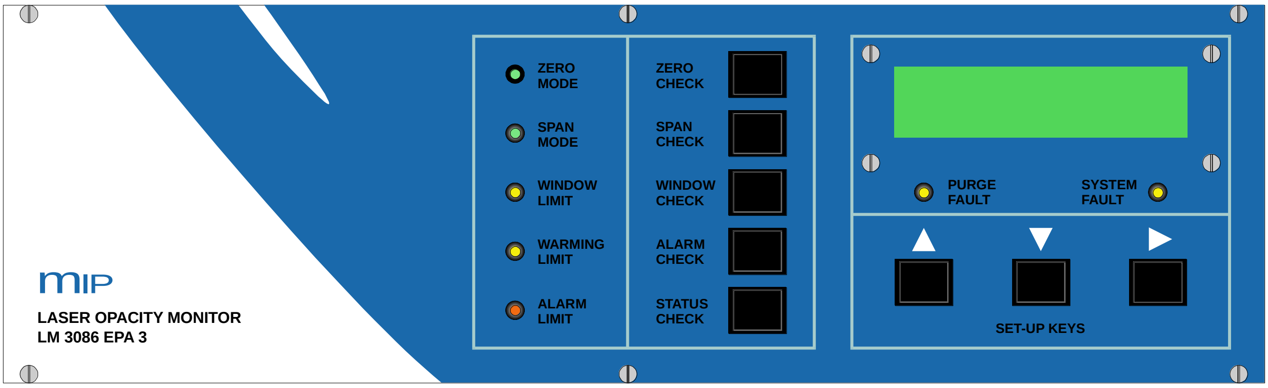
MIP LM 3086 EPA3
MIP LM 3086 SE

Laser Opacity and Dust Monitors



Operation and service manual

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1 MONITOR DESCRIPTION

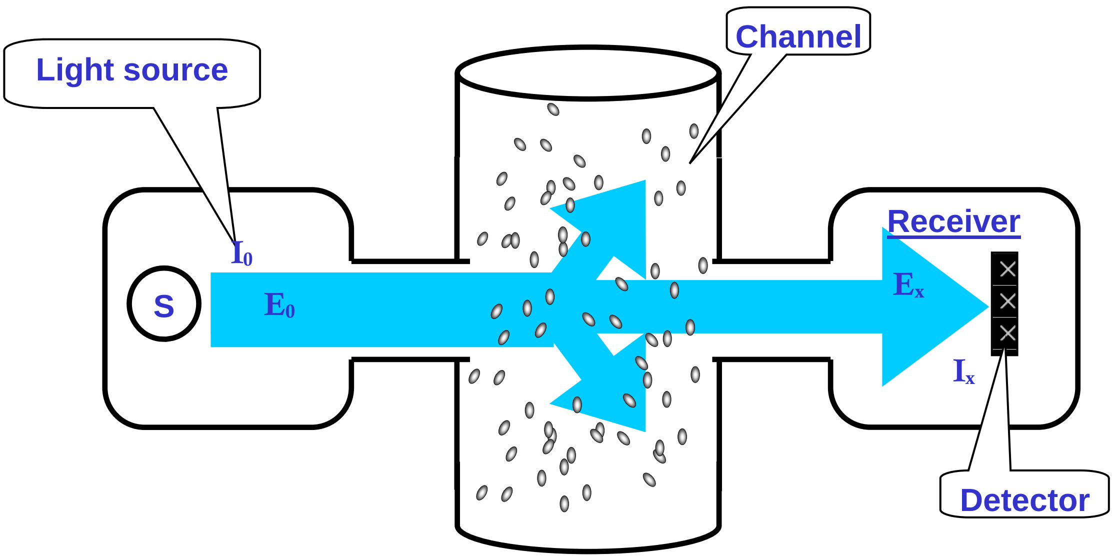
1.1 INTRODUCTION

This manual describes the construction, operation, maintenance and features of the LM 3086 EPA3 and LM 3086 SE laser based opacity and dust monitors. These monitors are similar except the laser light source. EPA3 model uses He-Ne gas laser tubes and SE model uses semiconductor lasers. Further in the manual we use LM 3086 EPA3/SE to describe both models. The use of the laser light source brings many unique advantages that set this monitor apart from the traditional state of the art design. A special effort has been spent to advance the ease of use, maintenance, and conformance testing of the monitor. It should be noted that all sections should be read carefully. Changing one mode of operation can often affect instrument performance and possibly will change other modes to an undesirable state. Be sure you follow all the instructions and understand what you are doing first. If you don’t understand, call for help.

1.1.1 BASIC DEFINITIONS

Opacity is defined as the property of the stack gases to attenuate visible light due to the presence of particulate matter in the effluent. The amount of attenuation depends on the concentration of the light absorbing or scattering particulate, and the length of the instrument path.

The basic definition of opacity requires that an instrument measures light intensity at the source (Io) and the light intensity at the receiver (Ix) after it has passed through the stack effluent. The opacity is expressed as a percent (Op%)



A fully transparent stack gas has opacity of 0%, and a fully opaque gas has opacity of 100%.

Opacity **Op = (1- Ix / Io) x 100 %**

Optical Density: **D = Log10 (Io / Ix)**

The Opacity can be compared with the attenuation of light and shows the percentage of absorbed light. The Opacity measurement is used mostly in the USA and Asia. The advantage of Opacity is that the measuring devices must not be calibrated.

The Extinction (optical density) runs linear to the dust load due to taking the logarithm:

Doubling the dust amount results in the display of the unit doubling. Extinction is used in European countries and increasingly also in Asia. By calibrating the measuring location (not the measuring device) according to VDI 2066 or EPA CFR 40 Part 60 #5, an exact display of the dust load in mg/m³ is achieved. The site depending extinction coefficient k is defined by gravimetric comparative measurements. According to the smallest quadratic error from at least 15 single measurements, the calibration curve is calculated for the measuring location.

1.1.2 SINGLE PASS VS. DOUBLE PASS

Mann international regulations require a simulated zero and upscale calibration system to be included in the monitor. This makes it necessary to modify the basic single-pass design. Most double-pass opacity and dust monitors use a retro-reflector on the receiver side of the stack to reflect the light beam back to the transceiver. In this case, the light source has passed through the stack effluent twice. An extra mirror is used to simulate zero by inserting a mirror directly in front of the light source. This mirror swings down only when in use, and swings away from the effluent when not in use. The mirror does have a potential for dirt accumulation, which will in turn skew the true zero calibration.

The new laser technology of the LM3086 EPA3/SE relies on a single pass, dual path design. The single pass refers to single crossing of the laser light across the stack through the effluent. The double path refers to the second split laser light travelling through an independent fibre optic line (zero pipe) that passes around the stack to the receiver. The second path is only possible since laser light sources possess monochromatic light (one light wavelength) and highly collimated beams. This in turn allows a better more improved method of auditing the opacity and dust monitor, since a zero reference value is constantly evaluated through the independent light path through the fibre optic (zero pipe). The fibre optic or zero pipe has nothing to do with fibre optic modem links used in stack to controller communications.

The following advantages are realized when using a single pass design as opposed to a double pass design:

1.1.2.1 Better Linearity

The detector in a double-pass design actually receives light through two processes:

1. Light that is returned from the receiver, or the retro-reflector in the case of a double pass system. This light is attenuated by the stack particulate. The higher the concentration, the lower the intensity of the light received.
2. Back scattered light from the stack particulate, which increases the opacity reading.

As the detected light intensity on a double pass system is the sum of the two passes of the light across the stack, it is clear that the back-scattered light component will adversely influence linearity. All though this effect is not severe in the low range, it may be significant in the higher end of the instrument range.

In contrast, the LM3086 EPA3/SE single pass laser design is free from back- scattered light.

1.1.3 CHARACTERISTICS OF THE LIGHT SOURCE

The physical processes that influence an opacity and optical density reading depend on two things: properties of the particulate (concentration, size distribution, light absorption characteristics) and the wavelength distribution of the light source.

Any change in the particulate distribution will cause a change in the readings. However, any change in the source wavelength will also cause a false readings unrelated to a change in emissions.

The laser source is a monochromatic light source radiating only one well- defined wavelength. In fact, laser wavelengths are universally held constant to the extent that they are used to calibrate spectrophotometers, which are used to analyze non-laser light sources.

Using non-laser light sources, the wavelength distribution changes with time. This problem is made even more severe for the following reasons.

As the intensity of a non-laser light source diminishes over time, the amplitude or intensity can be increased. The wavelength distribution however cannot be changed, as it invariably does over time.

With a monochromatic light source like the laser, the intensity does degrade, but is compensated for electronically. The wavelength however does not fluctuate with intensity drops.

1.1.4 CHARACTERISTICS OF THE BEAM GEOMETRY

In order to minimize the effects of stray or scattered light sources the opacity and dust monitor should have a spatial response that is very directional, i.e. contained in the smallest possible space through the monitoring path.

The geometrical response of the opacity volume is the volume of space that is bound by the angle of view and the angle of projection. This is simple terms, refers to the opacity sampling cross section. Particulate within this volume only will contribute to the opacity reading. In most non-laser opacity and dust monitors with well-designed collimation optics, the angles are in the order of 2º to 4º.

The laser light source has an extremely well collimated beam. The angle of projection is expressed as the divergence of the beam. In the laser opacity unit, the divergence is 0.04º. This extremely high level of collimation also defines the total spatial response of the laser opacity and dust monitor (virtually independently of the angle of view) making the alignment very easy and allowing for very long monitoring path lengths. This makes the laser opacity and dust monitor not path length dependent.

1.1.5 CHARACTERISTICS OF THE LIGHT RECEIVER

Using non-laser light sources, the diameter of the light beam at the receiver is larger than the active area of the detector. This is called an overfill system.

The laser beam in a laser opacity and dust monitor is fairly small even over extended distances. The initial beam size is about 1 mm, growing approximately 0.8 mm for each meter of the monitoring path-length. Consequently, the beam diameter is about 5 mm at 5 meters' distance and 9 mm when 10 meters apart from the light source. The beam fits well within the 100 mm active area of the detector, allowing for small alignment changes due to vibration or heat fluctuations. As the detector now contains all of the laser beam within its active detector surface, this unique system is called the under-fill system leading to two immediate improvements from the overfill systems in non-laser opacity and dust monitors.

1. The clear path response (zero) of the under-fill system is independent of the path-length as the total laser beam is confined inside the detector at any distance. In the overfill system, the amount of light intensity decreases as the path-length grows. This means that the over-fill system must be zeroed for each application and may require different hardware for different distances. The laser under-fill system does not have an application dependent zero state and is portable to other applications with different path-lengths.
2. The response of the under-fill system is more uniform and more tolerant to cross stack alignment. Small changes in the alignment due to temperature variations or vibrations are normally unavoidable in stack emissions monitoring. With the under-fill system, any small deviations in cross-stack alignment are not as critical as in the overfill system. In the under-fill system, alignment changes are controlled by the size of the laser beam, and the oversized detector. As the laser beam moves due to alignment shifts, the large detector having a large active surface, contains the laser beam within its detector area. The detector is manufactured using a time-proven semiconductor process guaranteeing uniform sensitivity across the entire surface (< 1 % deviation). No non-laser-based opacity and dust monitor can make this guarantee. Of course, drastic shifts in alignment will affect monitoring reliability when the laser beam shifts outside the detector area. High vibrations and temperature shifts should be controlled as best as possible since they will affect the accuracy of the reading, and the life-span of the monitor. All of these factors make the under-fill system superior to the overfill system.

1.1.6 MAINTENANCE AND AUDIT PROCEDURE ADVANTAGES

Note: All screws and hex bolts are metric except for the laser 90ºdeflector hold-down bolts (4-40 UNC; 3/32”).

The big advantage of using the laser is that a minimum amount of optics, are needed in a normal monitoring path. Because of the excellent collimation characteristic of the laser light sources, no collimation lenses are used. In addition, since a dual-path exists using the zero pipes no retro-reflectors are needed. In fact, after the small 90º turning mirror on the laser tube, there are no optical surfaces in the measurement path until the laser beam reaches the receiver lens.

In the laser-based opacity and dust monitor, the only optical surfaces that are likely to accumulate dust are those in the receiver. This includes the receiver lens, the zero pipe lens, and the two sides of the zero pipe mirror. Opening can clean all three of which, the swing hinge held by four hex bolts (5 mm) on the receiver side. The zero pipe mirror can be loosened with a 1.5 mm hex key. This amount of contamination is constantly measured and compensated for during the zero cycle. Very rarely, the detector surface may need cleaned. Before opening the hasp side exposing the detector, put the transmitter in audit mode. Sometimes excessive light on the detector may overload the detector, causing the software to inaccurately report opacity readings. DO NOT use any solvents to clean the detector, it will be damaged. Since the detector is isolated from stack gases, it is rather unlikely that this will need to be cleaned, however, it should be checked periodically. There is no need to remove the laser, transmitter, or the receiver for cleaning. There exists one other optical surface, which should only be cleaned if a calibration problem occurs. Inside the optical block (see drawings at end of this manual), there is a chopper mirror. While a blower protects this chopper mirror, it is possible to get some dirt on the mirror. See the troubleshooting for help in diagnosing calibration problems, and the appendices for cleaning procedures and guidelines.

1.1.7 SUMMARY OF LASER BASED OPACITY BENEFITS

The same ease of use extends to audit procedures. To conduct an audit, there is no need to remove either component of the monitor, nor use any audit jigs. The zero pipe serves as an effluent-free audit path. Audit procedures will be discussed later.

The following is a brief summary of the benefits of using a laser-based opacity and dust monitor instead of a non-laser opacity and dust monitor.

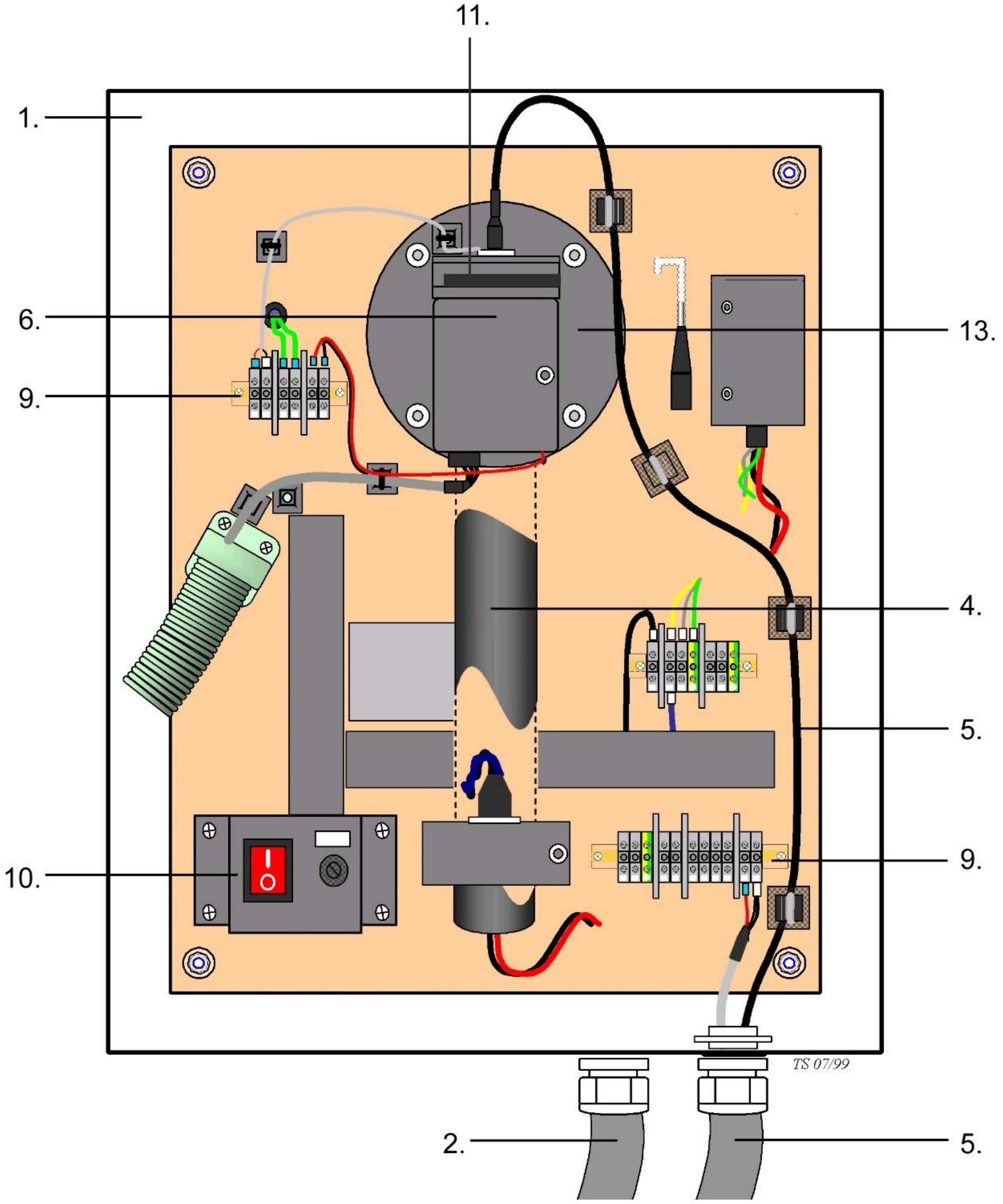
Technical Features	Laser Opacity Improvements
Dual path, single pass design with optical fibre (zero pipe) reference path	Better Linearity over whole range No audit jig required
Laser Source and Beam Quality	Ultimate in wavelength stability 100 % better beam collimation Easier to align Long path-lengths possible
Under-Fill System	Zero is independent of path-length More uniform response to alignment changes from heat and vibration due to large homogenous detector
Maintenance and other Features	Minimum optics means less window dirt

1.2 MONITOR PARTS DESCRIPTION

The LM3086EPA SE monitor consists of three components:

1. Laser (Transmitter) Unit L3086EPA3 (includes laser)
2. Receiver Unit R3086EPA3 (includes conduit with zero pipe and signal wire)
3. Controller Unit M3086EPA3 (includes serial connections)

1.2.1 LASER UNIT LM3086 EPA3

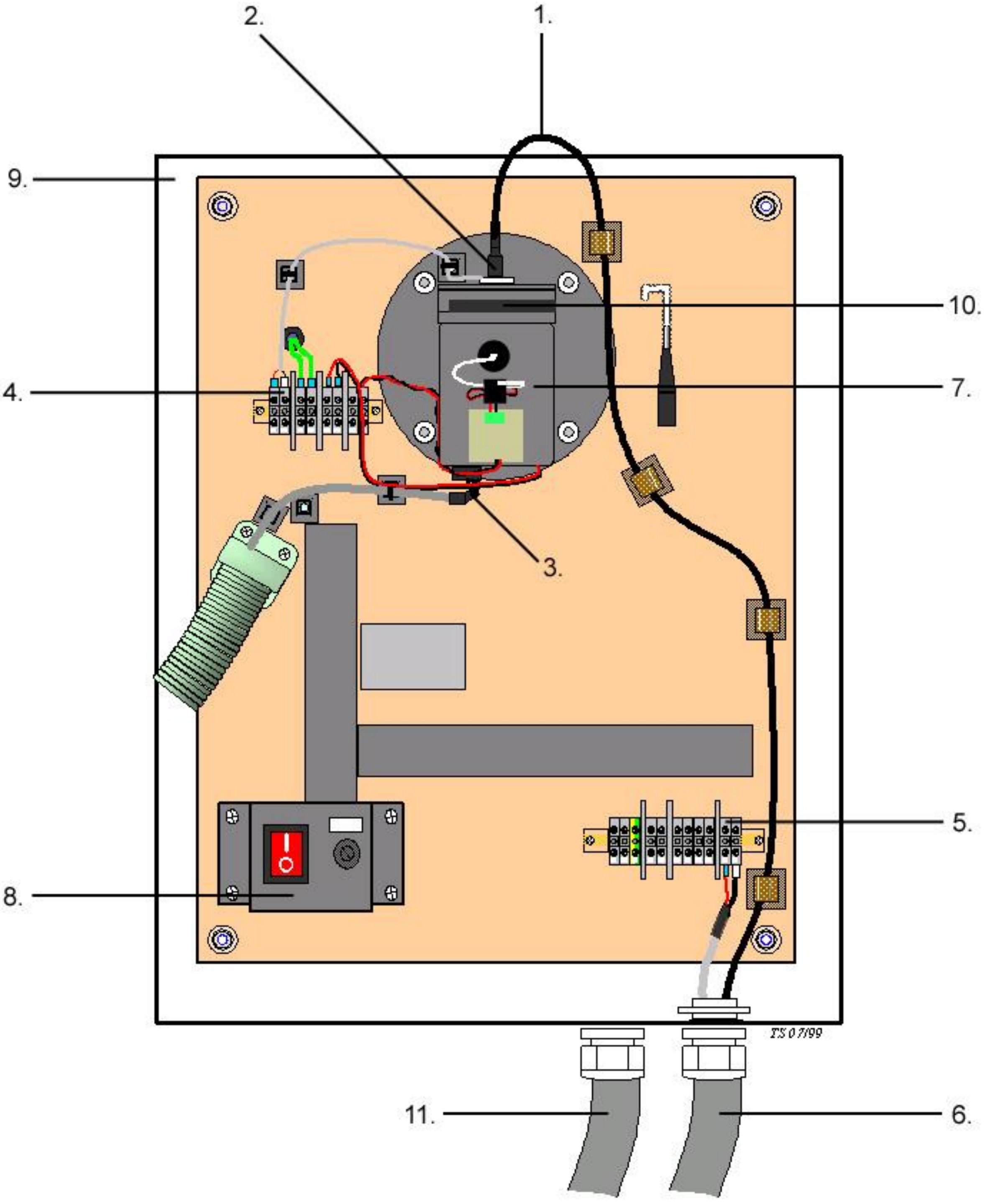


The laser unit consists of the following parts:

1. A hinged fibre-glass NEMA 12 X rated enclosure attached to a hinged, standard 4" ANSI 150 # flange.
2. ½ inch penetration for instrument air connection.
3. System components are assembled for ease of service and access.
4. Green, low power semiconductor laser and associated power supply. Laser is mounted on the front optical block.

5. Fibre optic (zero pipe) for zero reference between transmitter and receiver units.
6. Optical block containing a chopper (sometimes called Dopper) motor with a four-sided mirror. Mirror includes an upscale filter, and three deflecting mirrors to divert light source to the zero pipe, and to the reference detector.
7. Processor circuit board for controlling the optical block and calculating opacity values. All on-stack calculated opacity values are sent through the serial link (RS 422 for serial cable, RS 232 if using a fibre optic modem) in digital form, eliminating current losses.
8. Power circuit board with status lights, supplying regulated voltages to the processor board and the chopper motor.
9. Terminal blocks for wire connections
10. Local power switch
11. Audit filter slot for use while conducting audit procedures.
12. An optional fibre optic modem for communication between the controller and transmitter units.
13. Stainless steel fail-safe shutter assembly. Closes on loss of purge air and indicates a purge fault on the controller.

1.2.2 LASER UNIT LM3086 SE



The laser unit consists of the following parts:

1. Fibre optic (zero pipe) for zero reference between transmitter and receiver units

2. Reference Detector.
3. Cable Link to Processor Board
4. Power circuit board with status lights, supplying regulated voltages to the processor board and the chopper motor
5. Processor circuit board for controlling the optical block and calculating opacity values. All on-stack calculated opacity values are sent through the serial link (RS 422 for serial cable, RS 232 if using a fibre optic modem) in digital form, eliminating current losses.
6. Complete Zero Pipe: Protective tube “Anaconda” with Fiber and Cable.
7. Optical block containing a chopper (sometimes called Dopper) motor with a four-sided mirror. Mirror includes an upscale filter, and three deflecting mirrors to divert light source to the zero pipe, and to the reference detector.
8. Local power switch.
9. A hinged fibre-glass NEMA 12 X rated enclosure attached to a hinged, standard 4" ANSI 150 # flange.
10. Audit filter slot for use while conducting audit procedures.
11. A G11/4” to 38mm(ID) connection for purge air (G11/4” to 19mm(ID) optional).

An optional hand-held unit is available for servicing, trouble shooting, and auditing the unit more easily, allowing for easier service without watching the main controller unit. One person if necessary can do Service and audits.

Refer to the appendix of this manual for the location of the different components of the laser unit including terminal block connections.

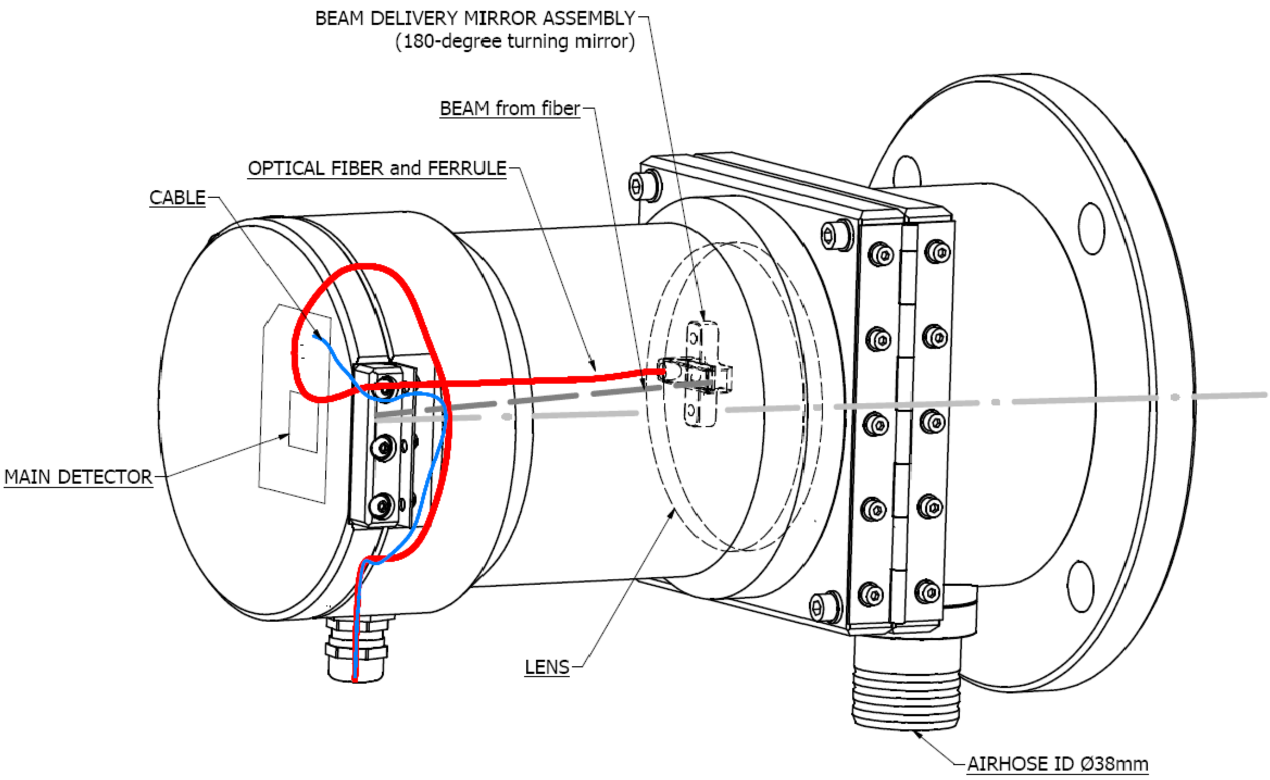
The laser unit L3086 has three modes of operation:

Normal Mode – The laser beam passes through the stack effluent to the main detector located in the receiver. The main detector signal is returned to the stack processor board, and compared to the reference detector signal. The opacity measurement is synchronized to the rotation of the chopper wheel to reject any stray non-laser light.

Simulated Zero Mode – (Zero and Dirty Window check) the laser beam is constantly deflected through the effluent-free zero pipe checking for dirt contamination on any of the three optical surfaces on the receiver unit.

Calibration Mode – (Span Check) the upscale filter located on one side of the chopper mirror is included in the zero measurement loop. The value of the filter is measured and the corresponding value is stored in memory.

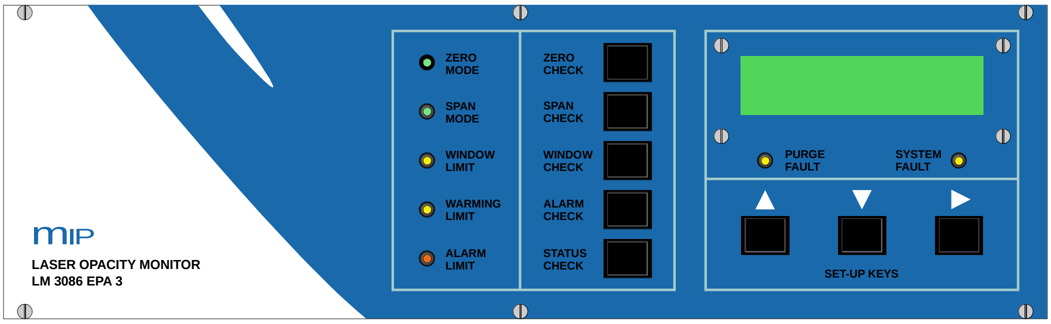
1.2.3 RECEIVER UNIT R 3086EPA3/SE



The receiver consists of the following:

1. A hinged anodized aluminium water tight enclosure attached to a hinged standard 4 inch ANSI 150 # flange. Bolthole patterns are included in the drawings section.
2. A G1 ¼" (38mm ID) connection for purge air. Optional G1 ¼" (19mm ID) connection available.
3. Large area lens accessible from the hinged, square flange of the receiver. The main detector is accessible from the hasp side of the receiver.
4. A zero pipe ferrule holder with a beam deflector mirror to orient the laser beam to the main detector.
5. A connector for signal connections to the transmitter.
6. A large 100mm focusing lens to capture the laser beam and direct it onto the main detector.

1.2.4 CONTROLLER UNIT M3086EPA3/SE



The controller unit contains all the electronics necessary to calculate opacity corrections (window compensation and stack exit correction {also known as stack taper ratio}) and averaged opacity values. The controller performs alarm limits and operation checks, memory functions and helpful special operations as well. The controller also provides a series of terminal connections to monitor system status via a DCS or process control panel.

The controller is housed in a standard 19-inch rack mountable frame. Power to the controller unit is supplied by an standard power plug, provided with the unit. The controller also has an incorporated serial link for communications with the transmitter. Serial cable lengths should be kept below 600 m lengths. If this is not possible, the optional fibre optic modem can operate at a maximum of 3000-meter distances. Local MIP dealer must install the optional fibre optic modem on request.

1.3 SYSTEM INTERCONNECTIONS

For the electrical and optical connections between different components, see the drawings section (number 6) of this manual.

1.4 MONITOR SPECIFICATIONS

The following specifications of the LM 3086 EPA3/SE monitor describe its technical features and performance specifications. It should be understood that the installation environment will ultimately affect the performance of the complete instrument.

1.4.1 LASER (TRANSMITTER) UNIT SPECIFICATION

	EPA3	RedEPA3	SE
Wavelength	543 nm	632.8nm	655nm
Laser output power	0.8 – 1.8mW	1 – 5mW	0.5 – 1.5mW
Beam diameter	0.75 mm	0.6 mm	2.5 mm
Beam Divergence (AOP)	4 mrad	1.4 mrad	0.4 mrad

Warm-up Time:	1 hour
Operating Temperature:	-28°C to 68°C /-18°F to 154°F
Operating Humidity:	0 – 90 % RH
Mounting Flanges:	4 inch 150 # ANSI flange
Power Supply:	115 or 230 VAC 40 VA
Angular Response:	< 0.06°
Background Sensitivity:	<0.2 % Opacity
Back Scatter Opacity Contribution:	<0.2 % Opacity
Calibration Error:	<0.5 % Opacity
Purge Flow:	See appendix for requirements

1.4.2 RECEIVER UNIT SPECIFIC SPECIFICATIONS

Detector	Optically matched silicon detector 20mm in diameter with a large 100 mm focusing lens
Angle of View:	< 2.0°
Operating Temperature:	-28°C to 68°C /-18°F to 154°F
Operating Humidity:	0 – 90 % RH
Mounting Flanges:	4 inch, 150 # ANSI, see drawings for bolt hole patterns.
Purge Flow:	See appendix for requirements

1.4.3 CONTROLLER UNIT SPECIFICATIONS

Operating Range:	0 – 99.9 % opacity.
Span Range	10 % - 99 % with 1 % increments.
Automatic Calibration Sequence	1 – 99 hours with 1 hour increments
Timing Options:	Hourly/or by minutes based on internal clock or internal clock time or externally by a contact closure.
Zero/Span Cycle Time	1 – 99 seconds with 1 second increments,
Opacity Averaging:	1 – 99 minutes with 1 minute increments. (EPA requires 6 minute block averages).
Stack Exit Correction (SEC):	0.20 – 2.50 with 0.01 increments.
(Stack Taper Ratio)	(Password protected)
Operating Humidity:	0 – 90 % RH

1.4.4 CONTROLLER RESOLUTION

Opacity:	0.1 %Opacity
Optical Density:	0.001 OD
Particulate Concentration:	0.001 grains/ft 3 or 1 mg/m3

1.4.5 POWER REQUIREMENTS

Laser (Transmitter) Unit:	115 or 230 VAC, 40 VA
Control Unit:	100…250 VAC, 15 VA
Optional Blowers:	3~400VAC, 1000 VA or 2* 230VAC, 600VA

1.4.6 OPERATION ENVIRONMENT

Laser/Transmitter Ambient Temperature Limits:	- 29°C to 49°C/-20°F to 120°F

2 MONITOR DISPLAYS AND CONTROLS

2.1 LASER UNIT CONTROLS

All controls of the laser unit are located inside the enclosure. The controls consist of four simple items:

- A power switch
- A fuse for protecting the electronics
- Shutter gate position selector
- Push button audit switch

2.1.1 RECEIVER UNIT CONTROLS

There are no electrical controls in the receiver unit.

2.1.2 CONTROLLER UNIT DISPLAYS AND CONTROLS

The D/A converter inside the controller can be adjusted to accommodate signal loss due to wire lengths and impedance of PLC units, or DCS devices. There are four potentiometers inside the controller, none with labels. They sit on the main board where the E-Prom fits, all lined up, with the adjustment screw on top. The screws are painted shut since they are calibrated at the factory. Since it is impossible to set each pot to the customer's system they may need to be adjusted if the LCD display does not agree with the data collection device.

