DynOptic Systems Ltd
www.dynoptic.com

DSL-460 MkII Double Pass Opacity/Particulate Monitor

Installation Manual V1.3

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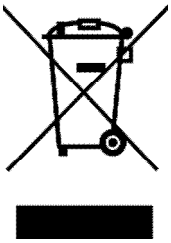
All technical details and specifications are subject to change without notice

Contents

Warnings

Throughout the manual the following symbols are used to highlight the potential dangers when installing, operating and servicing the instruments.

	Caution; Care must be taken, refer to specific instructions.
	Warning; Risk of electric shock.
	Protective Conductor Terminal.
	Recycle Responsibly.
	Attention; observe precautions for handling electrostatic sensitive devices.
Note:	Highlights a specific instruction or operating procedure.

General Warnings

Each section of the manual outlines the specific warnings for that part of the process or procedure. Below are some general guidelines that should be followed at all times:-

- ***The instrument is particularly vulnerable during transportation and manual handling. Always transport the instrument in its original packaging and handle with utmost care.***

- ***Prior to use, the equipment should be stored in its original packaging in a dry and sheltered area.***

- ***Applications vary and all installations will involve a degree of application engineering which is the responsibility of the customer, not DynOptic Systems.***

- ***All installations and connections must be made by suitably qualified and experienced electrical / mechanical engineers with proper regard to good practice and compliance with applicable legislation.***

- ***The instrument contains sensitive optics and electronics and must be protected from physical shock, vibration and exposure to moisture at all times. Always handle with care, replace lids and covers when not in use and protect from water ingress.***

- ***The instrument contains sensitive electronics which are vulnerable to ESD and therefore care should be taken to avoid making contact with electronic circuit boards & components. Use ESD handling precautions.***

- ***All electrical work must be carried out with the power to the instrument OFF i.e. it must be isolated from any source of voltage. Failure to do so could result in equipment failure, injury or death.***

- ***Do not make or break electrical connections whilst power is connected to any instrument. "Hot plugging" as this is known, may damage the electronics and require a circuit board to be replaced. This is NOT covered under warranty.***

- ***Always calculate the potential voltage drop when specifying the type / length of any DC power cable, taking care to allow for the***

output tolerance of the power supply. The stated voltage supply is that at the point of connection at the instrument.

- ***The cables to and from the instrument carry sensitive electronic signals which can be affected by RFI and EMI, so care should be taken to run the cables away from high voltage power cables, high frequency signal cables, or switch gear cabling. Ideally any cables connecting to the instrument, or between instrument components, will follow an independent route and will not be installed in bundles or cable trays with other cabling.***

- ***The ferrite tubes supplied should be fitted on all cables where they enter or exit instrument enclosures.***

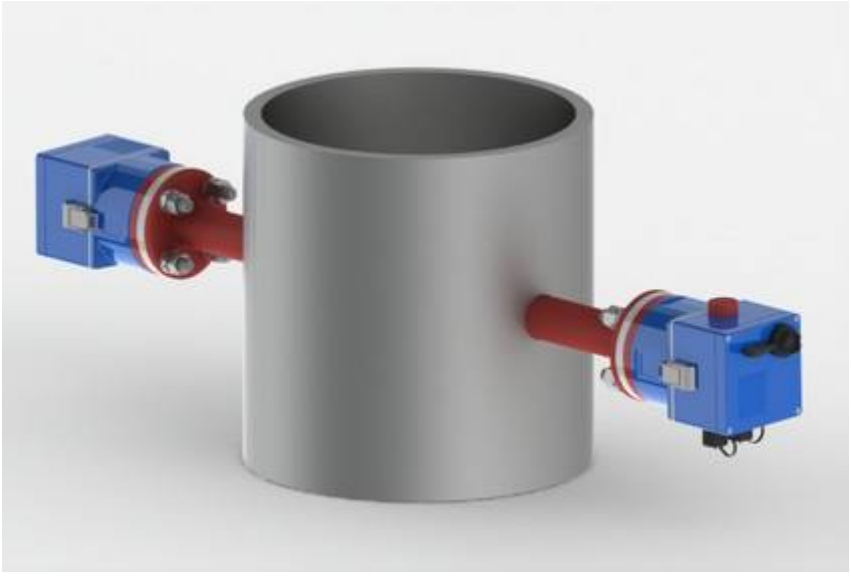
- ***Proper connection to a local Earth potential should be given consideration when choosing a location for the instrument components. Protective Earthing is essential, not just as a safety precaution, but also to maintain the instruments compliance with European safety directives and CE marking.***

- ***A Warranty Certificate is provided with each order. Failure to follow the procedures outlined in this manual, unless specifically instructed to do otherwise, could invalidate the warranty.***

- ***Read the manual in full before proceeding. If in doubt contact your local distributor or DynOptic Systems direct.***

Product Overview

The DSL-460 MkII Double Pass Opacity Monitor measures open path light transmission using a Transceiver (TRX) and Reflector system. It is typically installed on a duct, stack, chimney or flue for the purpose of monitoring increases in Opacity (0-100%) or Particle Density (mg/m^3) caused by suspended particles (dust and smoke) passing through the light path. Other available units include transmission (T), extinction and optical density.



The TRX and Reflector are mounted opposite each other across the stack so that the light beam generated in the TRX passes across the centre of the duct, stack or flue (through the gas stream) and falls directly onto the Reflector on the other side. The Reflector then returns the light beam to the TRX. Any dust or smoke particles present will attenuate the light beam and cause the intensity of the light received by the TRX to fall. The amount of light lost in crossing the duct, stack or flue is the opacity and this correlates to the amount of dust or smoke present in the gas flow. These measurements may be used directly or in conjunction with calibrated scale factors to generate a reading in a choice of units.

A number of checks and measures are employed to maintain continued accuracy of the instrument, including direct monitoring and compensation for the light source intensity as well as monitoring and compensation of the internal instrument temperature.

The DSL-460 MkII contains an integrated visual alignment aid, which makes installation easier. The TRX contains a viewing port which allows the user to see an image of the light returned by the Reflector head against a reticle target. Positioning the image within the centre of the target is used to align the TRX head.

The DSL-460 MkII can be supplied for “stand alone” configuration, (i.e. TRX / Reflector heads only; no control unit), in which case command and control of the instrument is performed using either the Utility software provided (for use on a laptop PC) or by ModBus serial comms connected to the TRX. In the stand alone configuration, the TRX head has a range of interface outputs including analogue output, level/service alarm contacts, ModBus and USB, allowing it to fit into standard industrial monitoring systems.

Alternatively the DSL-460 MkII can be supplied with a DSCU (DynOptic Systems Control Unit) which is an OI (Operator Interface) that consists of a numeric / directional keypad, a two line LCD display and a terminal compartment. The DSCU is a multi-headed OI and, if required, can be connected to up to eight separate instruments.

The keypad and display on the DSCU combine to form an interface which can be used to setup and control any connected instrument, providing similar functionality to the PC based Utility software supplied with each instrument.

Both TRX and Reflector heads are supplied with air-purge bodies. These not only provide the physical mounting point for the instrument but also allow users to connect a high volume, low pressure air supply to help keep the optics clean and prolong service intervals. By default, the instrument is a 24Vdc powered device but it can be optionally supplied with universal input 90-265Vac PSU for AC operation.

Calibration varies depending on the measurement units selected; Opacity, Transmission, Extinction and Optical Density require zero calibrating. Particle Density (mg/m^3) will require an upscale calibration based on comparison between instrument readings and independent gravimetric sample measurements.

An optional Calibration Head and filters can be purchased to allow for manual zero and span drift checking. The Calibration Head is inserted between the TRX and the air purge head, when a calibration check is required. The reference mirror and filter inserts are then introduced in accordance with the calibration check routine and any performance drift can be measured and corrected, where appropriate. The calibration check routine must be run using the DSL-460 MkII Utility Software on a PC.

