cfm each side

Accessories

Available:	Fail-safe Shutters
	Blowers
	Adapter Flanges
	Weather Cover
	Calibration Filters
	Control Room Unit
	Calibration Stands

D2 Auxiliary Functions Unit & Auxiliary Power Supply (AFU & APS)

Data Communications

Data port:	Modbus RS232 or RS485. Two or four-wire, 9600 or 19200 baud, Odd, Even or No parity. Opacity, Optical Density, Dust Density, and Status Information available. Remote control.
Control port:	Modbus RS232 or RS485. Two or four-wire, 9600 or 19200 baud, Odd, Even or No parity. Remote control and diagnostic information.

Inputs and Outputs

Analogue Outputs:	Two isolated 4-20 mA current outputs, each configurable for Opacity, Optical Density, or Dust Density. Selectable for active or passive operation. Maximum impedance 500 Ω
Relay Outputs:	System OK, Maintenance (Data not Valid), Zero Calibrating, Upscale Calibrating, Two Alarm Relays, each configurable for Opacity, Optical Density, or Dust Density. 48 V 1A maximum.
Blower Monitoring	Four logic inputs for monitoring up to two purge air blowers.
Failsafe Shutter Control	Four logic inputs and two logic outputs for monitoring and controlling up to two failsafe shutters.
Remote Calibration Trigger	Logic input for external volt-free contacts. Triggers a Calibration Check Cycle.
Remote Fuel Selection	Two logic inputs for external volt-free contacts. Selects one of three sets of Dust Density Calibration Constants corresponding to different fuels or operating conditions.

Power Required

AC~ Voltage:	110 V ±10% or 220V ±10% or 230 V ±10% depending on the blower connected to the blower terminals*

CAUTION

Do not connect a voltage/frequency that is unsuitable for the blower.

Frequency:	50 or 60 Hz ac depending on the blower connected to the blower terminals*
Maximum Power:	5 kVA

* See Section A6.1

Mains Power Distribution Option

Blower power:	Two 20A MCBs, with neutral and earth terminals

Environmental

Operating temperature:	-40 to 55 °C / -40 to 131 °F
Environmental rating:	IP65 / NEMA4X

Compliance

EMC:	Conforms to EN 61326-1
Safety:	Conforms to EN 61010-1

Mechanical Data

Weight:	5.5 kg (12 lb)
Dimensions (H x W x D):	254 x 577 x 145 mm (11.8 x 22.7 x 5.5 in)

END OF SECTION

E MAINTENANCE

E1 Identifying Faults

The Model 4500 MkIII Dust and Opacity Monitor has been designed to assist the user to find and correct a number of possible problems. If the instrument detects a problem it will switch off the Green System OK LED and de-energise the System OK relay.

Further diagnostic information may be obtained as follows:

1) Press ⏎

2) Use the ⇧ and ⇩ arrows to select Diagnostics  and press ⏎
The number of faults present is shown in the top left corner of the display.

3) If the number of faults is not zero, use the ⇧ and ⇩ arrows to select List Faults  and press ⏎
The first Fault Number is displayed. Its meaning and the recommended action are listed in the Table opposite.

4) Use the ⇧ and ⇩ arrows to see any other Fault Numbers. If there are no other faults, the number will not change.

5) Press ⏎

6) To clear the faults, use the ⇧ and ⇩ arrows to select Clear Faults  and press ⏎. The number of faults will be updated. If there are still faults present, this will not be zero.

> **Note**
>
> The list of displayed faults is only updated on entry to the diagnostics menu, and in response to a Clear Faults instruction. Changes in fault status while the Diagnostics menu is in use may not be visible.

7) Press ✕ to return to the main screen.

Fault Number List

Fault Number	Description	Recommended Action
1	Zero motor jammed.	Check the Zero Reflector drive mechanism. Warning – Do not move the mechanism by hand or the precision gearbox may be irreparably damaged.
2	Upscale motor jammed.	Check the Upscale Filter drive mechanism. Warning – Do not move the mechanism by hand or the precision gearbox may be irreparably damaged.
3	Source LED failed	Check the Source LED connections. Replace the Source LED Assembly.
4	Flood LED failed	Check the Flood LED connections. Replace the Flood LED Assembly.
5	ADC Over-range	The signal arriving at the Analogue-to-Digital Converter is too large. Check that the correct reflector element and aperture plate are fitted in the retro-reflector. Replace the Detector PCB. Warning – The Detector PCB must be optically aligned.
6	ADC Fault	The Analogue-to-Digital Converter is not working. Replace the Detector PCB. Warning – The Detector PCB must be optically aligned.
7	Transceiver shutter fault	If fitted, the fail-safe shutter should close during calibration check and then reopen. Check shutter wiring. Check shutter operation during calibration check. Replace shutter motor or clutch. Replace shutter. As a temporary measure, a faulty shutter can be locked open to allow opacity measurements to continue. Refer to E3 below.
8	Retro shutter fault	As 7 above.
9	Transceiver blower fault	Check blower power. Check pressure switch wiring. Check blower filter.
10	Retro blower fault	As 9 above
11	AFU Fault	Communications lost to Auxiliary Functions Unit. Check wiring to AFU. Check links LK1 and LK2 are fitted (refer to Section A4.8). Possible hardware fault in AFU - replace main board.
13	Negative Opacity	Check that the installation pathlength is correct. Perform a Clear Stack Calibration.
14	Checksum Error	The microprocessor's program memory is defective. Re-program the Main PCB. Change the Main PCB. Warning – All of the instrument settings and calibration constants are stored on the Main PCB. Re-enter this data after changing the PCB.
15	Lens Contamination Limit	The zero drift correction system has reached its limit. Clean the main lens. Perform a Calibration Check. If the problem persists, make sure the Zero Reflector is clean. Note that this fault can only be cleared by a successful Calibration Check or Clear Stack Calibration.
16	Failure during Calibration	Something has prevented completion of a calibration. User actions can cause this fault. Perform a Calibration Check. If the problem persists, check the Zero Reflector and Upscale Filter drive mechanisms. Warning – Do not move either mechanism by hand or the precision gearbox may be damaged irreparably.

Note

When contacting AMETEK Land Instruments Service Department please have the Instrument Type and Serial Number available. This will ensure a more accurate and efficient response.

E1.1 Troubleshooting

Problem seen	Possible cause	Recommended solution
Transceiver display is blank	No power	Check power supply Check power cable
	Hardware fault	Contact AMETEK Land for advice
Transceiver does not recognise AFU	Communications problem. This can be identified by looking at communications LED23 (TXD) and LED24 (RXD) which should flicker rapidly if communications are normal	Check wiring Check jumpers LK1 And LK2 are fitted on AFU
	AFU Switch settings	Check status of AFU switches S2, S5, S7
AFU 4-20 mA outputs do not function	Transceiver is not communicating with AFU	As above
Unit does not output opacity after calibration	Output is PLCF	No action needed. Instrument is designed to output the PLCF value for 90 s at the end of a calibration check
Unexpected calibration checks	Internal timer is in use	Set parameter 95 to value 0 to disable calibration check timer
	Intermittent loss of power causes instrument to restart	Check power connections are secure Check mains power to AFU is reliable

E2 Routine Maintenance

The AMETEK Land Instruments International Model 4500 MkIII has been designed for a minimal amount of routine maintenance. To ensure a maximum monitor lifetime however, the following maintenance schedule has been developed. Remember that the air purge system should always be left on, even if the boiler is off, to prevent any contamination of the optics. In exceptionally dirty facilities, the time periods below should be shortened. Frequent "Lens Contamination limit" alarms or blower faults may indicate a need to shorten the maintenance period.

Item	Part	Maintenance	Procedure
Air Hoses	306.046	90 Days	Examine hoses for holes or leaks. Test all hose clamps for tightness.
Pre-filter (Where fitted)	317.560	90 Days	Dust level should be below the line. Remove, empty, wipe out, and replace.
Filter Element Safety Filter (where fitted)	317.561 317.604	90 Days Annually	Remove the filter from the filter housing. Remove the cap. Empty the cap and wipe out. Wear eye protection, tap gently to remove dust. Clean carefully with a blow gun. Examine for holes or rips. Re-fit. Replace with new filter.
Blower		90 Days	Check for bearing noise. (Bearing failure, and subsequent blower failure, can be detected early.) Check blower air flow to be sure that the blower is performing normally. (Dirty air filters may reduce air flow and cause undue stress on the blowers.)
Optics	N/A	90 Days	Check and clean the optics as described below.
Air Purge Adapter	N/A	90 Days	Unclip and hinge open the Transceiver and Retro-Reflector and check that there is no ash buildup inside the purge adapters that could block the light path.

During the regularly scheduled maintenance periods, any optional equipment (e.g. shutters, pressure switches, weathercovers) should be checked for correct operation. If any potential problems are noted, the equipment should be repaired or replaced if necessary.

Cleaning the Optical Surfaces

After prolonged use, it is likely that some contamination will occur on the optical surfaces of the Model 4500 MkIII. The time taken for significant contamination to occur depends very much on the nature of the installation, but in a typical situation it should be sufficient to clean the optics every 90 days.

CAUTION

Always use a lint free lens cloth to clean the optical surfaces. Ensure the cloth is kept clean. A dirty lens cloth can scratch the optical surface and cause permanent damage to the Model 4500 MkIII. Replacement lens cloths can be purchased from AMETEK Land Instruments International. **Ordinary tissues and dusters are not suitable, and can scratch the delicate optical surfaces.**

To clean the Retro-Reflector, open the housing by undoing the two quick-release clamps. Carefully wipe the glass surface of the Retro-Reflector with the lens cloth. Close the housing and fasten the two quick-release clamps.

To clean the mains lens, open the Transmissometer housing by undoing the two quick-release clamps. Wipe the lens using the lens cloth. Close the housing and fasten the quick-release clamps.

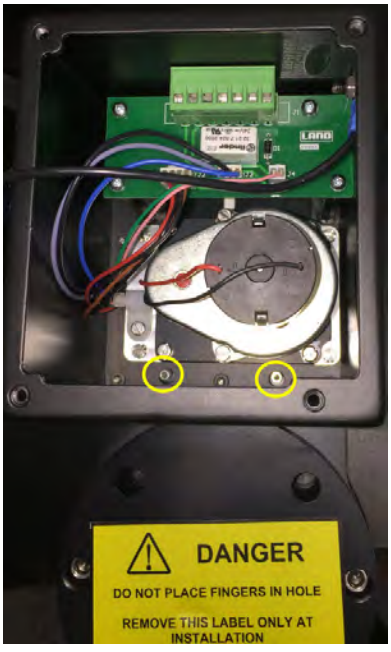
CAUTION

Do not attempt to move the zero reflector by hand. The precision gearbox will be damaged irreparably.

E3 Locking the Fail-Safe Shutter Open

If the fail-safe shutter develops a fault and will not open automatically, it is possible to lock it in the open position as follows:

1) Remove the cover from the shutter
2) Identify the locking screws (circled) and remove them using a 2 mm hex key.
3) Remove the spacers and replace the screws loosely. Do NOT tighten them at this stage.
4) Using a 2 mm hex key, remove the grub screw in the bottom of the shutter flange.
5) Insert a rod or narrow screwdriver into the screw hole and push the shutter fully open.
6) With the shutter held open, tighten the two locking screws.
7) The shutter will remain open.



E4 Upgrading the 4500 MkIII Transceiver Firmware

This section gives snstructions for upgrading both the Controller firmware, and the Human Interface firmware in a 4500 MkIII transceiver.

Also refer to this section when you need to remove the transceiver cover to access internal switches and components.

Equipment Required

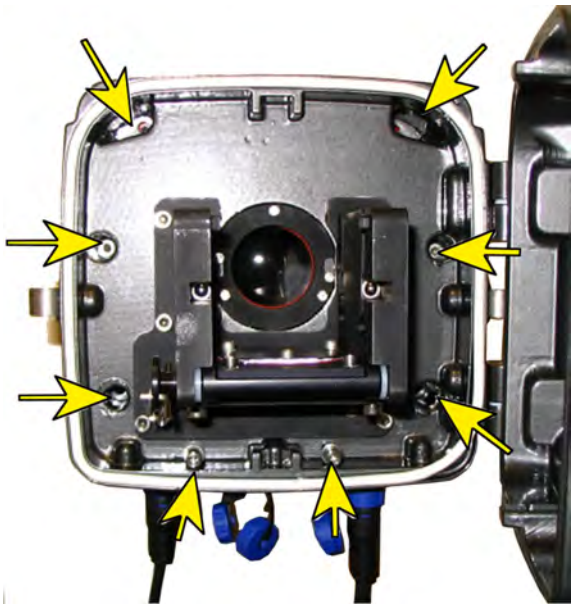
- An Atmel AVRISP MkII is required to perform the updates. See the Atmel web here: http://www.atmel.com/dyn/products/tools_card.asp?tool_id=3808.
- Laptop / Desktop PC on which to run the programmer software
- Set of connecting leads and a power supply for the 4500 MkIII transceiver.

Install the software that comes with the AVRISP MkII (AVR Studio 4). This also installs USB drivers.

Ensure the firmware upgrade (.HEX) files are accessible from the programming PC

Removing the Transceiver Cover

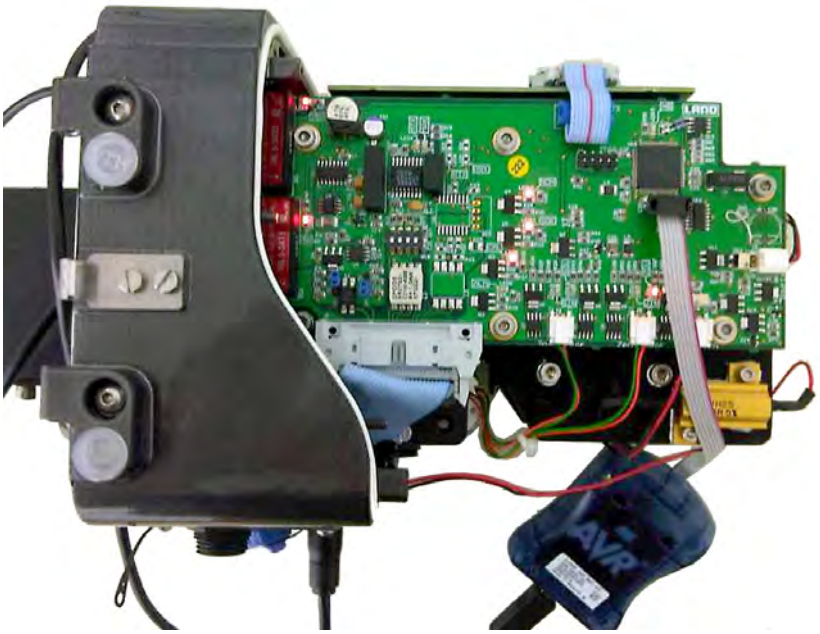
1) Unfasten the clip which secures the rear section of the transceiver and open up the unit via the hinges on the opposite side to the clip.
2) The internal face of the transceiver is revealed (see below). Use a 3mm Allen key to remove the 8 screws that secure the instrument cover.



3) Slowly pull back the red cover until the keyboard connector can be seen. Disconnect the keyboard ribbon, and then remove the cover.

Upgrading the Controller firmware

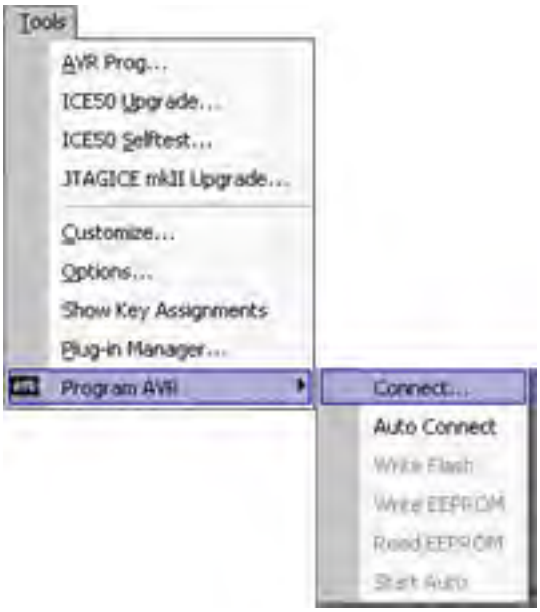
1) Connect the AVRISP programming connector to the connector on the main PCB. Make sure the connector is oriented as shown below.



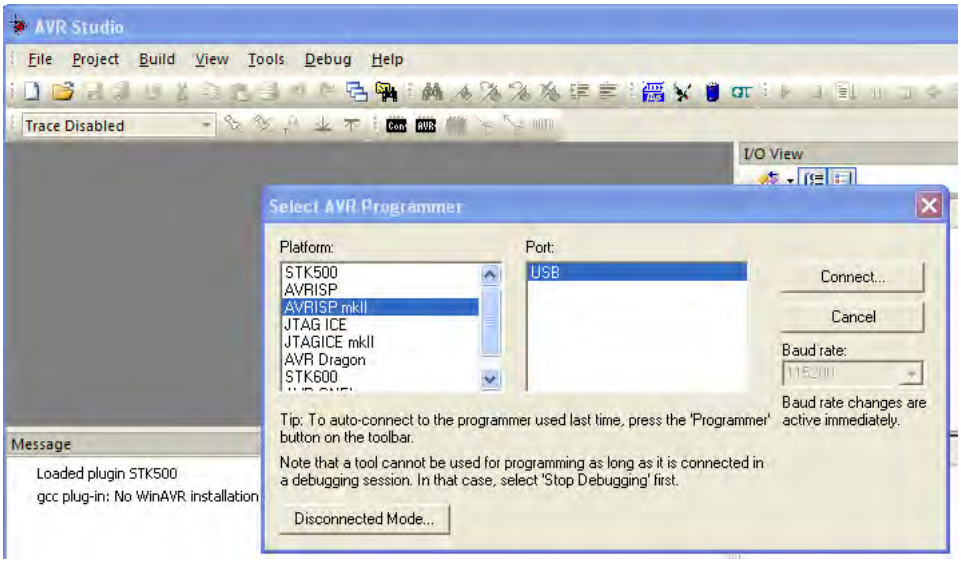
2) Connect the power lead and a 24V power supply to the instrument and power it on.
3) Connect the AVRISP to a USB port, and start up AVR Studio 4

4) Click **Cancel** on the 'Welcome to AVR Studio' dialogue

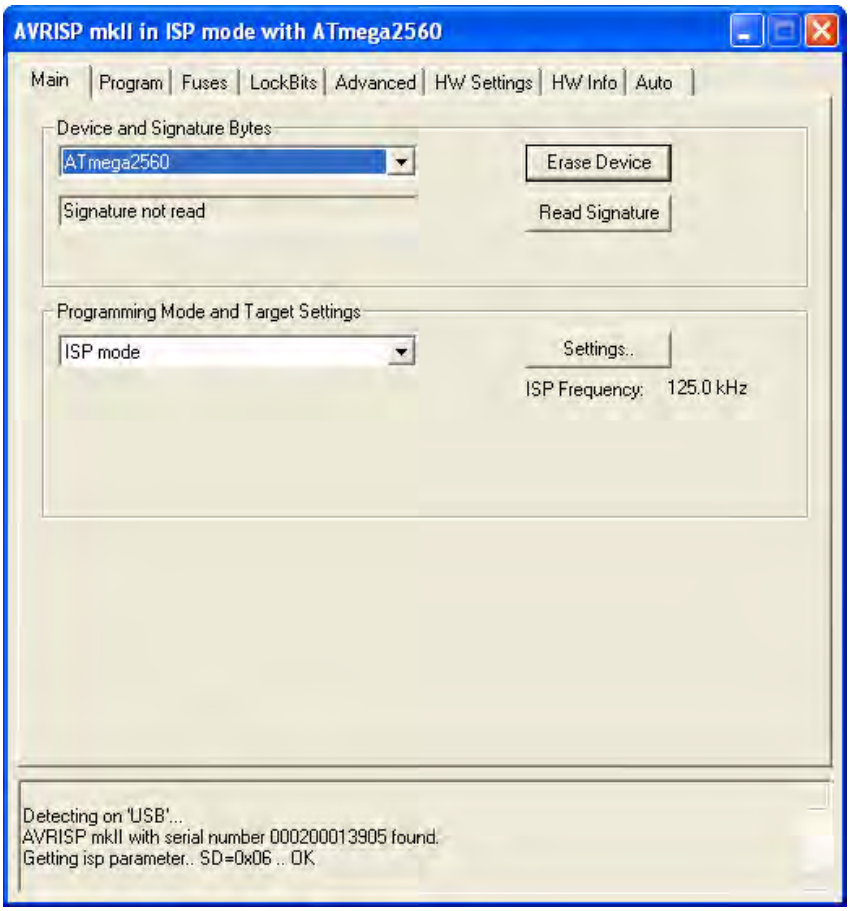
5) Select **Tools** > **Program AVR** > **Connect**.



