
nCLD
NO / NO_2 / NO_x
Analyzer
ECO PHYSICS
Operating Manual

0.

nCLD Operating Manual, Chapter Overview

1. INTRODUCTION

Read the safety rules first!
(Section 1.2)

1.

1. Introduction

The chemiluminescence technique has become the leading measurement method for nitrogen oxides worldwide. The method is capable of producing a linear signal over the whole measuring range. It is very specific and produces a continuous signal with a short response time for NO.

Thanks to the use of modern microprocessor techniques the nCLD sets new standards in signal processing, control, operating, error handling and data acquisition. The touchable color screen allows the graphical and numerical display of the measurement data. The integrated memory stores the measurement data for at least one-year continuous operation. The instrument allows a lot of interfaces, as LAN, Wi-Fi, Bluetooth, USB and RS232. Any data can also be automatically backed up to any computer in the local network. In addition, the measurement data and error messages can be logged to a microcomputer (PC) or remote terminal through the serial interface (RS232) and optionally the analog output. All calibration, range-changing and diagnostic functions can also be initiated by the remote PC.

Stabilization of many variable instrument parameters such as PMT-temperature, reaction chamber temperature etc. produces a more stable calibration point and high reproducibility of the measurements.

The highly modular system of the nCLD analysers offers the possibility to adjust every single instrument to the needs of its user. All components required such as the thermal ozone destroyer and the vacuum pump are integrated. Later upgrades are also possible. This manual describes all configurations.

Operating the nCLD instrument is extremely easy. The dialogue-type programming is accomplished using the built-in graphical touch screen (GUI = graphical user interface). Nevertheless, nCLD operators are advised to study the pertinent sections in this manual in order to fully appreciate the wide range of operating modes offered by this high-quality instrument.

1.2 Safety precautions

This section summarizes the safety precautions, which are to be observed without exception when using the nCLD analyser (in the following sections called "analyser").

For all persons working with the analyser, reading and comprehending the sections relevant to their work is obligatory. This is especially valid for this section, the reading of which is binding for all persons operating the analyser, including those using it only temporarily or occasionally, e.g. for service purposes.

1.2.1 Definitions, personnel, definitions of terms

Supplier

- The supplier is ECO PHYSICS AG in CH-8635 Duernten, Switzerland and all other persons who claim to be the supplier by marking the analyser with their name, their logo or any other distinguishing label.
- Furthermore, the representative or the importer of the analyser or other commercial businesses in the distribution channel acts as supplier, as far as their activities influence the safety conditions of the analyser.

End user

- The end user is the local owner of the analyser. He is responsible for the intended use (see below).

Qualifications of the operating personnel (I.e. all persons involved with the analyser)

- General operation:
  Installation, operation, calibration and periodic maintenance must be performed by personnel who have attended technical courses and have adequate instrument-related skills. This basic knowledge allows them to estimate potential risks and hazards in the use of the analyser and its accessories. Alternatively, these persons have been specifically trained in order to comply with these requirements.

- Service:
  Repair, exchange of modules, printed circuit boards etc. must be performed only by trained service personnel, instructed and authorized by ECO PHYSICS.

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- Programming, communication and electronics:
  Programming of the serial interface in order to operate the analyser by a remote computer system and to install the communication interface shall be performed by appropriately skilled and qualified software engineers.

Significance of the safety precautions

The goal of these safety precautions is to draw attention to the remaining risks in order to allow a safe and economical operation.

1.2.2 Symbols and safety hints used in this manual

Safety symbols like the following are used in this manual to draw attention to potential risks when the analyser is used according to its intended use:

WARNING

Toxic gases!

Safety warnings in and at the analyser

Warning labels inside the analyser:

Danger - High Voltage

Gefahr - hohe Spannung

Disconnect power before opening

Vor dem Öffnen Netzstecker ziehen

Do not over pressurize the ozone generator!

Überdruck kann den Ozongenerator beschädigen!

Warning labels on the back panel (outside):

Servicing to be performed by qualified personnel only. Disconnect power before undertaking repair or maintenance

Servicearbeiten dürfen nur durch qualifiziertes Personal durchgeführt werden. Netzstecker ziehen vor Reparaturen oder Instandstellungsarbeiten.

1.2.3 Intended use of the analyser

The analyser is exclusively designed for monitoring of nitrogen oxides in gases.

The intended use implies:

- operating the instrument within the technical specifications described in section two
- following this operating manual and observing all the hints, warnings and recommendations it contains

Non-intentional use (misuse)

All other types of use beyond the description above are considered as non-intentional. Damages resulting from such misuse cannot be claimed from the supplier. He assumes no responsibility. The whole risk remains with the end-user.

1.2.4 General dangers

⚠	WARNING Exhaust gas!

The vacuum pump exhaust must be allowed to vent either above roof level or to a special purpose ventilation system using a tube with a minimum inner diameter of six millimetres. Neglecting to observe this safety precaution may cause severe health problems (e.g. the inhalation of NO_2 may cause irritation of the respiratory tract or in severe cases to lung damage.)

⚠	WARNING High pressure gas!

All relevant safety precautions must be observed without exception:

- Pressurized gas cylinders must be secured against falling. Horizontally stored cylinders must be prevented from rolling.
- The pressure reduction valves and all tubing from gas cylinder to vent must be regularly checked for leak tightness.
- etc.

1.2

WARNING Toxic gases!

Nitrogen monoxide (NO), especially Ozone (O_3) and nitrogen dioxide (NO_2) are toxic!

Ozone

Low concentrations of ozone can be harmful to the upper respiratory tract and the lungs. The severity of injury depends on both by concentration of ozone and the duration of exposure.

NO_2

Nitrogen dioxide is toxic by inhalation. Symptoms of poisoning tend to appear several hours after inhalation a low but potentially fatal dose. Low concentrations (4 ppm) will anesthetize the nose, thus creating a potential for overexposure.

Following the recommendations and instructions in this manual assures safe operation when the analyser is correctly used ("intentional use" condition).

Specific dangers with the analyser

NO

Nitrogen monoxide is used only for calibration. This should be performed at a similar concentration as the expected concentration of the sample gas.

NO_2

We recommend that for the determination of NO_2 the converter shall be checked by the principle of gas-phase-titration (GPT; refer to section 6.2.6). However, when using bottled NO_2 extreme care shall be observed on account of the high toxicity to avoid any leakage of the gas.

O_3

Ozone is produced inside the analyser in the ozone generator using dried ambient air or O_2. In a correctly installed and operated system this ozone will be destroyed in the ozone scrubber located on and immediately upstream of the vacuum pump. Furthermore, the actual concentration of ozone is low, and under fault conditions the ozone generator is automatically shut down by the analyser control system.

1.2

Dangers involving peripherals

A complete description of precautions to eliminate the dangers associated with peripheral devices, which are application-specific, is beyond the scope of this manual. As an example (relating to the sampling system) special care should be observed when handling hot and aggressive gases, and the appropriate safety precautions applied.

1.2.5 General safety rules

Legally binding regulations

In addition to the instructions in this manual, all current environmental, safety and technical regulations must be respected.

General inspection requirements

To be met after each maintenance, repair or service operation.

Power connections

The analyser may only be installed and connected to the mains power supply according to the installation guide in section 4.2 of this manual. All power lines must be switched to cut off the electrical supply at source.

Accessories and spare parts

For maintenance and repair the options and spare parts originally manufactured by ECO PHYSICS and included in this manual should be used exclusively.

Modifications and alterations

Modifications of the analyser or options and parts, which affect safety aspects, are only permissible with the written consent and prior agreement of ECO PHYSICS AG.

Mechanical modifications are forbidden, e.g. to drill holes in the analyser for rack mounting.

1.2.6 Responsibilities and duties of the supplier

The supplier is responsible for the safety of the product; this can only be guaranteed if the end user undertakes to follow fully the requirements and suggestions contained in this operating manual. The end-user has a duty of care to ensure that this is done.