See the appendices for a complete procedure on how to adjust the analogue outputs. On the controller, there are three features of the controller. The first is the two-line alphanumeric display, which displays the opacity readings, averages, text for mode selections, and fault descriptions. The second component is the push buttons. Each push button, and some combinations of the push buttons activate certain menus and functions. The details of each push button and their functions will be described in detail later. Thirdly, there are a series of trouble lights, the functions of which are explained by either the printing on the controller plate, or their physical association with certain push buttons.

2.1.3 AUTOMATIC SHUTTER GATE

The automatic shutter gate closes upon loss of purge air (< 1 mig), therefore protecting all internal components of the transmitter enclosure from flue gases. The shutter gate will also close if the door is opened. If the shutter does not close when the door is opened, check the position of the shutter gate selector. Severe damage may occur when exposing the monitor to flue gases. The shutter gate can be kept open manually for inspection and service by moving the shutter gate selector to the "open" position. Do not keep the shutter in the manually open position without the purge air diverted to the stack when the monitor is exposed to flue gas. If the shutter closes due to a loss of purge air two things will happen. The controller will receive a purge fail alarm, and the opacity reading will spike to 99.9 %. The transmitter is included with a ½ inch hole to receive A fitting for customer supplied purge air. If the blower option is purchased, a bulkhead will install at the factory

2.2 MONITOR MODES OF OPERATION

Modes are presented in the following order:

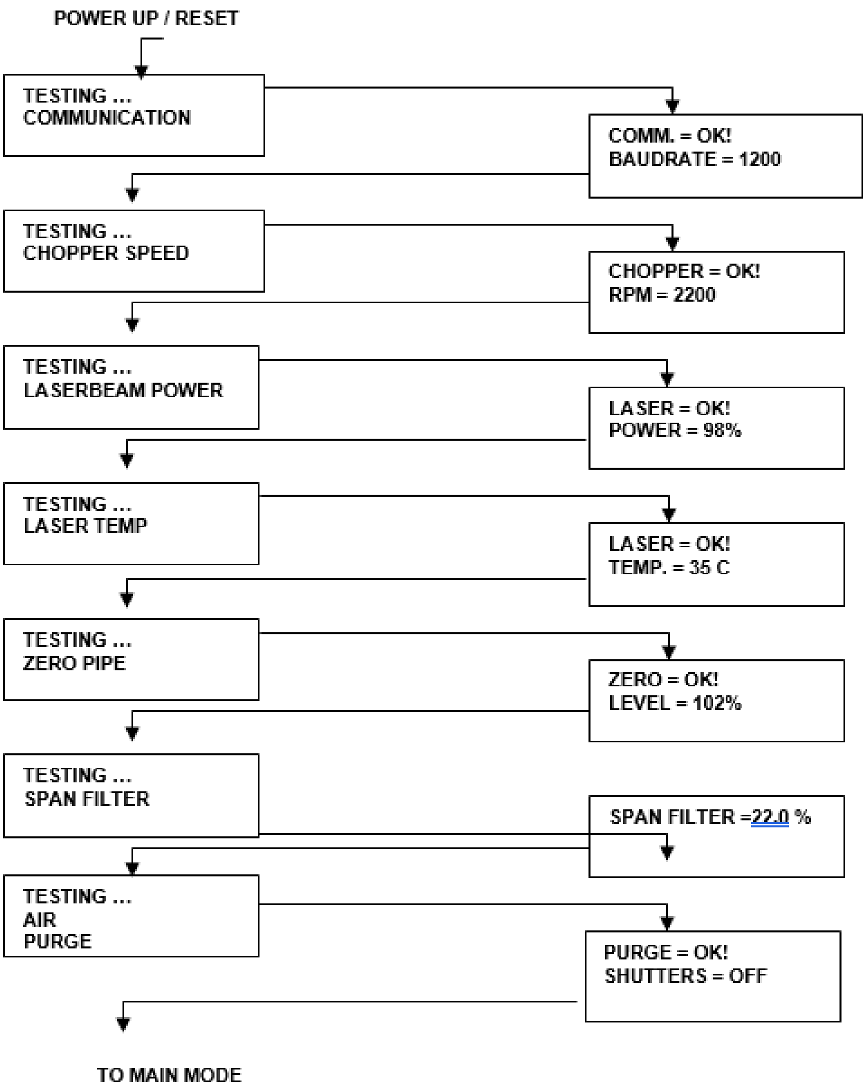
1. The diagnostic and operational modes are presented in the order in which they appear.
2. The manual modes, which are likely to be operated occasionally.
3. The set-up modes, which are used to configure the system to meet the customer's needs.
4. The service modes in order of occurrence for use by specialized personnel.

For each mode, all the entry and exit conditions as well as its influence on the monitors operation are explained. Most mode operations are explained by the display.

2.2.1 CONTROLLER DIAGNOSTIC MODES

This mode is entered every time the controller powers up, or when a controller reset is performed by pushing the up, down, and next buttons simultaneously for > 5 seconds.

The diagnostic mode begins by displaying text first for about 3 seconds. At the same time, all indicator lights are turned on; relay outputs close (or open depending on relay logic), and the analogue out channels will show 4mA for about 1 second, and 20 mA for 1 second. The current loop test can be reproduced and adjusted from the hardware test mode described later. After these tests, the unit will run through the following self-diagnostic procedure checking various modes.



**Diagnostics flow as presented by tests and LCD-displays*

**Answerback displays to the tests If a test fails then "OK!"-string is replaced by "FAIL".*

All the tests happen fully automatically without user interference. To repeat a test keep Up-key pressed, while the test is active. To skip the remaining tests, push Down-arrow

2.2.2 RUN-TIME DIAGNOSTICS

During normal monitor operation, the system is checked automatically at regular intervals. The following checks are continually performed to ensure valid data:

- Controller Power Level
- Stack Power Level
- Purge Shutter Status
- Laser or Chopper Failure
- Laser Power Level
- Laser Temperature
- Zero Pipe Power Level
- Calibration Validity
- Chopper Motor Speed
- Reference Anomaly
- Reference Detector Level
- Ambient Light Alarm
- Trax Alarm (for a PC connection to 9-pin connector)

These diagnostics happen approximately every minute. Some of the detected faults are more serious than others, and will automatically terminate monitor operation. Others will issue a warning to the user.

All alarms will be indicated by the system fault light, and can be viewed by pushing the status check button.

Fatal errors include the following:

System Power Level: If the power is off, there will be no display at the controller unit.

Stack Power Level: If the power to the monitor unit is off, or the serial link is broken, there will be no data flow to the controller unit. The controller will stop and display “Stack Power Down”. Once the data link or power is restored, the alarm will disappear.

Laser or Chopper Failure: Whenever detected, the controller will stop calculations and issue ”Laser/Chopper Fail” until the error is corrected. This will occur due to either a misalignment in the optical path, or a failure of any of the optical components.

Reference Anomaly: The system monitors both current and long-term reference values at all times. If the current reference value is > 10 % different from the long-term value due to dirt, fogging, or a failure of the reference detector the “Reference Anomaly” alarm will appear.

The other faults are warning type, not resulting in a fatal error and can be viewed the same way as described above.

2.2.3 MAIN MONITORING MODE

This mode is always entered automatically after completion of the diagnostic mode, calibration mode or via a time-out from other modes. It can also be entered (before the time-out) via pushing buttons from manual, set-up and service modes.

During the main mode, the opacity values, both real-time and averaged are continuously calculated, displayed and outputted through the current loops. All alarms are detected and indicated at this time also.

The upper row in the LCD display presents real-time, and average opacity values, changing once per second for real-time and at the end of the averaging period for the average value. This value is also stored in memory. (Default average is 6 minutes, can be changed) Pushing the down arrow from the main monitoring screen will toggle between block averages for opacity, and running average. The EPA requires 6-minute block averages. There is no direct indication on the screen whether the unit is in block averages or running average mode. The way to differentiate the two is the create a high opacity reading by closing the shutter, spiking the instrument to 99.9 % OP. If the average block increases quickly, the unit is in running average, if the average does not change immediately, the unit is in block average mode.

The default is 6-minute block averages.

The lower display row presents the currently selected instrument range (can be changed) and one of three options. The first option is a bar graph display showing real-time opacity values. The second is optical density, and the third is mass emissions. Mass emissions readings must be configured before getting an accurate value. See paragraph 2.2.5.18 for details on setting the mass coefficient.

The default setting is the bar graph display.

The following modes will be occasionally activated by the internal chip program based on some user applied settings.

2.2.4 AUTO ZERO MODE

This mode is entered automatically upon initiation of the automatic zero interval.

The zero interval will last for the time period set-up in the service mode (default 30 seconds). See paragraph 2.2.5.10 for details. This is not the same function as pushing the manual zero button on the unit, it is activated internally by the chip program according to the set calibration interval. Manual calibrations are described in paragraph 2.2.5.

During the zero cycle, the zero value is checked via the zero pipe optical fibre path, and the resulting value is compared to the stored zero value from the previous zero calibration cycle. The computed result is shown on the display and outputted to both current loops. At the end of the zero cycle, the opacity reading that represents the shift in the zero level is stored in memory for future reference. At the same time the window compensation value that represents the cumulative sum of all zero shifts is updated and stored as well. The zero mode indicator LED will illuminate and the corresponding relay will close or open during this cycle dependent on the relay logic set up (default N/O).

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2.2.5 AUTO SPAN MODE

The auto span mode is nearly identical to the auto zero mode except that the span filter on the chopper mirror is checked in the reference path. The display and the output signals reflect the value of the calibration filter. Both span and zero mode always go back to the main monitoring mode after completing the calibration cycle.

Manual mode / Functions:

Some buttons may have special functions, if so their special function will be described in the sections where applicable.

Note: Pushing the manual check buttons causes a relay closure. Customers using a DCS with a calibration triggered by a relay closure should see the service mode in paragraph 2.2.7.4. This will disable the relay closure during manual checks but will still allow it to function during auto-calibration.

The monitor unit may also initiate a window check during the calibration cycle, depending on the setting of the Auto-window mode, described in paragraph 2.2.6.12 and 2.2.6.15.

Set-ups of the following functions are covered in paragraphs 2.2.5.10 and 2.2.5.11.

2.2.5.1 Manual Zero Mode (Zero Check Button)

When the zero check button is pressed from the main display, the simulated zero value is displayed for one minute. This zero value is the current zero state of the unit but is not stored in the calibration history. The historical data displayed consists of the last 32 calibration values of the zero data stored during the complete automatic calibration cycle.

2.2.5.2 Manual Calibration Mode (Span Check Button)

This mode is the same as the manual zero mode except automatic span values are stored for the last 32 calibration cycles.

2.2.5.3 Manual Window Mode (Window Check Button)

The present window dirt and the previous 32 historical window dirt values for each calibration cycle are viewed and stored here. If the auto-window feature is off, the window will be checked and logged, but will not be displayed, cause a relay closure, or outputted to the analogue loops during the calibration cycle. The auto-window feature can be referenced in paragraph 2.2.6.15.

2.2.5.4 Warning Limit (Alarm Check Button)

This mode shows he currently set warning, alarm and stack exit correction values (SEC).

2.2.5.5 Alarm Limit (Status Check Button)

The alarm status button shows any current system faults that exist on the monitoring system.

2.2.5.6 Up/Down/Nxt Buttons

These buttons are used to toggle numbers or select answers to mode questions.

2.2.5.7 Set-Up Modes

These modes are entered from the main monitoring mode by pushing the NXT button. The first push of the button will enter to the first mode listed below. Repeated pushes of the NXT button will run through all set-ups and finally back to the main monitoring mode. If desired, pushing the status check button exits at any time. All changed parameters are recorded upon exit. Other buttons will also exit, but the status check button is preferred since it does not close any relays. Since relay closures sometimes signal a calibration in a DCS, the status check button should be used.

Set-up modes let the user configure several modes listed below. There is a visible cursor in the display. The cursor will appear after one push of either the up or down key. The numeric character in the cursor position can be increased or decreased within the allowed range by pushing the up and down keys. The cursor will move to the next character position with the NXT key. After setting up the parameter displayed. pushing NXT will remove the cursor, a second push of the NXT button will exit the featured parameter and move on to the next parameter set up. Most values are set to the current EPA requirements at the factory, or according to the customer's specifications.

All outputs, relays and indicators are frozen during the entry of this mode.

Exiting the mode restores normal operation.

2.2.5.8 Span Set-Up (Instrument Range)

This mode provides the ability to set the instrument measuring range, which effects both the bar graph display and the current outputs. The measuring range should be set to the customers range specified in the permit.

- Span Range (Instrument measuring range) = 10 % to 100% in 1 % increments
- Default Span (Range) = 100 %

2.2.5.9 Averaging Time Set-Up

This mode makes it possible to set up the block averaging time.

- Range = 1-99 minutes in 1 minute increments
- Default = 6 minutes (EPA requirement)

2.2.5.10 Zero/Calibration Interval Set-Up

This mode adjusts the time period between auto calibration cycles. See paragraph 2.2.5 to further explain how the instrument calibrates. This mode only sets the numerical value. The interval display also indicates what mode the time unit is set in.

For example:

Zero Interval Time (CLK) = 08

This would refer to a calibration cycle dependent on the internal clock, occurring daily at 08:00.

- External = Not time configurable
- Minutes = 1-99 minutes, 1 minute increments
- Hours = 1-99 Hours, 1 hour increments
- Clock = 1-24 Hours. 1-hour increments

Number setting reflects time of day to calibrate using internal clock

2.2.5.11 Zero Calibration Cycle Set-Up (Auto calibration Time)

The calibration cycle times can be set up. The time setting applies to both zero and calibration. Setting times to record on a DCS accurately should be considered here. For example, some DCS require a two-minute average.

Range = 1-99 seconds or minutes

Default = 30 seconds

See paragraph 2.2.6.9 referring to Z/C Time base to toggle between seconds and minutes if calibrations longer than 99 seconds are required.

2.2.5.12 Window Alarm Set-Up

This mode allows the user to set up the limit for the window contamination. On the receiver side, the window refers to any optical surface on the receiver side. The optical surfaces consist of the lens, the fibre optic lens, and both sides of the 180° zero pipe beam turning mirror.

Range = 1- 99 %

Default = 4 % (EPA requirement)

2.2.5.13 Warning Limit Set-Up

This is one of the two alarm limits. Two parameters are able to be set: the warning limit level in OP %, and the time frame at that limit which will indicate an alarm. The time setting is variable to allow for spikes in opacity that are only temporary, and are not a true indication of a warning state.

Range = 1-99 %

Default = 15 %

Time Range = 1-99 seconds

The warning alarm gives the operator time to adjust the process or check the opacity and dust monitor for trouble, so that an accidence can be avoided. Typically, the warning limit is set below the alarm limit.

2.2.5.14 Warning Time Set-Up

The warning time set-up allows for the customer to select how much time an opacity reading at the warning limit will trigger and alarm

Default = 5 seconds

2.2.5.15 Alarm Limit Set-Up

This set-up is identical to the warning set up except that the alarm limit is higher. Usually the alarm limit is set to the permit limit set by the state or governing body.

Exceeding the alarm limit may cause a violation of permit conditions.

Range = 1-99 %

Default = 20 %

Time Range = 1-99 seconds

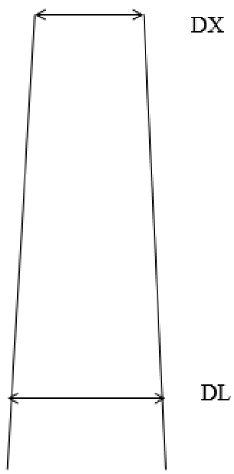
2.2.5.16 Alarm Time Set-Up

The alarm time works the same way as the warning time set-up.

Default = 5 seconds

2.2.5.17 Stack Exit Correction Set-Up (SEC)

Also known as stack taper ratio. This mode allows the user to enable the stack exit correction as defined by EPA regulations. If DL is the inner diameter of the stack at the monitoring location, and DX is the inner diameter of the stack at the top of the stack, the ratio DX/DL becomes the stack exit correction (SEC).



SEC = DX / DL

This feature is password protected. See paragraph 2.2.6.3 for the password.

Note: The SEC in a single pass opacity and dust monitor is one half the ratio of a double pass monitor.

The SEC ratio will affect the measured opacity at the monitor location OpL and the stack exit location OpX.

The following formula describes how the SEC affects opacity values.

log (1-OPX) = SEC * log (1-OpL)

The controller does this calculation internally after setting the SEC value.

2.2.5.18 *Mass Coefficient (K)*

Offers the user the ability to display opacity measurements as well in mass concentration (value). To see mass value on display, select the correct display mode, see paragraph 2.2.6.8.

The mass concentration calculation needs K (mass coefficient). System has default setup K=800. To show correct m (mass concentration), change K (mass coefficient) in monitor unit either to calculated or evaluated (based on mass gravimetric sampling) value. In dust monitor replace default K value with new K value.

a) Evaluated K value:

$$\frac{current\ K\ value}{new\ K\ value} = \frac{\frac{mg}{m3}\, from\ dust\ monitor\ display}{\frac{mg}{m3}\, from\ mass\ gravimetric\ sampling}$$

b) Calculated K value:

m (mass concentration) is calculated all the time by monitor unit based on the following formula:

$$m = K \times D$$

m = mass concentration in mg/m3
K = calculated coefficient set by the user (see below)
D = optical density (system calculates from measured opacity)

Note: K is one-point calibration value for mass concentration (second point is 0.0). Default value for K is 800 and optical density is variable which is calculated from measured opacity. In practise this might not be very accurate.

To calculate the K (mass coefficient) use the following formula:

$$K = \frac{800 \times P \times d}{L}$$

P = Specific gravity of particulate matter in kg/dm3 or tn/m3 (f.ex. water = 1.0)
d = Average diameter of particulate in micrometers
L = Path length in meters, usually inner stack diameter

The factory default, 800 assumes the following:

- 1.0 µm particle diameter (average)
- 1.0 meter path length
- 1.0 kg/dm3 specific gravity of particulate matter

The factory default will not give accurate mass values.

By calibrating the measuring location (not the measuring device) according to VDI 2066 or EPA CFR 40 Part 60 #5, an exact display of the dust load in mg/m³ is achieved. The site depending extinction coefficient K is defined by gravimetric comparative measurements (EN 13284 part 1). According to the smallest quadratic error from at least 15 single measurements, the calibration curve is calculated for the measuring location.

Gravimetric sampling can be used for calculating K (mass coefficient):

$$K = \frac{m}{D}$$

m = mass concentration in mg/m3 from mass gravimetric sampling result
K = calculated coefficient
D = optical density (recorded during mass gravimetric sampling)

2.2.5.19 Date/Time Set-Up

This mode enables the user to program the proper date and time of day. The date is given in YY/MM/DD format. Time is in the 24-hour format.

2.2.6 SERVICE MODES

The following modes detail the menus available by answering Yes to the 'Service Mode Y/N' prompt.

All opacity outputs, relays and indicators are frozen during this mode.

The service mode is entered by simultaneously pushing the up and down arrow for > 3 seconds. Use caution when pushing the up and down buttons. A momentary blink of the display changes the unit from 6-minute block averages to running averages. The blink will not be too obvious. If this occurs, push the down button again.

These modes enable the user to perform special tasks to access service values and sub-modes that are configurable to the users desires or needs. Each sub-mode is prefaced by a yes/no question; the up arrow selects yes the down arrow no. Upon completing the mode changes, the next key exits the sub-mode; the status button escapes the service mode. Special key- strokes are outlined in each mode description.

2.2.6.1 Service Mode Diagnostics (Yes to service mode)

When this mode is accepted by the up arrow or yes, the stack unit will transmit the measured monitor and reference channel in millivolts rather than a processed opacity reading. It should be noted that the millivolt readings are not the same values read directly off the detector pins. They are amplified millivolt values.

Readings will vary according to stack opacity, laser power, and fibre power. To exit service mode yes or hardware test, at any time push the status check button.

These following letters and their corresponding numbers are displayed during the first screen:

M = 9800 +- 100 Optimum level on a 100 % laser across a clear stack. Indicates the millivolt reading of the light reaching the measure (receiver) detector.

R = 9800 +- 100 Optimum level on a 100 % laser. Indicates millivolt reading of the light reaching the reference (transmitter) detector.

Z = 3000-5000 Readings vary on window dirt and signal loss through fibre in zero pipe. Indicates millivolt reading of the light-reaching passing through the zero pipe.

C = 4500-7500 Millivolt reading of the span factor on upscale filter on the chopper mirror.

By continually pushing the down button, the following readings can be viewed:

Laser Intensity – Usually 1>100 % on a new laser. This value will drop as laser degrades. Below 20 % will indicate a laser failure. This reading can not be adjusted. Adjusting the intensity of a weakened laser will result in erratic opacity readings.

Zero Pipe Intensity – Usually 60-80 % on a 100 % laser. A zero pipe failure will occur if the intensity drops below 20 %, or if the zero pipe is broken.

Chopper Motor Speed – 1800-3000 RPM

Temperature – Shows the temperature of the laser source. Laser tube will shut down at 70 °C and will re-start at 55 °C.

Stack Ambient Light – Amount of light other than laser light hitting the measure detector. A reading over 90 % causes a system fault.

Reference – The reference level is the relationship of current reference levels compared to long-term reference values. Usually 90-100 %. A reference anomaly alarm will occur if deviation out of this range occurs.

Hardware Test – The No response, simply takes you back to the service mode. Answering Yes enters a hardware diagnostic mode. Each mode are displayed until the down button is pushed. The first display indicates that a 20 mA (full scale) current is being applied to the analogue out channels (pins 11,12 and 13,14). Pushing down moves to a 4mA (zero scale) current to the analogue out channels. Analogue outs can be adjusted if a current drop occurs due to impedance in the signal wire. See the appendix for a document on adjusting current loops.

The fourth push of the down button closes (or opens depending on relay logic) all the relays and lights all the indicator lamps. All digital out pins indicated by the drawings in this manual can be checked at this point for continuity.

This concludes the section on the service mode/yes functions.

The following modes detail the menus available by answering No to the 'Service Mode Y/N' prompt.

Note: Answering yes to any service/no sub-mode enters the mode set-up, next moves to the next mode option.

2.2.6.2 This is Zero Mode

Before performing any of these functions, the user must assure that all of the optical surfaces are clean. That includes the lens, the fibre lens and the zero pipe turning mirror. The chopper mirror should be checked, but it is unlikely that it will have any dirt on it. Be sure to disable the chopper motor by pulling a wire to the chopper motor first. The spinning mirror will cause bodily harm if touched when spinning, not to mention that the mirror could be damaged. You can disconnect the chopper motor while the monitor is powered up, the power supply is 8 VDC low current.

There are three possibilities after answering yes to the 'This is Zero' mode. The next screen after yes to this is zero asks for a password. Passwords are used for protecting special functions that will seriously affect the operation of the opacity and dust monitor and should only be used by trained personnel or under the advice of a MIP technician. Passwords are listed in paragraph 2.2.6.3.

The following modes can only be entered with the appropriate password.

All modes use the same keystrokes as the Set-Up modes (up, down, nxt).

This is Zero - The opacity and dust monitor will perform a new zero set point when a clear stack is done. A clear stack can be either on a stack that has no effluent, or a simulated clear stack by mounting the receiver directly in front of the transmitter. It is the users responsibility to assure that a clear stack exists. Failure to do so will result in an inaccurate opacity reading. This section is just to provide and overview of the feature. See the appendix on 'Clear Stack Procedure' for complete details.

Dirty Stack Zero – After the password is entered, you will be prompted to answer yes/no to dirty stack zero? If yes is pushed, the opacity and dust monitor will perform a new zero set when flue dust is present in the stack. This is achieved by using the zero pipe, which is an independent zero path length. No simply exits.

New Span – The span value of the instrument can be change if needed. Simply enter the appropriate password and enter the desired span value, using the same keys as the Set-Up Modes.

When to Use This is Zero – There are two different conditions when a This is Zero is required. The first situation is when the monitoring system is initially built, or when re-installed in a new monitoring location.

Second, when a laser or chopper mirror re-alignment occurs, or when any of the following parts are replaced or adjusted:

- Laser Tube
- Reference or Measure Detector
- Controller E-Prom
- Controller Processor board
- Stack Board
- Stack E-prom
- Zero Pipe or Zero Pipe mirror
- Chopper Mirror

This is zero is required for any part replacement that involves the optical path length, or electronics used in the calculation of opacity. The only other exceptions are the two boards that supply and regulate power. The reason this is so critical, is that the controller unit stores a constant in memory that is a function of all of the optical surfaces. If one of the optical surfaces changes, the alignment and manufacturing imperfections will deflect the light at a different angle.

2.2.6.3 Password Protection

There are four functions that are password protected to limit non-qualified personnel from changing any of the sensitive parameters in the monitor. It is very critical to understand the application of each function before entering the password and changing the set-up parameters. The numbers of the passwords correspond to the keys on the front of the monitor unit. Numbering is as follows:

Button Number		**Passwords:**	
Zero Mode	= 1	This is Zero	= 3723
Span	= 2	Dirty Stack Zero	= 1111
Window	= 3	Span Filter	= 2222
Alarm	= 4	SEC	= 3723
Status	= 5		
Up	= 6		
Down	= 7		
Nxt	= 8		

2.2.6.4 PC-Download Mode

This mode gives the operator a means to save internal data in the controller to an external computer via the 9-pin RS 232 pin. The computer should have a program able to receive ASCII files. Hyper-terminal or other terminal emulator programs will work.

Baud rate should be 1200, bits 8, stop bits 1, no parity, no hardware or Xon/Xoff required. The PC interface will only work with version 3.31 controller chip and up.

The internal data banks:

- Averages – Last 128 averages
- Last Zeros – Last 32 zeros
- Last Cal – Last 32 span values
- Last Windows – Last 32 window checks
- Last SEC's – Last 32 Stack Exit Correction values
- Audit – Last audits in sequential order with date/time stamp. A new audit replaces the old data.
- System Log – Date/time of last SEC change, audit, new zero, stack power on, stack power off, monitor on, monitor off, air purge on, air purge off.

To dump data to the computer, push the upper arrow key. The down arrow key will exit to the next mode paragraph 2.2.6.13 describes the data stream and how to select different outputs.

2.2.6.5 Audit Mode

This mode is provided for periodic auditing of the monitor for both regulatory compliance and system checkout. It gives the auditor an opportunity to check the linearity of the instrument by the use of certified audit filters. In the transmitter, there is a slot on the top of the optical block.

To audit the unit, it is preferable to initiate the audit by the use of the blue audit button on the stack. Audits can be started on the ground, but the blue button will need to be used anyway, for repetition of each filter, or when changing the filter or exiting the audit mode. There is a small reminder sheet inside the swing door where the audit button is located on how to perform the procedure.

The one most important rule, which will become clearer as this explanation continues, is steady LED in, steady LED out, steady LED exit.

1. To initiate the audit, open the transmitter door, and then the inside door upon the door.
2. Push and hold the blue audit button for 1 second or so until the LED blinks then stops blinking and stays on.
3. Insert the audit filter all the way into the slot.
    a. See audit filter types in paragraph 8.8 and installation best practises in paragraph 8.9
4. Push the audit button; it will blink while the filter value is being calculated. When the LED is steady, the filter has been read, and is stored in the audit log on the controller. See paragraph 2.2.6.6 to access datalogs – note, filter numbers in the log are from last to first. The log is cleared every time when audit mode is set on. There are 3 memory slots so 3 last audit events can be stored. One log can have max. 30 audit measurements.
5. With the LED steady, remove the filter completely from the slot. The LED will blink 4-5 times, the instrument is now re-zeroing. Wait until the LED is steady to repeat, change filter values or exit audit mode.
6. With the light steady, re-insert the filter for repetition, or next filter value and repeat.
7. When the filter or filters have been checked, remove the filter, wait until the LED is steady on and push the audit button again to exit the audit mode.

Stack exit corrections are applied to the filters by the controller, so no filter corrections are necessary, the filter will read the correct value.

If desired, the audit filter values can be downloaded using the PC Connect feature. The last 32 filter audits will be displayed in reverse order.

If the filter is left in the slot when exiting, or removed during the LED blinking state, the instrument will read improperly when it returns to the normal reading mode. This occurs because the filter will now use the filter value as a zero point. To correct this mistake, perform a dirty stack or a clear stack procedure.

2.2.6.6 Datalogs

This feature allows the user to view the last 32 values of data for either of the two following options:

Audit Logs – Allows the user to view the last 32 values of audit filters evaluated in the last audit session. Remember that every time the audit button is pushed, the memory clears if the previous values are not recorded. The filter values are date stamped.

System Logs – Allows the user to view the last 32 values of system faults.

2.2.6.7 Alarm Logs

Displays the last 32 alarms logged with time stamps, with the exception of the stack power down and purge alarms, which are logged to the Datalog/System log described in previous entry.

2.2.6.8 Display Mode

Allows the user to change the display outputs. Options include the selection of

- mass in milligrains/ft3
- mass in milligrams/m3
- optical density
- average opacity.

Remember that to display the mass value, the coefficient K must be set first as described in paragraph 2.2.5.18. For analogue output settings see paragraph 2.2.6.10.

2.2.6.9 Trigger Mode

This feature is used in conjunction with the Zero Interval feature (which is more accurately called the zero/span cycle).

The unit's current set-up can be viewed by pushing the next button two times from the main monitoring mode. All cycles start upon exit of the trigger mode change.

The following four options are available:

Z/C interval in Setup Hours – The zero interval will be changed to an hourly cycle. Usually set to 24 hours, meaning one calibration every 24 hours. Range is 1-99.

Z/C Interval in Setup Minutes- The zero interval will be changed to minutes. Range is also 1-99. Not a recommended trigger interval unless repeated calibrations are required.

Z/C External – The calibration is initiated by a contact closure on pins # 17 and 18. Good for use with a PLC or when calibrations are to be done by a service technician.

Z/C Clock Time – Calibration is performed on a once a day basis according to the internal clock time. Can only calibrate on even hours. For example, every day at 8 am (08).

After the trigger cycle is set, with the exception of the external trigger, the time, minute, or hourly sequence must be set from the main monitoring mode by pushing the next key until z/c interval appears. The mode will appear like (CLK), (HRS), (MIN), or (EXT) = ##. To change the numerical value, use the procedure described in paragraph 2.2.5.10.

Default value is hourly, 24.

2.2.6.10 Output Mode

This feature designates which analogue output has which measure or calculated value assigned to it. The outputs are 4-20mA (actual range is 3...20mA , for negative values).

Output #1 Always fixed on real time opacity (R/T). Uses pins # 11 and 12.

Output #2 Variable between R/T Mass value, Average Opacity, Window Value, or Average Mass value. Terminals 13 and 14.

Default setting is R/T on #1, Average on #2.

2.2.6.11 Alarm Mode

The alarm mode allows the user to select the alarm trigger for the warning limit and the alarm limit between R/T opacity or average opacity. Combinations of each can be used if desired. Default is R/T on both warning and alarm. Warning and alarm limits are set in paragraphs 2.2.5.13 - 2.2.5.16.

2.2.6.12 WIN Refresh Time (Window Refresh Time)

This mode sets the time cycle for the window refresh rate. The window refresh rate refers to the frequency that the monitor corrects the opacity reading based on the dirt on the window (actually all four optical surfaces). The options are:

1. During zero cycle
2. Every one hour
3. Every 60 seconds
4. Every 6 seconds

Updating the dirty window correction is not the same as the window check. It will not affect the window dirt value; it simply corrects the opacity reading based on the current window value.

Default setting is 6 seconds, so the opacity reading is constantly correcting for dirt.

2.2.6.13 RS Output Mode

The EPA 3 controller unit has a standard 9-pin connector using RS 232 communications protocol. The 9-pin output has a dual function, which can select the type of data that is collected from the port. Hyper terminal or other terminal emulator programs can be used to receive the data via a PC. Refer to paragraph 2.2.6.4 for details on the computer set-up parameters for the terminal program. This feature is unrelated to the PC Download mode, except that the port parameters are the same. This feature will simply output an opacity reading data stream. The following functions are available:

Normal (NRM) – If normal is selected, then the RS output sends the displayed opacity values in real time. The data stream that is sent is the same as the display, with a few control characters that are a part of the chip program. This mode is designed to work with a PC since the data stream is fast and long. A new real time value occurs approximately every 1 second.

Average (AVE) – If average is selected, a PC can be used also, but now the data stream is averaged every six minutes. Additionally, alarm status will be outputted. A printer can also be used to receive the data, just make sure the COM port on the PC end is set to the appropriate parameters in paragraph 2.2.6.4.

2.2.6.14 Z/C Time base

This option is used in conjunction with the zero and calibration cycle time. The user may elect to calibrate zero and span in either seconds or minutes. After selecting the time base, be sure to set the appropriate time as described in paragraph 2.2.5.10.

2.2.6.15 Auto-window

This function allows the user to perform a dirty window check during the calibration sequence, or to disable it. If ON is selected, the unit will perform a window check between the zero and the span in the calibration sequence. Obviously, the OFF selection will disable the window check. By using the OFF feature, the window is still checked, but not sent to an analogue out channel. The # 1 analogue output (pins 11 and 12) will reflect the window value when the Auto-window is turned on. There is not a separate contact closure for the window cycle; in fact the window check shares the relay with the zero key. This could be a problem for a DCS that relies on a contact closure to record the zero. It is recommended that if the DCS used relies on a contact closure to flag calibrations, the window check is disabled. Pushing the window check button can, still perform window checks. See paragraph 2.2.7.4 for special information concerning manual mode outputs, a feature that controls the relay closures.

2.2.6.16 Audit Output

The audit output mode simply selects whether the audit values are outputted to both analogue out loops, or only one. If Channel 1 is selected, only channel 1 (pins 11 and 12) will output the audit filters. Channel 1 and 2 will output the audit filter value to channels 1 and 2 (pins 11 and 12, 13 and 14).

2.2.6.17 Dynamic Mode

The EPA 3 controller unit contains a special feature called Dynamic Mode. This feature only shows changes in opacity readings.

The setting is either on or off, default being off.

Note that the dynamic mode is not in conformance to the EPA Performance

Specification 1 requirements and cannot be used on any monitors that are used for regulatory compliance in the US. Not complying with this may result in a violation.

2.2.7 ADDITIONAL SUB MENUS FROM DYNAMIC MODE

For controllers with version 3.35 chips (new units built after 6/99) and up, the following sub-menus have been added to customize the unit to meet the customers needs better. The sub-menus are accessed from the Dynamic Mode. To access, push and hold the NO key for > 5 seconds until the next mode below is viewed.

