ABB MEASUREMENT & ANALYTICS | COMMISSIONING INSTRUCTION

AO2000-LS25

Laser analyzers

General purpose and explosion-proof variants

Measurement made easy

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1 Introduction

1.1 General

This manual contains information of installation, operation and maintenance of the AO2000-LS25 Laser analyzer. A description of the analyzer and its basic features is also included.

Please read sections 3 and 4 carefully before using the analyzer. It is a sophisticated instrument utilizing state-of-the-art electronic and laser technology. Installation and maintenance of the instrument require care and preparation. Failure to do so may damage the instrument and void the warranty.

1.2 Measuring principle

The analyzer is an optical instrument for continuous in-situ gas monitoring in stack, pipes, process chambers or similar and is based on tunable diode laser absorption spectroscopy (TDLAS). The analyzer utilizes a transmitter/receiver configuration (mounted diametrically opposite each other) to measure the average gas concentration along the line-of-sight path.

The measuring principle is infrared single-line absorption spectroscopy, which is based on the fact that each gas has distinct absorption lines at specific wavelengths. The measuring principle is illustrated in Figure 1-1. The laser wavelength is scanned across a chosen absorption line of the gas to be measured. The absorption line is carefully selected to avoid cross interference from other (background) gases. The detected light intensity varies as a function of the laser wavelength due to absorption of the targeted gas molecules in the optical path between transmitter and receiver. In order to increase sensitivity the wavelength modulation technique is employed: the laser wavelength is slightly modulated while scanning the absorption line. The detector signal is spectrally decomposed into frequency components at harmonics of the laser modulation frequency. The second harmonics of the signal is used to measure the concentration of the absorbing gas. The line amplitude and line width are both extracted from the second harmonics line shape, which makes the measured concentration insensitive to line shape variations (line broadening effect) caused by background gases.

NOTE: The analyzer measures the concentration of only the FREE molecules of the specific gas, thus not being sensitive to the molecules bound with some other molecules into complexes and to the molecules attached to or dissolved in particles and droplets. Care should be taken when comparing the measurements with the results from other measurement techniques.

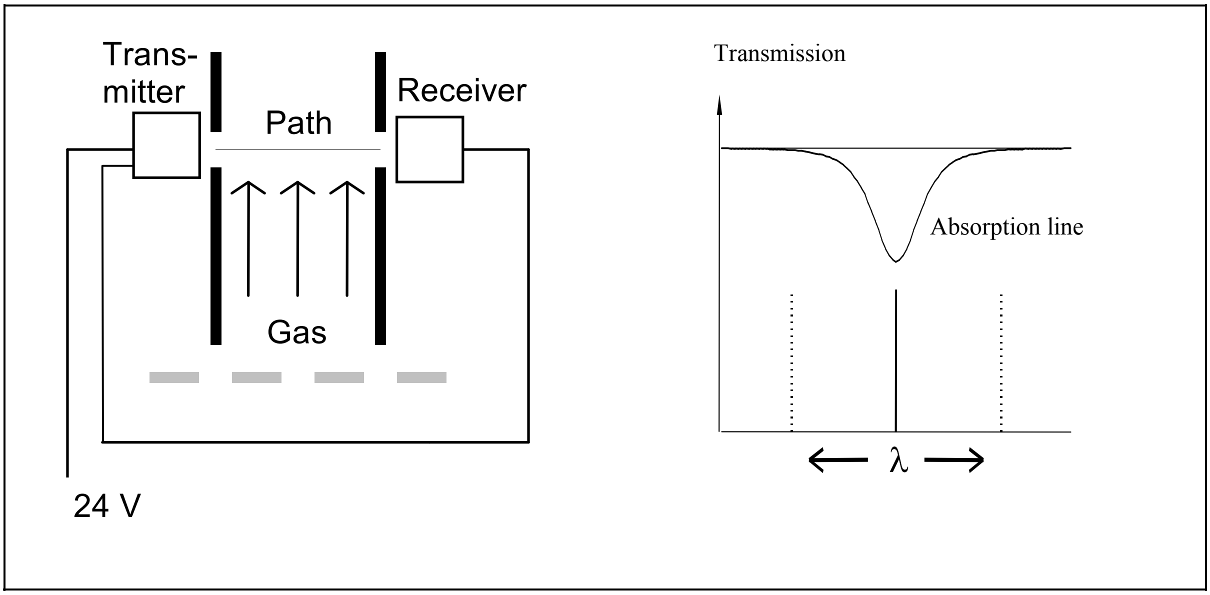


Figure 1-1: Measuring principle AO2000-LS25

1.3 Instrument description

The analyzer consists of 3 separate units (see Figure 1-2):

- Transmitter unit with purging
- Receiver unit with purging
- Power supply unit

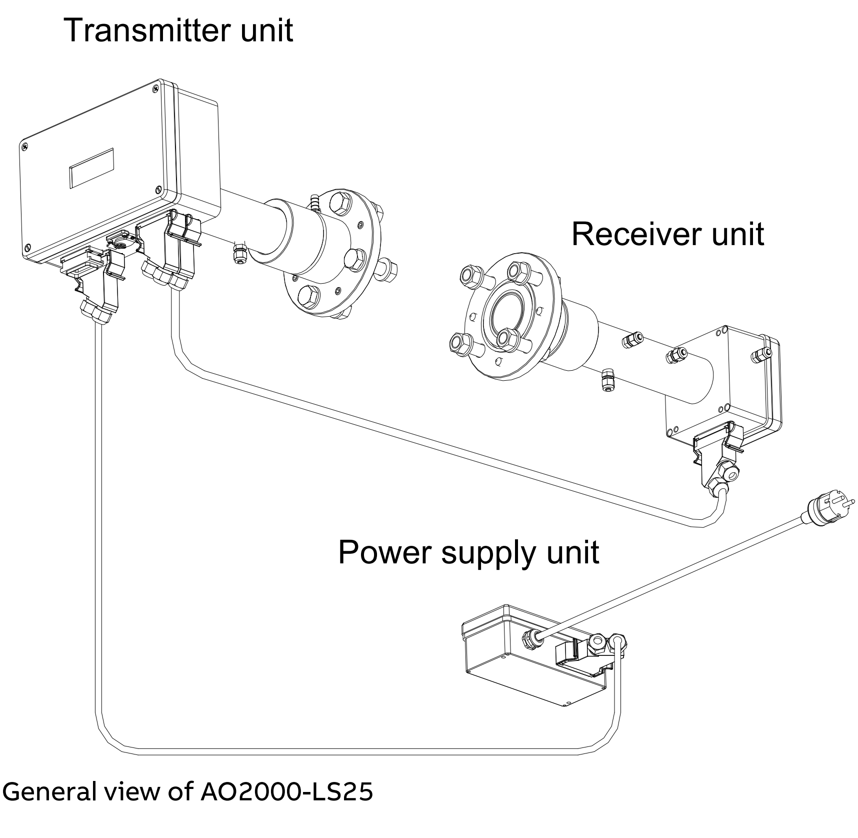


Figure 1-2: General view of AO2000-LS25

The transmitter unit contains the laser module with a temperature stabilized diode laser, collimating optics, and the main electronics in a coated Aluminum box. The receiver unit contains a focusing lens, the photodetector and the receiver electronics in a coated Aluminum box.

Both transmitter and receiver units have environmental protection IP66, and the standard optical windows withstand pressures up to 5 bar (absolute pressure). The monitor is installed by assembling the transmitter and receiver units with the supplied purging & alignment units, which in turn are mounted onto the DN50 process flanges (see Figure 3-1). The optical alignment is easy and reliable, and the purging prevents dust and other contamination from settling on the optical windows.

A block diagram of AO2000-LS25 is shown in Figure 1-3.

The power supply unit transforms 100-240 V AC to 24 V DC (if 24 VDC is available it can be supplied directly to the transmitter unit). The power supply box is connected to the transmitter box with a cable. The 4–20 mA input signals from external gas temperature/pressure sensors can be connected to the screw terminals inside the power box or directly to the cable connector on the transmitter unit.

The receiver electronics is connected with the transmitter electronics with a cable. The detected absorption signal from the photodetector is amplified and transferred to the transmitter unit through this cable. The same cable transfers the required power from the transmitter unit to the receiver unit.

The transmitter Al box contains the major part of the electronics. The CPU board performs all instrument control and calculation of the gas concentration. The main board incorporates all electronics required for instrument operation such as diode laser current and temperature control and analogue-to-digital signal conversion. A display (LCD) continuously displays the gas concentration, laser beam transmission and instrument status. The RS-232 port can be used for direct serial communication with a PC. The optional Ethernet board provides TCP/IP communication via LAN (local area network), which can be used instead of serial communication.

All cable connectors are Phoenix VARIOSUB type and waterproof.

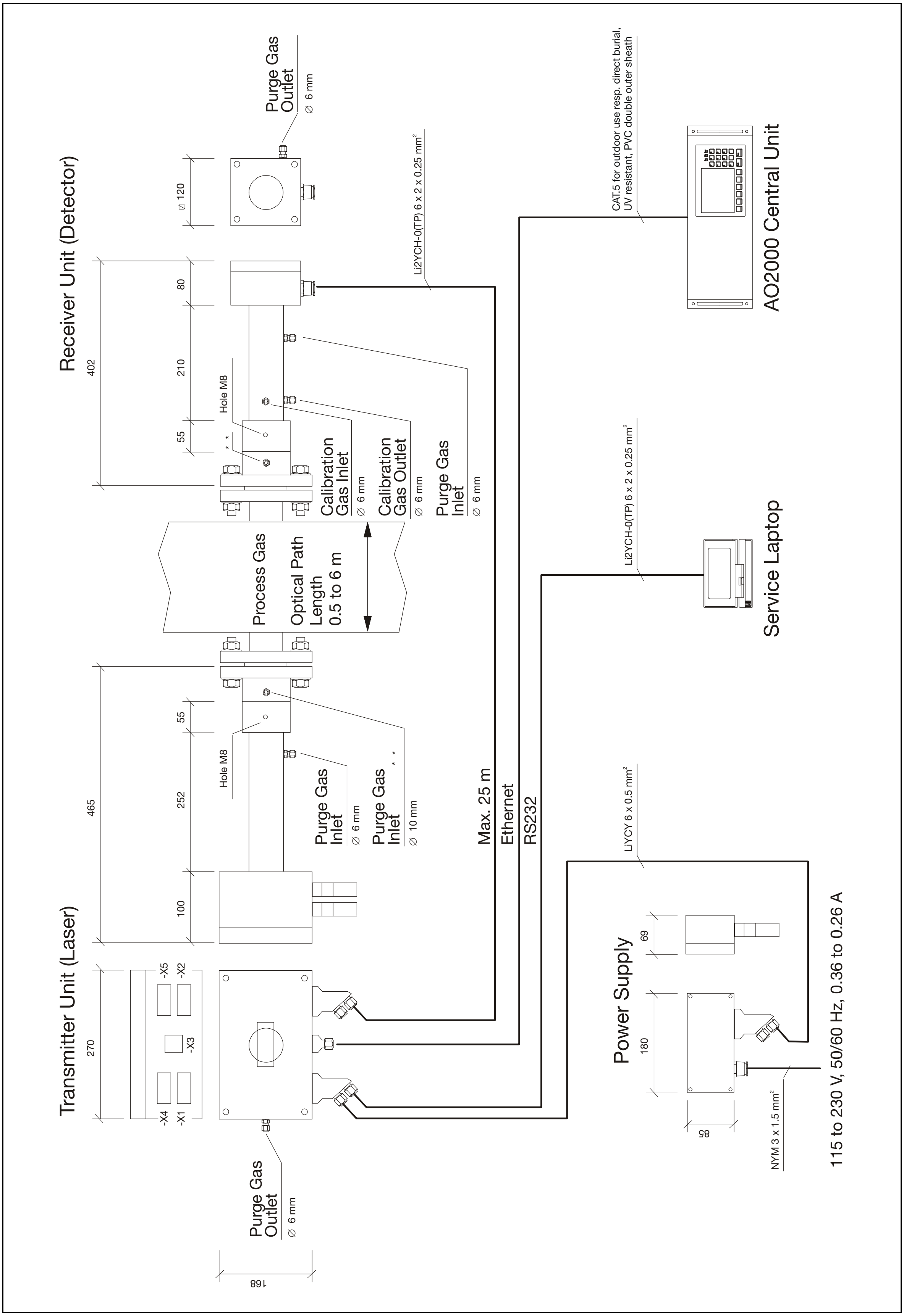


Figure 1-3: Block diagram of AO2000-LS25

1.4 Software

Software for the analyzer consists of 2 programs:

1. A program hidden to the user and integrated in the CPU electronics, running the micro controller on the CPU card. The program performs all necessary calculations and self-monitoring tasks.
2. A Windows based program running on a standard PC connected through the RS-232 connection. The program enables communication with the instrument during installation, service and calibration.

The operator will need to use the PC based program only during installation and calibration and not during normal operation of the instrument. See Section 4 for more details.

1.5 Laser classification and warnings

The diode lasers used in the analyzer operate in the near infrared (NIR) range between 700 and 2400 nm depending on the gas to be measured.

Laser Class 1M for sample component O_2
Laser Class 1 for all other sample components
according to IEC 60825-1.

NOTE: The lasers emit invisible light!

WARNING: Class 1M Laser Product – Do not open when energized! Do not view directly with optical instruments!

WARNING: Class 1 Laser Product – Do not open when energized!

2 Preparations

2.1 Tools and other equipment

The following equipment is necessary to install and calibrate the equipment:

- 2 pcs open-end spanners for M16 bolts
- 1 pcs Allen key 5 mm for the locking screws on flanges
- 1 pcs PC (386 or higher). Used during installation and calibration
- 1 pcs flat screwdriver 2.5 mm for electrical connections

2.2 Flow conditions at measuring point

When deciding the placement of the analyzer in the process, we recommend a minimum of 5 stack diameters of straight duct before and 2 stack diameters of straight duct after the point of measure.

2.3 Monitor placement

Both the transmitter and receiver units should be easily accessible. A person should be able to stand in front of either the transmitter unit or the receiver unit and adjust the M16 fixing bolts using two standard spanners. For the receiver unit there should be at least 1 m free space measured from the flange fixed to the stack and outwards as shown in Figure 2-1.

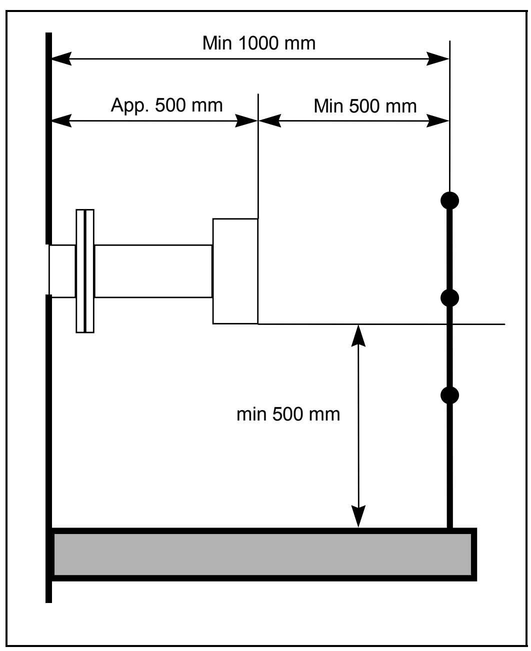


Figure 2-1: Transmitter and receiver installation tolerances

2.4 Flanges and stack hole requirements

The monitor requires two holes diametrically opposite to each other, at least 50 mm in diameter. Standard flanges used for connection are DN50/PN10 with an inner diameter of 50 mm and an outer diameter of 165 mm. The flanges can either be welded directly to the process, optionally be part of a valve connected to the process for safety purposes. The two alternatives are illustrated in Figure 2-2.

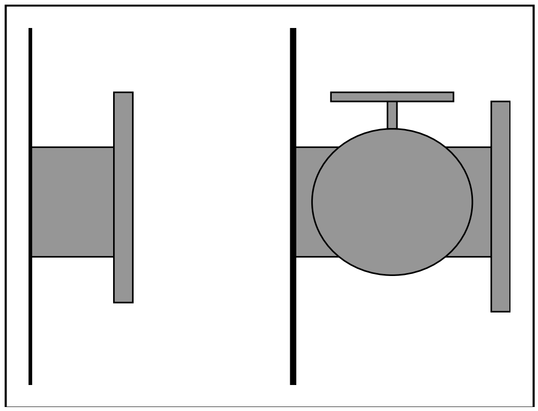


Figure 2-2: Flanges with and without valve

The analyzer is designed with an adjustment mechanism that can tilt the flanges. The flanges welded to the stack should, however, initially fulfil the specifications given in Figure 2-3 and Figure 2-4.

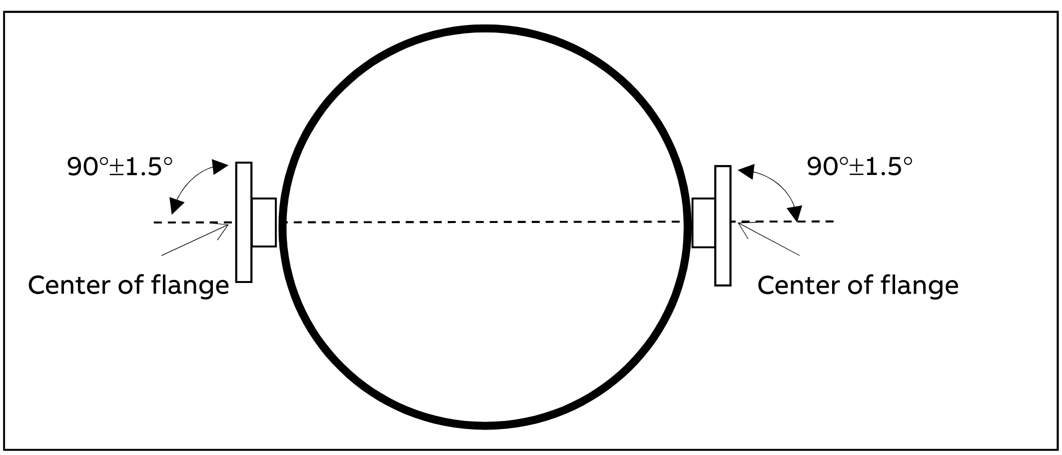
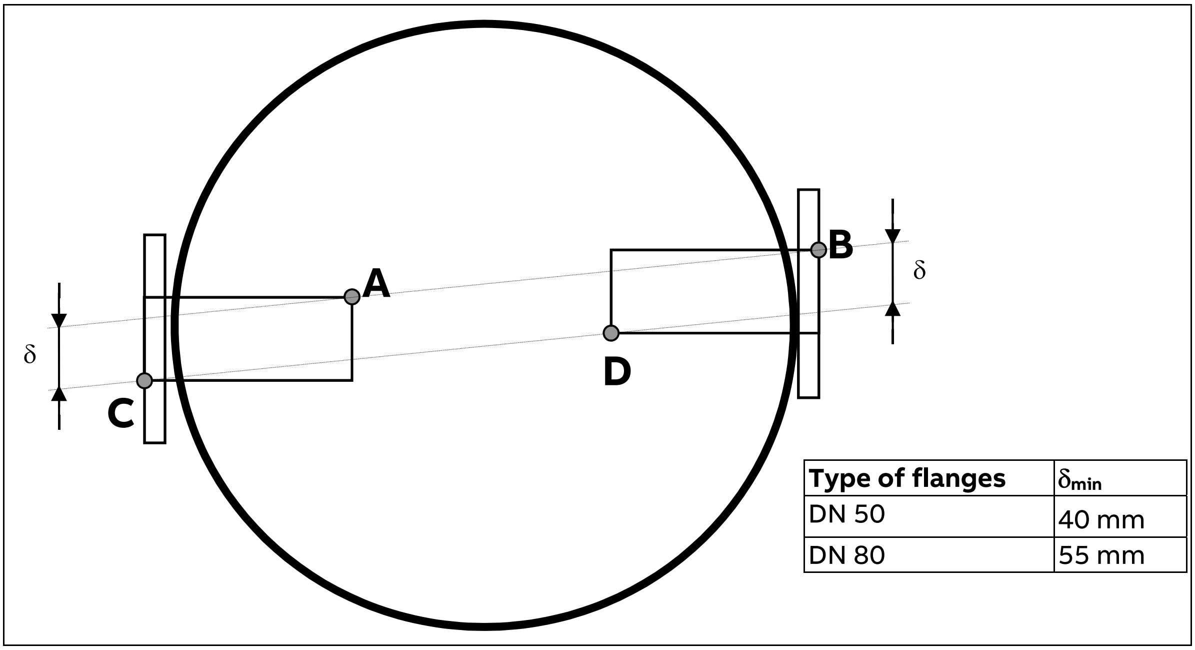


Figure 2-3: Flange angle alignment tolerances

The flange line-up should initially be better than 1.5° as specified in Figure 2-3. The distance between the thought parallel lines AB and CD (Figure 2-4) should fulfil the specifications in the table to ensure that the tubes do not shield the laser beam.



Type of flanges	δ_{min}
DN 50	40 mm
DN 80	55 mm

Figure 2-4: Flange line-up tolerances

After correct adjustment and line-up of the instrument the maximum allowed drift in angle between laser beam and receiver unit center axis due to temperature effects or vibration, is ±0.3° without having effect on the measurements.

2.5 Cables and electrical connections

The transmitter and receiver units are connected with the supplied receiver cable. This cable should not be exchanged without ABB's permission nor should the cable length be modified with more than 20 m as this may influence calibration or the instrument's accuracy.

The Service PC cable is 3 meters long, but it can be extended to approx. 10 meters.
The max. length of the power cable (power supply to transmitter unit) is 100 m.
The max. length of the loop cable (transmitter to receiver unit) is 150 m.
The max. length of the (optional) Ethernet cable is 100 m or more (depending on configuration of local network).

If electrical connections have to be made at installation, refer Section 6 for details.

3 Installation

3.1 Installation and adjustments

The installation procedure described in this section refers to Figure 3-1.