The supplier observes his product beyond the time of delivery. He is entitled to request information especially related to safety from the end user.

Duties of the end user: Training, personnel competence

The end user makes sure that only trained and authorized personnel can work with the analyser. He is responsible for comprehensive training following the instructions of this manual. He designates the responsible persons and delegates competencies.

Instruction on the dangers to personnel

The end user makes sure, that his personnel install and operates this analyser only in compliance with this manual. He is responsible for the necessary supply of safety-relevant tools and support materials.

Duty of care and maintenance

The analyser must be maintained in operational condition; full periodic maintenance shall be performed.

Duty to observe and inform

In case of any (remaining) risks or dangers, which have not been covered in this manual, the end user of the analyser is requested to inform the supplier immediately.

2. SPECIFICATIONS

Read the safety rules first
(Section 1.2)

2.1

2.1 Performance specification

Measurement ranges selectable [1]	
nCLD 62	from 0–5 ppm to 0–5’000 ppm
nCLD 63	from 0–0.5 ppm to 0–500 ppm
nCLD 66	from 0–50 ppb to 0–50’000 ppb
nCLD 82x	from 0–5 ppm to 0–5’000 ppm
nCLD 84x	from 0–0.5 ppm to 0–500 ppm
nCLD 85 (AL)	from 0–100 ppb to 0–50’000 ppb
nCLD 88	from 0–5 ppb to 0–5’000 ppb
nCLD-SL 811	from 0–1 ppm to 0–10’000 ppm
nCLD-SL 899	from 0–1 ppb to 0–5’000 ppb
nCLD 855 (AL[2])	from 0–100 ppb to 0–50’000 ppb

Detection limit (2σ, = +/– 1σ)	
nCLD 62	0.5ppm
nCLD 63	0.025ppm
nCLD 66	0.5ppb
nCLD 82x	0.125ppm
nCLD 84x	0.0125ppm
nCLD 85 (AL)	0.4ppb
nCLD 88	0.05ppb
nCLD-SL 811	1ppb
nCLD-SL 899	0.05ppb
nCLD 855 (AL[2])	0.4ppb

Signal noise (2σ, = +/– 1σ)		1% of measurement value [2]
		nCLD6x: 2% of measurement value [2]
Interferences		
water vapor[3]		
nCLDs		0.3 to 3.1 % per Vol-% H_2O
nCLD811		< 0.3 % per Vol-% H_2O
nCLD899		< 3 % per Vol-% H_2O
		dep. on type of analyser and options
carbon dioxide[3]		
nCLDs		0.1to 1.4 % per Vol-% CO_2
nCLD811		< 0.1 % per Vol-% CO_2
nCLD899		< 1 % per Vol-% CO_2
		dep. on type of analyser and options
Zero-point drift		< 0.1 ‰ of max. range / day
Sensitivity drift	nCLD6x	< 5%/ day
	nCLD8xx, SL	< 1% / day

Response times[4]	< 1 – 4 s dependent on type of analyser and options
Lag Time	< 3 sec
Rise Time 8xx, SL (0 - 90%)	< 1 sec
Rise Time 6x (0 - 90%)	< 3 sec
Fall Time (100 - 10%)	< 1 sec
Linearity within range	< 1% of point from 6% to 100% of range [5]

[1] each of the 4 different ranges definable
[2] Filter setting „slow" (set to 30 second, nCLD855 set to 120 seconds). Specified value depending on filter setting.
[3] Data in % of measurement value
[4] Data in [s] for: lag time, rise time (0-90%) and fall time (100-10%)
[5] CLD811: for measurement ranges <100ppm and >300ppm

2.2

2.2 Operating specification

Electrical data:	
– Power uptake	300–400 VA max. (SL 650VA max.)
– Mains voltage	100–240 V / 50–60 Hz
Installation/overvoltage category	II
Analog outputs (available on external USB-I/O-Box)	0 to 10 V 2 bis 10V (with 20% offset) 0 to 20 mA 4 to 20 mA (with 20% offset)

For more details see in the operating manual of the specific USB-Box. (If this accessory was ordered and delivered together with the analyser, then you will find it in the GUI by a click onto the HELP-button in the upper right corner of the I/O-Analog-Output Setup window)

Analog inputs and digital I/Os	available on external USB-I/O-Box
Permitted ambient temperature	0 to 40 °C, not freezing
Permitted humidity range	5 to 95 % RH (non-condensing)
Operating altitude	up to 2’000 m above sea level
Pollution degree	2

Converter type	Y [1]	M	S [4]	C
Converter temperature [°C]	375	400 [5]	650	650
NO_2 efficiency [%]	> 95	> 95	> 95	> 95
at max. NO_2 nCLD [ppm]	1;10 [2]	50;500 [3]	50;500 [3]	50;500 [3]
Ammonia efficiency [%]	< 4	< 10	30–60	> 90
at max. Ammonia [ppm]	1;10 [2]	20	500	500

Life expectancy of converter 10’000 h

Reaction chamber temperature 45 °C, regulated

PMT temperature [1] -10° to +5 °C, dep. on analyser type, regulated.

1) available only with nCLD AL, AL², 85, 855, 88, 899
2) or 20% of range
3) 10% of range
4) for NH3 only limited suitable
5) 350°C for nCLD811

2.2

Reaction chamber pressure[2]	14 to 40 mbar abs., dependent on model
Inlet pressure range[1]	
Sample gas	
nCLD 6x	ambient pressure, >700mbar abs
nCLD 8x(x), SL (811, 899)	600– 1’200 mbar, abs.
Calibration gas	
without option v2/v8	pressure-less (ambient pressure)
with option v2/v8	2 - 3bar abs.
with calibration gas divider	pressure-less (ambient pressure)
Sample flow	
nCLD 62, 63, 66	40, 300, 100ml/min
nCLD 8x(x)	1 l/min (option low flow available)
nCLD 811, 899	1 l/min
Humidity range of sample gas	
nCLD 6x	5 to 95% RH of ambient air temperature
nCLD 8x(x)	dew point <= instrument temperature. Sample gas must not condensate inside external sample gas line. Use a heated sample line in order to prevent condensation. ≈ 4 Vol-% H_2O at 30 °C instrument temperature ≈ 6 Vol-% H_2O at 35 °C instrument temperature
with option h	< 20 Vol-% H_2O nCLD811 < 25 Vol-% H_2O

Remark: Exhausted gas might be almost as humid as the sample gas and could condensate.

1) calibration gas pressure and sample gas pressure without option V2 (internal calibration gas pressure regulation) must not deviate by more than 3 mbar in order to fulfil the specifications

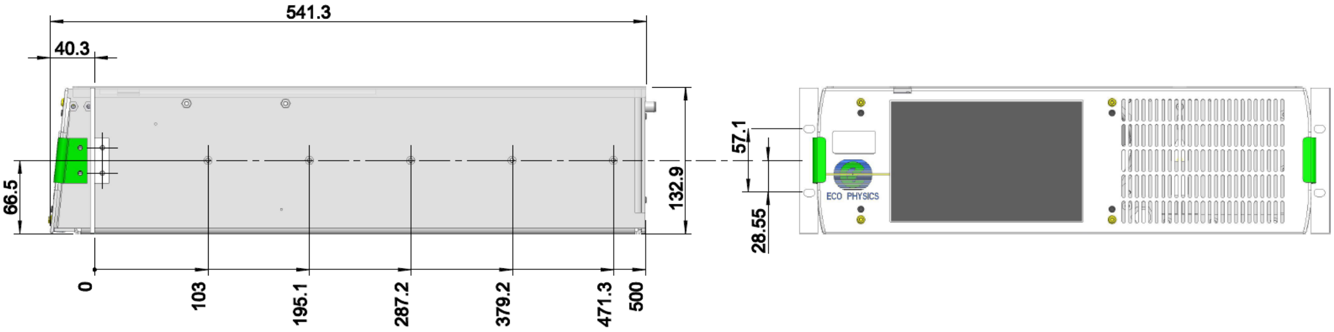
2) depending on model & version, see test report of the particular instrument