Physical Installation of the Heads

All installations and connections must be made by suitably qualified and experienced electrical / mechanical engineers with proper regard to good practice and compliance with applicable legislation.

The instrument contains sensitive optics and electronics and must be protected from physical shock, vibration and exposure to moisture at all times. Always handle with care, replace lids and covers when not in use and protect from water ingress.

The instrument contains sensitive electronics which are vulnerable to ESD and therefore care should be taken to avoid making contact with electronic circuit boards & components. Use ESD handling precautions.

It is very important that the installation of your DSL-460 MkII is planned out carefully in advance. Please study this section carefully and ensure that you have taken proper advice on local and national regulatory requirements before starting your installation. Proper planning will avoid the need for modification to your installation at a later date.

Choosing a location and general considerations

When choosing a location for the Reflector and TRX heads you must consider the following:

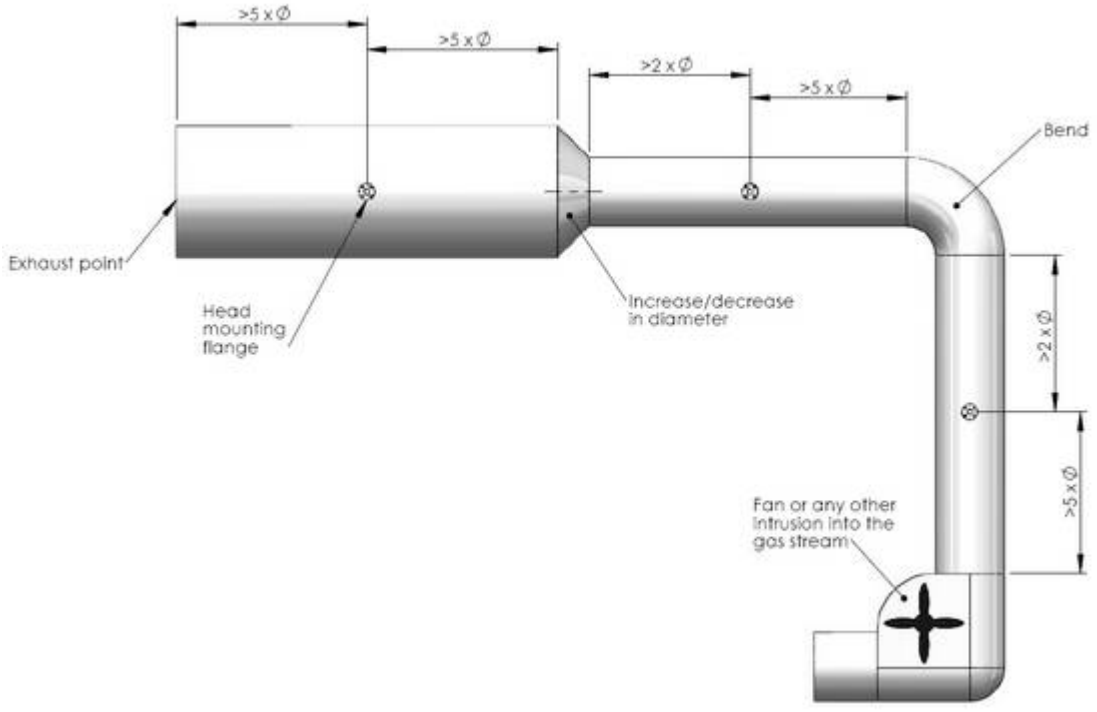
- Legislation (local or national) covering the installation may specify or make specific requirements on the positioning of the sensor heads. If legislation does affect the head position priority must be given to this legislation but do not disregard other considerations discussed here.

- Accessibility is very important for maintenance. Access to both heads should be easily available so positioning at the level of a gantry or platform is preferable.

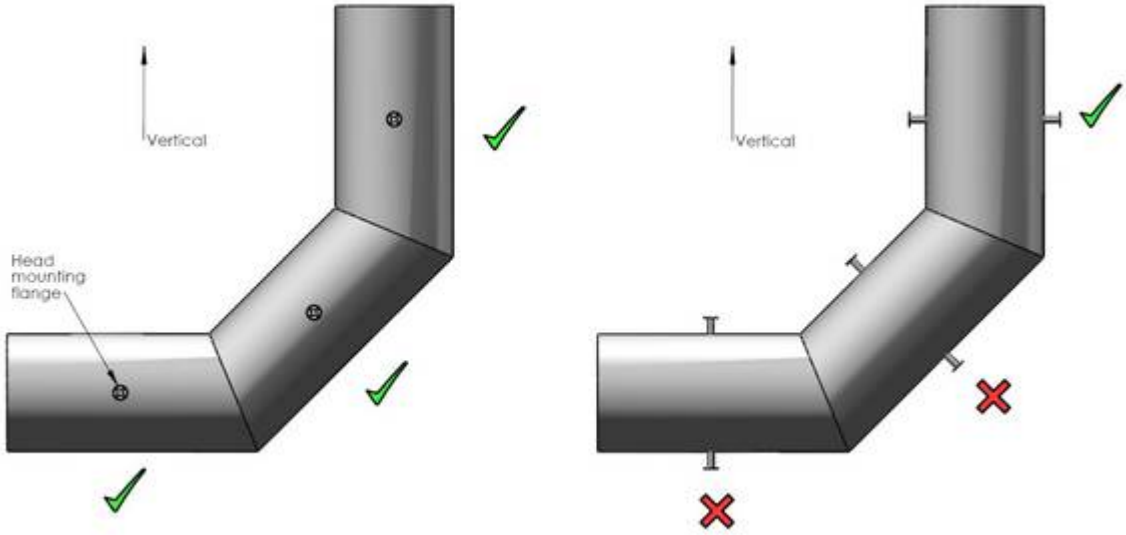
- Vibration and angular movement will cause the light beam to move and may result in an unstable measurement. Therefore, the heads must be mounted securely on a sturdy section of the duct or stack that will not be prone to high levels of vibration. If the duct wall is thin and flexible, it should be reinforced at the mounting position or a frame should be constructed to hold both heads stable in relation to one another. You must ensure that the angular relationship between the Reflector and TRX heads remains constant in all conditions. Particular consideration should be given to the possibility of vibration and also expansion / contraction of local structures with temperature.

- Gas flow characteristics within the stack at the measurement point should be considered carefully when locating the heads. Ideally the heads should be positioned on a straight section of duct with no increases/decreases in diameter, no bends, no inlets/outlets and no intrusions/protrusions, within at least 5 duct diameters of the heads downstream and 2 duct diameters upstream. The measurement point should be located at least 5 duct diameters from the exhaust point, see image below.

Where suitable sample planes exist in both vertical and horizontal sections of the duct, the vertical section is preferable.

