Safety Manual

TDLS GPro 500
Tunable Diode Laser Spectrometer

METTLER TOLEDO

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FIGURES

Disclaimer of Liability

To ensure consistency with the hardware and software described the contents of this publication have been reviewed carefully. However, since variance cannot be excluded entirely we cannot guarantee full consistency.

GPro is a registered trademark of the METTLER TOLEDO group in Switzerland, USA, Germany and France.

1 Introduction

1.1 Safety information

Read this manual and ensure that you fully understand its content before you attempt to install, operate or maintain the GPro 500® used in a safety integrated (SIL) environment.

1.2 Symbols

Pay particular attention to all special information and warnings. This type of information is marked with the corresponding pictograms. To observe these notices will ensure your personal safety and prevent damage of property:

> **WARNING**
> Warnings highlight specific hazards which, if not taken
> into account, may result in personal injury or death.

> CAUTION
> Cautions highlight hazards which, if not taken into account,
> can result in damage to the TDL or to other equipment or property.

This manual incorporates also "be aware" information, which is used as follows:

☞ This highlights information which is useful for you to pay attention, for example specific operation conditions.

1.3 Purpose

This document contains information and safety instructions required to use the GPro 500 with direct analog output option (GPro 500 XXXXXXXXXXXXXXXXX _ _ / _A in SIL environments.

The manual is intended for personnel responsible for planning, installation, commissioning, service and maintenance.

1.4 Qualified personnel

The GPro 500 described in this manual may be only operated by personnel which is qualified for the specific task in accordance with the relevant documentation, in particular its warnings and safety instructions.

Qualified personnel are those, who based on their trainings and experience, are able of identifying risks and avoiding potential hazards when working with the GPro 500.

1.4.1 Transport, storage and handling

Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the GPro 500 operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

1.5   Additional documentation

This manual has to be used together with the following documents:

• GPro 500 Series Pre-Installation Requirements
• Safety Instructions GPro 500 (Art. nr 30 037 965)
• GPro 500 Quick Setup Guide (Art. nr 30 080 928)
• Operating Instructions TDLS GPro 500 (Art. nr 30 029 557)

☞ Please study the entire documentation carefully before installing or using the GPro 500. It is a sophisticated instrument utilizing state-of-the-art electronic and laser technology. Installation, operation and maintenance of the instrument require care and preparation and should only be attempted by competent/qualified personnel. Failure to do so may damage the instrument and void the warranty.

CAUTION

METTLER TOLEDO strongly recommends having the final installation and commissioning executed under the full supervision of a METTLER TOLEDO representative.

Do not power up the system before the wiring has been fully checked by trained personal.

It is strongly recommended to have the wiring approved by
a METTLER TOLEDO Service representative.

Wrong wiring can lead to damage of the sensor head and/or the M400 transmitter.

1.6   General

The GPro 500 designed for continuous in situ monitoring of gases in stacks, pipes, ducts, extractive measurement cells etc. and it is based on tunable diode laser technology. The GPro 500 utilizes a single side installation (probe-type TDL) without the need for alignment to measure the average gas concentration along the line-of-sight path in the probe.

The GPro 500 can be considered to be a Type B element acc. to IEC 61508:2010.

The gas concentration is provided to the DCS as linear analog signal (4 – 20 mA, NAMUR). 4 mA indicate low level, 20 mA indicate high level. The analog values for instrument errors can be parameterized within the NAMUR settings.

1.7 Proper use of the product

The GPro 500 covers a wide range of applications. SIL may only be covered for applications within the following conditions:

Component	Process gas temperature (°C)	Process gas pressure (mbar abs. // psia)
O_2	0 … 600	0.3 … 8 // 4.35 … 116.03
O_2 & spectral temperature	0 … 150	0.8 … 5 // 11.63 … 72.52
CO (ppm)		0.8 … 2 // 11.63 … 29.00
CO (%)		0.8 … 1.5 // 11.63 … 21.75
CO_2 (%)		0.8 … 2 // 11.63 … 29.00
CO_2 & CO		0.8 … 2 // 11.63 … 29.00
H_2O	0 … 600	0.8 … 2 // 11.63 … 29.00
HCl		0.8 … 3 // 11.63 … 43.50
H_2S		0.8 … 2 // 11.63 … 29.00
CH_4		0.8 … 3 // 11.63 … 43.50
NH_3		0.8 … 3 // 11.63 … 43.50

Table 1. GPro 500 application conditions for in situ measurement

> **WARNING**
> The GPro 500 may only be used for applications described
> in the catalogue and approved by METTLER TOLEDO.

> **CAUTION**
> The approval might contain limitations which differ from the conditions
> provided in the table above. These limitations have to be followed.

1.7.1 Measuring principle

For detailed information about the measuring principle, the influence of dust load, temperature and pressure as well as cross interferences please refer to chapter 1.4 of the Operating Instructions TDLS GPro 500.

1.7.2 Instrument description

The GPro 500 TDL normally consists of 3 – 4 separate units:

- TDL head/spectrometer
- process adaption/probe
- junction box
- optional M400 transmitter (user interface; see remark below).

☞ The M400 transmitter is NOT included in the safety function.

☞ It is possible to connect the GPro 500 to the M400 transmitter also in a SIL installation to use the M400 as a local viewer.

CAUTION

When the analog outputs of the M400 are used and/or when the GPro 500
is configured or operated via the M400 the SIL compliance is no longer valid.

External pressure and temperature measurements must be available; depending on the application, ambient conditions and process adaption additional purge gas (in general N_2, 99.7) might be necessary.

1.7.3 Software

The software of the GPro 500 consists of 2 programs:
- The firmware of the GPro 500 (not visible to the user) which is integrated in the CPU electronics. It performs all necessary calculations and self-monitoring tasks.
- The MT-TDL Suite which is a Windows based program. It runs on a standard PC connected to the GPro 500 through the Ethernet connection. It enables communication and parameterization of the GPro 500 during installation, normal operation, calibration and service. For a detailed description please refer to chapter 6 of the Operating Instructions TDLS GPro 500.

1.7.4 System overview

A connecting device is required to connect the GPro 500
- to the power supply
- with the external 4…20 mA analog signals for temperature and pressure compensation
- with the DCS
- with the operating software MT-TDL Software Suite installed on a computer/laptop
- to the optional M400 transmitter

For ATEX applications, an existing junction box can be used, or one can be ordered as an accessory (see Operating Instructions TDLS GPro 500 Appendix chapter 2.3).

For more information about installation in hazardous areas, please refer to chapter 1.3.2, 1.3.3, 1.5.2 and 8 in the Operating Instructions TDLS GPro 500.

In SIL configurations the GPro 500 passive analog outputs are connected directly to the DCS. To configure the GPro 500 during commissioning and for maintenance operation, it is necessary to use the MT-TDL Software Suite.

Only the two direct analog outputs of the GPro 500 are considered as safety critical outputs and are part of the safety function. Please ensure that the control system is able to interpret the according failure analog values.
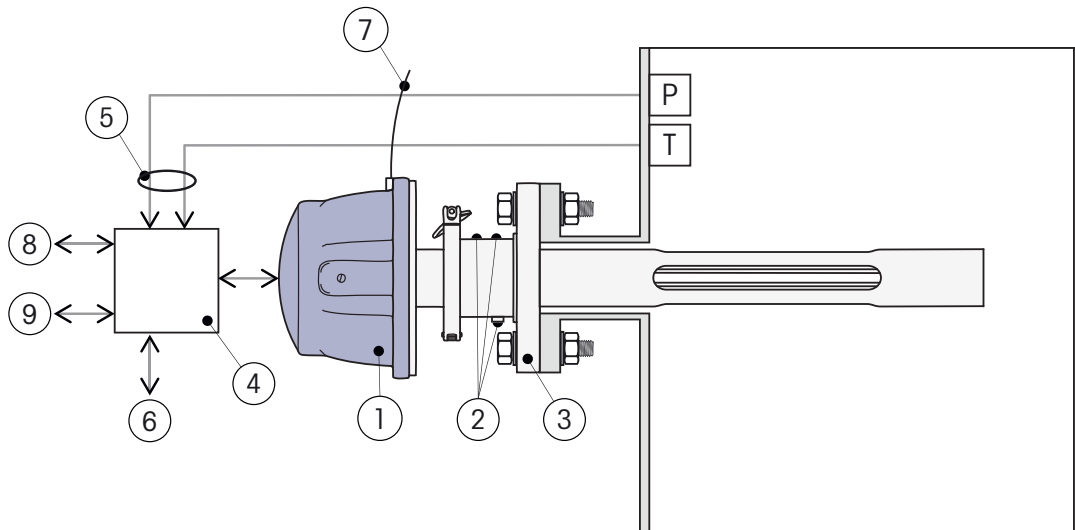
Figure 1. General setup GPro 500 – process adaption may vary

1   GPro 500 sensor head with insertion probe (here the 390 mm probe)
2   Purging with N_2, one inlet for the process side and one inlet and one outlet for the sensor side
3   Process flange
4   Junction box (connecting device)
5   2 × 4 … 20 mA analog input for pressure and temperature compensation
6   Ethernet connection
7   Grounding for the TDL head
8   External power supply (24 VDC; 5 … 60 W) for the sensor power head
9   2 × 4 … 20 mA direct analog outputs

⚠	WARNING
	When connecting the external power supply to the junction box, do not exceed the 24 VDC, max. 60 W limit!