2.3 Dimension and weight

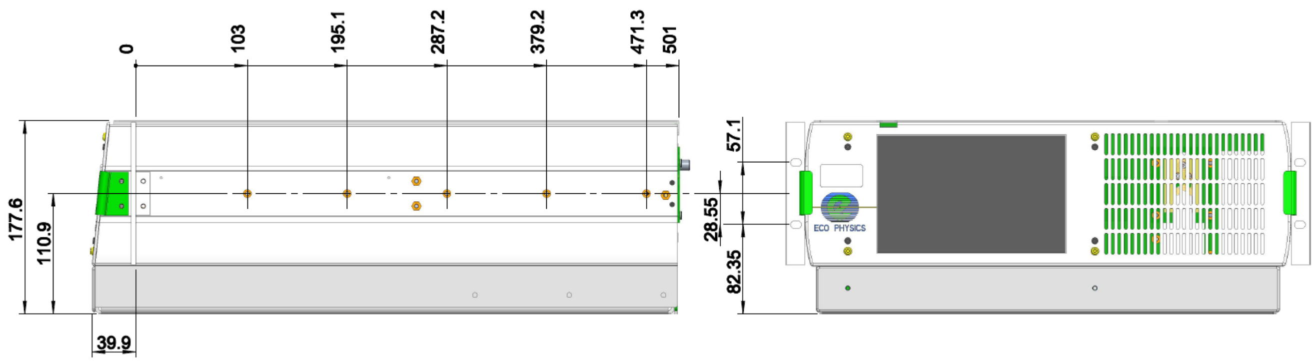
Dimensions:	Width x Height x Depth	(width with trims)
nCLD6x, 8xx ohne SL	448 mm x 133 mm x 540 mm	495
nCLD899, 811 (SL)	448 mm x 178 mm x 540 mm	495

Weight 20-26kg (SL 40–45 kg)

nCLD6x und nCLD8xx



nCLD-SL (811, 899)



3. FUNCTIONALITY

Read the safety rules first
(Section 1.2)

3.1

3.1 Measurement principle

The chemiluminescence method offers the best results whenever the difficult analysis of the tiny molecule NO in gases is required. Chemiluminescence method allows to detect extremely low concentrations of NO, being not only fast but also very sensitive and NO specific.

The reaction scheme of NO and O_3 by chemiluminescence is as follows:

$$NO + O_3 \longrightarrow NO_2 + O_2 \qquad [1]$$

$$NO + O_3 \longrightarrow NO_2^{*} + O_2 \qquad [2]$$

$$NO_2^{*} \longrightarrow NO_2 + h\nu \qquad [3]$$

$$NO_2^{*} + M \longrightarrow NO_2 + M \qquad [4]$$

The radiation emission is in the wavelength between 600 and 3000 nm with an intensity maximum at approximately 1200 nm. This chemiluminescence signal is detected photo-electrically. When O_3 is present in excess the signal is proportional to the NO concentration of the sample gas. By far the largest portion of the NO_2^{*} returns to ground state without radiation emission, due to collisions with other molecules (M) [4]. In order to enhance the light yield, the pressure in the reaction chamber is reduced.

Quenching is an unwanted phenomenon, and the extent to which it occurs depends on the character of the colliding molecule M. For instance, water (H_2O) and carbon dioxide (CO_2) quench NO chemiluminescence more effectively than nitrogen (N_2) and oxygen (O_2).

In order to measure NO_2 in the sample gas, it has first to be converted into NO. To accomplish this chemical reduction the sample gas is passed through a converter heated to more than 300 °C (572 °F). If the converter contains for example carbon as reducing agent, the following reaction takes place:

$$NO_2 + C \longrightarrow NO + CO \qquad [5]$$

Modern converters contain metallic active material, which allows better selectivity of NO_2. Since sample gas normally contains both NO and NO_2, it is possible to measure the sum [NO] + [NO_2] = [NO_x] in the converter channel. Using a catalyst that also converts amines to NO and a selective converter that only converts NO_2, the difference [NO_{xAmine}] – [NO_x] can be interpreted under certain conditions as the ammonia [NH_3] concentration.

It is possible to measure NO directly without any converter. The two-channel principle allows to simultaneously measure NO and NO_x giving a high precision of the NO_2 - calculation.

3.2 Description and functioning of the instrument

3.2.1 Introduction

The construction of the nCLD analysers follows a highly modular design. Optional equipment like pressure regulation or additional valves are to be found always at the same place inside the housings of an analyser family. There are three analyser families distinguished: the housings of the nCLD6x and nCLD8x are three units high (3HU), the Supreme Line analysers nCLD-SL are four HU high. All instruments are 54cm depth including front and fit into a 60cm deep 19"-rack-system. The front of the analysers is 40mm deep and protrudes the rack front. In order to achieve best air ventilation inside a 19"-rack we recommend the installation into racks being deeper than 60cm. The general layout of the different modules is shown on fig. 3.1 und 3.2.

The following pages describe and discuss the design and functioning of the main components. The gas flow path is also explained in detail.

3.2.2 Detector unit

The nCLD8xx and Supreme Line analysers are two channel instruments for simultaneous measurement of two gases, e.g. NO and NO_x. Each channel has its photo multiplier (PMT) and reaction chamber. The PMTs are cooled down and temperature controlled from 5 to -10°C, depending on the analyser model. This reduces variations of dark current, minimizes noise and stabilizes sensitivity. The nCLDs of the nCLD6x family are one channel instruments, containing one PMT that is temperature controlled but not cooled.

Parameters that influence the detector sensitivity are controlled continuously by several sensing elements and controls, such as chamber temperature and pressure, ozone generator high voltage.

Instruments based on the chemiluminescence principle are mass flow sensitive detectors. The signal depends on the number of NO molecules entering the reaction chamber. It is therefore necessary to keep the mass flow of the sample gas constant or to measure it with high accuracy.

By using high precision stainless-steel flow restrictions (orifices) with defined dimensions these requirements are met. The mass flow across the restriction only depends on the inlet pressure