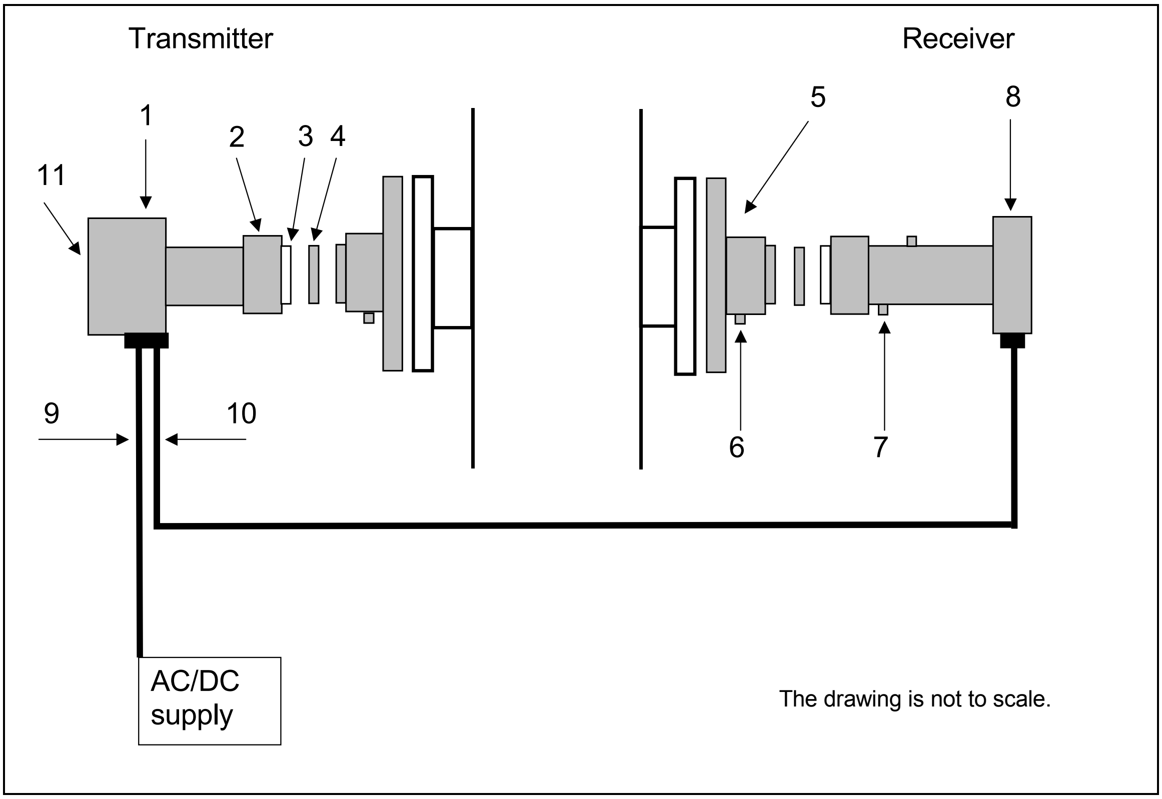


Figure 3-1: AO2000-LS25 units and their main components

1 Transmitter electronics and housing
2 Mounting nut
3 Optical window
4 Adapter ring
5 Alignment and purging unit (DN50 flange)
6 Purging gas inlet
7 Span cell inlet (non-corrosive gases, see also Section 7)
8 Receiver electronics and housing
9 DC power cable
10 Receiver cable
11 LCD display

3.1.1 AO2000-LS25 installation

Read thoroughly all instructions prior to installation.

All external parts are made of stainless steel or aluminum. All threads should be lubricated using suitable grease before installation. Both receiver and transmitter units have optical windows installed by the factory. **They should not be taken off and their angular positions should not be changed.** This is important for successful alignment. **Make also sure that**

power is disconnected or switched off before connecting any cable. Please note that the power plug is the disconnecting device (no separate mains switch on instrument) and should be placed easily accessible for the operator.
To install the instrument on the process follow the steps below.

1. Install transmitter alignment and purging unit (5) onto the stack flange with 4 pcs. M16x60 bolts (ref. Figure 3-4). All 4 bolts on either side must be tightened firmly to compress the large O-ring. Adjust the 4 locking screws prior to mounting the unit, to assure good alignment of the unit and a uniform compression of the O-ring.
2. Install pressurized instrument purging as described in Section 3.1.2.
3. Open the purging. Refer to Section 3.1.2 for details.
4. Put the window adapter ring (4) on the alignment unit. Make sure that the O-ring on the alignment unit is tight and greased. The guiding pin on the alignment unit must fit the hole in the adapter ring.
5. Affix an O-ring (not greased) to the adapter ring and connect the transmitter unit to the alignment unit. The guiding pin on the adapter ring must fit the hole in the transmitter window. Tighten the transmitter-mounting nut.
6. Repeat steps 1-5 for the receiver unit.
7. Connect the transmitter and receiver units with the corresponding cable (refer to Figure 6-1 for location of receiver connection on transmitter unit). All connectors are coded with small red pins on the inside.
8. Connect external 4–20 mA temperature and pressure probes (ref. Section 6.3 and 6.5). This is optional as some instruments operate without probes. Input signals are connected to the terminals in the power supply unit or directly to the terminals in the main power connector at the transmitter unit. If connected to the power connector the factory-mounted wires should be removed from the terminals in question.
9. Connect the transmitter and power supply units with the corresponding cable.

The analyzer can now be switched on. This procedure is described in Section 3.2.

3.1.2 Air purging of flanges

The instrument windows are kept clean by setting up a positive flow of air through the flanges and into the stack. This purging will prevent particles from settling on the optical windows and contaminating them. The purge gas must be dried and cleaned. We recommend using instrument air for purging. If instrument air is not available a separate blower is needed. A purge flow of approximately 20–50 l/min (process dependent) is sufficient for most installations. Alternatively, the initial velocity of the purge flow in the flanges is set to 1/10 of the gas velocity in the duct. After completion of the installation the purge flow is optimized as described in Section 5.3.

The air quality should conform to standard set by ISO 8573.1, Class 2-3. This means particles down to 1 micron should be removed, including coalesced liquid water and oil, and a maximum allowed remaining oil aerosol content of 0.5 mg/m^3 at 21°C (instrument air).

Note that some instruments require nitrogen purging, e.g. O_2 instruments for high temperature or pressure applications, some H_2O instruments etc.

3.1.3 Purging of transmitter and receiver units

For applications where purging of transmitter and receiver units is required the direction of flow is illustrated in Figure 3-3. Since there are optical surfaces inside these units, the cleanness of the gas should be ensured and additional filtering may be necessary. Note that so called “instrument air” may contain some oil and water. If receiver and transmitter are purged with such air they can be permanently damaged after a short time. It is highly recommended to use nitrogen as a purge gas. The purge flow must not be high to avoid pressure build-up inside the units. We recommend reducing the flow to less than 0.5 l/min. If the flow is blocked the units can hold the gas to better than 99.5% during one hour.

3.1.4 Isolation flanges

For toxic gas and highly corrosive applications especially in combination with high pressure the first flange has to be an isolation flange which isolates the process from the analyzer. In these cases a shut-off valve is always necessary in order to do maintenance on the flange. The isolation flange has to be “custom tailored” for the individual process. The isolation flange may be purged if necessary as described in Section 3.1.2. Due to the additional windows a certain loss of transmission is to be expected. The analyzer will be mounted on the isolation flange.

Before dismounting the isolation flange make sure the process is either turned off and safe or the volume between the nearly closed shut-off valve and the flange is purged thoroughly to make sure no harmful gas may leak out.

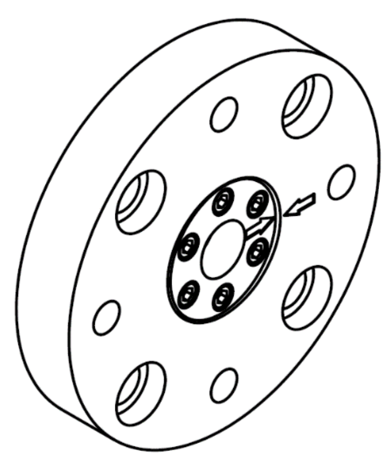


Figure 3-2: Example of an isolation flange

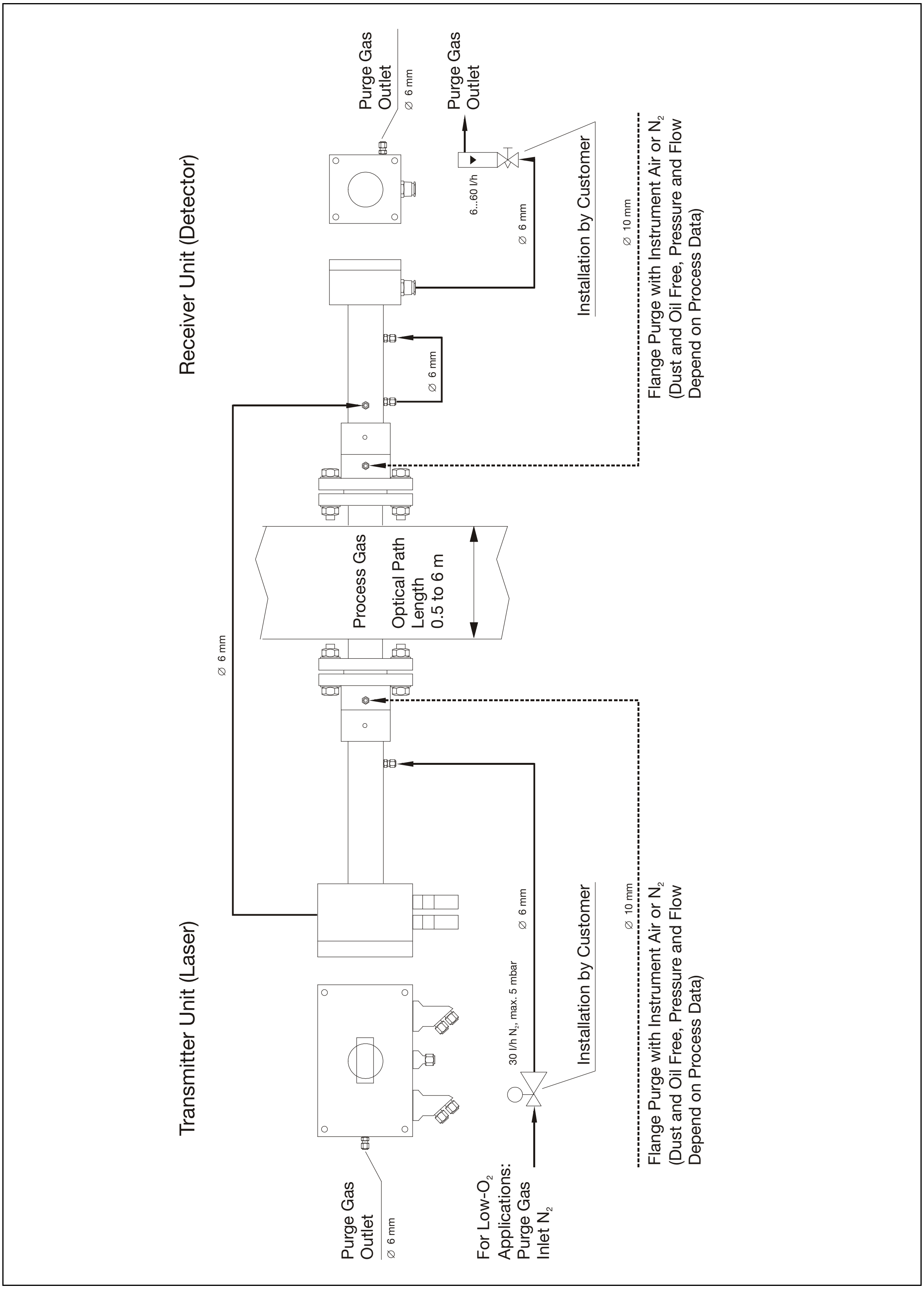


Figure 3-3: Purging of the transmitter and receiver units

3.2 Start-up

Having completed the installation of the transmitter and receiver according to the previous sections the analyzer is ready for start-up. The start-up of the system consists of 3 main activities:

- Start-up of electronics
- Alignment of transmitter
- Alignment of receiver

3.2.1 Start-up of electronics

Switch on the electronics. The LCD in the transmitter unit will enter start-up mode showing:

```
        ABB   6.1a1
        - power -
Self-test              OK
Start-up            0.998
```

The start-up sequence will make sure the laser is tuned to the correct temperature before it is switched on, and the instrument performs a self-test on all systems. Allow about 5 minutes for the instrument to start the laser.

The LCD will probably show «Laser line-up error» and «Low transmission» when the laser has started up. This is normal and indicates misalignment of the receiver and transmitter units, i.e. the laser beam does not hit the detector inside the receiver unit.

If you use a red laser alignment jig for alignment of the transmitter/receiver refer to Section 3.3.

3.3 Alignment of transmitter/receiver using red laser alignment jig

3.3.1 Alignment of transmitter unit

Necessary tools and other equipment for the adjustment procedure:

- 1 pcs red laser alignment jig
- 2 pcs spanners to adjust the flanges with (M16)
- 1 pcs 5mm Allen key for the locking screws

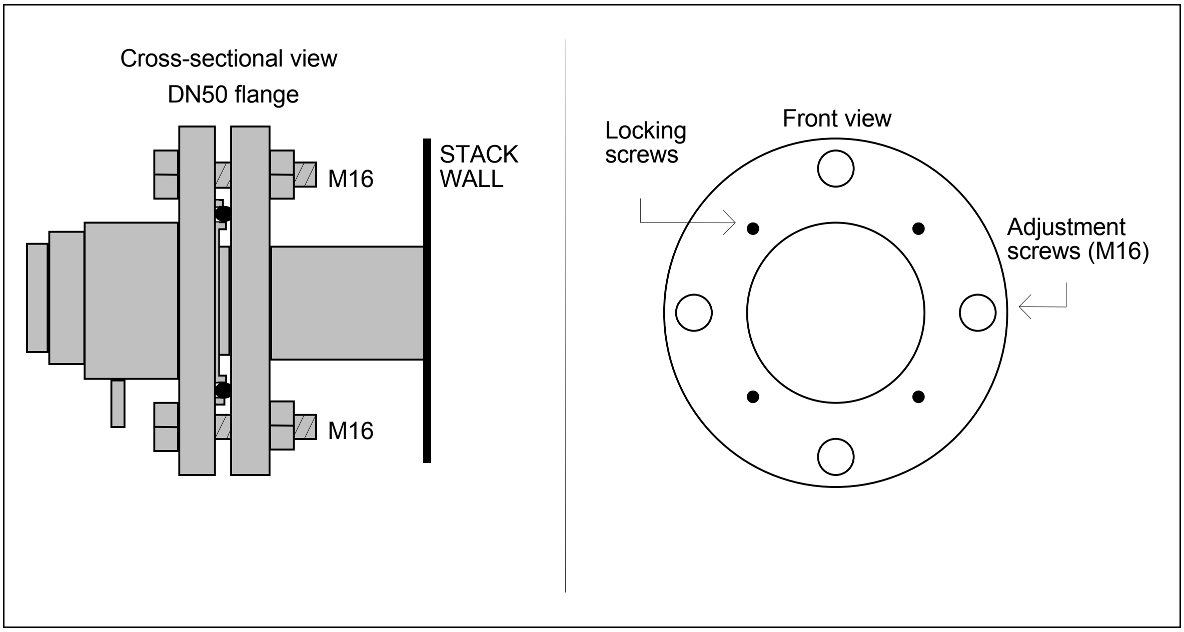


Figure 3-4: Alignment mechanism details

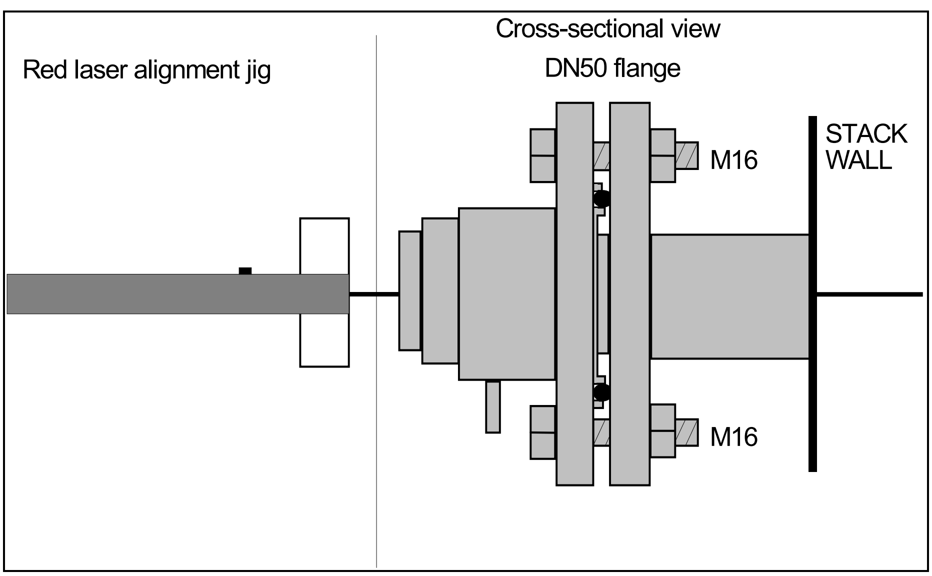


Figure 3-5: Red laser alignment jig

1. Leave the instrument switched ON, and disconnect both the transmitter and receiver units from their alignment units by loosening the corresponding mounting nuts. The laser beam from the transmitter is not visible. **Avoid looking directly into the transmitter!**
2. Remove the adapter ring (no. 4 in Figure 3-1) from the transmitter alignment & purging unit.
3. Mount the red laser alignment jig on the transmitter side using the supplied mounting nut and locate the laser beam on the receiver side using the target. Loosen the adjustment screws shown in Figure 3-4 on the transmitter unit purging flange and move it carefully from side to side and up and down to locate the laser beam in the receiver hole. (You may need two persons.)
4. Having found the laser beam, move the beam to the center of the hole by carefully adjusting the adjustment screws on the transmitter side. Lock the alignment by tightening the locking screws on the transmitter side and check that the alignment has not changed.
5. The laser beam is now centered, but not necessarily parallel with the optical axis of the receiver unit. The following section describes the procedure for aligning the receiver unit to maximize the signal of the analyzer.

3.3.2 Alignment of receiver unit

1. Remove the adapter ring (no.4 in Figure 3-1) from the receiver alignment & purging unit.
2. Disconnect the red laser alignment jig from the transmitter side and mount it on the receiver side. Locate the laser beam on the transmitter side. Loosen the adjustment screws shown in Figure 3-4 on the receiver unit purging flange and move it carefully from side to side and up and down to locate the laser beam in the transmitter hole. (You may need two persons.)
3. Having found the laser beam, move the beam to the center of the hole by carefully adjusting the adjustment screws on the receiver side. Lock the alignment by tightening the locking screws on the receiver side and check that the alignment has not changed.

Having completed the previously described operations successfully, the transmitter and receiver should be re-mounted. Check the transmission reading on the transmitter unit LCD. Proceed to Section 3.4, where tuning for maximum transmission using a voltmeter is described.

3.4 Tuning for maximum transmission

Fine alignment of the transmitter and receiver unit to ensure maximum signal is accomplished by measuring the alignment voltage with a voltmeter and the supplied cable with miniature power plug. The alignment voltage varies from 0V at 0% transmission to −3V (typically) at 100% transmission. The alignment voltage is measured by connecting a voltmeter to the alignment jack on the transmitter unit. This jack is located on Phoenix connector of the transmitter-to-receiver cable as shown in Figure 3-6. A similar alignment jack is found on the receiver unit (see Figure 3-6).

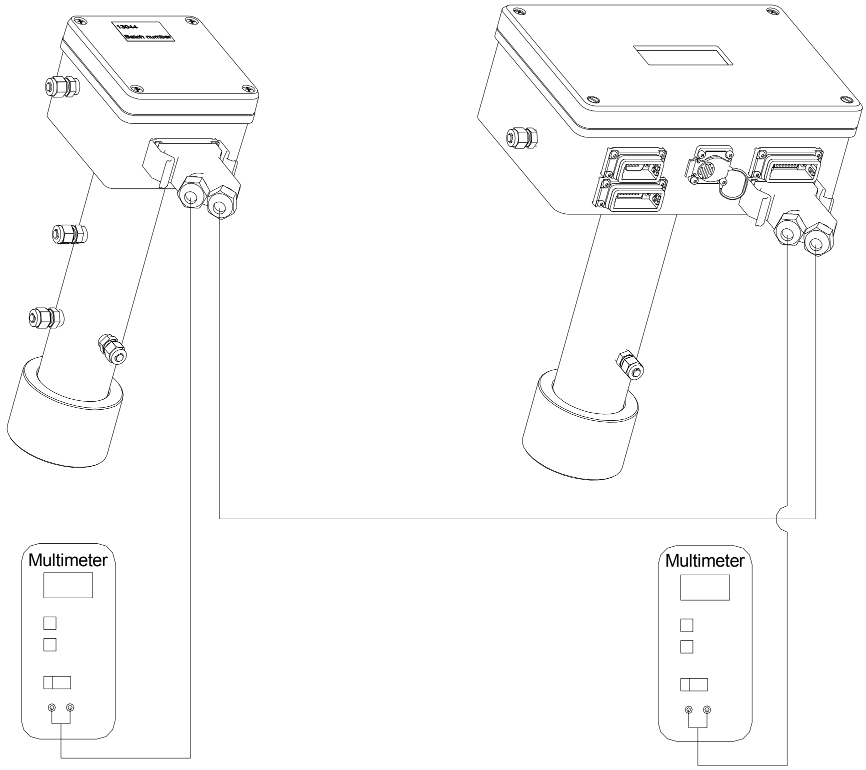


Figure 3-6: Measurement of alignment voltage

The fine-tuning procedure is as follows:

1. Connect a voltmeter with floating inputs (battery powered) and measure the alignment voltage from the receiver unit.
2. Maximize the voltmeter reading by carefully adjusting the adjustment screws on the receiver side.
3. Connect a voltmeter with floating inputs (battery powered) and measure the alignment voltage from the transmitter unit.
4. Maximize the voltmeter reading by carefully adjusting the adjustment screws on the transmitter side.
5. Repeat steps 1-2 and 3-4 until no further improvements in voltmeter readings.
6. Tighten the locking screws and check that the alignment has not changed.
7. Disconnect the voltmeter

Having completed the previously described operations successfully, the installation and process parameters need to be set correctly using a PC and the analyzer software to enable correct measurements. Setting of these parameters is explained in Section 4.

3.5 Connecting a PC

The software for service communication with the analyzer is supplied with the instrument and will run under Microsoft Windows®. The service program requires no installation.

1. Copy the software supplied onto the hard disk into a specified directory, which may be called for example “AO2000-LS25”.
2. Connect a PC serial port to the RS-232 connection on the transmitter unit (Figure 6-1) using the supplied serial cable and gender changer. As option a waterproof Phoenix connector cable can be used instead. The service program uses the serial port configured as 9600 baud, no parity, 8 bits and 1 stop bit. If network communication is used, connect the network cable to the Base-T connector on the transmitter unit (Figure 6-1). Note that in this case the serial cable must be disconnected from the instrument.
3. Thoroughly check the following parameters against the installation details and set them using the software (see Section 4 for detailed description):

- Process gas pressure and temperature	(Section 4.3.5)
- Concentration averaging	(Section 4.3.5)
- Instrument time	(Section 4.3.5)
- Gas concentration unit	(Section 4.3.6)
- Optical path parameters	(Section 4.3.5)

Having completed the setting of all necessary parameters, the instrument is in normal operation mode and should indicate this by updating the gas concentration on the LCD periodically. Operation, maintenance and calibration of the instrument are explained in Section 5.