⚠	WARNING
	When connecting the external analog inputs for pressure and temperature compensation make sure that the complete system is switched off!

2 Installation and start-up

☞ We recommend to have a pre-installation meeting with your local METTLER TOLEDO representative/METTLER TOLEDO service to discuss all details of the the installation.

☞ Further details and valuable information are provided in the GPro 500 Series Pre-Installation Requirements

☞ Note: For complete information regarding the installation please refer to GPro 500 Series Pre-Installation Requirements, the GPro 500 Quick Setup Guide, and to Operating Instructions TDLS GPro 500.

2.1 General considerations

2.1.1 External sensors for pressure and temperature

It is in the responsibility of the end user to install appropriate pressure and temperature sensors. We recommend using only external sensors with SIL qualified analog output (4–20 mA).

⚠️ **WARNING**
Ensure that neither the GPro 500 nor the external pressure and temperature sensors are energized when connecting them to the junction box.

Do not open the junction box in an explosive atmosphere when the GPro 500 is energized.

☞ If the analog outputs of the external sensors are set properly with respect to out-of-range and failure signals the GPro 500 is able to detect both.

- External analog signals between 3.6 … 3.8 mA and 20.0 … 20.5 mA are considered as out of range of the external sensors
- External analog signal is considered as failure signal when it is either below 3.8 mA or above 20.5 mA
- In case of failure signal the GPro 500 will also change to the failure state and the reading is set by the software to 110 %
- Please note: the GPro 500 is not able to detect measurement errors of the external sensors by using higher diagnosis function. As long as the external analog signal is between 4 and 20 mA the GPro 500 will assume well working external sensors

2.2 Preparations

- You will find a detailed information in chapters 2.1 to 2.4 of the Operating Instructions TDLS GPro 500

2.2.1 Cables and electrical connections

The laser head/spectrometer is connected to the junction box

- ATEX version: The GPro 500 comes with a pre-installed 16 wire cable and cable gland. The standard length of the cable is 5 m.
- FM version must be installed using a suitable cabling conduit system in accordance with local codes and regulations.

For details of the wiring please refer to chapter 5 of the Operating Instructions TDLS GPro 500.

⚠️ **WARNING**
Do not forget to ground the GPro 500

2.3   Installation and adjustments

2.3.1   Mechanical installation

The GPro 500 is designed to be very easy to install. The optical path is aligned in the factory so the installation procedure is simply to bolt it to the process flange, mount the purging tube (6 mm or optional ¼" tube fitting) and mount the cables.

For details about the flanges, dimensions for the flanges etc. please refer to chapter 4 of the Operating Instructions TDLS GPro 500.

☞ For efficient installation you must make sure that the pre-installation requirements are met prior to the visit of the METTLER TOLEDO technician.

☞ If the process is running it is recommended for purged probes to connect and turn on the purging at maximum flow before inserting the probe into the process. This is to avoid instant contamination of the optics.

⚠	WARNING
	Do not use FORCE when you assemble the spectrometer and the process adaption. The head will slot into the process adaption at the right angle. The mechanical tolerance of the parts is very small, using force will damage the interface resulting in alignmen issues and loss in transmission! Also ensure that the gasket is in place.
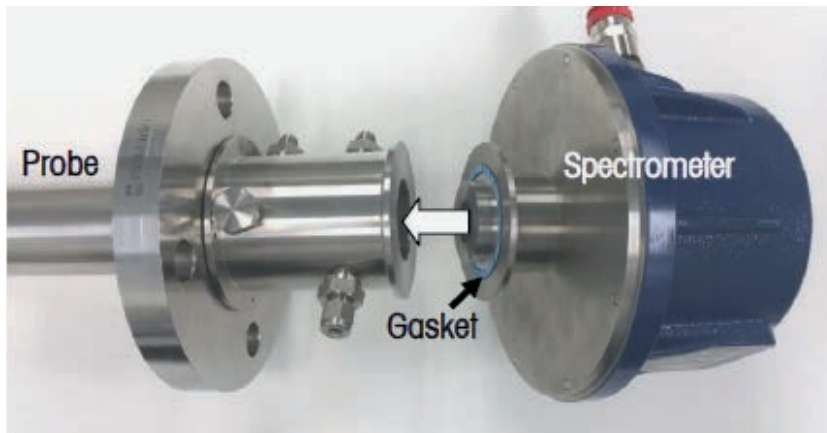
Figure 2. Probe, gasket, and spectrometer of the GPro 500

2.3.2   Orientation of the process adaption

- Ensure that the flange gasket is in place.
- When an SP or NP **without filter** is installed ensure that the holes/slots are facing the process that the process flow is perpendicular to the probe.
- Prior to installing a probe **with filter** mark the position/angle of the dust shield on the flange. Ensure that the dust shield is facing the process in coming flow

2.3.3 Purging

Depending on the configuration supplied there may be requirement for either one or two optical purges (instrument and process purge).

Standard purged probe	SP		Blow-back probe with filter	BB
Non-purged probe without filter	NP		Wafer type probe	W
Non-purged probe with filter	FP		Extractive probe	W

Detailed information about the location of the spectrometer and process purge connections is provided in chapter 3 of the Operating Instructions TDLS GPro 500.

Detailed drawings of all process adaptions are provided in chapter 4 of the Operating Instructions TDLS GPro 500.

Instrument purge

The GPro 500 TDL head attaches to the process adaption via a precision mechanical interface. Between the optical window of the TDL and the process window of the process adaption is a cavity. This cavity is part of the optical path of the analyzer and therefore it is important that there are no traces of the gas to be measured, i.e. O_2 or H_2O or other, in this space. Otherwise it will add to the measurement signal leading to a wrong reading. The instrument purge is to flush this space.

For O_2 measurement this is normally nitrogen is used and for other measurements instrument grade air is recommended.

Typical purge gas flow for instrument purge is < 1 L/min.

☞ Note: All current process adaptions require instrument purge.

☞ Note: Ensure that the purge is available at all times during operation.

Process purge

For standard purge probes and for in-line wafer cells in addition to the instrument purge a process purge is necessary to protect the optical surfaces from direct contact with the process gas. The process purge gas flow is adjusted during commissioning.

☞ Process purge is critical for the protection of the wetted optical components and for correct operation of the analyzer. Therefore, it must be running all the times! A no-flow alarm switch is recommended to this purpose.

For oxygen applications nitrogen purge is required or alternatively another clean, non-explosive, non-corrosive, dry and O_2 free gas. For other measurements, instrument grade air is normally recommended. The GPro 500 SP and W process adaption are designed to consume as little purge gas as possible while keeping the optical surfaces protected and clean.

Alternatively, gas cylinders may be used to ensure proper purging of the probes.

<table>
<tr>
<td rowspan="6">⚠️</td>
<td>WARNING</td>
</tr>
<tr>
<td>The process purge gas inlet must have a check valve to avoid contamination of the purging system from process gas.</td>
</tr>
<tr>
<td>Always start process purging at maximum before inserting the probe or before starting the process.</td>
</tr>
<tr>
<td>Process purge gas must always run in order to avoid contamination of the optical surfaces and ensure protection of the optical surfaces.</td>
</tr>
<tr>
<td>Do not remove and/or disassemble the process purge gas inlet otherwise the PED pressure certificate is void.</td>
</tr>
<tr>
<td>Do not connect the instrument and process purge in series, otherwise when disassembling the sensor head the process purging will stop.</td>
</tr>
</table>

For further details, please refer to chapter 3 of the Operating Instructions TDLS GPro 500.

Adjusting the process purge gas flow

The flow rate of the purging will affect the effective path length and consequently the measurement value. Therefore one of the following procedures should be used.

Adjusting the process purge gas flow for normal/high readings

Start with a very high flow rate and gradually decrease it. The measurement value will then start at a low value and increase with decreasing purge flow. At some point it will level out and stay constant for a while and then again start increasing. Choose a purge flow in the middle of the constant region.

CAUTION

If the process flow rate remains constant this will be a good purge flow but the effective path length will always be a function of the process flow rate so be observant on this.
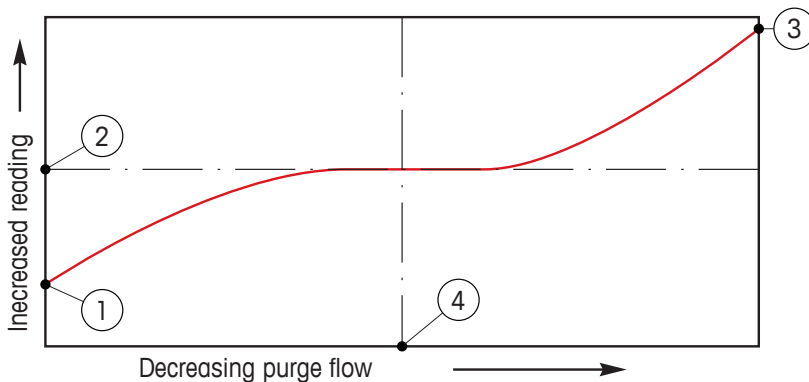

Figure 3. Optimizing the process purge gas flow

On the x-axis there is purge flow and on the y-axis there is the instrument concentration reading.