3.2

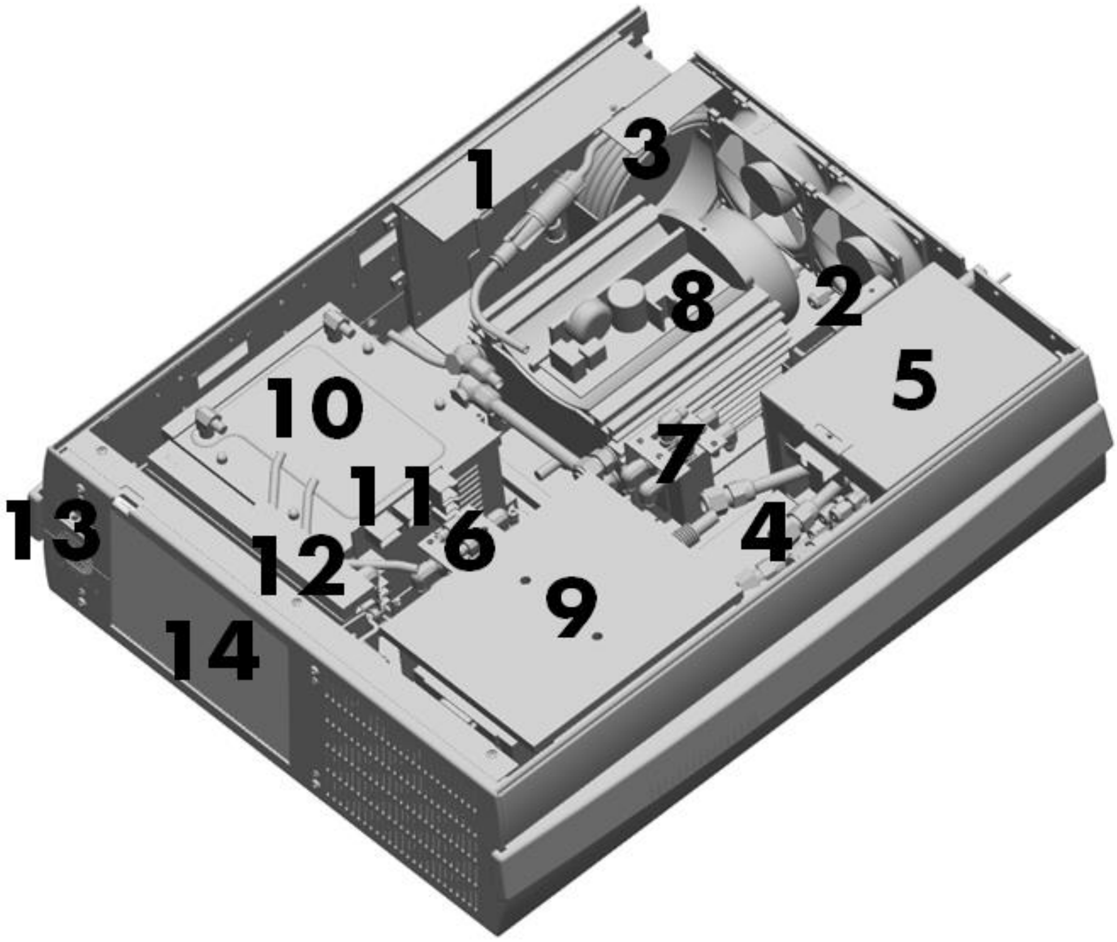
and the type of gas. The inlet pressure must be stabilized by means of an external pressure control unit if it is not internally controlled by the analyser itself.

Another important requirement met by the NO analyser is its high selectivity and low interference by other gas components. CLDs have the highest possible selectivity of all commercially available analysers.

Interference by water vapor and gases other than NO was carefully considered during its design phase to minimize the quenching with optimized pressure and flow values.

3.2

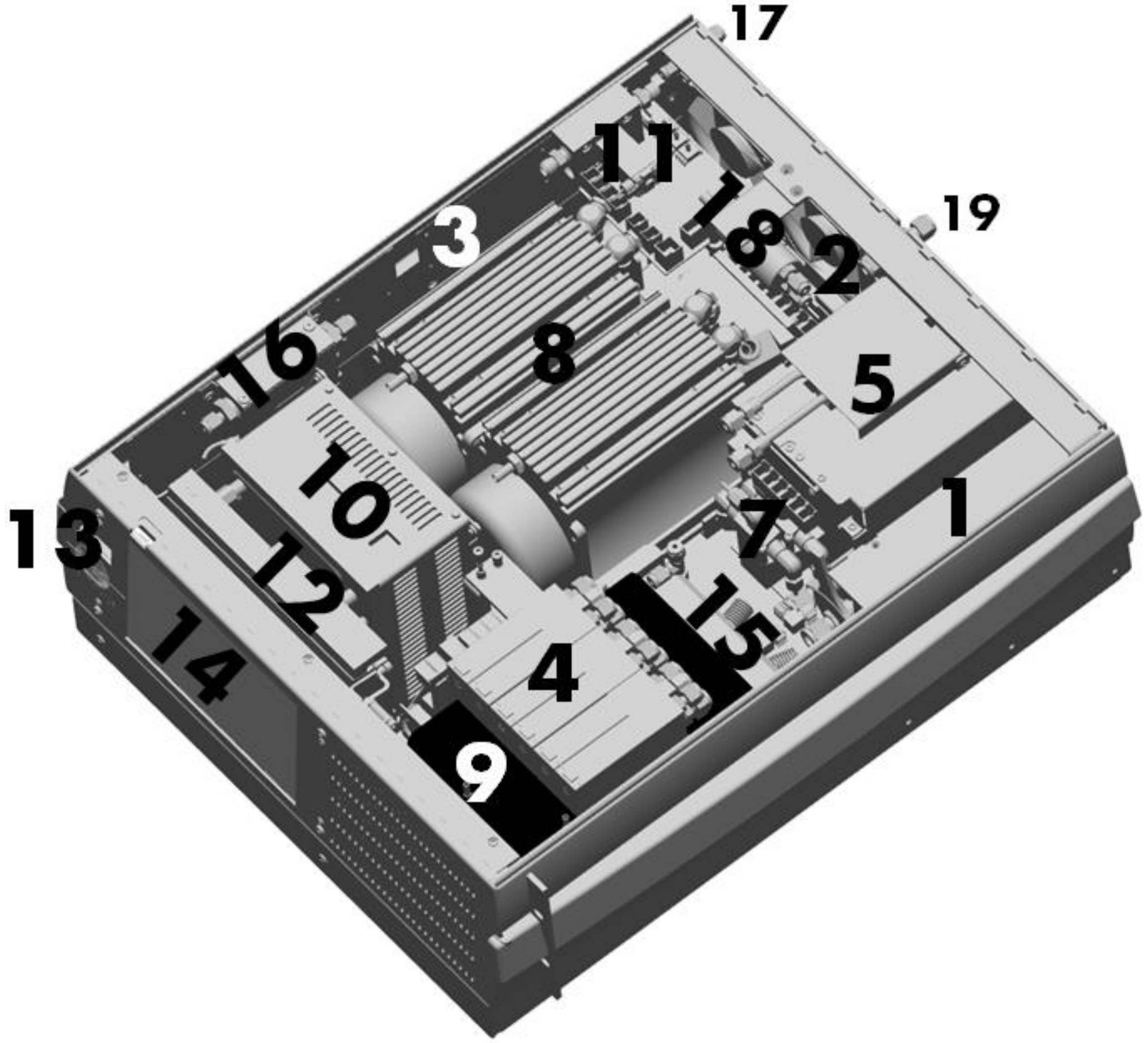
Fig. 3.1 "General arrangement of the nCLD6x and nCLD8xx"



1	Power Supply and Mainboard with Interfaces (USB) at backwall (nCLD 6x Power Supply external)
2	Calibration gas solenoid valves (zero / span gas). Calibration gas pressure regulator underneath pump.
3	Air dryer
4	Gas switching valves (for one-channel or NH3-analysers)
5	Hot Box (converter, scrubber and heated inlet)
6	Valves (various options)
7	Calibration gas / Sample gas switching solenoid valves. Option p valve.
8	Vacuum pump (nCLD 6x pump external)
9	Detector-unit (PMT-housing, reaction-chambers)
10	Ozone generator
11	FSY: Pressure sensors, Pump control and bypass pressure regulation system.
12	Multi purpose filter
13	HDMI socket
14	Graphical user interface, GUI with touchscreen

3.2

Fig. 3.2 "General arrangement of the Supreme Line (nCLD-SL)



1	Power Supply and Mainboard with interfaces (USB) at backwall	10	Ozone generator
2	Calibration gas solenoid valves (zero / span gas)	11	FSY: Pressure sensors, pump control and bypass pressure regulation
3	Air dryer tube	12	Multipurpose filter
4	Gas switching valves (for one-channel or NH3-analysers)	13	HDMI socket
5	Hot Box (converter, scrubber and heated inlet)	14	Graphical user interface GUI with touchscreen
7	Calibration gas / Sample gas switching solenoid valves	15	Reaction chambers
8	Vacuum pump	16	Oxygen pressure regulator (899 only)
9	Detector-Unit (PMT-cooling block, reaction-chambers)	17	Oxygen gas inlet
		18	Calibration gas pressure regulator
		19	Pump exhaust

3.2.3 Ozone generator

The integrated ozone generator operates on the silent electrical discharge principle. Dry air is passed through an alternating electrical field, and ozone is generated from ionized atmospheric oxygen. The high ozone output assures linearity of measurement over six NO and NO_x concentration decades.