4 The service program

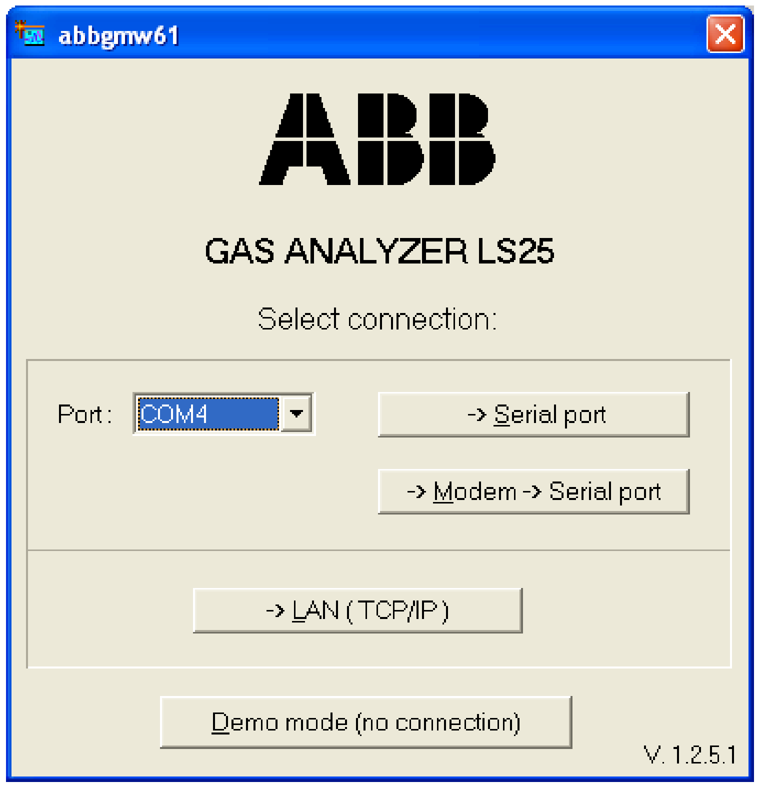
The instrument calculates the gas concentration from the measured signal, which depends on several process parameters. The instrument must therefore be configured for the specific installation. With the service program the user communicates with the instrument and changes installation or process relevant settings. With a PC connected to the instrument via a standard serial communication port the operator can perform the following major tasks:

1. Monitor the measured concentration and the laser beam transmission;
2. Plot the measured concentration as a function of time;
3. Log the concentration and other control parameters to a file;
4. Display the measured signal;
5. Save the measured signal and other control parameters to a file;
6. Observe and erase the instrument error logging;
7. Configure the 4–20 mA process temperature and pressure inputs;
8. Change the measurement averaging time;
9. Set the optical path parameters;
10. Change the concentration unit;
11. Change the format of the displayed concentration;
12. Change the instrument clock time;
13. Calibrate the instrument;
14. Save all instrument parameters to a file;
15. Restore the instrument parameters from a file.
16. Configure the Ethernet connection

Through different menus the necessary installation parameters may be set. After setting the necessary parameters the PC is no longer needed. The analyzer has all the parameters stored in the internal memory. The PC can therefore be disconnected and the analyzer can be turned off and on without resetting the parameters.

4.1 Software start-up

After starting the program a welcome screen will display a selection of instrument to PC connections:



The version of the service program is printed in the right bottom corner (in the example above V.1.2.5.1).

For direct serial or modem connection, select the PC serial port from the dropdown list of available ports and press the corresponding button. When using a modem, you will be asked for a telephone number to dial. If the first digit in this phone number is zero, the software will pause after dialing the zero before dialing the rest of the digits. If additional pausing is needed, apply "," between the digits.

If communication via LAN is used, you will be asked for IP address and port number: The IP address and port number are typically set to default values 192.168.1.237 and 5001, respectively. If the IP address and port number need to be changed, run the program with direct serial connection and configure TCP/IP parameters as described in Section 4.3.8.

After the connection with the instrument has been established you are prompted to start the program in User or Advanced mode.

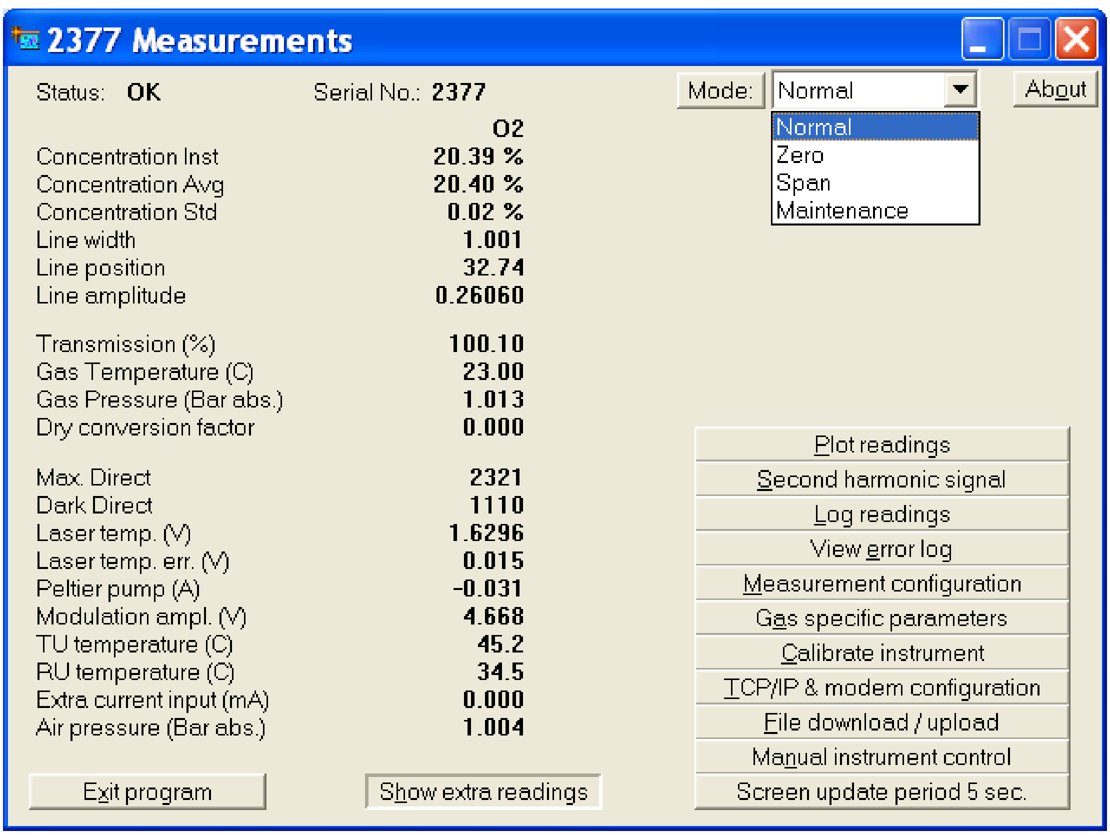
Press <User mode> to start the program. This program mode provides a simplified interface with limited access to the instrument setting parameters and should be used during installation and normal operation of the instrument. A password is only required for Advanced mode that enables full access to all the instrument setting parameters. This program mode should be used during service adjustment of the instrument. Your local distributor or ABB can provide the password on request.

Note that if the connection is moved to another instrument the program must be shut down and run again. It is possible to run several program windows simultaneously to communicate with different instruments using one PC.

The service program can also be started without a connection to an instrument by pressing <Demo mode>. This is for demonstration purposes of the service program. Two extra files are needed for this mode to work: *.dmp or *.rea and *.set or *.stt. These files can be created using the service program when a PC is connected to an instrument. The files are created by downloading the instrument readings to *.rea and settings to *.set (ref. Section 4.3.9). Alternatively, one can use the files supplied with the service program on the floppy disk or CD. These files were downloaded from the instrument at the factory prior to shipment.

4.2 The measurement menu

After pressing the <User mode> button the program opens the **Measurements** menu. The example below is for an instrument measuring oxygen.



The serial number of the instrument is shown in the title line of the menu. The bottom right of the screen shows different menus which can be accessed either by pressing the buttons or by pressing the underlined shortcut letters (e.g. <S> for Second harmonic signal). By pressing <Exit menu> one can always go back to the previous menu. The description of each menu will follow.

The rest of the screen is used to display different readings parameters. By default only the main readings parameters are displayed. By pressing <Show extra readings> all parameters are displayed. (NB: <Show extra readings> is activated in the example above).

The instrument readings update period is set by pressing <Screen update period>, which is 5 seconds by default. This time should not be shorter than the time required to calculate the concentration (the update time of the LCD).

The parameters are explained in detail below:

Status: The instrument status which may be SLEEPMODE / STARTUP / OK / WARNING / ERROR. See Section 5.

Serial No: Serial number of the analyzer.

Mode: The measuring mode of the instrument. This is optional and only for instruments with zero/span check. . By clicking on the mode button 3 different measuring modes may be selected (not that maintenance mode is not implemented for this analyzer). See Section 5.1 for details.

Concentration Instant: Displays the last value calculated by the analyzer with no averaging. This is in the following called a primary measurement.

Concentration Average: Displays the running average calculated by the analyzer (not by the service program) from the last N values, where N is the averaging count specified in menu <Measurement configuration>. A description of the averaging method will be given in that subsection.

Concentration Standard: Gives an estimate of the running standard deviation also calculated by the analyzer. This number indicates how much the calculated gas concentration fluctuates from its average value. If the gas concentration is truly constant it will provide a measure of the instrument precision.

Line width: Relative measure of the width of the absorption line. In combination with the line amplitude it determines the integrated absorption, which in turn is used to calculate the gas concentration. The reference line width parameter is equal to 1.000 at T = 23 °C and P= 1.013 bar (1 atm.) and when the gas composition is equal to those used when calibrating the instrument. The line width increases with gas pressure and decreases with gas temperature. It also depends on the gas composition, for example water vapor broadens the absorption lines significantly.

Line position: The position of the line peak (maximum absorption) in samples of the AD converter [0–63]. The value should be close to the reference line position, which is given in the menu <Gas specific parameters> for the corresponding line. The instrument automatically tracks the line, i.e. if it deviates more from the reference position than a given value, the instrument adjusts the laser temperature and thereby the wavelength.

Line amplitude: Relative measure of the peak of the absorption line of the second harmonic signal. If this value approaches 0.5-1.0 the absorption is strong and saturation of the AD converter may be very close (actual saturation initiates the ERROR). In the region 0.01–0.1 the signal is good. Below 0.01 the signal is approaching the low level below which line width cannot be measured and line tracking is off.

Transmission (%): Indicates how much light the receiver detects in % of the maximum value. If the optical windows are covered with dust and the transmission drops below a pre-set level, a warning will appear on the display of the transmitter unit. The optical windows of the instrument should then be cleaned. The warning will also appear for improper alignment of the transmitter and receiver.

Gas temperature(C): The temperature currently used to calculate the gas concentration. It may be a fixed value set by the user, the value measured by a 4–20 mA current T-probe or the value measured by the instrument itself optically or electrically. Optically measured temperature is called Spectral temperature. Electrically measured temperature is the temperature measured by the embedded temperature sensors (only used when the gas temperature is equal to ambient temperature) offset-corrected to be equal the ambient air temperature. In the example above the gas temperature is set equal to the Spectral temperature. These settings can be configured in the <Measurement configuration> menu.

Gas Pressure (Bar abs.): The pressure in bar absolute currently used to calculate the gas concentration. It may be a fixed value set by the user, the value measured by a 4–20 mA current P-probe or the value measured by the instrument itself using the embedded pressure sensor (mainly for O_2 instruments and only used when the gas pressure is equal to the ambient air pressure). This is configured in the <Measurement configuration> menu.

Dry conversion factor: Factor currently used to multiply the gas concentration if dry basis conversion is selected (see Section 4.3.5). The initial (wet) concentration reading may be converted to dry reading if the H2O concentration is known. If dry basis conversion is not activated the factor is always 1.0.

Max. Direct: Maximum value of the direct signal in the levels of AD converter [0–4096]. This value together with Dark Direct determines the value of the light transmission.

Dark Direct: Optical zero of the direct signal measured when the laser is switched off for a short period. The unit is the same as for Max. Direct.

Laser temp. (V): The voltage across the thermistor located in the vicinity of the diode laser. Higher voltages indicate lower laser temperature. Changing laser temperature changes the laser wavelength.

Laser temp. error: The amplified difference in Volts between the measured Laser Temp and the reference value. Should be around 0.000. It indicates the quality of the laser temperature regulation and thus the quality of the wavelength stabilization.

Peltier pump (A): The current drawn by the Peltier element.

Modulation ampl. (V): Amplitude of the high frequency modulation voltage to the laser.

TU/RU temp.: The temperatures measured by the embedded thermistors located inside the transmitter and receiver unit.

Extra current input (mA): Current measured on extra current input (Flow 4–20 mA input).

Air pressure (Bar): The ambient pressure measured by the embedded pressure sensor located inside the transmitter unit.

4.3 The program menus

4.3.1 Plot readings

Plot readings plots the measured average and instant concentration of gases, transmission and spectral temperature (if measured). Two different plots can be shown simultaneously. Clicking on the axis labels modifies the scale of the plot.

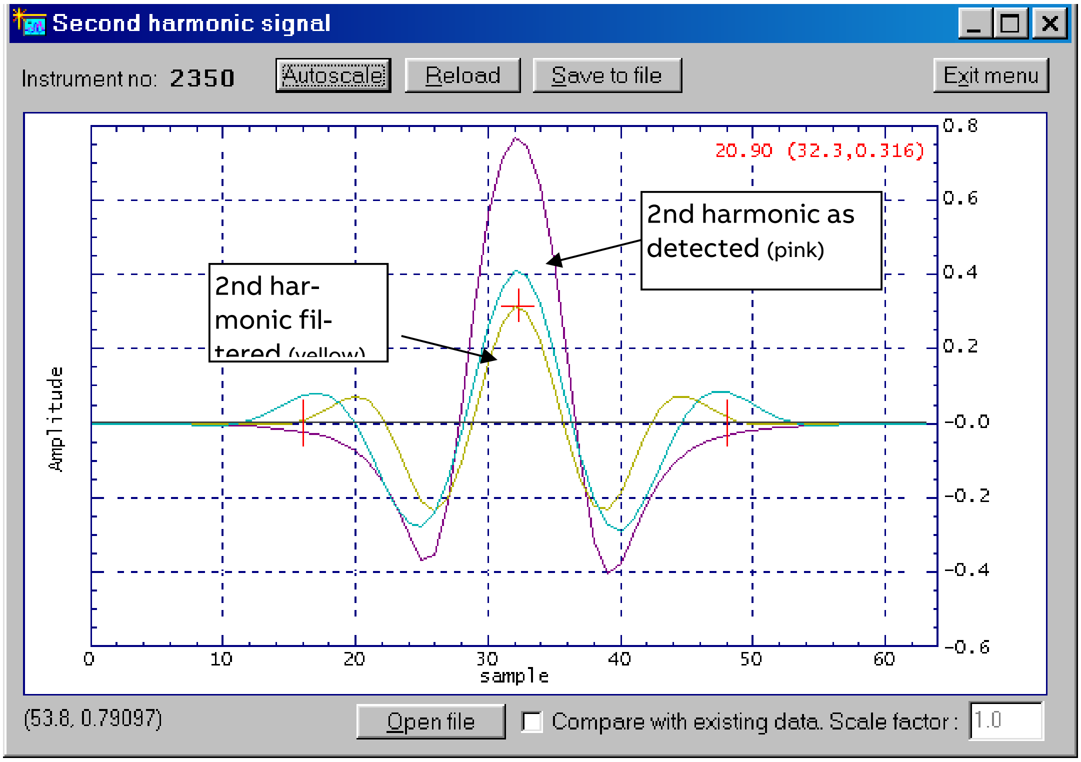
4.3.2 Second harmonic signal

Second harmonic signal displays signals recorded by the instrument for calculation of the gas concentration. This signal is also useful for inspection and analysis of the absorption spectra, verification of proper laser function, and fault diagnostics. In total three curves are displayed: the normalized second harmonic signal as detected (pink curve) and the same signal after filtering with two different filters (yellow and blue curves). For some instruments only one filter is applied to the signal.

The example given below displays the signal from an oxygen absorption line. The peak of the yellow curve is marked with a red cross. The instantaneous gas concentration as measured from this line; the sample number and position of the peak are printed in the upper right corner in parenthesis. The latter are referred to as *Line position* and *Line amplitude* described in previous Section 4.2. The line position must be within the acceptance window marked by the two vertical red lines. For some instruments such as dual gas instruments more than one absorption line is plotted.

With the <Reload> button the second harmonics signal is updated. The data can be saved to file (<Save to file>) for later analysis. This is equivalent to <Download readings> in the **File download/upload** menu (Section 4.3.9). The scale of the axes is modified by clicking on the axes labels.

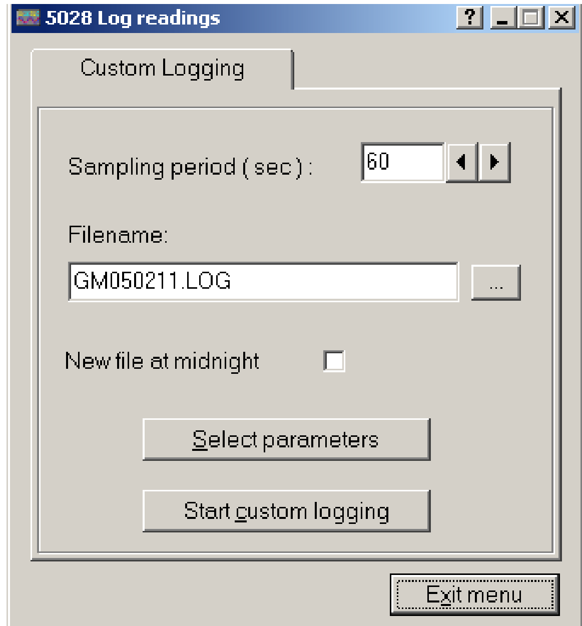
It is possible to open a previously saved signal and scale it to compare with existing signal. There will be shown two curves for each signal.



4.3.3 Log readings

With <Custom Logging> all data displayed in the **Measurements** menu can be logged to an ASCII file at specified regular intervals. The sampling period (logging interval), file directory, and the filename are user defined (default filename is “gmYYMMDD.log”). If <New file at midnight> is selected the program will create a new logging file at every midnight with the default filename reflecting the new date.

Before logging <Select Parameters> should be pressed and the parameters of interest should be marked. The selected parameters are automatically arranged in columns in the logging file. The first column is always seconds after the last midnight (PC time) and the last two columns are always the instrument status (-4 (sleep mode)/ -1 (startup)/ 0 (ok)/ 1 (warning)/ 2 (error)) and the measurement mode (0 (ok)/ 1 (zero)/ 2 (span)). Parameters can be added to or deleted from the logging file without interrupting the logging process. The configuration of the logging file may be modified (e.g. specify text qualifier, data separator, add comment on top etc.).



4.3.4 View error log

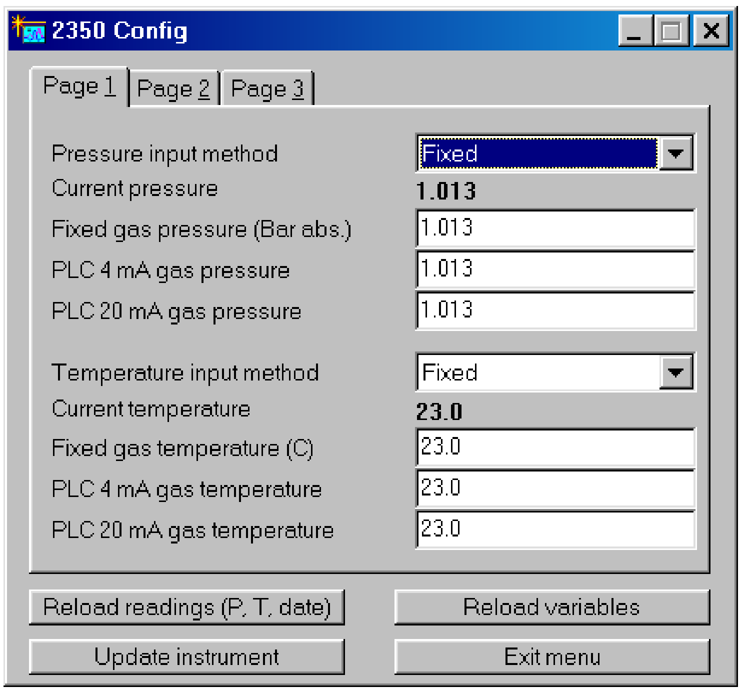
After pressing <View error log> the program downloads the log of the instrument's errors and warnings (see Section 5.5 for description of the errors) including the date and time of their last activation and deactivation. The currently active errors and warnings are marked with a cross (x), while the inactive errors are marked with a dash (-). <Save error log> saves the current list of errors to a text file. <Clear error log> clears all the errors and warnings from the instrument's internal memory.
The instrument also stores the log (System log) of internal status and self-test information. This information is useful for advanced diagnostics and faultfinding and downloaded to a text file by pressing <Save system log>. Older system information may be downloaded by pressing <Rewind system log 100 lines> and subsequently <Save system log>.
In case of instrument failure it is always useful to download the error log and the system log and send both files to ABB for diagnostics.

4.3.5 Measurement configuration

In this menu the most important parameters can be set:

Gas pressure	(page 1)
Gas temperature	(page 1)
Pressure / temperature input method	(page 1)
Pressure / temperature PLC input range	(page 1)
Concentration averaging	(page 2)
Optical path variables	(page 2)
Instrument time	(page 2)

Note that the parameters are modified in the program but the instrument is not updated with the new values until the button <Update instrument> is pressed.



<u>Gas pressure and temperature</u>

The strength of the absorption line and line width are pressure and temperature dependent. This is compensated for by calculating a correction factor based on deviation of pressure and temperature from the standard atmosphere (P=1.013 bar, T=23 °C). For relative concentration units (ppm, %, mg/Nm^3, g/Nm^3) the gas pressure and temperature are in addition directly involved in calculation of the concentration through the ideal gas law. Therefore, correct setting of gas pressure and temperature is important for the accuracy of the measurement. *Current pressure* and *Current temperature* are the values used for calculation at present. These values are only downloaded from the instrument after an update of parameters or explicitly after pressing <Reload readings (P, T, date)>.