6) Select AVRISP MkII and USB then click **Connect**.



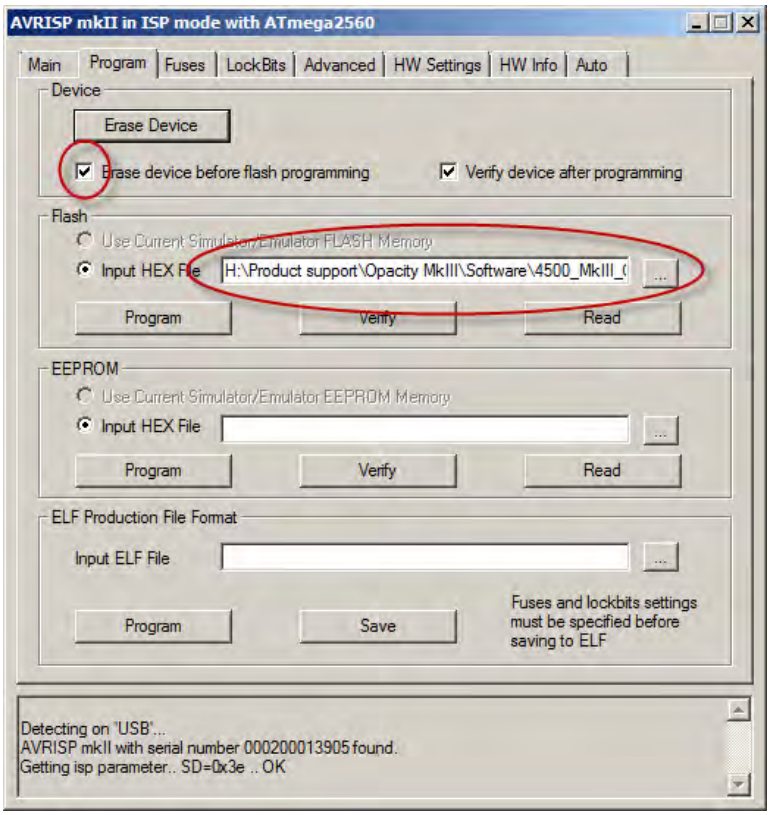
7) Click the Main tab if not already selected. In the Device box select **ATmega2560**.



8) Click the **Program** tab. Ensure that the **Erase Device** box is ticked.

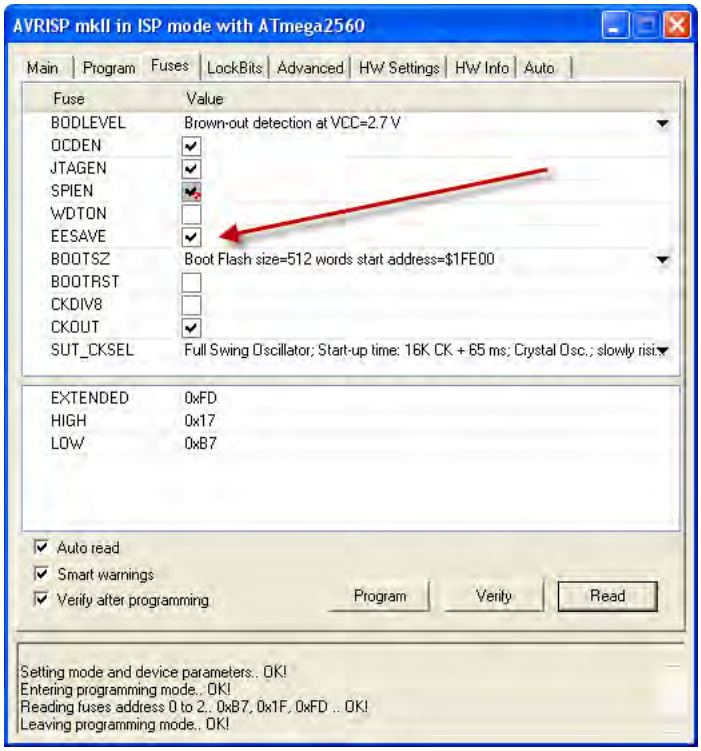
9) Click the file selector for the Flash Input HEX File and navigate to the .HEX file for the controller firmware upgrade (This will normally be named something like 4500MkIIIController.hex).

Do not click the Program button at this stage.

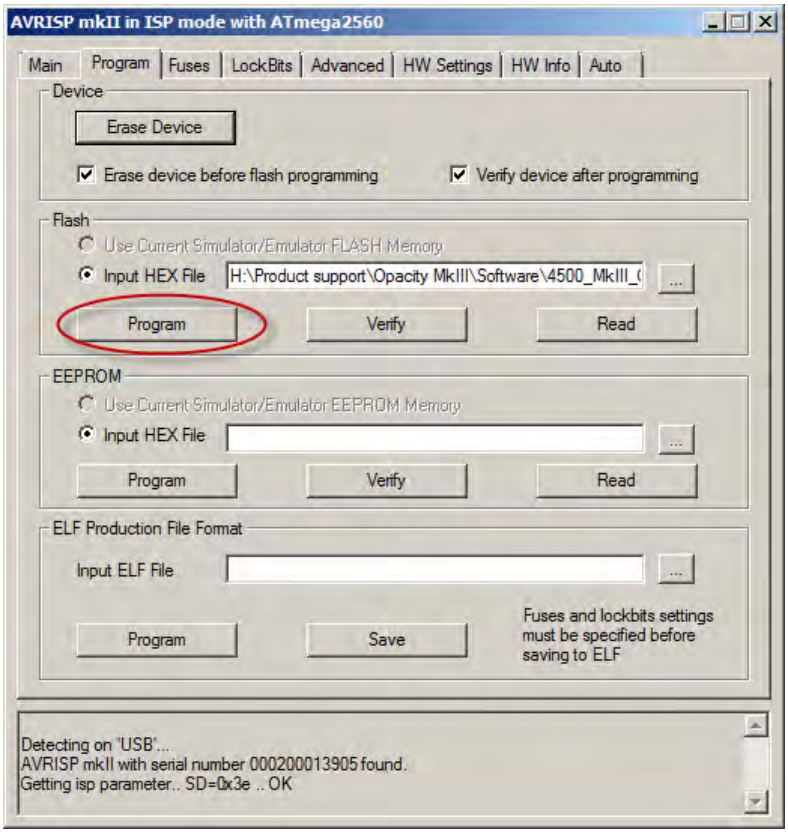


10) Click the **Fuses** tab. If all is well the device fuse settings will be read from the controller and the status window at the bottom will indicate that this action was successful.

11) Ensure that the tick box **EESAVE** is ticked. This ensures that the instrument does not lose its calibration when the firmware is upgraded.



12) Click the **Program** tab and click the **Program** button under **Flash**.



13) Programming takes a few seconds. Check that the LEDs on the AVRISP MkII are as shown. If all is well, the status window at the bottom will indicate that this action was successful.

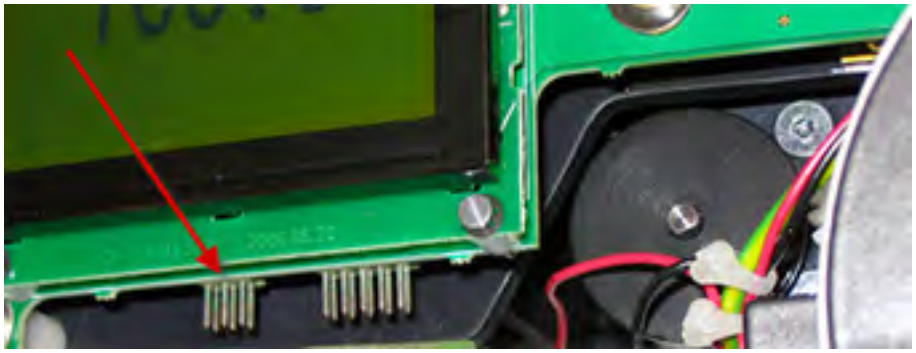
14) Close the AVRISP MkII dialogue box. Disconnect the programming connector. The Controller firmware is now upgraded.

Upgrading the Human Interface firmware

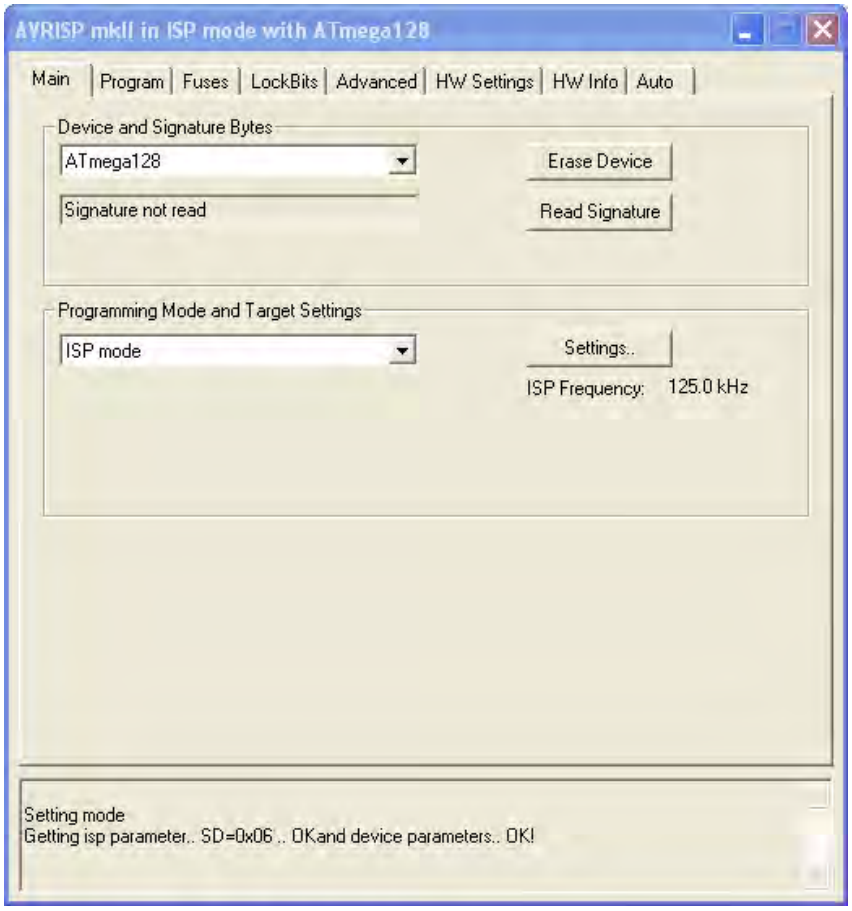
1) Connect the programming connector to the 10 way JTAG header on the display PCB. Make sure the arrow on the connector matches pin 1 marked on the PCB.

   The procedure for programming the Human Interface is similar to that for the main software.

2) Connect the AVRISP mkII programmer to the connector adjacent to the display.



3) Select Device **ATmega128** on the Main tab
4) Select the appropriate .hex file on the Program tab



Check the software and replace the instrument cover.

1) Cycle the instrument power Off then On.
2) Ensure that after a few seconds, the calibration motors move, the display shows the startup splash, followed by the version numbers of the Controller and Human Interface firmware.
3) Check that the version numbers are those expected from the upgrade.
4) Remove the power.

5) Carefully replace the cover, ensuring that it doesn't jam on any components. When the cover is close enough, refit the keyboard connector ribbon, ensuring it is not offset by one pin.
6) Ensure that the white cord seal is correctly seated before pushing the cover home. Secure the cover with the eight screws.
7) Switch on the instrument and check display and keyboard functionality.

E5 Replacement Parts and Consumables

Consumables

320.804	Lens cloth
701.972	Flange sealing ring

Spare Parts

804347	Transceiver (without Purge Assembly)
804348	Purge Assembly
702.789	Purge for long-pathlength retro
804351	Retro-reflector (without Purge Assembly or elements)
702.793	Retro mount for long-pathlength retro
804349**	Reflector element set 0.6 m
804350**	Reflector element set 0.8 m
801523**	Reflector element set 1.5 m
801524**	Reflector element set 3.0 m
801525**	Reflector element set 7.0 m
801526**	Retro element set 10.6 m
804320*	Main PCB
804319*	Detector PCB
804537*	Display PCB Assembly
804542	Connector Plate Assembly
804321	Flood LED PCB
804284	Source Assembly
804285	Main Lens Assembly
804283	Eyepiece Assembly
804322*	Auto-calibration Assembly
804368*	Calibration motor and gearbox
804404	Upscale filter Assembly
804367	Upscale grating set
804405	Zero reflector Assembly
804470	Zero reflector grating set
804406	Transceiver case complete
804390	Case clip and hook (304 SS)
804394	Case hinge set – 1 Pair
318.238	Hose clip
306.046	Hose 39 mm – per m

Spares for Standard Mounting Flange 703.020

804557	Spherical washer – Set of 3
804558	Disc spring – Set of 24
804559	M10 Nylock nut – Set of 3
804561	M10 Full nut – Set of 3
703.021	M10 stud
809699	Rebuild Kit for Standard Standpipe

Spares for Large Mounting Flange 702.790

702.749	Spherical washer (each)
318.284	Disc spring (each)
315.040	M12 Nylock nut (each)
705.755	M12 Stud (each)
802823	M12 Stud (each) - for use with fail-safe shutter
809700	Rebuild Kit for Large Standpipe

AFU and APS Spare Parts Consumables

Spare Parts

809825	AFU-APS-I/O - 4500 MkIII
805468	AFU Basic Unit -4500 MkIII
804645	Main AFU PCB for 4500 MkIII
804648	Process AFU PCB for 4500 MkIII
807334	4500 MKIII Analogue I/O Upgrade Kit
	Use 807334 for upgrade; use 804648 for replacement
805388*	Power supply 120W 24V (-40°C)
804651	Ethernet AFU PCB (Tested) - 4500 MkIII
812112	Head Cover Screws (Pk of 4) AFU

Stand Alone Power Supply Options

809014	APS1 Stand-alone PSU
809015	APS2 Stand-alone PSU

NOTES

Many jurisdistions require users to maintain appropriate spare parts on-site. AMETEK Land recommends the following parts which allow immediate repairs of the most likely fault conditions:

* Recommended spare parts to keep on-site

** Select correct retroreflector to keep on-site

Identifying Spare Parts

Lens Cloth
(Part Number 320.804)

Flange Sealing Ring
(Part Number 701.972)

Spherical Washer
(Set of 3)
(Part Number 804.557)

Spring Washer (Set of 24)
(Part Number 804.558)

M10 Locking Nut (Set of 3)
(Part Number 804.559)

Flange Stud (Set of 3)
(Part Number
809645)

809699 Rebuild kit for standpipe comprises one each of 804557, 804558, 804559 and 809645.

END OF SECTION

F CHANGING THE INSTALLATION PATHLENGTH

F1 Set the correct focus

The Transceiver focus and retro reflector must be set according to the instrument's specified flange-to-flange path length. Refer to the focus table (Section F5) for the correct focus spacer setting.

1) Remove the main lens assembly by undoing the three fixing screws.
2) Remove the screws. Remove the lens retaining plate by turning it clockwise.
3) Carefully remove the spacers, O-ring, lens and more spacers.
4) Look up the flange-to-flange path length in Section F5. Find the row where the pathlength lies between the values in the minimum and maximum columns.
5) Make a note of the Lens Spacers and the Reflector Part Number.
6) The complete set of spacers contains two of each size: 8, 4, 2 and 1 mm. Select spacers which add up to the value in the table e.g. 18 = 8 + 8 + 2. Put these spacers into the lens holder. Insert the lens (flat side down), then the O-ring and finally the remaining spacers.
7) Replace the retaining plate and lock by pressing down an turning anti-clockwise. Check that all three screw holes are open. If not, remove and reposition the plate.
8) Replace the lens holder in the Transceiver and **tighten the three screws**.

F2 Align and Calibrate the Model 4500 MkIII

The following must be done in a laboratory or a clean workshop. A test kit comprising tabletop stands and power supply available from AMETEK Land instruments and make the procedure more convenient.

1) Optically align the Model 4500 MkIII
2) Perform a clear stack calibration using the Recalibrate function. Verify that the instrument reads 0% opacity on a clear path and 100% opacity when the beam is blocked.

F3 Set the B constant

Check the B (balance) value using the Calibration: Manual Cal function. The B (balance) value must be within the range of 0.95 to 1.05. If the value is outside this range, carry out the following procedure to choose new aperture and grating plates.

1) Remove the Zero Reflector and disassemble as shown in Figure F-1. Find the aperture and grid identifiers etched on the tabs and identify the relevant sequence number.
2) If the B-value is too low, choose an aperture and grid with a sequence number greater than the current value. If the B-value is too high, choose an aperture and with a sequence number less than the current value. Each sequence number corresponds to approximately 0,05 difference in the B-value.
3) Fit the new aperture and grating, and replace the check reflector.
4) Repeat the clear-path calibration and check the B value. If it is within the range 0.95 to 1.05, the B value is acceptable. Otherwise repeat the procedure.