1. Concentration reading with high purge flow. The path length is now shorter than the effective path length since the purge tubes is completely filled with purging gas and some of the purging gas is flowing into the measurement path.
2. Concentration reading with optimized purge flow. The path length is now equal to the effective path length since the purge tubes are completely filled with purge gas. See the illustration below.
3. Concentration reading with no purge flow. The path length is now equal to the nominal path length since the probe is completely filled with process gas.
4. The optimized purge flow.

Adjusting the process purge gas flow for low readings

1 Connect the GPro 500 to the MT-TDL Suite

2 Switch to the adjustment tab*

3 If necessary, scale the adjustment graph to 0.005 per scale or lower

4 Start with a high flow rate and gradually decrease it until:

    a The NSL ratio is below 50

    b The signal-to-noise amplitude is $<2 \times 10^{-4}$ in the graph
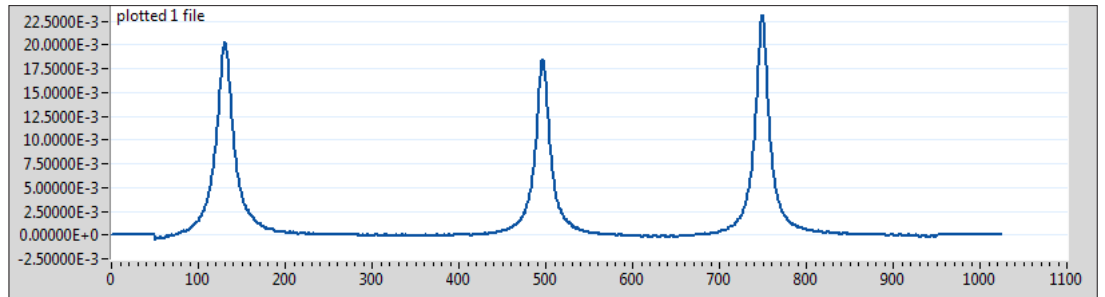
* Available with MT-TDL Suite Version 6.17 and higher

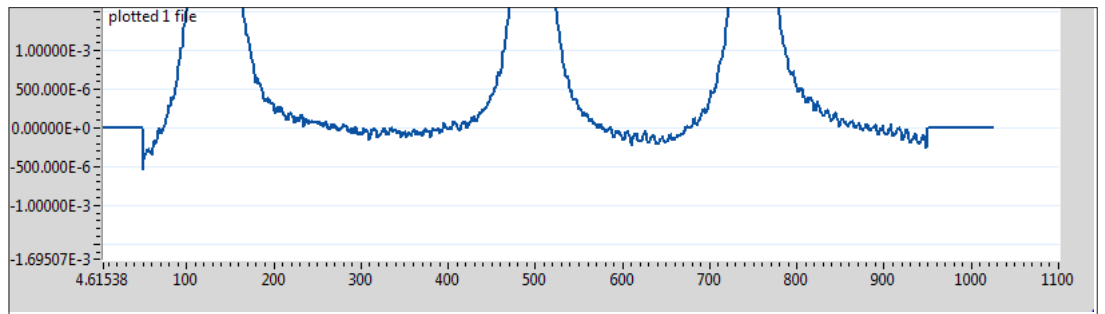Figure 4. Graph of the raw data from the adjustment window

Figure 5. Scaled graph, noise has to be less than 2×10^{-4}

2.3.4 **Signal optimization**

MT-TDL Suite always shows two diagnostic values which aid in optimizing the signal quality:
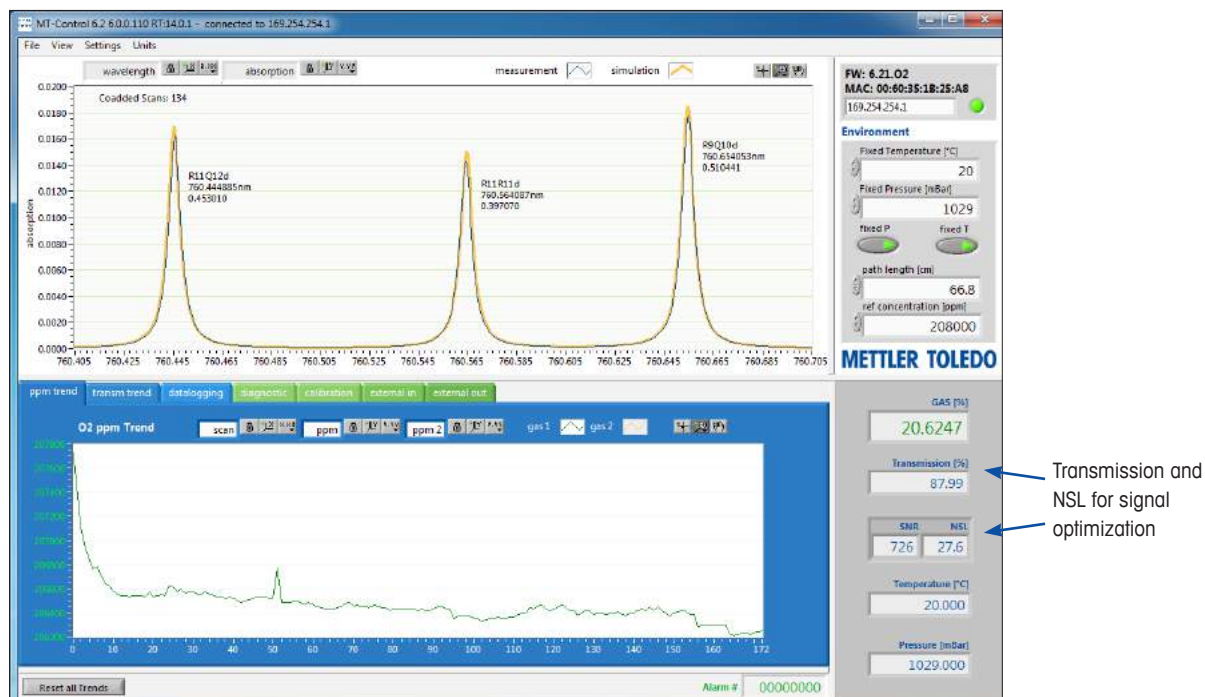
• Transmission value

• NSL

Figure 6. Transmission and NSL for signal optimization

Signal optimization is achieved by slow rotating the blue TDL head (with loosen security clamp) until the NSL value is below 50 and the transmission value is at least higher than 50 %, ideally above 70 %. Subsequently fully tighten the security clamp and confirm that the values are still acceptable.

3 Configuration of the GPro 500 with the MT-TDL Suite

3.1 Wiring and connection with the PC

The connection between the PC and the GPro 500 is made by connecting the Ethernet port of the PC to pin 13 … 16 of the junction box with a common available Ethernet cable. Depending on the type of Ethernet cable (T568A or T568B) the wiring is as below:

- T568A Ethernet cable
  - White/green goes to 13
  - Green solid goes to 14
  - White/orange goes to 15
  - Orange solid goes to 16
- T568B Ethernet cable
  - White/orange goes to 13
  - Orange solid goes to 14
  - White/green goes to 15
  - Green solid goes to 16

After start of the MT-TDL Suite the connection between the GPro 500 and the PC is established automatically.

☞ When using the software VPN must be turned OFF.