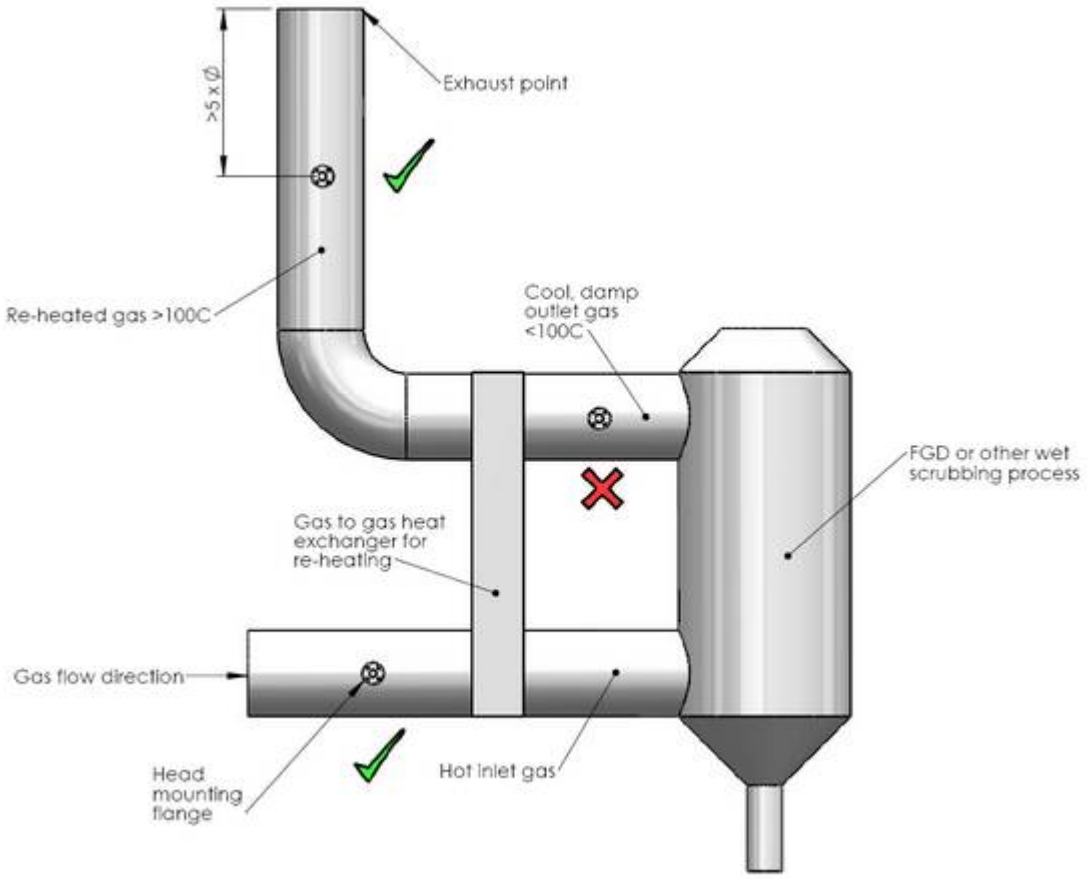


Note: *The heads should never be positioned top and bottom of a horizontal duct or angled duct, as particle matter will fall under gravity into the bottom head and cause the optics to become dirty more quickly.*



- Mist, spray, droplets and condensing liquids will affect the light in a similar way to the dust or smoke particles. In most installations, it is undesirable to measure the contribution from liquid droplets and therefore a mounting location should be chosen that is free from such contaminates.

As a general rule, the heads should be located at least 5 stack diameters upstream of the exhaust point, at a point where the exhaust gas is consistently in excess of 100°C, and upstream of any wet scrubber or other process, which may introduce liquid mist or spray (unless fitted with an re-heater or demister).



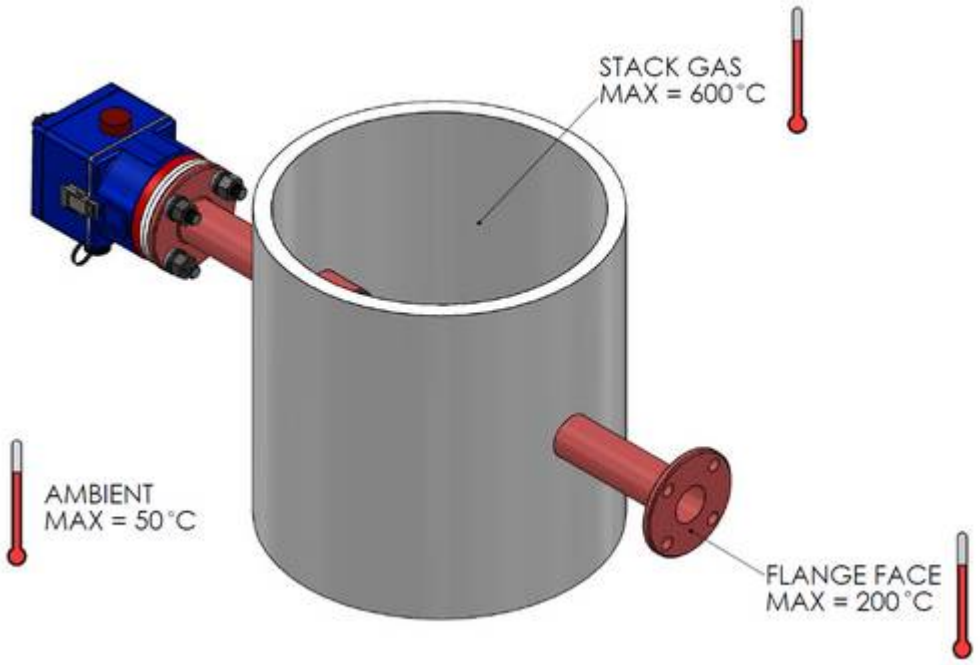
If the heads are mounted on a vertical stack section near to the exhaust point, there is the possibility that heavier droplets (from rain or condensing steam) may fall down into the stack, against the direction of the gas flow. These droplets will also generate a reading, which may be undesirable and an alternative location should be considered.

Knowledge of the process gas conditions, engineering logic and common sense should be employed to choose a location for the heads that will not be affected by mist, spray, droplets or condensing liquids.

- Temperature is probably the single most important consideration when choosing a location for the heads and the main considerations are:

- Stack gas temperature
- Mounting flange temperature
- Ambient air temperature around the heads
- Radiated heat
- Direct sunlight

The mounting flange face temperature must not exceed 200°C and the standard installation recommendations provided in this manual are for a maximum stack gas temperature of 600°C. Please consult DynOptic Systems if the application has stack gas temperatures higher than 600ºC.



The ambient air temperature around the heads should be in the region -20°C to +50°C.

If the ambient air temperature around the head is being affected by radiated heat from the duct, the use of rock wool lagging on the duct or a heat shield in front of the heads, may be necessary.

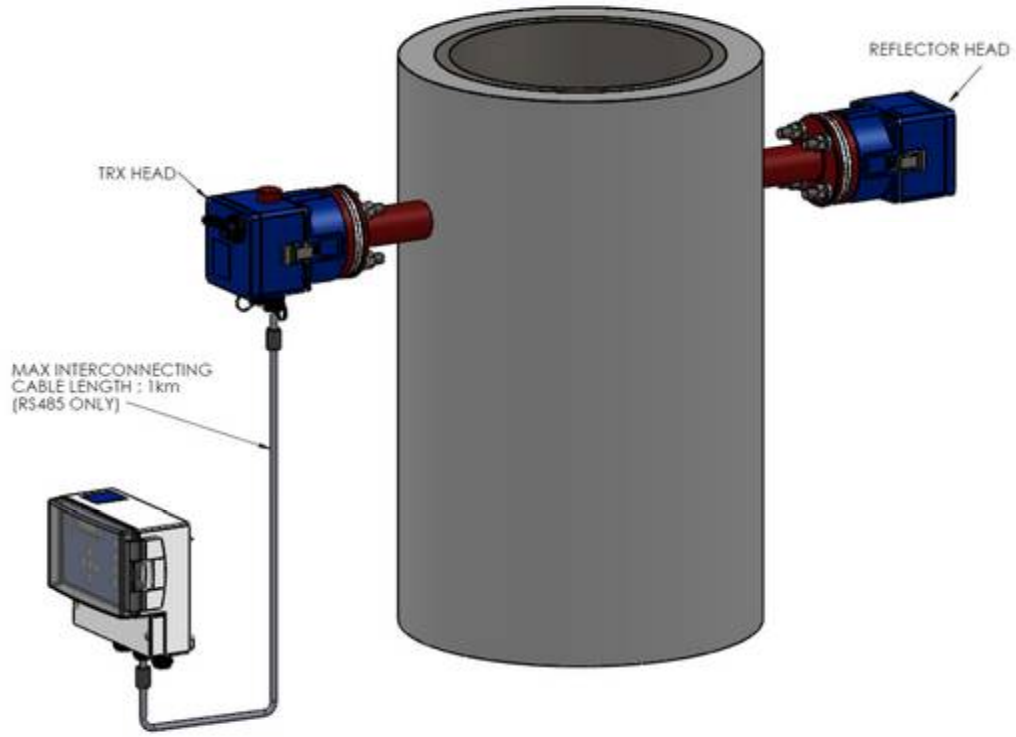
Where the heads are mounted externally they should be shielded from direct sunlight at all times. The heads may be mounted under a canopy or shelter, or alternatively an optional weather cover is available from DynOptic Systems.