Example

The B-value is 1.23, Grating 2, Aperture F

- Sequence number is 25.
- B-value is 0.20 too high.
- 0.20 = 4 x 0.05, so the required sequence number is 29
- Refer to Section F6. The sequence number is 29. Therefore select Grating 2, Aperture J.

F4 Calibration Error Test

Perform a calibration error test according to ASTM D6216-12 para 7.8. Select three audit filters selected according to the requirements of ASTM D6216 para 7.5. The 2” square audit filters provided as an optional item with the Model 4500 MkIII are suitable. Ensure the calibration certificates are up-to-date.

1) Open the 4500 MkIII transceiver at the hinge and place the low-level filter in the audit filter slot.

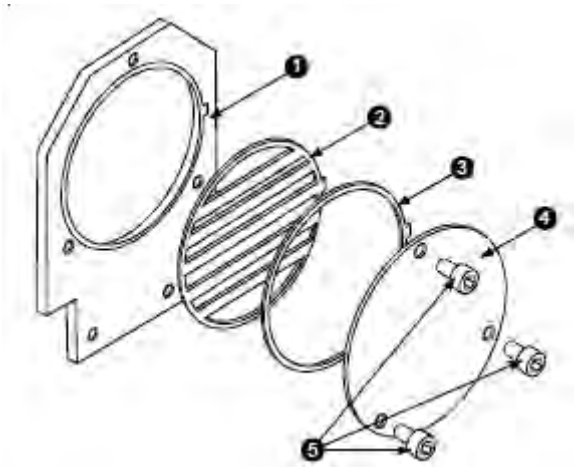


Fig. F-1

2) Close the transceiver and wait for the reading to settle. Record the opacity value indicated on the site data acquisition system. As a precaution, it is advisable to write down the value displayed on the Model 4500 MkIII user interface.
3) Repeat steps 1 and 2 for the mid- and high-level opacity filters.
4) Repeat steps 1, 2 and 3 four more times, to give a total of five readings for each filter.
5) Calculate the calibration error as described in D6216 para 7.8.

F5 Focus Table

Installation Pathlength (mm)		Installation Pathlength (in)		Focus spacer (mm)	Retro Part Number
Min	Max	Min	Max		
514	537	20.2	21.1	30	804349
538	562	21.2	22.1	29	
563	588	22.2	23.1	28	
589	617	23.2	24.3	27	
618	648	24.3	25.5	26	
649	681	25.6	26.8	25	
682	717	26.9	28.2	24	
718	757	28.3	29.8	23	
758	800	29.8	31.5	22	804350
801	847	31.5	33.3	21	
848	900	33.4	35.4	20	
901	958	35.5	37.7	19	
959	1023	37.8	40.3	18	
1024	1095	40.3	43.1	17	
1096	1177	43.1	46.3	16	801523
1178	1269	46.4	50.0	15	
1270	1375	50.0	54.1	14	
1376	1498	54.2	59.0	13	
1499	1642	59.0	64.6	12	
1643	1812	64.7	71.3	11	
1813	2020	71.4	79.5	10	
2021	2272	79.6	89.4	9	801524
2273	2585	89.5	101.8	8	
2586	2991	101.8	117.8	7	
2992	3532	117.8	139.1	6	
3533	4298	139.1	169.2	5	
4299	5438	169.3	214.1	4	801525
5439	7305	214.1	287.6	3	
7306	10626	287.6	418.3	2	

F6 Sequence Numbers for Grating and Aperture Combinations

	Grating A	Grating 1	Grating 2	Grating 3	Grating 4	Grating 5
Aperture B	1	11	21	31	41	51
Aperture C	2	12	22	32	42	52
Aperture D	3	13	23	33	43	53
Aperture E	4	14	24	34	44	54
Aperture F	5	15	25	35	45	55
Aperture G	6	16	26	36	46	56
Aperture H	7	17	27	37	47	57
Aperture I	8	18	28	38	48	58
Aperture J	9	19	29	39	49	59
Aperture K	10	20	30	40	50	60

END OF SECTION

G INSTRUMENT RECORD SHEETS

G1 Configuration Record Sheet

Please complete the Configuration Record Sheet.

General Information	
Instrument Serial Number	
Date of Purchase	
Technical Information	
Pathlength	

Service History	
Date	Action

Repair History			
Date	Action	Part Replaced	Part No.

G2 Model 4500 MkIII Parameter Record Sheet

The following parameters give valuable information on the operation of the Model 4500 MkIII. Recording them regularly (e.g. as part of a quarterly calibration audit) can be valuable in diagnosing fault conditions.

Parameter	Label	Description	Value
6	Software	Version number	
7	HI Software	Version number	
51	Faults	No. of faults	
52	Error Flags 1	Fault code	
121	Sm	Signal measurement	
122	Rm	Reference measurement	
123	Sf	Signal flood value	
124	Rf	Reference flood value	
125	So	Signal offset	
126	Ro	Reference offset	
127	Opacity	Calculated opacity	
137	PLCF	Path length correction factor	
140	C working	Calibration slope	
141	X working	Calibration offset	
142	B working	Calibration balance factor	
149	W	Dirty window correction	
153	Op0	Zero compensation	
154	Opz	Cal check zero value	
155	Opc	Cal check upscale value	

END OF SECTION

H OPTIONAL I/O MODULES FOR THE AFU

The Auxiliary Functions Unit (AFU) can be fitted with up to two optional I/O modules. These modules can either be factory fitted or purchased separately.

At present, the following optional module is available:

- Ethernet Module (AMETEK Land Part No 804651)

H1 Ethernet Module (804651)

If you have installed or have a factory fitted Ethernet module, then the following items will be required.

- Digicom device discovery software on CD
- Ethernet cross over cable
- Laptop or other PC
- 4500 MkIII AFU

Ethernet Communications

The Ethernet connection provides a high-speed communications interface. It can be used to request live data and remotely configure the 4500 MkIII from anywhere on the user's network, using the Modbus MBAP protocol.

To make use of the external communications, customers must send commands to the processor using the Modbus specified format.

Full details of the Modbus standard messaging interface are given in the appropriate Modbus standard obtainable from Modbus.org.

The 4500 MkIII Modbus registers are given in the user guide.

Cable Requirements

The processor provides a connection for a 10BASE-T RJ45 Shielded Twisted Pair (STP) connector of CAT5 specification.

The general cable recommendation is to use shielded 10BASE-T LSOH Category 5 / Level 5 STP cable. This provides protection from electromagnetic interference in industrial environments.

The use of unshielded 10BASE-T LSOH Category 5 / Level 5 UTP is only recommended for areas that are guaranteed to be free from severe electromagnetic interference.

The maximum cable length allowed is 100m / 328ft, which can be extended to 457m / 1499ft by utilising external network repeaters.

The Ethernet module comes pre-configured with a static IP address of 10.1.10.200 with a subnet mask of 255.255.0.0.

The unit can be accessed via a web browser, providing the static address is within the allowed range on your network.

If it is not possible to connect the module directly onto your network using this static address, then it will be necessary to setup a direct connection between the module and a PC in order to configure the module. The following describes how to do this using a PC running Windows XP with SP2.

Direct Connection

In order to configure the AFU Ethernet module, a direct connection to the device is recommended. The following instructions provide the preferred set up procedure: if in doubt contact your network Administrators.

1) Connect the cross-over Ethernet cable between the AFU & PC/Laptop.
2) Disable the 'Proxy Server' from the system, allowing direct IP addressing (Internet Protocol - TCP/IP) between the laptop/PC and the AFU Module.
3) The following instructions detail how to set the IP address of the AFU instrument (static addressing) from within a Windows XP Operating System and how to disable the 'Proxy Server' from 'Internet Explorer'.
   - From the Windows XP desktop, click **Start** and **Settings**.
   - Choose **Control Panel**.
   - Double-click on **Network Connections**.
   - Identify the network adapter in use (typically **Local Area Connection**).
   - Highlight and right-click on **Local Area Connection**.
   - Choose **Properties**.
   - Highlight **Internet Protocol (TCP/IP)**.
   - Click **Properties**.
   - Select **Use the following IP address**.
   - Enter the IP address given with the AFU interface unit and add 1 to the last number of the IP address:
     i.e. 10.1.10.200 (AFU IP address)
     10.1.10.201 (IP address to be entered)
   - Set the **Subnet Mask** to 255.255.0.0 (default) or identical to the AFU and ensure that the **Default Gateway** is blank.
   - Click **OK** (twice).
   - Close **Control Panel**. The settings are applied automatically.

To disable the 'Proxy Server' option;

- From the **Start** menu, select **Internet Explorer**.
- Click the **Tools** tab.
- Choose **Internet Options**.
- Click the **Connections** tab.
- Click on **LAN Settings**.
- In the **Proxy Server** options, ensure that the **Use a Proxy Server for Your LAN (These settings will not apply to dial-up or VPN connections)** is not checked. When this option is unchecked, the address and port options are disabled.
- Click **OK**.
- Click **Apply** and **OK**.
- Close **Internet Explorer**.

Note

In different versions of **Internet Explorer**, some **Proxy Server** options may differ from options detailed above.

If the network operates MAC Address filtering, the MAC Address must first be added to the network configuration.

The MAC Address for the AFU is located on the Module Serial No. label.

Contact your local Network Manager for further information.

All AFU modules are set to Factory Default Settings prior to dispatch.

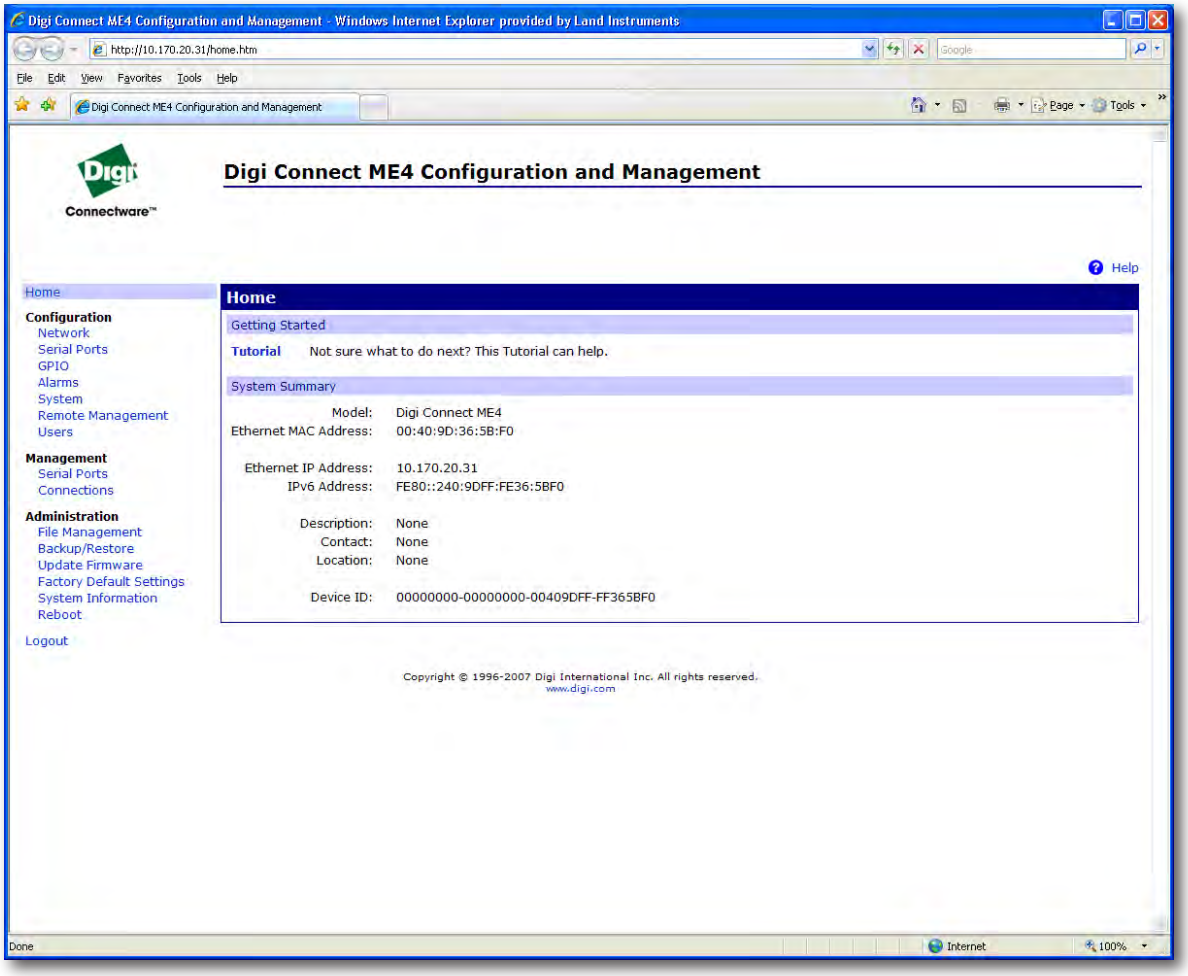
Factory Default Settings

- **IP Address = 10.1.10.200 (static)**
- **Port Number = 502**

The unit is supplied with the IP address fixed. However, the network settings of the unit can be changed by entering the following into the web browser window:

http://10.1.10.200/home.htm

The **Digi Connect ME4 Configuration and Management** screen is displayed:



From the **Configuration** menu list, select the **Network** option. The **Network Configuration** screen is displayed.

Note

Network parameters must only be changed by experienced network users, as any incorrect settings could result in the loss of communication or data.

Changing the IP addressing mode from fixed to dynamic (DCHP) will cause the address to change and may cause a loss of communication.

The **Device Discovery** program (supplied on disk with the instrument) can be used to find all connected units.

If you are unsure about any of the settings, then contact your Network Manager.

If the unit it to be used stand alone or in a fixed IP network system, then provided the settings on the **Network Configuration** screen are within the allowed addressing range of the network, no further changes will be needed.

If changes are made to any of the settings on the module, click on **Apply** to implement and save the settings.

Once configured to operate on the network, the unit will communicate via the MBAP V1.0a TCP protocol and no further settings are required.

The module can now be connected to the network, the default slave address of the 4500 MkIII transceiver is 7, but the actual slave address of the transceiver can be found using the Human interface, this will need to be matched by the Modbus master.

If other Modbus protocols are required, then refer to the Modbus user documentation for details of the required settings.

END OF SECTION

APPENDIX 1
LONG PATHLENGTH OPTION

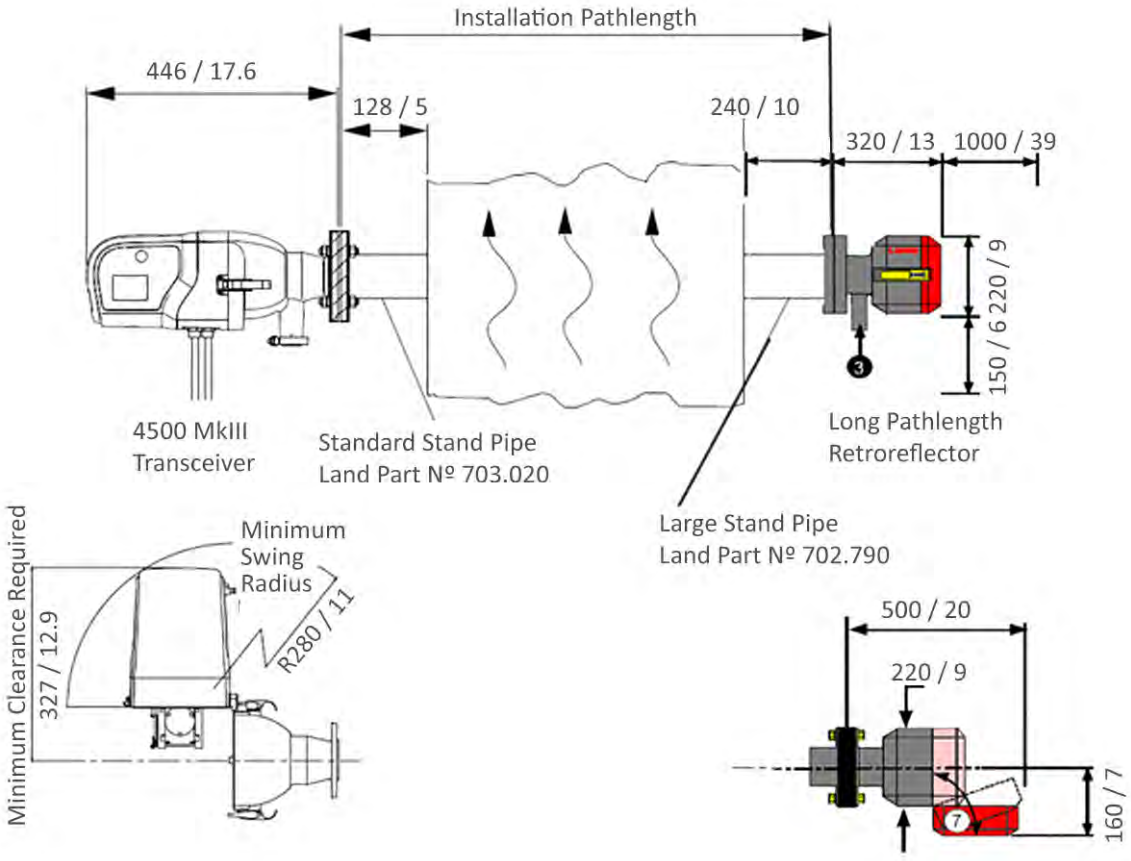
Long Pathlength Option

The standard 4500 MkIII is suitable for installation pathlengths up to 10.6 m (35 ft).

A special retroreflector allows the 4500 MkIII to be used on installation pathlengths up to 15 m (50 ft).

The long-pathlength retro is larger than the standard unit and mounts to a larger standpipe.

The installation is shown below.