☞ Windows XP users need to correct the IP address please refer to chapter 6.2 of the Operating Instructions TDLS GPro 500.
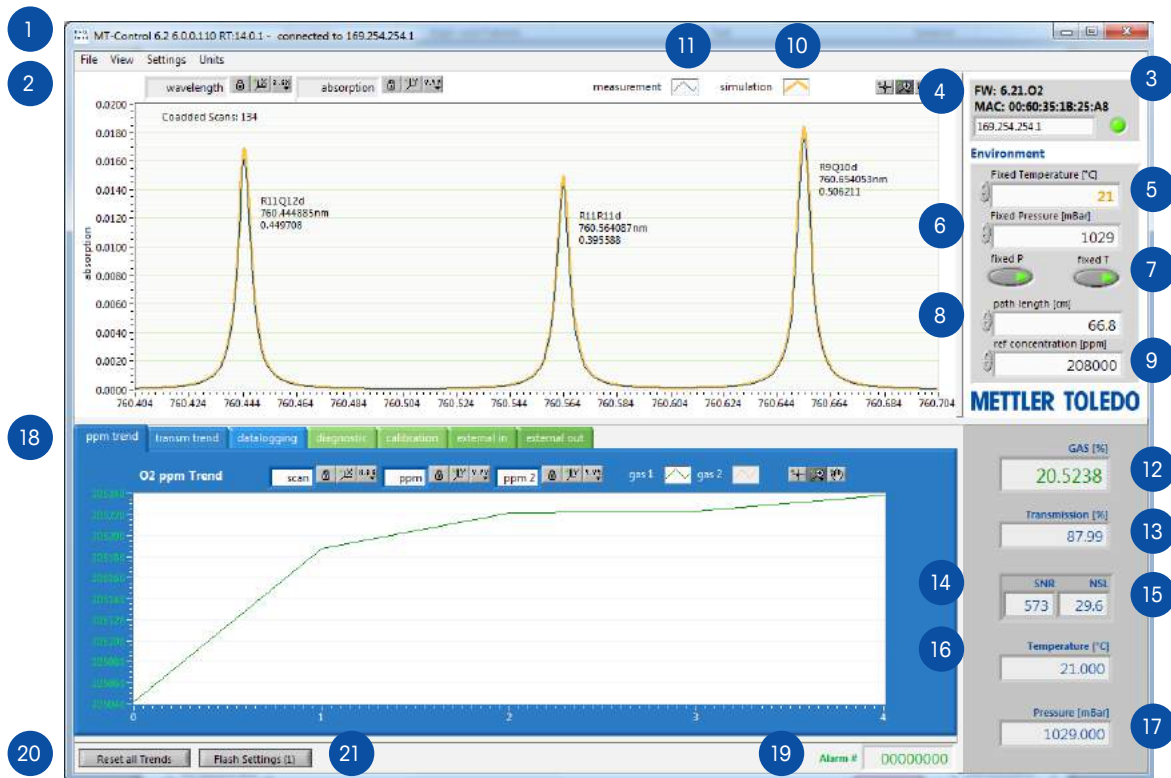
3.2 MT-TDL Suite overview / structure

Figure 7. Start window of MT-TDL Suite (connected to an O$_2$ laser)

1   Version of MT-TDL Suite
2   Menu bar
3   Version of the firmware installed on the GPro 500
4   MAC and IP address of the GPro 500
5   Value for the temperature when fixed temperature is activated (see no. 8)
6   Value for the pressure when fixed pressure is activated (see no. 8)
7   Toggle between fixed and measured values for temperature and pressure
8   The effective optical path length
9   Set point for simulated curve
10   Simulated curve (yellow)
11   Measured curve (blue)
12   Actual concentration of the measured gas
13   Transmission value
14   SNR (= signal-to-noise ratio)
15   NSL (= noise-to-signal level)
16   External temperature reading
17   External pressure reading
18   Tab menu
19   Alarm
20   Reset all trends
21   Flash settings

3.3 Setting the password

Firmware 6.23 for O_2 or higher can be password protected.

To activate the password change to the menu "password → change password", enter a new password and confirm it.

☞ The TDL is delivered with the standard password 0000

☞ As long as the standard password is not changed the password protection is not active

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CAUTION

Reset of the password can only be done by the METTLER TOLEDO service.

3.4 Configuration of the pressure and temperature compensation

The GPro 500 with direct analog output option can be used in SIL installations with the following settings for the process pressure and temperature:

- Pressure: FIXED VALUE or EXTERNAL INPUT
- Temperature: FIXED VALUE or EXTERNAL INPUT

Configuration for fixed pressure and/or temperature values

☞ The use of fixed values for either process gas temperature and/or pressure is only recommended if they are stable for example when a heated extractive cell is used.

To activate and configure fixed values for pressure and/or temperature proceed as follows:

1 Activate either fixed pressure or temperature (or both) by clicking on the respective button (no 8)
2 Enter the correct value/values (no 6 and/or 7)
3 Transmit the settings by using the "flash settings button" (no 22)

Configuration of pressure and/or temperature compensation using external sensors

When external pressure and temperature sensors are used the analog inputs have to be configured according to the specification of the sensor:
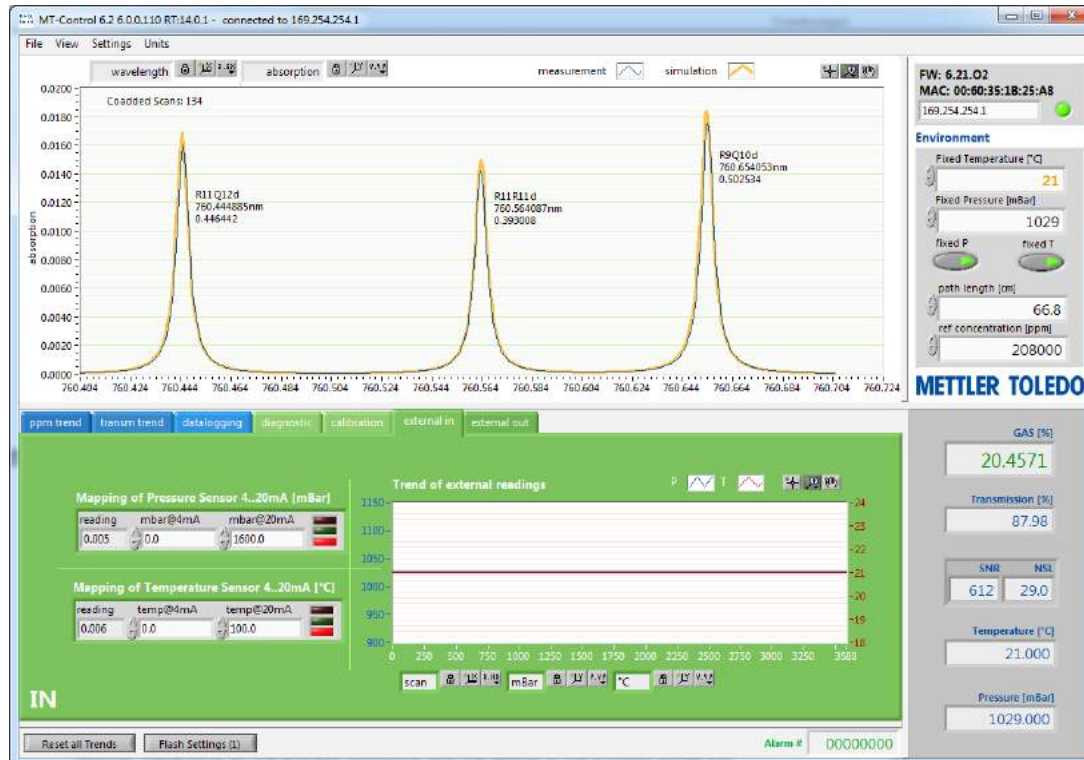

Figure 8. Menu for configuring the pressure and temperature compensation using external sensors

1   Switch to the "external in" tab
2   Enter the start and end value of the pressure/temperature sensor in the respective field
3   Transmit the settings using the "Flash Settings" button

☞   If the settings are correct and the wiring between the analog outputs of the sensors and the junction box is correct the actual readings for pressure and sensor are shown in 17 and 18

☞   The trend of the external readings is shown in the graph in the "external in" tab

General note on pressure and temperature compensation

☞ We recommend to use an absolute pressure sensor

☞ The quality/accuracy of the pressure signal has a direct impact onto the reading of the GPro 500.

☞ As a rule of thumb an error in the pressure reading of 5 mbar result in an error of 0.5 % of the reading of the GPro 500.

☞ The accuracy of the temperature measurement also influences the reading of the GPro 500.

☞ As a rule of thumb an error or 1 °C in the temperature signal will lead to an error of 0.25 % of reading

☞ In case of failure and/or disconnection of the pressure and/or temperature sensor, the analog output of the GPro 500 will switch into the alarm/failure state.

☞ Please note the GPro 500 is not able to detect measurement errors of the external sensors by using higher diagnosis function. As long as the external analog signal is between 4 and 20 mA the GPro 500 will assume well working external sensors.

The best readings are achieved when the correct process pressure and temperature is provided via correct working external sensors. However, for processes which run on stable or nearly stable pressure and/or temperature using fixed pressure and/or temperature may be the better choice. Whether the measurement will work without pressure and/or temperature sensor has to be discussed during the evaluation of your application.

3.5 Setting of optical path length

The reading of the GPro 500 depends on the correct optical path length (opl). It depends on the probe length installed. Detailed information about the opl for all our probes is provided in chapter 4 of the Operating Instructions TDLS GPro 500 in particular page 63).

The values given in the table are valid when the instrument and the process purge are running. Depending on the process conditions and the setting of the process purge this value may have to be slightly adapted.

To change the settings for the optical path length proceed as follows:

1 Click on the respective field in the MT-TDL Suite (no 9)
2 Enter the new value
3 Observe the reading
4 If the reading is correct make the setting permanent by using the "flash settings" button (no 22)
5 If the reading is not correct repeat step 1 … 4.

☞ The optical path length influences directly the reading of the GPro 500. The setting of the adequate OPL has a direct impact on the accuracy of the measurement value.

3.6 Configuration of analog outputs

In SIL configurations the GPro 500 passive analog outputs are connected directly to the DCS. To configure the GPro 500 during commissioning and for maintenance operation, it is necessary to use the MT-TDL Software Suite.