It is essential that the instrument is protected from extreme temperature conditions.

- Cable route and length needs to be considered when choosing a location for the heads. Cable lengths should be kept as short as possible to reduce voltage loss and to reduce the possibility of interference pick-up.

Where an instrument is being powered through a DSCU the length of the cable between the DSCU and the TRX is limited by the voltage drop likely to occur on the 24Vdc supply carried in this cable. Always calculate the potential voltage drop when specifying the type/length of this cable, taking care to allow for the output tolerance of the power supply. The 24Vdc supply to the TRX must not fall below 20Vdc.

Alternatively, separate local power supplies can be used for both the DSCU and the TRX, in which case voltage drop is no longer the limiting factor and the maximum cable length is 1km.



The cable route should ideally be independent of other plant cabling and the DSL-460 MkII cables must not be laid alongside anything which may emit electromagnetic or RF signals, such as heavy power cables or switch gear cabling.

Tight bends, pinching, clamping and the possibility of wear or abrasion must also be avoided when choosing the route.

- **Earth connection** to the TRX metal enclosure is essential to protect the electronic circuit boards inside from the effects of Electro Static Discharge (ESD) and high voltage transients.

If the TRX metal enclosure is not directly earthed, any local ESD or high voltage surge is likely find a path to earth through the sensitive circuit boards inside the head, inevitably causing damage. However, if the metal enclosure is properly earthed, that same ESD, or surge, would find its way back to earth through the proper electrical earth connection, instead of through the electronics in the heads.

A location for the heads must be chosen where a proper electrical earth is available. It is not acceptable to rely on the stack or the mounting flanges as an earth point.

- Summary: A location for the heads must be chosen with consideration to all the points above. If it is impossible to satisfy all the recommended criteria please make a sensible compromise rather than disregard one point altogether.

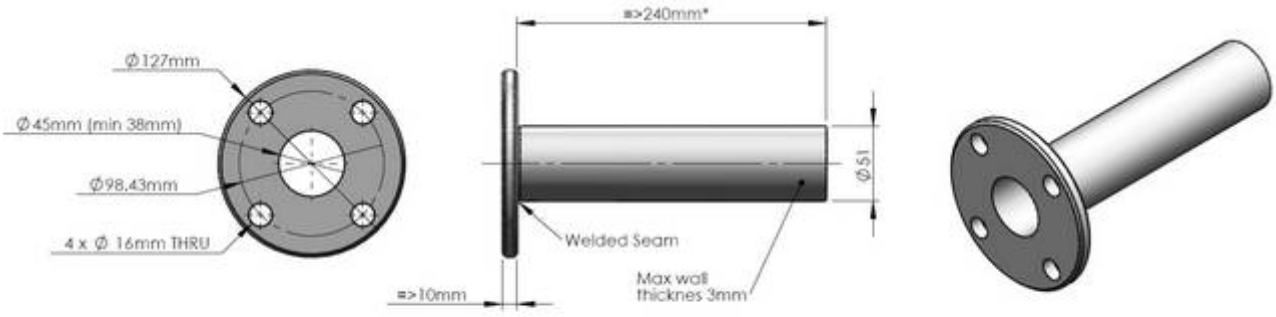
Having selected a location, suitable mounting flanges should be prepared and installed at the chosen location.

Fixing the mounting flanges and heads

Care must be taken when working on the stack. In particular hot surfaces and hot stack gases. Take all necessary precautions.

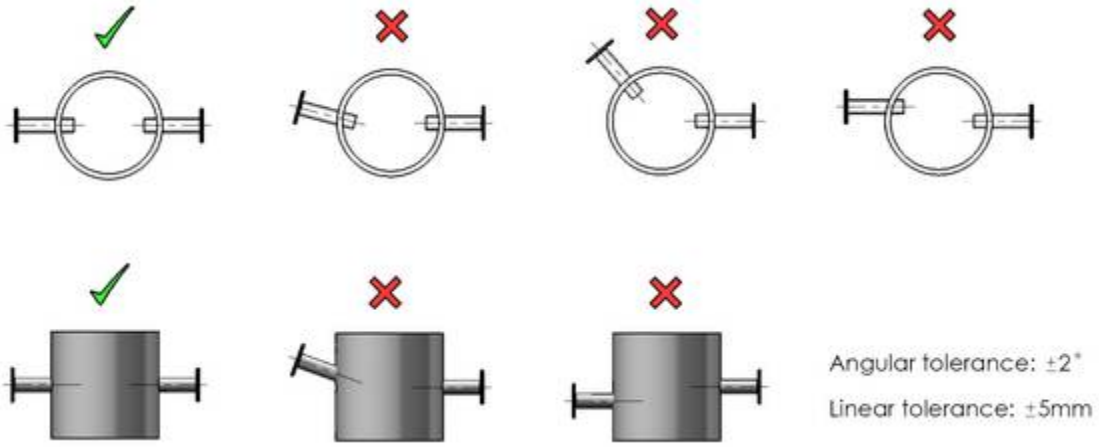
The Reflector and TRX heads must be mounted directly opposite each other across the stack or duct so that light from the TRX passes through the centre of the duct and falls directly onto the Reflector.

Each head should be bolted to a suitable mounting flange (1.5” ANSI 150 pattern) extended away from the side of the stack on a short extension tube. See below for the required construction details of a suitable mounting flange extension. Pre-fabricated mounting flange extensions can be purchased from DynOptic Systems as an accessory.

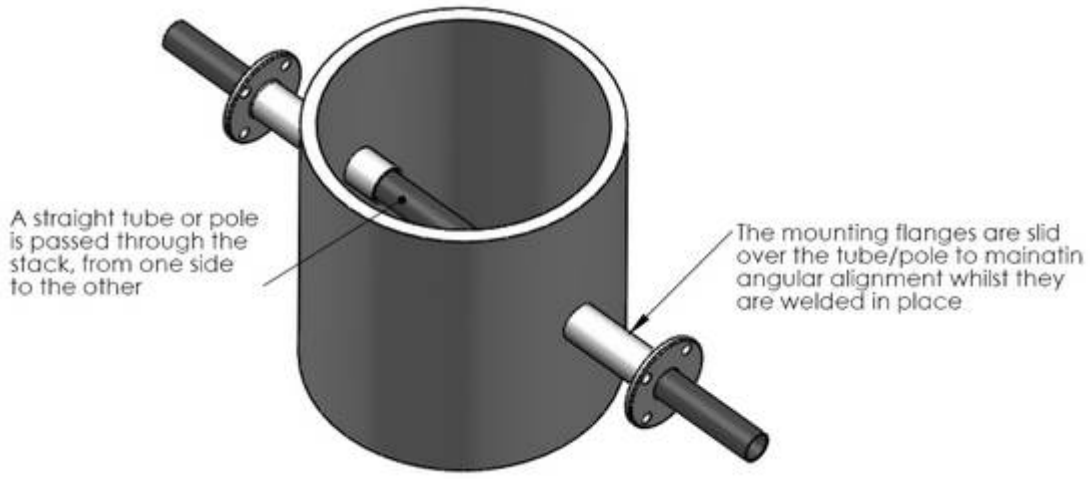


*Note: it is essential that the length of the extension tube allows for the required clearance between the mounting flange and stack wall and/or insulation, as shown later in this section.