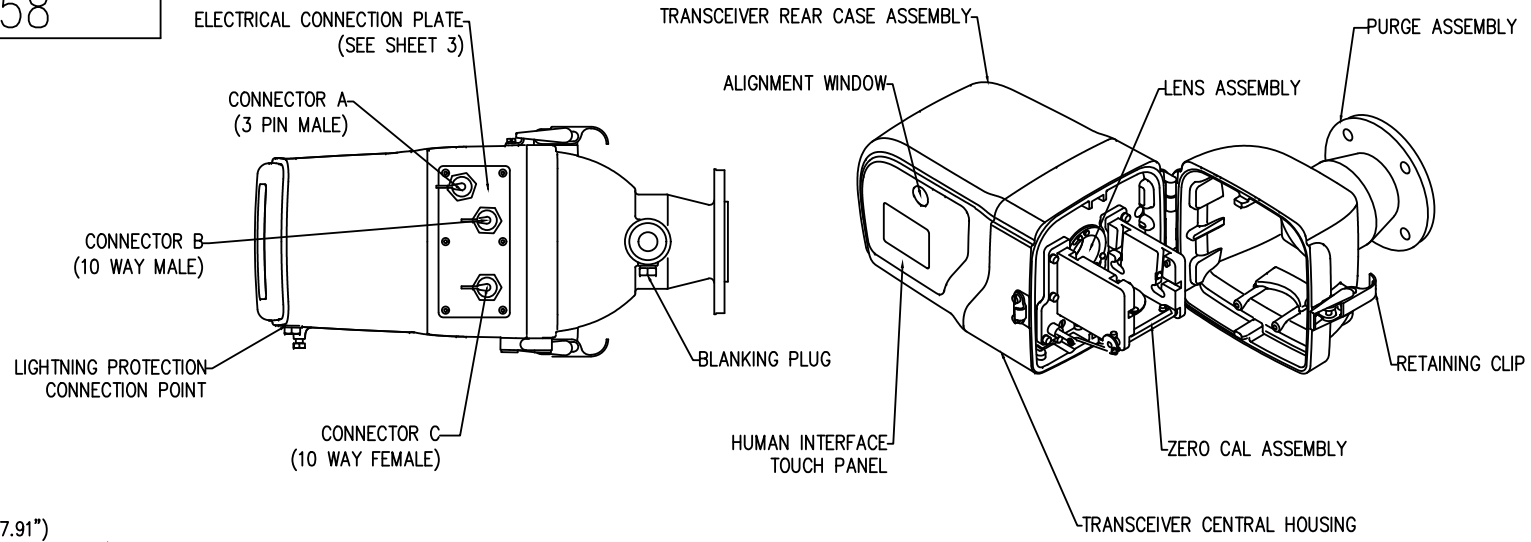


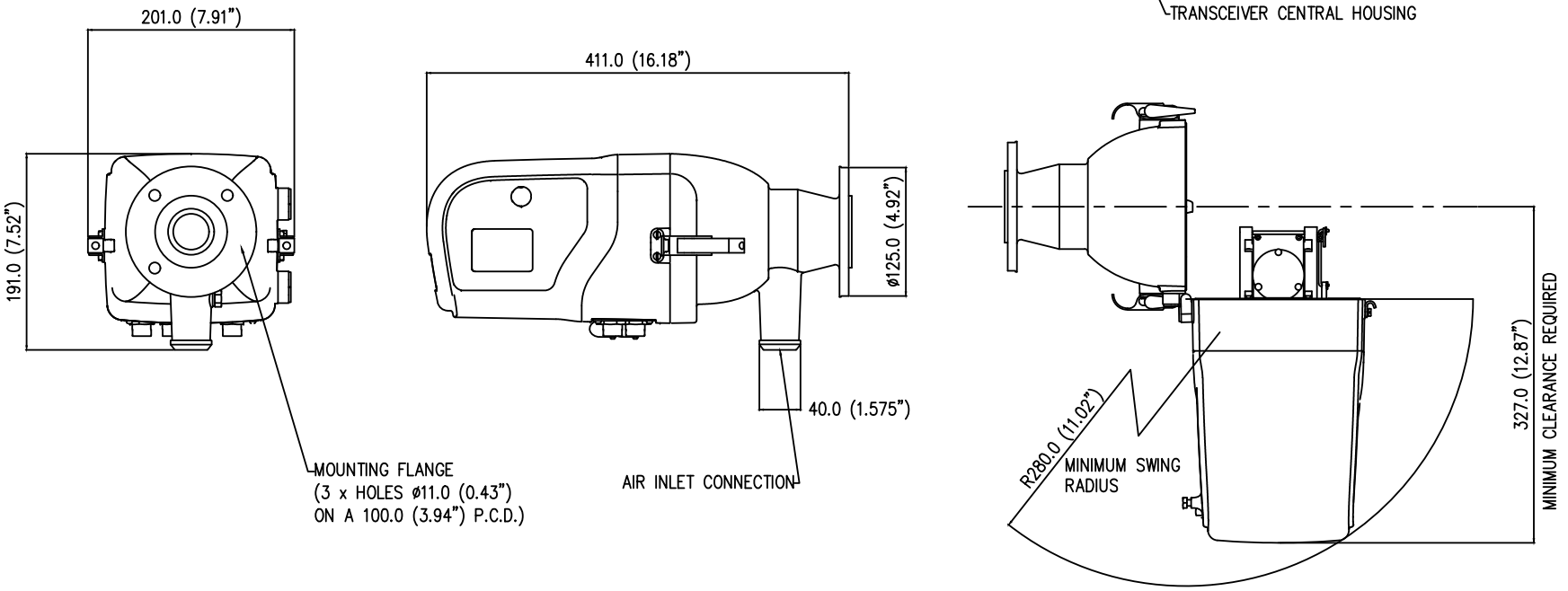
END OF SECTION

APPENDIX 2
INSTALLATION DRAWINGS

DRG.No.
A3-740-058

PROJECTION





MODIFICATION	DATE	ISSUE
See ECO-549	17/01/16	C
Renumbered Sheet 1 of 11, was 1 of 7. Approved E. O'Neill	11/08/14	B

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ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII Transceiver Installation

MATERIAL

FINISH

SHEET 1 of 20

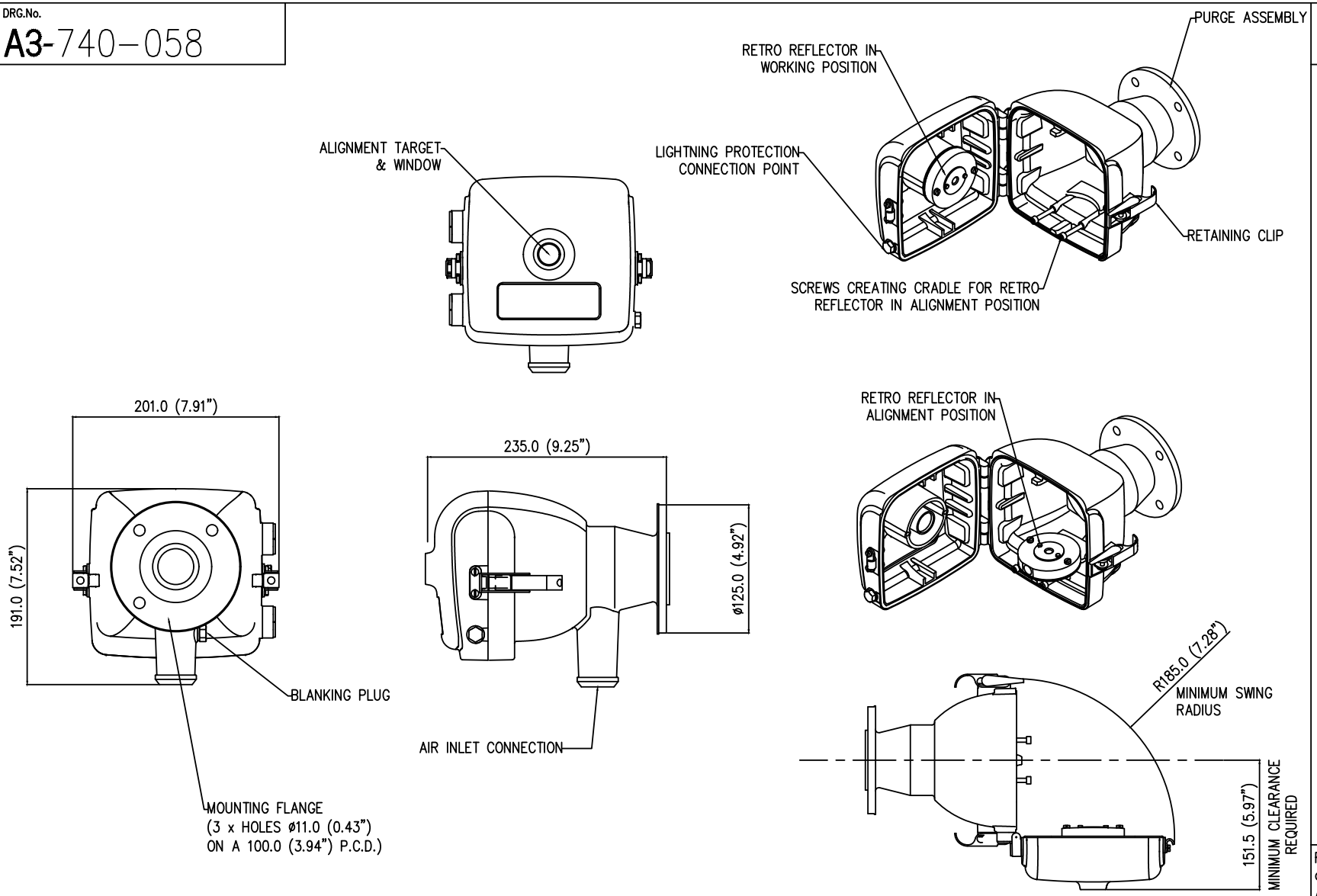
DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

DRAWN	LAE	DATE	03/06/08
CHECKED		ORIGINAL SCALE	n.t.s.
APPROVED		DATE	

DRG.No. A3-740-058 Revision C

DRG.No.
A3-740-058



PROJECTION

Renumbered Sheet 2 of 11, was 2 of 7. Approved E. O'Neill	11/08/14	B

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CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII Retro Reflector Installation

MATERIAL

FINISH

SHEET 2 of 20

DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

MODIFICATION	DATE	ISSUE
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CHECKED	ORIGINAL SCALE	n.t.s.
APPROVED	DATE	

DRG.No. A3-740-058 Revision C

DRG.No.
A3- 740.058

PROJECTION

CONNECTOR A
3 way socket

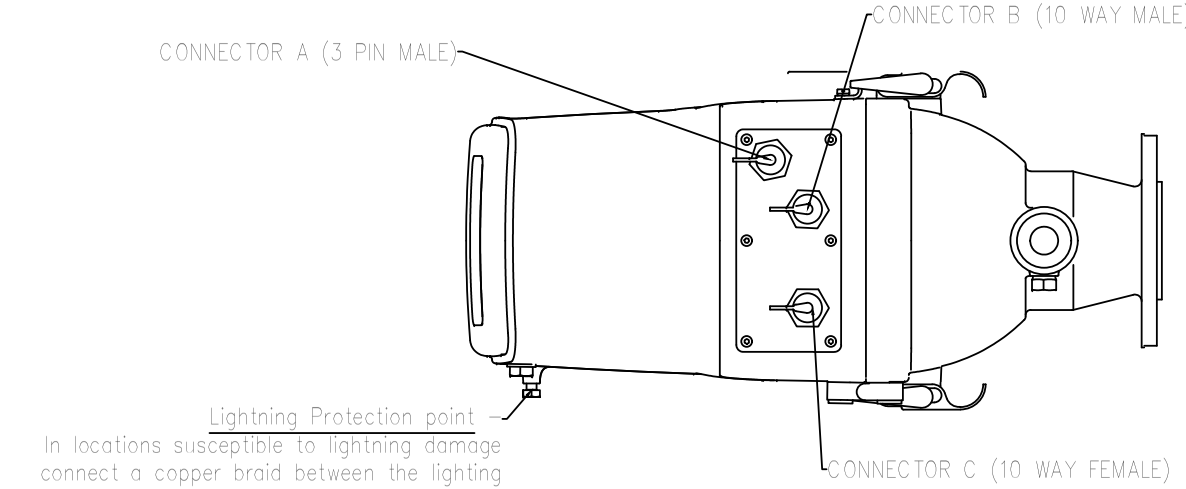
PIN No.	COLOUR	FUNCTION
L	RED	+24V d.c.
N	BLUE	0V
E	SCREEN	SCREEN

CONNECTOR B
10 way socket

PIN No.	COLOUR	FUNCTION
1	RED	In Cal Relay NO
2	BLUE	Alarm Relay COM
3	WHITE	Alarm Relay NO
4	YELLOW	CLOP Out Pos
5	GREEN	CLOP Out Neg
6	SCREEN	SCREEN
7		N/C
8	BLACK	In Cal Relay COM
9	BROWN	Alarm Relay NC
10	VIOLET	In Cal Relay NC

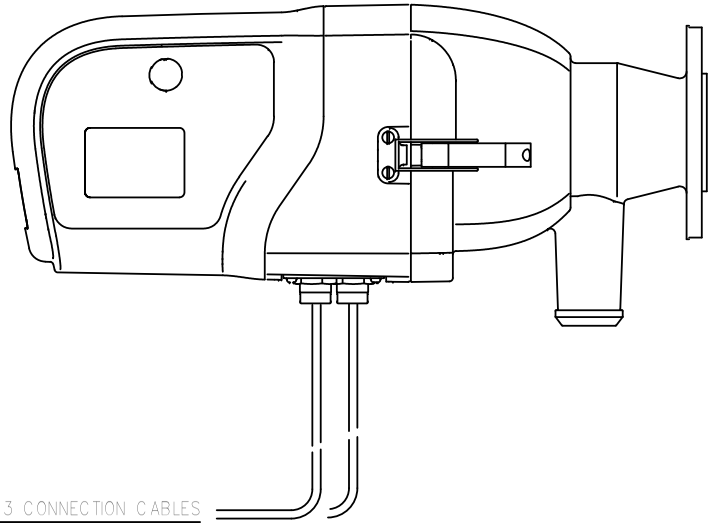
CONNECTOR C
10 way plug

PIN No.	COLOUR	FUNCTION
1	SCREEN	SCREEN
2		N/C
3	RED	Sys OK Relay COM
4	BLUE	Sys OK Relay NO
5	GREEN	RS485 D1
6	YELLOW	RS485 D0
7		N/C
8		N/C
9	WHITE	Sys OK Relay NC
10	BLACK	RS485 COM



Lightning Protection point

In locations susceptible to lightning damage connect a copper braid between the lighting protection point and a reliable electric ground.



SET OF 3 CONNECTION CABLES

CUSTOMER CONNECTION BOX MUST BE MOUNTED WITHIN 5m OF TRANSCEIVER.

Renumbered Sheet 3 of 11, was 3 of 7. Approved E. O'Neill	11/08/14	B

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ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500MkIII Installation Drawings

SHEET 3 of 20

DRG. TITLE
4500MkIII Electrical Terminations

DRG.TO BS 308

MATERIAL –

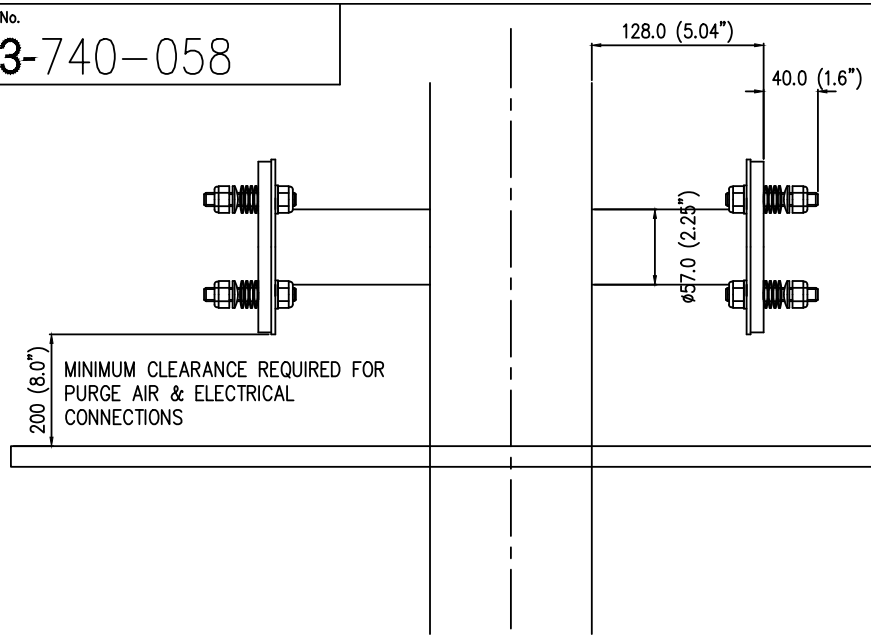
FINISH –

DIMENSIONS ARE IN MILLIMETRES

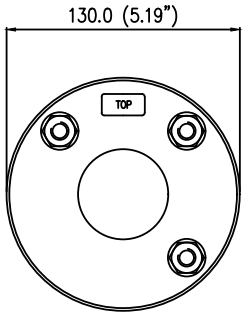
MODIFICATION	DATE	ISSUE
DRAWN LAE	DATE 02/06/08	
CHECKED	ORIGINAL SCALE NTS	
APPROVED	DATE	

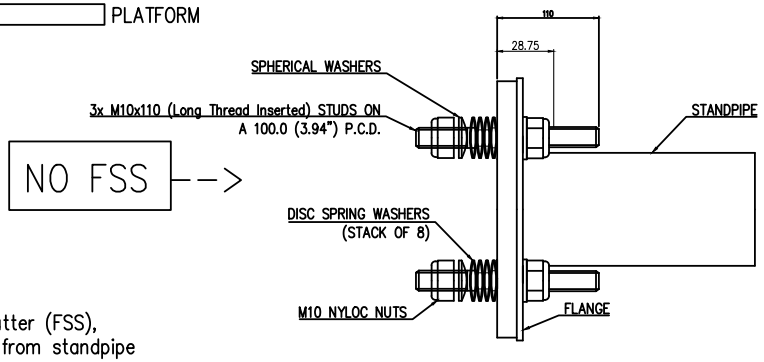
DRG.No. A3- 740.058 Revision C

DRG.No.
A3-740-058

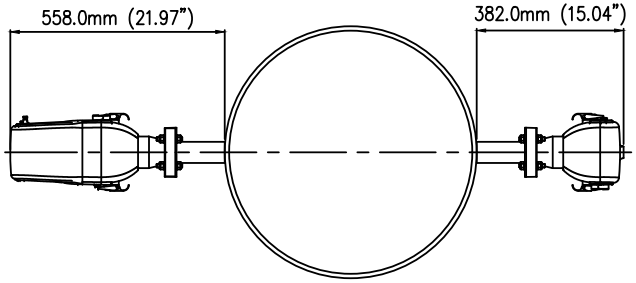


VIEW ON STANDPIPE SHOWING CORRECT ORIENTATION

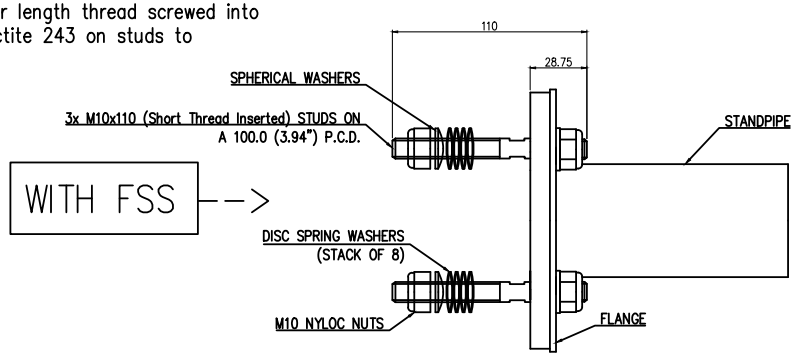




NOTES:
To attach a Fail-Safe Shutter (FSS), remove the 110mm studs from standpipe and assemble 110mm studs back in orientation shown, with the shorter length thread screwed into the standpipe. Use Loctite 243 on studs to secure.