Ambient air is dried by means of a permeation drier that is service free and operates by reflux.

3.2.4 Converter

The NO_2/NO converter consists of a heated and thermally isolated steel block that houses the converter cartridge. If needed, this cartridge can easily be exchanged. The converter uses a metal catalyst with a large specific surface for maximum efficiency and long life.

The life expectancy of the converter is limited because the NO_2 conversion and other reactions slowly reduce the specific surface. As the material is consumed the converter efficiency declines and eventually it must be replaced. Conversion efficiency should be checked periodically (see chapter 6).

The expected useful life of the converter cartridge is approximately 10’000 hours (no longer than 1 year).

This figure must be taken as an approximate value. Each converter cartridge has got a different life span. Some external factors can affect the conversion efficiency (e.g. by other interfering gases, like Ammonia). Therefore, a converter efficiency test should be performed on a regular basis, and not just when the converter approaches its expected end of life (see chapter 6).

The converter must be chosen to suit the application according to the technical data in section 2.2. The lower the temperature selected for NO_2 conversion the more specific it is performed. The higher the converter temperature selected for conversion the more efficiently high NO_2 concentration is it performed.

3.2.5 Gas flow schematic

Fig 3.3a to 3.5d show the flow diagrams of various nCLD analyser configurations. This is a selection only of possible flow diagrams.

The numerous gas flow schemes are grouped and listed as followed:

Fig. 3.3 One-channel analysers of the nCLD6x family

Fig. 3.4 Analysers of the nCLD8xx family

Fig. 3.5 Analysers of the Supreme Line (nCLD-SL)

Fig. 3.xa Gas flow concepts of the appropriate nCLD families

Fig. 3.xb....z Various gas flow scheme examples (x=3,4 or 5)

See the .... FlowSchemes:

The vacuum system

A powerful vacuum pump generates a vacuum of approximately 15 to 40 mbar in the reaction chambers, and flows for:

- sample gas
- permeation drier
- ozone generator
- sample gas dilution
- PMT housing flush (nCLD8xx and nCLD-SL)

Sample gas flow

The sample gas is guided through a flow restrictor FR-S2 and is in case of an installed converter blended with cleaned dry air defined by a flow restrictor FR-D1. For some analyser versions (811) this diluted sample gas is splitting into two partial flows by the restrictors FR-S3 and FR-S4 in order to achieve a higher total signal range of up to 7 decades. Some analyser versions (899) are equipped with pre-chambers in order to reduce zero signal interferences at low NO concentrations (ppt) by other gas components. In order to measure NO_x, the sample gas is split and routed through the converter upstream of the reaction chamber. One-channel analysers need a solenoid valve in order to switch the NO and NO_x sample gas streams. Two-channel analysers have two PMTs and two reaction chambers in parallel achieving a simultaneous measurement of NO and NO_x and hence a timely correct NO_2 signal.

The chemiluminescence reaction takes place in the reaction chamber. The vacuum pump aspirates the gas from the reaction chamber into the ozone destroyer and lets it optionally stream through a silencer to the exhaust outlet.

Ozone flow

Ambient air passes through an internal filter (multi-purpose filter) located behind the front panel and is dried by means of a permeation drier that is service free and operates by reflux with a partial flow from the restriction FR-D3. The ozone containing air then passes through a flow restriction FR-O1 and mixes with the sample gas inside the reaction chamber.

PMT housing flush

The restriction FR-D4 limits a flow of dry air to flush the PMT housing to prevent the photomultiplier tubes from condensation.

Two converter instruments (e.g. option "Amines")

The concept allows a converter in each channel. With this option both channels can measure NO if needed. Using special converters (option CM or CY) it is possible to measure amines (measurement mode "NO, NO_x + Amines, Amines") and NO_2 (measurement mode "NO, NO_x, NO_2").

Option "d": Dual instrument

Two separate sample gas inlets make the difference from the two converter instruments.

Options v2 and v8 are not yet available together with option d.

Calibration gas valve options: Options v2 and v8: Solenoid calibration valves

The base version requires connecting the calibration gas and the sample gas to the same inlet. The switching between the gases must be accomplished by the user. The option v1 offers internal switching between the sample gas and the calibration gases. The option v2 ("Zero & Span Cal. Valves") offers internal switching between all three types of gases, i.e. sample, span and zero gas. With option v2 the calibration gases (span and zero) can be connected at pressures up to 2 bar (30 PSIG). Options v1 and v2 are available for all nCLD8xx except for option hr and d. The option v8 offers separate calibration gas ports for each measurement range according to the automotive requirement (AK). Analyser nCLD811 with one of these two options (v2 or v8) and analysers nCLD8xx with option v2 can automatically control an external gas divider and/or converter efficiency test unit (EFT).

Options v2 and v8 are not yet available together with option d (dual sample gas inlets).

3.2

Option "r": Pressure regulation system (Bypass-Controller)

This option eliminates pressure variations and reduces the time delay between source and analyser by a high gas flow. The total sample flow is 1.1l/min for all instrument configurations by means of the flow restriction FR-S1. The pressure control unit (Bypass Controller) mixes as much filtered air to achieve a constant bypass pressure of 350mbar (SL: 160 mbar). The vacuum pump aspirates this gas mixture by means of an intermediate stage.

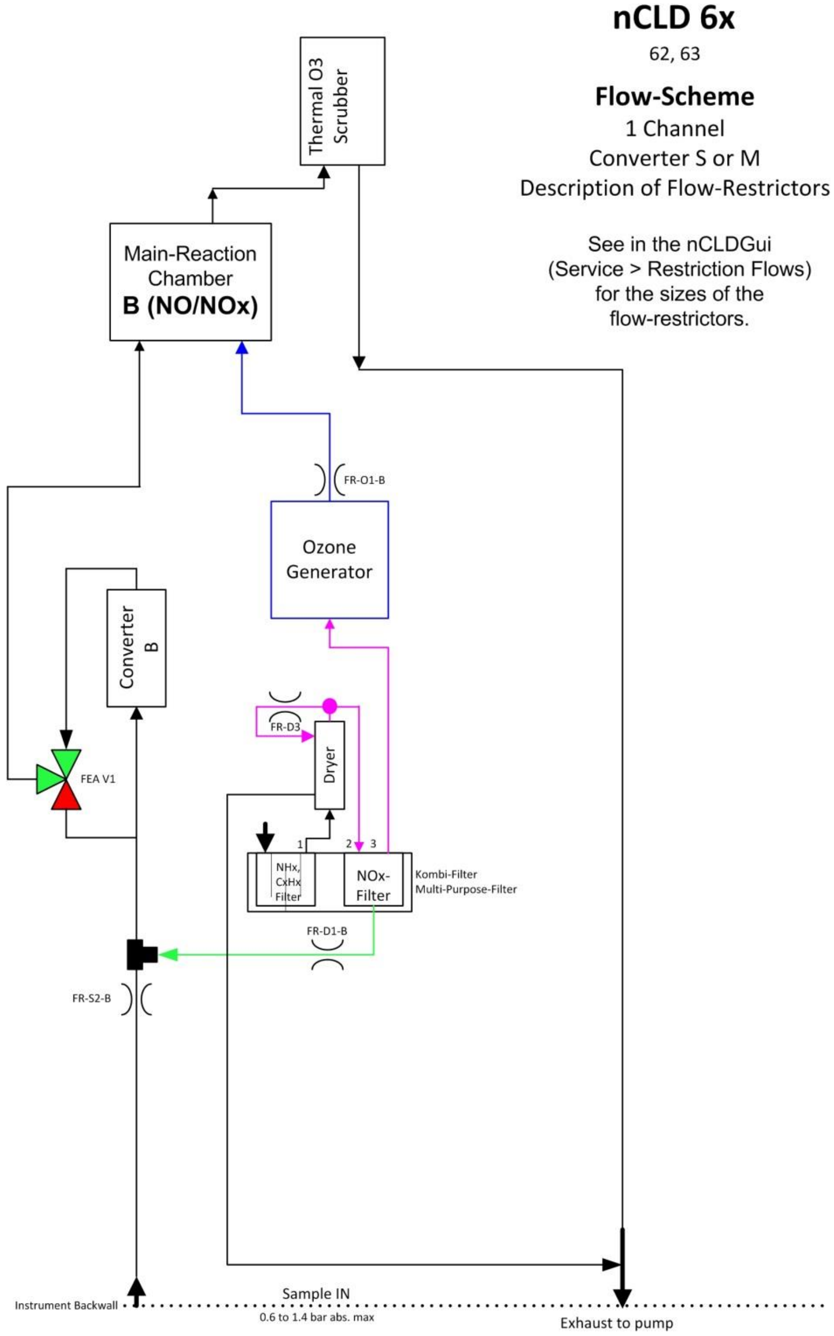
Option "h": Heated inlet (Hot Tubing)