The mounting flange extensions should be fitted on opposite sides of the stack such that the bore of both extension tubes are concentric and co-linear, with a maximum angular alignment tolerance of +/-2° and a maximum linear alignment tolerance of +/-5mm (see below).

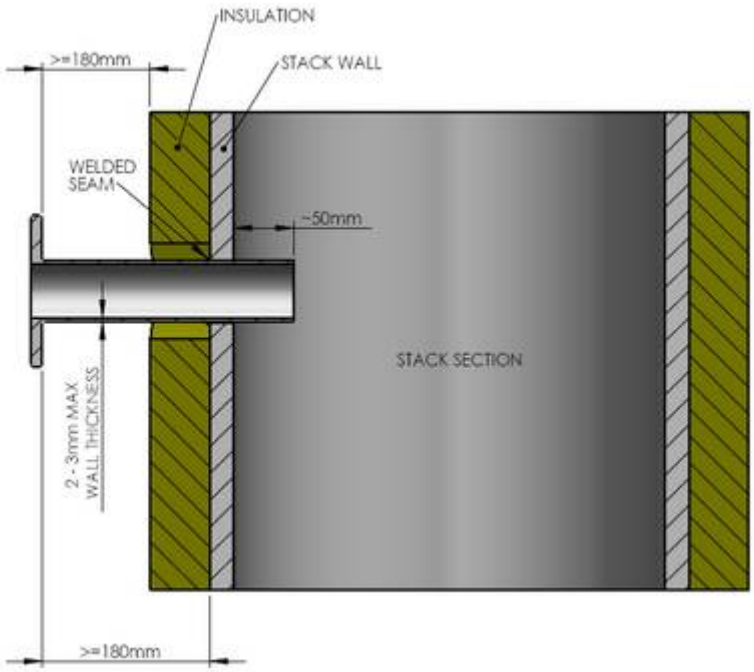


An excellent way to ensure that mounting flange extensions meet the required angular and linear alignment tolerances, is to insert a straight pole or tube through the stack so that it protrudes either side of the stack. Then slide the mounting flange extensions over the protruding pole/tube on each side, before welding the flange extensions in place on the stack. This technique will ensure that the mounting flanges are well aligned as they are welded in place. See below for an example of the technique.

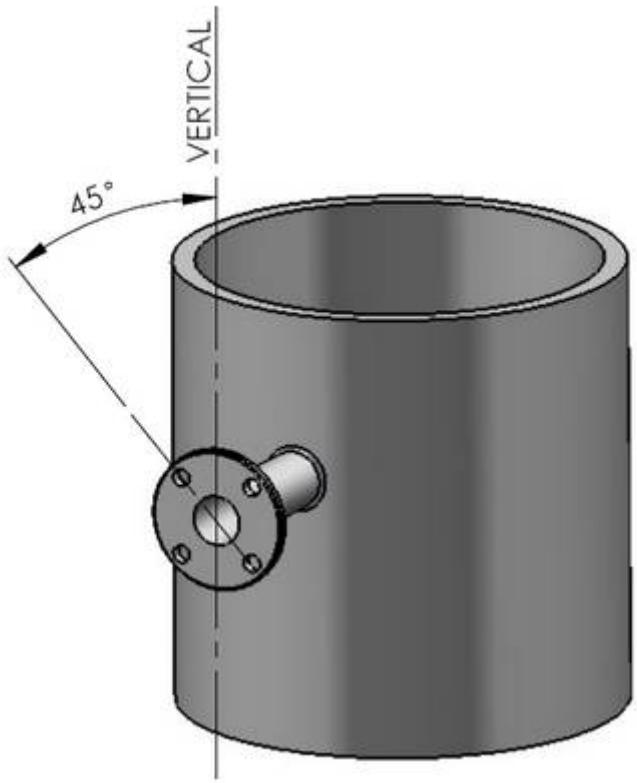


When fitting the mounting flange, the extension tube should pass through the wall of the stack and protrude slightly (~50mm) into the duct. The purpose of the intrusion is to prevent any dirt or slime build-up on the inner wall of the duct falling down the wall and passing through the light path.

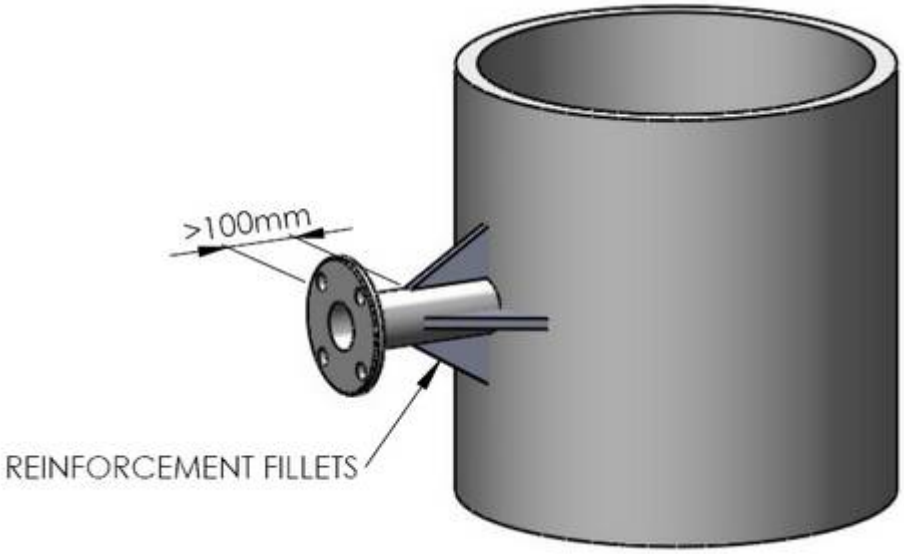
Keep the flange extension tube as short as possible whilst maintaining the minimum clearance between the mounting flange and the stack wall and/or the insulation, as shown below.



The flange extensions should be installed with the bolt holes at 45° to the vertical, as shown below.



The mounting flange extensions must be installed on a sturdy section of duct where there is no danger of movement or vibration. The mounting flanges must maintain angular alignment at all times during operation. Relative movement between the TRX and Reflector will cause errors in the reading. Thin wall stacks should be reinforced at the head location. Alternatively, reinforcement fillets or a support frame should be made up to support the heads. Support structures and frames may vary in design but it's essential that there is at least 100mm clear extension tube between the support structure and the mounting flange, in order to reduce the heat conducted between the stack and the mounting flange.



The DSL-460 MkII comes with two air-purge bodies, these are either the standard cast Aluminium design or the higher performance Stainless Steel design. The installation of these air-purge bodies onto the mounting flange plate are illustrated in the following drawings.