WELD STANDPIPES INTO PLACE. NOTE THAT TUBES MUST BE CO-AXIAL & ALIGNED ±1.0°.



PROJECTION

View added showing longer studs and new stud design. Note added for attaching FSS. E. O'Neill.	09.09.14	B

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CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII Standpipe Installation

MATERIAL

FINISH

SHEET 4 of 20

DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

MODIFICATION	DATE	ISSUE
DRAWN LAE	DATE	03/06/08
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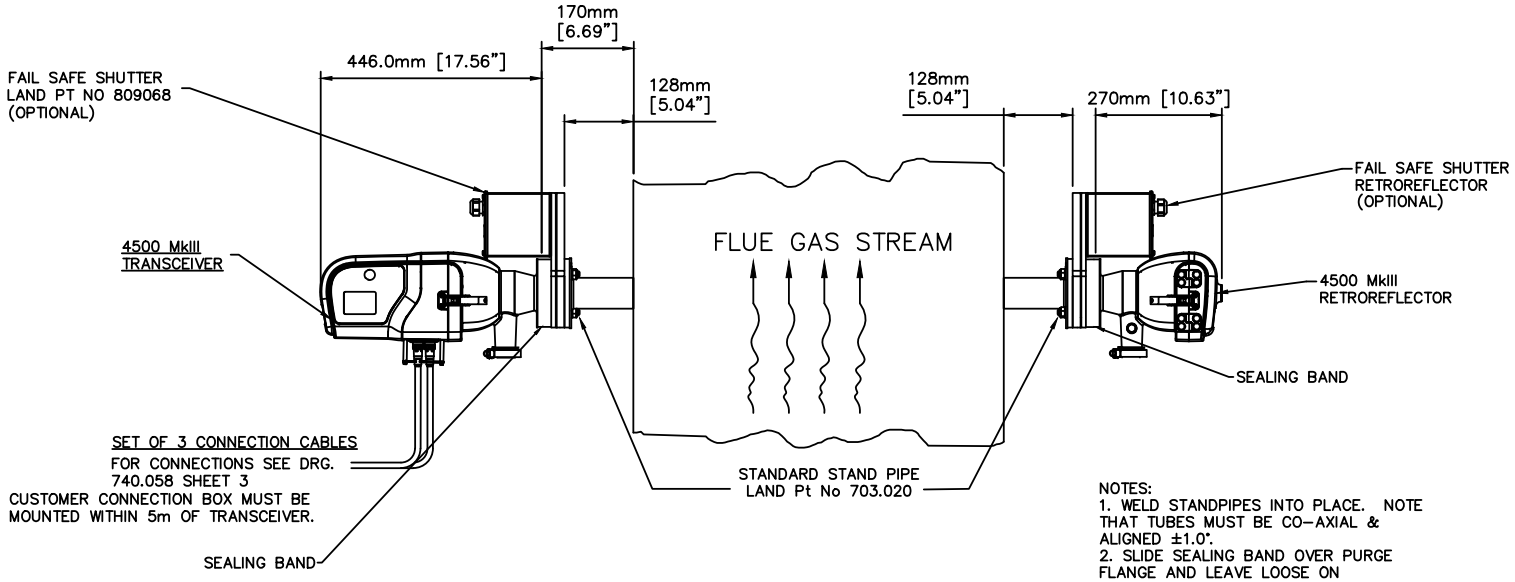
DRG.No. A3-740-058		Revision C

DRG.No.
A3-740.058

PROJECTION



NOTES:
1. WELD STANDPIPES INTO PLACE. NOTE THAT TUBES MUST BE CO-AXIAL & ALIGNED ±1.0°.
2. SLIDE SEALING BAND OVER PURGE FLANGE AND LEAVE LOOSE ON INSTRUMENT PURGE.
3. REMOVE NUTS & SPHERICAL WASHERS FROM STUDS, LEAVING DISC SPRINGS IN PLACE.
4. FIT TRANSCEIVER ASSEMBLY ON TO STUDS.
5. FIT SPHERICAL WASHERS & STUDS FROM STEP 3.
6. TIGHTEN THE NUTS UNTIL THE GAP BETWEEN FLANGES IS 14mm (9/16"") ALL ROUND.
7. INSTALL SEALING BAND AS SHOWN.
8. MOUNT RETRO-REFLECTOR ASSEMBLY AS IN STEPS 4 TO 7.
9. SWITCH ON PURGE AIR SUPPLY.

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TOLERANCES U.O.S.
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ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500MkIII with FSS Installation Drawing

DRG. TITLE
General Layout 4500MkIII, FSS, Std Standpipe

MATERIAL –

FINISH –

SHEET 5 of 20

DRG.TO BS 308

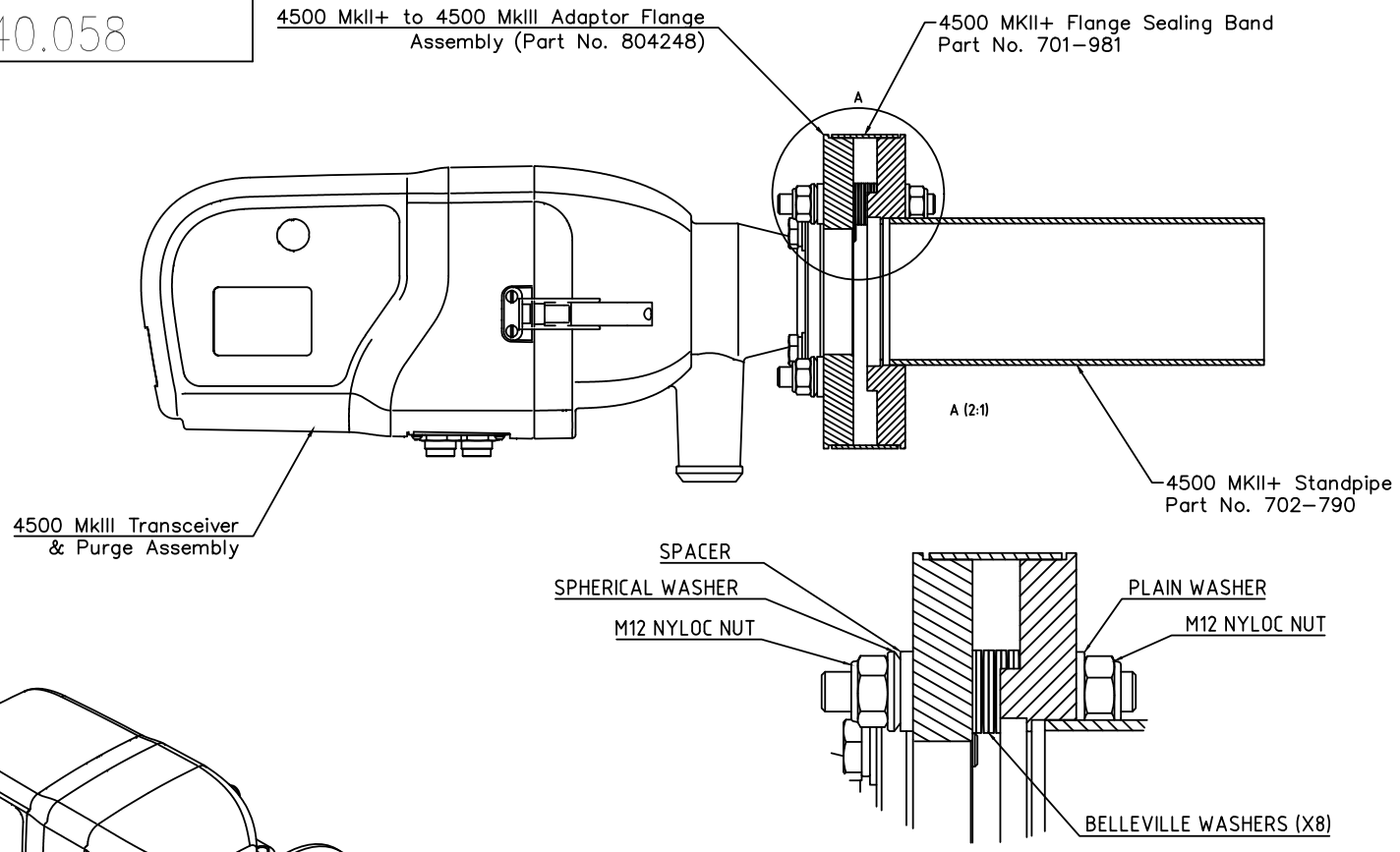
DIMENSIONS ARE IN MILLIMETRES

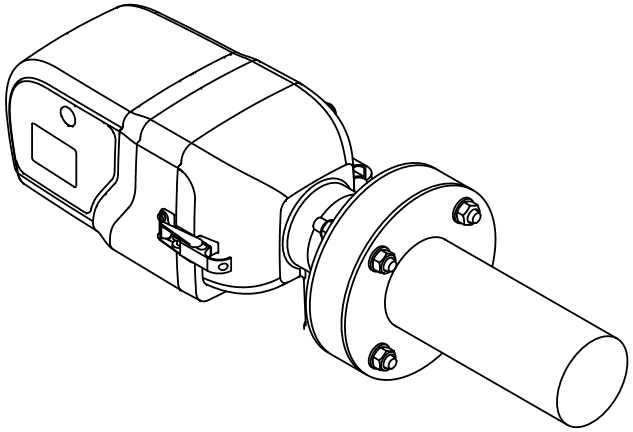
MODIFICATION	DATE	ISSUE
DRAWN LAE	DATE 02/06/08	
CHECKED	ORIGINAL SCALE NTS	
APPROVED	DATE	

DRG.No. A3-740.058 Revision C

DRG.No.
A3-740.058

PROJECTION





NOTES:
1. REMOVE EXISTING 4500 INSTRUMENT FROM STANDPIPE RETAINING THE NUTS & SPHERICAL WASHERS.
2. MOUNT 4500 MkIII INSTRUMENT to ADAPTOR FLANGE ASSEMBLY USING BOLTS, WASHERS & GASKET SUPPLIED WITH ADAPTOR FLANGE ASSEMBLY.
3. SLIDE SEALING BAND OVER STANDPIPE FLANGE & LEAVE LOOSE ON STANDPIPE.
4. FIT TRANSCEIVER ASSEMBLY ON TO STANDPIPE STUDS.
5. FIT SPHERICAL WASHERS & NUTS FROM STEP 1 PLUS SPACER to RETAIN.
6. TIGHTEN NUTS UNTIL THE GAP BETWEEN FLANGES IS 14mm (9/16") ALL ROUND.
7. INSTALL SEALING BAND AS SHOWN.
8. SWITCH ON AIR PURGE SUPPLY.

MODIFICATION	DATE	ISSUE
Renumbered sheet 6 of 11, 4500 changed to 4500 MKII+ in text, detail view added with additional spacer.	11/08/14	
Approved: E. O'Neill		

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CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500MkIII Installation Drawing

SHEET 6 of 20

DRG. TITLE
4500 MkIII with Adaptor Flange & 4500 MKII+ Standpipe

DRG.TO BS 308

MATERIAL –

FINISH –

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DRAWN	LAE	DATE	02/06/08
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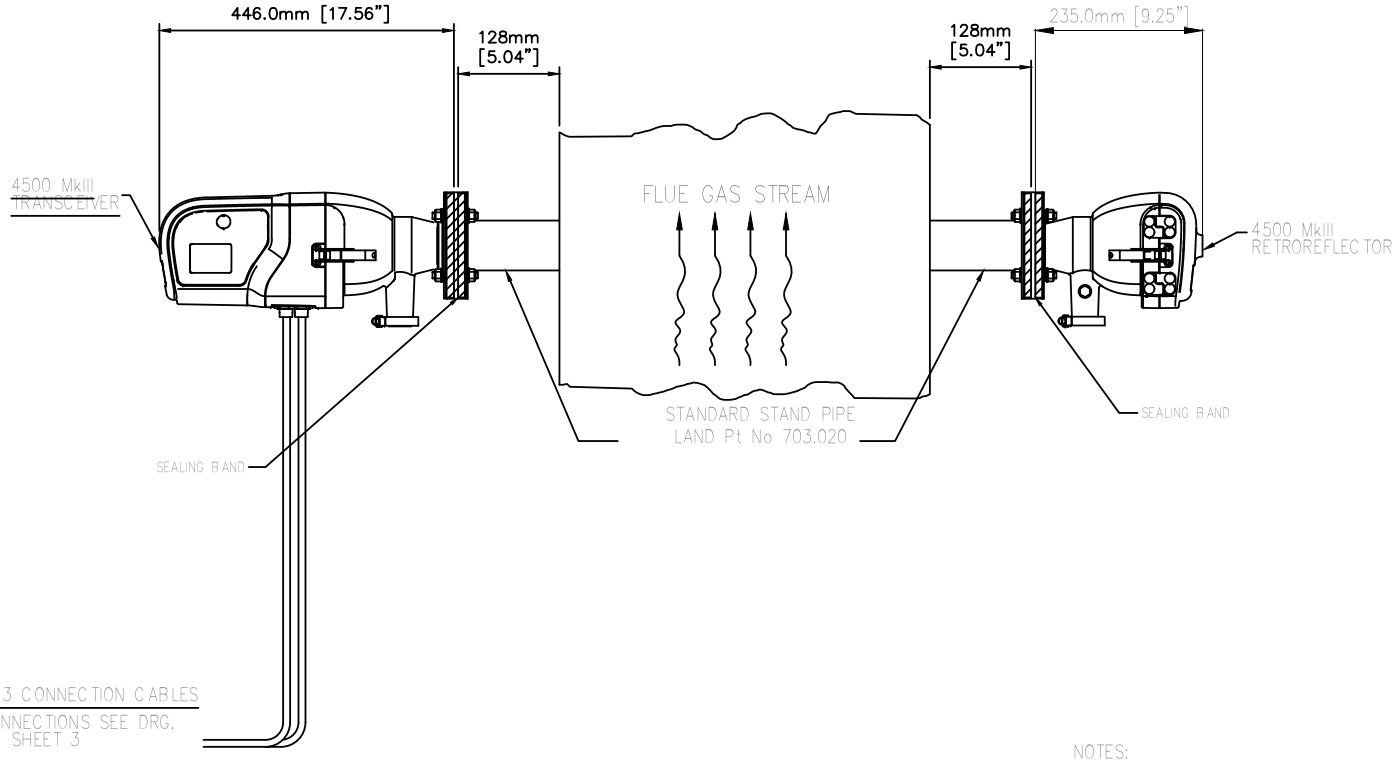
APPROVED		DATE	

DRG.No. A3-740.058 Revision C

DRG.No.
A3- 740.058

PROJECTION



SET OF 3 CONNECTION CABLES
FOR CONNECTIONS SEE DRG. 740.058 SHEET 3

CUSTOMER CONNECTION BOX MUST BE MOUNTED WITHIN 5m OF TRANSCEIVER.

NOTES:
1. WELD STANDPIPES INTO PLACE. NOTE THAT TUBES MUST BE CO-AXIAL & ALIGNED ±1.0°.
2. SLIDE SEALING BAND OVER FLANGE AND LEAVE LOOSE ON STANDPIPE.
3. REMOVE NUTS & SPHERICAL WASHERS FROM STUDS, LEAVING DISC SPRINGS IN PLACE.
4. FIT TRANSCEIVER ASSEMBLY ON TO STUDS.
5. FIT SPHERICAL WASHERS & STUDS FROM STEP 3.
6. TIGHTEN THE NUTS UNTIL THE GAP BETWEEN FLANGES IS 11mm (7/16"") ALL ROUND.
7. INSTALL SEALING BAND AS SHOWN.
8. MOUNT RETRO-REFLECTOR ASSEMBLY AS IN STEPS 4 TO 7.
9. SWITCH ON PURGE AIR SUPPLY.

MODIFICATION	DATE	ISSUE
Blower removed. Drawing Re-titled. Approved: E. O'Neill	31/07/14	B

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ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII INSTALLATION DRAWING

SHEET 7 of 20

DRG. TITLE
4500 MkIII General Arrangement (Simple)

DRG.TO BS 308

MATERIAL –

FINISH –

DIMENSIONS ARE IN MILLIMETRES

DRAWN	LAE	DATE	13/06/06
CHECKED		ORIGINAL SCALE	NTS
APPROVED		DATE	

DRG.No. A3- 740.058 Revision C

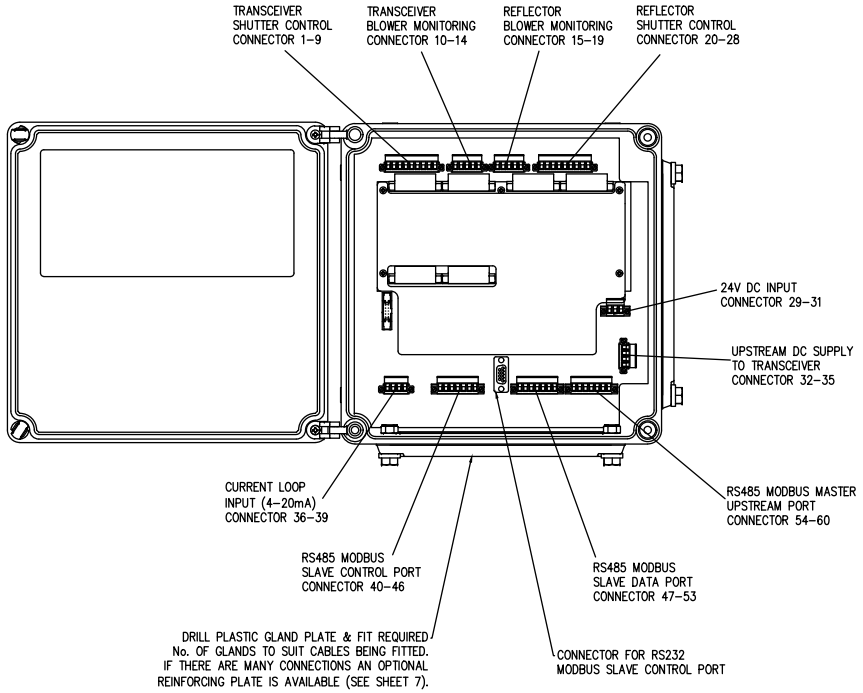
DRG.No.