This option allows the measurement of humid gases or special gas mixtures which otherwise could react with each other at room temperature. The area of the sample gas inlet and the first restriction (FR-S1) are stabilized to 190 °C (374 °F). Humidity does not condense because the restriction provokes a low pressure, and specific gas mixtures are almost prevented from any reaction until the components can be detected by the analyser.

Option v1 and v2 are not available for analysers with option hr.

Flow Schemes:

Fig. 3.3b



ECO PHYSICS AG, HS 09.10.2017, 13.04.2018, Flow-Scheme-nCLD-62S-63M-en.vsd

Fig. 3.3c

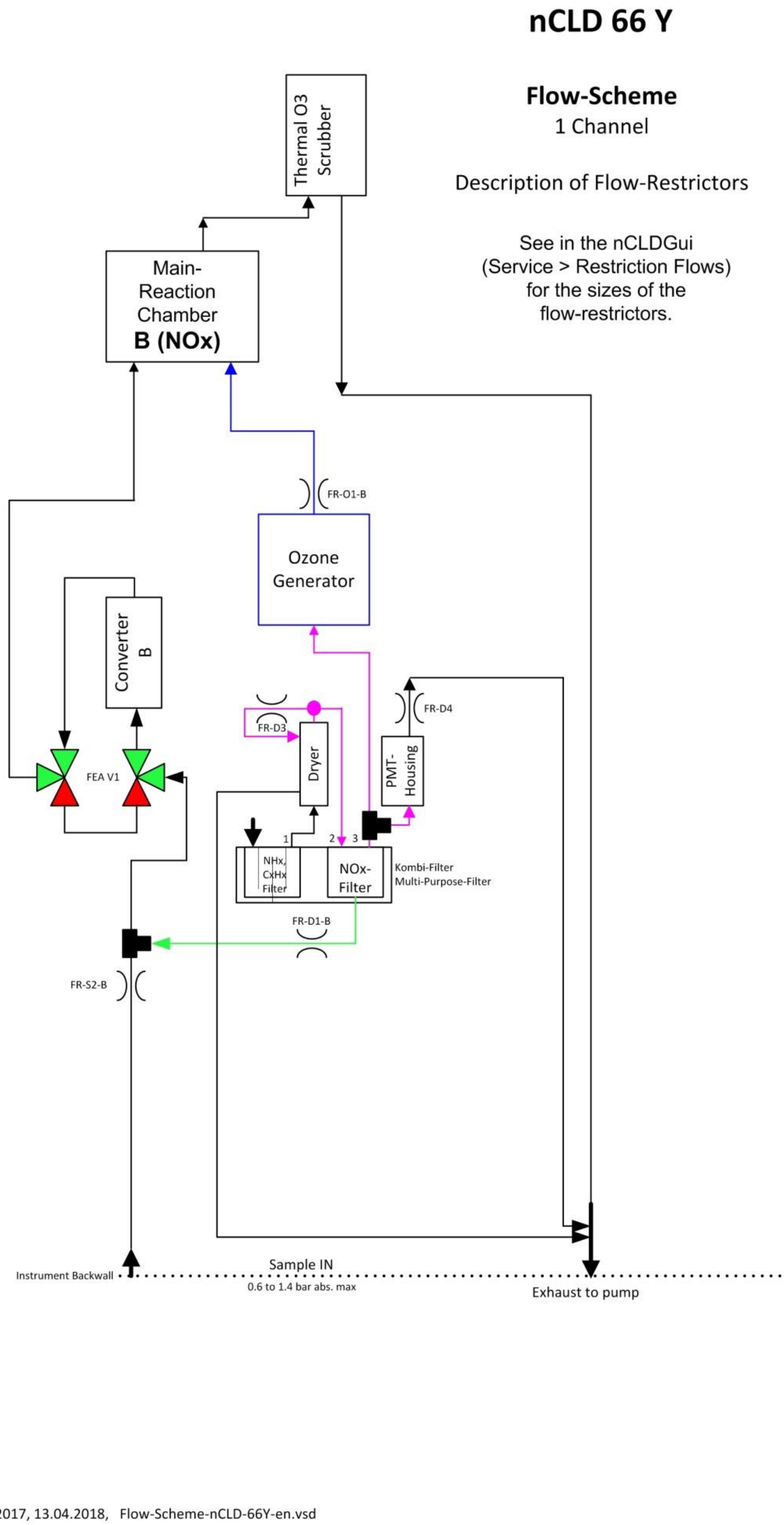
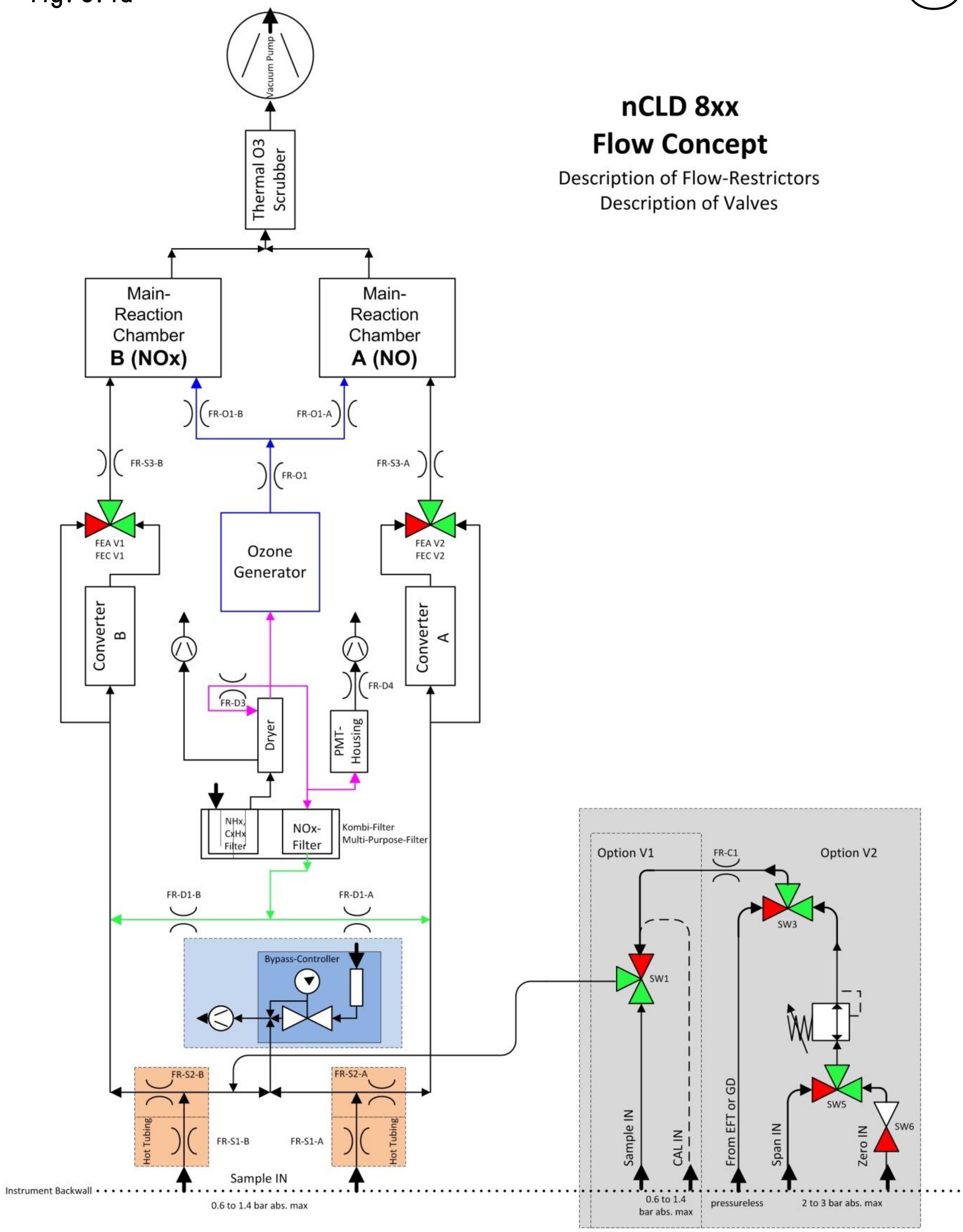
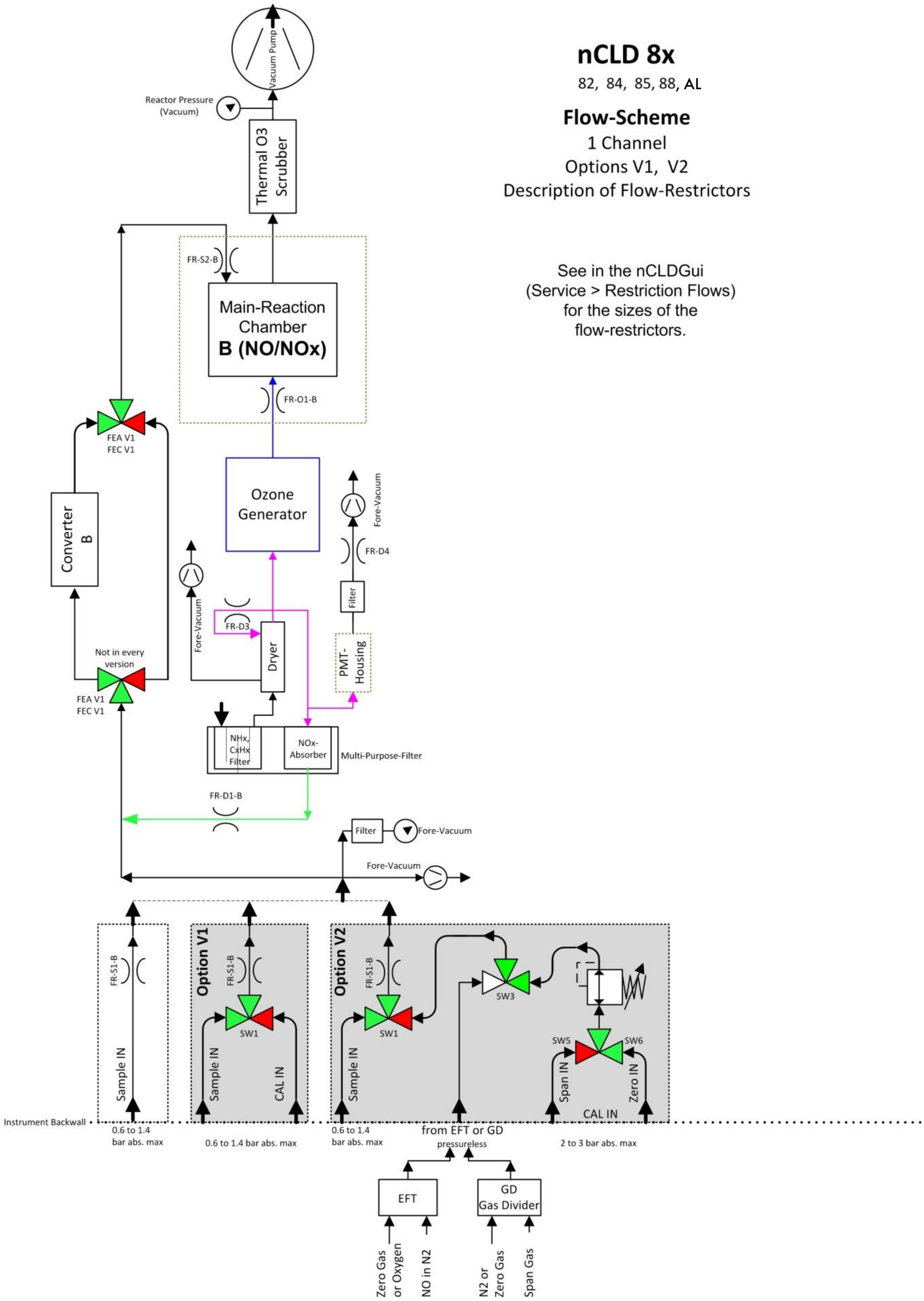