Note that the gas pressure is always specified in bar absolute. To convert pressure from bar gauge to bar absolute use the following relation:

P(bara) = 1.013 + P(barg)

To convert pressure from Psig to bar absolute use the following relation:

P(bara) = 1.013 + P(psig)/14.5

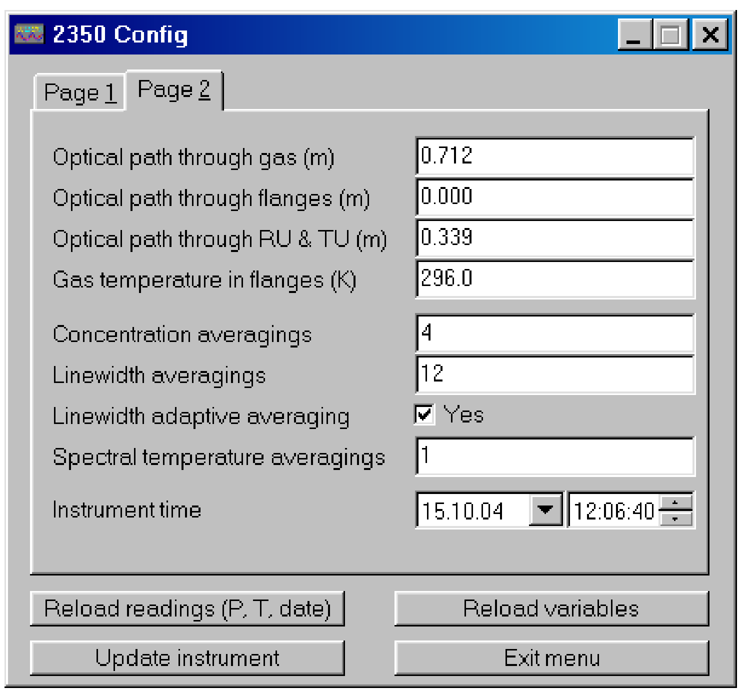
Note that the gas temperature is always specified in Celsius. To convert temperature from Fahrenheit to Celsius the following relation can be used:

$$T(C) = (T(F) - 32)/1.8$$

To convert temperature from Kelvin to Celsius the following approximate relation can be used:

$$T(C) = T(K) - 273$$

Pressure and temperature input method
<Pressure/Temperature input method> defines if the values are fixed or read with one of the following methods: Current loop, Internal, Spectral, and Serial.
If method “Current loop” is activated the values are input from the corresponding 4–20 mA current input. In this case the PLC 4 mA and PLC 20 mA values must be specified.
Method “Internal” sets the gas pressure equal to the ambient pressure measured by the internal pressure sensor (*Air pressure* in **Measurements** menu). The gas temperature is set equal to the average of the measured temperatures inside the RU and TU (*TU* and *RU Temp* in **Measurements** menu), which are offset corrected to be approximately equal to the ambient temperature.
Method “Spectral” (only for temperature) sets the gas temperature equal to the temperature measured spectroscopically. This method is only applicable for instruments measuring gas temperature like the O_2 +Temperature monitor.
Method “Serial”: Pressure and temperature input through RS-232 or Ethernet connector (requires special data packet, contact ABB for details).



Optical path through gas (m)
The length (in meters) of the optical path through the gas to be measured (Lg in Figure 4-1). It is normally equal to the stack diameter or the free space between insertion tubes. In case of installations with a measurement cell it is equal to the length of the cell.

Optical path through flanges (m)
The combined length of the flanges (Lf1+Lf2 in Figure 4-1). This parameter is important only if the measured gas is present in the flange region and the instrument must compensate for

this extra gas absorption. This is usually the case for O_2, H_2O, CO_2, CH_4 monitors, i.e. monitors measuring atmospheric gases. Note that for this compensation to work, the gas concentration in the flanges must be specified in **Gas specific parameters** menu (Section 4.3.6).

Optical path through RU & TU (m)
The optical path through the transmitter and receiver units (TU & RU). This is the internal optical path of the instrument. The value is set by the factory. If this parameter is changed, the original value should be noted down in order to be able to restore the original setting when required. This parameter is only important if the measured gas is present in the internal instrument volume so that the additional gas absorption must be compensated for (see above). Note that for this compensation to work, the gas concentration in RU & TU must be specified in **Gas specific parameters** menu (Section 4.3.6).

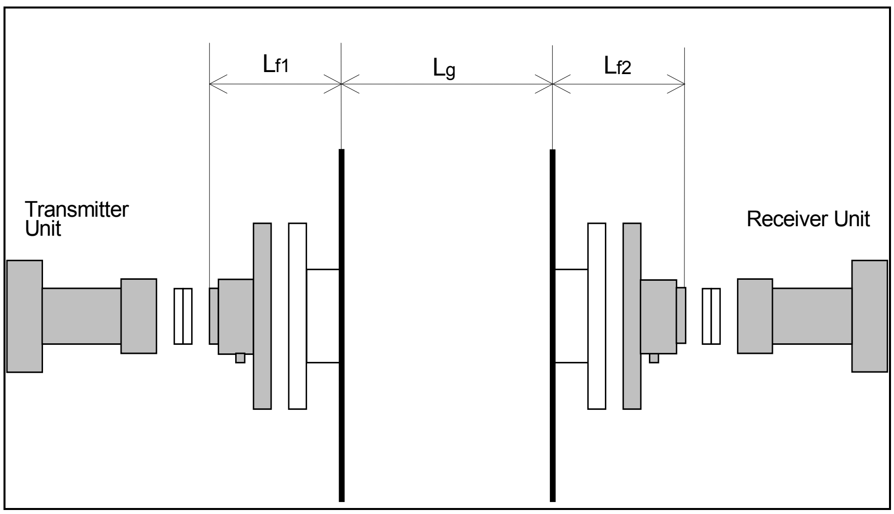


Figure 4-1: Optical lengths needed for setting initial parameters

Gas temperature in flanges (C)
The average temperature of the gas in the flanges in degrees Celsius. If the measured gas is not present in the flanges, the flange temperature is irrelevant.

Note: Proper setting of the optical path parameters is important for correct measurements.

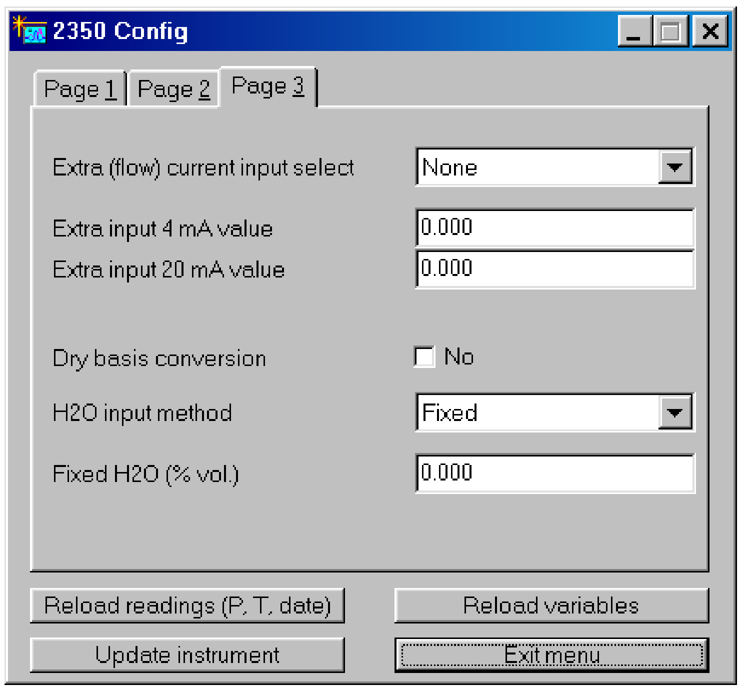
Concentration averaging
The amount of primary measurements used to calculate the averaged concentration (*Concentration Avg* in **Measurements** menu). The instrument measures and calculates the gas concentration at regular intervals. A primary measurement (*Concentration Instant* in **Measurements** menu) takes approximately 1-4 seconds depending on the gas type. The instrument calculates a “running” average of the primary measurements, which is then output in the following three ways: 1) printed on the display in the electronics unit, 2) driven through the 4–20 mA analogue output, and 3) transmitted as a digital signal in the optical fiber output (optional). All these output channels use the averaged gas concentration. The display and the current loop are updated after every primary measurement, while new data is transmitted through the fiber optic output after the defined averaging time. The amount of averaging is specified by the averaging count (T_{av} = N x T_{prim}).

Line width averaging:
Specifies the number of line width averaging.

Line width adaptive averaging:
Switched OFF = the rolling average (as for concentration) applies.
Switched ON = the number of averaging depends on the signal strength i.e. weak signals are averaged longer. NB: This will only be effective if line width averaging is specified > 10.

Spectral temperature averaging:
Specifies the number of spectral temperature averaging.

Instrument time
The instrument has a built-in clock, which also runs when power is off. Using this menu the instrument time should be set equal to the local time. The current instrument time is only downloaded from the instrument after an update of parameters or explicitly after pressing <Reload readings (P, T, date)>.



Extra (flow) current input select
Configures the extra (denoted as “Flow”) current input to the instrument. It can be set to “None”, “Gas - % vol”, “Gas - g/Nm3”, “Gas – g/m3”, and “Flow”. Input “None” simply deactivates the extra current input. For all other inputs the 4 mA and 20 mA values must be specified. The current input can be used to connect an external gas sensor (typically an H2O sensor for dry basis conversion) to the instrument. In this case “Gas” input with the corresponding concentration unit should be selected. The measured input current can be monitored in the **Measurements** menu. Input “Flow” is currently not implemented.

Dry basis conversion
The primary measurements of the gas concentration are always on wet basis. The instrument can also present the results on dry basis if the H2O concentration is known. If <Dry basis conversion> is selected the instrument converts the measured concentrations according to the following simple equation:

$$N(dry) = N*100 / (100- H2O(\%))$$

where N is the originally measured gas concentration on wet basis and H2O(%) is the input H2O concentration in % vol. The factor that multiplies N is *Dry conversion factor* which can be monitored in the **Measurements menu**.

H2O input method

The following input methods for the H2O concentration can be selected: Fixed, Current loop, Measured, Calculated.

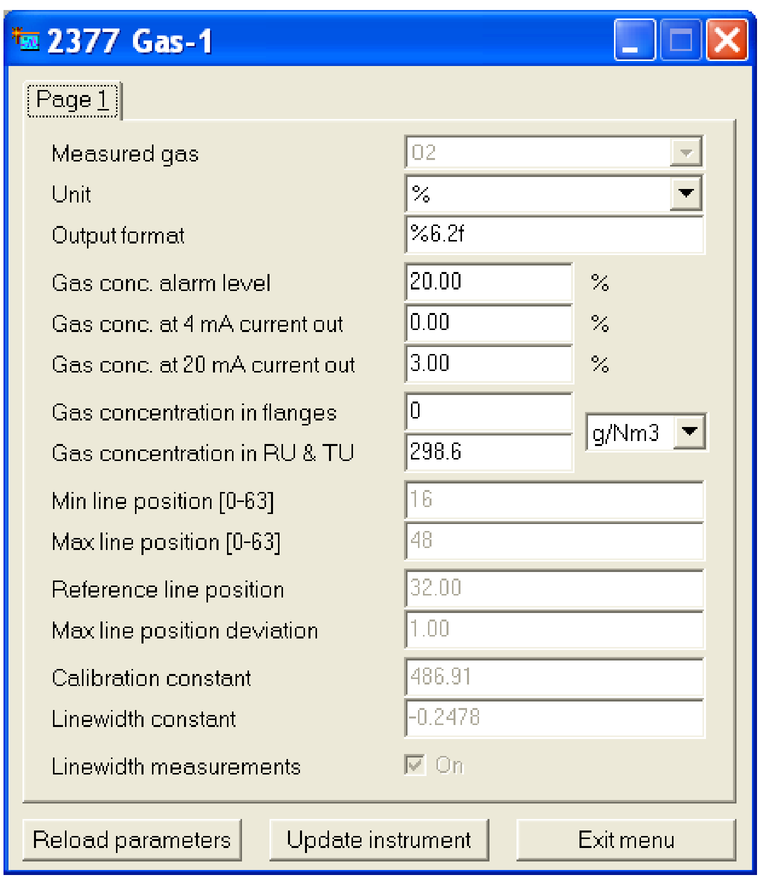
Method "Fixed" sets the H2O concentration equal to the manually specified value.

With method "Current loop" the H2O concentration is input from an external H2O sensor via the Extra (Flow) current input. In this case Extra (flow) current input select must be set to "Gas-unit", where "unit" corresponds to the output concentration unit of the external H2O sensor. The 4 and 20 mA values must be specified. Method "Measured" can be used when the analyzer is configured to measure several gases and one of them is H2O. The maximum H2O concentration used for dry basis conversion with this method is limited to 50% vol. If the measured concentration exceeds this value the value used for dry basis conversion will still be 50% vol. When method "Calculated" is selected, the instrument calculates saturated water vapor concentration based on the gas temperature and pressure input values. The calculated H2O concentration is then used for dry basis conversion. The maximum gas temperature for this method is about 90 deg. C and the maximum calculated H2O concentration is limited to 70 % vol. The same H2O limit is used also for "Fixed" and "Current loop" methods.

4.3.6 Gas specific parameters

If the instrument monitors more than one absorption line a selection menu with the relevant gases appears first.

Upon selection of one gas the following menu is displayed:



Measured gas
Displays the gas type. Cannot be modified if the program runs in User mode.

Unit
Select the appropriate unit for output of the gas concentration from the dropdown list.
The units may be grouped in two different categories, the absolute units: *g/m³*, *mg/m³* and *µg/m³* and the relative units: *%, ppm, ppb, g/Nm³*, *mg/Nm³* and *µg/Nm³*.
Some more specific units are also available such as *%*m*, *ppm*m* and *ppb*m*. These units are often used for open path analyzers and represent the concentration recalculated to 1 meter optical path length. Note that the actual path length in **Measurement configuration** menu should nevertheless be set to the correct value.
The primary unit used by the instrument to calculate the gas concentration from the absorption line is the absolute unit *g/m³*. All other units are calculated from this primary unit assuming the ideal gas law is applicable.
The relative units *g/Nm³*, *mg/Nm³* and *µg/Nm³* are the values obtained from the conversion of the absolute units (*g/m³*, *mg/m³* and *µg/m³*) to standard pressure and temperature assuming the ideal gas low. According to the European standard which applies for the analyzer these values are P = 1.013 Bar and T = 0 °C. Please note that the US standard for the relative units *g/Nm³* and *mg/Nm³* deviates with regard to standard temperature and refers to 25 °C.
Note that the gas concentration is always measured on “wet basis”, i.e. no correction is done for water vapor present in the process gas.

Output format
The numerical format of the gas concentration on the LCD display and in most parts of the service program.
The format is presented according to the programming language C (%6.2f means that the floating number will be presented with 2 decimals and 6 digits including the decimal point, e.g. 123.45).

Gas concentration in flanges, RU and TU
The gas concentrations in the flanges and in the RU & TU. The unit can be chosen between *g/Nm³*, *%* or *ppm* from the dropdown list. If the measured gas is not present inside RU and TU and/or in the flanges the corresponding gas concentration must be set to zero.
Note that the corresponding optical path lengths are specified in the **Measurement configuration** menu.

Min/Max line position [0-63]
These values define the acceptance window (in samples) for the line position in the second harmonic signal (see Section 4.3.2). The values cannot be modified if the program runs in User mode.

Reference line position
Specifies the position of the absorption line (in samples) in the second harmonic signal. The value cannot be modified if the program runs in User mode.

Max line position deviation
Specifies the maximum deviation of the line position (in samples) from the reference line position. In case the deviation is larger than the specified value the instrument will adjust the laser temperature to bring the line back to the reference position. The value cannot be modified if the program runs in User mode.

Calibration constant

The constant used in calculation of the gas concentration. The calibration constant is modified after calibration (see Section 4.3.7). The value cannot be modified manually in this menu if the program runs in User mode.

Line width constant

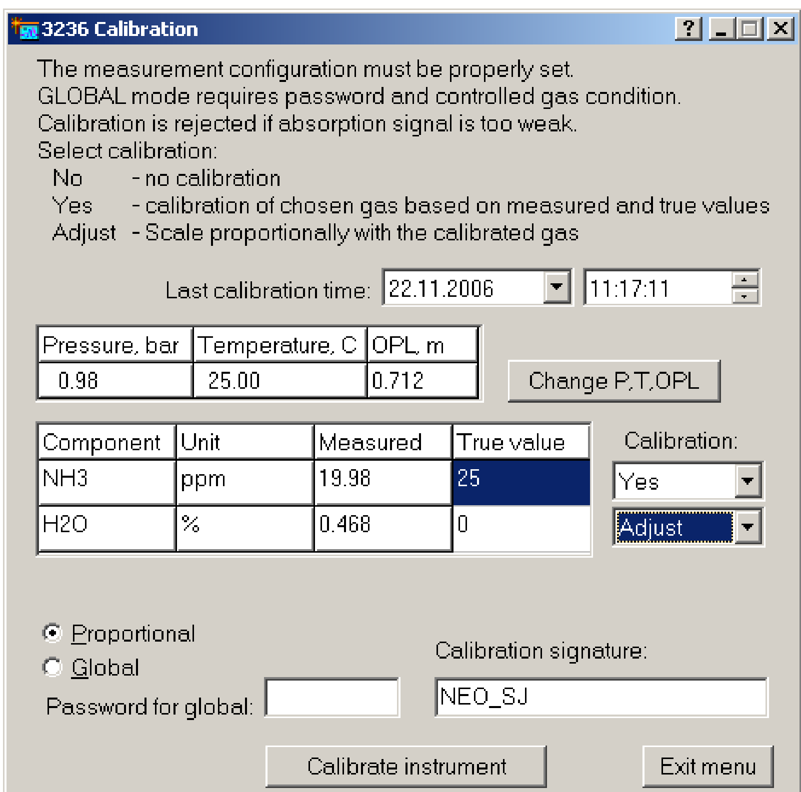
The constant used to calculate the line width, which in turn is used to calculate the gas concentration. The line width constant can be modified together with the calibration constant after calibration (see Section 4.3.7). The value cannot be modified manually in this menu if the program runs in User mode.

Line width measurement

This parameter switches the line width measurement function ON and OFF. If switched OFF the theoretical line width for the given gas pressure and temperature is used. If switched ON the line width is measured from the shape of the second harmonic absorption line. The value cannot be modified manually in this menu if the program runs in User mode.

4.3.7 Calibrate instrument

Calibration of all gases and the spectral temperature (if applicable) is carried out in this menu. The example below is for an instrument measuring two gases.



There are two available calibration modes: “PROPORTIONAL” and “GLOBAL”, which can be toggled.

The default calibration mode is **PROPORTIONAL**. In this mode the instrument performs proportional adjustment of the calibration constant based on the measured and supplied concentrations. There are no special requirements to the gas parameters and signal quality. The PROPORTIONAL calibration may be done whenever it appears necessary to the user that the instrument measurements should be adjusted, for example during measurement of process gas. Please note the following:

- All gases can be calibrated individually. The true gas value is specified and “Calibration” is set to “Yes” from the corresponding dropdown list.
- For gases that are not to be calibrated, “Calibration” is set to “No” from the corresponding dropdown list.

It is also possible to auto-calibrate gases. Gas A is calibrated by filling in the true value and selecting “yes”. Gas B is auto-calibrated by setting the correct value to zero and select “adjust”. In this case the calibration constants for line amplitude and line width for gas B are adjusted according to the calibration of gas A. This is useful if only one calibration gas is available or if the relative ratio of the measured concentrations after the calibration shall be preserved.
In the example above, NH_3 gas is calibrated to 25 ppm. The calibration constants for H_2O will be adjusted accordingly.
Enter your initials for identification of calibration.
Press <Calibrate instrument> to update the instrument with a new calibration. The instrument will use the currently measured average concentration to perform all necessary calculations. The new calibration will be stored permanently. The calibration time will be updated automatically.

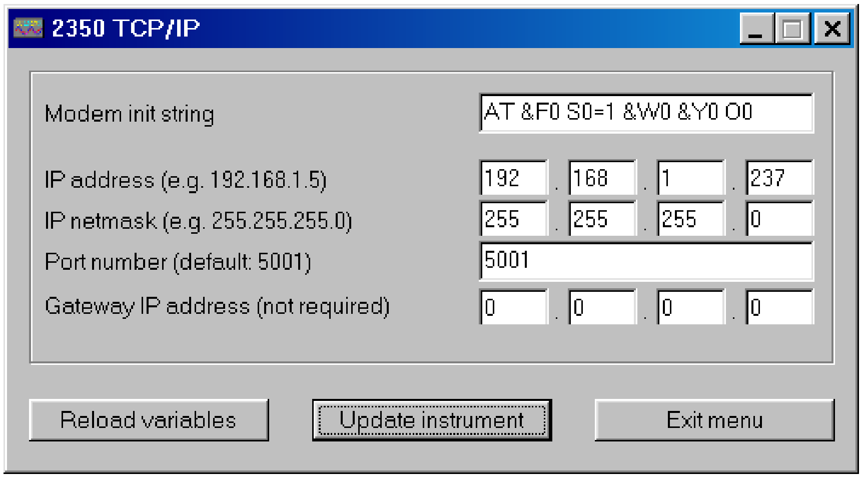
ABB calibrates all instruments under controlled conditions using certified gas. This calibration is then verified for the specified range of temperature and pressure. There is no need to calibrate the instrument upon reception. However, if the measured concentration does not match an expected value or wet chemical control measurements, the user may wish to recalibrate the instrument directly on the process. **Please note that after such a calibration the factory is relieved of responsibility for correct instrument calibration in the specified range of gas temperature and pressure.** An O_2 analyzer can measure incorrect zero level after such a calibration. This can happen if the new calibration constant does not correspond to the background oxygen absorption in the receiver and transmitter units and/or in the flanges.

In the **GLOBAL** calibration mode the instrument performs reference measurements of the absorption line width in addition to the line amplitude. The calibration constant and reference line width are then adjusted based on these measurements. This calibration procedure requires stable and controlled conditions of the reference gas. It should be performed using a test cell and a certified mixture of measured gas with nitrogen and only if it was verified that the current calibration is not valid. The procedure requires technical skills and some experience in handling gas mixtures. As a rule only qualified personnel should perform GLOBAL calibration after major services. General recommendations concerning this calibration option are given in Section 5.4. To calibrate the instrument proceed in the same way as described above for PROPORTIONAL calibration mode. The only difference is that the program will ask for a password, which is available from the local distributor or the factory. The GLOBAL calibration, if performed correctly (ref. Section 5.4), guarantees the validity of the calibration parameters in the specified pressure and temperature range.

Calibration mode PROPORTIONAL/GLOBAL is common for all gases. Nevertheless, it is possible to calibrate one gas in global mode and another in proportional mode. In this case the mode is set to GLOBAL and the line width measurements for the gas, which should be calibrated proportionally, must be switched OFF in **Gas specific parameters** menu (only for the program running in Advanced mode). It can be switched back ON after the calibration. Calibration mode is not applicable to the spectral temperature.

4.3.8 TCP/IP and modem configuration

TCP/IP parameters of the embedded Ethernet board and the initializing string of a modem can be configured using this menu.



IP address
The address assigned to the Ethernet board of the instrument. Default IP address is typically set to 192.168.1.237 for LAN communication. The user can assign any free local IP address or a valid global IP address for direct internet connection.

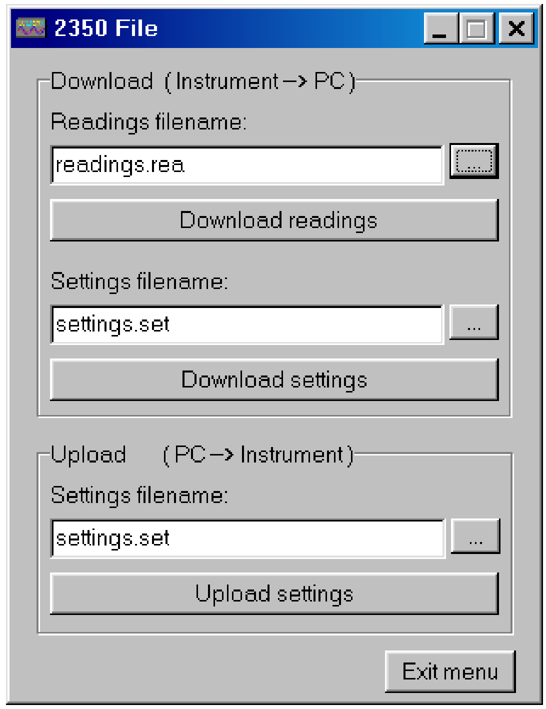
IP netmask
Defines the subnet mask for LAN connection. Default net mask is 255.255.255.0.