A3-740-058

CONNECTION DETAILS FOR MAIN PCB

AFU Connector Terminal Assignment

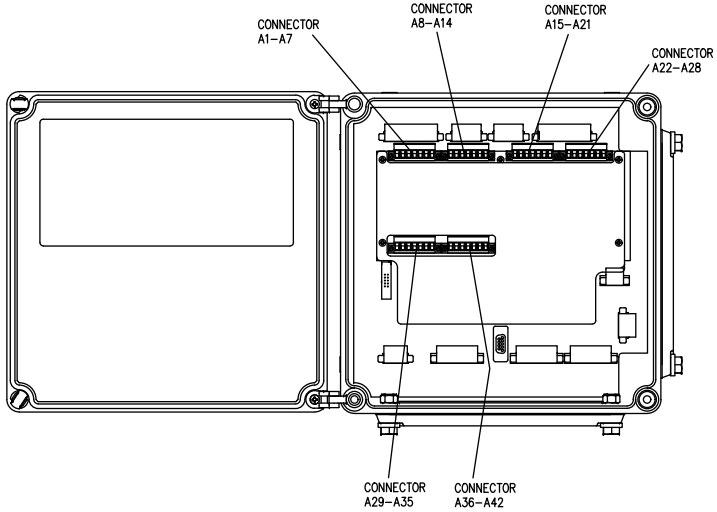
Transceiver Shutter Control	**Transceiver Blower Monitoring**	**Reflector Blower Monitoring**	**Reflector Shutter Control**
1 - Shutter Supply 0V (Optional)	10 - Blower Fail Input	16 - Blower Fail Input	20 - Shutter Supply 0V (Optional)
2 - Shutter Supply +24V (Optional)	11 - Blower Fail Return	16 - Blower Fail Return	21 - Shutter Supply +24V (Optional)
3 - Shutter Open NO	12 - Cable Screen	17 - Cable Screen	22 - Shutter Open NO
4 - Shutter Open COM	13 - Blocked Filter Input	18 - Blocked Filter Input	23 - Shutter Open COM
5 - Cable Screen	14 - Blocked Filter Return	19 - Blocked Filter Return	24 - Cable Screen
6 - Shutter Closed NO			25 - Shutter Closed NO
7 - Shutter Closed COM			26 - Shutter Closed COM
8 - Open Shutter Common			27 - Open Shutter Common
9 - Open Shutter			28 - Open Shutter
			24V DC Input
			29 - +24V DC Supply Input
			30 - 0V DC Supply Input
			31 - Cable Screen
			DC Supply to Transceiver
			32 - +24V DC Output
			33 - 0V DC Output
			34 - Cable Screen
			35 - Cable Screen
Current Loop Input (4-20mA)	**RS485 Modbus Slave Control Port**	**RS485 Modbus Slave Data Port**	**RS485 Modbus Master Port**
36 - Not Fitted	40 - Cable Screen	47 - Cable Screen	54 - Cable Screen
37 - Not Fitted	41 - Cable Screen	48 - Cable Screen	55 - Cable Screen
38 - Not Fitted	45 - Modbus TXD1	52 - Modbus TXD1	56 - Modbus RXD1
39 - Not Fitted	43 - Modbus TXD0	50 - Modbus TXD0	57 - Modbus RXD0
	44 - Modbus Common	51 - Modbus Common	58 - Modbus Common
	42 - Modbus RXD0	53 - Modbus RXD0	59 - Modbus TXD0
	46 - Modbus RXD1	49 - Modbus RXD1	60 - Modbus TXD1



CONNECTION DETAILS FOR PROCESS PCB

Process Input/Output Connections

A1 - Alarm 2 Common	A2 - Alarm 2 OK	A3 - Alarm 2 Active	A4 - Cable Screen	A5 - Alarm 1 Common	A6 - Alarm 1 OK	A7 - Alarm 1 Active	A8 - Maintenance (Data not Valid) Common	A9 - Fault	A10 - Maintenance (Data not Valid)	A11 - Cable Screen	A12 - System OK	Common	A13 - Fault	A14 - System OK	A15 - Span Cal in Progress	Common	A16 - Normal Running	A17 - Span Cal in Progress	A18 - Zero Cal in Progress	Common	A19 - Normal Running	A20 - Zero Cal in Progress	A21 -	A22 - Output 1 +	A23 - Output 1 -	A24 - N/C	A25 - Cable Screen	A26 - Output 2 -	A27 - Output 2 +	A28 -
A29 - Cal Trigger	A30 - Common	A31 - Cal Trigger Input	A32 - Supply	A33 - Cable Screen	A34 - Not Used	A35 - Not Used	A36 -	A37 - Fuel Select 1 Common	A38 - Fuel Select 1 Input	A39 - Fuel Select 1 Supply	A40 - Cable Screen	A41 - Fuel Select 2 Common	A42 - Fuel Select 2 Input	A43 - Fuel Select 2 Supply										



IF MORE SPACE IS REQUIRED FOR THE CABLE GLANDS AN OPTIONAL GLAND PLATE CAN BE FITTED TO THE LEFT HAND SIDE OF THE ENCLOSURE (SEE SHEET 7 FOR PART No. & FITTING DETAILS).

PROJECTION

MODIFICATION	DATE	ISSUE
Renumbered as 740.058 sheet 8, was 740.062 sheet 2. AFU connections label updated to 804883 Rev C, mounting pods removed, "Connector for HI Module" label & arrow removed. Approved: E. O'Neill	11/08/14	B

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SHEFFIELD
S18 1DJ

DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ± 0.1
ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII AFU Electrical Connections

MATERIAL

FINISH

SHEET 8 of 20

DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

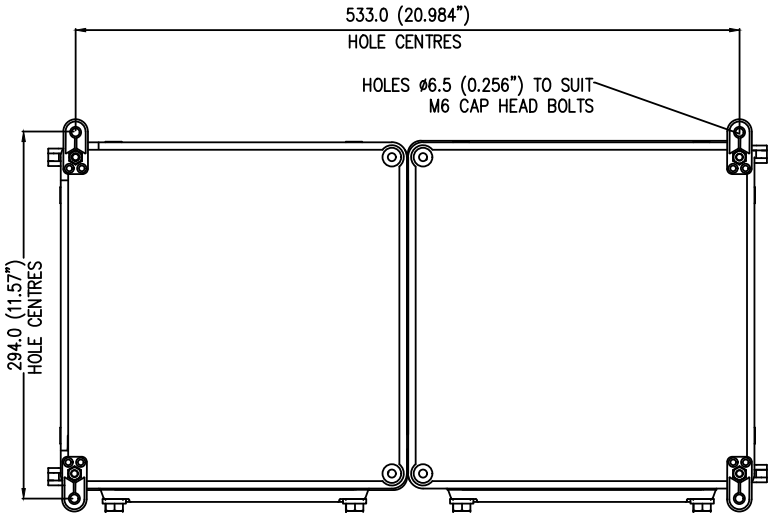
DRAWN	LAE	DATE	08/12/08
CHECKED		ORIGINAL SCALE	n.t.s.
APPROVED		DATE	

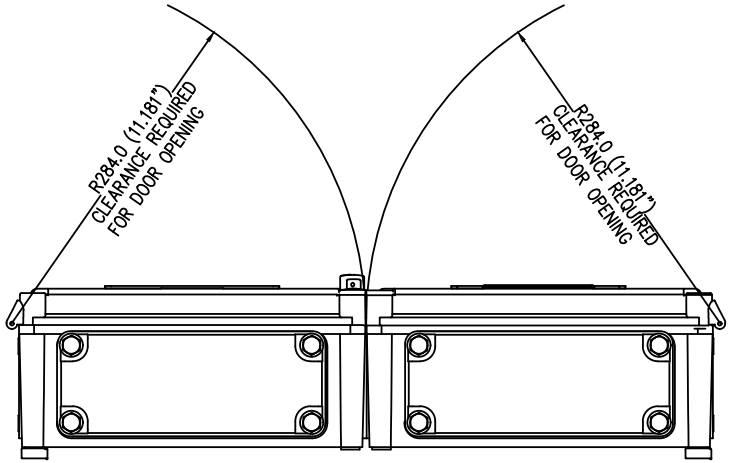
DRG.No. A3-740.058

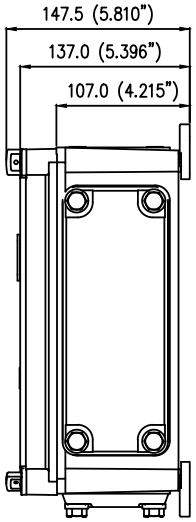
Revision C

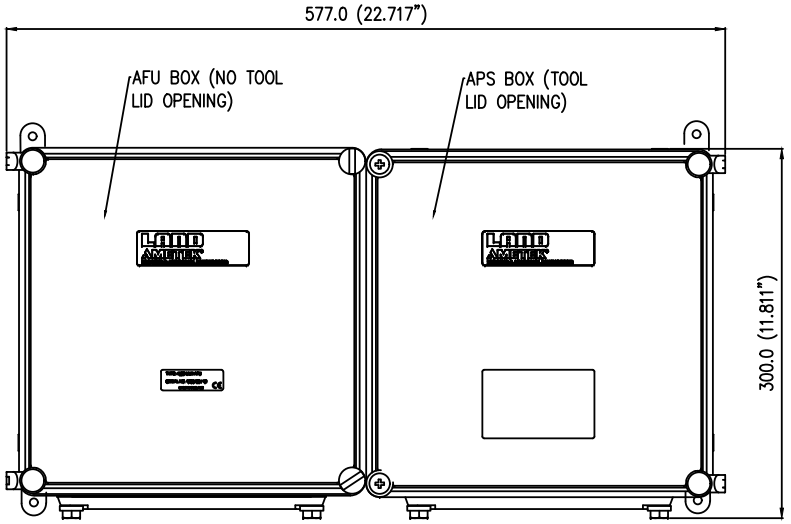
DRG.No.
A3-740-058

PROJECTION









Modified to show feet added to enclosures. Approved By: L. Earnshaw.	17/02/14	B

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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ± 0.1
ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 16
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII AFU/APS Mechanical Installation

MATERIAL

FINISH

SHEET 9 of 20

DRG.TO BS 308

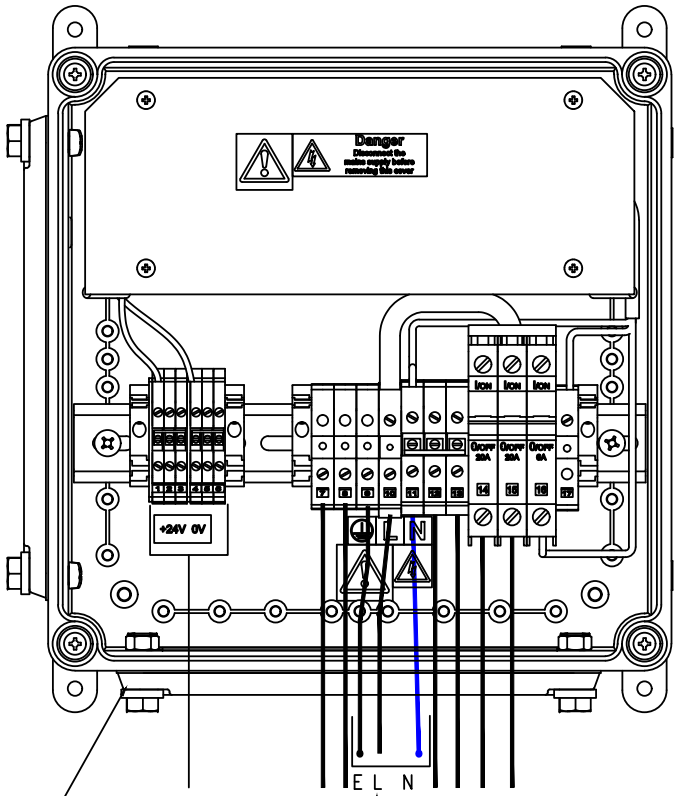
DIMENSIONS ARE IN MILLIMETRES

MODIFICATION		DATE	ISSUE
DRAWN	LAE	DATE	10/12/08
CHECKED		ORIGINAL SCALE	n.t.s.
APPROVED		DATE	
DRG.No.	A3-740.058		Revision C

1 2 3 4 5 6

DRG.No.
A3-740-058

APS UNIT SHOWN WITH LID REMOVED FOR CLARITY



DRILL GLAND PLATE & FIT CABLE GLANDS (or CONDUIT FITTINGS)
SUITABLE FOR INCOMING MAINS & BLOWER CABLING or 24V OUTPUTS

PROJECTION

MODIFICATION	DATE	ISSUE
Modified to show new 24V Fail Safe Shutter Connections. Approved By: L. Earnshaw.	17/02/14	B

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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ± 0.1
ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII APS Electrical Connections

MATERIAL

FINISH

SHEET 10 of 20

DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

DRAWN	LAE	DATE	11/12/08
CHECKED		ORIGINAL SCALE	n.t.s.
APPROVED		DATE	

DRG.No. A3-740.058

Revision C

DRG.No.
A3-740-058

PROJECTION

Connecting the Transceiver to the AFU.

Only connectors A & C are needed to connect the 4500 MkIII transceiver to the AFU. All connections are made to the AFU main circuit board, not the daughter board. Customer connections can be made directly to the AFU.

OPTIONAL CUSTOMER CONNECTIONS

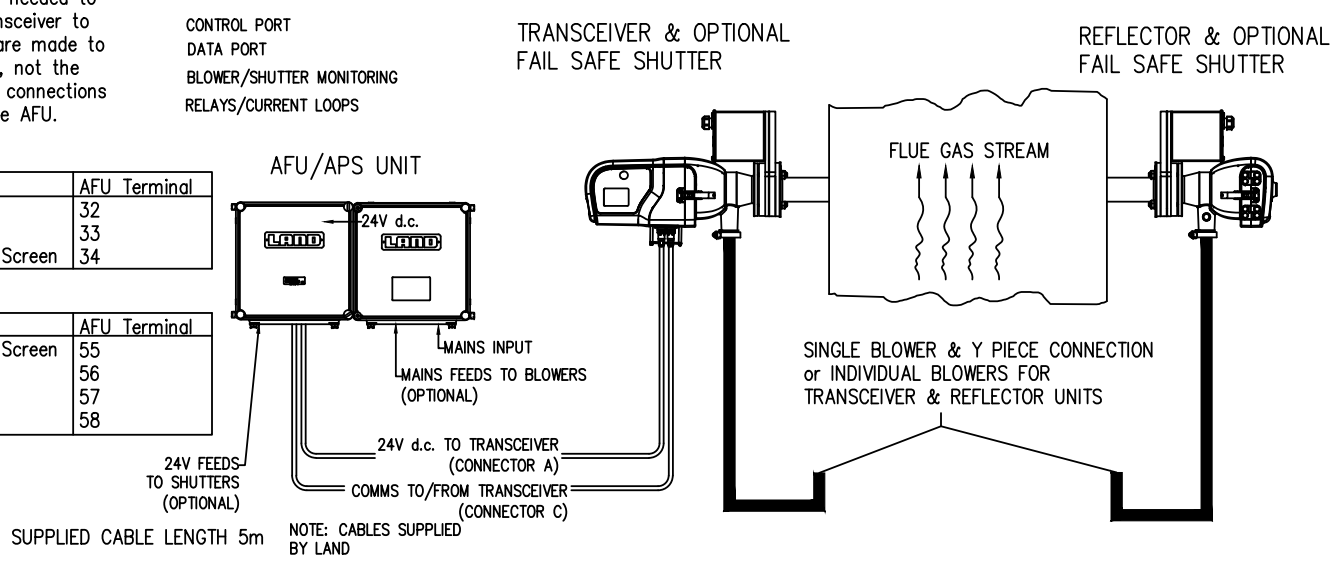
CONTROL PORT
DATA PORT
BLOWER/SHUTTER MONITORING
RELAYS/CURRENT LOOPS

Connector A

Function	Colour	AFU Terminal
24 V dc	Red	32
0 V dc	Blue	33
Screen	Braided Screen	34

Connector C

Function	Colour	AFU Terminal
Screen	Braided Screen	55
Modbus D1	Green	56
Modbus D0	Yellow	57
Modbus Common	Black	58



Modified to show new 24V Fail Safe Shutters. Approved By: L. Earnshaw.	17/02/14	B

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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ± 0.1
ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII General Arrangement (with AFU-APS)

MATERIAL

FINISH

SHEET 11 of 20

DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

MODIFICATION	DATE	ISSUE
DRAWN LAE	DATE 11/12/08	
CHECKED	ORIGINAL SCALE n.t.s.	
APPROVED	DATE	

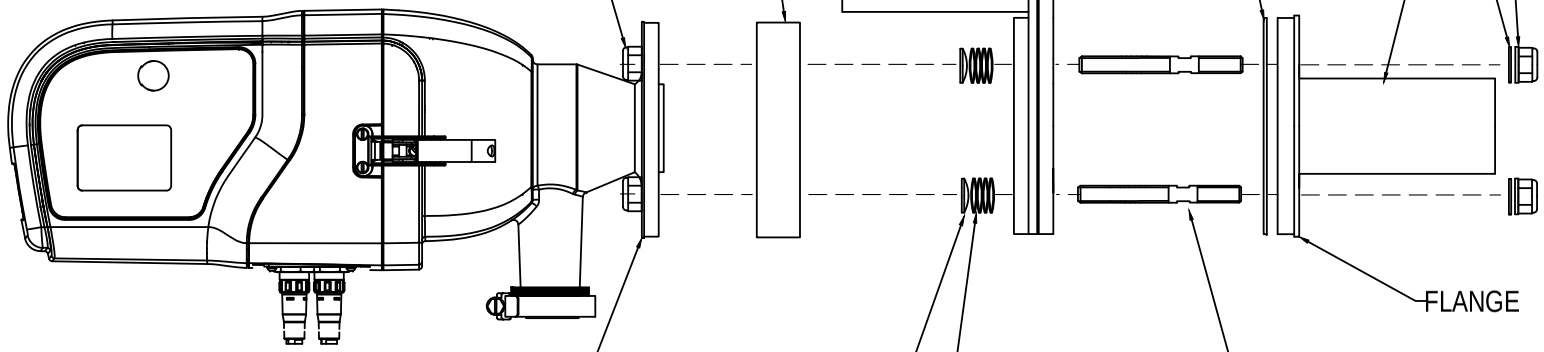
DRG.No. A3-740-058 Revision C

DRG.No.
A3-740-058

PROJECTION

NOTES:
To attach a Fail-Safe Shutter (FSS), remove the 70mm studs from standpipe (using 8mm spanner on flats) and assemble 110mm studs in the orientation shown (8mm spanner). Secure studs using a medium strength threadlock recommended for securing studs.

Use a 17mm spanner for all 6 x M10 Nyloc Nuts.