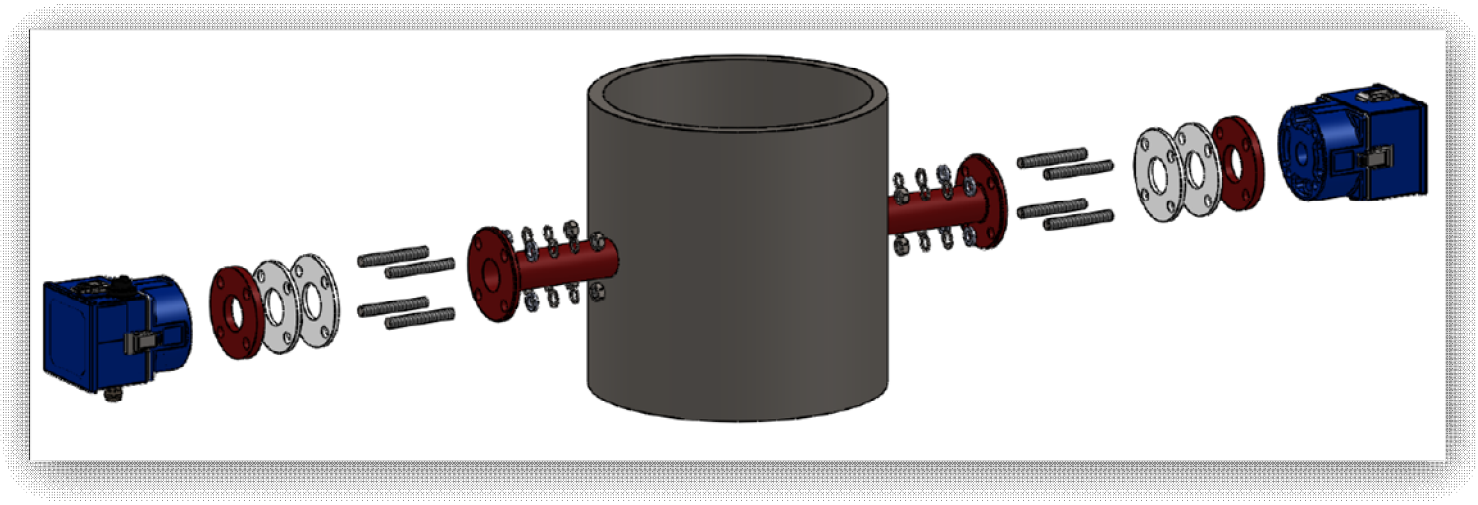
The Aluminium air-purge body has four M14 tapped holes on a PCD to match the mounting flange. This air-purge body can be installed on the mounting flange either by inserting a bolt from the stack side of the flange, or by fitting short lengths of M14 threaded stud into the air-purge head and securing them from the stack side of the flange with matching nuts.

The Stainless Steel air-purge body has four M14 through holes on a PCD to match the mounting flange. This air-purge body can be installed on the mounting flange by using short lengths of M14 threaded stud with suitable nuts and washers on both ends.

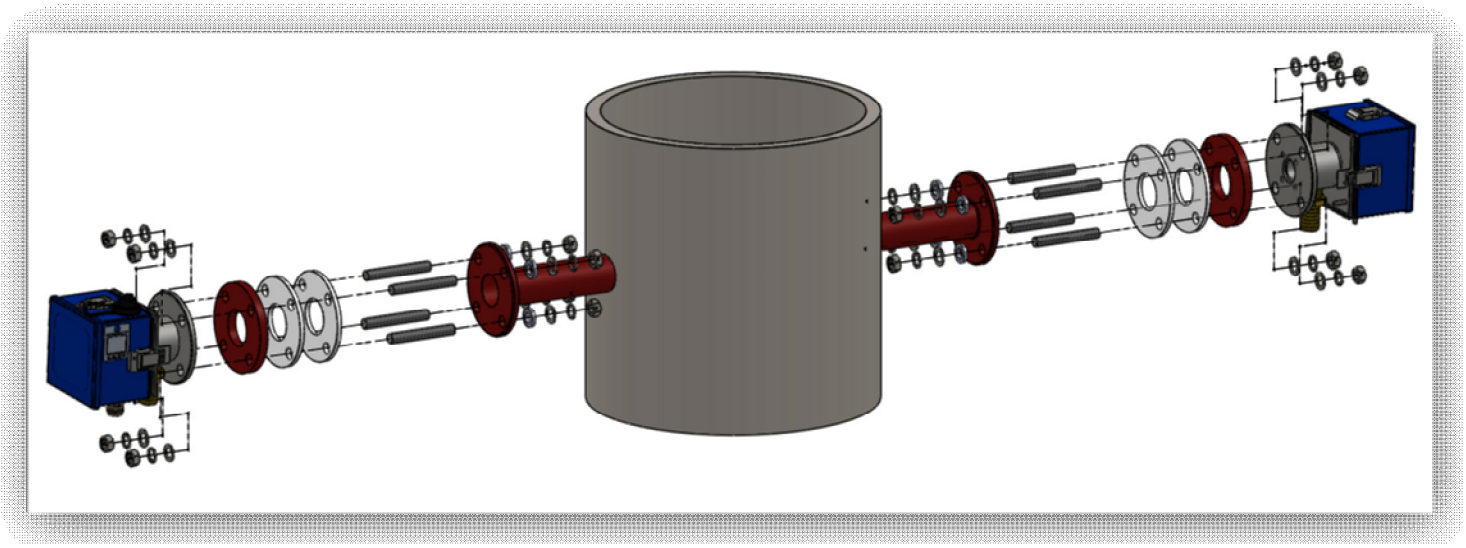
The nuts or bolts will be tightened at a later stage to achieve optimum alignment of the heads (see operators manual). For installation they should be tightened to the minimum torque setting of 10Nm.

Select bolts and studs of a suitable length, and remember to allow for the additional thickness of the rubber alignment gaskets, heat insulating gaskets,

washers, and any weather shield that may be fitted as part of the installation. Fixing kits containing suitable M14 studs, washers and nuts are available from DynOptic Systems.



Aluminium Purge Bodies



Stainless Steel Purge Bodies

The instrument is supplied with four (4) heat insulating gaskets manufactured from a 6mm thick woven ceramic fibre cloth (white in colour). Two (2) of these gaskets must be installed on each side of the stack. They must be installed as shown, so that they are installed against the hot mounting flange surface, and will therefore protect the red silicone rubber alignment flange, and the TX/RX head from conducted heat from the flange face.

The instrument is supplied with eight (8) heat insulating washers manufactured from 5mm thick Teflon (white in colour). These washers must be installed as shown, so that they are fitted between each nut/bolt/washer

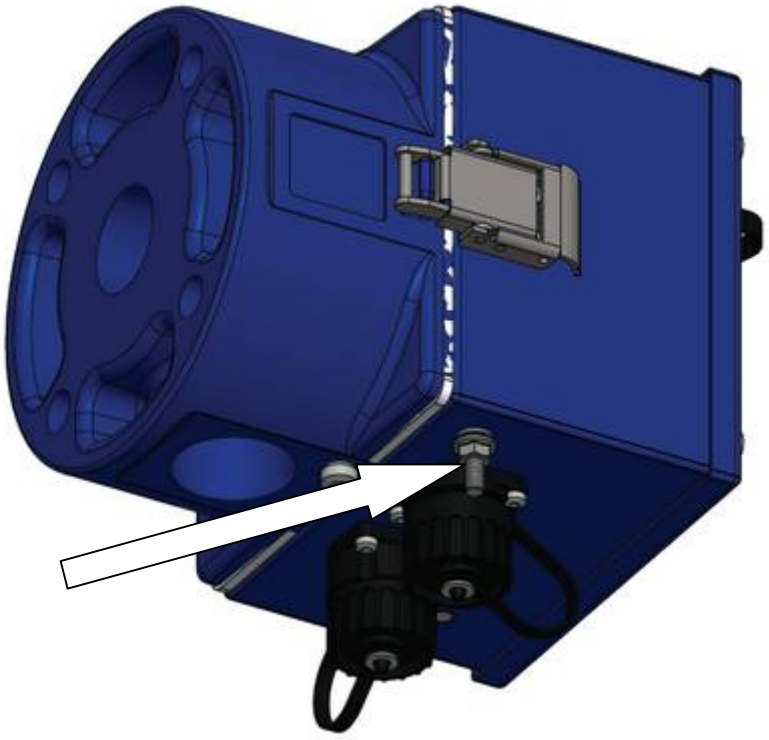
arrangement and the hot mounting flange surface. Their purpose is to prevent heat from the mounting flange conducting through the fixing bolts.