Port number
Specifies the port number for TCP/IP communication. Default port number is 5001, but the user can assign any free port number.

Gateway IP address
The address of a server used to route TCP/IP traffic to/from the Ethernet board to another network. This is normally not needed for local communication, but may be needed when the Ethernet board is setup for internet connection.

4.3.9 File download / upload

The menu allows to save/restore instrument data to/from file.



Two different types of data can be downloaded from the instrument to a PC and saved into ASCII text files: the instrument readings and the instrument settings. The readings file contains the measured data shown in the **Measurements** menu. The settings file contains all static parameters of the instrument including those in the different menus described above. The filenames can be edited. We recommend using the file extension *.rea* or *.dmp* for the instrument readings and the extension *.set* or *.stt* for the instrument settings. If an existing file name is chosen the new data are appended to this file.
After pressing <Download readings> the readings data are downloaded and written to a file with the specified name. The data can be viewed and analyzed. Alternatively, the instrument readings can be downloaded from the **Second harmonic signal** menu.
After pressing <Download settings> the instrument setting parameters are downloaded and written to a file with the specified name. The setting file is useful as backup of the instrument settings. It is advisable to save instrument settings before modifying the instrument parameters, and before and after each calibration.
It is possible to upload instrument settings from a PC, thus updating the instrument with new settings or restoring a previously saved instrument configuration. It is important to ensure that the settings file is correct and actually belongs to this analyzer. The settings file can be edited with any text editor and parameters, which should not be uploaded, can be removed.

Note that updating the instrument with wrong settings such as laser current and laser temperature may damage the laser.

4.3.10 Manual instrument control

Enter Sleep mode
The instrument will be forced into Sleep mode

Reset Microcontroller
Microcontroller is reset

Collect AD statistics
For service purpose only

Current loops and digital i/o
This menu is for testing the 4–20 mA inputs or outputs mainly during installation of the analyzer. Note that the instrument will be set into sleep mode for these tests.

Save system log
See section 4.3.4.

Rewind system log 100 lines
See section 4.3.4.

4.4 Configuration via AO2000 central unit

Those parameters which are used to fit the laser analyzer to the measuring point can also be configured via the AO2000 display and control unit. This configuration method has the same effect as that using the service software.
The following overview briefly explains the parameters and their possible settings (refer to Sections 4.3.5 and 4.3.6 for detailed information).

```
Menu
 |_Maintenance/Test
    |_...
    |_Analyzer spec. adjustm.
       |_...
       |_LS25 basic configuration
```

_Serial number	for information only
_Unit	unit of gas concentration:
_Meas. range	g/m³, mg/m³, %, ppm, g/Nm³, mg/Nm³
_Neg. concentration	display of negative measured values: on or off
_Temperature	input method: fixed value, 4–20 mA, internal sensor, AO2000 correction
_Temperature → _Value	fixed temperature value in K
_Temperature → _Value at 4 mA	temperature value for 4 mA at current input
_Temperature → _Value at 20 mA	temperature value for 20 mA at current input
_Pressure	input method: fixed value, 4–20 mA, internal sensor, AO2000 correction
_Pressure → _Value	fixed pressure value in hPa
_Pressure → _Value at 4 mA	pressure value for 4 mA at current input
_Pressure → _Value at 20 mA	pressure value for 20 mA at current input
_Advanced settings	
_Advanced settings → _Optical path gas	optical path length through gas
_Advanced settings → _Optical path flanges	optical path length through both flanges
_Advanced settings → _Gas temperature flanges	gas temperature in flanges in K
_Advanced settings → _Concentration flanges	gas concentration in flanges in g/Nm³
_Advanced settings → _Concentration TU & RU	gas concentration in transmitter and in receiver unit in g/Nm³

5 Operation, maintenance and calibration

5.1 Operating modes

After having set all necessary instrument parameters as described in Section 4, the instrument is ready for operation. During continuous operation, the analyzer may be in any of these three modes:

1. Start-up mode
2. Measuring mode (or normal mode)
3. Fault mode (or Error mode / Sleep mode)

1. Start-up mode: After turning on the power the instrument runs through initializing, self-test and start-up before starting measurements. This is indicated by appropriate texts in the instrument display (LCD). The instrument stays in start-up mode until the laser temperature stabilizes within acceptable limits. The LCD typically shows the following:

```
          ABB    6.1a1
           - power -
Self-test                 OK
Start-up               0.356
```

In the upper right corner of the LCD the firmware version used by the instrument is printed. In this case the version is 6.1a1.
The next row shows the cause for the instrument being in start-up mode. Normally it will show -power- indicating that the power has recently been switched on. In case of a restart due to unexpected software or hardware conditions the word -watchdog- would be printed instead.
If the self-test has passed successfully, a number appears in the lower right corner of the LCD. This number decreases as the laser temperature stabilizes. When the number is below 0.3, the instrument slowly powers up the laser. The start-up mode normally lasts less than 3 minutes.

2. While the operating mode is **«measuring»**, the instrument can be in 3 measuring modes:

a) «Normal»: Normal measurement,
b) «Zero»: Measurement of zero point.
c) «Span»: Measurement of span (with span cell).

Note that «Maintenance» mode is not implemented for this analyzer (if selected the analyzer will continue to operate in normal mode).
The measuring mode is defined by input through digital communication (with service program see Section 4.2).
a) In normal mode the measured gas concentration is periodically 1) printed on the LCD, 2) output to the 4–20 mA current loop (PLC) (optional), and 3) output to the optical fiber cable (optional). Measurements can also be polled through serial cable (RS-232) with the service program, and through an Ethernet cable to AO2000. The measured gas concentration is updated every 1–5 seconds depending on factory settings which are optimized for the application. If the instrument can measure two gases the LCD might look as follows:

```
Tr  100 %              ABB     6.0d2

CO     21.32 %
CO2    32.64 %
```

The LCD shows the measured average gas concentration(s) in the chosen unit and the laser beam transmission, which indicates how much light hits the detector relative to the maximum value (calibrated by the factory).
In case of a warning, the instrument continues to measure the gas concentration while displaying the message in the bottom line. In case of an error, the LCD shows <Instr. ERROR> instead of the concentration, and displays the message in the bottom line. An explanation of LCD messages is given in Section 5.5.

b) and c)
Zero and span check functionality are optional features of the analyzer. Please refer to Section 7 for a more detailed description of these options.

3. Fault mode is entered when the instrument has detected a severe failure during the self-test or normal operation, which might permanently damage the instrument. In this case the instrument stops measuring the gas concentration and most instrument functions are turned off. This operating mode is indicated on the LCD with <Instrument Off>, no gas concentration is displayed, and the bottom line of the display indicates the nature of the fault (See Section 5.5). The instrument automatically attempts a restart after one hour.

5.2 Maintenance

The analyzer is designed to reduce maintenance to a minimum. Experience has shown that maintenance interval of more than three months are acceptable for most applications. The maintenance operations described in this section will secure a continuous and safe operation of the monitor.

5.2.1 Routine maintenance

ABB gas monitors have no moving parts and require no consumables. For best performance, however, we recommend to routinely carry out the follows steps:

- Check optical transmission regularly (daily). This can be done automatically by use of instrument output (if ordered).
- Clean windows and adjust alignment when necessary (see below).
- For applications where the concentration of measured gas is normally zero (“zero”-gas application): Check instrument response by applying some gas at least once every three months. Apply sufficiently high gas concentrations to obtain a strong instrument response for at least 10 minutes (at least 70 minutes after power on). No warnings or errors should be displayed during the test. For certain instruments this procedure is not necessary as the laser is tracking on another absorption line than the “zero gas” line (e.g. H_2O line for an HF instrument). Contact ABB if you are in doubt about your instrument.
- Check calibration every 3 - 12 months (depending on the required accuracy). Recalibrate if necessary. (See below.)
- After each calibration check, save instrument settings and measurement data recorded with some gas (refer to Section 4.3.9). This is for tracking purposes in case of future service issues.

5.2.2 Cleaning of optical windows

Dust or other contamination on the optical windows will reduce the signal level. The instrument is designed to allow a considerable reduction of transmission (down to 10-30%) without influencing the quality of the measurements. However, if the transmission drops below the level of reliable measurements, the LCD shows «Low transmission», and the windows should then be cleaned. To reduce accumulation of dust on the optical windows, each instrument is normally equipped with a purging unit. A check of the optical windows should also be done in connection with purging failures.
The optical windows can be cleaned with nonabrasive detergents or solvents. If there are cracks or damages the window should be replaced. Since the windows are wedged, the orientation of the new window must be the same in order to preserve the system alignment.

5.2.3 Alignment of the instrument

The alignment of the receiver and transmitter units may change due to outer strains. The transmission can, therefore, decrease with time. The LCD will show «Laser line-up error» alternating with «Low transmission». To realign the transmitter and receiver follow the installation procedure explained in Sections 3.3 and 3.4.

5.3 Optimizing the flange purge flow

It is difficult to advice in general terms how much purge gas to use for given applications, because this will depend on the gas velocity in the duct, the length and diameter of flanges etc. As a rule of thumb one can start with a velocity of the purge flow in the flanges equal to 1/10 of the gas velocity in the duct.
If the gas concentration to be measured is fairly constant (and non-zero) over a few minutes one can try one of the following procedures to measure the required purge flow:
Alternative 1:
1. Connect the service PC and start <Custom logging> with Concentration Instant selected and 2 second sampling period (ref. Section 4.3.3). Alternatively, you can write down the instant concentration manually while watching Measurements menu.
2. Quickly turn off the purge flow for 30-60 seconds and then back on. The flanges will be filled with duct gas a few seconds after the purge gas is turned off.
3. Repeat step 2) a few times to be sure to have good reproducibility of the change in the measured gas concentration, as opposed to true fluctuations in the process.
4. From the data in the log file calculate the ratio of measured gas concentration without and with flange purge air. Compare this with the ratio of the length RU-to-TU-window to the length flange-tip-to-flange-tip. From this one can estimate the "fill-fraction" of purge air in the flanges. If the ratios are equal the flanges are completely filled with purge air. If the gas-ratio is less than the length-ratio the flanges are only partly filled with purge air.
5. Adjust the amount of purge gas and repeat the test until the flanges are filled with purge air.

Alternative 2:
1. Set the measurement length (Optical path through gas, ref. Section 4.3.5) of the instrument equal to the distance from the RU window to TU window.
2. Turn off the purge flow for sufficiently long to fill the flanges with gas, and measure the concentration.
3. Reset the measurement length equal to the distance from flange tip to flange tip.
4. Increase the purge flow until it measures the same as in step 2.

If the windows have become dirty during the tests, remember to clean them. If the required amount of purge gas is difficult to obtain, alternatively Optical path through gas can be adjusted according to the test results.

5.4 Calibration of the instrument

The analyzer is factory calibrated using certified gas mixture and a calibration certificate is supplied together with the instrument. There is therefore no need for the user to calibrate the instrument upon reception.

After some period of operation the instrument parameters may change due to ageing of the diode laser. In this case a new calibration might be necessary. We recommend verifying calibration of the instrument once a year using a certified test gas and the supplied gas cell. The certified test gas should in most cases be a mixture of **nitrogen** with the measured gas. O_2 analyzers can be tested and calibrated using dry air. Percent level H_2O analyzers are normally calibrated using calibration gas generators (e.g. type HovaCAL) to generate defined moisture concentrations. For alternative methods please contact ABB or your local distributor.

Since the calibration of the instrument affects all subsequent measurements, the user should verify the need for a new calibration. We do not recommend performing a calibration if the instrument readings deviate less than 2–3 % from the nominal value within the recommended concentration levels indicated below. This is the typical absolute accuracy for calibration gas mixtures. One should also account for the precision of the analyzer, which is about 1% of the measured value if pressure and temperature are correctly set in the instrument.

The second harmonic technique used in the analyzer is intrinsically a baseline-free technique. Therefore, a calibration of the zero level is never done. If one attempts to calibrate the zero level, the service program will display an error message. The monitor can only be calibrated if it detects an absorption signal amplitude above a predefined level. This level is factory set and is typically 20 times the detection limit for an optical path length of 1 m.

To obtain the optimal signal-to-noise ratio when using the calibration cell of 0.712 m length (accessory available from ABB), the gas concentrations of Table 5-1 should be used for our standard monitors (contact your local distributor for non-standard monitors). Please note that HF is calibrated with a special 0.1–0.15 m. PTFE cell with sapphire windows. This cell can be supplied by ABB.

If only a gas mixture with higher gas concentration is available, dilute the gas mixture with nitrogen using a calibrated gas mixing system to the specified values below. Significantly lower concentrations should not be used because the measurements might be influenced by noise as well as by adsorption and de-sorption processes in the cell and the tubes.

Measured gas	Recommended concentration range
HF	50 – 500 ppm (PTFE cell)
HCl	15 – 200 ppm
NH_3	30 – 400 ppm
H_2O (low conc.), HCN, CH_4	50 – 500 ppm
H_2S	300 – 2000 ppm
CO, CO_2	0.5 – 5 % vol.
CO, CO_2 (low conc.)	50 – 500 ppm
NO	500 – 5000 ppm

Table 5-1: Recommended gas concentrations for calibration

Follow the steps described below to perform verification and calibration.

1. Let the instrument operate for at least 1 hour before performing the verification and/or calibration.
2. Connect the transmitter and receiver units to the test cell as shown in Figure 5-1. Run the service program (ref. Section 4.1 for start-up).
3. Make sure the measurement configuration parameters are properly set, as described in Section 4.3.5. The flange length or concentration should be set to zero. Check that the manually set temperature and pressure are correct, or that the PLC inputs for the gas temperature and pressure are correct.
4. Introduce the calibration gas into the cell. Wait until the system reaches stable levels.
5. Check if the reading is in agreement with the concentration of the certified gas. If required, perform calibration (PROPORTIONAL or GLOBAL) as described in Section 4.3.7.
6. Save the instrument settings to a file as described in Section 4.3.9.
7. Re-set the optical path parameters, pressure and temperature back to the installation values (ref. Section 4.3.5).
8. The instrument can now be mounted back in its measuring position.

Note that when gas is flushed through the cell, the cell pressure is higher than the ambient pressure. The pressure difference depends on the flow rate and the diameter and length of the outlet tubes. It is therefore highly recommended to measure the gas pressure close to the cell, using an absolute pressure sensor in order to provide the instrument with correct gas pressure during the verification and calibration procedure. If only the ambient pressure is known or the pressure sensor is located far away from the cell, one can switch off the gas flow before calibration, wait 1 minute for the measurement readings to stabilize and subsequently perform calibration. In this case the gas pressure is equal to the ambient pressure.

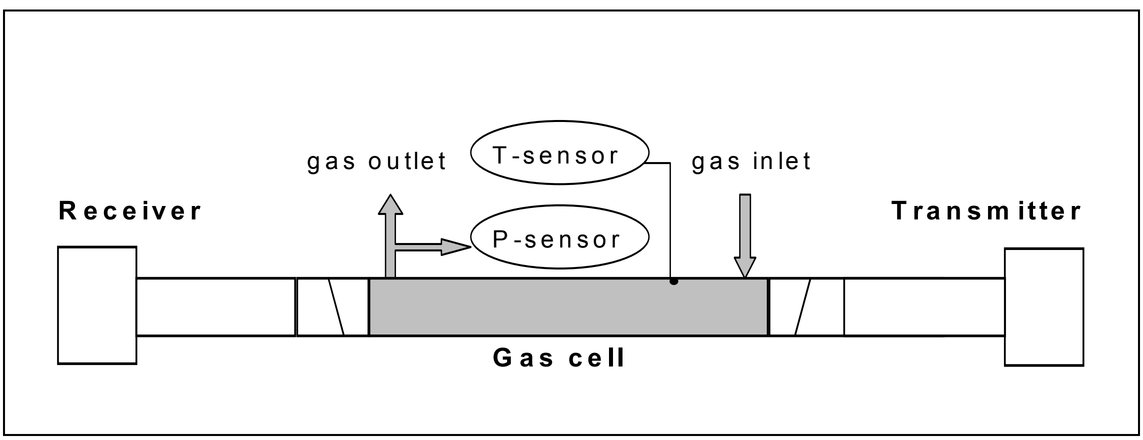


Figure 5-1: Calibration cell with monitor connected

Special care should be taken for reactive and “sticky” gases such as HF, NH_3, H_2O, HCl and H_2S. Because of the nature of these gases, it is difficult to obtain the required concentration in the calibration cell due to adsorption and de-sorption in the connection tubes and within the cell itself. The following recommendations should then be followed:

- Use stainless steel cells (PTFE for HF!)
- Use PTFE connection tubes.
- Use the shortest possible length of the tubes.
- When flushing calibration gas through the cell, use large flow rates such as 5-7 l/min.
- Wait until the concentration in the cell has stabilized.
- Switch off the flow and observe how fast the concentration degrades. If it degrades rapidly, the cell needs to be passivated.
- Check that the measured concentration remains the same with an increasing flow. If it does, the concentration in the cell most likely has reached the expected value.

5.4.1 PROPORTIONAL versus GLOBAL calibration

Line broadening compensation requires a large number of parameters to be measured. These parameters are critical for accuracy, but only when line broadening compensation is used. Most of the parameters seldom or never need to be adjusted.

PROPORTIONAL calibration:
This calibrates the span of the gas concentration by adjusting the proportionality between the peak amplitude of the absorption line and the gas concentration. Only the *proportional calibration constant* is affected by PROPORTIONAL calibration.

GLOBAL calibration:
Calibrates both the gas concentration span and line width parameters. It is important to follow the calibration procedure carefully and specify to the instrument the exact pressure and temperature of the calibration cell. The P, and T values can be set fixed with the service program, or use 4–20mA inputs if such probes are connected to the calibration cell. One can also use the readings of the internal sensors if these are close to the values for the calibration cell. It is also important to use dry gas mixed with nitrogen. For O_2, dry air can be used.

Use GLOBAL calibration:

- If spectral properties of the laser seem to have drifted. This can be evaluated by qualified service personnel from readings files recorded with the instrument when it was measuring on a calibration gas.
- After major instrument services such as replacement of laser module, main board or receiver board. (Qualified service personnel only!)
- After adjustment of laser parameters (laser temperature, modulation amplitude or phase, or other laser currents). (Qualified service personnel only!)

DO NOT use GLOBAL calibration when:

- The instrument is measuring on the process (with process gas).
- The concentration of the calibration is low or the path length of calibration cell is short such that the signal-to-noise ratio is not good.
- The conditions for GLOBAL calibration described above are not satisfied. If recalibration is required in such cases, use PROPORTIONAL calibration instead.

5.5 Troubleshooting the instrument

During operation essential status information about the instrument is displayed on the LCD mounted in the transmitter / main unit. The instrument messages and their possible explanations and actions to be taken are given in the table below. If there is no output to the display, please refer section 6.8.

Fault message	**Explanations and actions**
Low transmission	WARNING The optical transmission has dropped below the limit for reliable measurements. This might indicate misalignment of the optical units or contamination of the optical windows. Clean windows and check alignment.
Laser line-up error	ERROR The laser beam does not reach the detector. Clean the optical windows, check the optical path for obstructions, and check the alignment.
PLC T-read error	ERROR Failure reading temperature through 4–20 mA PLC input. Input current from temperature sensor is either above 23.7 mA or below 0.3 mA. Check connections to temperature sensor or use fixed temperature setting in the analyzer.
PLC P-read error	ERROR Failure reading pressure through 4–20 mA PLC input. Input current from pressure sensor is either above 23.7 mA or below 0.3 mA. Check connections to pressure sensor or use fixed pressure setting in the analyzer.
T-read out of range	WARNING Input current from temperature sensor is either above 22 mA or below 3.2 mA. The measured gas temperature may be wrong. Check temperature sensor or use fixed temperature setting in the analyzer.
P-read out of range	WARNING Input current from pressure sensor is either above 22 mA or below 3.2 mA. The measured gas pressure may be wrong. Check pressure sensor or use fixed temperature setting in the analyzer.
P/T out of range	WARNING Pressure and temperature compensation is outside acceptable range. The accuracy of the measured gas concentration may be reduced. If supplied values are correct, the instrument is operating outside specifications.
Ex-read out of range	WARNING Input current from external gas sensor is either above 22 mA or below 3.2 mA. Check Extra (Flow) current input.
Voltage supply fail	The power supply voltage input to the instrument (transmitter unit) is exceeding acceptable range (for standard instrument; 18–36V). Check and correct voltage. If the error remains, contact service personnel.
Low laser temp. High laser temp.	ERROR The laser temperature regulation has failed and the laser is too cold/warm. The instrument has entered FAULT mode and attempts automatic restart after one hour. If the transmitter unit is overheated, cool it down by thermal shielding and/or improved ventilation. If transmitter is not overheated, the error might indicate a bad electrical contact or other hardware failure. Contact service personnel if repeated.

Fault message	**Explanations and actions**
Low box temp. High box temp.	ERROR Internal temperature of transmitter or receiver is exceeding the operating limit. The instrument has entered FAULT mode and attempts automatic restart after one hour. Check ambient temperature for receiver and transmitter, and correct by thermal shielding and/or ventilation if temperature is exceeding instrument specifications. Otherwise contact service personnel.
EEPROM error	ERROR Failure of the internal memory of the instrument. Upload a backup settings file (with the original settings) to the instrument. Contact service personnel if repeated.
Self-test fail	ERROR The instrument has detected a self-test error during start-up. Try to restart the instrument. If the failure remains, write down all messages as they appear on the LCD, download Error log and System log, and contact service personnel.
Low line position High line position No absorption line	ERROR The instrument has detected a spectroscopic fault. This can have several causes: Unknown interference gas in process, incorrect laser temperature (wavelength), transmitter unit is operating outside acceptable temperature range, or laser malfunction. Check the instrument on calibration cell with a gas concentration suitable for calibration, and allow it to run continuously for > 70 minutes. If error does not disappear or calibration is significantly wrong contact service personnel.
Saturation of direct	ERROR The photodetector is saturating or transmission is > 130%. If the error remains when the receiver window is obscured, this is an electronic fault. Otherwise the error may occur after replacement of laser module or receiver electronics. Reduce receiver amplification (if possible) or transmission. If the problem cannot be solved contact service personnel.
Saturation of harm.	ERROR A second harmonic signal is saturating. This may be for one of the following reasons: The gas concentration is too high or the length of the optical path for measurement is too long. Reduce the amplification for the second harmonic signal in the receiver (contact service personnel for details), or use a shorter measurement length for high gas concentrations. If the error remains when the receiver window is obscured, this is an electronic fault. Contact service personnel.
All other error messages	Write down all the LCD messages and contact service personnel.

Table 5-2: Instrument LCD error messages

No.	Text	O	E	M	F	Corresponds to LCD error message
366	The LS25 analyzer has an error.	x	x			
367	The LS25 analyzer has a maintenance request.	x		x		
368	The LS25 analyzer starts measurement.	x	x			
369	LS25 analyzer detector error #	x	x			
370	The beam transmission exceeds the permissible range.			x		Low transmission
371	The temperature input signal exceeds the permissible range.			x		T out of range
372	The pressure input signal exceeds the permissible range.			x		P out of range
374	The detector signal is too low for measurement.	x	x			Laser line-up error
375	The input current loop (4–20mA) has an error.	x	x			T-read error, P-read error
376	This LS25 module is under maintenance.				x	(Communication with service software via RS232. No measured values are transferred.)