FLANGE SEALING BAND
Pt No.701.972

FAIL SAFE SHUTTER
Pt No. 809068

3 x M10 NYLOC NUTS
Pt No.804559

3 x M10 WASHER

GASKET
Pt No.804247

STANDPIPE
Pt No.703.020

3 x M10 NYLOC NUTS
Pt No.804559

FLANGE

SPHERICAL WASHERS
Pt No.804557

4500 MkIII FLANGE

3x M10x110 STUDS ON
A 100.0 (3.94") P.C.D.
Pt No.809645

DISC SPRING WASHERS
(STACK OF 8)
Pt No. 804558

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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ±
ANGLES ±
CASTING ±
SURFACE FINISH ✓
ALL SHARP CORNERS REMOVED
INTL. CORNERS R
EXTL. CORNERS R

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII FAIL SAFE SHUTTER INSTALLATION

MATERIAL

FINISH

SHEET 12 of 20

DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

MODIFICATION	DATE	ISSUE
DRAWN RAL	DATE 15/09/14	
CHECKED	ORIGINAL SCALE n.t.s.	
APPROVED	DATE	

DRG.No. A3-740-058 Revision C

DRG.No.
A3-740-058

PROJECTION

Installation Procedure:

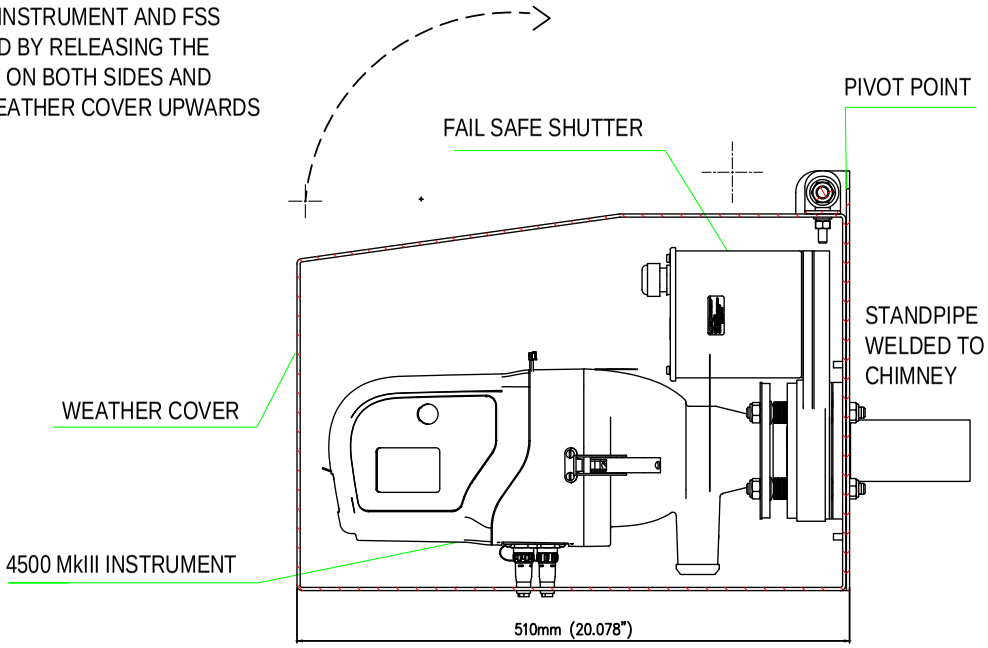
1.Remove nuts & washers from chimney side of standpipe with a 17mm spanner & retain for future use.

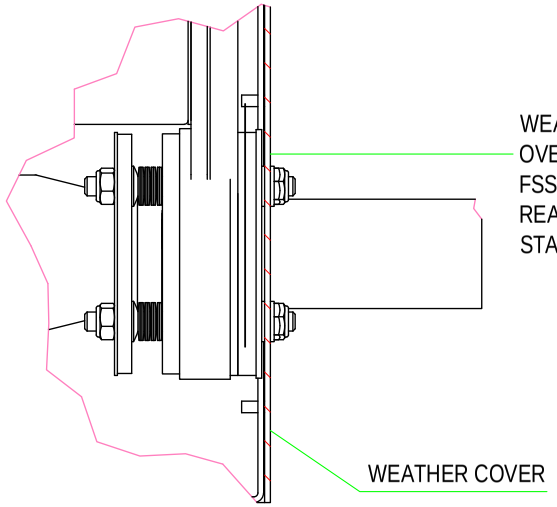
2.Place instrument cover over standpipe & slide away from chimney, lining up the holes in the instrument cover with the studs of the standpipe. (In some cases it may be beneficial to remove transceiver during install of cover)

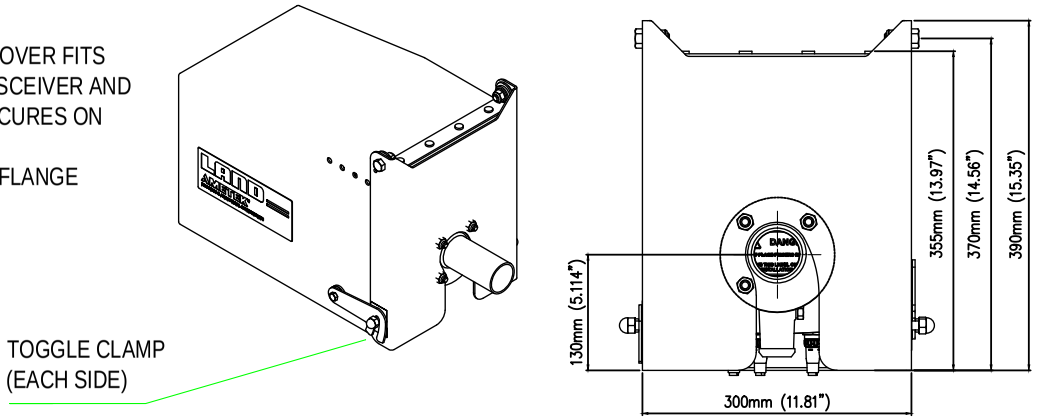
3.Slide instrument cover back until it is tight up against the standpipe flange.

4.Refit nuts & washers from stage 1 to lock cover in position.

ACCESS TO THE INSTRUMENT AND FSS CAN BE OBTAINED BY RELEASING THE TOGGLE CLAMPS ON BOTH SIDES AND PIVOTING THE WEATHER COVER UPWARDS ON THE HINGES.







LAND

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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ±
ANGLES ±
CASTING ±
SURFACE FINISH ✓
ALL SHARP CORNERS REMOVED
INTL. CORNERS R
EXTL. CORNERS R

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII Weather Cover Installation Drawings

MATERIAL

FINISH

SHEET 13 of 20

DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

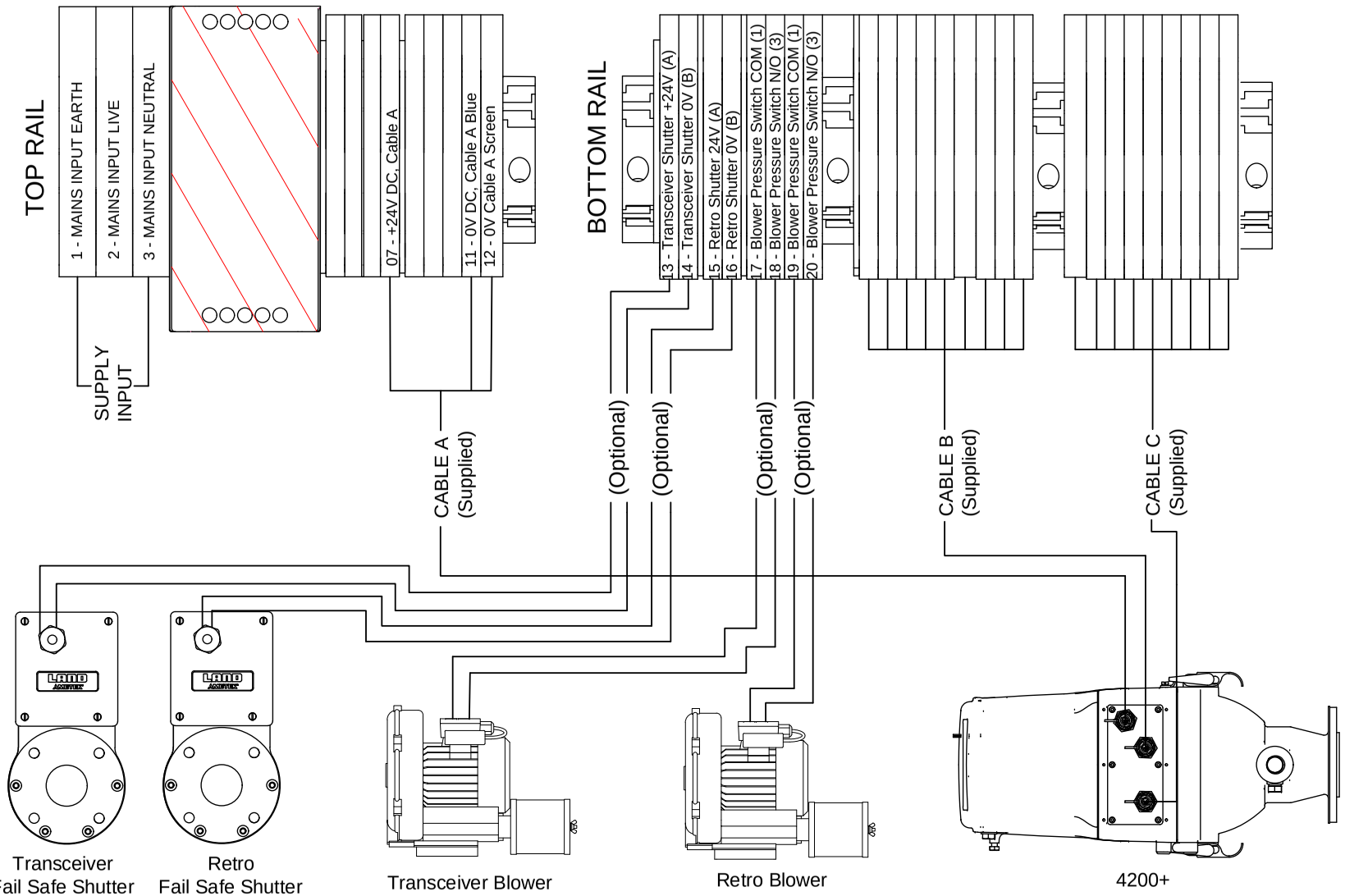
MODIFICATION	DATE	ISSUE
DRAWN R.Lintin	DATE 25/09/14	
CHECKED	ORIGINAL SCALE n.t.s.	
APPROVED	DATE	

DRG.No. A3-740-058 Revision C

DRG.No.
A3-740-058

NOTE - REMOVE LINK FITTED TO TERMINALS 17-18 OR 19-20 CONNECTED TO BLOWER PRESSURE SWITCH.

PROJECTION



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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ± 0.1
ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
APS42 Electrical & Terminal Connections 1

MATERIAL

FINISH

SHEET 15 of 20

DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

MODIFICATION	DATE	ISSUE
DRAWN R.Lintin	DATE 23/10/14	
CHECKED	ORIGINAL SCALE n.t.s.	
APPROVED	DATE	

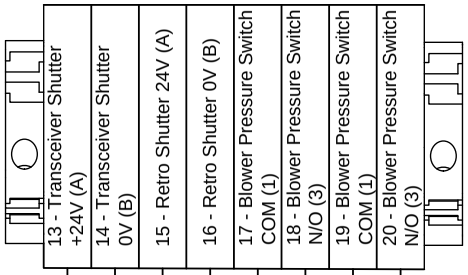
DRG.No. A3-740-058 Revision C

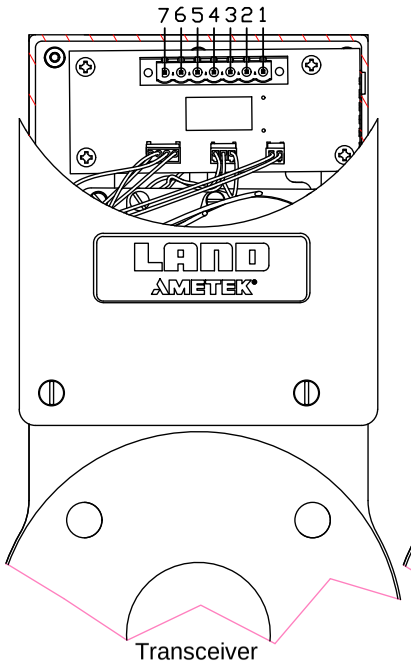
DRG.No.
A3-740-058

PROJECTION

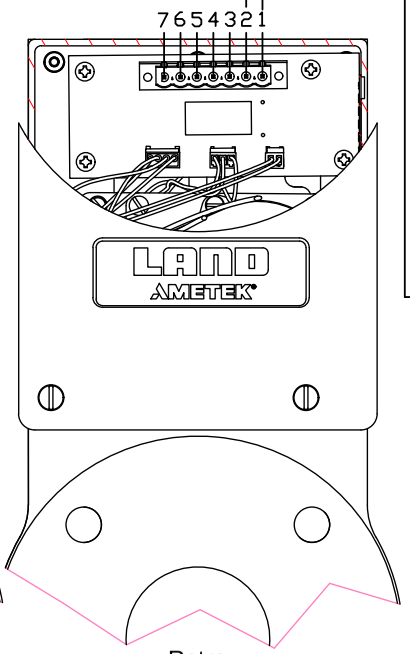
NOTE –
REMOVE LINK FITTED TO TERMINALS 17-18 OR 19-20 CONNECTED TO BLOWER PRESSURE SWITCH.

BOTTOM RAIL
Terminals 13 - 20
(OPTIONAL)

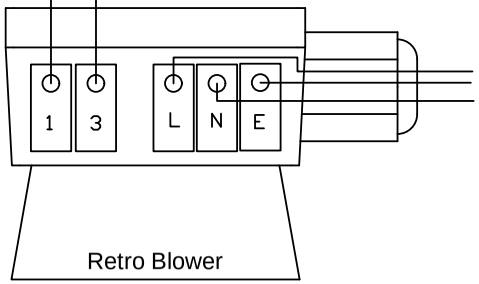




Transceiver
Fail Safe Shutter

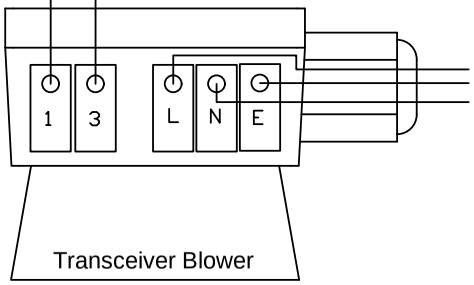


Retro
Fail Safe Shutter



Retro Blower

Blower Mains Supply



Transceiver Blower

Blower Mains Supply

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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ± 0.1
ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
APS42 Electrical & Terminal Connections 2

MATERIAL

FINISH

SHEET 16 of 20

DRG.TO BS 308

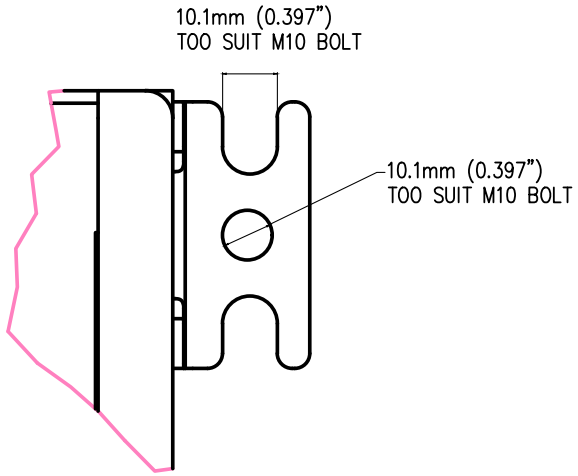
DIMENSIONS ARE IN MILLIMETRES

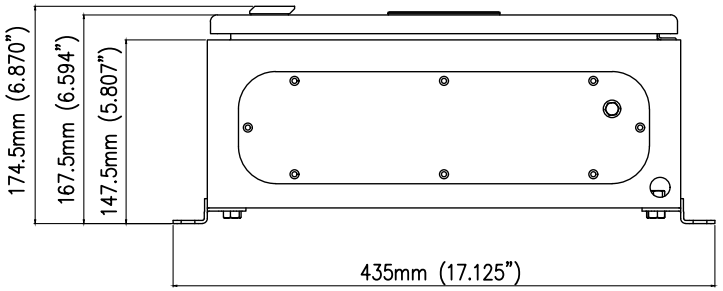
MODIFICATION	DATE	ISSUE
DRAWN R.Lintin	DATE 23/10/14	
CHECKED	ORIGINAL SCALE n.t.s.	
APPROVED	DATE	

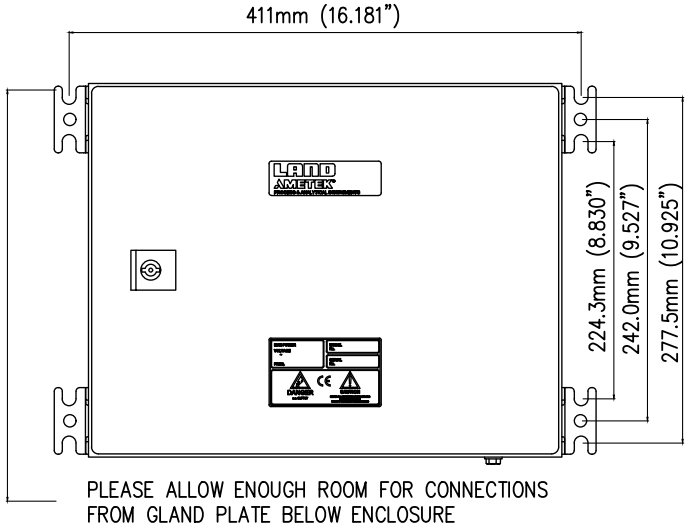
DRG.No. A3-740-058 Revision C

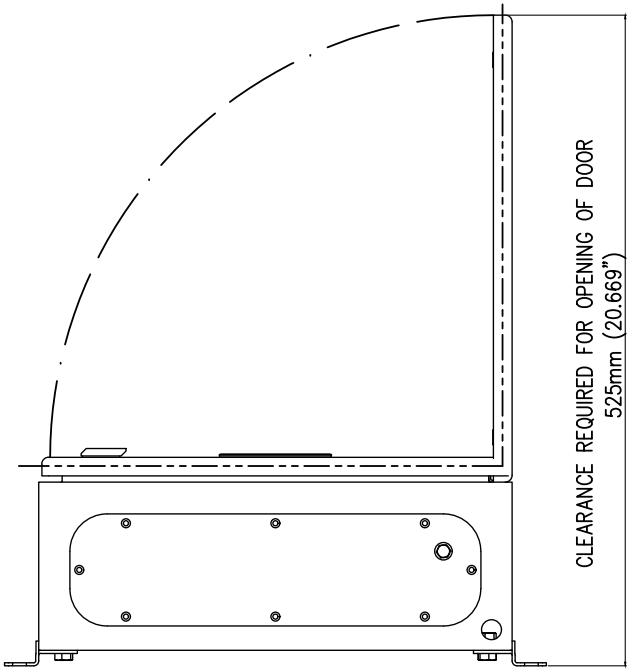
DRG.No.
A3-740-058

PROJECTION









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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ± 0.1
ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
APS42 Mechanical Installation