2.2.7.1 Process On/Off

This is a dry input that is controlled by and external switch on a process control board. Similar to a maintenance switch, however it only works in conjunction with the LaserTrax 2000 software to invalidate data collected in maintenance mode. Default setting is off.

2.2.7.2 Trax Monitor

The Trax monitor feature is a way that the monitor unit can sense via the 9-pin RS 232, whether the PC connected to the unit has crashed, or the data collection software has failed. A system fault displaying Trax Alarm will occur if the PC or software has failed. If no 9-pin connection exists, the Trax Monitor should be turned off, as it will give an alarm. The default setting is off.

2.2.7.3 Relay Logic

Allows the user to configure the logic of each relay to either normally open (N/O) or normally closed (N/C). Each relay can be set individually and mixed and matched according to the users desire. To set, toggle the up or down key to set logic, next moves to the next relay, status check saves and exits. All relays are defaulted to N/O.

2.2.7.4 Manual Mode Outputs

This feature allow the user to select one of two options:

LCD Only – This mode is preferred. When the manual zero, span and window check buttons are pushed, the relays do not close, the zero, span or window only appears on the display. Analogue outputs are frozen, and do not output window values, span zero values. This is a helpful feature for monitors attached to a DCS, since relay closures (or openings if relays are configured as N/O) can trigger zero or calibration sequences on a DCS. This will also allow the user to check the window value without accidentally triggering a calibration cycle on the DCS.

LCD and Outputs – Performs the same functions as the LCD Only, but closes/opens (depending on relay logic) the relay contacts. Also shows the zero, span or window on the analogue output(s).

3 INSTALLATION AND START-UP

3.1 PRE-INSTALLATION TESTS

The operation of the instrument and features of all components are tested at the factory to assure proper operation of the instrument. These tests include power supplies, laser alignment, receiver operation, signal processing, linearity testing, and drift testing. The instrument is set up in a clear stack situation where it is aligned properly, and set up accordingly. A 'This is Zero' and some other set-up parameters relating to instrument operation on a clear stack are performed to assure reliable operation. After all parameters are set, an in-path audit filter check is performed to again assure the operation of the instrument. Any failures are corrected or adjusted prior to shipment.

The unit requires a 1-hour warm-up time to allow the laser and the electronics to stabilize. This is especially important when performing optical component change outs, since the laser must be at optimum operating temperature in order to make necessary adjustments. Since the laser tube contains a gas chamber inside, Charles and Boyle's gas laws pertaining to temperature and pressure influences on gases affect the operation of the laser.

3.2 INSTALLATION SITE REQUIREMENTS

Since monitoring effluent steams is governed by German and EU regulations, the monitoring site should be in compliance with all the regulations set forth in local legislation.

The following guidelines refer to some of the important points that should be considered:

3.2.1 TURBULENCE AND EFFLUENT MIXING

The installation site should accurately represent the actual dust conditions inside the stack Two factors, the turbulence and the mixing time contribute a representative concentration of particulate and stack gas. The mixing is considered representative when the monitor is installed more than 4 diameters down-stream from any disturbances in the stack gas flow. It is also recommended that the monitor installation occur in the plane of the bend with the beam passing through the central area of the stack. Some variations may exist, and are outlined in the EPA 40 CFR60, Appendix B Performance Specification 1.

3.2.2 PRESSURE CONSIDERATIONS

One of the conditions that causes problems for opacity monitors, is the periodic positive pressure out-blows from the stack towards monitoring equipment. Although the MIP Opacity monitor does minimize this effect by reducing the number of optical surfaces and smaller openings to the stack, it is best to try to avoid positive pressure monitoring locations. Negative pressure monitoring locations are favourable, such as the negative side of an ID fan. If negative pressure monitoring locations are not available, careful attention should be made to the availability quantity and quality of the purge air.

3.2.3 VIBRATION AND ALIGNMENT

As was described earlier, the laser-based MIP opacity monitor uses the under fill system as opposed to an overfill system. Any change in position due to vibration or alignment changes using an overfill system will result in erroneous opacity readings. In addition, small changes in the path-length of overfill systems will also affect opacity readings.

With the laser-based under-fill system, this problem has been minimized with the use of a large area measure detector. Minor vibration, alignment, and path-length changes will not affect the reliability of the opacity readings. Since the laser beam possesses excellent collimation characteristics, path-length changes will not affect the readings. In addition, the detector surface is a uniform semi-conductor, having < 1.0% variation in readings on different portions of the detector, opacity readings are unaffected. Finally, since the detector is large in comparison to the beam size, vibration will not affect the reliability of the opacity readings.

It should however be noted that severe vibration, or warping of the stack due to temperature changes, or even rain falling on the stack can affect the cross-stack alignment enough to cause erroneous opacity readings. In most installations, the variations are slight, and do not pose a problem. Severe vibration and temperature applications may also shorten the life span of the laser.

3.2.4 TEMPERATURE AND MOISTURE

There are temperature and moisture limitations to the transmitter and the receiver. The moisture and temperature requirements are usually met by providing the proper flow of purge air, either instrument grade or blower air. See the appendices for purge air requirements.

Laser opacity and dust monitors have been used in applications where gas temperatures reach over 800 °C. In heat conduction situations between the tow mounting flanges, the heavy donut-like mounting gasket on the transmitter, provides some insulation.

Water condensation in high-moisture stacks is a problem for almost all opacity and dust monitors. Caution should be taken when the stack contains water droplets that may condense on the receiver lens. Operators should find a monitoring location where the temperature is high enough to keep water in a gaseous phase. Caution should be taken to install the monitor unit in accordance with local and federal permitting guidelines.

3.3 CROSS-STACK ALIGNMENT CHECK

The cross-stack alignment check involves simply physically aligning the transmitter so that laser beam strikes the detector on the receiver side dead center. This allows the opacity and dust monitor to read correctly when slight movements or vibration in the transmitter due to stack movement occur.

The EPA defines a misalignment as an out of line situation causing a greater than 2% increase in opacity compared to a well-centred beam. With the laser opacity, this just doesn't occur as long as the beam strikes the detector. The detector has a uniform sensing surface which varies by, 1.0 %, one-half of the EPA standard. Not to mention the under fill vs. overfill system. The full alignment procedure can be found in the appendices.

3.4 CALIBRATION/LINEARITY CHECK

This procedure is performed just like the Audit procedure. The linearity check procedure is simply performed on the stack after installation to verify monitor operation.

As was discussed earlier, the under fill system used in the laser opacity and dust monitor does not require any stack diameter input into the overall calculation.

This check is done both at the factory and at the customer's site to insure both tests match with similar results.

The one additional test required by the EPA, as part of the linearity test is response time. The response time test consists of simply inserting an up-scale filter five times and measuring the time that the instrument responds to the upscale, and the time it takes to drop to zero.

EPA rules state that response times must be less than 10 seconds. Typically, the MIP Laser Opacity and Dust monitor responds upscale within 7-9 seconds and back to zero within 5 or so seconds.

3.5 EPA FIELD CERTIFICATION TESTS DURING START-UP

Six tests are performed to assure that the Laser Opacity and Dust Monitor is both in compliance with EPA rules, and for quality assurance. Only the EPA mandates three, however MIP performs the additional three to assure correct operation of the monitor.

EPA Required:

- A cross stack alignment is performed using the supplied alignment disk on the receiver end.
- An on-stack audit (linearity) test is performed.
- A calibration drift over 7 days (168 hrs) is performed.

Additional:

- A complete audit test is performed at the factory. If the unit is required by EPA or state regulations to use a different filter range than 0-100%, the audit is performed on both a 0-100% and the required customer range.
- A calibration test is performed each hour for 24 hours. This is a proposed EPA rule, not yet enacted into legislation.
- All set points on the opacity and dust monitor are verified to be in accordance with the customers' specifications.

4 MAINTENANCE AND SERVICE

This section is designed to give a general overview of maintenance and service that should be performed regularly. The maintenance interval will depend on the location of the monitor and the surrounding environment. In-depth service or maintenance problems are described in the appendices.

4.1 SELF-DIAGNOSTIC TEST

As explained in the diagnostic mode section, the monitor can run a self-diagnostic test by pushing the up, down and next keys simultaneously. Data collection will stop at this time until the unit completes the diagnostic cycle. A FAIL will indicate a failure in the designated system. If the unit does not get past the Communication test, the problem usually lies in the serial link between the stack and the ground. Check the wiring first, and the power on the stack next.

4.2 DIRT ACCUMULATION TEST

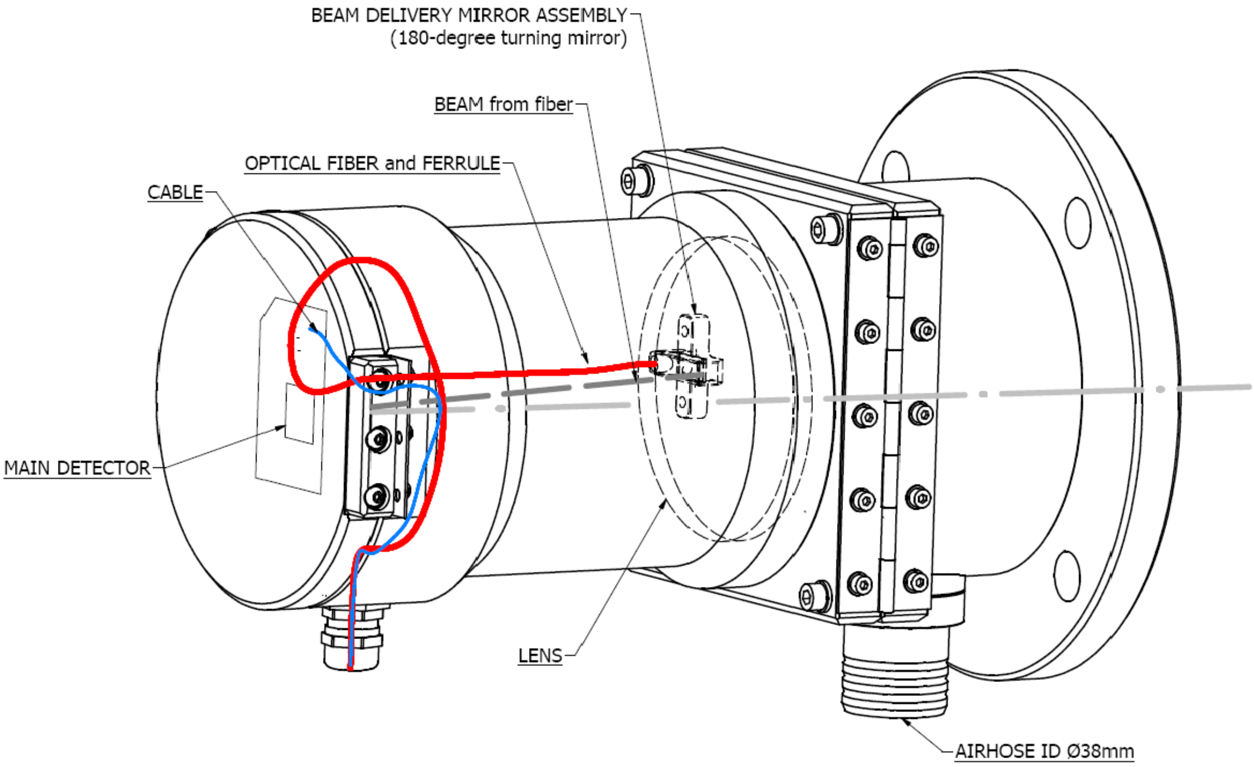
This test is achieved by regularly monitoring the window dirt either via the second analogue out, or by simply pushing the window check button occasionally. EPA regulations allow a dirt accumulation up to 4%, after which, data is considered to be invalid. A window dirt accumulation > 4% will result in a calibration fail. It is the users responsibility to keep track of the window dirt and perform optic cleanings as necessary. Once again, the service interval will be based on the installation environment. The optical system in the receiver differs from standard opacity and dust monitors in which that more than just the lens must be cleaned. Refer to the next section for cleaning details. Note that window dirt will not affect the opacity reading until it reaches 4% since it is self-compensating. It is unrelated to the actual compensation factor, which is calculated internally.

When the window dirt approaches 4%, the receiver optics should be cleaned. It is best to clean them before the window dirt (window check) reaches 4% or greater.

Unlike some double pass opacity and dust monitors, the optics on the receiver side consist of more than just a lens. Since the laser opacity and dust monitor uses an independent zero path, three additional surfaces have potential for dirt contamination. In a double pass opacity and dust monitor, none of the surfaces measuring window dirt take into account dirt because none of them are exposed to the stack effluent. The laser opacity and dust monitor uses a superior dirt accumulation method since all the optical surfaces used in window dirt compensation accumulate dirt also form the stack effluent. This method results in a more accurate window dirt value.

4.2.1 CLEANING THE OPTICS

As was said in section Dirt accumulation test, the receiver consists of more than just a lens. There are four optical surfaces on the receiver side that should be cleaned when the window dirt approaches 4%.



The first surface is the receiver lens, the second and third are both sides of the180° turning mirror for the zero pipe, and the fourth is the lens on the zero pipe fibre optic line.

All optical surfaces should be cleaned with a lint free cloth and optical cleaner. Before mechanical cleaning is good to try first use bottle air for remove a particles on optical surfaces. If a greasy film on the optics occurs, isopropyl alcohol (rubbing alcohol) can be used. Be careful to use too much on the180° turning mirror as it may de-laminate the silver on the backside of the mirror. Occasionally, the detector on the receiver side should be checked for dust. If it is dusty, blow the dust off, or brush the dirt off carefully, do not use alcohol.

In rare occasions, dirt may find its way onto the chopper mirror. A failed span calculation is an indication of dirt accumulation and may require cleaning of the chopper mirror. Cleaning the chopper mirror involves several steps. See appendix B for full details on cleaning the optics.

4.3 CROSS-STACK ALIGNMENT CHECKS

Over time, the cross stack alignment, as described in paragraph 5.3.4 may shift due to temperature changes, wearing of the alignment gasket or simply sagging of the flanges. The cross stack alignment should be performed occasionally to ensure that the monitor is operating correctly. While minor misalignments are compensated for by the use of an oversized detector, gross misalignments will cause inaccurate opacity readings. See appendix H for details.

4.4 HARDWARE DIAGNOSTICS IN THE LASER UNIT

The two circuit boards in the transmitter unit include diagnostic LED lamps. The power board contains three LED’s to indicate that the proper operating voltages. Each LED has its nominal value printed underneath.

The processor board has six LED’s to indicate different faults/warnings in the Laser Unit operation.

Laser Fail – Indicates low laser power, a miss-aligned laser, miss-aligned chopper mirror, or a malfunctioning chopper motor.

Sync Fail – Indicates a fault in the chopper motor, a miss-aligned laser, or low laser power.

Typically laser fail and Sync fail occur simultaneously, since they depend on each other.

Purge Fail – Indicates a loss of purge air or a malfunction in the shutter assembly.

Temp Fail – Indicates an over heating of the laser tube. The power is shut off to the laser tube when the temperature reaches 70°C (168°F) for protection of the electronics.

Serial LED – The serial LED flashes green continuously as long as the serial link between the transmitter and the controller is intact. A steady green with a ‘Stack Power Down’ on the monitor indicates a loss of the serial connection.

Audit LED – Indicates that the unit is in audit mode, also signals operator when to perform certain stages of the audit.

More detailed procedures of service and maintenance procedures will be outlined in the appendices.

The next sections will cover installation, drawings, including appendices on maintenance and service procedures.

4.5 INSTALLATION INSTRUCTIONS

First, be sure that the location where the opacity unit is to be installed is in conformance with the EPA 40 CFR Appendix B Performance Specification 1 (Installation Specifications).

1. Test ports for the transmitter and receiver should be able to hold 150 lbs. 4 “150 # ANSI flanges are recommended, using schedule 40 steel pipe or better. Flanges should have an 8-hole bolt –pattern on each the transmitter and the receiver side. At least 3 inches of pipe should separate the transmitter from the stack wall to allow some air-cooling between the stack and the unit. If stack temperatures are >200 °C, extend the pipe to greater than 3 inches. Allow room to swing both the transmitter and the receiver door open for maintenance.
2. Purge air can either be customer supplied or provided by a MIP blower option. If purge air is supplied by the customer, it should be instrument grade (-20 dew point). The purge line when customer provided should be ½ “ or have a flow rate of 15CFM (400l/min) at the transmitter, and 20CFM (550 l/min) at the receiver, both at 30 psig (2bar) (line pressure, units itself does not need so much pressure; 0.3 -0.7psi (20…50mbars) is enough. Volume is much important than pressure.). Here is example to estimate required pressure:
   160feet (50m) long ½” tubing causes 17.4 psi (1,2bar) pressure lost when 15CFM (400l/min) flow is supplied from 30psig (2bar) pressure line. And maximal flow that this 160feet tubing can give is 18.3CFM (520l/min).

If using the MIP supplied blower, the blower should be mounted about halfway (dual-model) between the transmitter and the receiver or wherever is convenient to maintenance. Blower hoses should be kept short, and not against the stack. Room should be allowed to swing the door open. Blowers draw 5A at 230 V. Single blower boxes should be installed just close transmitter and receiver units.

3. Attach all power supplies.
4. With the purge air running, mount the transmitter, using the supplied bolts and vibration mounts. An anti-seizing compound is recommended on the bolts.
5. Route the conduit link and the receiver to the receiving side of the stack, being careful that the conduit is not kinked, or pinched. Roll up any excess and tie down in a safe place, but not permanently, since in some occasions it is necessary to bring the receiver to the transmitter to perform a clear stack set up. The conduit contains the zero pipe, which is a fibre optic link and can be damaged. Mount the receiver on the receiving side, again using the supplied mounting hardware and vibration mounts. If bringing the receiver with the conduit attached to the transmitter side is very difficult, a second zero pipe can be purchased.
6. The communications link between the transmitter and the controller should be connected. Pay attention to the terminal connections, # 7 and # 8 terminals are opposing on one end (RX to TX, TX to RX). If using serial wire use at least 18 AWG 2 pair shielded, routed through conduit or a wire tray. Serial wire lengths should be kept less than 500 m. If a longer run is necessary, local dealer can install fibre optic modems. Fibre optic modems can run up to 3000 meters. Installation of fibre optic modems requires special wiring to the monitor unit, and should be requested by the customer when ordering.
7. Plug all conduit connections inside the transmitter and the receiver with the gray sealing putty. This is to prevent purge air from being lost through the conduit connections.
8. After powering up the unit, the laser should turn on. Perform a cross-stack alignment (see appendices) to ensure that the laser is striking the detector on center. Use the enclosed alignment disk.
9. The controller is a standard 19 “ rack mount, and only requires the power cord to be plugged in, and any serial connections (or fibre links) to be connected.

5 APPENDIXES

5.1 APPENDIX A: ROUTINE MAINTENANCE

5.1.1 OVERVIEW

Maintenance, like many other pieces of analytical equipment is required periodically. While the instrument was designed to be as maintenance free as possible, exposing a monitor to a dirty stack requires certain cleaning procedures. To dictate a maintenance schedule to every user of the laser opacity and dust monitor would be unreasonable, since all facilities and monitored processes differ in their particulate loading, chemical make-up, heat, vibration and other physical attributes.

The best piece of advice is to monitor the below mentioned areas frequently for a couple of months to see how the unit operates in the installed location and establish a maintenance schedule accordingly.

The following checks will be classified into three categories, daily checks that should be done on a daily basis or near to it, frequent checks possibly weekly, and infrequent checks possibly monthly.

Every maintenance schedule will need to be adjusted according to historical observations.

5.1.2 DAILY CHECKS

1. The daily calibrations, both zero and span on the instrument should be monitored for compliance with the state or federal guidelines. Daily calibrations according to the EPA should be within 3 % of the target value. This rule has exceptions based on drift tests, and state or local laws.
2. The window dirt should be checked daily to determine whether the lens and its related components should be cleaned. Calibrations with window dirt > 4%, are considered to invalidate data as per the EPA regulations.
3. Service numbers along with the laser power, and fibre level should be monitored. When either one of these reaches 20%, an alarm will occur. The fibre will drop before the laser since the zero power is a function of the laser light. Some signal loss occurs in the fibre link, resulting in a lower zero than laser reading. As the fibre/laser power approaches 30 %, it's a good idea to order a fresh laser to avoid a malfunction of the unit. Lasers should not be ordered until needed since they have a six-month shelf life. The life span of the laser itself is also somewhat unpredictable, depending on the physical attributes of the stack. Heat, vibration and a repeated power up and down of the laser will result in a shorter life span.

5.1.3 PERIODIC CHECKS

1. The only check that falls into the periodic category is the status of the purge air system whether it is a customer provided purge air system, or MIP supplied system. Purge air filters should be checked weekly for cleanliness. If using the MIP system, check both the coarse out filter and the inner canister filter. Simply banging the filter out is not sufficient if it is found to be dirty. Filter elements should be replaced when they look dirty. If not, breakthrough may occur potentially damaging the sensitive electronics. If the purge fail light comes on, and there appears to be purge air flowing, it's likely that the purge system has lost it's flow due to either a clogged filter, or a malfunction of the blower system.
2. Checking the status buffers should be done once in a while to ensure accurate opacity readings. The laser replacement procedure details how to do this, what they mean and how to correct them. Assuring that the buffers are OK will result in a more linear, better operating instrument.

5.1.4 IRREGULAR CHECKS

Irregular checks involve examining areas of the monitor that are less likely to malfunction or collect dust. The most important area to check is the chopper mirror. This involves disconnecting one of the wires on terminal block XA3. The pins that provide power are labelled chopper motor. Removing the cover plate and viewing the chopper mirror with a light will allow you to see if any dirt accumulation has occurred on the mirrors. If the purge air is operating correctly, there should be little or no dirt accumulation on the mirrors. DO NOT use alcohol when cleaning these mirrors, use lens cleaner. Don't try to remove the mirrors or the chopper motor, it's easy to re-install, but very awkward to re-align. The opacity readings depend heavily on the alignment of the optical bench. This procedure is discussed in Appendix B.

5.2 APPENDIX B: CLEANING THE OPTICS

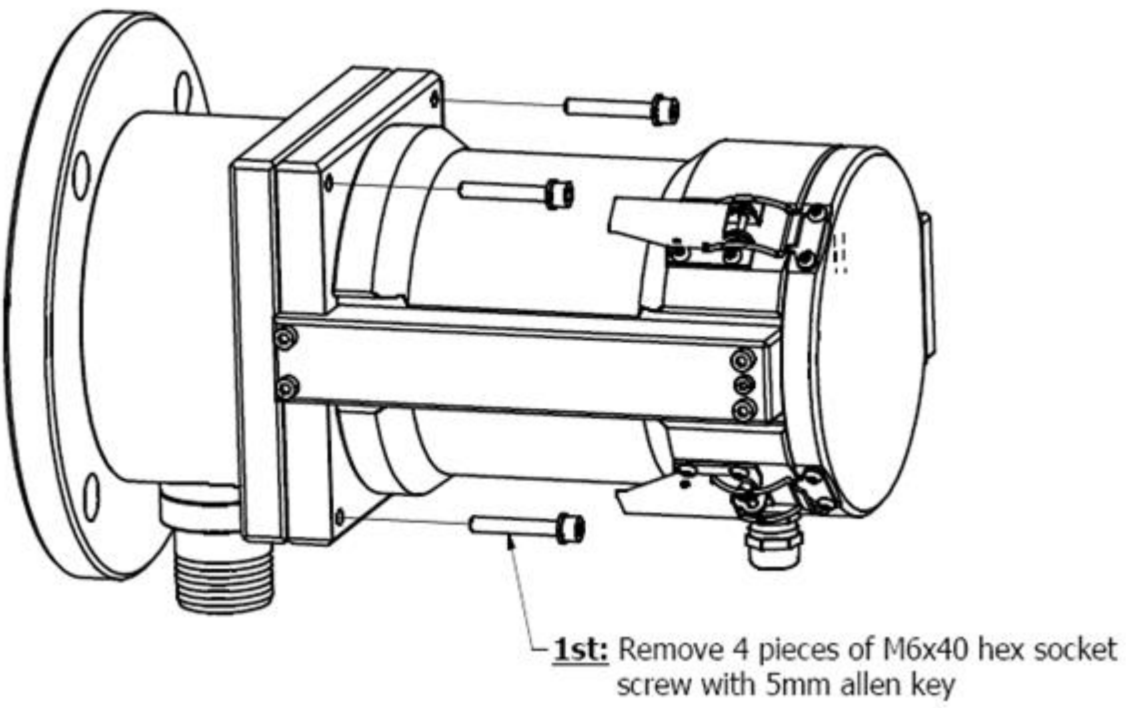
5.2.1 OVERVIEW

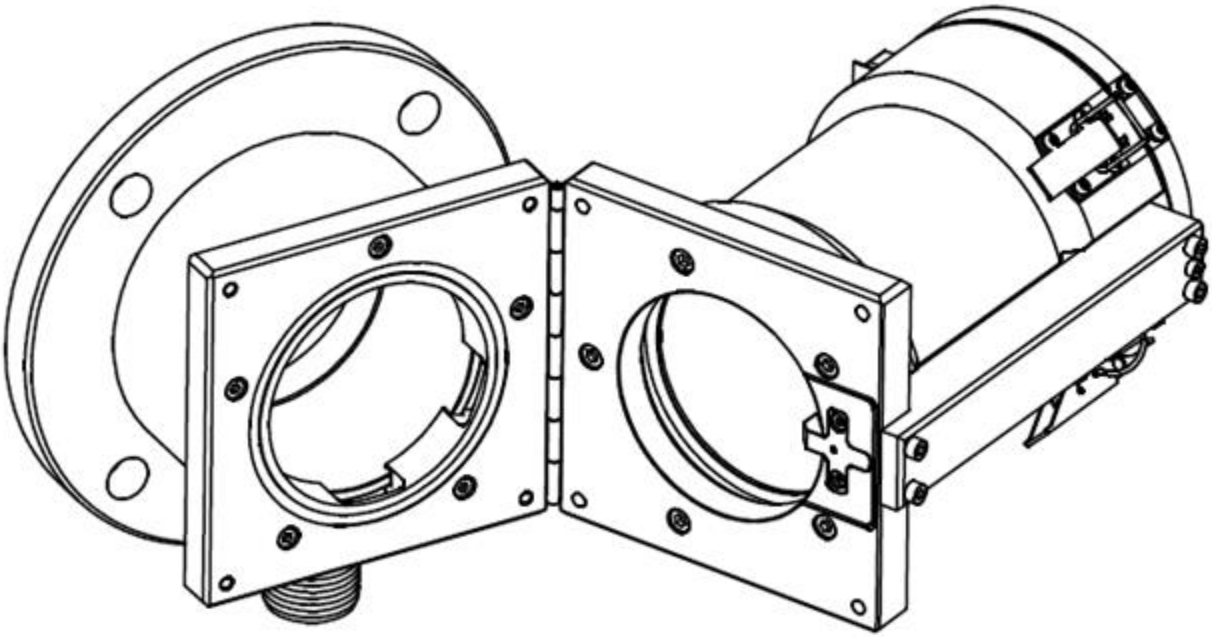
Optical cleaning falls into two areas, the receiver side and the transmitter side. Both procedures will result in false opacity readings or even faults.

5.2.2 RECEIVER SIDE / CLEANING A DIRTY WINDOW

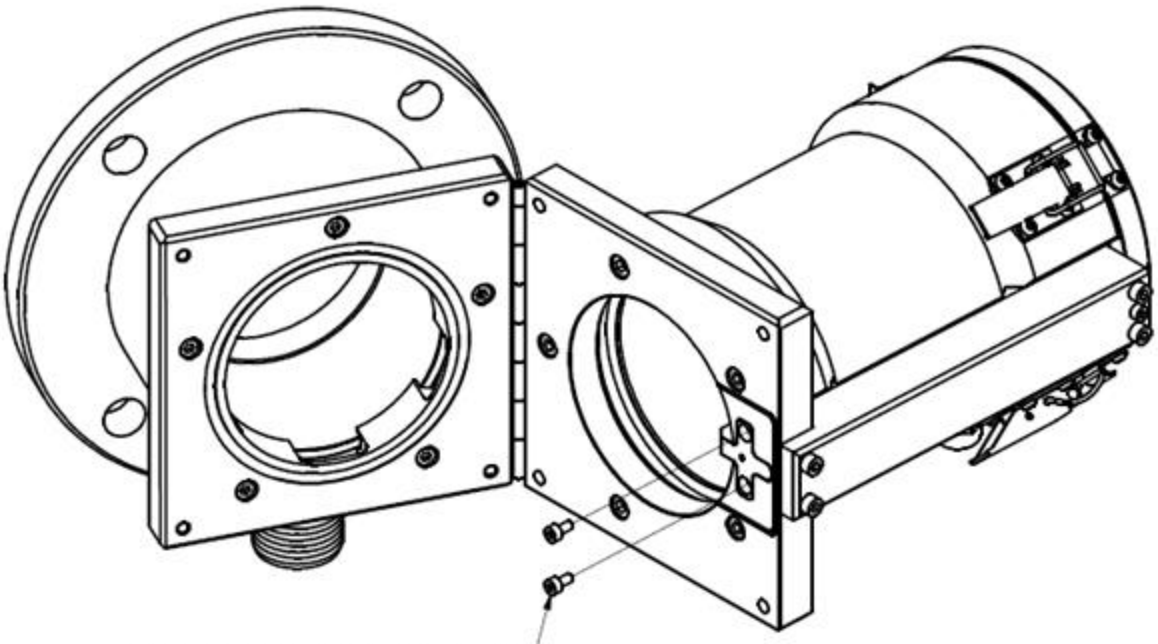
Cleaning the window will become necessary when the window check reveals opacity of something above 0 %. It is up to the discretion of the operator when to clean the window, keeping in mind that a window dirt > 4% results in invalid data collection.

The cleaning procedure differs somewhat from other manufacturers of opacity equipment. Since the laser opacity and dust monitor utilizes an independent zero path length, more optical surfaces have potential of accumulating dirt on the receiver side.

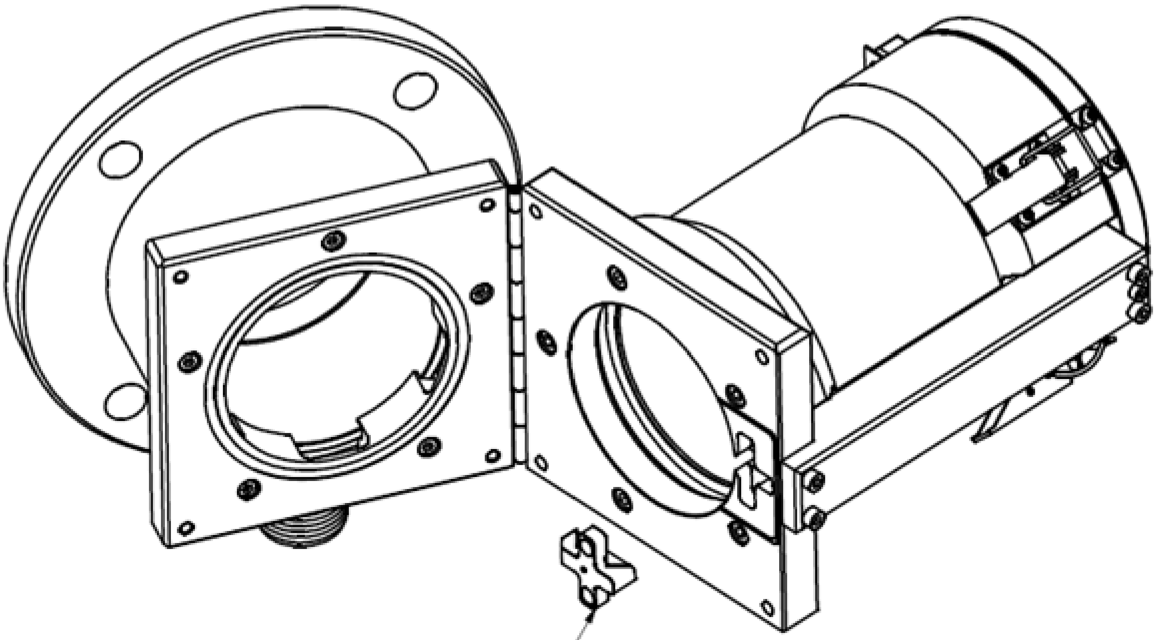




2nd: open hinge carefully



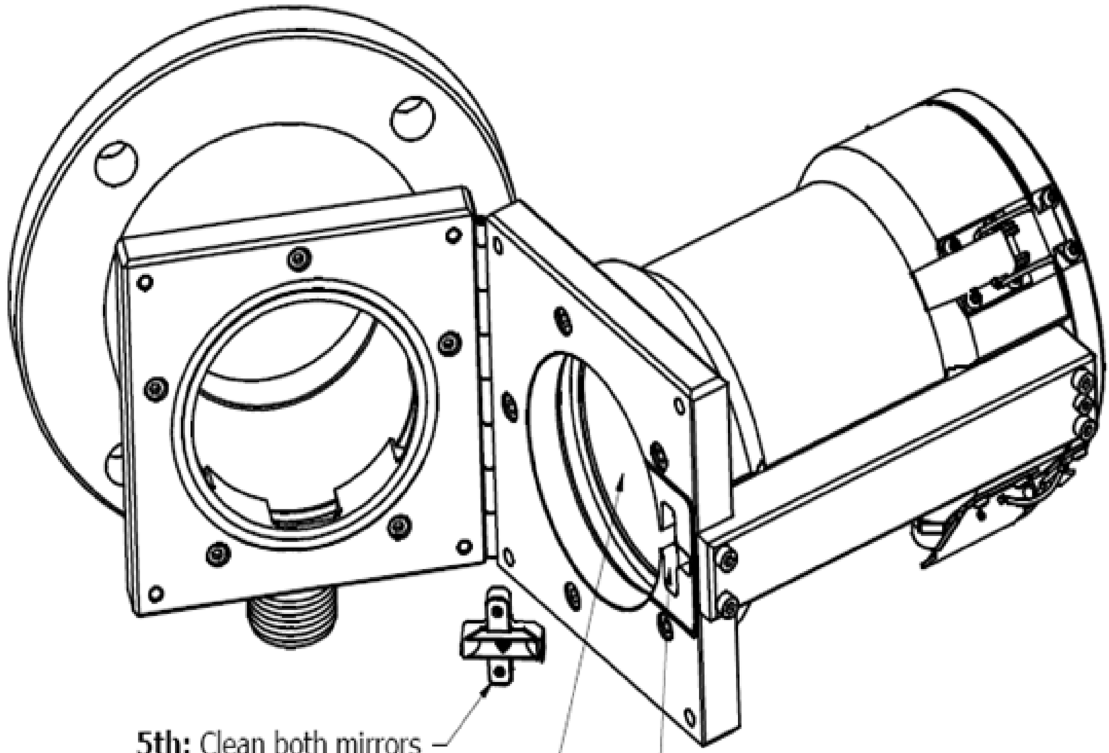
3rd: Remove 2 pieces of M4x8
hex socket screws
with 3mm allen key



4th: Remove periscope assembly by hands

Cleaning procedure:

-For cleaning use bottle air. If dirt is stikcy then use alcohol and air to remove dirt.
If dirt still is in place use alcohol and soft lint-free cloth.