Only the two direct analog outputs of the GPro 500 are considered as safety critical outputs and are part of the safety function. Please ensure that the control system is able to interpret the according failure analog values.

The analog outputs are configured in the "external out" tab of the MT-TDL Suite. If the "external OUT" tab is not visible, the connected GPro 500 does not have the direct analog output option.
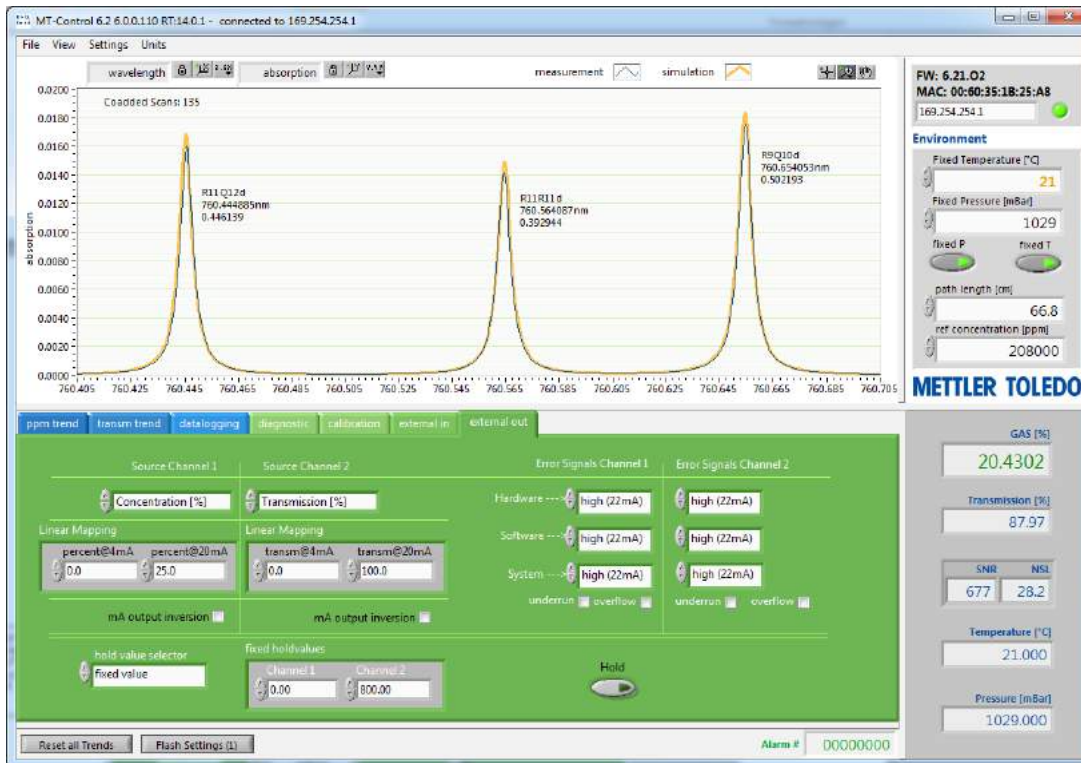
Figure 9. Configuring menu of the analog outputs GPro 500

1   **Assignment of the analog outputs:**
    Each analog output (AO) can be assigned to the following parameter by choosing from the drop down menu:
    • Concentration (ppm and dewpoint for H_2O measurement)
    • Concentration (%vol)
    • Pressure (mbar and psi)
    • Temperature (°C and °F)
    • Transmission (%)
    • DLI (days)
    • TTM (days)

2   When the parameter is selected put in the respective range that has to be linearly mapped to the 4 … 20 mA values. Units must be the same as those of the parameter selected above.

3   **Assignment of the error level:**
    Error signals can be set for each AO for the hardware, software and the system. To do this use the respective pull-down menu. The following choices can be selected:
    • No alarm: no action is taken when an error occurs
    • Low alarm: AO signal goes to 3.6 mA in case of an error
    • High alarm: AO signal goes to 22 mA in case of an error

4   In addition, the AOs can be set to 3.8 or 21 mA in case of an out-of-range condition. To activate this, use the check boxes "underrun/overflow".

5   **Assignment of the hold mode:**
    The behavior of the AOs during operations like calibration, service mode etc. can be set as follows by using the respective pull-down menu:
    • Last value
    • Fixed value
    The fixed readings can be set using the corresponding fields.

6   Make the settings permanent by using the "Flash Settings" button

4 Operation

4.1 Instrument start-up

Assumed that the TDL is connected correctly via the junction box to the power supply it will power up automatically when the power is switched on. The start-up time is approximately 1 min.

4.2 Instrument shut-down

To shut down the instrument simply disconnect it form the power supply. No other measures need to be taken.

⚠	WARNING To not interrupt the process purge as long as the process is running and the probe is in the process!

4.3 Fault indication

The GPro 500 will signal a fault situation as analog value to the DCS. Depending on the configuration the analog value will either fall below 3.6 mA or go to 22 mA.

The reading will stay at 110 % as long as the fault/error message is active.

☞ It is important that the receiving device (in general the DCS) is able to detect and interpret the fault situation to comply with the safety function.

Fault messages are also indicated at the simulation window (upper half) of the MT-TDL suite.
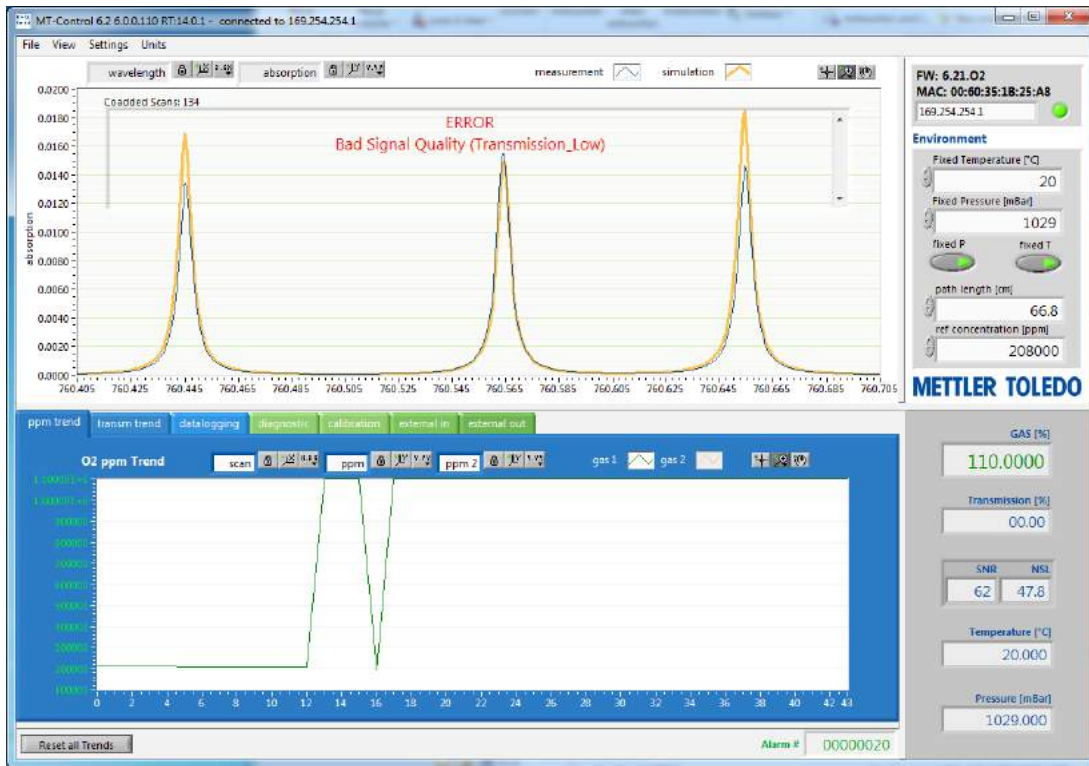
Figure 10. Screenshot of MT-TDL Suite with active fault indication

☞ Monitoring the transmission of the GPro 500 via the 2nd analog output gives always complete information about the cleanliness of the optical surfaces of the GPro 500. Furthermore, if the transmission starts to drop a maintenance/service intervention can be planned.

For troubleshooting of all fault situations please refer to chapter 9 of the Operating Instructions TDLS GPro 500.

5   Maintenance

The GPro 500 is designed to reduce maintenance to a minimum. Experience has shown that mainte-nance intervals of more than 12 months are acceptable for most applications. The maintenance opera-tions described below will secure continuous and safe operation of the instrument.

5.1   Routine maintenance

The GPro 500 has not moving parts and require no consumables. However, for best performance we recommend to routinely carry out the following steps:

• Monitor the transmission value (see above)
• Clean the process window and corner cube when necessary (for details please refer to chapter 7.3.2, 7.3.3 and 7.3.4 of the Operating Instructions TDLS GPro 500)
• Check the connection between the measurement probe and the process for leakages.
• For applications where the concentration of the measured gas is normally zero: Check the instrument response by applying some gas at least every 12 months. Do the test only when the GPro 500 is at least 70 minutes powered on. Apply a sufficiently high concentration of the measurement component to obtain a strong response for at least 10 minutes. During this test no warnings or errors should be displayed. If you are in doubt about your analyzer contact your supplier.
• Check the calibration every 12 months (depending on the required accuracy). Recalibrate if necessary, see next section.