The instrument is supplied with two (2) red silicone rubber alignment gaskets which must be fitted as shown, so that they are protected from the heat of the mounting flange by the heat insulating gaskets. These rubber alignment gaskets will allow for a degree of adjustment to be made in the angular alignment of each head during commissioning. The alignment gasket must not come into contact with any surface that has a temperature in excess of 150°C.

Earth connection

A heavy duty earth wire, or braid, should be connected between the M5 studs on the outside of the head enclosures, and a proper electrical earth point.

It is not acceptable to rely on the stack or the mounting flange as an earth point.



Protective Earth Terminal

Failure to make a proper earth connection to the heads will leave the instrument vulnerable to damage from ESD and high voltage surges.

Air-Purge System

The purge air system must be in place and operational prior to the installation of the heads. The purge air system must remain operational at all times, even if the instrument itself is not. Failure to maintain an operational purge air system may result in the heads being damaged by hot, corrosive stack gas coming into contact with them.

Overview and requirements

The DSL-460 MkII uses optical techniques to make dust/opacity measurements. Each measurement head therefore has an optical surface exposed to the dirty and potentially harmful environment of the stack interior. In order to protect the optical surfaces from contamination by particle depositions and the damaging effects of heat and/or corrosive stack gas, it is necessary to employ an air-purge system to repel the stack gas and prevent it from coming into contact with the heads

The air-purge system achieves this by producing a flow of clean and dry air flowing away from the head and into the stack. This air-flow provides a clean air barrier between the optics and the stack gas.

A complete air purge system will comprise of:

- **Air-purge bodies** on both sides of the stack (supplied) which serve to duct the purge air over the optical surfaces and into the stack
- **A clean, dry, purge air supply** which could be derived from a suitably filtered air blower or pressure regulated and filtered compressed air (not supplied).
- **Hose and fittings** necessary to connect the air supply to the heads (not supplied)

The air-purge bodies are supplied with the instrument; all the other elements are available as accessories. For more information on the available options and technical specifications required, please refer to the ‘Purge Air Requirements’ document.

Note: *We recommend that flexible hose is used. The use of non-flexible hose can affect the ability to align the heads.*

Note: *Due to the possibility of damage to the heads if the purge air fails or is turned off, a failsafe shutter is available from DynOptic Systems.*

Physical Installation of the DSCU

Please refer to the DSCU Installation & Operators Manual for more information.

Physical Installation of the Cable

Always calculate the potential voltage drop when specifying the type / length of any DC power cable, taking care to allow for the output tolerance of the power supply. The stated voltage supply is that at the point of connection at the instrument.

The cables to and from the instrument carry sensitive electronic signals which can be affected by RFI and EMI, so care should be taken to run the cables away from high voltage power cables, high frequency signal cables, or switch gear cabling. Ideally any cables connecting to the instrument, or between instrument components, will follow an independent route and will not be installed bundles or cable trays with other cabling.

The ferrite tubes supplied should be fitted on all cables where they enter or exit instrument enclosures.

Because of the potentially long and variable lengths of cable required to connecting the DSL-460 MkII, this instrument is not supplied with any cable. Suitable cable must be sourced locally or can be purchased separately from DynOptic Systems.

The instrument is supplied with 2 connectors that connect power/comms and the outputs from the TRX. These can be ordered pre-wired/terminated from DynOptic Systems. See wiring diagram for more information.

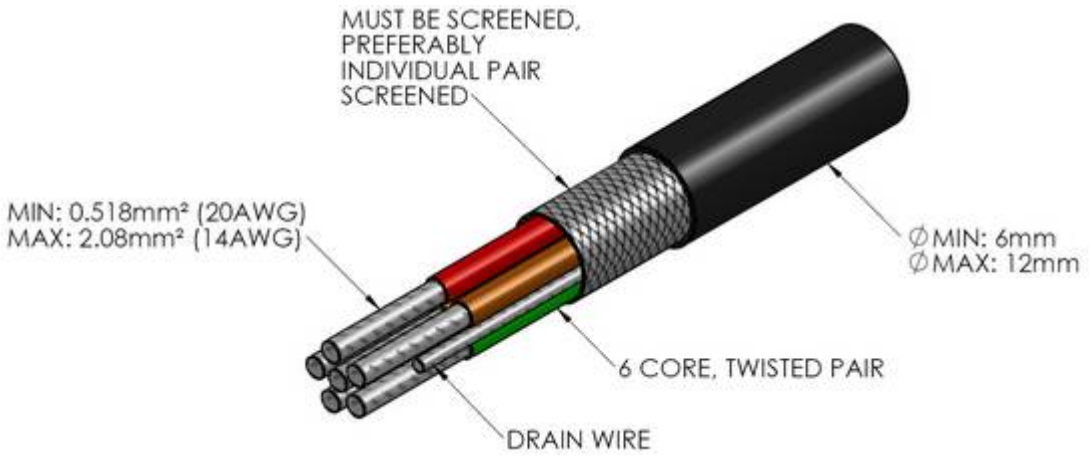
Where an optional DSCU is installed, the cable connecting the DSCU to the TRX must have a minimum of 4 cores and meet the specification shown below. The maximum length of this cable is limited by the voltage drop likely to occur on the 24Vdc supply carried in this cable. Always calculate the potential voltage drop when specifying the type/length of this cable, taking care to allow for the output tolerance of the power supply. The 24Vdc supply to the RX head must not fall below 20Vdc.

Alternatively, separate power supplies can be used for both the DSCU and the TRX, in which case voltage drop is no longer the limiting factor and the maximum cable length is 1km.

All cables should have an individual core size of between 0.518mm² (20AWG) and 2.08mm² (14AWG).

All cables must be screened, ideally individually screened twisted pairs with a common drain wire, such as Belden 9873 (6 core, screened pair, 20AWG).

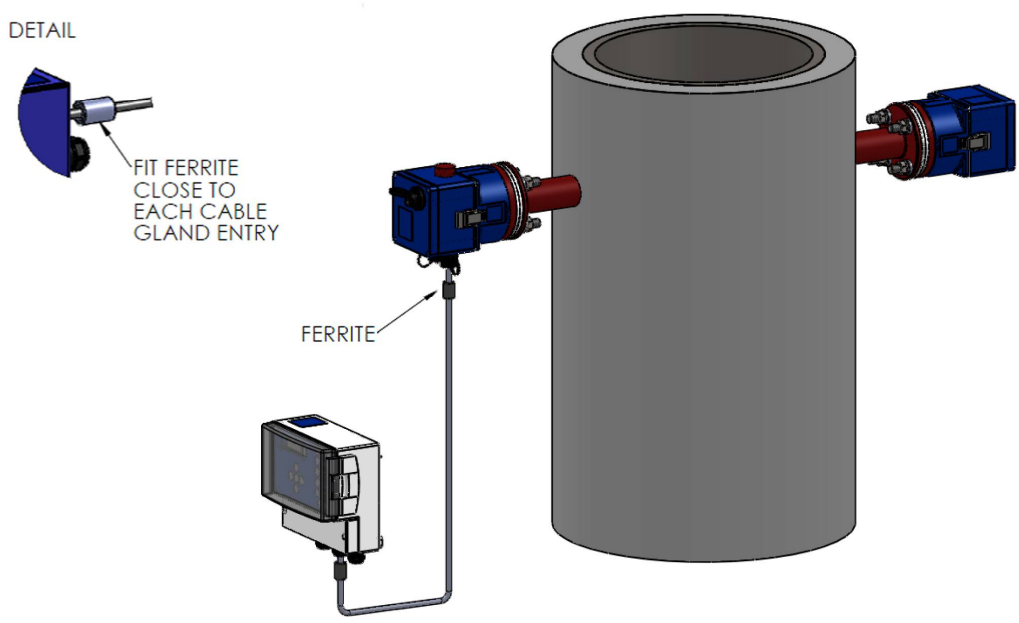
The overall diameter of the cable should be between 6 and 12mm.