5th: Clean both mirrors

6th: Clean entire lens

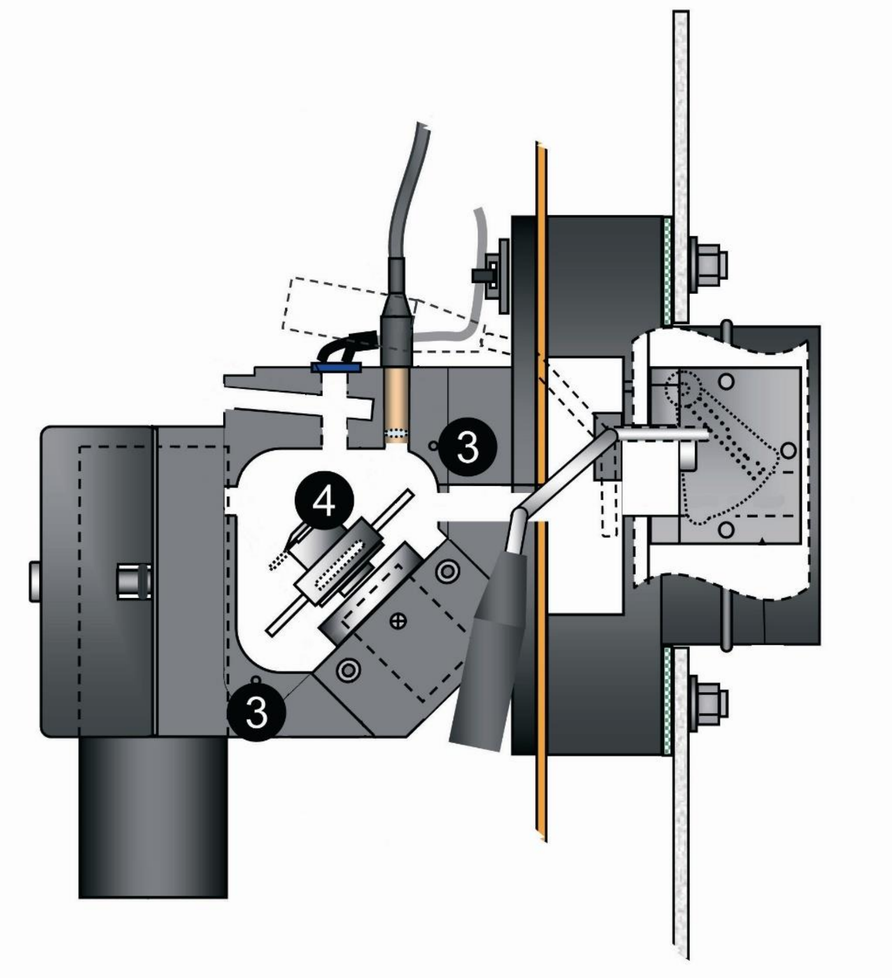
7th: If you look in to the slot where periscope assembly was positioned you should see the tip of the zero pipe, it should be shining green with laser light.
Clean the tip of the zero pipe lens with a Q-tip and lens cleaner.
Blow any dust or fibres off the lens when done.

8th: Re-install periscope assembly to it's slot. Re-install M4 hex socket screws.
9th: Close hinge and re-install M6x40 hex socket screws

This procedure should always be performed when doing a dirty or clean stack.

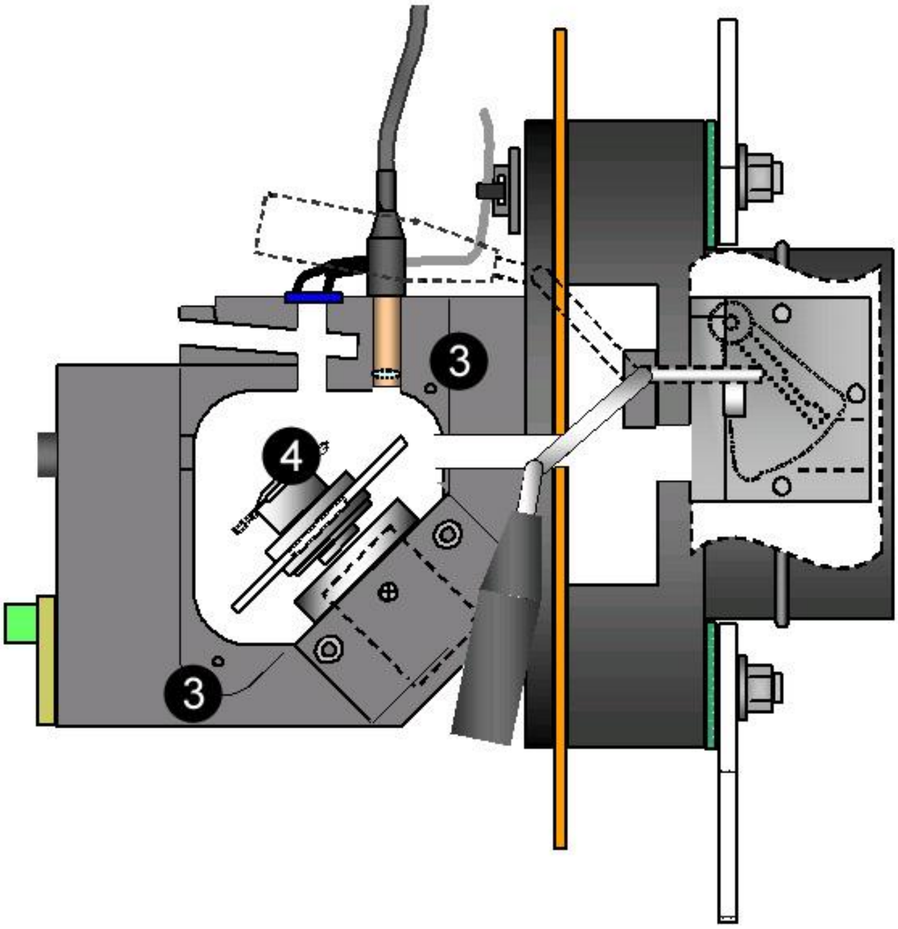
5.2.3 TRANSMITTER SIDE

The transmitter side has only one area for dirt accumulation, and needs cleaned very infrequently, unless a purge air problem deposits dirt inside the transmitter. The area that is sometimes affected is the chopper mirror.



EPA3

1. Open the transmitter door.
2. Detach one of the chopper motor lines on block XA3. This is a low-voltage power supply (8VDC). This will stop the mirror from turning.
3. Remove the chopper mirror cover plate (see diagram in drawings). It's held by the smaller set of Allen screws (2mm).
4. Examine both sides of the chopper mirror by shining a flashlight on the surfaces of the mirror.
5. Clean dirt off mirrors with a Q-tip and lens cleaner. Blow out any dust that may be present on the mirror or in the chopper space.
6. Replace the cover plate and the screws.
7. Re-attach the chopper motor wires.



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5.3 APPENDIX C: LASER UNIT REPLACEMENT AND ALIGNMENT PROCEDURES

Both models have own procedures for replacement of the laser units.

5.3.1 OVERVIEW

NOTE: Laser tube replacement and alignment always involves a clear stack procedure. That is why these procedures are broken into two sections, yet are listed in the same appendix.

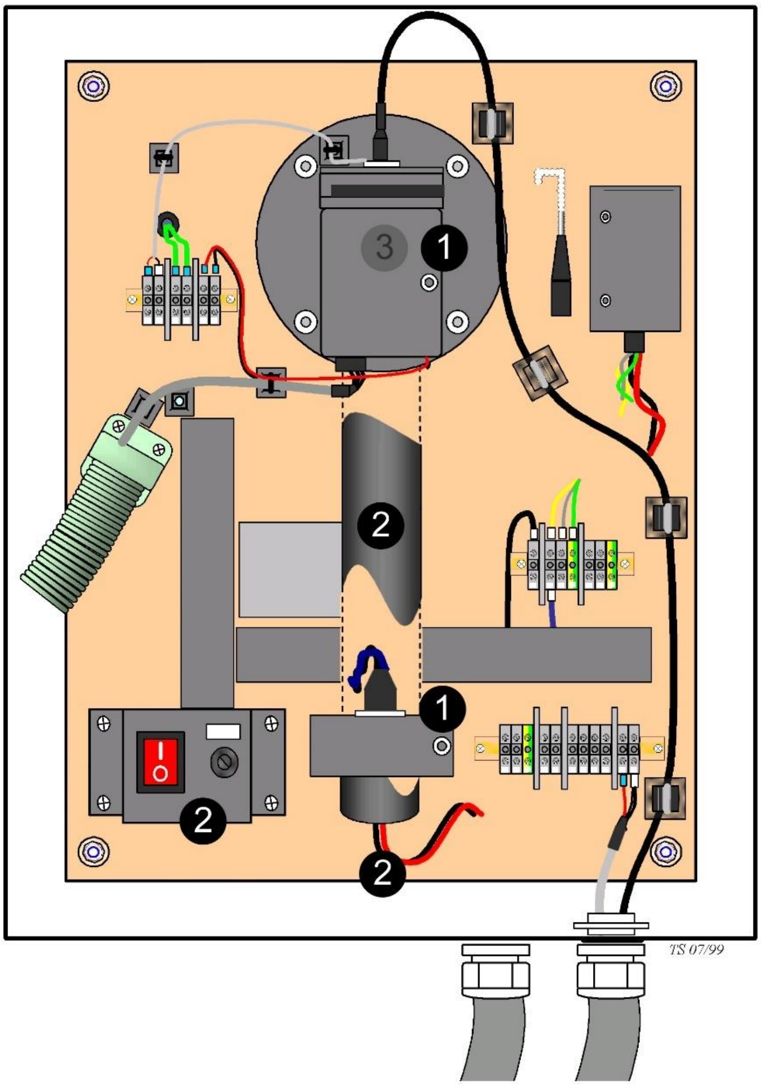
The lasers used in MIP opacity and dust monitors will not cause damage to your eyes, as long as you don't stare at the laser beam. The laser tubes are simply a bright light source, and will not cause any injury to your eyes unless you expose them to the beam for hours on end, directly in your eye.

5.3.2 REPLACEMENT LM 3086EPA3

If only re-aligning the tube, skip to the alignment procedure.

If replacing the tube, first turn the transmitter power off and disconnect the power plug to the laser tube.

The laser tube power supply uses a very high voltage (2000 VDC) and may arc, causing a serious injury or death if the power is not disconnected.

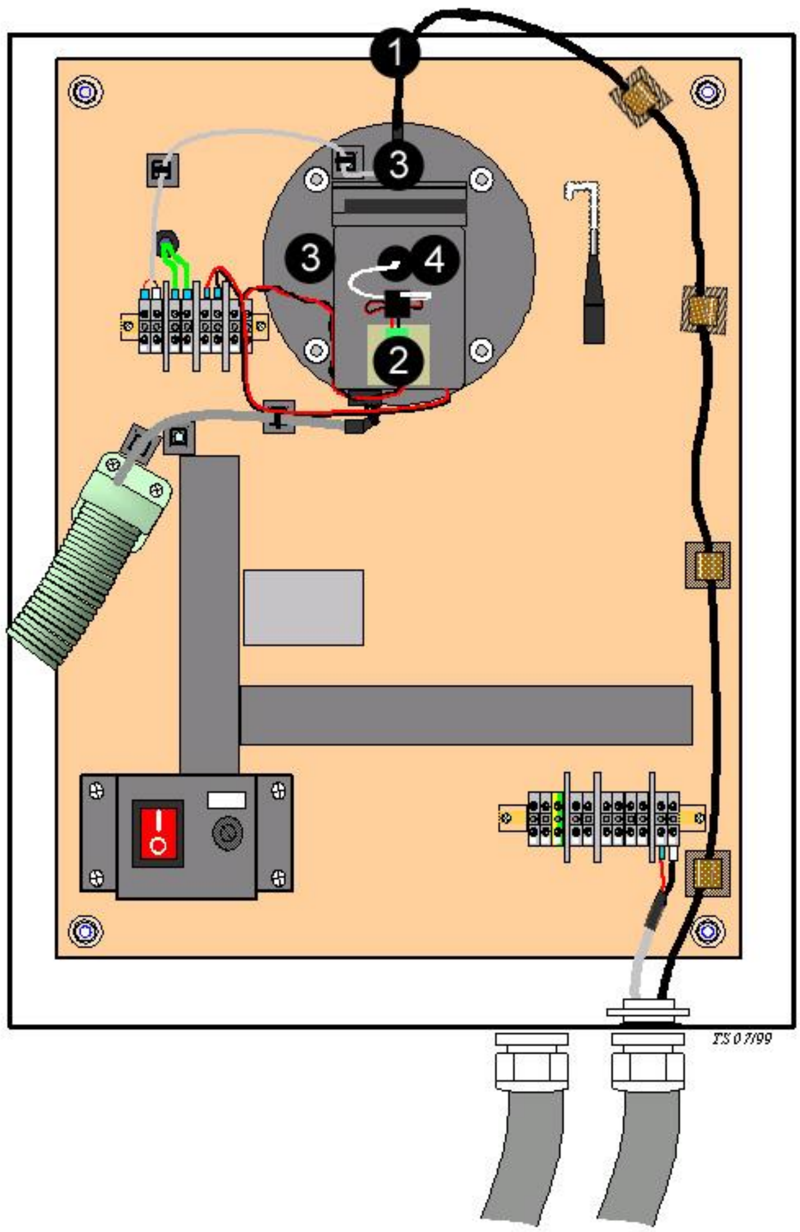


1. Loosen the laser tube hold-down brackets (3mm hex key).
2. Remove the laser tube disconnecting the power plug, assuring that the power switch to the transmitter is off.
3. Remove the deflector assembly from the end of the tube (3/32 " hex bolts). This part is re-usable and does not need to be replaced each time the laser is replaced. Check for any dirt accumulation in the apertures and be sure that the O-ring is in good condition. It is unlikely that it will deteriorate.
4. Re-attach the deflector assembly to the end of the new laser tube, ensuring that both the O-ring is seated properly, and that the laser exit hole faces away from the label on the tube. Don not over-tighten the deflector, just snug it down the till the threads seat, tightening in a criss-cross pattern to allow even seating. Uneven seating may crack the glue on the end of the tube, damaging the laser tube.

5. Open the aperture. Melles Griot lasers use a slide aperture on the top of the tube to open the shutter. It is labelled. Melles Griot lasers are now replacing REO lasers.
6. Plug the tube into the power supply. If a new power supply is enclosed, install and wire observing the correct wire connections as noted on the power supply. Remove the zero pipe assembly from the top of the optical block by loosening the set-screw (Use a 1.5mm hex key). Insert the hex key in the small hole on the right side of the chopper block.
7. Power the unit back up, avoiding direct visual contact with the laser tube. Assure that the laser is functioning by shining it on your hand. Verify that you see one distinct light point from the tube. Sometimes it takes a few seconds or so for it to turn on. If it doesn't, power down the transmitter and check that the power plug is fully seated, and that the aperture is open. A meter measuring > 2000 VDC is required to check the voltage output (PLEASE DON´T TRY TO MEASURE HI-VOLTAGE POWERSUPPLY IF YOU DON'T KNOW WHAT YOU ARE DOING. Without load voltage can rise more than 12 000V !). The current is factory set and should not be adjusted.
8. Re-install the laser tube in the mounting brackets, keeping the hex bolts loose, pointing the laser beam into the hole in front of the chopper wheel area (Avoid looking at the beam directly since there are mirrors in this area). Position the tube so that the beam strikes the center of the crosshairs inside the cabinet on the 'roof' over the top of the mounting assembly. This may take some twisting and turning or even raising or lowering of the laser tube. Be patient, you will get it with some effort. Tighten the mounting bracket just enough to hold it in position, but not so much that the laser tube can't be turned or moved. Try to tighten each hold down evenly, observing for shifting of the image on the cross hairs. Over-tightening will damage the laser; so don't crank it down too hard. Sometimes you may have to predict the movement of the laser image, as when each hold down is tightened, it will tend to shift the beam image on the crosshairs. Offset the image to allow for the tightening effect. Re-install the zero pipe, but don't tighten the set-screw yet.

The installation of the laser is only the first step; the next step is to align the laser properly, and lastly set the clear stack.

5.3.3 REPLACEMENT LM 3086SE



1. Remove the zero pipe fibre with lens. If the laser is valid you can see a dot reflection inside the equipment enclosure top. Otherwise the laser is invalid and needs to be replaced,
2. Assure that the main power switch is off and detach the red and the black cable from the circuit board at the bottom of the optical block.
3. Loosen the two screws located at the top and at the left of the optical block.
4. Pull the laser unit out and replace it with new one.
5. Attach the red and black power cable to the circuit board.
6. Tighten the two screws but don't tight them fully yet. The laser may need adjustment.

7. Turn the main power switch on and look for the reflection dot. There is an alignment crosshair inside the equipment enclosure top. The reflection dot should be visible at the middle of the crosshair. You can adjust the reflection dot by rolling the laser unit in its socket. Tighten the two screws carefully after the laser is adjusted.

5.3.4 ALIGNMENT

The following assumes that the stack is clear, the laser tube is either new or in serviceable condition with a power level > 20 %, and no effluent is present in the stack. If this is not the case, detaching the receiver unit and placing it in front of the transmitter unit so that the laser will strike the targeted area should simulate a clear stack. It can be temporarily mounted to the flange on the monitor side using bolts.

One very important note. DO NOT EVER adjust the amplifier pots if you have an laser tube that has been in service. *The amplifier pots should only be adjusted when installing a new, unused laser tube that has been manufactured less than six months prior to installation.*

First and foremost, clean all receiver optical surfaces, there are four. (Lens, fibre lens, two sides of 180-degree mirror)

Secondly, if the laser is not already running or is a fresh replacement, allow it to warm up for at least one hour before performing adjustments.

1. Using the hand-held unit, (if no hand-held have a second person monitor the control unit and relay information via radios) enter the service mode (Up and down pressed simultaneously for 5 seconds). Answer yes to service mode. When you see the four values (M, R, C, and Z), push next and select RT (Real Time). Observe the Z value, and note both how much it is reading, and how much it is fluctuating. The Z value should be between 2000 and 5000.

   Typically (if the laser is reasonably new with power near 98 %), it will be around 3000-4500. The fluctuation should be less than 100 units up and down, 50 being excellent. If this is not the case move to step 2, otherwise skip to step 3.

2. The Z value can be stabilized by physically turning the laser tube in its mounting brackets left and right, and moving it up and down. A very small movement will affect the Z value a lot. Try moving the tube 1-2 mm at a time left and right first, then try the up and down movement. Wait and re-observe the Z value, repeating the physical laser adjustments until a stable reading is obtained. Be careful not to move the laser beam so much that it moves far off the cross-hair target inside the monitor box and disappears. Typically, the laser will perform properly when the laser is on the cross hairs (not always true though). On a fresh laser tube, the M and R readings may be over 9800 or well below 9800, adjustment will occur later. After the laser tube has been aligned where the Z value is stable, remove the zero pipe, and assure that the

   Z value drops to 0 or close to it (<50). If it doesn't, the beam is probably split, and will resemble a comet trail as it hits the cross hair target. Used laser tubes needing re-alignment will not read the same values, but it is ok to realign as long as the service values are stable. Older tubes will read lower values on the M, R, Z due to laser wear. The laser is fine to use, as long as it is above 20 %. It's best to check the laser powers after the readings are stable, which is viewed by pushing the down button from the service number screen. New tubes M and R readings can be adjusted up or down accordingly, old tubes cannot and should not be adjusted up, but can be adjusted down. The up and down adjustment is an amplifier gain; you can't amplify a weak signal since it will have too much noise. The opacity and dust monitor will adjust for laser degradation, but has no lamp adjustment like other opacity and dust monitors. The adjustment procedure is covered in the next sections.

3. **For a fresh tube replacement only:** After a stable Z reading is obtained, open the door to the board where the audit button is located. There are two blue pots (amplifier pots), side by side that need to be adjusted. DO NOT ADJUST ANY SEALED POTS!! While watching the hand-held (or the controller values via a second person on a radio) observe the M and R values. These values should ideally be 9800 (+-50). If they are not, turn the left pot to adjust M, the right pot for R. Try to get the M and R values as close as possible (+-50) to each other, and as close to 9800 as possible. Higher than 9800 is not better, and neither is less than 9800. There is some settling after adjusting the pots. Adjust the pots, and wait a few minutes to get an accurate reading

When all steps are complete, re-tighten the zero pipe setscrew.

The next section will cover the Clear Stack Portion.

5.3.5 CLEAR STACK PROCEDURE

This procedure assumes that all of the previous steps have been performed.

1. After obtaining both a stable Z value, and adjusting the M and R to 9800 (+- 50), from the service value menu where the M, R, Z, C values are displayed (9800 reading is only for fresh tubes, used tubes will be less), back out by pushing status check once.
2. Answer no to Service Mode Yes/No, next answer yes to This is Zero. Enter the 3723 password to This is Zero (understanding completely the implications in the manual). New Zero Opacity = XX appears. Push the down arrow twice to enter zero. Push status check to back out to This is Zero Yes/No.
3. **Do this next part quickly:** Push next to get to the Service Mode Yes/No, Answer Yes, you will see the four service numbers and push down four times to Hardware Tests? Yes/No. Push and hold Next for 5 seconds until Hardware Copy appears. Select Copy. DO NO SELECT CALC. Back out using Status Check to the main display where you see the opacity instantaneous and average readings.
4. Push Status Check, quickly while the status displays No More Faults (Assuming there aren't any), push the next button. Request Buffer will appear, displaying four values Z, W, H, G fairly quickly. You may have to repeat this to view the numbers properly. Verify that the numbers following Z and H are the same (Usually around 1000 +-). If your laser has been is service for some time, the 1000 value will be much less due to laser degradation. If the numbers are not the same, re-check the Z stability from the service menu, re-do this is zero, and also the Hardware copy. The Z and H values on the Buffer requests display should be the same (NOVARIATION).

5.3.5.1 Explanation of the Buffer Values:

The Z buffer refers to the current zero of the instrument. This number will shift within 10-25 units as the unit calibrates, and drifts a little.

The W value refers to the current window value. For example:

0010 = 1 %   and   0001 = 0.1 %

The H value is a value that was established when the Hardware copy was performed. This is the set point the opacity instrument uses to gauge a clear stack from. This number is a critical number, since all opacity calibrations are made in reference to this value, using it as a baseline. If the instrument drifts drastically, a dirty stack zero will set the Z value, to the known, unchanging (unless you redo the hardware copy) H value. It will not be an exact re-setting of zero, but it will be within reasonable limits, enough to get the instrument to read and calibrate within the EPA required limits.

The G value is an internal value used for the calibration and calculation of opacity. It may change from time to time as the unit runs. The operator cannot change it.

As a last comment, I can't stress enough the importance of both cleaning the receiver optics, and understanding when it is safe to perform a clear stack. If the optics is not clean, you will be calibrating the window dirt out when you perform a clear stack, resulting in a false opacity reading. Most drift problems and opacity and dust monitor problems occur due to dirt on the optics, or a laser tube miss-alignment.

5.4 APPENDIX D: E-PROM REPLACEMENT

5.4.1 E-PROM REPLACEMENT FOR THE MONITOR UNIT

There are only two e-proms in the laser opacity unit, one on the stack, and one in the monitor unit.

When installing the chip, observe electrostatic precautions.

Turn the power off first.

Note the orientation of the chip. The printed text on the chip (not on the paper label) is upside down when read from the back of the unit. The dot on the corner of the chip faces on the upper front of the display panel.

1. Remove the defective chip. An E-Prom puller is the best way to remove the chip. Send all used chips back to the factory at the Hatfield PA address.
2. Insert the chip into the board with the correct orientation, making sure that all spokes (aka prongs) are in their receptacles, and are not bent.
3. Next you MUST do a clear stack procedure, not a dirty stack. You have to re-establish a clear stack reference value.

5.4.2 E-PROM REPLACEMENT FOR THE STACK

The removal and insertion of the stack chip is the same.

However, there are a couple of differences in the procedure.

Turn the power off first.

1. Before removing the old chip, observe the service numbers (if possible) and note the M and R readings.
2. Note the orientation of the old chip and then insert the new chip, orienting it correctly.
3. Turn the power back on, and let the unit warm up for an hour or so.
4. Observe the M and R numbers again and be sure that they are about the same as before.
5. If the numbers are different, the higher value of the two should be adjusted down. Typically the M and R will stay the same if an adjustment is not made.
6. Perform a clear stack, only if the M and/or R were adjusted, otherwise no clear stack is necessary.

Replacing the entire boards with new chips involves a different procedure, and is discussed in Appendix E.

Call if you have questions on this procedure. DO NOT adjust the laser pots if the values are within listed specifications (explained in Appendix C).

5.5 APPENDIX E: BOARD REPLACEMENTS

5.5.1 OVERVIEW

There are two boards in the laser opacity and dust monitor that require a procedure to be replaced. The two unlisted boards are replaced by simply removing the old and inserting the new. The stack board and the monitor PCB (aka mother board) must be replace using the following procedures.

Static precautions should be taken.

5.5.2 STACK BOARD REPLACEMENT

1. If the laser has been in service for some time, and is not in need of replacement, first check and record the M and R service numbers in real time (RT).
2. Power the stack unit down.
3. Remove the board and unplug connectors.
4. Install the new board, re-connect.
5. Power up the unit, and allow to run for at least one hour.
6. Check your service numbers for M and R again. They will likely change with a new board/chip combination.
7. Adjust the pots (the side by side ones) so that M and R are about the same (+-100) as before. The left pot is the M pot and should be adjusted first. The right pot is the R pot and should be adjusted secondly. Sometimes adjusting the R pot creates interaction with the M pot, so re-check your values. Let the unit stabilize for about 2-3 minutes, and re-check the values again. Re-adjust and wait for 2-3 minutes again.
8. First, you MUST assure that all optical surfaces are clean. That involves the lens, fibre lens, zero turning mirror. If a clear stack is done on dirty optics, the amount of dirt on the surfaces will be calibrated out resulting in a false opacity reading.
9. Next you will have to do a clear stack procedure. With the pots adjusted, and the shutter open to the stack, go to the controller.
10. Perform a Clear Stack as described in Appendix C.

5.5.3 MONITOR BOARD REPLACEMENT

1. Power the monitor down and disconnect the power cable.
2. Remove the front panel of the monitor by loosening the six screws.
3. Detach the ribbon cables.
4. Clip the wire ties holding the board to the rail.
5. Slide the board towards you gently, removing it from the monitor, noting the orientation of the chip side.
6. Insert new board, same way the old one was inserted, pushing it home into the receptacle in the back, assuring that it locks in.

7. Fix the board in place using small wire ties; being sure that the board is still pushed into the back receptacle.
8. Re-attach the ribbon cables, noting the labels on the board and the cables as to which cable goes where.
9. Screw the faceplate back on.
10. Power the unit back up.
11. Perform a clear stack. This is necessary and can't be substituted with dirty stack, the buffer values stored on the E-prom need to be re-established.

The unit should be operating normally now.

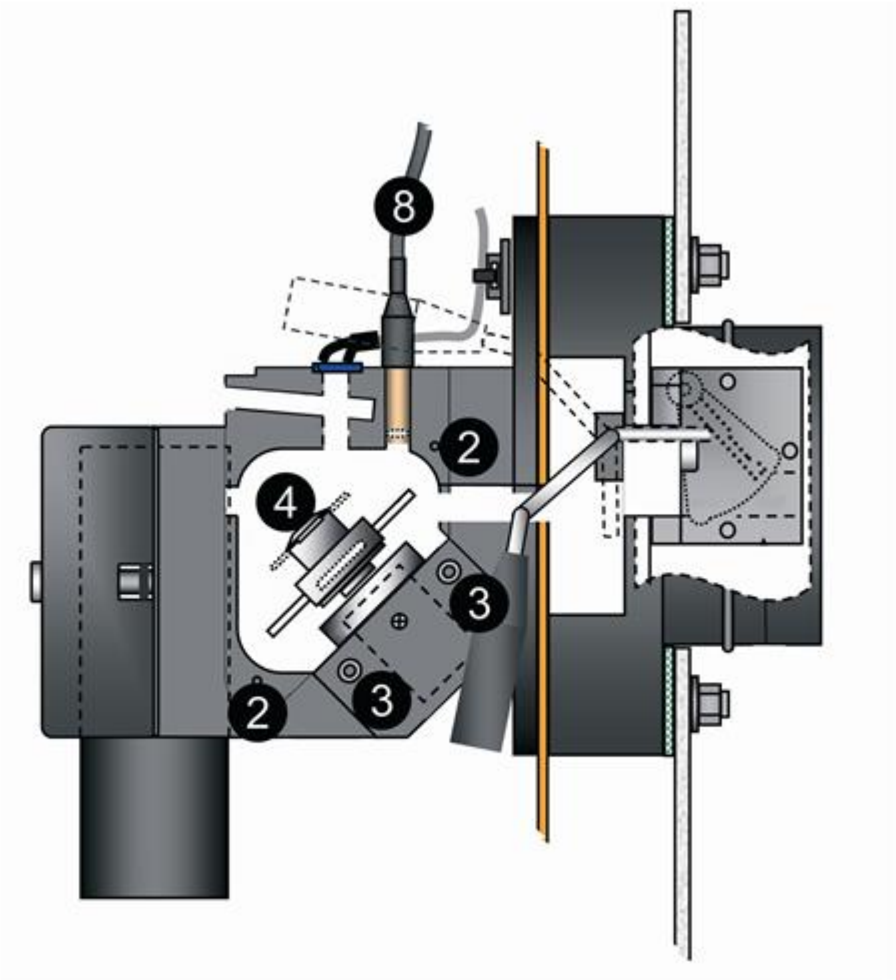
5.6 APPENDIX F: CHOPPER MOTOR / MIRROR REPLACEMENT

5.6.1 CHOPPER MOTOR / MIRROR REPLACEMENT

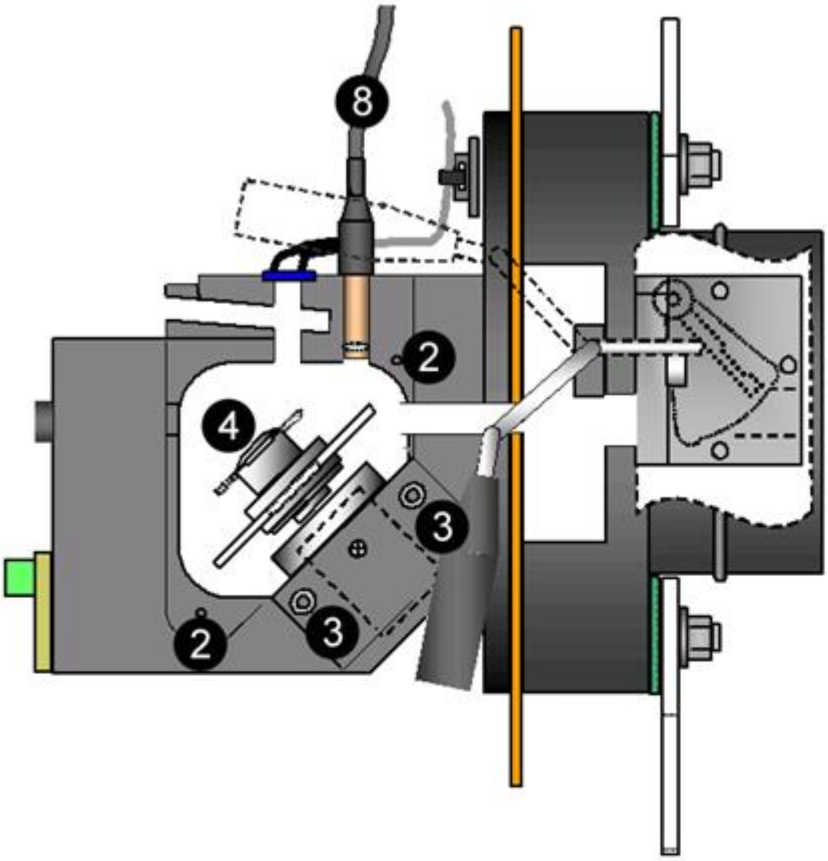
1. On terminal XA3, remove wire #5 or #6 to stop the chopper motor from spinning. You can do this while the unit is powered up, there is only a low voltage 8VDC source powering the chopper motor. Cut all wire ties holding the power wire down.
2. Using metric Hex keys, loosen the two small hex bolts (2mm) on the cover plate of the optical block. You should see the laser shining on the chopper mirror assembly, with the mirror stationary.
3. Remove the larger (3mm) hex bolts, and remove the entire chopper motor mounting block including the motor and the mirror. Don't loosen the Philips head screw.
4. After the chopper block assembly is removed, the motor should be loose in the clamp assembly. Using the 0.9 mm hex key (provided with the replacement chopper motor), loosen the set screw holding the chopper mirror to the motor shaft. Remove the mirror and slip the defective motor out of the ring clamp.
5. Re-install the new motor/mirror combination into the ring clamp/block assembly.
6. Attach the chopper mirror to the chopper motor shaft. It's probably a good idea to clean it, or verify that it's clean at this time.
7. Loosely reinstall the chopper motor/mirror block assembly into the optical block don't tighten the hex bolts fully yet. DO NOT RE ATTACH THE WIRES YET.
8. You will probably notice that the motor is loose in the ring clamp. First loosen the zero pipe set screw (the screw is in a hole and is a 2 mm hex key). Remove the zero pipe.
9. While the laser is on and the zero pipe removed, look up inside the transmitter case for the cross hairs. As you will the notice, there are two planes of mirrors on the chopper mirror, two small, and two large. The idea is to turn the mirror manually (with the laser on – the laser power is very low and will not cause eye damage unless you stare at it for hours) so that the laser beam strikes the large mirror, passing through the zero pipe hole, lining up on the cross hairs inside the transmitter case. You can adjust this alignment by moving the chopper motor up and down in the ring clamp. One note of caution be sure that there is sufficient clearance between the bottom of the chopper mirror assembly and the ring clamp, so that when the mirror spins, it will not strike the clamp.
10. Once you get this alignment done, you will have to hold the motor in position with one hand, and tighten the hex bolts with the other, retaining the motor/mirror assembly in the desired alignment. Over-tightening will damage the chopper motor.
11. Being absolutely sure that the motor can spin without binding or damaging the mirror, re-attach the power wires to the terminal block. The sticker reminds you which wire goes to which terminal.
12. Replace the cut wire ties.