☞   Ensure that the DCS is aware of any maintenance work

☞   The GPro 500 is only one part of the safety installation we strongly recommend to test also the external pressure and temperature sensor acc. to the recommendations of the respective manufacturers

6 Calibration and adjustment

The GPro 500 is factory calibrated and – proper installation, operation, and maintenance assumed – it does not require any calibration during the whole service life. The drift of the spectrometers laser diode emission frequency is negligible since it does not come into contact with the process and do not decay drastically over time thus we only recommend a verification check once a year.

Moreover, the unique Spectra-ID™ software of the GPro 500 has a built-in line locking function which checks the emission frequency of the laser diode independent of the measured target gas concentration.

However, there might be situations were a calibration is desired or necessary.

6.1 Tools required for verification and calibration

- Certified calibration gas or ambient air (set point 20900 ppm) for Oxygen calibration
- Verification/calibration kit (p/n 30 034 139) plus the cross-pipe verification add-on tool (p/n 30 428 120) if your process adaption is a cross-pipe
- Temperature and pressure sensor or alternatively localized weather services can be used

☞ If your GPro 500 measures CO ppm level please contact your supplier about the correct configuration of the calibration tube.

☞ Depending on site regulations and for your personal safety it is recommended to use your personal protective equipment (PPE)

☞ Access to the analyzer must be granted ("hot-work" permit)

In the following the terms adjust/adjustment and calibrate/calibration are used in the following sense:

Adjust:	Calibration values will be overtaken and used for the measurement. Additionally, the data will be stored in the calibration history
Calibration:	The calibration values will be stored in the history for documentation but will not be used for the measurement. The calibration values from the last valid adjustment will be further used for the measurement

6.2 Calibration

Depending on the configuration of the GPro 500 (for example with in situ probe installed, with in situ probe installed in a by-pass, with a blow-back probe or extractive probe) the verification process may differ slightly

6.2.1 Calibration of oxygen sensors using the calibration tube

- Remove the spectrometer head (blue head) from the process probe and connect it gently to the calibration tube. Do not forget the flat gasket (p/n 30 080 914)
- Connect your computer / laptop to the junction box using the Ethernet port and start MT-TDL Suite
- Rotate the head on the calibration unit gently until the transmission is maximized (in any case above 50 %)
- Fully tighten the safety Tri-Clamp
- Connect the calibration tube to the calibration gas and to the exhaust
- If certified calibration gas is used, flush the calibration tube with calibration gas and wait at least 5 min to allow for thermal stabilization
- During the stabilization time change the optical path length to 20 cm in the MT-TDL Suite
- Configure the gas pressure and temperature to be constant and enter the respective value

If you are only performing a simple calibration, observe the values of the reading and record it for documentation and certification purposes.

For documentation in MT-TDL Suite you can also follow the calibration procedure described in section 6.3 but activate "calibrate" instead of "adjust". The calibration factor is stored in the calibration history but not used for measurement.

If the reading shows more than 2 % error or when an adjustment is requested follow the calibration procedure described below.

> ⚠️ **WARNING**
> Do not interrupt the process purge as long as the process is
> running and the process adaption is in the process!

6.2.2 Calibration of all other gases using an additional extractive flow-through cell

The optional calibration tube is only suitable for the calibration for oxygen sensors. For all other gases, there is the possibility to use an extractive cell for the target gas you want to verify/calibrate. Please consult your local METTLER TOLEDO representative for exact configuration.

Your local METTLER TOLEDO organization will provide you further details about these two possibilities.

This section describes the validation of a GPro 500 using an extractive flow-through cell available from METTLER TOLEDO.

For the validation of O_2 and H_2O with an external extractive cell N_2 for spectrometer purge and corner-cube purge (only dual-window) is mandatory.

- If you are using corrosive or toxic gases for the calibration process carry out a leak test following your site regulations
- Remove the spectrometer head (blue head) from the process probe and connect it gently to the calibration cell, do not forget to use the flat gasket
- Connect your computer/laptop to the junction box and start MT-TDL Suite
- Rotate the head on the calibration unit gently until the transmission is maximized (in any case above 50 %)
- Fully tighten the safety Tri-Clamp
- Connect the calibration unit to the calibration gas and to the exhaust
- If certified calibration gas is used flush the calibration tube with calibration gas and wait at least 5 min to allow for thermal stabilization
- During the stabilization time check whether the optical path length of the calibration cell is correct in MT-TDL Suite, if not change it
- Configure the gas pressure and temperature to be constant and enter the respective values

If you are only performing a simple calibration, observe the values of the reading and record it for documentation and certification purposes.

For documentation in MT-TDL Suite you can also follow the calibration procedure described in section 6.3 but activate "calibrate" instead of "adjust". The calibration factor is stored in the calibration history but not used for measurement.

If the reading shows more than 2 % error or when an adjustment is requested follow the adjustment procedure described below.
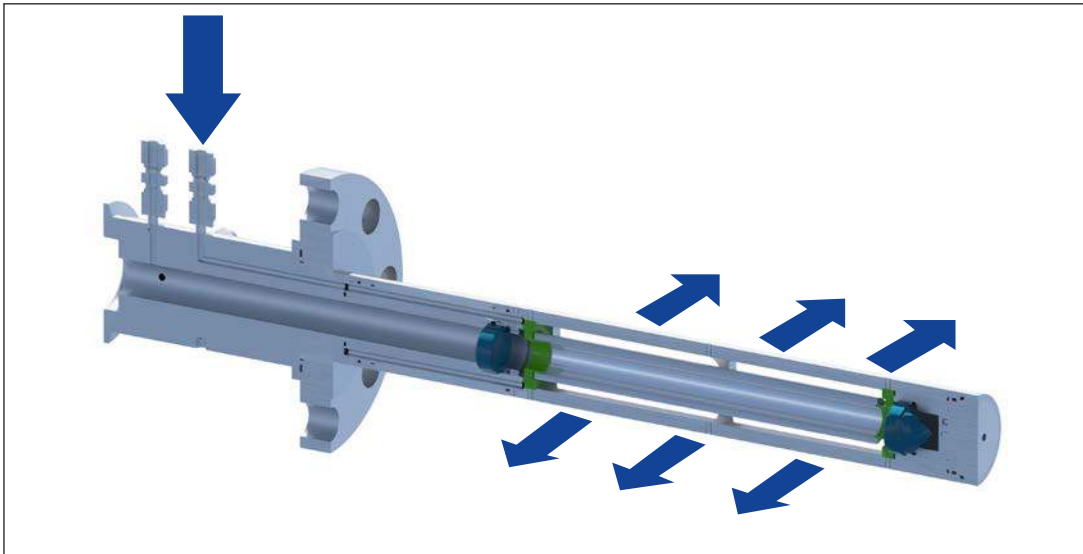
6.2.3 Calibration of a Blow-Back Process Adaption

Figure 11. Blow-back process adaption

Blow-back filter process adaptions are especially good at coping with process gases that contain particularly high levels of dust or liquids. It is also possible to fill the protected inner volume of the filter with a calibration gas:

- Connect the calibration gas bottle via a pressure reducer and a flow regulator to the blow-back inlet of the process adaption.
- Adjust the pressure to be slightly above the process gas pressure
- Adjust the flow regulator to a flow between 1 and 10 l/h
- If you are using corrosive or toxic gases for the calibration process carry out a leak test following your site regulations
- Connect your computer/laptop to the junction box and start MT-TDL Suite
- Open the calibration gas bottle and flush the filter with calibration gas.
- Observe the reading of the TDL (ppm-trend tab) and wait until the signal is stable
- If the signal does not stabilize enhance the pressure of the calibration gas.

If you are only performing a simple calibration, observe the values of the reading and record it for documentation and certification purposes.

We highly recommend a flow monitoring alarm switch at the process purge inlet to detect blocking of the filter by dust.

For documentation in MT-TDL Suite you can also follow the calibration procedure described in section 6.3 but activate "calibrate" instead of "adjust". The calibration factor is stored in the calibration history but not used for measurement.

If the reading shows more than 2 % error or when an adjustment is requested follow the adjustment procedure described in section 6.3.

6.2.4 Calibration of a GPro 500 with in situ probe in a by-pass installation

Special preparation
- The by-pass must be closed for the duration of the verification/calibration
- Temperature and pressure sensors must be installed in the by-pass and wired properly to the GPro
- Purging (spectrometer and process) must kept on during the verification/calibration at the same flow as under normal process conditions
- In case of a hot process make sure that the system has enough time to reach thermal stability.

Verification

☞ Connect your computer/laptop to the junction box and start MT-TDL Suite

- Connect the calibration gas supply to the by-pass and start flushing the by-pass with approx. the same gas speed as the process gas. This is necessary to ensure the optical path length remains the same during the verification.
- In case the same process flow conditions cannot be reached the opl will change and must be changed to calibration flow conditions in MT-TDL Suite for the time of the calibration.