MATERIAL

FINISH

SHEET 17 of 20

DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

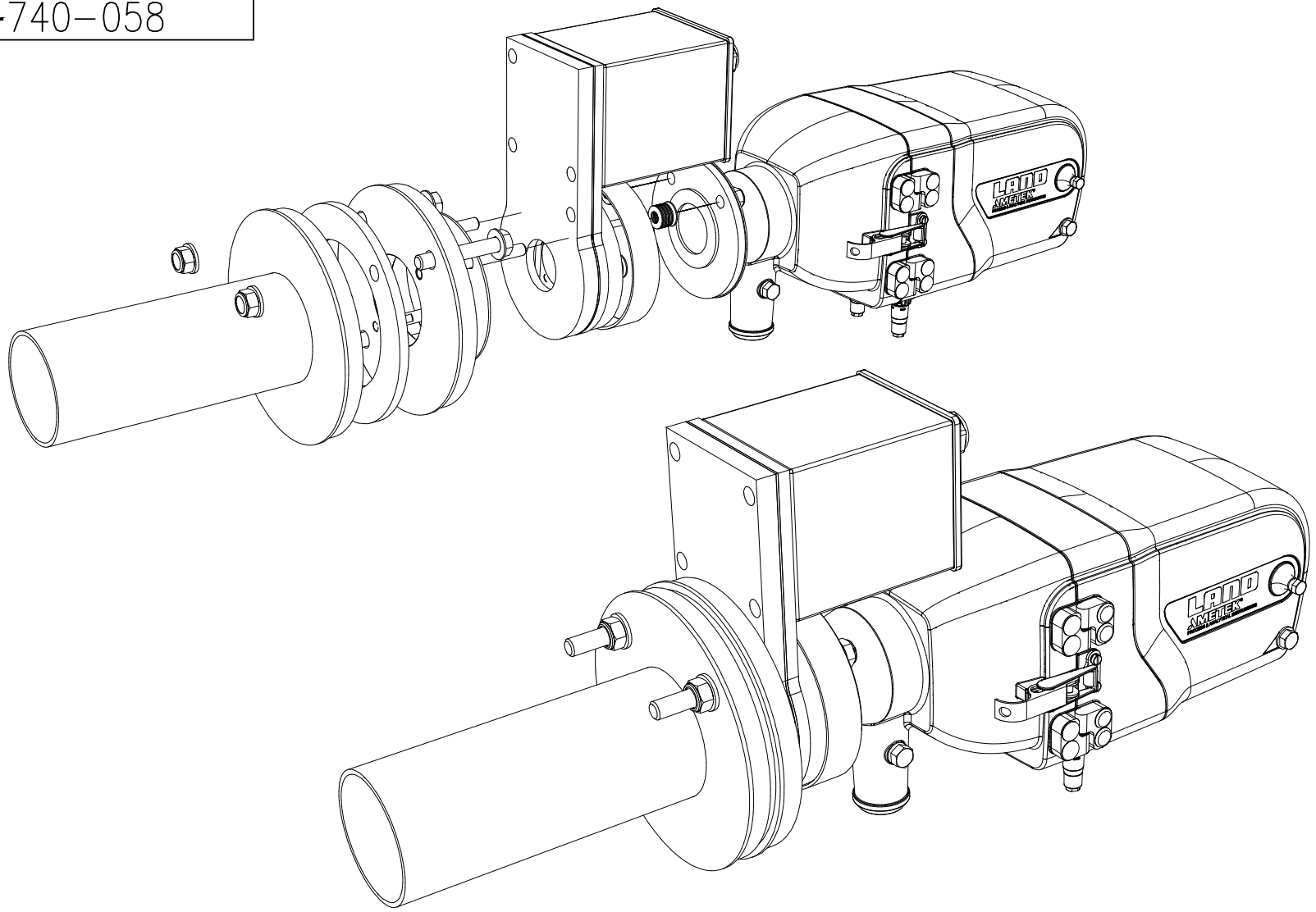
MODIFICATION	DATE	ISSUE
DRAWN R.Lintin	DATE 23/10/14	
CHECKED	ORIGINAL SCALE n.t.s.	
APPROVED	DATE	

DRG.No. A3-740.058 Revision C

1 2 3 4 5 6

DRG.No.
A3-740-058

PROJECTION



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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ±
ANGLES ±
CASTING ±
SURFACE FINISH ✓
ALL SHARP CORNERS REMOVED
INTL. CORNERS R
EXTL. CORNERS R

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4200 to 4500 MkIII FSS Adaptor (811013) Installation

MATERIAL

FINISH

SHEET 19 of 20

DRG.TO BS 308

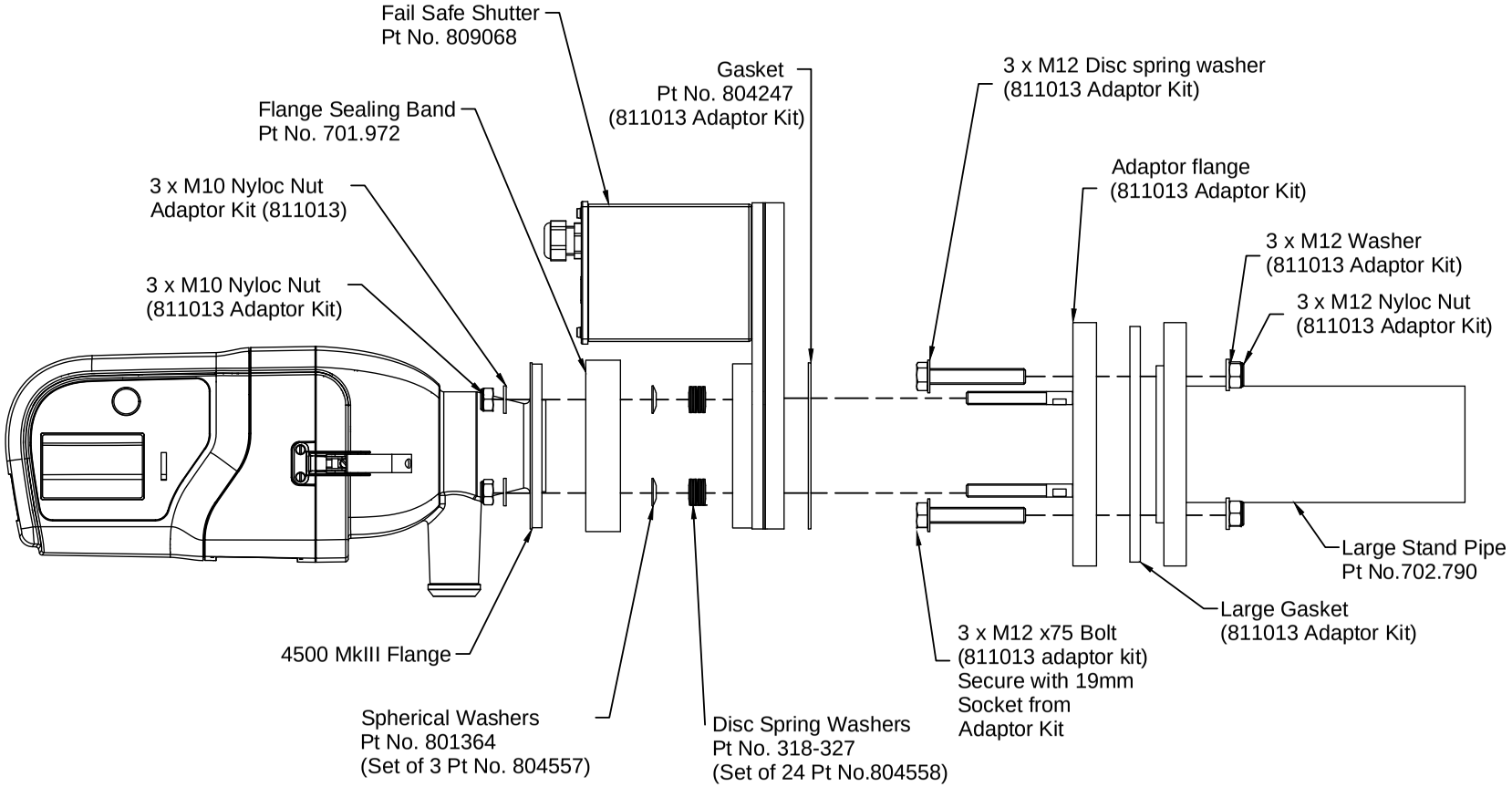
DIMENSIONS ARE IN MILLIMETRES

MODIFICATION	DATE	ISSUE
DRAWN RAL	DATE 28/08/15	
CHECKED	ORIGINAL SCALE n.t.s.	
APPROVED	DATE	

DRG.No. A3-740-058 Revision C

DRG.No.
A3-740-058

PROJECTION



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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ±
ANGLES ±
CASTING ±
SURFACE FINISH ✓
ALL SHARP CORNERS REMOVED
INTL. CORNERS R
EXTL. CORNERS R

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4200 to 4500 MkIII FSS Adaptor (811013) Installation

MATERIAL

FINISH

SHEET 18 of 20

DRG.TO BS 308

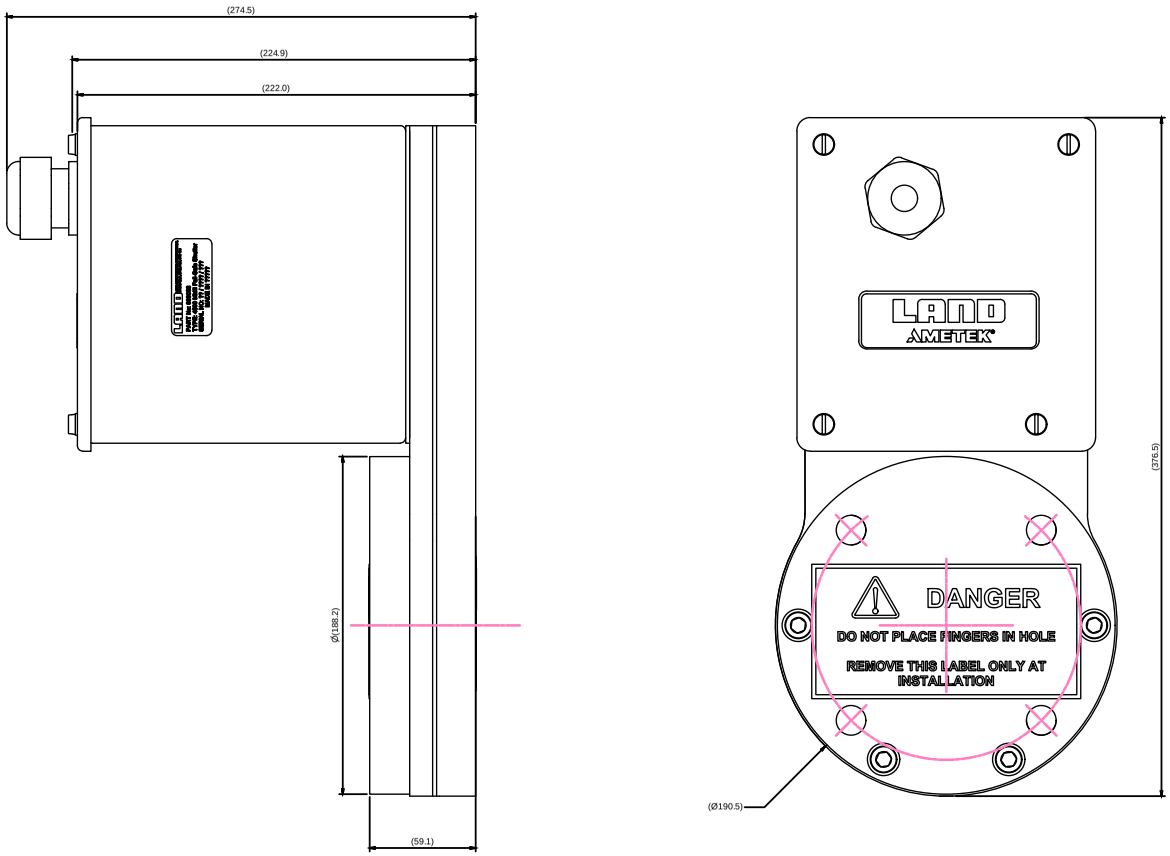
DIMENSIONS ARE IN MILLIMETRES

MODIFICATION	DATE	ISSUE
DRAWN RAL	DATE 28/08/15	
CHECKED	ORIGINAL SCALE n.t.s.	
APPROVED	DATE	

DRG.No. A3-740-058 Revision C

DRG.No.
A3-740-058

PROJECTION



OVERALL DIMENSIONS

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S18 1DJ

DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ± 0.1
ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII FSS Dimensions

MATERIAL

FINISH

SHEET 20 of 20

DRG.TO BS 308

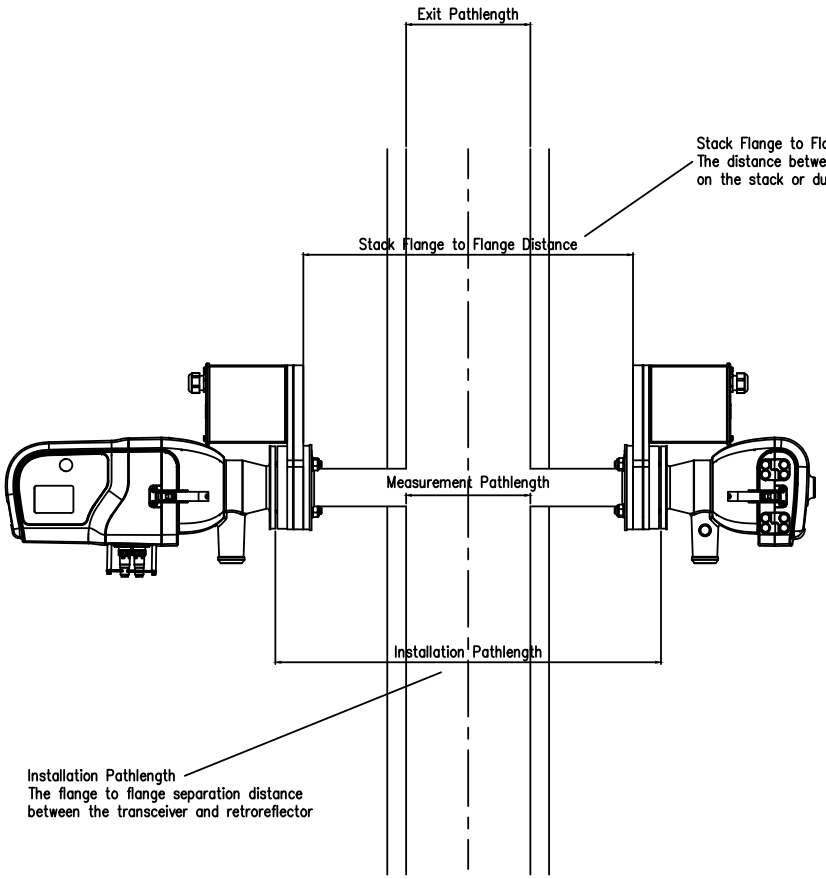
DIMENSIONS ARE IN MILLIMETRES

MODIFICATION	DATE	ISSUE
DRAWN LAE	DATE 14/06/16	
CHECKED	ORIGINAL SCALE n.t.s.	
APPROVED	DATE	

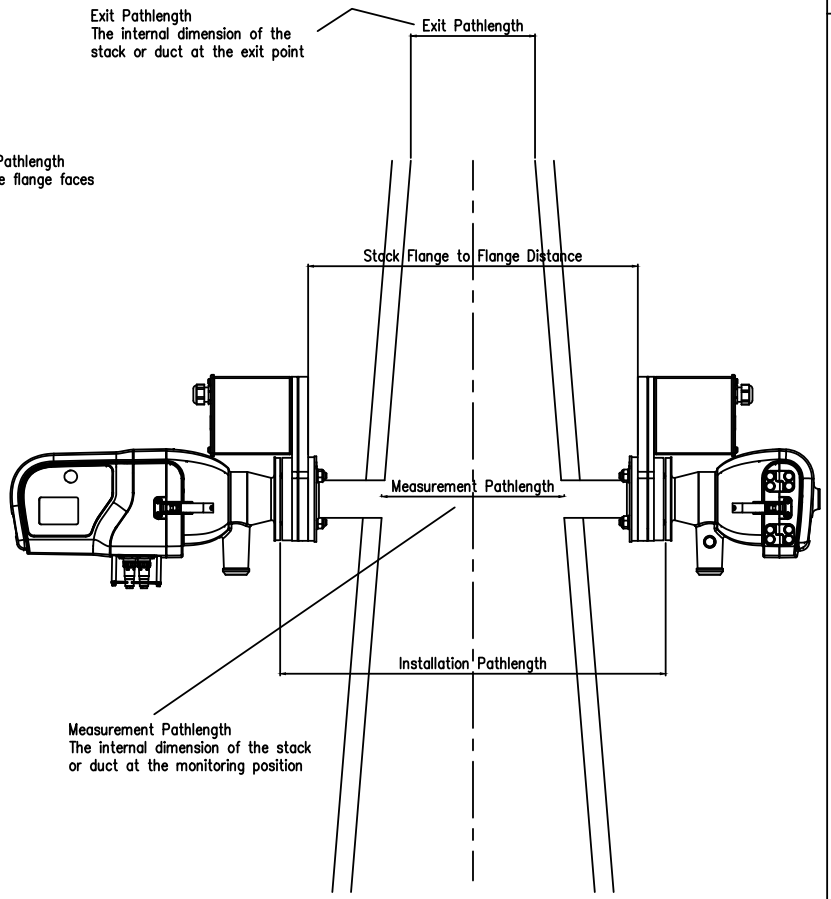
DRG.No. A3-740-058 Revision C

DRG.No.
A3-740-105

PROJECTION



Straight Stack Dimensions



Conical Stack Dimensions

LAND

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SHEFFIELD
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DO NOT SCALE

TOLERANCES U.O.S.
DIMNS. ± 0.1
ANGLES ± 1°
CASTING ± 0.4
SURFACE FINISH 1.6
ALL SHARP CORNERS REMOVED
INTL. CORNERS R 0.25
EXTL. CORNERS R 0.50

ORIGINALLY USED ON PRODUCT TYPE
4500 MkIII Installation Drawings

DRG. TITLE
4500 MkIII Pathlength Designations

MATERIAL

FINISH

SHEET 1 of 20

DRG.TO BS 308

DIMENSIONS ARE IN MILLIMETRES

MODIFICATION	DATE	ISSUE
DRAWN LAE	DATE 19/02/14	
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4500 MKIII

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Continuous product development may make it necessary to change these details without notice.

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