13. Watch the motor spin, and make sure that the laser is hitting the cross hairs well.
14. Replace the cover plate and hex bolts.
15. Replace the zero pipe, but wait to re-tighten the set screw.

Next, a clear stack will have to be performed (Appendix C) verifying that the laser is still in proper alignment and that the M and R service numbers are within adjustment. A cross-stack alignment will also be required.



LM 3086EPA3

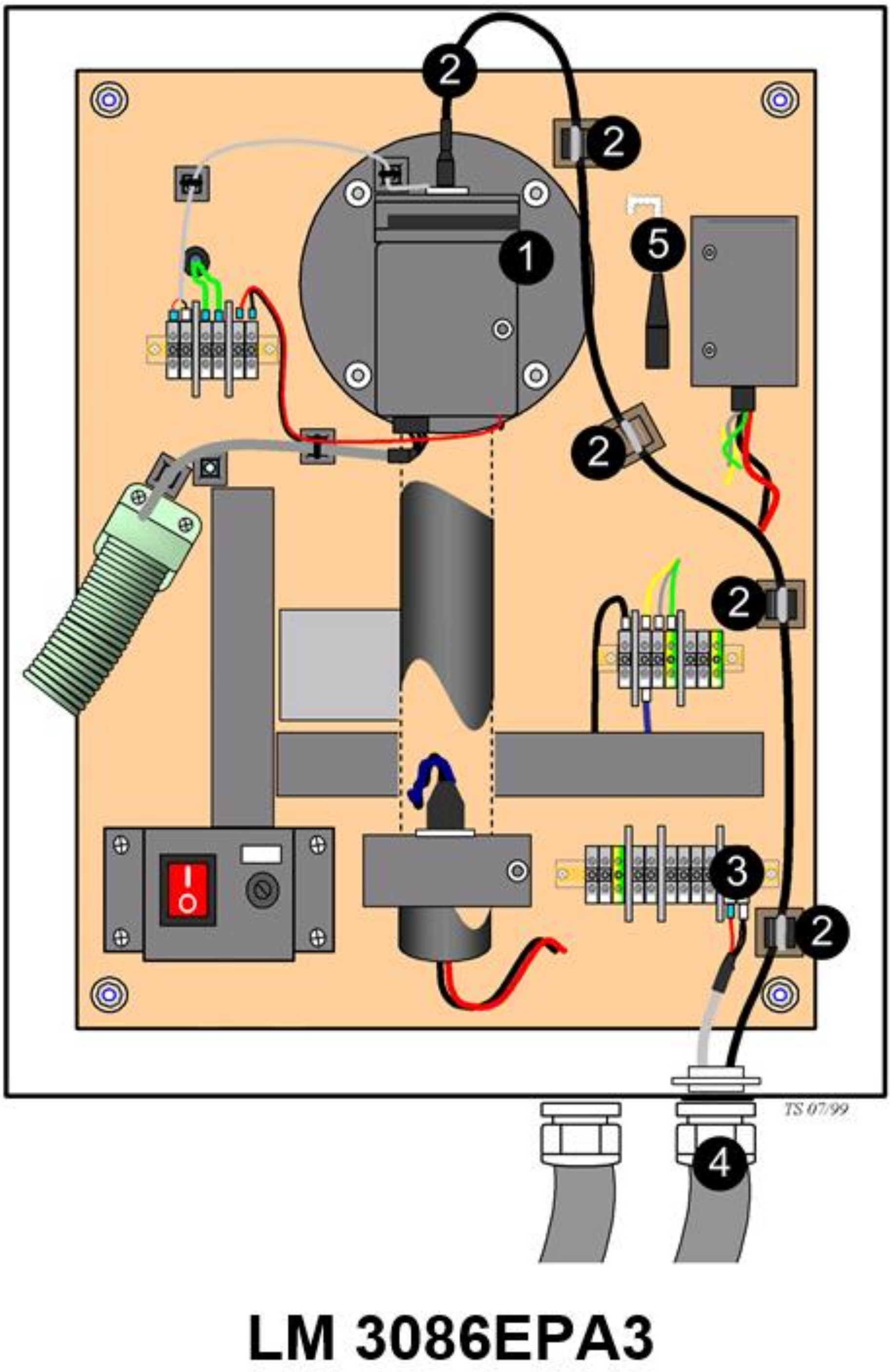


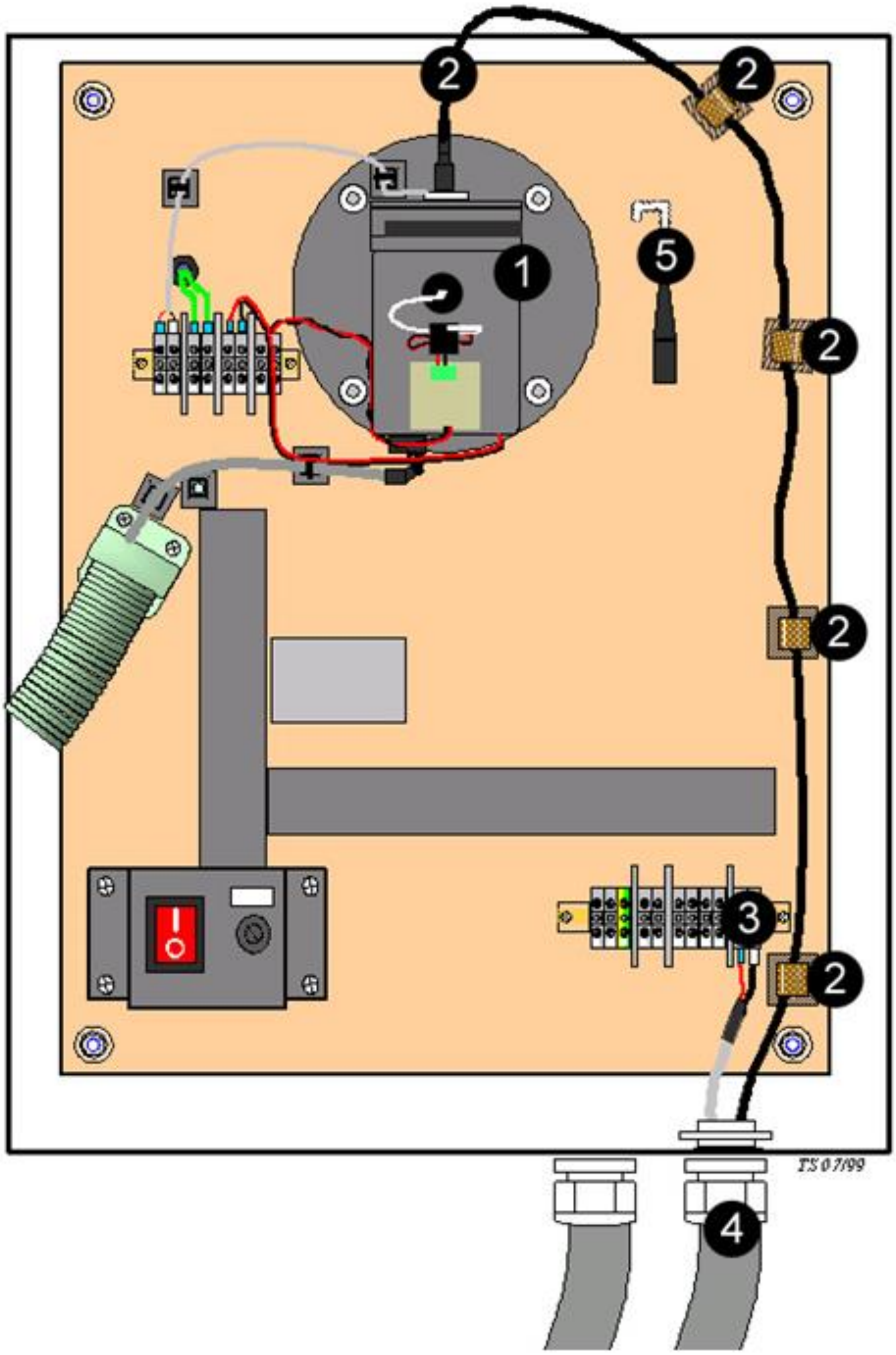
LM 3086SE

5.7 APPENDIX G: ZERO PIPE REPLACEMENT

5.7.1 ZERO PIPE REPLACEMENT

5.7.1.1 Transmitter

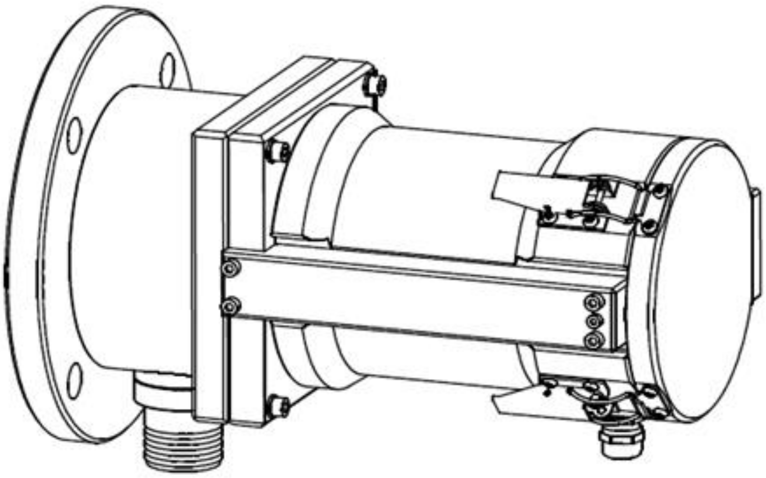




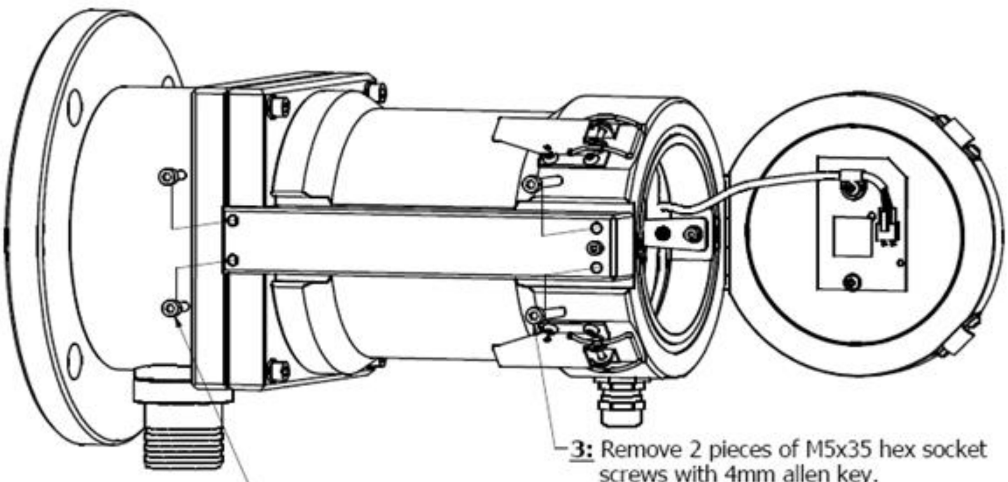
LM 3086SE

1. Loosen 1.5 mm set screw on transmitter side. Set screw is in a hole on the right side of the optical block near the top right.
2. Remove zero pipe, unclipping it from all the hold down clips.
3. Remove two signal wires from terminal block XA1. They are the ones labelled 'main detector'. Note which colour belongs on which terminal. The label serves as a reminder.
4. Loosen seal-tight fitting and remove conduit bundle with wires and zero pipe inside.
5. Close the shutter on the transmitter by leaving it in the automatic position, and opening the transmitter door.

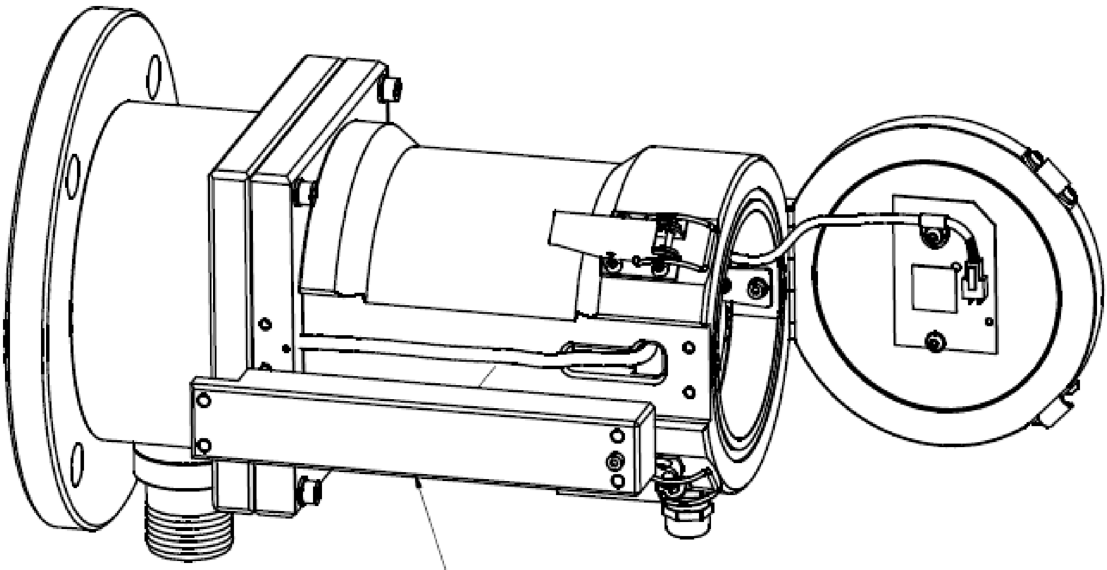
5.7.1.2 Receiver

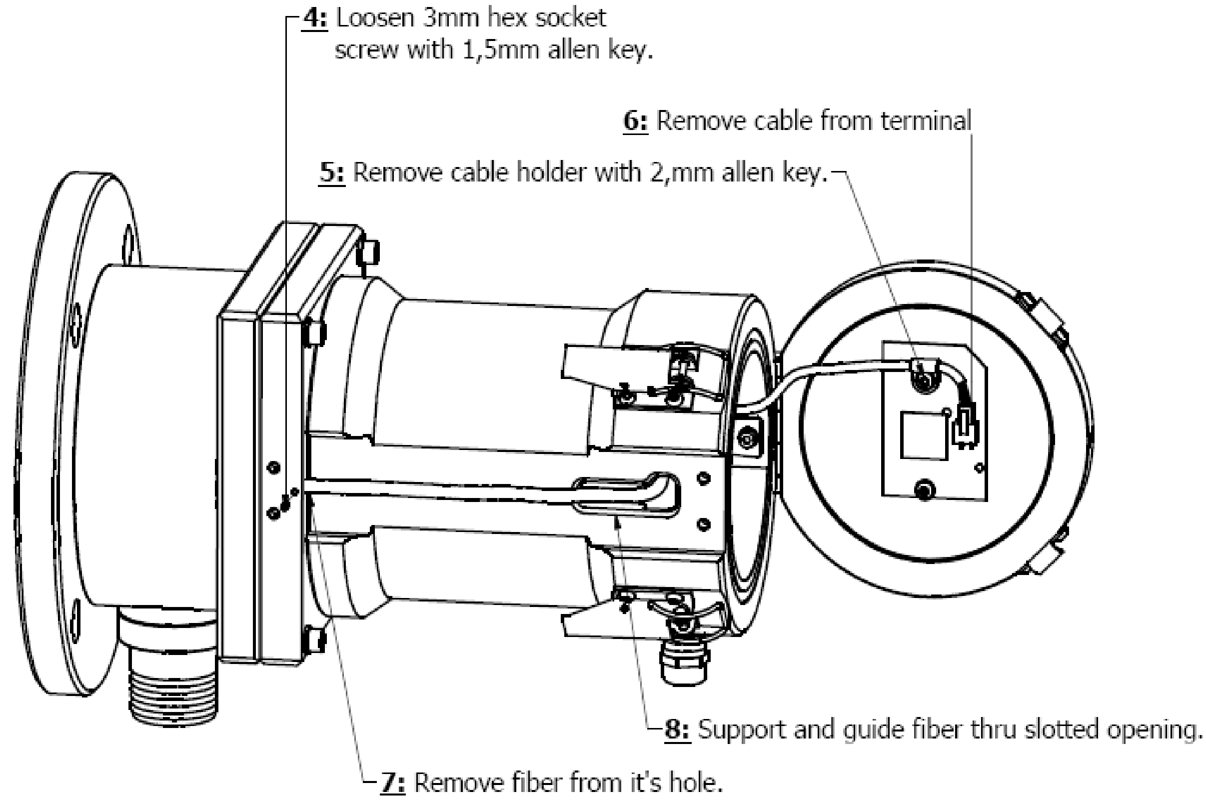


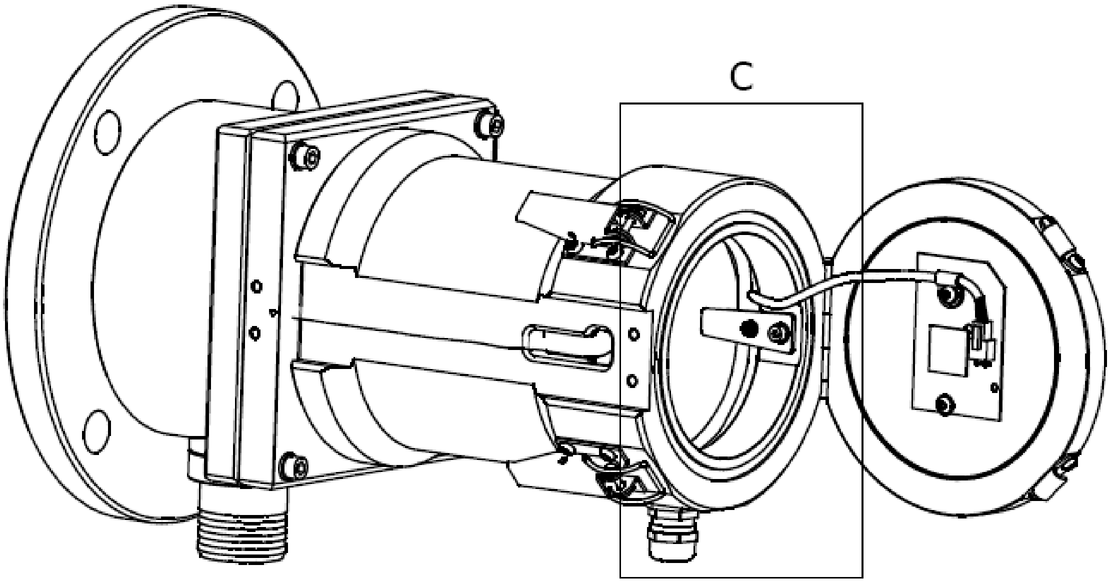
1: Open both locks and transmitter door.

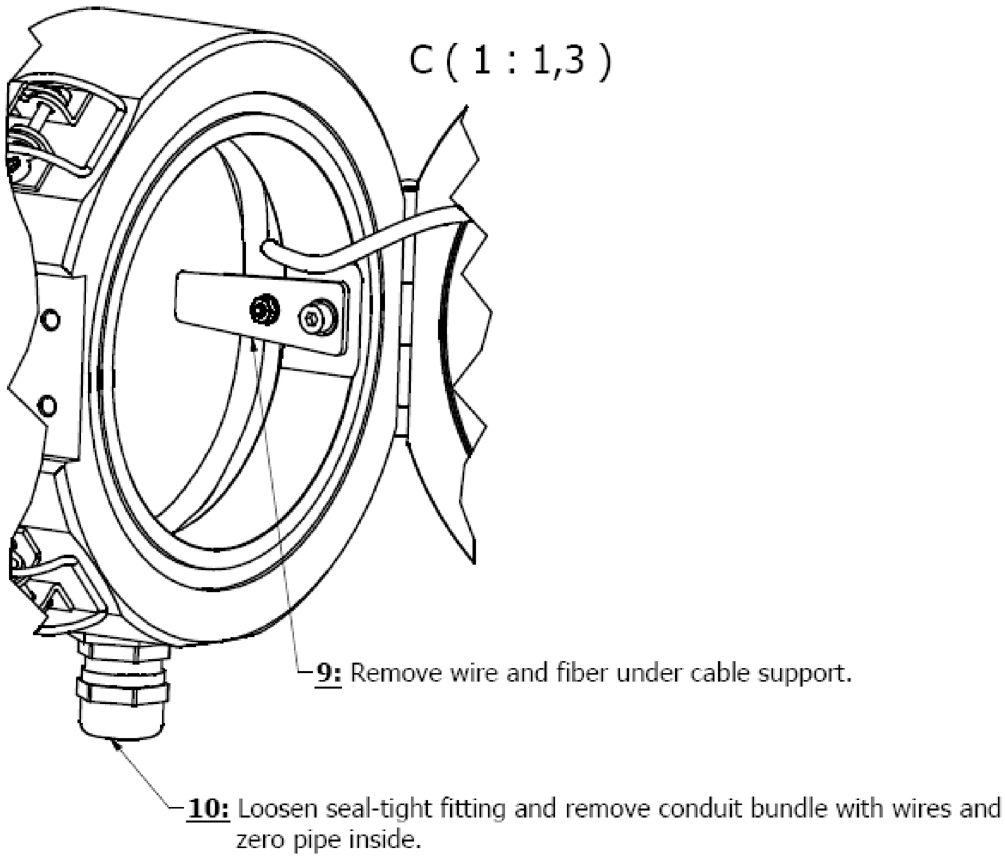


Be careful not to drop fiber protector when removing screws.


3: Remove fiber protector by hands.


4: Loosen 3mm hex socket screw with 1,5mm allen key.
6: Remove cable from terminal
5: Remove cable holder with 2,mm allen key.
8: Support and guide fiber thru slotted opening.
7: Remove fiber from it's hole.


C


C (1 : 1,3)
9: Remove wire and fiber under cable support.
10: Loosen seal-tight fitting and remove conduit bundle with wires and zero pipe inside.

Continue at receiver side:

6. Stretch conduit in a straight line.
7. Remove both the signal wire and the zero pipe. Pulling gently on both the wire and the fibre if the conduit is straight can do this.
8. Insert a fish tape into conduit.
9. The best way to fish the zero pipe is to attach the signal wire to the fish tape, and the zero pipe to the wire, putting the strain on the wire. Zero pipe, which is just a large fibre cable, is somewhat fragile, so use caution when fishing. Note the labels on the zero pipe. The best way to fish the bundle through is to pull the receiver end through the conduit allowing 18 inches of slack on the zero pipe at the receiver end, about 24 inches or so will be left on the laser end. The length on laser end is not critical, just the receiver end. You will only need 4 inches or so of the signal wire on each end. The zero pipe is longer than the signal wire. Please do not try to pull connector thru conduit.
10. Verify that the lens, fibre turning mirror and the fibre lens on the receiver are all very clean.
11. Re-attach the appropriately labelled ends to both the transmitter and the receiver. Put the excess zero pipe in the hold down clips. Re-tighten the zero pipe set screws and the signal wire.
12. Power up transmitter, then the monitor.
13. A clear stack will need to be performed, see appendix c for details. Allow the monitor and the laser to warm up, with the transmitter door close for at least one hour.

5.8 APPENDIX H: CROSS STACK ALIGNMENT

5.8.1 CROSS STACK ALIGNMENT

The cross stack alignment procedure is fairly simple. It involves the physical aligning of the transmitter and receiver so that the laser light strikes the receiver detector.

A step, by step procedure is not necessary. The alignment is achieved by using the alignment wheel located inside the top of the transmitter.

The wheel is taken to the receiver side, and placed inside the receiver housing on the hasp side. The zero pipe is fished through the cut-out. The idea is to get the laser beam, which is the brighter smaller image, centred on the cross hairs of the alignment wheel. The larger fixed green image is the zero pipe.

Loosening and tightening the transmitter side achieve the alignment. Tightening the left side of the transmitter for example, will shift the image on the alignment wheel to the right, and vice versa. The same holds true for the up and down motion.

The cross stack alignment is important, since most stacks shift with temperature changes, potentially moving the laser image outside of the detector area. It is not a critical situation if the image is not 100% centred after the unit operates, and the stack shifts, as long as the image strikes the detector, accurate reading will be calculated. The centring just allows for variations in stack movement.

5.9 APPENDIX I: TROUBLE SHOOTING

Symptom	Possible Cause	Remedy
Communication Failure (Serial Light not Blinking)	Broken serial link Incorrectly wired serial link Power loss at transmitter Loose or malfunctioning Electronics Loose or malfunctioning E-prom	Check cables or replace Check wiring Check power at transmitter Check board connections (with power off) Check E-Prom connection (with power off)
Chopper Motor Fail	Dirty or damaged chopper Mirror Failed chopper motor	Clean or replace Replace (usually has bad bearings, grinds)
Laser Power Fail	Failed laser tube Misaligned laser tube Laser tube shutter not open	Replace laser assembly Re-align Open shutter
Laser Temp. High Alarm	High ambient temperature Insufficient purge air	Increase air flow Check blower filters
Zero Pipe Fail	Broken or misaligned zero pipe Dirty zero pipe lens Broken chopper mirror	Replace or re-align Clean lens Replace chopper mirror
Failed Span	Dirty or broken chopper Mirror Reference detector dirty or failed	Clean or replace chopper mirror Clean or replace reference detector
Purge Fail	Low or loss of purge air Shutter assembly dirty or malfunctioning	Check blower filters/Check air flow Rate Clean shutter assembly/Check wiring
Failed Zero	Broken or dirty zero pipe Broken or dirty chopper Mirror Failed main detector	Clean zero pipe lens or replace zero pipe Clean or replace chopper mirror Replace detector
Dirty Window Alarm Low Z Reading (<2000) (Also triggers zero pipe failure)	Dirt on optics Dirt on optics Laser tube weak or misaligned	Clean optics Clean optics Re-align laser tube, or replace
R Reading 2000 units less than M	Dirty reference detector Moisture on reference detector Insufficient purge air to transmitter	Clean detector/check purge air Quality Check purge air quality Increase purge air flow
M Reading 2000 units less than R	Dirty or bad main detector	Clean/replace main detector
M and R flickering 1000 units	Misaligned or defective laser tube	Re-align laser assembly, or replace
PC Download not working	Wrong pin connections on 9 pin cable Terminal program misconfigured	Check cable or replace Configure according to section 2.2.7.3
Audit Mode will not Zero or flickers	Bad zero pipe	Clean zero pipe lens or replace zero pipe

Symptom	Possible Cause	Remedy
Stack Power Down Alarm	Power loss at transmitter Serial wire damaged or disconnected	Re-establish power Check/replace serial wire (or fibre if using modems)
Opacity Reads Higher than Expected	Laser misaligned Dirty or bad main detector Dirty or bad reference Detector Dirty purge air causing detectors to fog Buffer values Z and H don't match	Re-align laser tube Check quality of purge air, clean/replace detector Check quality of purge air, clean/replace detector Check quality of purge air, clean detector Perform clear stack (see appendix C for complete description of buffer values and procedure)
Sync Fail	Chopper motor failed Chopper mirror damaged/dirty Reference detector dirty or failed Misaligned or defective laser tube	Check wiring, or replace (bearings noisy) Clean/replace chopper mirror Clean/replace detector Re-align/replace laser
Controller will not turn on	No power to controller Power source failure	Check power supply/switch/fuse Replace power supply
Controller turns on, no text	Failed E-Prom or PCB	Replace E-Prom/PCB
Reference Anomaly	Detector problem Chopper wheel dirty/damaged	Clean/replace reference detector Clean/replace chopper mirror

5.10 APPENDIX J: PURGE FLOW GUIDELINES FOR PLANNING

5.10.1 CALCULATORY FLOW TABLE FOR PIPELINING IN FACTORY

Flue Gas Temperature ° C	l/min per unit (under pressure stack)
400	550
300	550
250	400
200	400
150	400
100	400
40	400

The maximum values above are to be used when estimating the air consuming, pipeline length and diameter. Flow valves are recommended to be installed in all pipes (for final adjustment). The actual, required values are depending on many parameters.

5.11 APPENDIX K: SHORT CUT KEYES AND HIDDEN FUNCTIONS

5.11.1 HIDDEN SHORTCUT KEYS

Below is the list of the most common shortcut keys currently (v.3.35) in use in the EPA3 monitor program. Note that these are undocumented features and susceptible to change at any time. Caution should be used when using them, understanding the full implications first.

When Available?	How to Activate?	What Operation Provided?
During Power-Up	Keep any key pressed (v.3.35 or earlier)	Will load Default Parameter values, except for: - Date and Time - Password - Stack Buffer Block - User Cal. Value - See comment #1
During "MIP 3086…"- display	Up & Down pressed for a few seconds	Will show the current 'This is Zero' Password and let user modify it.
During any Diagnostic Test	Up pressed	Will freeze on that test until up pressed again.
During any Diagnostic Test after Communications Check	Down pressed	Will skip the remaining tests
During Main mode	Up pressed (>2secs)	Toggles between the Display Modes
During Main mode	Down pressed (>2secs)	Toggles between the Memory/Running Averages See comment #2
During Status mode with "No (more) faults" - Display	Next key pressed	Will cycle through Stack Buffer Block -values
During "Password?"-Display in New Zero	Push "1111"	Will perform Dirty Stack Zero -Operation
During "Password?"-Display in New Zero	Push "2222"	Access to User Cal.-value modification.
During "Service Mode?" - Display	Next Pressed (>4s)	Access to Diagnostic Counters. Up & Down will reset the counters. Counter is time/date stamped.
During "Hardware Tests?" - Display	Next Pressed (>4s)	Access to Hardware Zero setting.
During "Dynamic Mode?" - Display	Down Pressed (>2s)	Access to "Hidden" parameters: - Process On/Off - Trax Monitor - Relay Logic - Manual Outputs

Comments:

1. Loading default parameters re-sets all of the user settings. The user will have to re-set every set up parameter. If needed, keep a record of required setup parameters required by the user.
2. Use caution when toggling running/block averages. The EPA requires 6- minute block averages, so if the unit is accidentally left in running average mode, the data may not be acceptable to the State or Federal agencies. Running average mode is usually easy to detect. Quick spikes will change the running average quickly. A good way to check the mode if you are uncertain is to close the shutter, spiking the instrument to 99.9 %, and watching for a quick ramp up of the average.

5.12 APPENDIX L: PARTS LISTS

Spare part catalogs with identifiers and pictures are available as separate documents.

If needed, please contact your local distributor or visit:

http://opacitymonitors.fi/spare_parts/

5.13 APPENDIX M: DIGITAL / ANALOG POTENTIOMETER ADJUSTMENT

5.13.1 DIGITAL / ANALOG OUTPUT ADJUSTMENT

Occasionally, as was discussed in the main body of this manual, the impedance of a PLC or DCS, or simply the signal wire length may cause a current loss. The DCS may not indicate the same opacity reading as the Laser Opacity Unit.

The D/A converters can be adjusted to account for this signal loss.

When looking from the top of the controller unit at the main board (PCB), there are four pots with white paint in a row.

All four pots are 20 turn pots, clockwise increasing the output.

The top grid of the Controller may have to be removed; usually a small screwdriver can be inserted through the grid to access the pots.

The one closest to the LCD display while looking from the top is the channel 2 (pins 13 and 14) analogue out span.

The second pot from the front is the channel 2 zero (13,14).

The third from the front is the Channel 1 span (Pins 11 and 12)

The fourth from the front is the Channel 1 zero (11,12)

5.14 APPENDIX O: SAFETY INFORMATION

5.14.1 WARNINGS AND CAUTIONS FOR OPERATION AND SERVICE

1. Always disconnect electrical supply before repair or maintenance of electrical Circuits. Do not stare directly at the laser beam, or stare at the beam for an extended period of time. See next two pages for comments on laser safety. If using customer supplied instrument air, air quality must be per ISA Quality Standard for Instrument Air – 1975. Typically, -20 F dew point 15 CFM at 20 PSIG both on the transmitter and receiver. 20-30PSIG line pressure with ½” tubing should give suitable flow. If tubing is more than 100ft long then higher pressure or bigger tubing is required. The other option is to use a MIP supplied blower system.
2. Do not install the opacity unit on the stack without a sufficient supply of purge air. If purge air is not available immediately, blinding disks between Flanges should be used to block stack gases from entering the transmitter and the receiver units. Failure, to use purge air or blinding disks voids the warranty of the opacity unit.
3. Verify that the shutter gate (see drawings for location) is in the automatic position. The shutter will open when the transmitter door closes, and purge air is applied to the transmitter box. Putting the shutter in the manual position while the stack contains flue gas may damage the opacity unit.

5.14.2 U.S. REGULATIONS FOR THE USE OF LASERS

This is an excerpt from a correspondence with a Canadian Customer expressing concern with the use and safety of lasers. This correspondence clarifies the safety issues that may arise when using the MIP opacity and dust monitor.

The regulations governing the manufacturing, use and safety of lasers fall under a few different regulatory agencies in the US.

The manufacturing process is regulated by the FDA and the CDRH (Radiological health agency). The FDA determines the classes of lasers based on their power and radiation level. The laser used in the MIP opacity and dust monitor is classified as a Class III R. Type III R covers lasers with power levels below 5mW, having little or no radiation exposure. MIP lasers have a power level between 0.5mW and 1mW.

The American National Standards Institute (ANSI), Occupational Safety and Health Administration (OSHA) and various safety agencies recommend and enact safety regulations in the US. OSHA regulations are the safety laws enforced in the US. ANSI standards along with the FDA, CDRH and other governmental agencies make recommendations backed by rigorous testing, to OSHA. Internationally, and in your case in Canada, there exists a set of International standards. The US standards are pretty much the benchmark for safety, so any reference to US safety standards will apply in most countries. In the case of lasers, ANSI is the organization that created the classification system of laser types, based on suggestions from the CDRH.

The point of all this commentary is get you aware that there are numerous safety regulations governing the use of lasers. The type of laser used in the MIP opacity and dust monitor, Class III A, has the following description in the ANSI standard Z-136.1-1986. The Class IIIA laser is quite simply a bright, concentrated light source.