☞ The quality of the calibration depends on the quality of the setting for the new opl!

If you are only performing a simple verification, observe the values of the reading and record it for documentation and certification purposes.

For documentation in MT-TDL Suite you can also follow the calibration procedure described in section 6.3 but activate "calibrate" instead of "adjust". The calibration factor is stored in the calibration history but not used for measurement.

If the reading shows more than 2 % error or when an adjustment is requested follow the adjustment procedure described in section 6.3.

6.2.5 Calibration of a GPro 500 working in an extractive system

The correct procedure to provide calibration gas depends strongly on the realization of the sampling system. As a consequence, we can give only some general guidelines.

> **WARNING**
> Before you open the sample gas path of the extractive system check whether there can be back pressure from the exhaust line.
> If this is the case the connection between the exhaust line and the sample gas outlet of the extractive cell need to be closed by a suited valve

- Let the spectrometer purge run
- Switch off the process gas flow
- Connect the extractive cell to the calibration gas or open the calibration gas valves
- Flush the cell with calibration gas
- Allow at least 5 min time for thermal stabilization

If you are only performing a simple verification, observe the values of the reading and record it for documentation and certification purposes.

For documentation in MT-TDL Suite you can also follow the calibration procedure described in section 6.3 but activate "calibrate" instead of "adjust". The calibration factor is stored in the calibration history but not used for measurement.

If the reading shows more than 2 % error or when an adjustment is requested follow the adjustment procedure described in section 6.3.

6.3 Adjustment of the GPro 500

If a calibration is requested switch to the "calibration tab" in MT-TDL Suite:
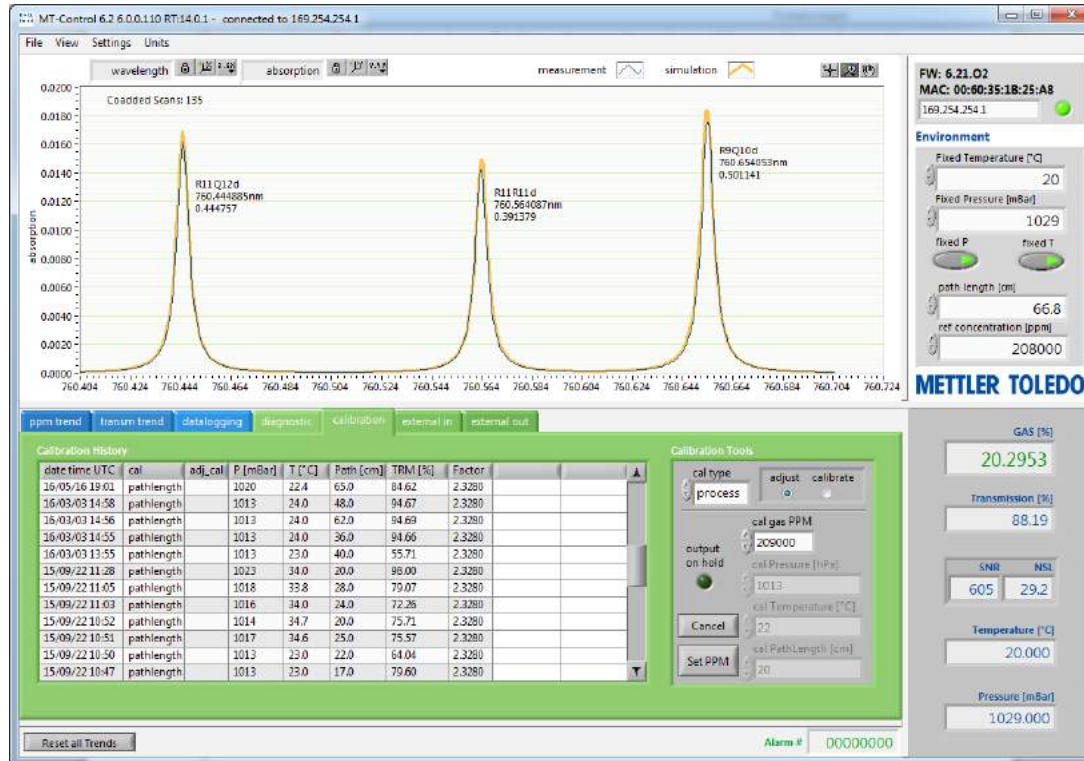
Figure 12. Calibration menu

Calibration modes

One-point-calibration:	Calibration with a certified calibration gas
Process calibration:	Process gas is used as calibration gas. For this calibration method it is necessary to obtain the concentration of the measurement gas by a 2nd analyzer. Please note that the quality of the calibration depends strongly on the quality of the concentration value.

Both are slope calibrations.
"cal type" allows to switch between both modes

Difference between "adjust" and "calibrate"

| Adjust:	Calibration values will be overtaken and used for the measurement. Additionally, the data will be stored in the calibration history
Calibration:	The calibration values will be stored in the history for documentation but will not be used for the measurement. The calibration values from the last valid adjustment will be further used for the measurement

6.3.1 One-point calibration
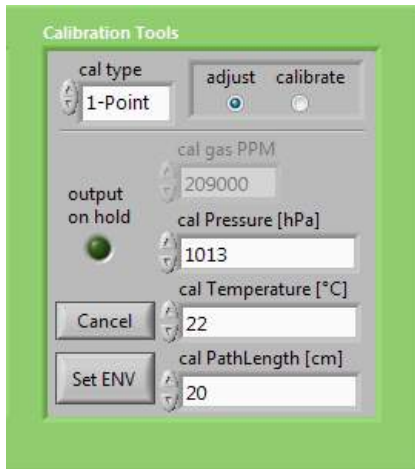
- Choose "1-Point" in the "cal-type" field
- Activate "adjust"
- Set the correct values for temperature and pressure
- Set the right opl (typically for the standard calibration tube 20 cm)
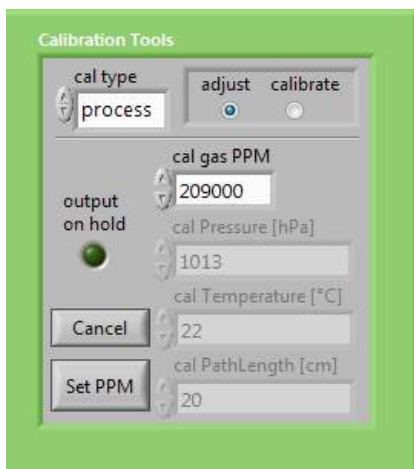- Press "Set ENV"
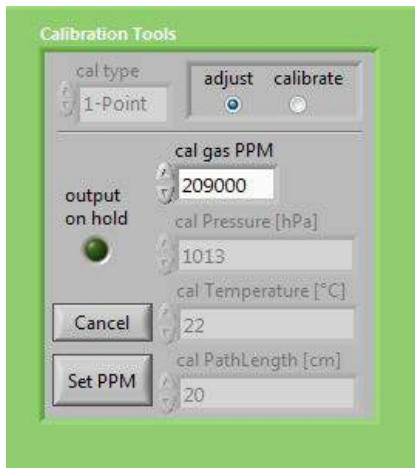
- Enter the correct calibration gas concentration
- Press "Set PPM"
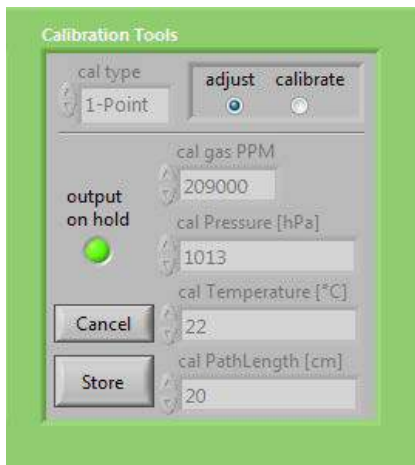
- Wait until "output on hold" will light up
- Observe the reading of the TDL
- Click "Store"
- Wait until the "output on hold" green light has turned off
- One-point calibration finished

Figure 13. Screenshots one-point calibration

6.3.2 Process calibration

- Activate ″process″ in the ″cal type″ field
- Activate ″adjust″
- Enter the correct concentration in ppm
- Click on the ″Set PPM″ button
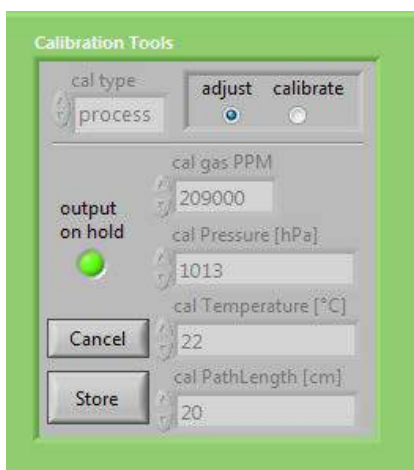
- Wait until ″output on hold″ is activated
- Wait until the reading of the GPro 500 is stable
- Click on the ″Store″ button
- Wait until the ″output on hold″ light is switched off
- Process calibration finished

Figure 14. Screenshots process calibration

☞ If the calibration fails please contact your supplier or the METTLER TOLEDO support.