The DSL-460 MkII cables carry sensitive electronic signals, which can be affected by RFI and EMI so care should be taken to run the cables away from high voltage power cables, high frequency signal cables or switch gear cabling.

Ideally any cables connecting to the instrument, or between instrument components, will follow an independent route and will not be installed in bundles or cable trays with other cabling.

The supplied ferrite tubes should be fitted on the cables where the cables enter the DSCU enclosure and before the connectors of the TRX. The ferrites should be secured in place so that they remain fixed adjacent to connector or the cable gland entry.



All cables entering the DSCU must do so through the cable glands provided. All cable glands must be tightened onto the cable to maintain the enclosures environmental rating.

Any unused cable gland entries should be sealed using the rubber bungs supplied. Tighten the gland onto the rubber bung to ensure protection.

Wiring details are covered in the electrical wiring details section.

Electrical Wiring Details

Caution; care must be taken

All installations and connections must be made by suitably qualified and experienced electrical / mechanical engineers with proper regard to good practice and compliance with applicable legislation.

Caution; care must be taken

The instrument contains sensitive optics and electronics and must be protected from physical shock, vibration and exposure to moisture at all times. Always handle with care, replace lids and covers when not in use and protect from water ingress.

Risk of Electric Shock

All electrical work must be carried out with the power to the instrument OFF i.e. it must be isolated from any source of voltage. Failure to do so could result in equipment failure, injury or death.

Caution; care must be taken

Do not make or break electrical connections whilst power is connected to any instrument. "Hot plugging" as this is known, may damage the electronics and require a circuit board to be replaced. This is NOT covered under warranty.

Protective Earth Terminal

Proper connection to a local Earth potential should be given consideration when choosing a location for the instrument components. Protective Earthing is essential, not just as a safety precaution, but also to maintain the instruments compliance with European safety directives and CE marking.

Cable specification and physical cable installation are discussed in an earlier section.

Installation wiring diagram:
Stand-alone configuration (no DSCU)

The following page shows the TRX head wiring connection details for the DSL-460 MkII when installed in “stand-alone” configuration (i.e. heads only with no DSCU).

This diagram includes details of all connections necessary for basic functionality and also shows the terminal assignments for all output and interface connections.

Cable screen connections

All cables should be screened where possible. Cable screens must be connected to the marked terminal on the connector (see drawing below).

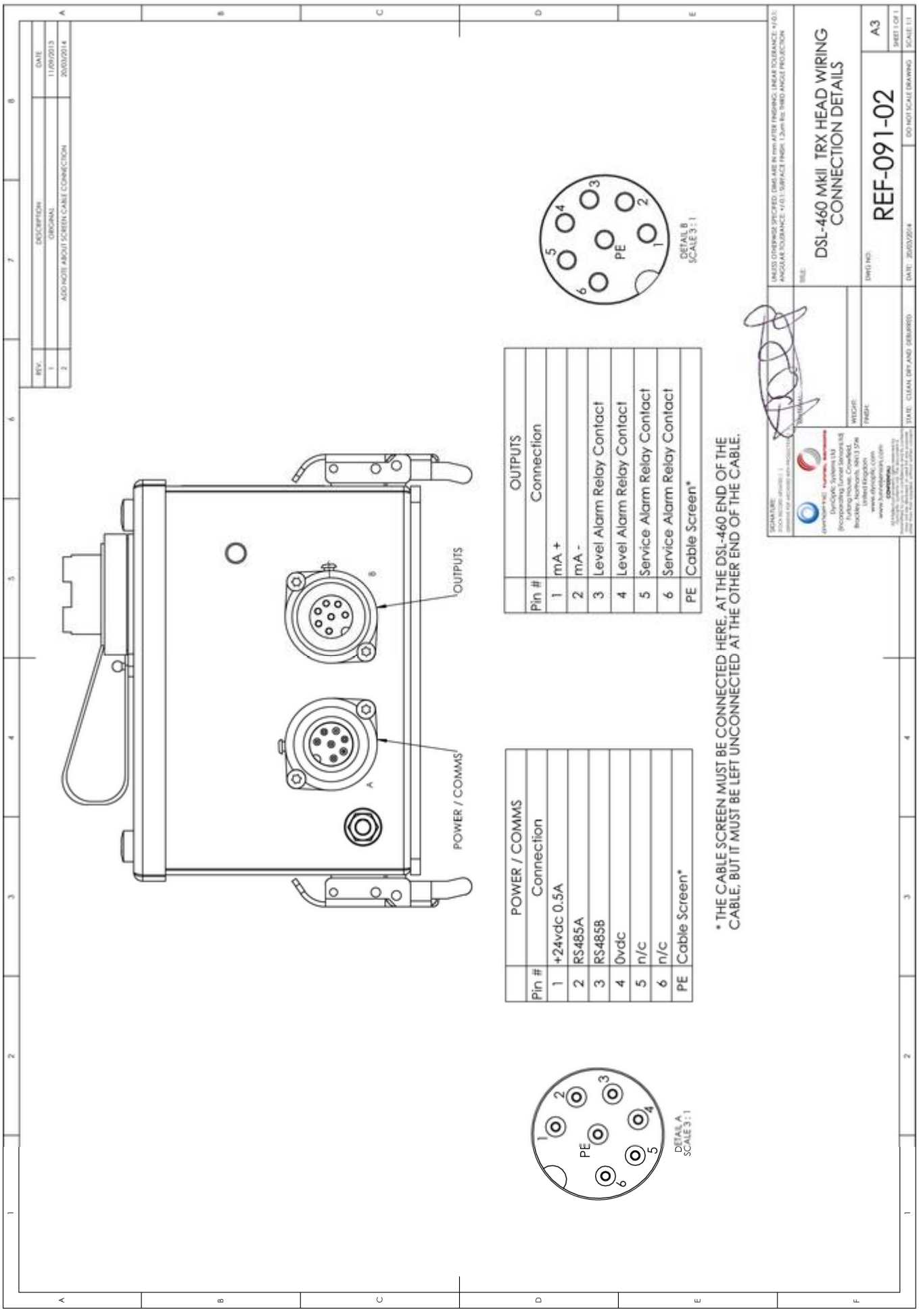
Note: *Cable screens must be bonded at the DSL-460 MkII end only. They must not be bonded to any other device or connected in any way at the opposite end of the cable.*

Protective earth connection

It is essential that the enclosure is bonded to a local protective earth connection, as described earlier in this manual.

DSCU Wiring

For DSCU wiring details please see the ‘DSCU Installation and Operators Manual’.



Pin #	POWER / COMMS Connection
1	+24vdc 0.5A
2	RS485A
3	RS485B
4	0vdc
5	n/c
6	n/c
PE	Cable Screen*

Pin #	OUTPUTS Connection
1	mA +
2	mA -
3	Level Alarm Relay Contact
4	Level Alarm Relay Contact
5	Service Alarm Relay Contact
6	Service Alarm Relay Contact
PE	Cable Screen*

Revision Control

Version	Revision Date	Revision Details	Author
V1.0	21/06/2013	Original.	Dominic Sheedy
V1.1	03/02/2014	Updated instrument earthing details.	Colin Edge
V1.2	25/03/2014	Updated Head Connection Details drawing, updated notes on cable screening.	Dominic Sheedy
V1.3	21/04/2015	Included Stainless Steel purge body installation drawing	Colin Edge

All technical details and specifications are subject to change without notice.

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