Class III A covers lasers that cannot injure the unaided eye of a person with a normal aversion response to a bright light, but may cause injury when the light is concentrated and directed into the eye as with binoculars.

This statement emphasizes the fact that the lasers in use in our MIP opacity and dust monitors are not dangerous unless used or serviced carelessly.

In addition to this standard, OSHA states the following in 29 CFR 1926.54 concerning laser safety personal protection.

5.14.3 LASER-BASED OPACITY AND DUST MONITORING, SUBPART C

Employees when working in areas in which a potential exposure to direct or reflected laser light greater than 0.005 watts (5 milliwatts) exists, shall be provided with anti-laser eye protection devices as specified in Subpart E of this part.(MIP lasers are < 5 milliwatts)

Sub-part E just mentions the types of laser safety glasses used. None of which are required for a class IIIA laser, but can be used if desired. If used, they must be specifically laser safety glasses providing protection for green lasers operating at 543.5 nm (with red laser 655nm).

The conclusion from these two pieces of legislature is the following.

The types of lasers used in the MIP opacity and dust monitor (Class III R) are not greater than the 5 mill watts guideline, and do not require the use of any laser eye protection under the regulations. Eye damage will not result unless you stare at the laser beam for an extended period of time (2-3 hours continuously, the damage would be the same as looking at the sun directly for 2-3 hours).

Attached are a list of references that substantiate the policies and guidelines discussed in this correspondence.

References

The following is a list of references to Laser Safety Regulations. All of which can be accessed from the Internet.

The laser used in the MIP EPA 3 falls under Class III R regulations, and meets all the regulatory guidelines. The manufacturer Melles Griot, in compliance with federal regulations, has registered this laser with the CDRH (Center for Devices and Radiological Health) under the accession number 8010237. This number can be traced to the CDRH compliance documentation for the laser used in the MIP Laser Opacity and Dust Monitor.

ANSI

American National Standards Institute, American National Standard for the Safe Use of Lasers: ANSI Z-136.1 (1993), Publisher: Laser Institute of America, Orland, FL, 1993. (SAFETY INFORMATION)

American National Standards Institute, American National Standard for the Safe Use of Optical Fibre Communication Systems Utilizing Laser Diode and LED Sources: ANSI Z-136.2 (1988), Publisher: Laser Institute of America, Orland, Florida, 1988.

American National Standards Institute, American National Standard for the Safe Use Lasers in the Health Care Environment: ANSI Z-136.3 (1996), Publisher: Laser Institute of America, Orland, Florida, 1996.

FDA/CDRH

U.S. Department of Health and Human Services, Title 21 CFR. Chapter Subchapter J-Radiological Health.

U.S. Department of Health and Human Services, Title 21 CFR, Subchapter J. Part 1040.10, Performance Standard for Laser Products, and Part 1040.11, Special Purpose Laser Products.

OSHA

U.S. Department of Labor: Guidelines for Laser Safety and Hazard Assessment, OSHA Instructional PUB 8-1.7, Directorate of Technical Publications, August 19,1991

OSHA Instruction CPL 2-2.20B CH-2; Chapter 17: Laser Hazards, April 19, 1993, Directorate of Technical Support

U.S. Department of Labor, Bu. of Labor Standards, Safety and Health Regulations for Construction, Section 1518.54 Non-Ionizing Radiation, Code of Federal Regulations(CFR), 36 (75): pp.7348-7349, Saturday, April 17, 1971

U.S. Government: Public Law 91-596, Section 5 (a)(1) "General Duty Clause", December 29, 1970

U.S. Department of Labor: Laser Construction Standard (non-ionizing radiation), Occupational Safety & Health Administration (DOL/OSHA): 29 CFR 1926.54

U.S. Department of Labor: Laser Eyewear Standard,Occupational Safety & Health Administration (DOL/OSHA): 29 CFR 1926.102

U.S. Department of Labor: General Duty Clause: Section 5(a)(1), Occupational Safety & Health Administration, OSHA Act of 1970, Public Law 91-596

U.S. Department of Labor: Lockout/Tagout Standard, Occupational Safety & Health Administration (DOL/OSHA): 20CFR 1910.147, October 31, 1989.

U.S Department of Labor: Occupational Noise Exposure, Occupational Safety & Health Administration (DOL/OSHA): 29 CFR 1910.95

U.S. Department of Labor: Respiratory Protection, Occupational Safety & Health Administration (DOL/OSHA): 29 CFR 1910.134

U.S. Department of Labor: Toxic & Hazardous Substances, Occupational Safety & Health Administration (DOL/OSHA): 29 CFR Subpart Z

MILITARY

US Department of the Army, Control of Hazards to Health from Laser Radiation, May 1975, TB MED 524, Washington, DC, June 1985.

US Department of the Air Force, Laser Health Hazards Control, AFM 161-8, Washington DC, 1980.

INTERNATIONAL STANDARDS

IEC 825-1:1993, Safety of Laser Products - Part 1: Equipment Classification Requirements and User's Guide

IEC 825-2:1994, Safety of Laser Products - Part 2: Safety of Optical Fibre Communications Systems

IEC 825-3:1996, Safety of Laser Products - Part 3: Guides for Laser Displays and Shows. (Technical Report)

ISO 11553:1996, Safety of Machinery - Laser Processing Machines Safety Requirements.

EN 60825-1:1994 with amendment A11: (October 1996)

EN 12626 Safety of Machinery - Laser Processing Machines, Safety Requirements: 1996 (Except for a normative annex, same as ISO 11553)

ELECTRICAL STANDARDS

U.S. Department of Labor: Electrical Safety Related Work Practices, Occupational Safety & Health Administration (DOL/OSHA): 29 CFR 1910.309-330

American National Standard Electrical Code, ANSI/NFPA 70-1984

IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3kHz to 300 GHz, IEEE C95.1-1991

NEC, Section 110-16, Work Space About Electric Equipment (600 Volts Nominal of Less)

OTHER STANDARDS AND CODES

American National Standard Compressed Gas Cylinder Value Outlet and Inlet Connections, ANSI\CGA V-1-1977

American National Standard Safety Standard for Radio Receivers, Audio Systems, and Accessories, ANSI/UL 1270-1978

American National Standard General Safety Standard for Installations Using Non-Medical X-Ray and Sealed Gamma-Ray Sources, Energies up to 10 MeV, ANSI/N543-1974 (reaffirmed in 1989)

American National Standard Specifications for Accident Prevention Signs, ANSI Z535.1-1991

American National Standard Method of Marking Portable Compressed Gas Containers to identify the Material Contained, ANSI/CGA C-4- 1978

American National Standard Practice for Occupational and Educational Eye and Face Protection, ANSI Z87.1-1989

American National Standard for Industrial Robots and Robot Systems-Safety Requirements, ANSI/RIA R15.06 (1986)

American National Standard Fundamentals Governing the Design and Operation of Local Exhaust Systems, ANSI Z9.2 (1979)

American Conference of Governmental Industrial Hygienists (ACGIH): Industrial Ventilation: A Manual of Recommended Practice (latest revision)

ACGIH: Threshold Limit Values for Chemical Substances and Physical Agents and Biological Exposure Indices (latest revision)

ACGIH: Guide for Control of Laser Hazards, 1990. Available from ACGIH, P.O. Box 1937, Cincinnati, OH 45201.

Laser Institute of America, Laser Safety Guide, 1993. Available from LIA, 12424 Research Parkway, Suite 125, Orland, FL 32826-3274.

5.15 APPENDIX Q: WARRANTY

5.15.1 WARRANTY TERMS AND CONDITIONS

MIP Laser Dust Monitors are warranted for a period of 12 months from the date of the initial shipment. The terms and conditions of the warranty are according to the warranty certificate given. This warranty does not extend to damage caused by negligent or improper handling in use, storage, or transportation nor for products from which the original identification markings or labels are removed, defaced or altered.

Special contracts or contracts for non-standard products may have modified terms of warranty and, in such case, the terms as stated in the individual contract must be signed by the duly authorized officer of MIP and will supersede the standard terms. MIP reserves the right to change the warranty policy without any prior notice. Please contact MIP directly with any questions pertaining to your warranty.

Products believed by the purchaser to be defective shall be returned to MIP following warranty procedure (described on next page). Transportation, insurance, duties, etc. are to be paid by the purchaser. Repaired or replaced products will be returned to the purchaser by MIP (F.O.B. city of destination, domestic as well as foreign territories). MIP will not be responsible for duties, levies, taxes, etc. on returned items.

After receiving product MIP will make the final determination as to the cause or existence of the defect and, repair or replace the products that prove to be defective during the warranty period. If returned product is very dirty, not electrically safe or further usage would cause more damage, and therefore reliable determination can't be done without additional work (excessive cleaning, pre-repairing etc.), MIP has right to charge additional costs. In that case, the purchaser will be notified before any activities.

Products replaced under warranty will be warranted only for the balance of the warranty period of the originally supplied instrument. Purchased replacement parts, i.e. laser tubes, power supply modules, etc., are warranted for a six-month (6) period.

Failures due to using instrument against instructions, recommendations or the usual practice of instruments this kind are not warranted. Typical examples of previous are the electrostatic damage, excessive voltage or current or operation at the temperatures beyond recommended levels.

Warranty limitations for light sources:

This warranty does not apply to single laser diode, laser tube or led light source, which is removed from transmitter.

5.15.2 WARRANTY PROCEDURE

Review the terms of purchase and the date in warranty certificate to determine the validity of warranty claim. Warranty claims should only be made for products that are within the terms of the warranty policy. Out-of-warranty items may be sent to be evaluated and fixed as an additional service. MIP must be notified within 15 days of noticing the defect. Defective product should be sent for determination before the expiration of the warranty period.

Prior to returning any unit for repair or evaluation, please contact MIP either by phone (+358-10-322 2631) or via email (support@mip.fi) to obtain authorization and Returned Material Authorization (RMA) code to return the unit. Please be prepared to furnish the following information when requesting an authorization number:

- Product model number and serial number
- Date of shipment/purchase
- Brief description of problem/failure
- Pictures from site or mounting place and if known defected part of product
- Name and phone number of contact person at your organization.

Obtain MIP instructions for transportation and packaging and ship the product (freight etc. prepaid) with the proper documentation containing the information specified above.

MIP will advise the purchaser of its determination results at the earliest possible time. Providing complete information as requested will help to expedite this process. For products outside of their warranty period, determination will be made as a service after purchaser has approved cost estimate for repair/replacement. Charges for repair work will be invoiced at the current repair rate (available upon request from MIP) plus the cost of any additional required parts. Repair work will be warranted for a period of 6 months.

For returns in foreign countries where representation is present, please contact your distributor. For customers in the countries where distributorships and/or representation is not available, all claims and corresponded should be addressed to:

MIP Electronics Oy

Palokorvenkatu 2

04250 Kerava

Finland

6 MANUFACTURER´S CERTIFICATE OF CONFORMANCE TO EC-LABELLING PROCEDURE

This is to certify that the following dust measuring/monitoring products, manufactured by MIP Electronics Oy:

Dust monitors LM 3189, LM 3086EPA3, LM3086SE

are constructed/tested according to the following standards and EC-regulations:

2006/95/EC	Directive on Low Voltage Devices
EN 55011	Electromagnetic Compatibility
IEC/EN 61000-6-2	Electrostatic Discharge

1st of June, 2015 Kerava, Finland

Jouni Lukkari, MD

7 CERTIFICATE OF ORIGIN

We hereby confirm that Dust Monitor MIP LM 3189 is manufactured by MIP Electronics Oy, Finland and is Finnish origin.

Manufacturer: MIP Electronics Oy

Country of Origin: Finland

VAT-Code: FI1627111-2

CN-code: 90275000

EU control: Not-Listed ECCN: EAR99

1st of June, 2015 Kerava, Finland

Jouni Lukkari

Managing Director

8 DRAWINGS

8.1 EPA 3 / SE OPTICAL DESIGN

The laser opacity unit construction is shown in the following three drawings. After the three drawings, drafted diagrams display dimensional characteristics and installation support information.

The following clarifies the construction of the optical block shown on the next page. The optical block is the heart of the laser opacity unit. As shown in the drawing, the analytical technique relies on the chopper principle using a continuously rotating chopper assembly, employing a span and zero reference. The mirror divides the laser bean into three separate paths:

Io – The main beam measuring the stack opacity

I3 and I4 – Reference beams deflected to the reference detector

I1 and I2 - Zero calibration beams through the simulated zero path to the main detector.

The effluent-free zero path uses a high quality glass-fibre optical cable optimized for a monochromatic laser wavelength of 543 nm.

The main purpose of the reference detector is to track and compensate for any changes in the laser power, or the laser optics.

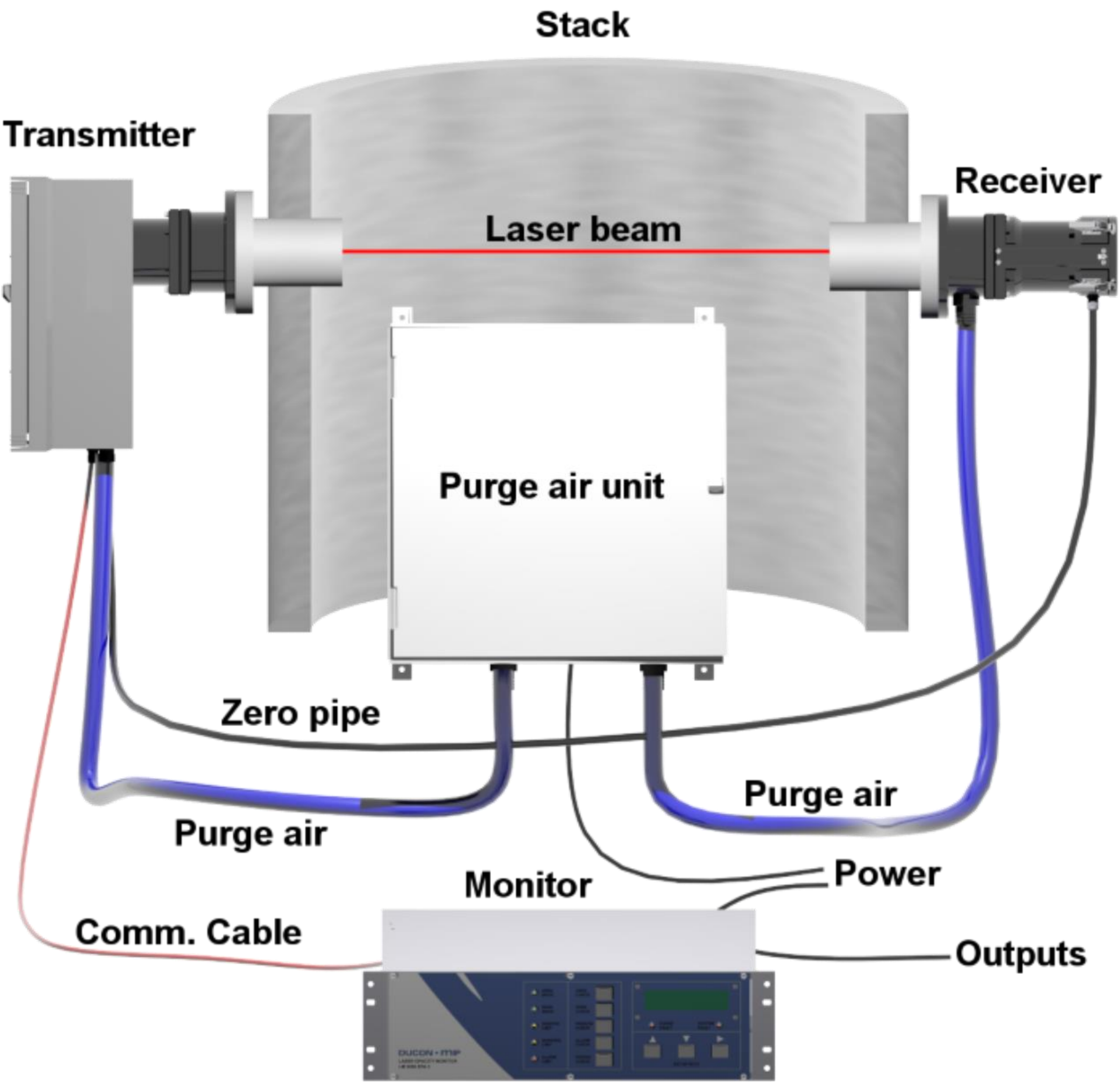
The main purpose of the simulated zero path is to track and compensate for zero changes due to dust contamination on the detector optics, and secondly to verify the correct calibration of the instrument. This is why the chopper mirror has different surfaces, much like the principle of a chopper used in gas analytical equipment. The mirrors have two types of surfaces, one a plain mirror, the second a span filter.

The nominal speed of the chopper speed is around 2000 rpm. As the zero and span mirrors are inserted into the laser path once during every rotation of the chopper, system zero and calibration are checked. Depending on the actual speed of the chopper motor, the system zero and calibration are checked approximately 40 times a second. Consequently, there is a real-time, continuous integrity check of the dirt compensation, and calibration of the instrument.

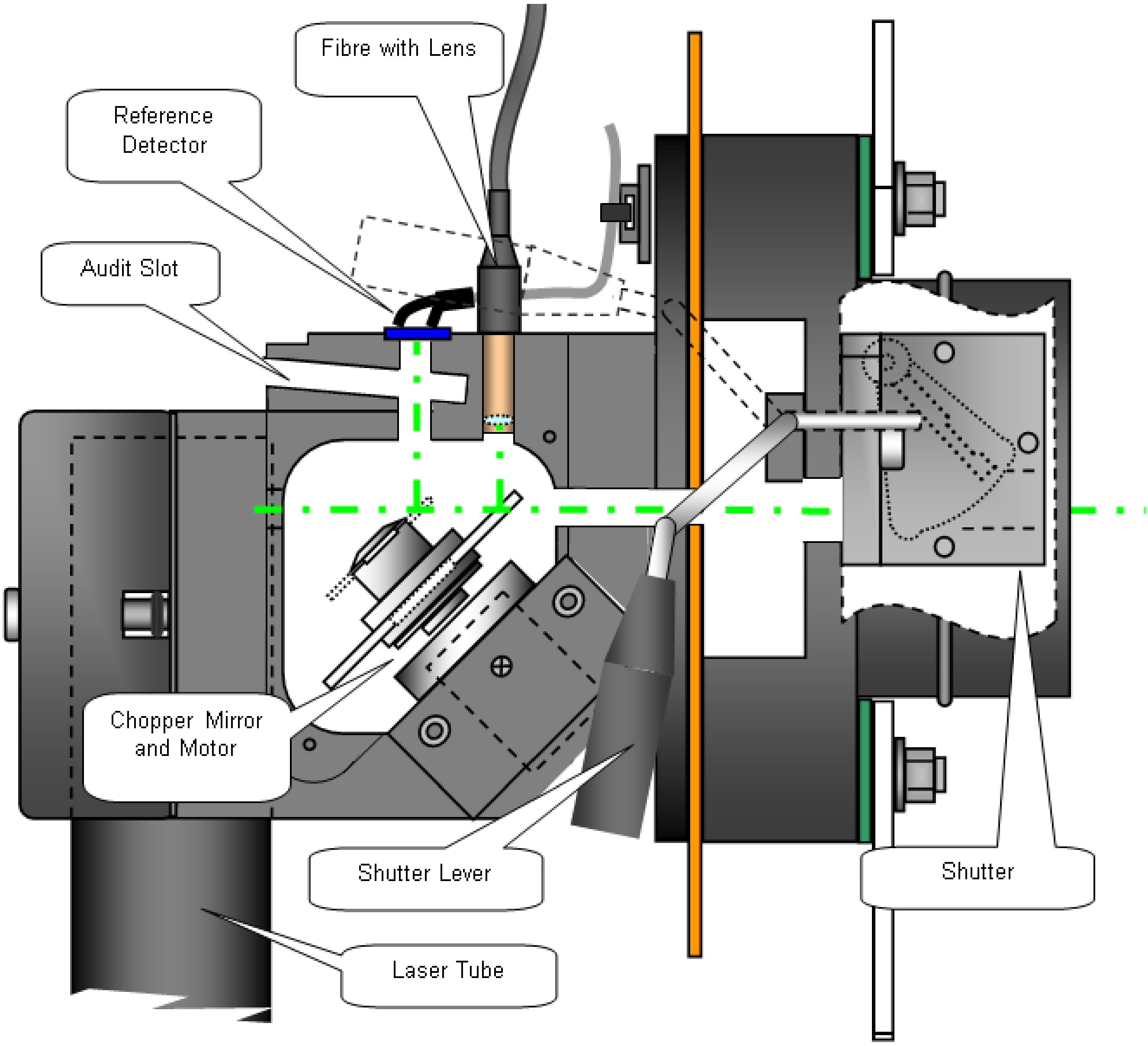
The following optical design features are noteworthy

1. Simulated zero path check uses all optical surfaces included in the main measurement path.
2. Special algorithms in the system software to differentiate dust accumulation on any zero path surfaces from dust accumulation on the monitoring path surfaces.
3. All main chopper signals monitoring reference, zero and calibration beam intensities are easily accessible at the service mode display. All service values are constantly monitored for out of range values to ensure valid data.
4. An optical block designed for the audit filter checks. Since the unit uses and independent zero path-length, this allows audits to be performed in situ without the need to remove any monitoring equipment from the stack. Incorporated into this system are several software features that simplify and record the audit filter results. No filter correction is needed as long as the Stack Exit Correction (SEC, aka Stack Taper Ratio) value has been correctly inputted into the controller unit.

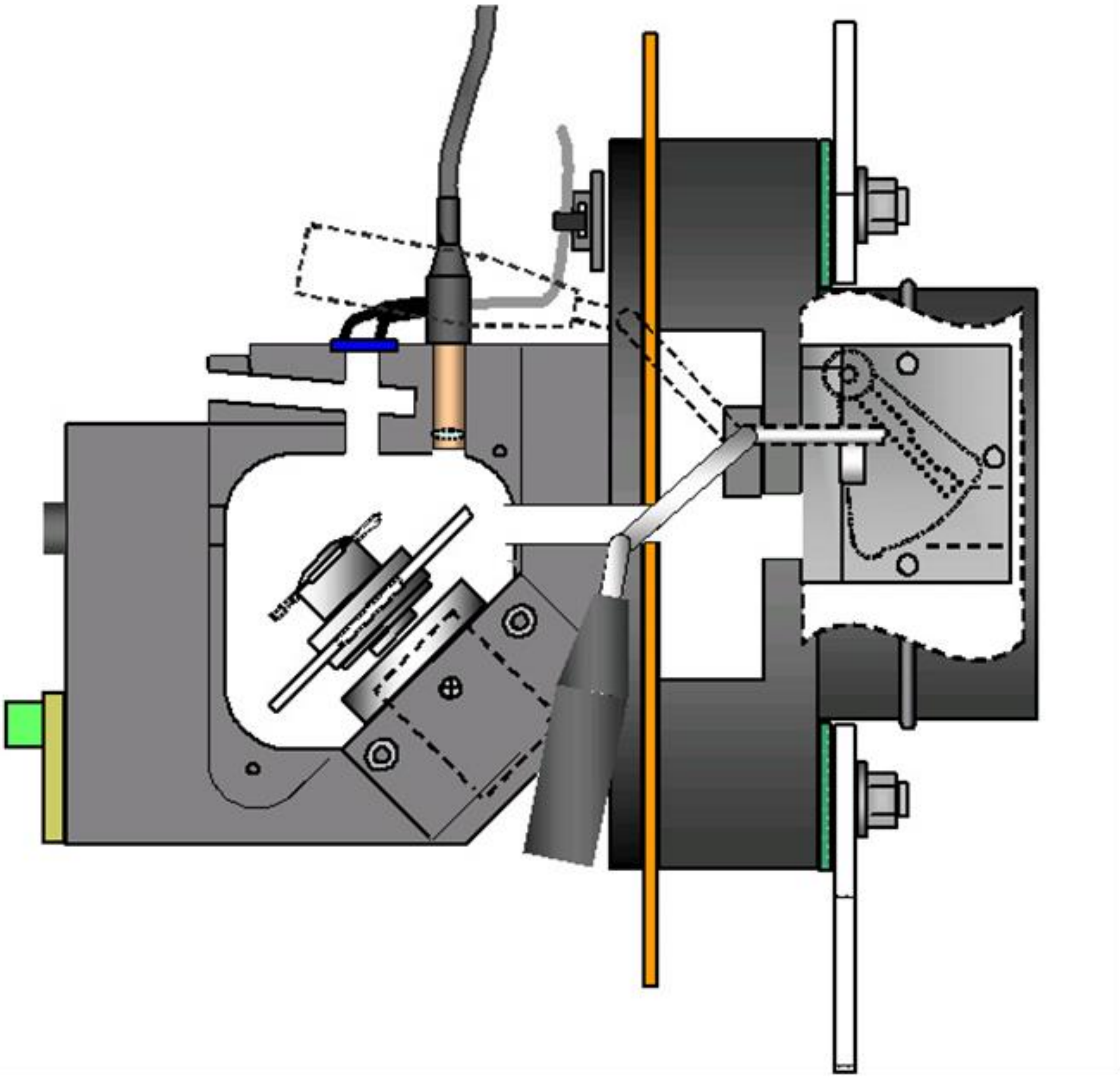
8.2 LM 3086 EPA3/SE LASER OPACITY AND DUST MONITOR



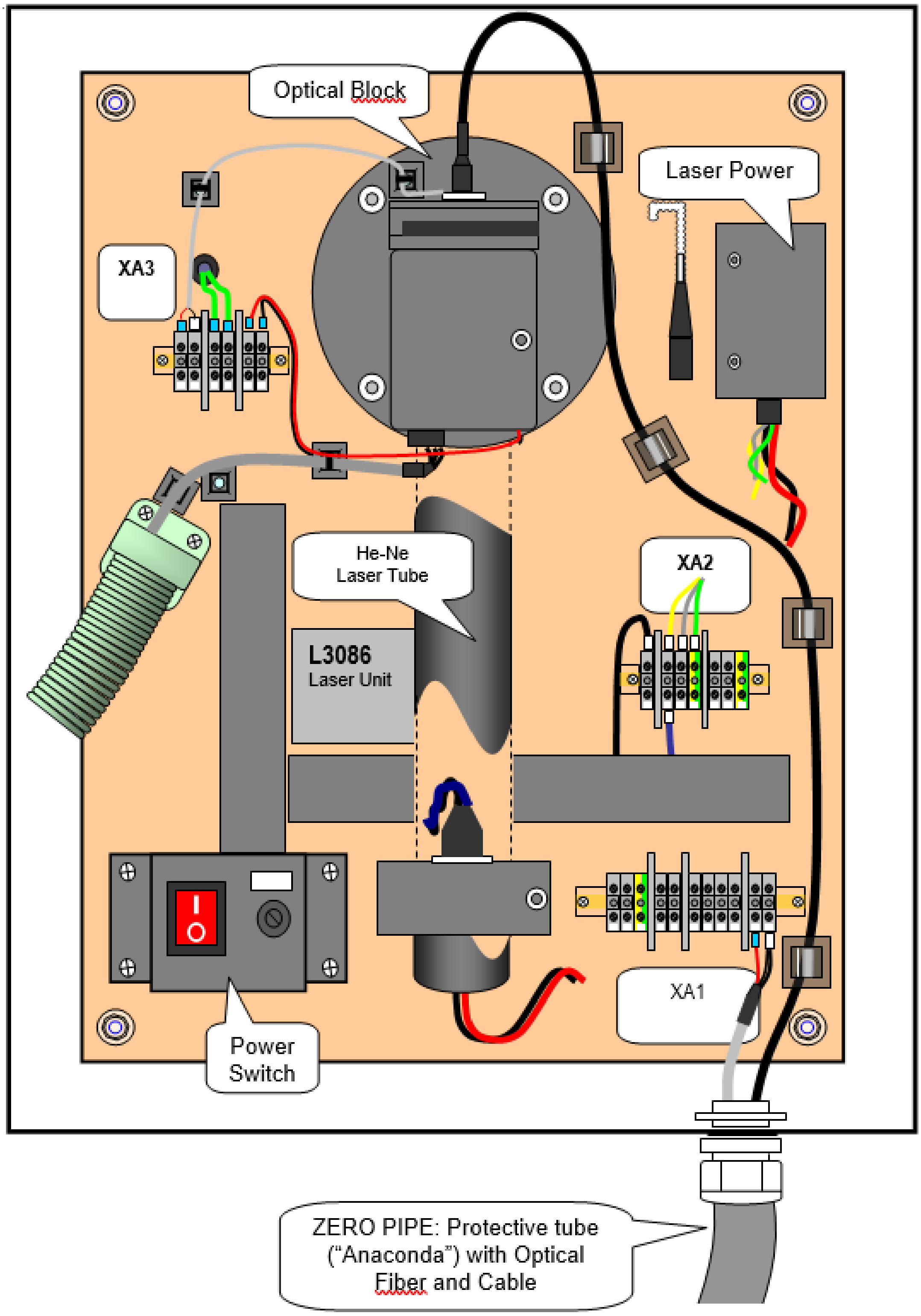
8.3 OPTICAL BLOCK FOR LM3086 EPA3



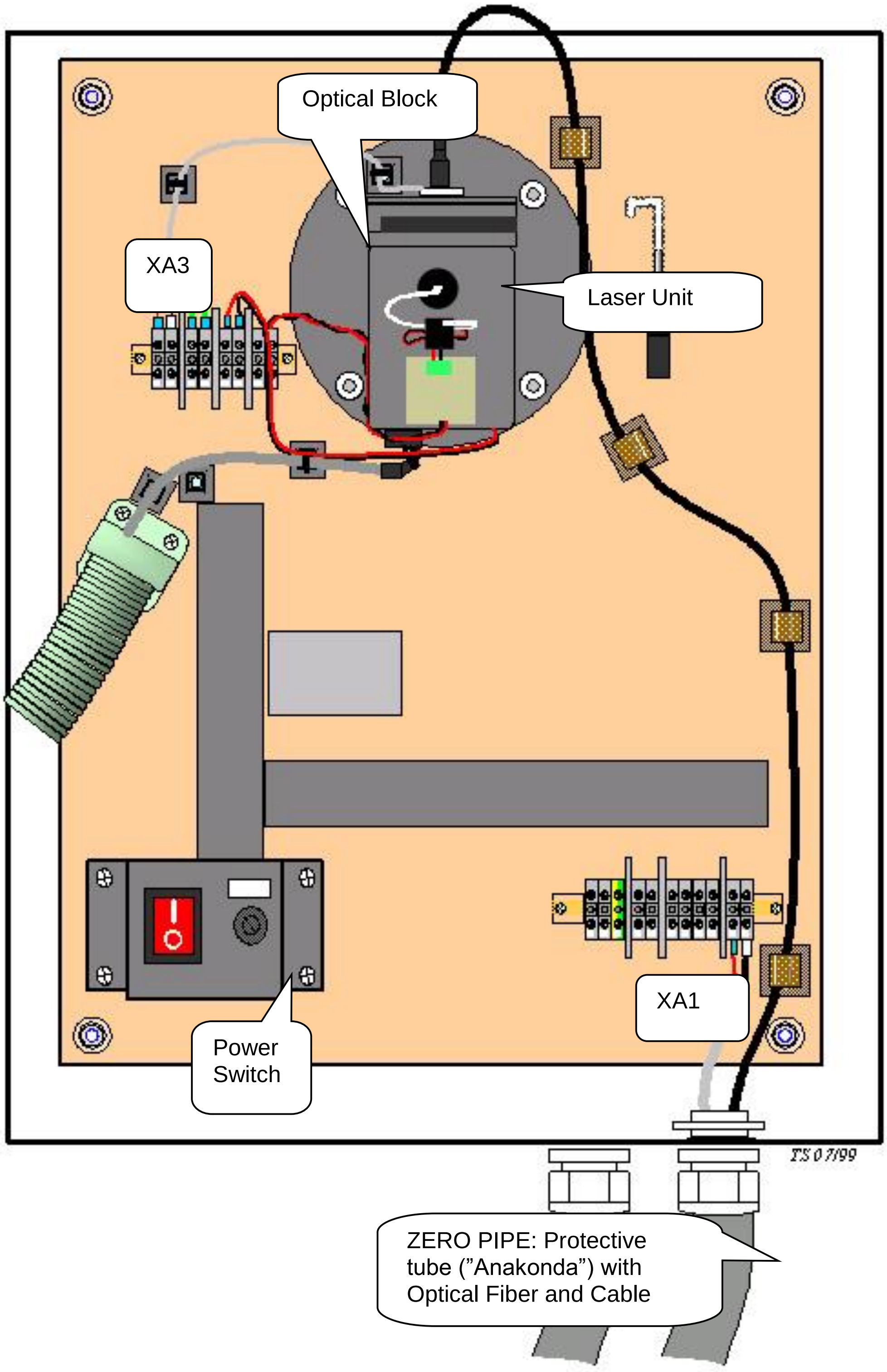
8.4 OPTICAL BLOCK FOR LM 3086 SE



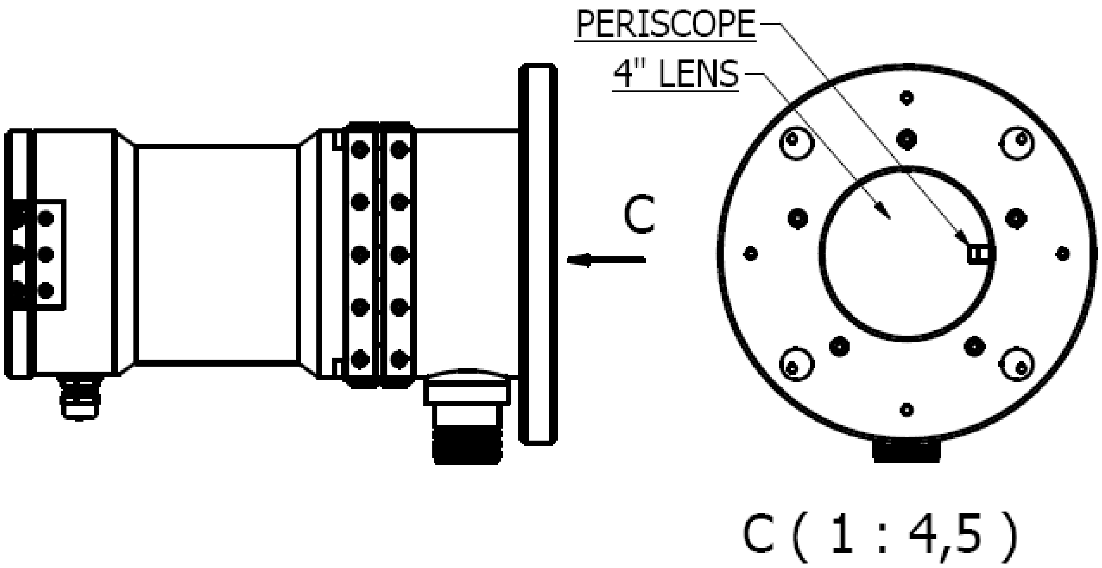
8.5 LM3086 EPA3 LASER UNIT

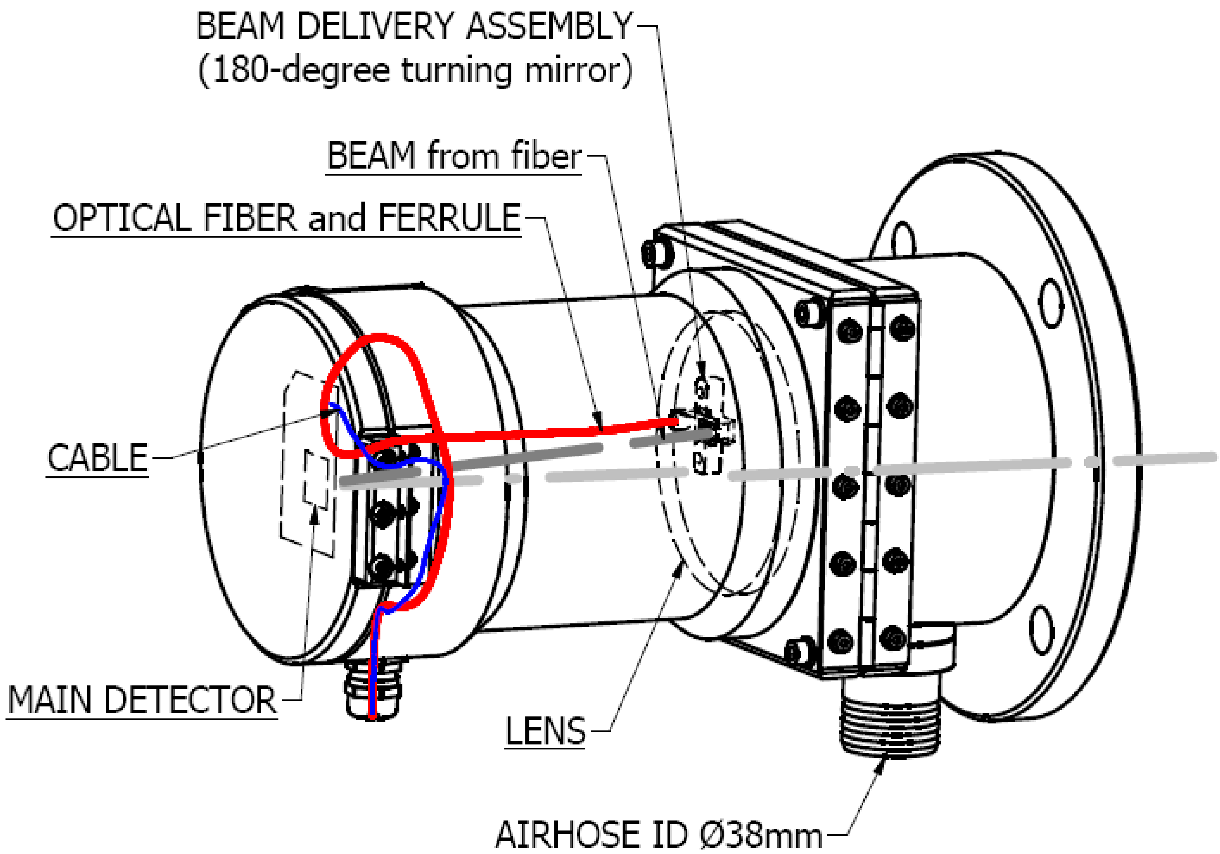


8.6 LM3086 SE LASER UNIT



8.7 LM3086 EPA3/SE RECEIVER UNIT





8.8 SUITABLE AUDIT FILTERS FOR AUDIT SLOT

A: Cal Check certified audit filter – current model with plunge pins to secure on place