Table 5-3: AO2000 error messages

O x = Message sets the overall status
E x = Message sets the “Error” individual status
M x = Message sets the “Maintenance Request” individual status
F x = Message sets the “Maintenance Mode” individual status

6 Electrical connections

Note that in the table columns labelled “Description”, the indicated polarities of the items are for naming only and do not necessarily reflect the polarity of real voltages. All potentials are floating and none of them should be grounded to box. This applies to all connection tables.

Note the specific information on electrical installation for the Class I Division 2 version (see Section 8.5) and for the ATEX Zone 2 version (see Section 9.5).

6.1 Transmitter unit interface

The electronic interface for the transmitter unit is depicted in Figure 6-1.

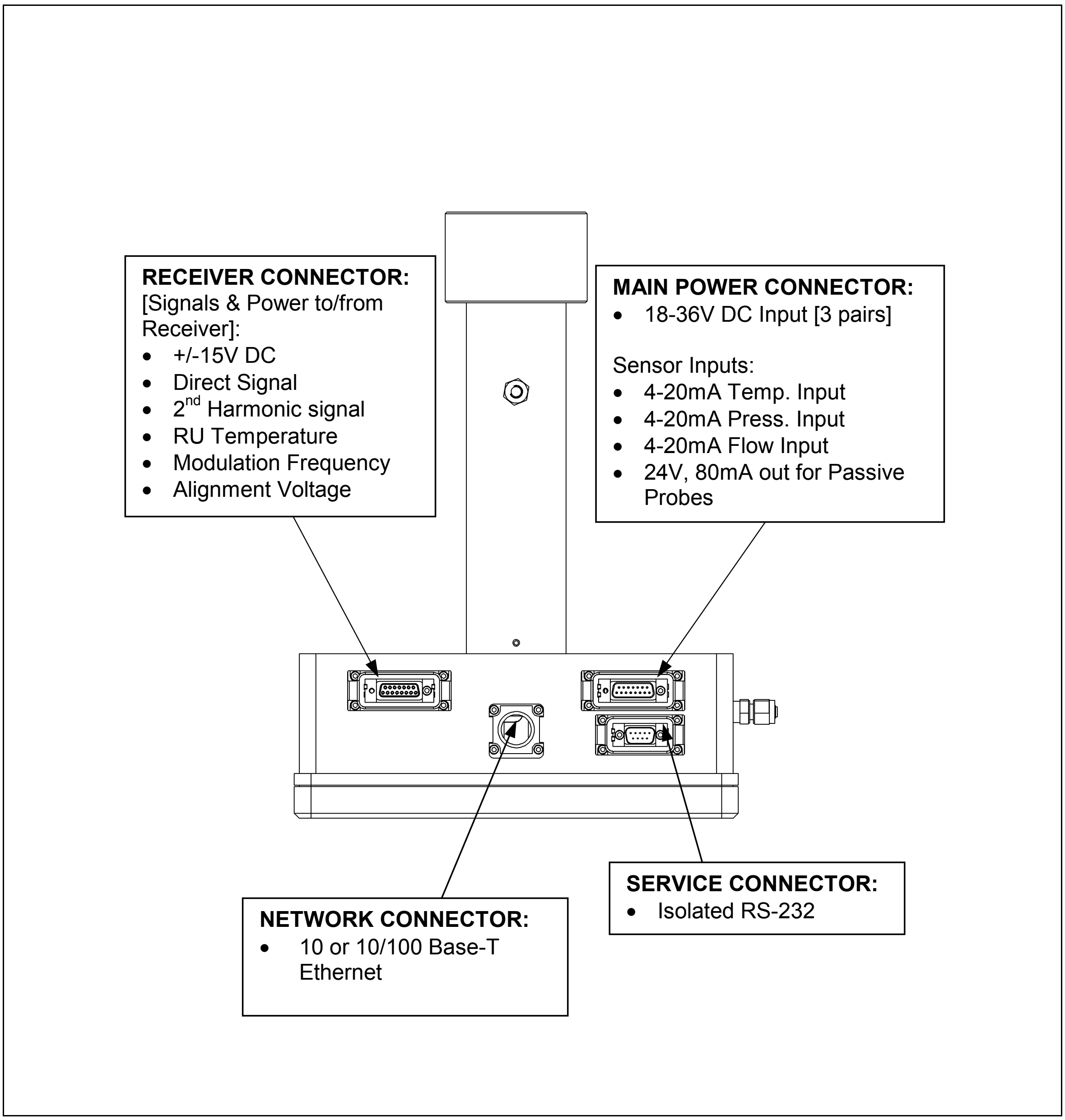


Figure 6-1: Transmitter unit electronic interface

The receiver cable is connected to the receiver connector. The power cable is connected to the power connector (with optional wiring for temperature and pressure probe inputs).

6.2 Receiver cable connections

Table 6-1 shows wiring of the receiver cable connector. This wiring applies to both ends of the cable (both transmitter and receiver side).

Terminal:	*Pair no:*	*Color code:*	*Description:*
1		**Red (*)**	Lineup+
2	3	**Pink**	RU Temp-
3	3	**Grey**	RU Temp+
4	4	**Red**	MODSQ-
5	4	**Blue**	MODSQ+
6	5	**Black**	RU PWR +
7	5	**Violet**	RU GND +
8		**NC**	
9	6	**Grey/Pink**	RU GND -
10	6	**Blue/Red**	RU PWR -
11	1	**Brown**	Direct -
12	1	**White**	Direct+
13	2	**Yellow**	2. Harmonic -
14	2	**Green**	2. Harmonic +
15		**Black (*)**	Lineup-

Table 6-1: Receiver cable connections (Phoenix connectors)

Terminal:	*Pair no:*	*Color code:*	*Description:*
1		**Red (*)**	Lineup+
2	3	**Pink**	RU Temp-
3	3	**Grey**	RU Temp+
4	4	**Red**	MODSQ-
5	4	**Blue**	MODSQ+
6	5	**Black**	RU PWR +
7	5	**Violet**	RU GND +
8	7	**Green/White**	Servo Sig
9	6	**Grey/Pink + Black (*)**	RU GND - / Lineup-
10	6	**Blue/Red**	RU PWR -
11	1	**Brown**	Direct -
12	1	**White**	Direct+
13	2	**Yellow**	2. Harmonic -
14	2	**Green**	2. Harmonic +
15	7	**Green/Brown**	Servo +5V

Table 6-2: Receiver cable connections (Phoenix connectors) with P/N 14205

(*) – internally connected to the alignment jack.

Lineup	Alignment voltage
RU Temp	Signal from embedded receiver temperature sensor
MODSQ	Modulation signal from transmitter to receiver (used for detection of 2. harmonic)
RU PWR	Power supply to receiver unit
Direct	Direct laser transmission signal from receiver detector
2. Harmonic	Detected second harmonic signal from receiver detector
Servo	Control of servomotor moving sealed cell

Note: For some instruments the receiver unit is supplied without detachable Phoenix contact but with cable gland. In this case refer to Table 6-3 for wiring.

Terminal:	*Pair no:*	*Color code:*	*Description:*
1	7	**White/ Green**	Optional 1 / NC
2	7	**Brown/ Green**	Optional 2 / NC
3	8	**White/ Yellow**	Optional 3 / NC
4	8	**Yellow/ Brown**	Optional 4 / NC
5	3	**Grey**	RU Temp+
6	3	**Pink**	RU Temp-
7	4	**Blue**	MODSQ+
8	4	**Red**	MODSQ-
9	5	**Black**	RU PWR +
10	5	**Violet**	RU GND +
11	6	**Grey/ Pink**	RU GND -
12	6	**Blue/ Red**	RU PWR -
13	1	**White**	Direct +
14	1	**Brown**	Direct -
15	2	**Green**	2. Harmonic +
16	2	**Yellow**	2. Harmonic -

Table 6-3: Receiver unit – receiver cable connections (for cable gland only!)

6.3 Power cable connections

Table 6-4 shows wiring of the power cable connector. This wiring applies to both ends of the cable (transmitter unit and power supply unit side).

PWR – power supply from power to transmitter unit. All 3 power pairs should be wired to ensure even current flow through the connector.

External temperature and pressure probes can be connected to the connector at the transmitter end of the cable or inside the power box (ref. Section 6.5).

(*) Wires may be replaced at the transmitter end of the cable (see Section 6.5).

Terminal:	*Pair no:*	*Color code:*	*Description:*
1		**Blue (*)**	Temperature Probe -
2		**Red (*)**	Temperature Probe +
3		**Black (*)**	Pressure Probe -
4		**Violet (*)**	Pressure Probe +
5		**White/Green (*)**	Flow Probe -
6		**Brown/Green (*)**	Flow Probe +
7		**Grey/Pink (*)**	Probes +24V
8		**Blue/Red (*)**	Probes AGND
9		**White/Yellow (*)**	Probes +24V
10		**White**	PWR+ (+18-36V)
11		**Green**	PWR+ (+18-36V)
12		**Grey**	PWR+ (+18-36V)
13		**Brown**	PWR- (0V)
14		**Yellow**	PWR- (0V)
15		**Pink**	PWR- (0V)

Table 6-4: Power cable connections (Phoenix connectors)

6.4 RS-232 and Ethernet connectors

Terminal:	*Color code:*	*Description:*	*Comments:*
1		Data Carrier Detect	Connected to 4.
2		Transmit Data	
3		Receive Data	
4		Data Terminal Ready	
5		Ground	
6		Data Set Ready	Connected to 4.
7		Request To Send	Connected with 8.
8		Clear To send	Connected with 7.
9		Ring Indicator	Not Connected.

Table 6-5: Transmitter unit – RS 232 Phoenix connector

Terminal:	*Color code:*	*Description:*	*Comments:*
1	**White/Orange**	TX+	
2	**Orange**	TX-	
3	**White/Green**	RX+	
4	**Blue**		
5	**White/Blue**		
6	**Green**	RX-	
7	**White/Brown**		
8	**Brown**		

Table 6-6: Transmitter unit – Ethernet RJ-45 connector

6.5 Ethernet connection to AO2000

The transmitter unit is connected to the AO2000 central unit via an Ethernet cable (for outdoor use, acid and UV resistant).

Note: The LS25 Ethernet port is switched off when the LS25 service interface is in use.

6.5.1 AO2000 with software version 3.0.7 or 4.0.1

As a rule the 2nd Ethernet interface (on the network card) is used to connect one or more laser analyzers to the AO2000 central unit.

6.5.1.1 AO2000 with one laser analyzer

The laser analyzer is connected directly to the 2nd Ethernet interface on the network card using a crossover Ethernet cable. The 1st Ethernet interface is used e.g. to connect AO2000 to the plant network.
Factory-set IP addresses:

AO2000	1st Ethernet interface	192.168.1.1
	2nd Ethernet interface (network card)	192.168.2.1
AO2000-LS25 (example)		192.168.2.100

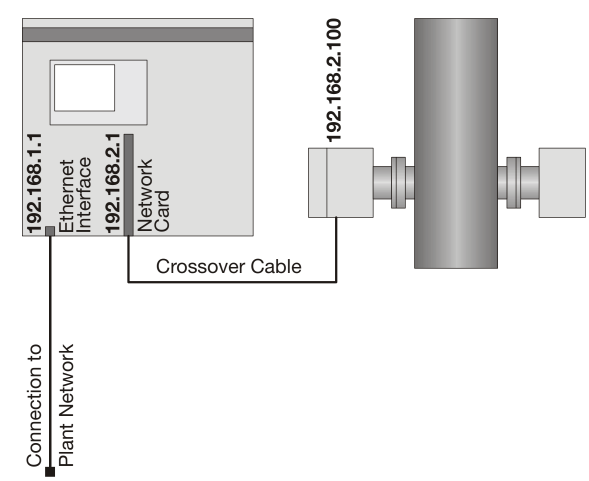


Figure 6-2: Ethernet connection – AO2000 with one laser analyzer

6.5.1.2 AO2000 with two or three laser analyzers

The laser analyzers are connected to a switch which is connected to the 2nd Ethernet interface on the network card via its uplink port. Each laser analyzer must have a unique IP address within the same network group as the network card. The 1st Ethernet interface is used e.g. to connect AO2000 to the plant network.

Factory-set IP addresses:

AO2000	1st Ethernet interface	192.168.1.1
	2nd Ethernet interface (network card)	192.168.2.1
AO2000-LS25 (examples)		192.168.2.100
		192.168.2.101
		192.168.2.102

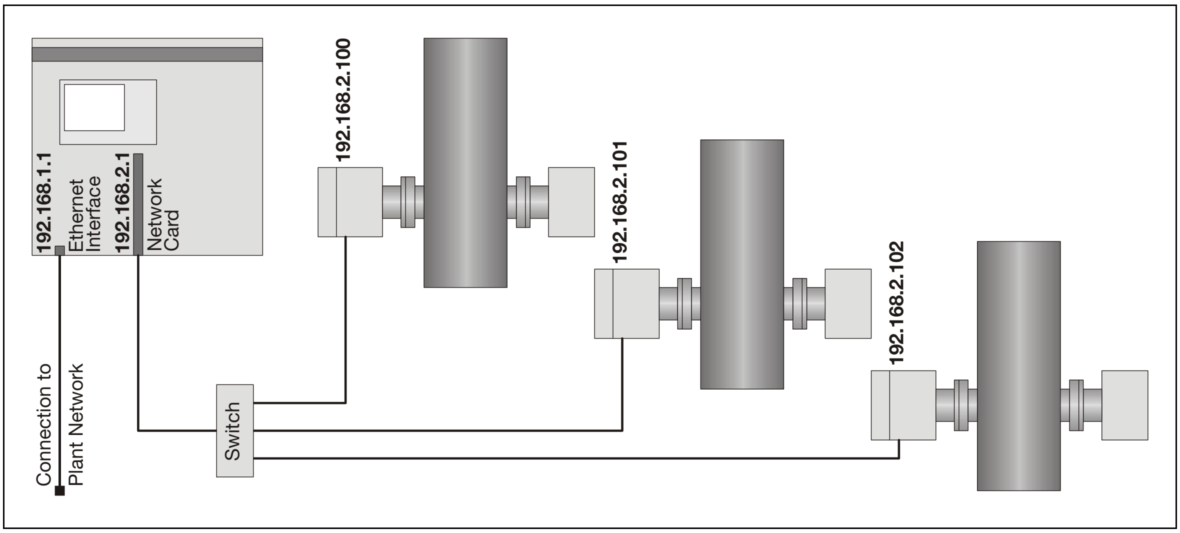


Figure 6-3: Ethernet connection – AO2000 with two or three laser analyzers

The minimum requirements for a switch are as follows:

- ≥ 6 Port nway Fast Ethernet
- 10 Mbps / 100 Mbps dual-speed Ethernet/Fast Ethernet Ports
- One uplink port
- Suitability for the intended installation location

6.5.2 AO2000 with software version ≥ 5.0.0

6.5.2.1 AO2000 with one laser analyzer

In case the AO2000 is to be integrated in a plant network the 1st Ethernet interface –X09 should be used for the connection to the plant network, while the 2nd Ethernet interface –X08 should be used for the connection of the analyzer to the AO2000 central unit (see Figure 6-4). The advantage of this configuration is that the plant network communication is not conducted through the laser analyzer – AO2000 CU network.

Factory-set IP addresses:

AO2000	1st Ethernet interface –X09	192.168.1.1
	2nd Ethernet interface –X08	192.168.2.1
AO2000-LS25 (example)		192.168.2.100

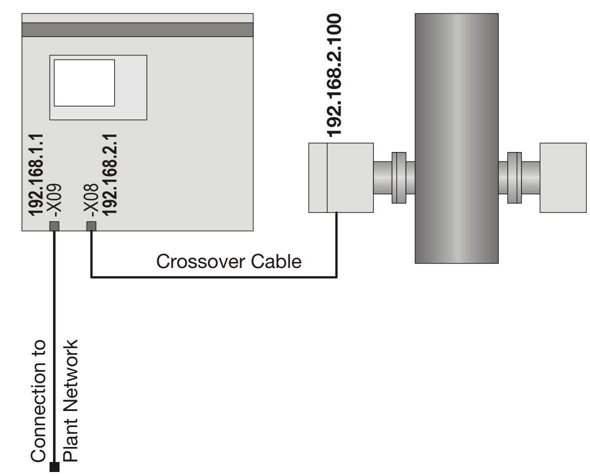


Figure 6-4: Ethernet connection – AO2000 with one laser analyzer

6.5.2.2 AO2000 with two or three laser analyzers

The laser analyzers are connected to a switch which is connected to the 2nd Ethernet interface –X08 via its uplink port. For the connection between the laser analyzer and the switch a parallel cable is necessary. Each laser analyzer must have a unique IP address within the same network group as the Ethernet interface. The 1st Ethernet interface –X09 is used e.g. to connect AO2000 to the plant network (see Figure 6-5).

Factory-set IP addresses:

AO2000	1st Ethernet interface –X09	192.168.1.1
	2nd Ethernet interface –X08	192.168.2.1
AO2000-LS25 (examples)		192.168.2.100
		192.168.2.101
		192.168.2.102

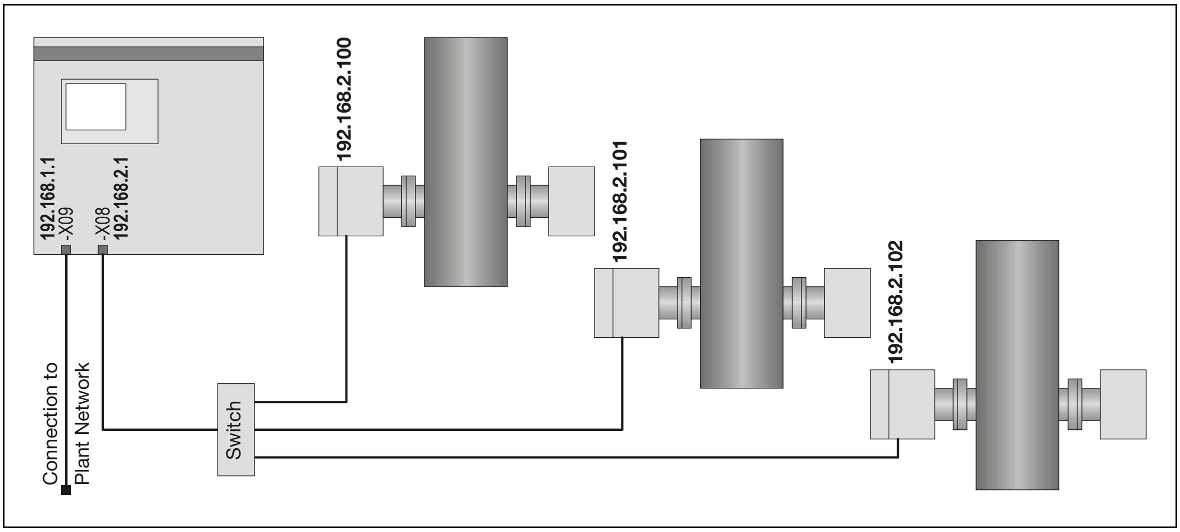


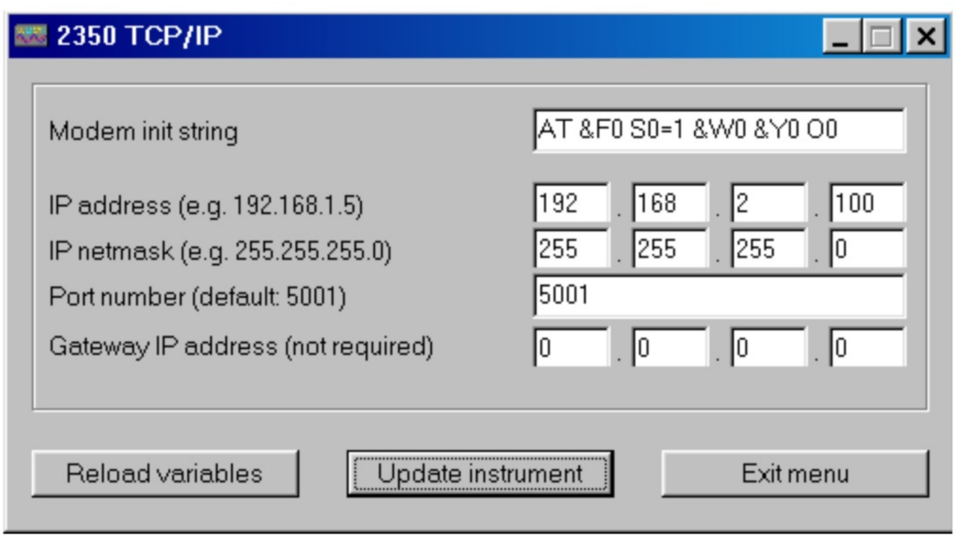
Figure 6-5: Ethernet connection – AO2000 with two or three laser analyzers

The minimum requirements for a switch are as follows:

- ≥ 6 Port nway Fast Ethernet,
- 10 Mbps / 100 Mbps dual-speed Ethernet/Fast Ethernet Ports,
- One uplink port,
- Suitability for the intended installation location.

6.5.3 Setting the IP address on AO2000-LS25

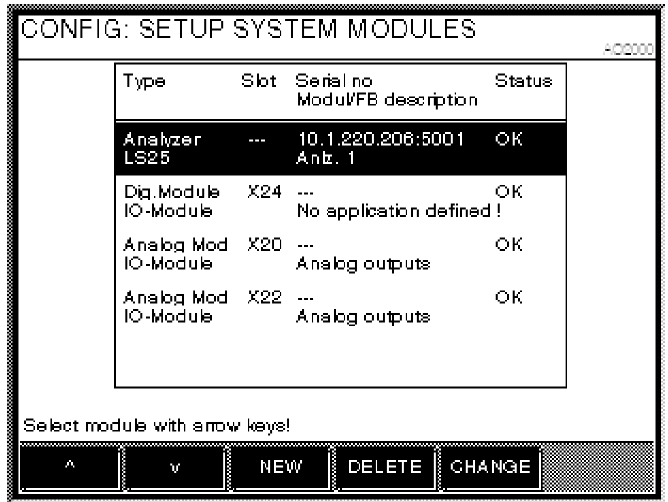
The IP address of the analyzer is set in the menu `TCP/IP & modem configuration` of the service program (see Section 4.3.8):



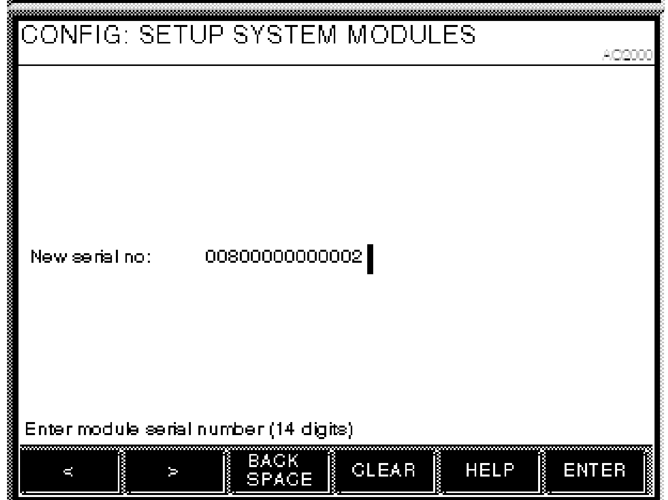
6.5.4 Setting up the laser analyzer in AO2000

1. Select the `MENU` → `Configure` → `System` → `Setup system modules` menu item and press the `<NEW>` softkey.

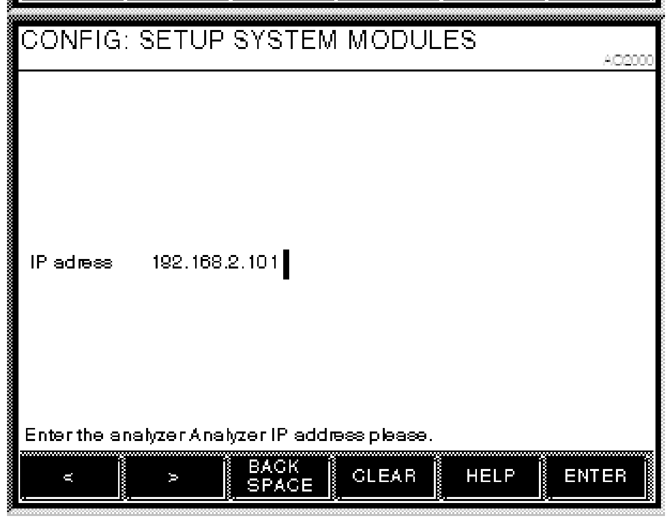
   (The IP address shown in the adjacent picture is an arbitrary example.)