☞ Regardless whether the GPro 500 is validated or calibrated we strongly recommend to measure the analog value of the analyzer by use of a suited multimeter and check whether the expected value in shown in the DCS.

6.4   Verification of the direct passive analog outputs

The direct passive analog outputs of the GPro500 can be checked using the hold mode of the analog outputs.
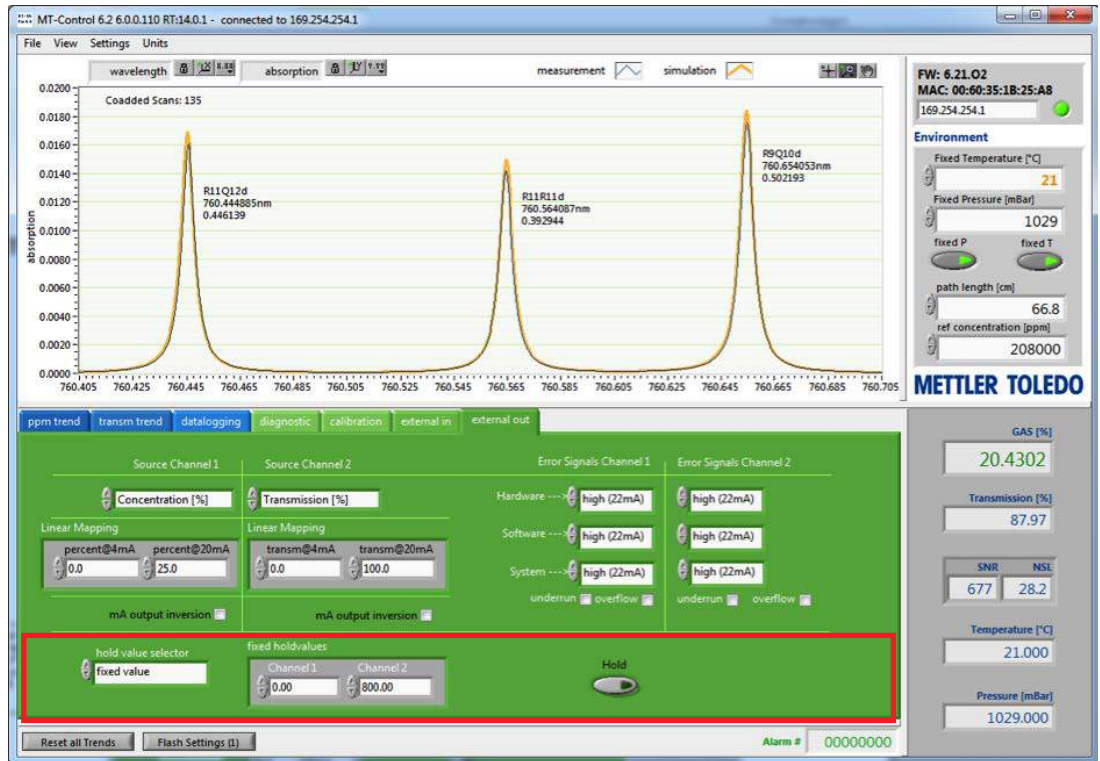
Figure 15. External out tab

- Check that the passive analog outputs are powered correctly
- Connect the passive analog outputs to a multi meter
- Connect the GPro 500 to the PC and start MT-TDL Suite
- Switch to the "external out" tab
- Choose "fixed value" for the hold mode
- Enter the respective fixed values in the corresponding fields; please note the values must be within the range defined in the "Linear Mapping" section.
- For example, for the configuration shown in Fig. 15 the fixed value for channel 1 must be set to
  - 0 % to get an analog signal of 4 mA
  - 12.5 % to get an analog signal of 12 mA
  - 25 % to get an analog signal of 20 mA
- Switch the hold button on
- The reading of the multi meter shall now show the analog equivalent of the setting for the fixed value
- To return to normal measurement mode: switch the hold button off

7 Troubleshooting

All information about the maintenance and error messages are given in chapter 9 of the Operating Instructions TDLS GPro 500. There you find also some recommendations about the actions to be taken.

8 Failure rate data, certifications, standards, and labelling

8.1 SIL Parameters

8.1.1 Covered types of GPro 500

- GPro 500 with direct analog output option (GPro 500 XXXXXXXXXXXXXXXX _ _ / _ A)
- Software version 6.0 and higher
- GPro 500 with 4 … 20 mA current output

8.1.2 SIL parameters

- SIL requirement: SIL 2
- PFD_{avg} (1 year):   1.00 E-03
- Safe failure fraction (SFF):   91%

The GPro 500 can be considered to be a type B element with a hardware fault tolerance of 0. The failure rates according to IEC 61508:2010 for the GPro 500 are listed in the Appendix

8.2 Compliance and standards information

- The GPro 500 TDL complies with the European Community "Electromagnetic Compatibility Directive" and "Low Voltage Directive"
- The TDL is rated in accordance to Over voltage Category II, Pollution Degree.
- The TDL complies with the Class B digital apparatus requirements of ICES-003 of Canada through the application of EN 55011:2007.
- L'analyseur est conforme aux Conditions B numériques d'appareillage de classe de NMB-003 du Canada par l'application du EN 55011:2007.
- This TDL complies with Part 15 of the US FCC Rules for Class B equipment. It is suitable for operation when connected to a public utility power supply that also supplies residential environments.
- The TDL has been assessed to IEC 61010-1:2001 +Corr 1: 2002 + Corr 2:2003 for electrical safety including any additional requirements for US and Canadian national differences.
- METTLER TOLEDO Ltd is a BS EN ISO 9001 and BS EN ISO 14001 certified organization.

8.3 Labels

8.3.1 Type labels

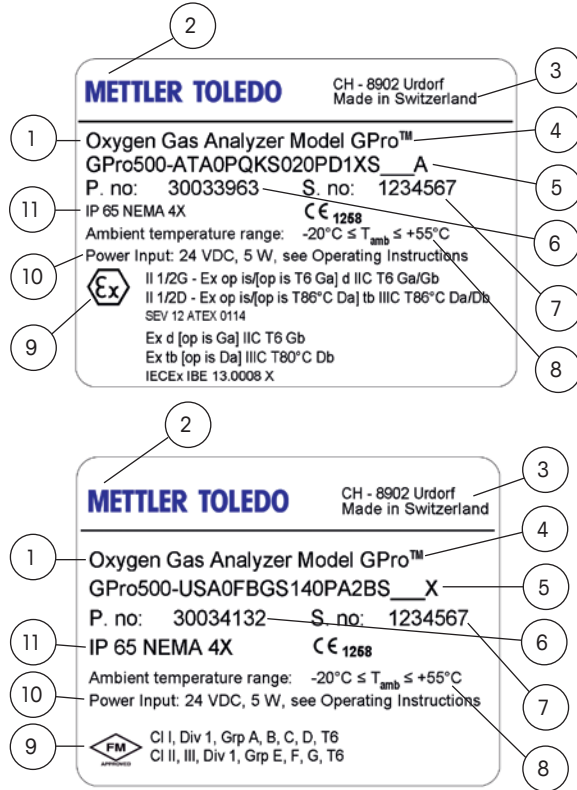The spectrometer of the GPro 500 is marked with a product identification label:

Figure 16. Labels for ATEX (left) and FM (right) version

1   Gas to be measured
2   Manufacturer
3   Country of origin
4   Product name
5   Product key
6   Part number
7   Serial number
8   Ambient temperature limits
9   ATEX (left) / FM (right) marking
10 Power rating
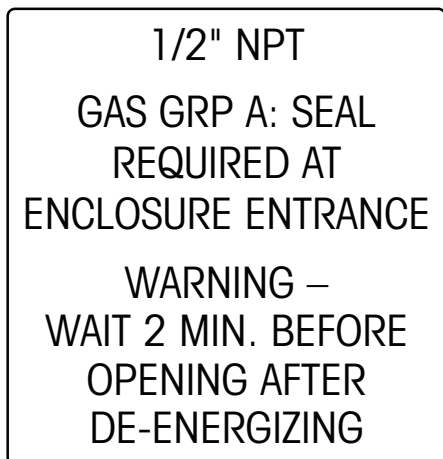11 Enclosure rating

8.3.2 Additional labels

Note labels

> 1/2" NPT
>
> GAS GRP A: SEAL
> REQUIRED AT
> ENCLOSURE ENTRANCE
>
> WARNING –
> WAIT 2 MIN. BEFORE
> OPENING AFTER
> DE-ENERGIZING

Figure 17. Note label

Grounding labels

⊕ M6x12

⊕ M4x6
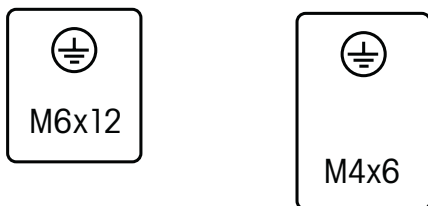
Figure 18. Grounding labels

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