Suitable for most of LM 3086 EPA3 / SE /SER models

B: Cal Check certified audit filter – older model

Suitable for LM 3086 series, except LM 3086 EPA2

C: Audit filter for special filter values – with plunge pins to secure on place

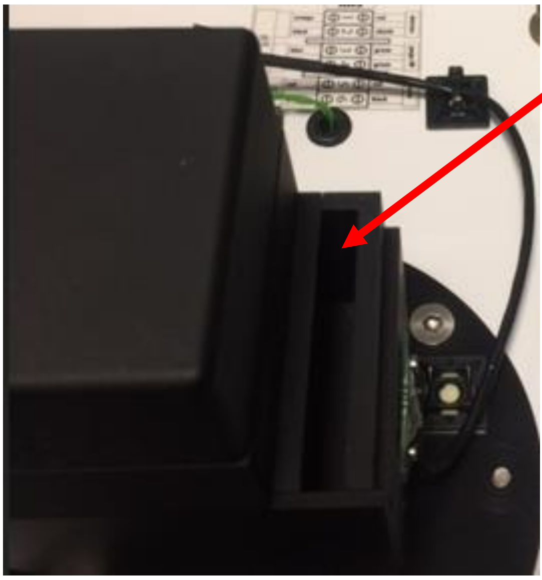
Suitable for most of LM 3086 EPA3 / SE /SER models

D: As well plain neutral density filter, absorption type can be used

(50 x 50 mm size is recommended)

8.9 AUDIT FILTER MOUNTING ORIENTATION AND BEST PRACTISES

Note! Audit filter shouldn't block laser beam! Filter with frame needs to be installed so that the glass edge of the filter goes to the bottom of the audit slot.

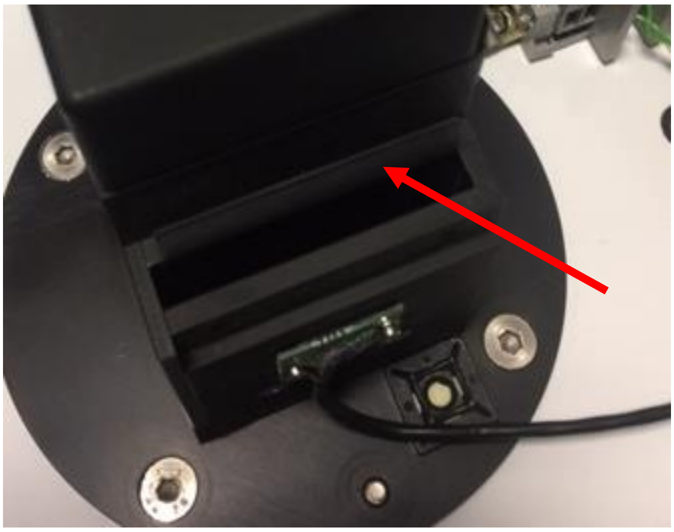


Empty audit slot

Audit slot needs to be empty in normal operation!

Install audit filter only when audit light is steady (not blinking)

D: Plain neutral density filter:

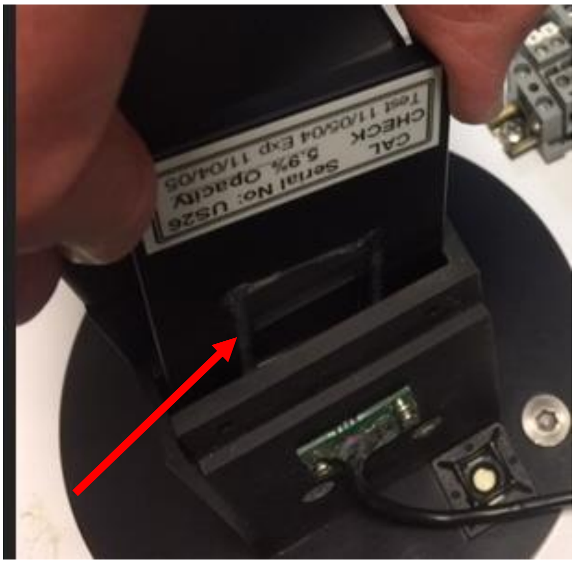


Stays in slot with its own weight

Can be installed any way, but use always the same way (make markings on filter that points correct position and mounting direction)

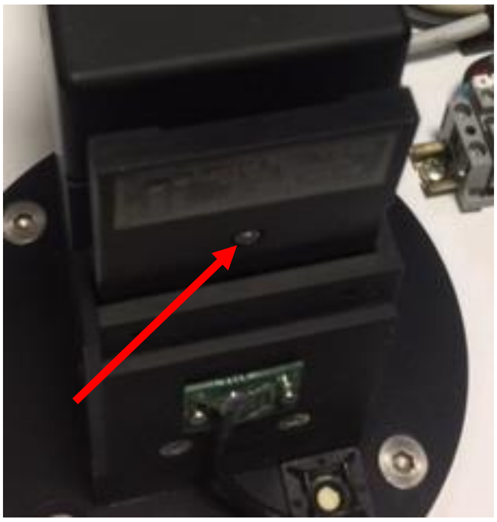
Do not touch the glass (hold filter at edges)

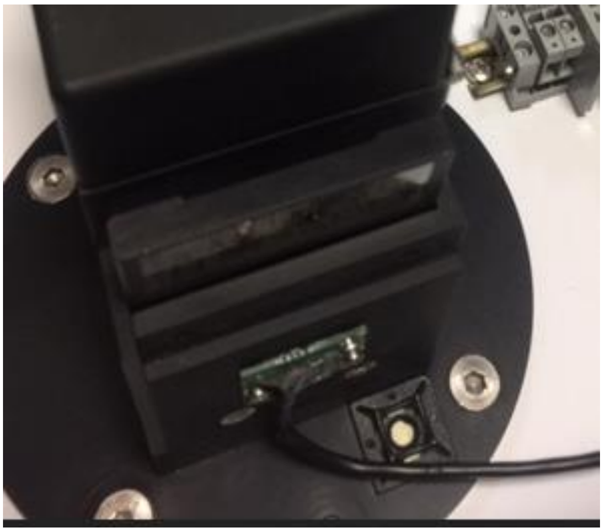
B: Cal Check certified audit filter - older model:



- Stays in slot with its own weight
- Install that audit filters silicon fitting is towards detector. <u>Audit filter can move in slot so install every time into the same position!</u>
- **Do not touch the glass**

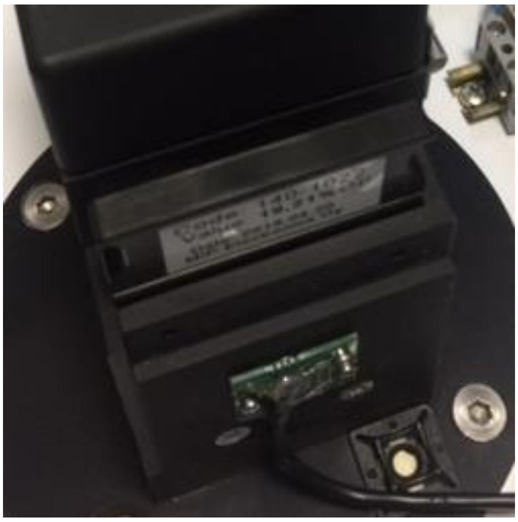
A: Cal Check certified audit filter - current model with plunge pins to secure on place:





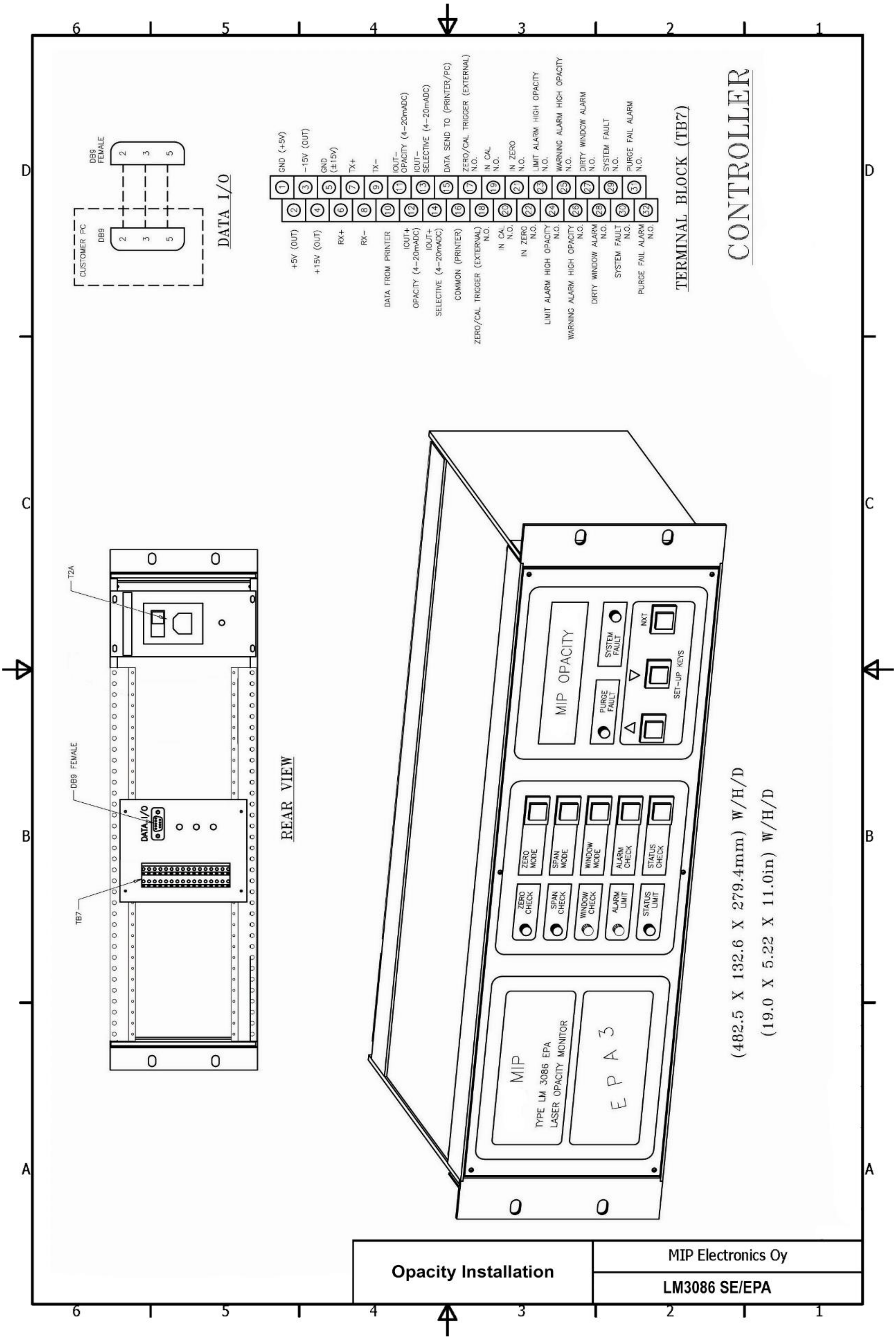
- Forced to stays in slot with plunge pins
- Install that audit filters silicon fitting is towards detector. <u>Push all the way to the bottom (may need some force)!</u>
- **Do not touch the glass**

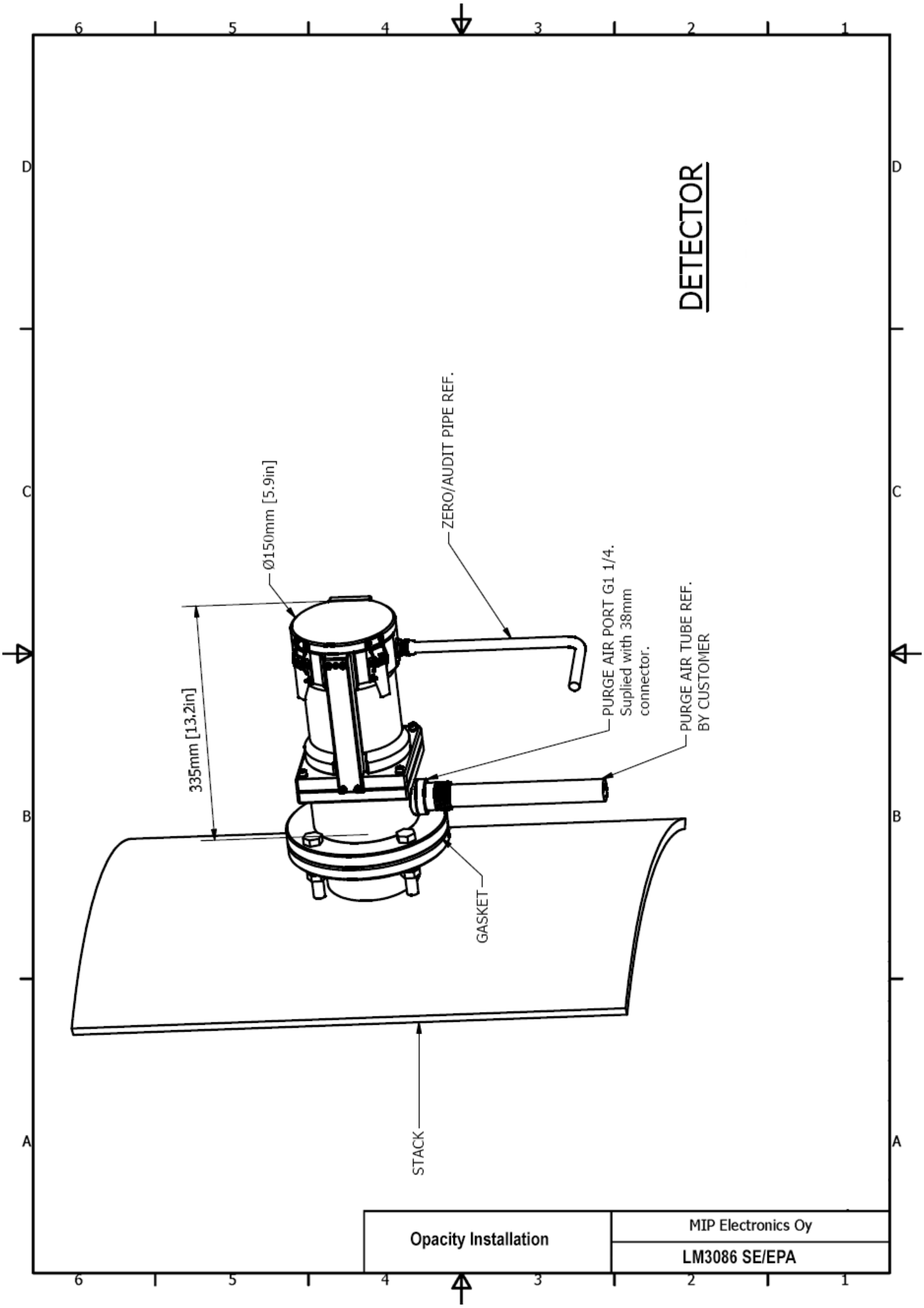
C: Audit filter for special filter values – with plunge pins to secure on place:

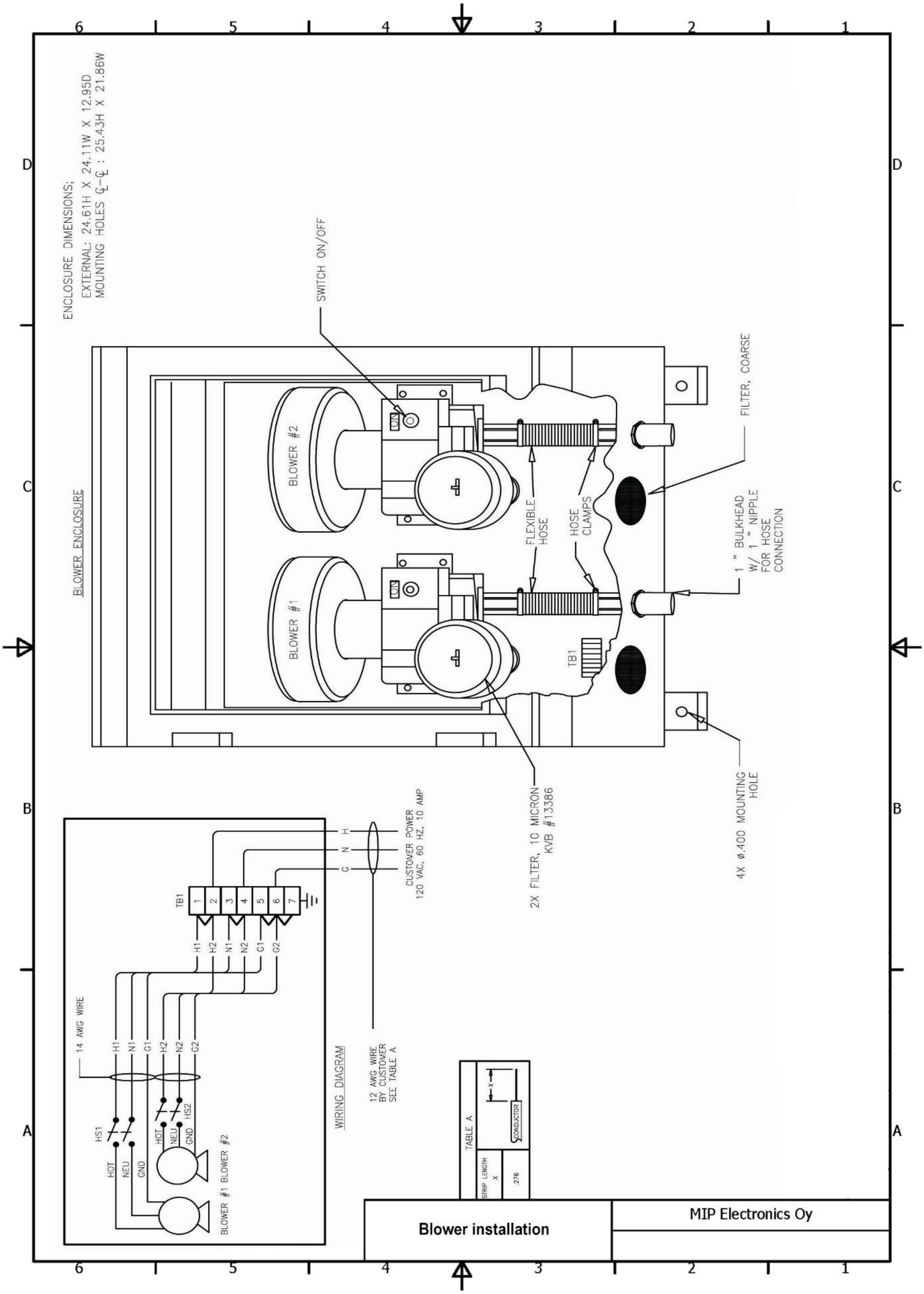


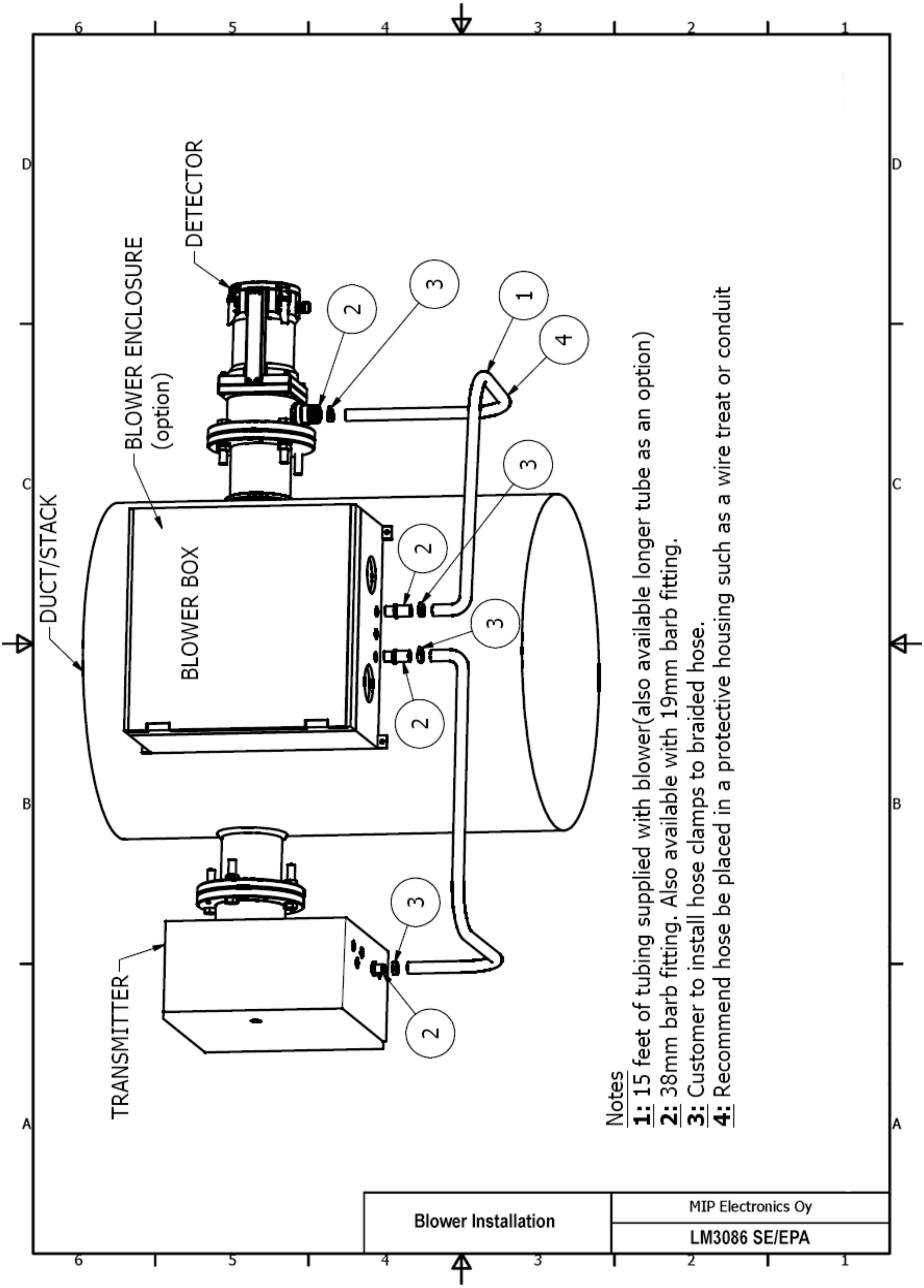
- Forced to stays in slot with plunge pins
- Install that label is towards detector. <u>Push all the way to the bottom (may need some force)!</u>
- **Do not touch the glass**

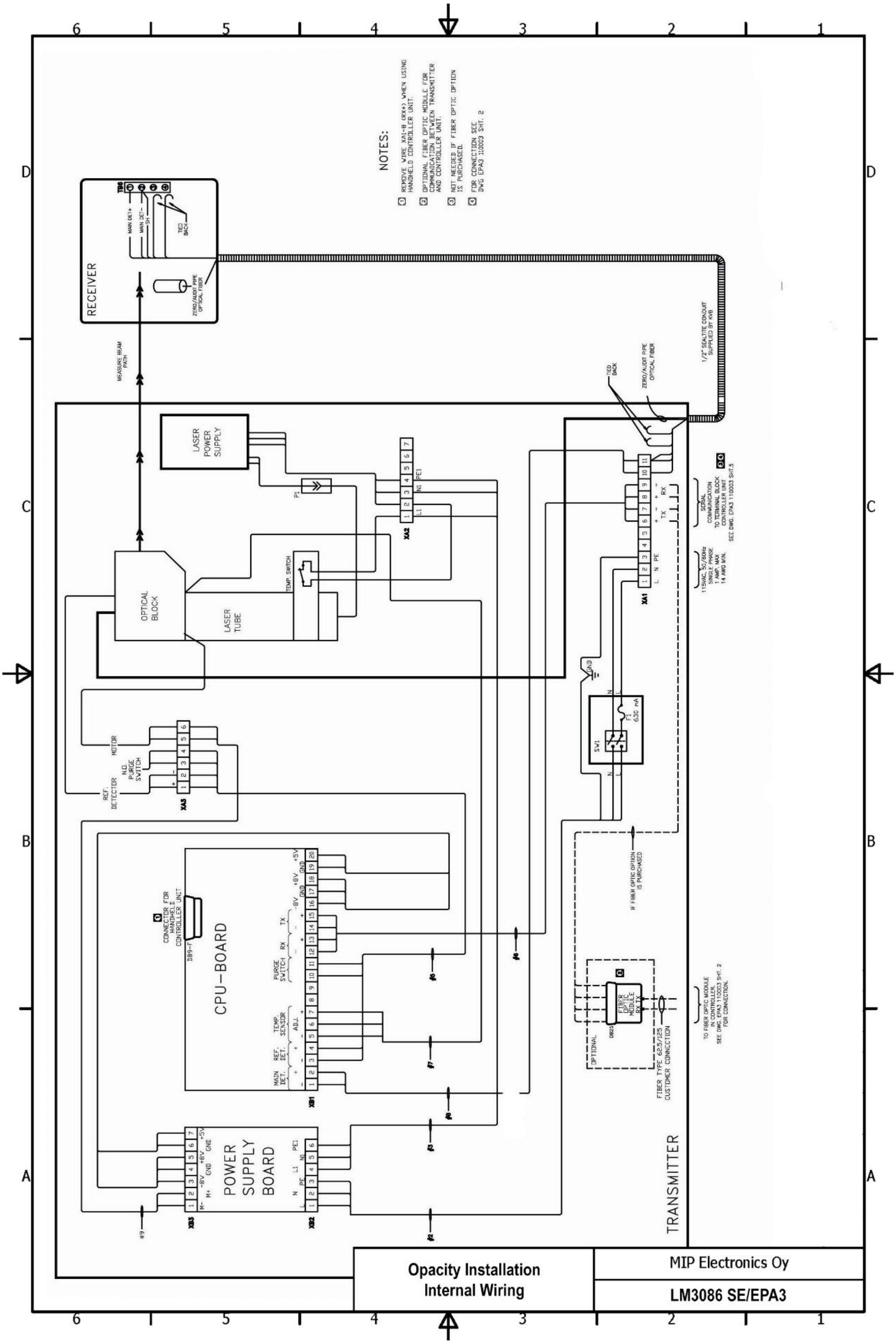
DRAWINGS

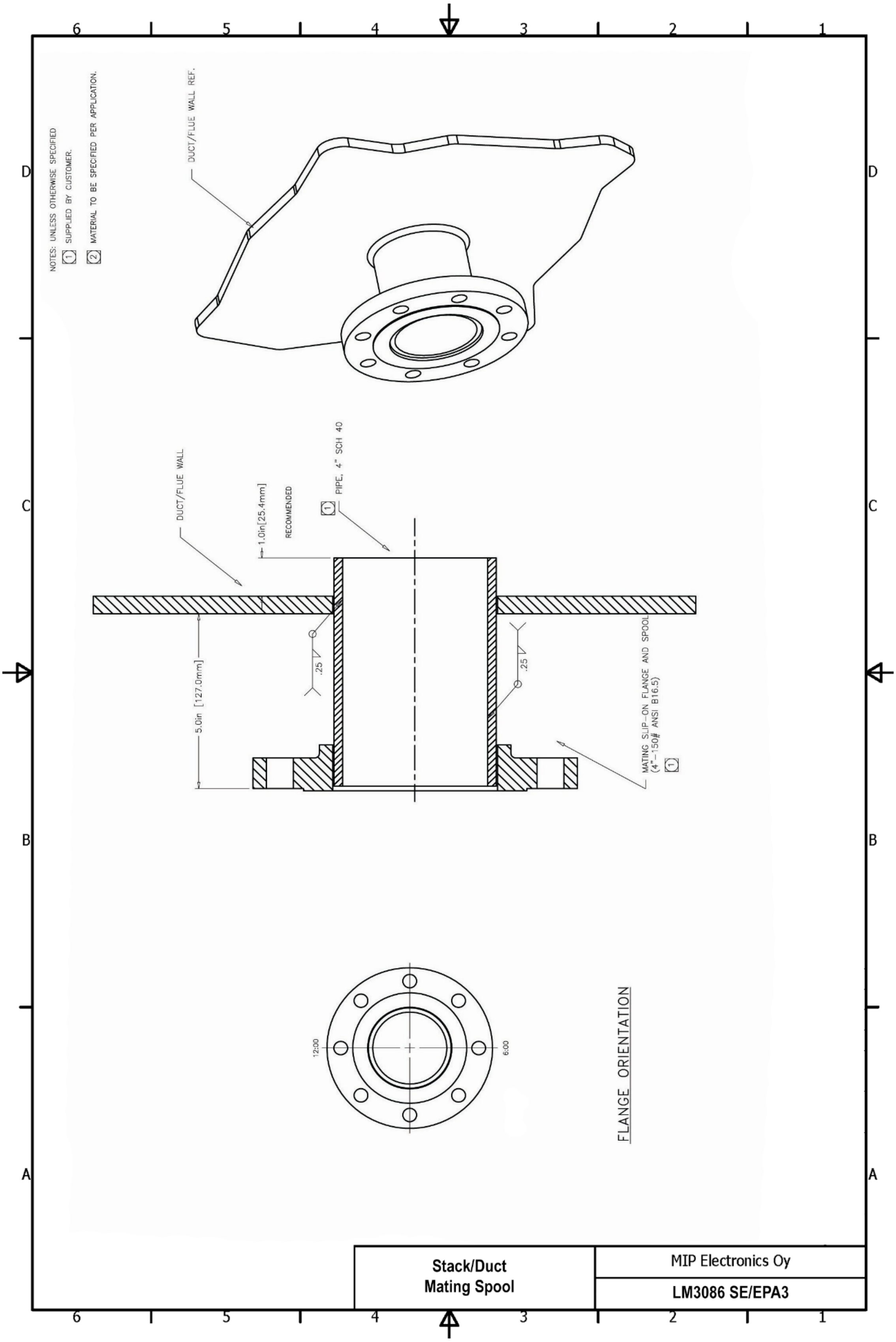

CONTROLLER
TERMINAL BLOCK (TB7)
DATA I/O
REAR VIEW
(482.5 X 132.6 X 279.4mm) W/H/D
(19.0 X 5.22 X 11.0in) W/H/D
MIP OPACITY
SYSTEM FAULT
PURGE FAULT
SET-UP KEYS
MIP TYPE LM 3086 EPA LASER OPACITY MONITOR
EPA 3
Opacity Installation
MIP Electronics Oy
LM3086 SE/EPA