2. Enter an arbitrary 14-digit serial number. The first three digits must be “008” and the serial number must be different for each laser analyzer.
3. Press `<ENTER>`.



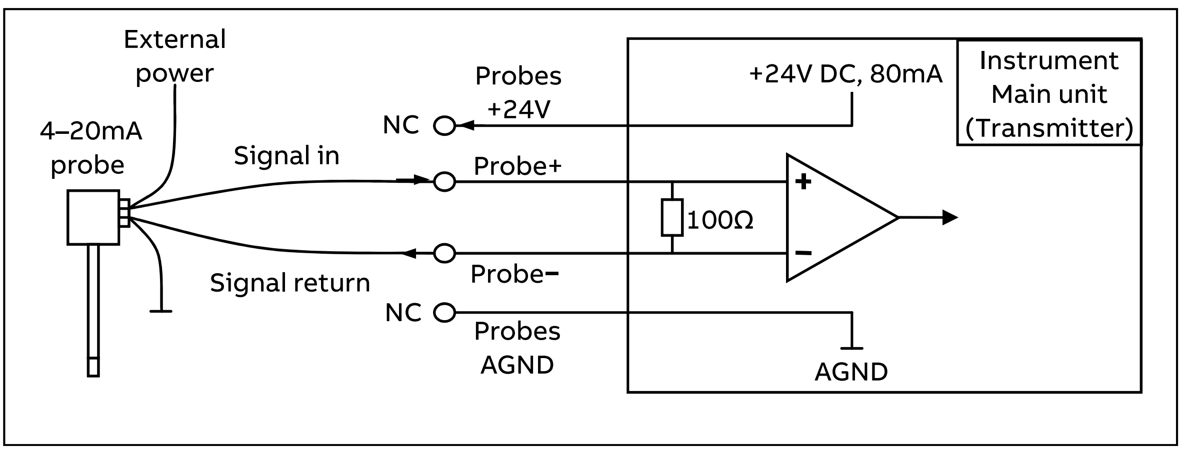
4. Enter the IP address of the laser analyzer and press `<ENTER>`.
   The factory-set IP address is 192.168.1.237 (see pages 25 and 40).
   In the system modules list the laser analyzer will be shown with a `New` status.

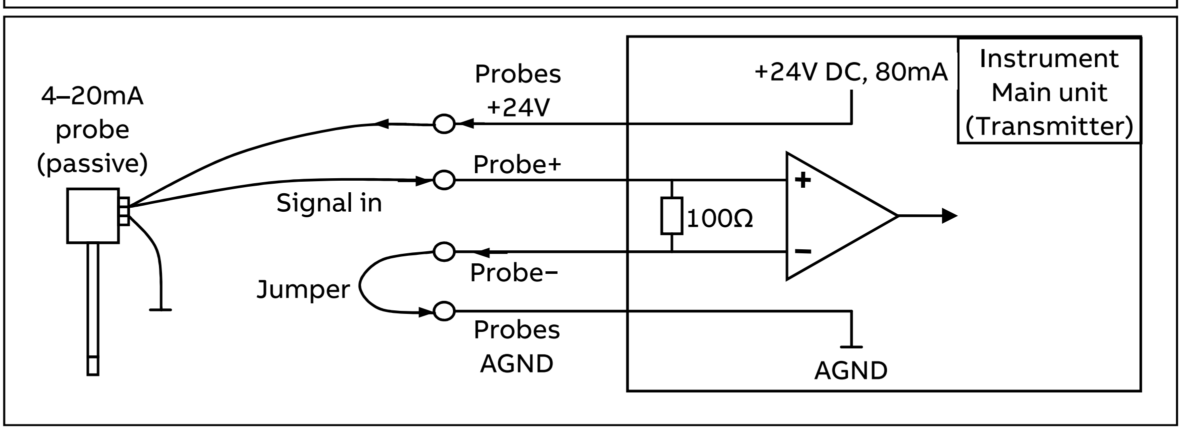


6.6 Current loop (4–20 mA) input connections (PLC)

There are several possible ways to connect external pressure and temperature probes to the instrument. They can be wired inside the power unit. For this purpose the power box should be opened and the probe outputs connected to the screw terminals marked with Probe+ and Probe− (or +24V for passive probe) (Probe is referred to either Temperature, Pressure or Extra (Flow)). They can also be wired inside the power cable connector on the transmitter unit side. For this purpose the corresponding Phoenix cable connector should be disassembled and the probe outputs connected to the screw terminals according to Table 6-4. Note that if the connection is made on the transmitter side, the factory-mounted cable wires may be disconnected from the screw terminals in question. Note that conductors with area 0.14–0.5 mm^2 (AWG 26–20) must be used (ABB recommends 0.25mm^2). The cable outer diameter (1 pr nipple) must be 3–9 mm.

Figure 6-6 and Figure 6-7 show how active and passive 4–20mA current loop input probes (referred to as PLC) are connected to the instrument. The *Probe+* and *Probe−* constitute a differential input which are tolerant to common mode voltages up to ±200V. *Probe+* and *Probe−* are connected internally in the instrument by a 100Ω resistor, which give a voltage drop of 2V at 20mA. Several instruments can therefore be chain connected to the same probe by connecting *Probe−* of the first instrument to *Probe+* of the next instrument, etc.





6.7 Mains power cable connection

The mains power cable connects to the power supply unit (PSU). The clamping range of the cable gland on the PSU is 5–10 mm diameter. The 220 VAC power terminals inside the PSU can accommodate conductors with area < 2.5 mm^2 (ABB uses 1 mm^2).

6.8 Transmitter board – fuses and LED's

The transmitter board has one main fuse and some LED's to indicate status of different supply voltages. Figure 6-8 shows the main / transmitter board layout.

If the LED close to the main fuse ("18–36V Input OK") is lit but the other LED's are not, check the main fuse. If all LED's are dark, check the 24 V supply to the instrument. If some LED's are lit and others are not, please note which are lit and which are not lit, and contact your local distributor as the board might have to be serviced.

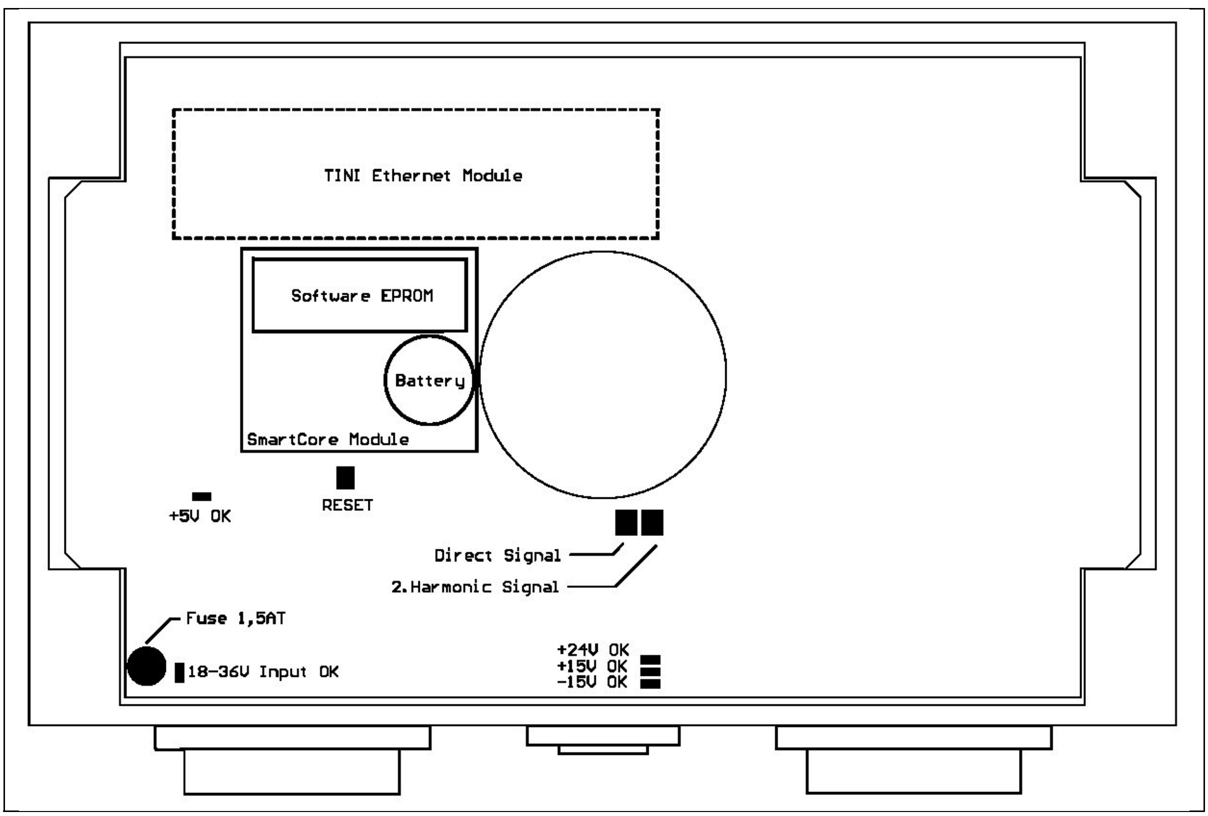


Figure 6-8: Power electronics card fuses and LED's layout

7 Span and zero check options

The LS 25 monitor may be fitted with different options to carry out span and zero checks for validation on the process. The following are available:

1. Span check for non-corrosive gases (e.g. O_2, NO, CO, CO_2) with internal flow through cell inside receiver unit
2. Span check for corrosive gases (e.g. HCl, NH_3, H_2S) with additional span flow through cell mounted between receiver unit and process
3. Span and zero check with internal sealed span cell

Contact your local distributor for more information about these options.

7.1 Span check with flow through cell

Span checks to validate analyzer performance may be carried out with the instrument installed on the process. For non-corrosive gases the internal 100 mm volume between receiver window and receiver lens is used to this end. For corrosive gases a dedicated span cell (accessory available from ABB) mounted between receiver unit and process applies. The span gas is measured in parallel with the process gas; therefore it is important that during normal operation this internal or span cell is empty for span gas.

The span mode is initiated by input through digital communication (with the service program, see Section 4.2).

The instrument calculates and stores the absorption signal for the gas concentration measured in normal mode just before the span check. This absorption signal is continuously subtracted from the measured signal during span check operation. The resulting signal, therefore, corresponds to the signal from the internal cell (or span cell) providing that the signal from the process remains stable. Ambient temperature and pressure recorded with the internal temperature and pressure sensors located inside the receiver unit is used to calculate the concentration of the span gas. By default the concentration is referred to 1-meter path length. This means that, if the span gas concentration is for example 1% vol., the measured span will be 0.1% vol. (The span can be scaled to another path length. Contact ABB for details.)

The span check procedure:

1. Initiate span check through one of the channels described above. The instrument is forced to span check operation. After few seconds the message “SPAN” appears on the transmitter LCD. The measured concentration should come to zero, which indicates that the process absorption signal is properly subtracted.
2. Start flushing the internal cell with the span gas. Use moderate flow rates (approximately 1–2 l/min) to avoid pressure build-up in the cell.
3. Measure span concentration.
4. Remove any residual span gas from the flow through span cell by flushing it with Nitrogen or air.
5. Set the instrument back to normal.

7.2 Span and zero check with internal sealed cell

Note that this option also includes zero check functionality.

Span and zero checks may be carried out with the instrument installed on the process. The receiver unit includes a small sealed gas cell containing the gas to be measured. This cell is moved into the laser beam path by a compact servomotor.

The span and zero mode is initiated by input through digital communication (with the service program see Section 4.2),

The instrument calculates and stores the absorption signal for the gas concentration measured in normal mode just before the span check. This absorption signal is continuously subtracted from the measured signal during span check operation. The resulting signal, therefore, corresponds to the signal from the internal cell providing that the signal from the process remains stable during span procedure (typically 15 seconds). Ambient temperature and pressure recorded with the internal (integrated inside the receiver unit) temperature and pressure sensors are used to calculate the concentration of the span gas. By default the internal span cell is calibrated to give a 75–80% of full-scale reading. (alternative calibration is possible, contact ABB or your local distributor).

8 Notes and instructions for Class I Division 2 version

8.1 Preliminary remarks

This part of the manual contains information of installation, operation and maintenance of the analyzer, Class I Division 2 version (CSA approved).

Advance Optima Analyzers must be connected using Division 2 wiring methods. Alternatively, these devices may be installed in a suitable enclosure, cabinet or rack with provision for connection of Division 2 wiring methods, acceptable to the local inspection authority having jurisdiction.

Conduit seals prevent explosions from spreading through conduit systems and igniting outside atmospheres. Seals must be placed in each conduit of a device that might produce arcs, sparks, or high temperatures. When properly installed and filled with a CSA/UL-listed sealing compound, they prevent the passage of gases, vapors, or flames from spreading from a hazardous location to a nonhazardous location.

CAUTION: The installation instructions of the conduit sealing manufacturer must be observed.

8.2 Instrument design

The analyzer consists of three separate units (see Figure 8-1):

- Transmitter unit with purging fittings and transmitter connection box with screw terminals for connection of power and receiver cable and optional inputs/outputs
- Receiver unit with purging fittings
- Power supply box (not suitable for installation in Class 1, Div. 2)

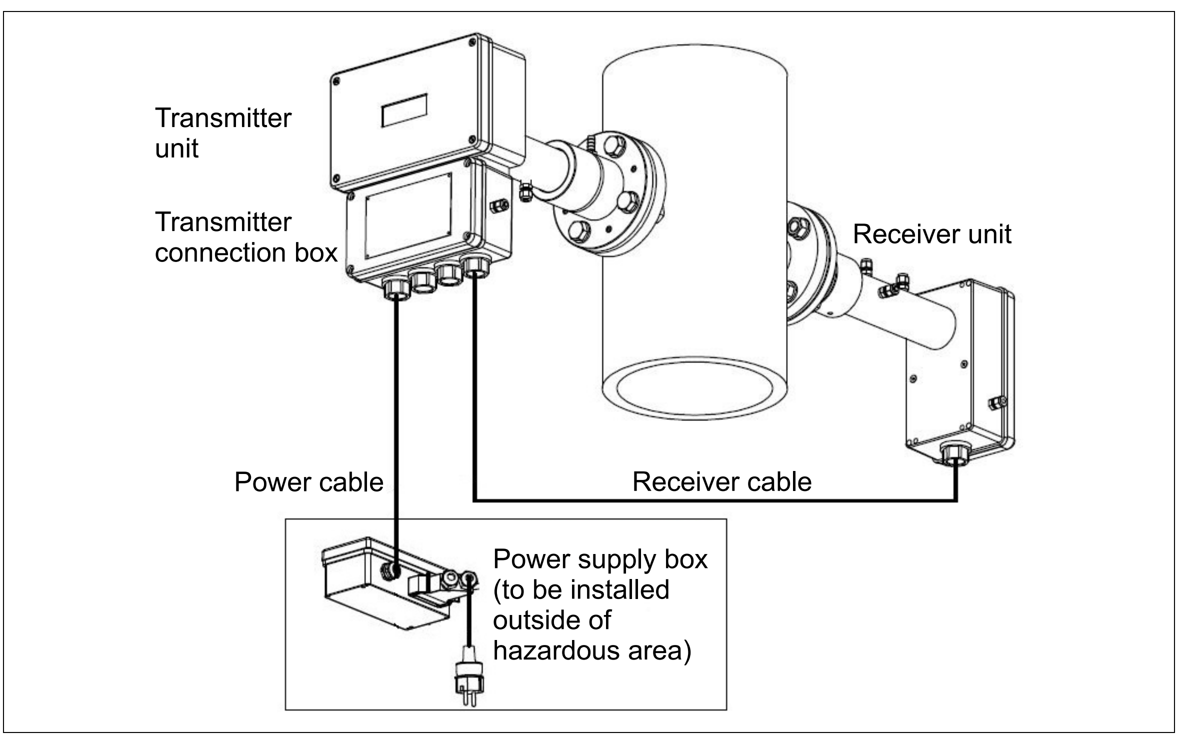


Figure 8-1: AO2000-LS25 for installation in hazardous areas

8.3 Product data

8.3.1 Environmental conditions

- Operating temperature: −20°C to +55°C
- Storage temperature: −20°C to +55°C
- Protection classification designed for outdoor use (all modules IP65 qualified)
- IP rating is not part of the CSA certification
- Pollution degree: 2
- Installation category (overvoltage category): II
- Altitude: 2000 m
- Humidity: 0 to 95%

8.3.2 Power supply

- Input power supply unit: 100–240 VAC, 50/60 Hz, 0.36–0.26 A
- Output power supply unit: 24 VDC, 900–1000 mA
- Input transmitter unit: 18–36 VDC, max. 20 W

8.3.3 Interfaces

- RS232 complies with standards EIA/TIA-232 and V.28/V.24 communications interfaces. Voltage out: Max. ±15V. Current out (short-circuit): Max. ±60mA
- Ethernet: Protocol 10/100Base-T
- Max. voltage: ±2.5V

8.3.4 CSA certification

- CSA Class I Division 2 Groups A, B, C, D, Temperature code T4, electrical equipment
- Applicable requirements:
  - CAN/CSA C22.2 No. 0-M91 (R2001): General Requirements – Canadian Electrical Code, Part II
  - CSA Std. C22.2 No. 142-M1987: Process Control Equipment
  - CSA Std. C22.2 No. 213-M1987: Non-Incendive Electrical Equipment for Use in Class I, Division 2 Hazardous Locations
  - UL Std. No. 916-2007: Energy Management Equipment
  - ANSI/ISA-12.12.01-2010: Non-Incendive Electrical Equipment for Use in Class I and II, Division 2 and Class III, Divisions 1 and 2 Hazardous (Classified) Locations
- Certificate No. 1105720

8.4 Warnings

WARNING: Failure to follow safety instructions may cause ignition of hazardous atmosphere resulting in serious personal injury and/or property damage.

WARNING: Explosion hazard – Substitution of components may impair suitability for Class I Division 2!

8.5 Electrical installation

8.5.1 Important safety notes

The cable glands (Myers Hubs) to connect the connection cable for the transmitter unit and the receiver unit to the junction box are included with the gas analyzer. They are not covered by the certification issued to ABB with regard to explosion protection.

When handling the cable glands (Myers Hubs) and the connection cables, the provisions in the NEC standard and the local regulations must be observed. In addition, the instructions of the manufacturer of the cable glands and the conduit system including the instructions for handling the sealing compound must be observed.
The cable glands which are not used must be closed in accordance with the instructions of the manufacturer and the relevant standard applicable in the country of installation.

The power supply unit is described in Section 6.7. It is not suitable for installation in Class I, Div. 2 areas. If the power supply unit cannot be installed in a GP area, a suitable third party Class I, Div. 2 approved power supply unit must be used. Please contact your local ABB representative.

The PC with the software for service communication with the analyzer must be placed in an explosion safe area. For long distance communication it is recommended to use the optional Ethernet connection.

8.5.2 Transmitter unit electronic interface

The electronic interface of the transmitter connection box is depicted in Figure 8-2. Receiver and main power Myers Hubs are defined by the factory. Any of the two Myers Hubs in the center can be used as communication hub. The Myers Hubs are sized ¾". The connections to the transmitter unit are made in the transmitter connection box.

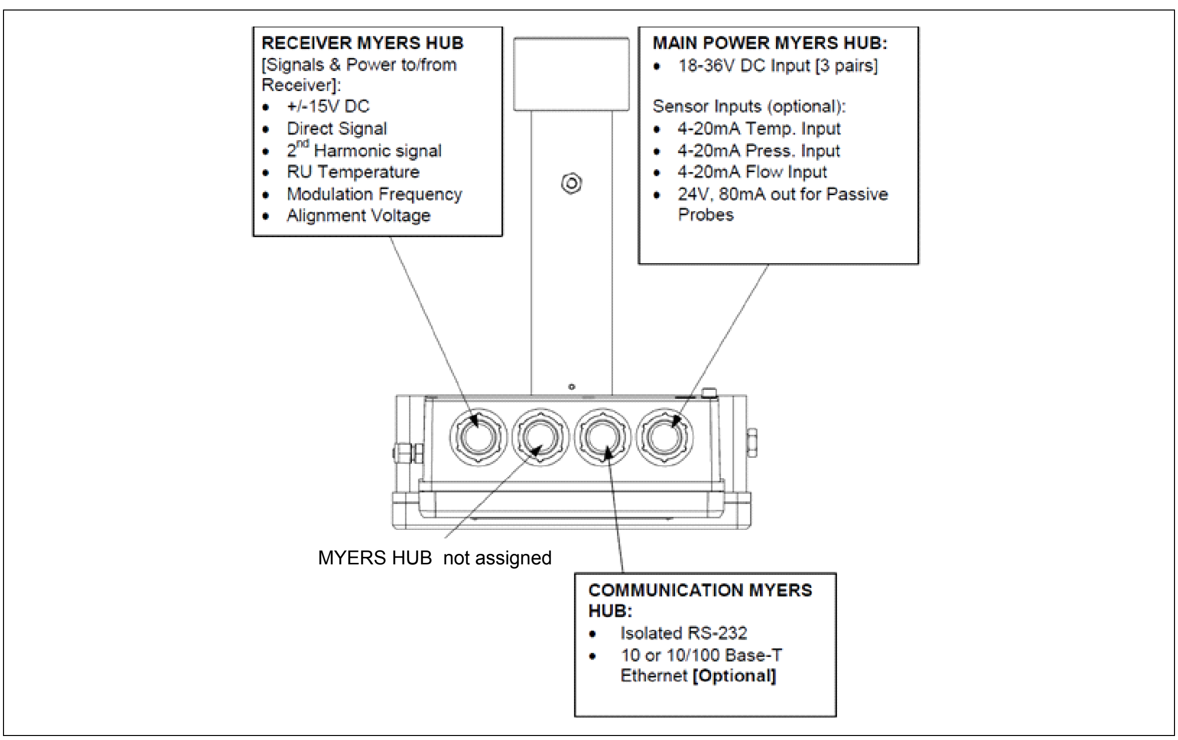


Figure 8-2: Transmitter unit – electronic interface

8.5.3 Cable connections

8.5.3.1 Preliminary remarks

The transmitter and receiver units are connected with a cable (receiver cable). This cable should not be exchanged without ABB's permission nor should the cable length be modified with more than 20 m as this may influence calibration or the instrument's accuracy.