DETECTOR
ZERO/AUDIT PIPE REF.
Ø150mm [5.9in]
335mm [13.2in]
PURGE AIR PORT G1 1/4.
Suplied with 38mm
connector.
PURGE AIR TUBE REF.
BY CUSTOMER
GASKET
STACK
Opacity Installation
MIP Electronics Oy
LM3086 SE/EPA


ENCLOSURE DIMENSIONS;
EXTERNAL: 24.61H X 24.11W X 12.95D
MOUNTING HOLES ℄-℄ : 25.43H X 21.86W
SWITCH ON/OFF
BLOWER ENCLOSURE
BLOWER #2
BLOWER #1
FLEXIBLE HOSE
HOSE CLAMPS
FILTER, COARSE
1 " BULKHEAD W/ 1 " NIPPLE FOR HOSE CONNECTION
TB1
4X ø.400 MOUNTING HOLE
2X FILTER, 10 MICRON KVB #13386
CUSTOMER POWER 120 VAC, 60 HZ, 10 AMP
H
N
G
14 AWG WIRE
H1
H2
N1
N2
G1
G2
HS1
HS2
HOT
NEU
GND
BLOWER #1
BLOWER #2
WIRING DIAGRAM
12 AWG WIRE BY CUSTOMER SEE TABLE A
TABLE A
STRIP LENGTH X
.276
CONDUCTOR
Blower installation
MIP Electronics Oy


DETECTOR
BLOWER ENCLOSURE (option)
DUCT/STACK
BLOWER BOX
TRANSMITTER
Notes
1: 15 feet of tubing supplied with blower(also available longer tube as an option)
2: 38mm barb fitting. Also available with 19mm barb fitting.
3: Customer to install hose clamps to braided hose.
4: Recommend hose be placed in a protective housing such as a wire treat or conduit
Blower Installation
MIP Electronics Oy
LM3086 SE/EPA


Opacity Installation
Internal Wiring
MIP Electronics Oy
LM3086 SE/EPA3


NOTES: UNLESS OTHERWISE SPECIFIED
1 SUPPLIED BY CUSTOMER.
2 MATERIAL TO BE SPECIFIED PER APPLICATION.
DUCT/FLUE WALL REF.
DUCT/FLUE WALL
1.0in [25.4mm]
RECOMMENDED
1 PIPE, 4" SCH 40
5.0in [127.0mm]
.25
.25
MATING SLIP-ON FLANGE AND SPOOL
(4"-150# ANSI B16.5)
1
12:00
6:00
FLANGE ORIENTATION
Stack/Duct
Mating Spool
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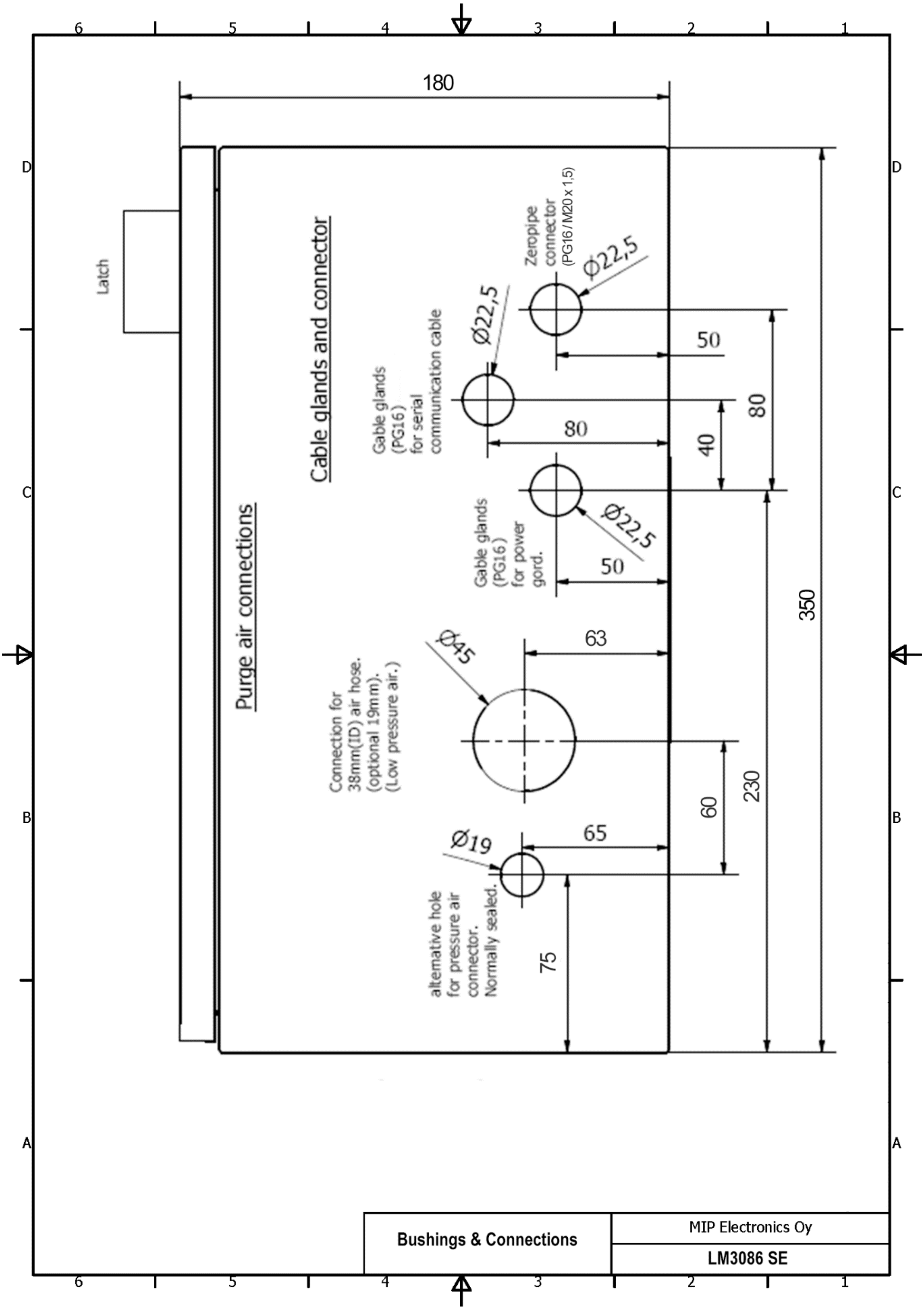
180
Latch
Cable glands and connector
Purge air connections
Zeropipe connector (PG16 / M20 x 1,5)
Ø22,5
Gable glands (PG16) for serial communication cable
Ø22,5
50
80
40
80
Gable glands (PG16) for power gord.
Ø22,5
50
350
Ø45
63
Connection for 38mm(ID) air hose. (optional 19mm). (Low pressure air.)
230
60
Ø19
65
alternative hole for pressure air connector. Normally sealed.
75
Bushings & Connections
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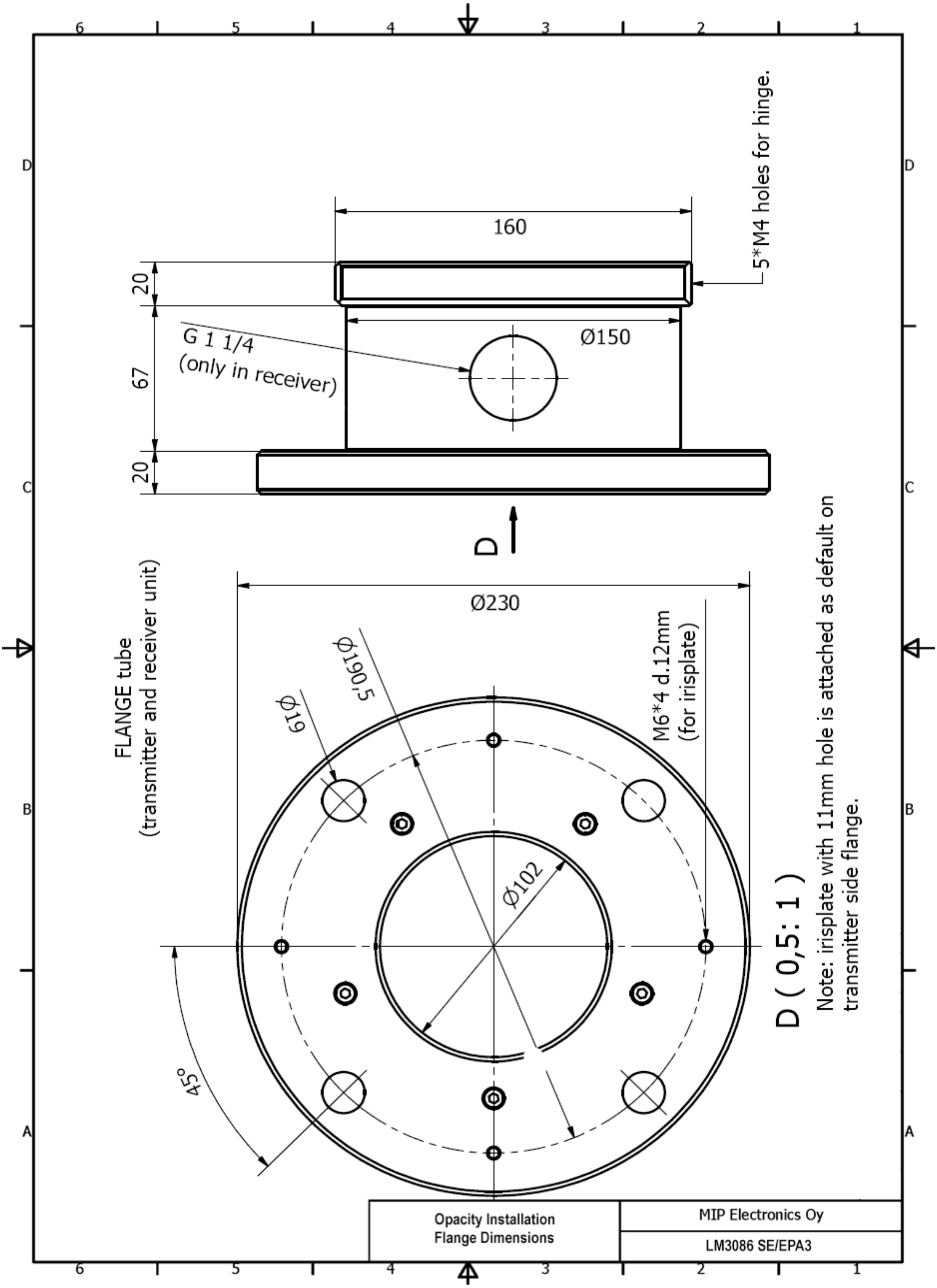
LM3086 SE


5*M4 holes for hinge.
160
20
67
20
G 1 1/4
(only in receiver)
Ø150
D
Ø230
Ø190,5
Ø19
Ø102
45°
M6*4 d.12mm
(for irisplate)
FLANGE tube
(transmitter and receiver unit)
D (0,5: 1)
Note: irisplate with 11mm hole is attached as default on
transmitter side flange.
Opacity Installation
Flange Dimensions
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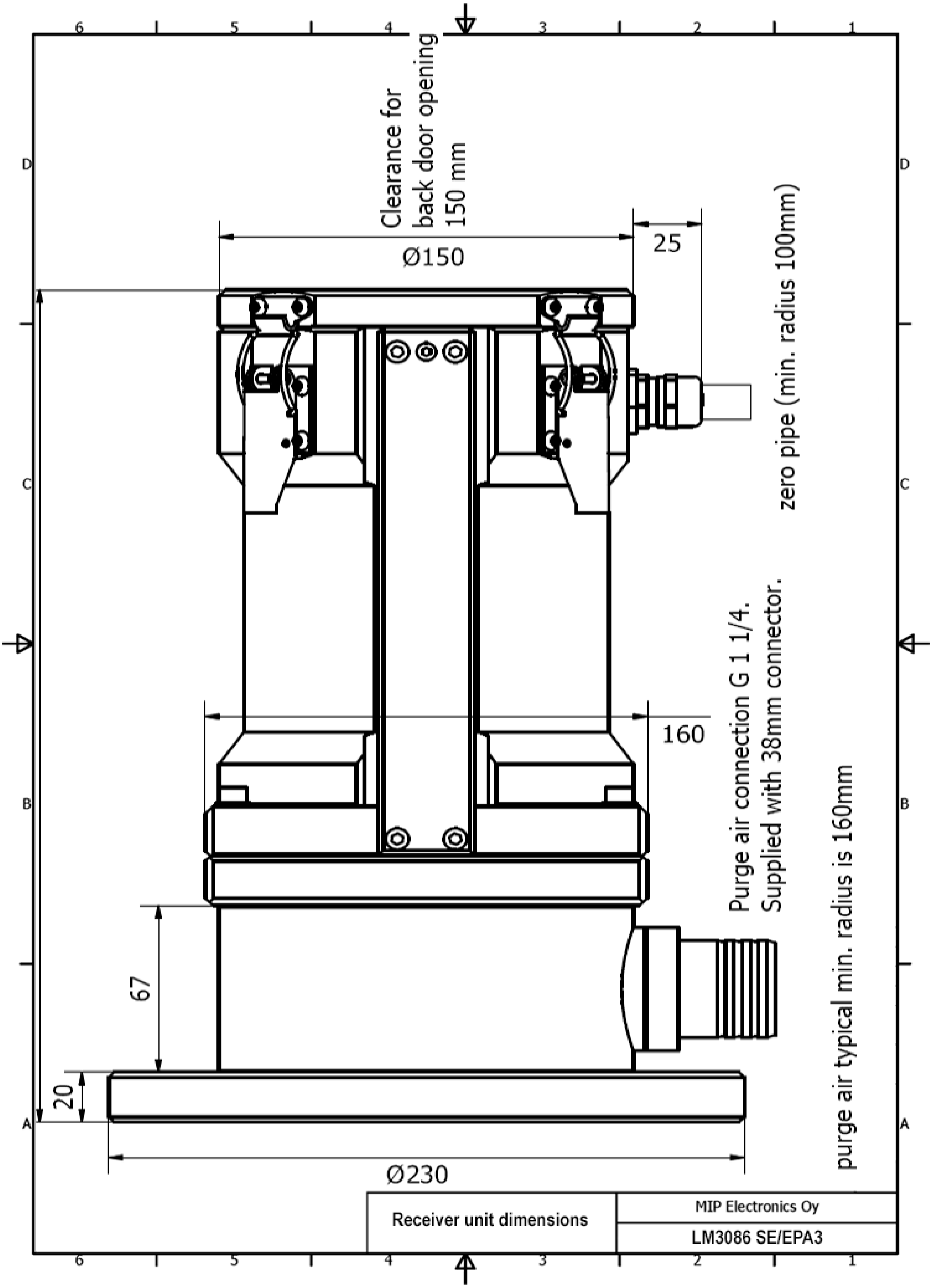
Clearance for back door opening 150 mm
Ø150
25
zero pipe (min. radius 100mm)
160
Purge air connection G 1 1/4.
Supplied with 38mm connector.
purge air typical min. radius is 160mm
67
20
Ø230
Receiver unit dimensions
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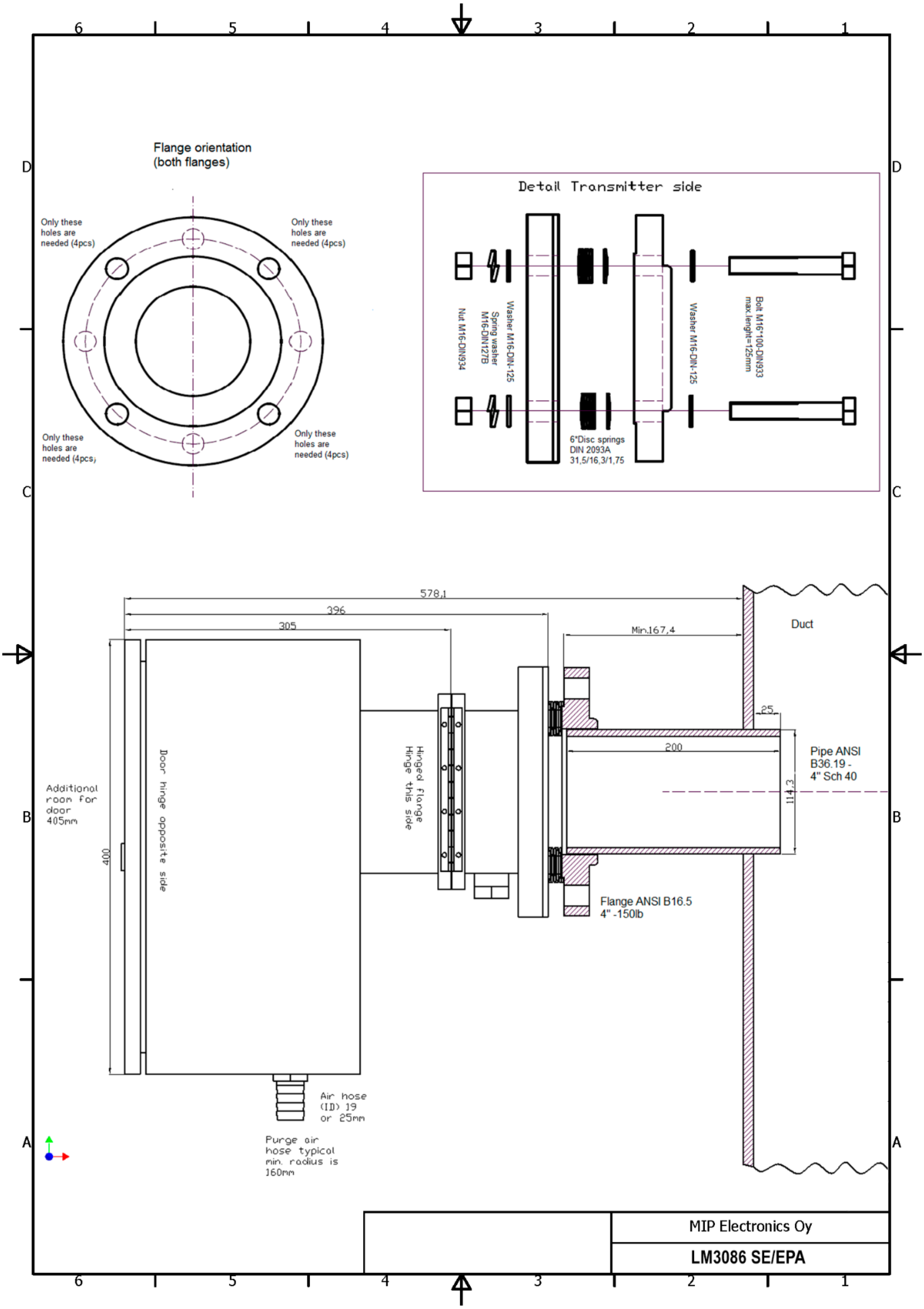
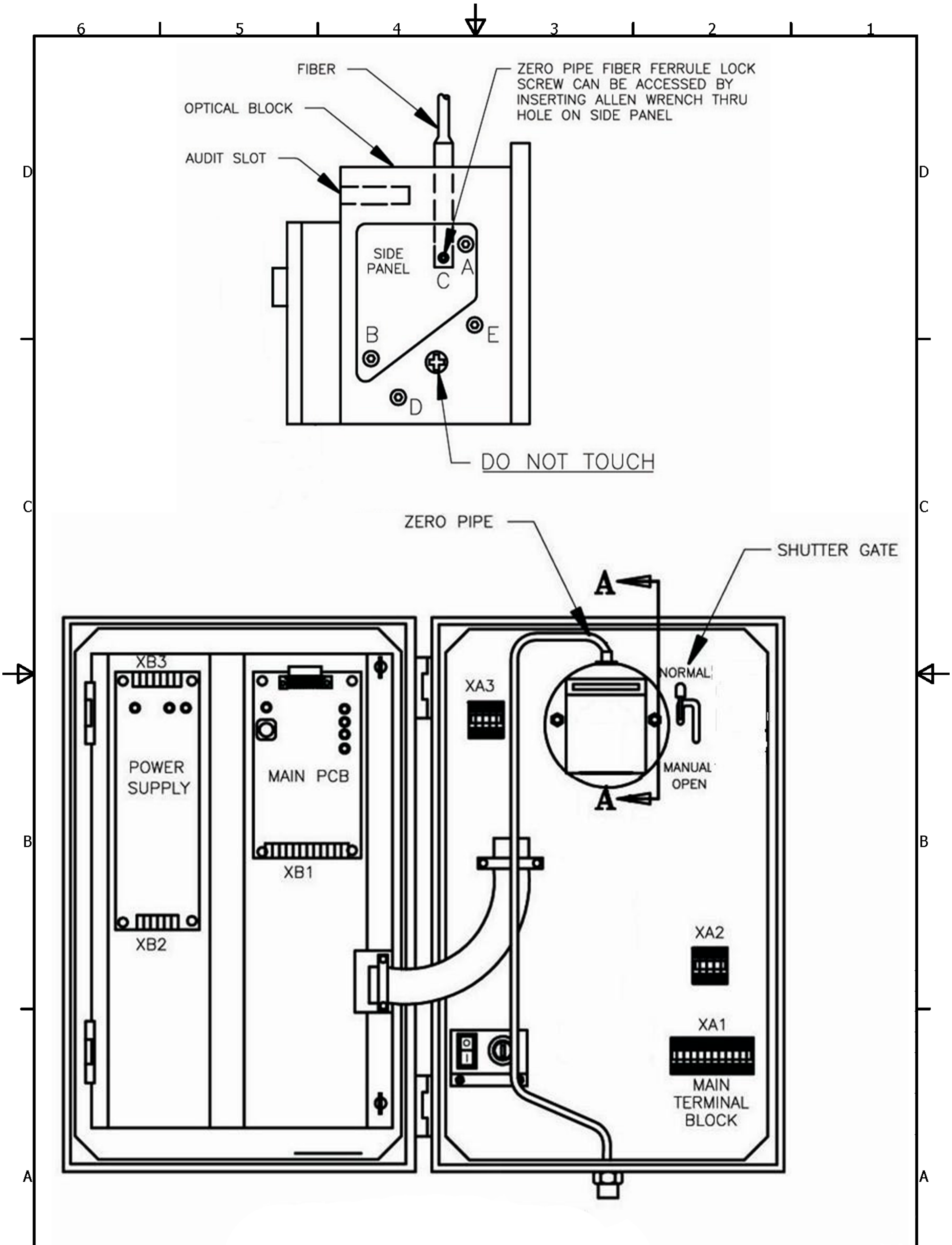

Flange orientation
(both flanges)
Only these holes are needed (4pcs)
Only these holes are needed (4pcs)
Only these holes are needed (4pcs)
Only these holes are needed (4pcs)
Detail Transmitter side
Nut M16-DIN934
Spring washer M16-DIN127B
Washer M16-DIN-125
6*Disc springs DIN 2093A 31,5/16,3/1,75
Washer M16-DIN-125
Bolt M16*100-DIN933 max.lenght=125mm
578,1
396
305
Min.167,4
Duct
25
200
Pipe ANSI B36.19 - 4" Sch 40
114,3
Flange ANSI B16.5 4" -150lb
Hinged flange
Hinge this side
Door hinge opposite side
Additional room for door 405mm
400
Air hose (ID) 19 or 25mm
Purge air hose typical min. radius is 160mm
MIP Electronics Oy
LM3086 SE/EPA



Internal Layout	MIP Electronics Oy
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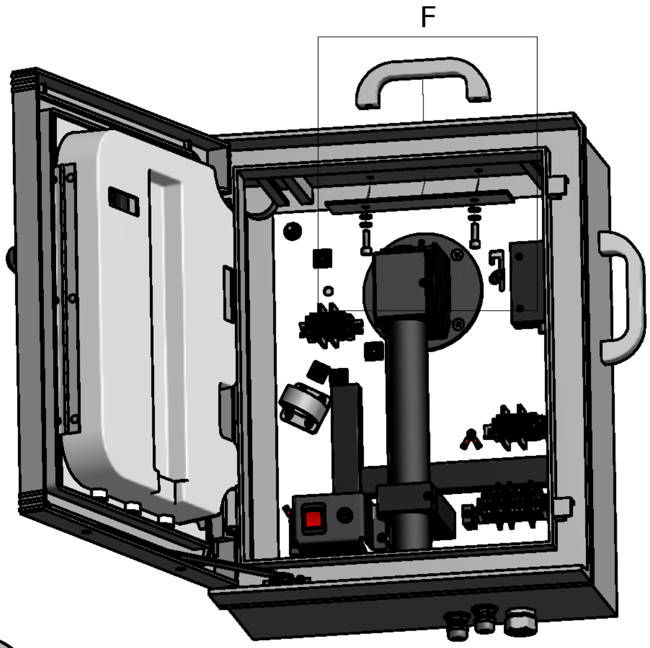
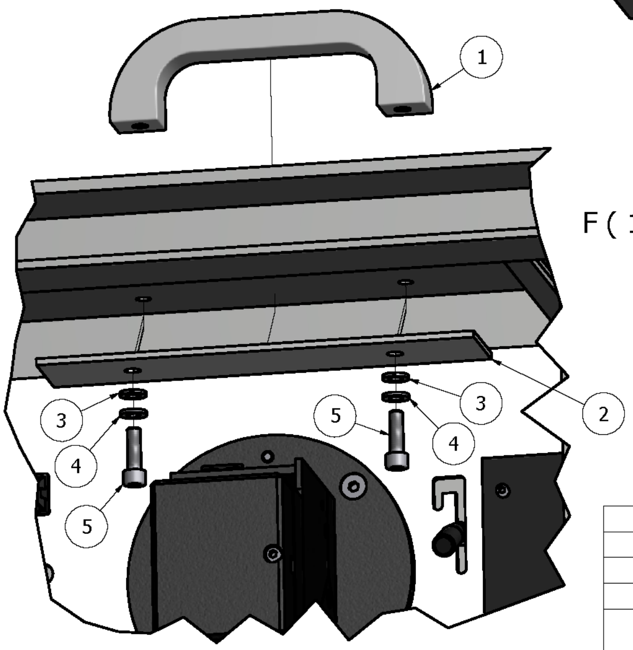
For top:





F (1 : 1,8)

Parts List		
ITEM	QTY	DESCRIPTION
1	2	Handle
2	2	Handle plate
3	4	Spring washer DIN 127b 6mm
4	4	washer DIN 125 A4 6mm
5	4	Socket cap screw DIN 912 M6x20 A4 or hex bolt DIN 933 M6x20 A4

Carrying Handles	MIP Electronics Oy
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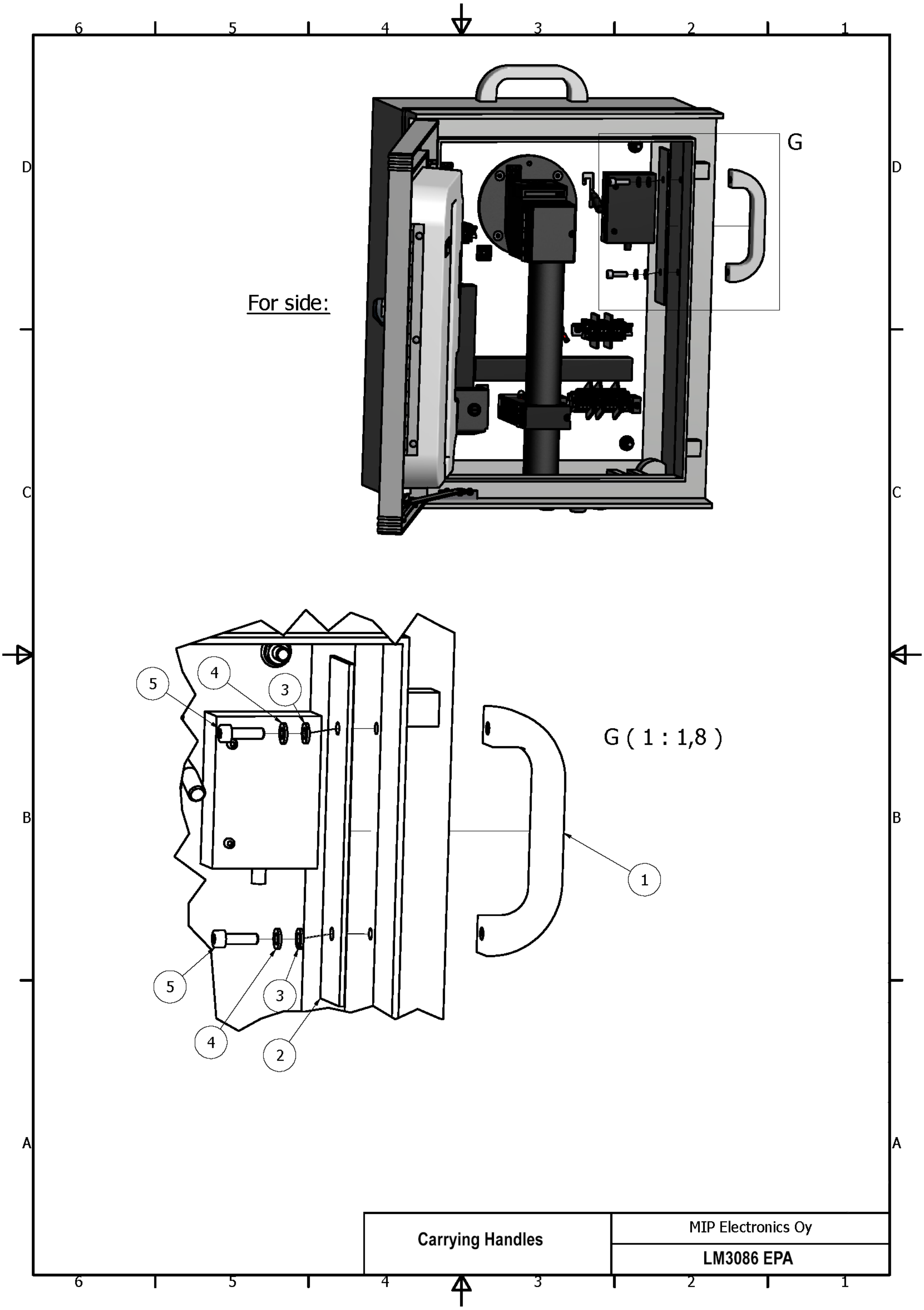
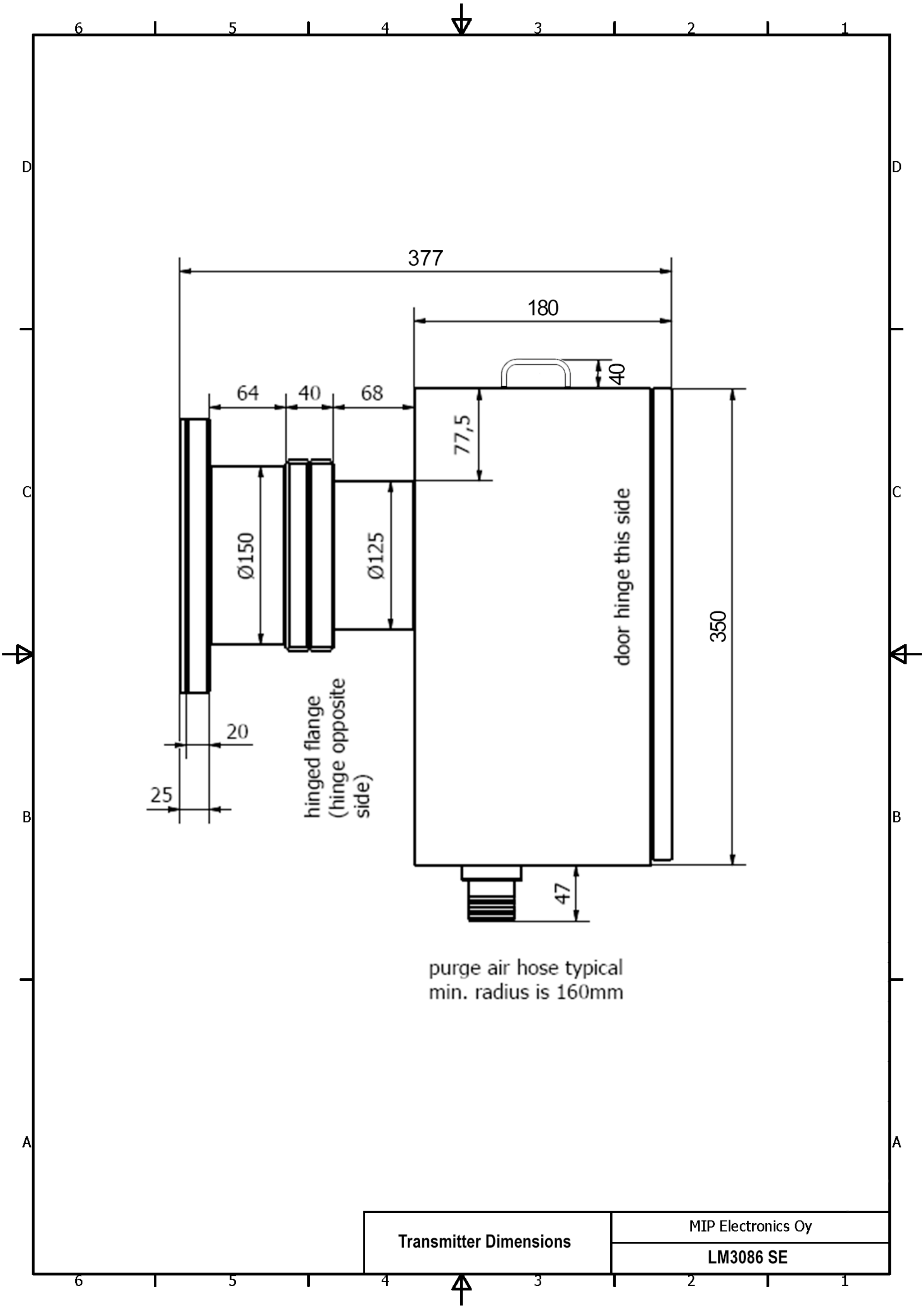

6
5
4
3
2
1
D
C
B
A
For side:
G
G (1 : 1,8)
1
2
3
4
5
Carrying Handles
MIP Electronics Oy
LM3086 EPA


377
180
64
40
68
40
77,5
Ø150
Ø125
door hinge this side
350
20
25
hinged flange (hinge opposite side)
47
purge air hose typical min. radius is 160mm
Transmitter Dimensions
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LM3086 SE