- The max. length of the receiver cable (transmitter to receiver unit) is 150 m.
- The max. length of the power cable (power supply to transmitter unit) is 100 m.
- The max. length of the (optional) Ethernet cable is 100 m or more (depending on configuration of local network).
- The service PC cable is 3 meters long, but can be extended to approx. 10 m.

8.5.3.2 Notes for installation

- If not pre-connected from factory, connect the main power cable and receiver cable in the transmitter connection box (ref. Table 8-1 and Table 8-3).
- If not pre-connected from factory, connect the receiver cable in the receiver unit (ref. Table 8-2).
- Input signals such as external temperature and pressure probes are connected to the assigned terminals in the transmitter unit (use main power Myers Hub, ref. Table 8-3). If connected to the terminals in the transmitter the factory-mounted wires should be removed from the terminals in question.
- If the supplied 100–240 VAC to 24 VDC power converter box is operated it must be placed outside the hazardous area.

NOTE: In the table columns labelled “Description”, the indicated polarities of the items are for naming only and do not necessarily reflect the polarity of real voltages. All potentials are floating and none of them should be grounded to box. This applies to all connection tables.

8.5.3.3 Receiver cable connections

Junction list	Terminal	Pair no	Color code	Description
J7	1		NC	
J7	2	3	Pink	RU Temp −
J7	3	3	Grey	RU Temp +
J7	4	4	Red	MODSQ −
J7	5	4	Blue	MODSQ +
J7	6	5	Black	RU PWR +
J7	7	5	Violet	RU GND +
J7	8	7	Green/White*	Servo Sig*
J8	9	6	Grey/Pink	RU GND −
J8	10	6	Blue/Red	RU PWR −
J8	11	1	Brown	Direct −
J8	12	1	White	Direct +
J8	13	2	Yellow	2. Harmonic −
J8	14	2	Green	2. Harmonic +
J8	15	7	Green/Brown*	Servo +5V*
J8	16		NC	Chassis

Table 8-1: Transmitter unit – receiver cable connections

* Only connected for instruments equipped with option “Span check with internal sealed cell”.

RU Temp	Signal from embedded receiver temperature sensor
MODSQ	Modulation signal from transmitter to receiver (used for detection of 2. harmonic)
RU PWR	Power supply to receiver unit
Direct	Direct laser transmission signal from receiver detector, signal may be used for alignment purposes (see Section 3.4)
2. Harmonic	Detected second harmonic signal from receiver detector
Servo	Control of servomotor moving sealed cell

NOTE: The voltage for alignment purposes (see Section 3.4) is also available at plug J14.

Terminal	Pair no	Color code	Description
1	7	Green/White*	Servo Sig*
2		NC	
3		NC	
4	7	Green/Brown*	Servo +5V*
5	3	Grey	RU Temp +
6	3	Pink	RU Temp −
7	4	Blue	MODSQ +
8	4	Red	MODSQ −
9	5	Black	RU PWR +
10	5	Violet	RU GND +
11	6	Grey/Pink	RU GND −
12	6	Blue/Red	RU PWR −
13	1	White	Direct +
14	1	Brown	Direct −
15	2	Green	2. Harmonic +
16	2	Yellow	2. Harmonic −

Table 8-2: Receiver unit – receiver cable connections

* Only connected for instruments equipped with option “Span check with internal sealed cell”.

8.5.3.4 Power cable connections

Junction list	**Terminal**	**Color code**	**Description**
J5	1	Blue*	Temperature Probe –
J5	2	Red*	Temperature Probe +
J5	3	Black*	Pressure Probe –
J5	4	Violet*	Pressure Probe +
J5	5	N.C.	Flow Probe –
J5	6	N.C.	Flow Probe +
J5	7	Grey/Pink*	Probes +24V
J5	8	Blue/Red*	Probes AGND
J6	+18-36 V In	White	+18–36V Input
		Green	+18–36V Input
		Grey	+18–36V Input
J6	0 V In	Brown	0V Input
		Yellow	0V Input
		Pink	0V Input

Table 8-3: Transmitter unit – power cable connections

* Factory mounted wires may be replaced.

J6: Power supply from power supply unit to transmitter unit. All 3 power pairs should be wired to ensure even current flow.

External temperature and pressure probes can be connected inside the transmitter connection box to J5 terminals 1–8.

Terminal	**Color code**	**Description**
1	Blue*	Temperature Probe –
2	Red*	Temperature Probe +
3	Black*	Pressure Probe –
4	Violet*	Pressure Probe +
5	White/Green*	Flow Probe –
6	Brown/Green*	Flow Probe +
7	Grey/Pink*	Probes +24V
8	Blue/Red*	Probes AGND
9	White/Yellow*	Probes +24V
10	White	PWR + (+18–36V)
11	Green	PWR + (+18–36V)
12	Grey	PWR + (+18–36V)
13	Brown	PWR – (0V)
14	Yellow	PWR – (0V)
15	Pink	PWR – (0V)

Table 8-4: Power supply unit – power cable connections

8.5.3.5 RS232 connection

Junction list	Terminal	Description	Comments
J13	1	Data Carrier Detect	Connected to 4
J13	2	Transmit Data	
J13	3	Receive Data	
J13	4	Data Terminal Ready	
J13	5	Ground	
J13	6	Data Set Ready	Connected to 4
J13	7	Request To Send	Connected with 8
J13	8	Clear To send	Connected with 7
J13	9	Ring Indicator	Not connected

Table 8-5: Transmitter unit – RS232 connection

Alternatively connector J15 may be used (remember gender changer).

8.5.3.6 Ethernet connection

Junction list	Terminal	Color code	Description	Comments
J2	1	White/Orange	TX+	for straight-through connection (hub)
J2	2	Orange	TX−	
J2	3	White/Green	RX+	
J2	4	Green	RX−	

Junction list	Terminal	Color code	Description	Comments
J2	1	White/Green	TX+	for cross over connection (direct to PC)
J2	2	Green	TX−	
J2	3	White/Orange	RX+	
J2	4	Orange	RX−	

Table 8-6: Transmitter unit – Ethernet connection

9 Notes and instructions for ATEX Zone 2 version

9.1 Preliminary remarks

This part of the manual contains information of installation, operation and maintenance of the analyzer, ATEX Zone 2 version.

9.2 Instrument design

The analyzer consists of three separate units (see Figure 9-1):

- Transmitter unit with purging fittings and transmitter connection box with screw terminals for connection of power and receiver cable and optional inputs/outputs
- Receiver unit with purging fittings
- Power supply box (not suitable for installation in Zone 2)

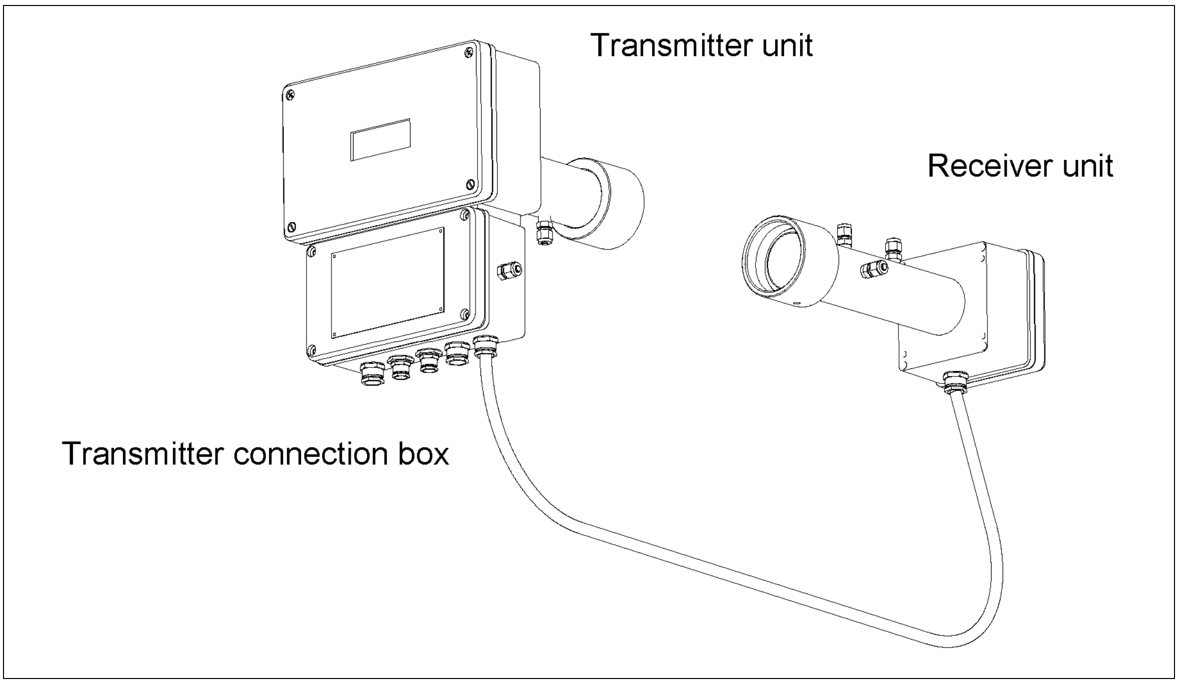


Figure 9-1: AO2000-LS25 for installation in ATEX Zone 2

9.3 Product data

9.3.1 Environmental conditions

- Operating temperature: −20°C to +55°C
- Storage temperature: −20°C to +55°C
- Protection classification designed for outdoor use (all modules IP66 qualified)
- Pollution degree: 2
- Installation category (overvoltage category): II
- Altitude: 2000 m
- Humidity: 0 to 95%

9.3.2 Power supply

- Input power supply unit: 100–240 VAC, 50/60 Hz, 0.36–0.26 A
- Output power supply unit: 24 VDC, 900–1000 mA
- Input transmitter unit: 18–36 VDC, max. 20 W

9.3.3 Interfaces

- RS232 complies with standards EIA/TIA-232 and V.28/V.24 communications interfaces.
  Voltage out: Max. ±15V. Current out (short-circuit): Max. ±60mA
- Ethernet: Protocol 10/100Base-T
- Max voltage: ±2.5V

9.3.4 ATEX certification

- II 3 G Ex nA nC [op is Ga] IIC T5 [1)] Gc, −20 °C ≤ Ta ≤ +55 °C
  II 3 D Ex tc [op is Da] IIIC T100°C Dc, −20 °C ≤ Ta ≤ +55 °C
  1) T4 for special applications
- Type Examination Certificate No. Presafe 16 ATEX 8621X

9.4 Warnings

WARNING: Failure to follow safety instructions may cause ignition of hazardous atmosphere resulting in serious personal injury and/or property damage.

WARNING: To avoid electrostatic charge, wipe the instrument with a damp cloth before performing maintenance.

9.5 Electrical installation

9.5.1 Important safety notes

The cable glands which are not used must be closed in accordance with the instructions of the manufacturer and the relevant standard applicable in the country of installation.

The power supply unit is described in Section 6.7. It is not suitable for installation in Zone 2 areas. If the power supply unit cannot be installed in a GP area, a suitable third party Zone 2 approved power supply unit must be used. Please contact your local ABB representative.

The PC with the software for service communication with the analyzer must be placed in an explosion safe area. For long distance communication it is recommended to use the optional Ethernet connection.

9.5.2 Transmitter unit electronic interface

The electronic interface of the transmitter connection box is depicted in Figure 9-2. The connections to the transmitter unit are made in the transmitter connection box.

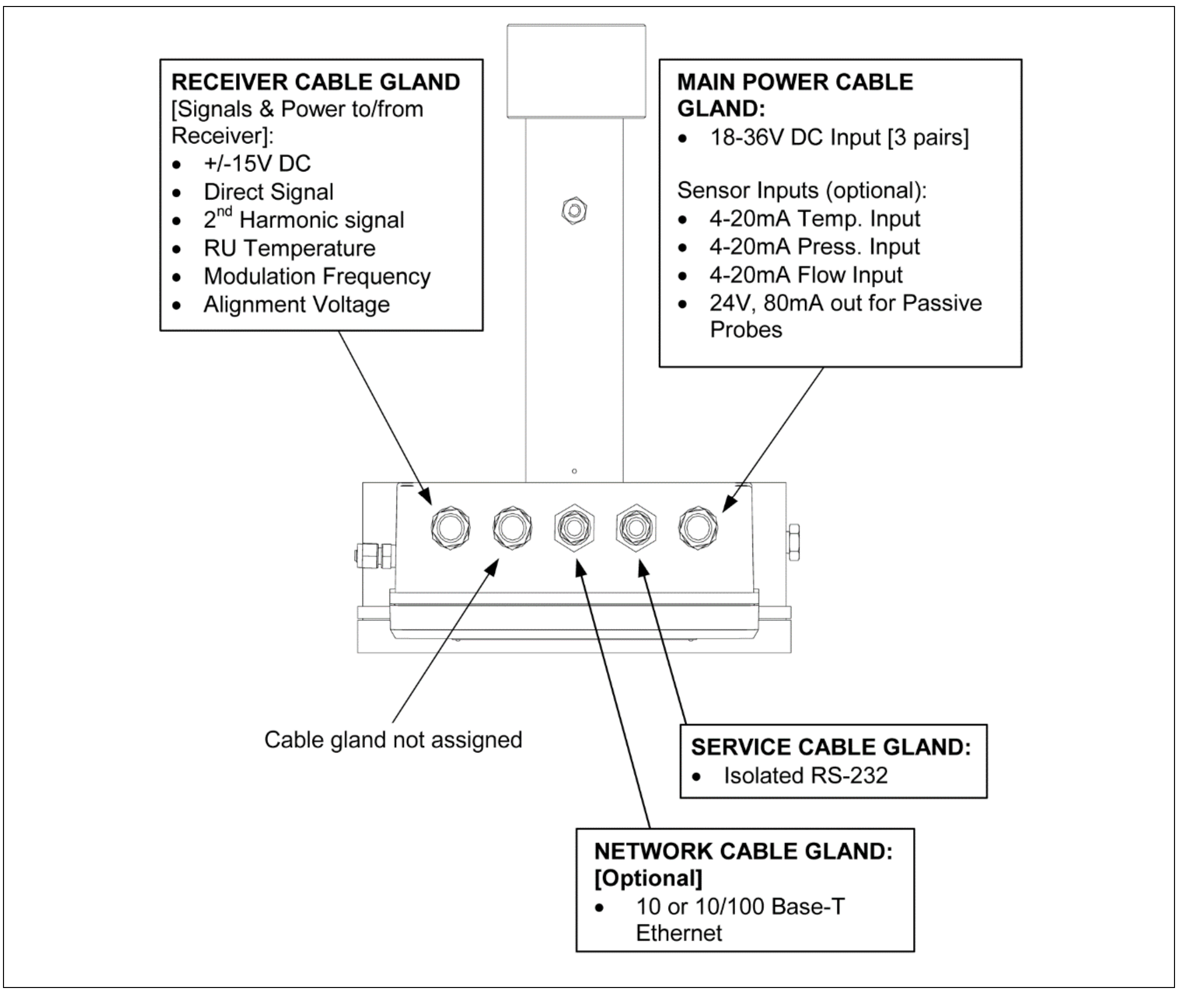


Figure 9-2: Transmitter unit – electronic interface

Receiver and main power cable glands: M20, cable outer diameter 7–12 mm
Network and service cable glands: M16, cable outer diameter 3.5–8 mm

9.5.3 Cable connections

9.5.3.1 Preliminary remarks

The transmitter and receiver units are connected with a cable (receiver cable). This cable should not be exchanged without ABB's permission nor should the cable length be modified with more than 20 m as this may influence calibration or the instrument's accuracy.

- The max. length of the receiver cable (transmitter to receiver unit) is 150 m.
- The max. length of the power cable (power supply to transmitter unit) is 100 m.
- The max. length of the (optional) Ethernet cable is 100 m or more (depending on configuration of local network).
- The service PC cable is 3 meters long, but can be extended to approx. 10 m.

9.5.3.2 Notes for installation

- If not pre-connected from factory, connect the main power cable and receiver cable in the transmitter connection box (ref. Table 9-1 and Table 9-3).
- If not pre-connected from factory, connect the receiver cable in the receiver unit (ref. Table 9-2).
- Input signals such as external temperature and pressure probes are connected to the assigned terminals in the transmitter unit (use main power cable gland, ref. Table 9-3). If connected to the terminals in the transmitter the factory-mounted wires should be removed from the terminals in question.
- If the supplied 100–240 VAC to 24 VDC power converter box is operated it must be placed outside the hazardous area.

NOTE: In the table columns labelled "Description", the indicated polarities of the items are for naming only and do not necessarily reflect the polarity of real voltages. All potentials are floating and none of them should be grounded to box. This applies to all connection tables.

9.5.3.3 Receiver cable connections

Junction list	Terminal	Pair no	Color code	Description
J7	1		NC	
J7	2	3	Pink	RU Temp −
J7	3	3	Grey	RU Temp +
J7	4	4	Red	MODSQ −
J7	5	4	Blue	MODSQ +
J7	6	5	Black	RU PWR +
J7	7	5	Violet	RU GND +
J7	8	7	Green/White*	Servo Sig*
J8	9	6	Grey/Pink	RU GND −
J8	10	6	Blue/Red	RU PWR −
J8	11	1	Brown	Direct −
J8	12	1	White	Direct +
J8	13	2	Yellow	2. Harmonic −
J8	14	2	Green	2. Harmonic +
J8	15	7	Green/Brown*	Servo +5V*
J8	16		NC	Chassis

Table 9-1: Transmitter unit – receiver cable connections

* Only connected for instruments equipped with option “Span check with internal sealed cell”. This option is only available on request.

RU Temp	Signal from embedded receiver temperature sensor
MODSQ	Modulation signal from transmitter to receiver (used for detection of 2. harmonic)
RU PWR	Power supply to receiver unit
Direct	Direct laser transmission signal from receiver detector, signal may be used for alignment purposes (see Section 3.4)
2. Harmonic	Detected second harmonic signal from receiver detector
Servo	Control of servomotor moving sealed cell (option)

NOTE: The voltage for alignment purposes (see Section 3.4) is also available at plug J14.

Terminal	Pair no	Color code	Description
1	7	Green/White*	Servo Sig*
2		NC	
3		NC	
4	7	Green/Brown*	Servo +5V*
5	3	Grey	RU Temp +
6	3	Pink	RU Temp −
7	4	Blue	MODSQ +
8	4	Red	MODSQ −
9	5	Black	RU PWR +
10	5	Violet	RU GND +
11	6	Grey/Pink	RU GND −
12	6	Blue/Red	RU PWR −
13	1	White	Direct +
14	1	Brown	Direct −
15	2	Green	2. Harmonic +
16	2	Yellow	2. Harmonic −

Table 9-2: Receiver unit – receiver cable connections

* Only connected for instruments equipped with option “Span check with internal sealed cell”. This option is only available on request.

9.5.3.4 Power cable connections

Junction list	Terminal	Color code	Description
J5	1	Blue*	Temperature Probe −
J5	2	Red*	Temperature Probe +
J5	3	Black*	Pressure Probe −
J5	4	Violet*	Pressure Probe +
J5	5	N.C.	Flow Probe −
J5	6	N.C.	Flow Probe +
J5	7	Grey/Pink*	Probes +24V
J5	8	Blue/Red*	Probes AGND
J6	+18-36 V In	White	+18–36V Input
		Green	+18–36V Input
		Grey	+18–36V Input
J6	0 V In	Brown	0V Input
		Yellow	0V Input
		Pink	0V Input

Table 9-3: Transmitter unit – power cable connections

* Factory mounted wires may be replaced.

J6: Power supply from power supply unit to transmitter unit. All 3 power pairs should be wired to ensure even current flow.

External temperature and pressure probes can be connected inside the transmitter connection box to J5 terminals 1–8.

Terminal	Color code	Description
1	Blue*	Temperature Probe −
2	Red*	Temperature Probe +
3	Black*	Pressure Probe −
4	Violet*	Pressure Probe +
5	White/Green*	Flow Probe −
6	Brown/Green*	Flow Probe +
7	Grey/Pink*	Probes +24V
8	Blue/Red*	Probes AGND
9	White/Yellow*	Probes +24V
10	White	PWR + (+18–36V)
11	Green	PWR + (+18–36V)
12	Grey	PWR + (+18–36V)
13	Brown	PWR − (0V)
14	Yellow	PWR − (0V)
15	Pink	PWR − (0V)

Table 9-4: Power supply unit – power cable connections

9.5.3.5 RS232 connection

Junction list	Terminal	Description	Comments
J13	1	Data Carrier Detect	Connected to 4
J13	2	Transmit Data	
J13	3	Receive Data	
J13	4	Data Terminal Ready	
J13	5	Ground	
J13	6	Data Set Ready	Connected to 4
J13	7	Request To Send	Connected with 8
J13	8	Clear To send	Connected with 7
J13	9	Ring Indicator	Not connected

Table 9-5: Transmitter unit – RS232 connection

Alternatively connector J15 may be used (remember gender changer).

9.5.3.6 Ethernet connection

Junction list	Terminal	Color code	Description	Comments
J2	1	White/Orange	TX+	for straight-through connection (hub)
J2	2	Orange	TX−	
J2	3	White/Green	RX+	
J2	4	Green	RX−	

Junction list	Terminal	Color code	Description	Comments
J2	1	White/Green	TX+	for cross over connection (direct to PC)
J2	2	Green	TX−	
J2	3	White/Orange	RX+	
J2	4	Orange	RX−	

Table 9-6: Transmitter unit – Ethernet connection

10 Notes for disposal

Products that are marked with the adjacent symbol may not be disposed of as unsorted municipal waste (domestic waste). They should be disposed of through separate collection of electric and electronic devices.

This product and its packaging are manufactured from materials that can be recycled by specialist recycling companies.

Bear the following in mind when disposing of this product and its packaging:

- As of 8/15/2018, this product will be under the open scope of the WEEE Directive 2012/19/EU and relevant national laws.
- The product must be supplied to a specialist recycling company. Do not use municipal waste collection points. These may be used for privately used products only in accordance with WEEE Directive 2012/19/EU.
- If there is no possibility to dispose of the old equipment properly, ABB service can take care of its pick-up and disposal for a fee. To find your local ABB service contact visit abb.com/contacts or call +49 180 5 222 580.

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ABB Automation GmbH
Measurement & Analytics
Stierstädter Str. 5
60488 Frankfurt am Main
Germany
Fax: +49 69 7930-4566
Mail: cga@de.abb.com

abb.com/analytical

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