nCLD 66 Y
Flow-Scheme
1 Channel
Description of Flow-Restrictors
See in the nCLDGui
(Service > Restriction Flows)
for the sizes of the
flow-restrictors.
Thermal O3 Scrubber
Main-Reaction Chamber
B (NOx)
FR-O1-B
Ozone Generator
Converter B
FEA V1
FR-D3
Dryer
FR-D4
PMT-Housing
1
2
3
NHx, CxHx Filter
NOx-Filter
Kombi-Filter
Multi-Purpose-Filter
FR-D1-B
FR-S2-B
Instrument Backwall
Sample IN
0.6 to 1.4 bar abs. max
Exhaust to pump
ECI PHYSICS AG, HS 20.06.2017, 13.04.2018, Flow-Scheme-nCLD-66Y-en.vsd

Fig. 3.4a



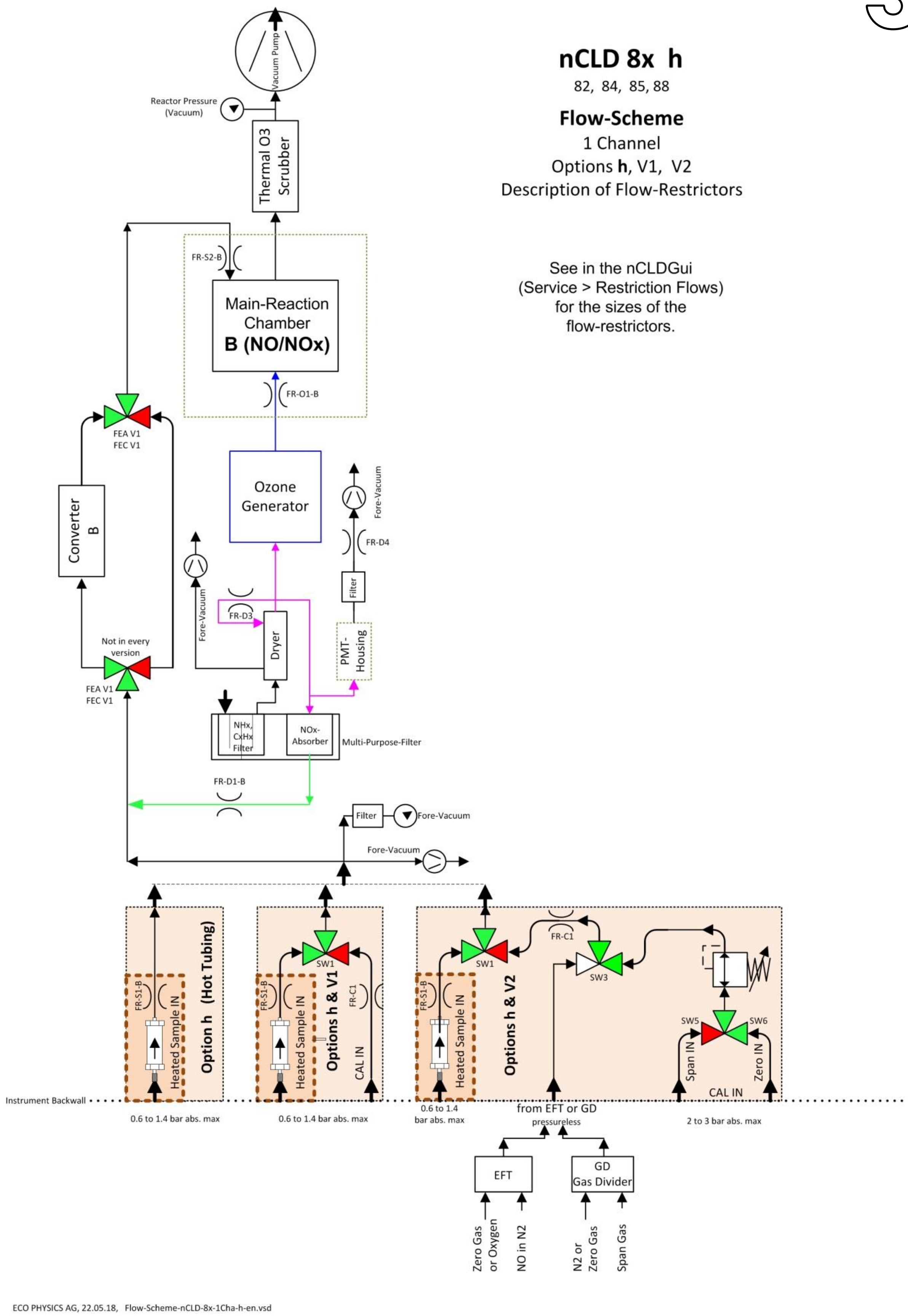
ECO PHYSICS AG, 12. 04. 18, Flow-Scheme-nCLD-8xx-Concept-en.vsd

Fig. 3.4b



ECO PHYSICS AG, 12.05.18, Flow-Scheme-nCLD-8x-1Cha-en.vsd

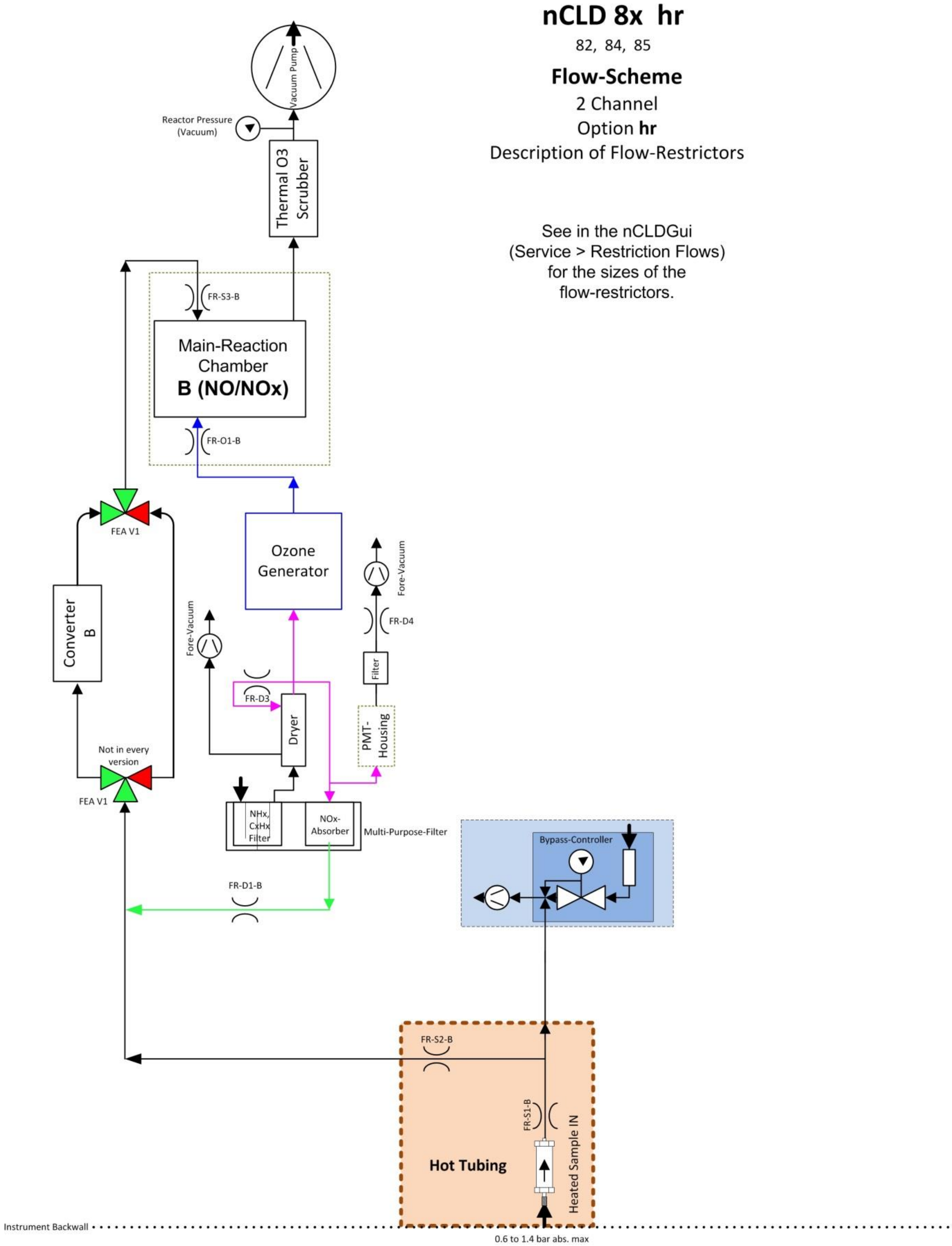
Fig. 3.4c



nCLD 8x h
82, 84, 85, 88
Flow-Scheme
1 Channel
Options h, V1, V2
Description of Flow-Restrictors
See in the nCLDGui
(Service > Restriction Flows)
for the sizes of the
flow-restrictors.
Vacuum Pump
Reactor Pressure (Vacuum)
Thermal O3 Scrubber
FR-S2-B
Main-Reaction Chamber
B (NO/NOx)
FR-O1-B
FEA V1
FEC V1
Converter B
Ozone Generator
Fore-Vacuum
FR-D4
Filter
FR-D3
Dryer
PMT-Housing
Not in every version
NHx, CxHx Filter
NOx-Absorber
Multi-Purpose-Filter
FR-D1-B
Fore-Vacuum
FR-S1-B
Heated Sample IN
Option h (Hot Tubing)
SW1
FR-C1
Options h & V1
CAL IN
SW3
SW5
SW6
Options h & V2
Span IN
Zero IN
Instrument Backwall
0.6 to 1.4 bar abs. max
0.6 to 1.4 bar abs. max
from EFT or GD
pressureless
2 to 3 bar abs. max
EFT
GD
Gas Divider
Zero Gas or Oxygen
NO in N2
N2 or Zero Gas
Span Gas
ECO PHYSICS AG, 22.05.18, Flow-Scheme-nCLD-8x-1Cha-h-en.vsd

Fig. 3.4d

3.2



ECO PHYSICS AG, 22.05.18, Flow-Scheme-nCLD-8x-1Cha-hr-en.vsd

3.2

Fig. 3.4e

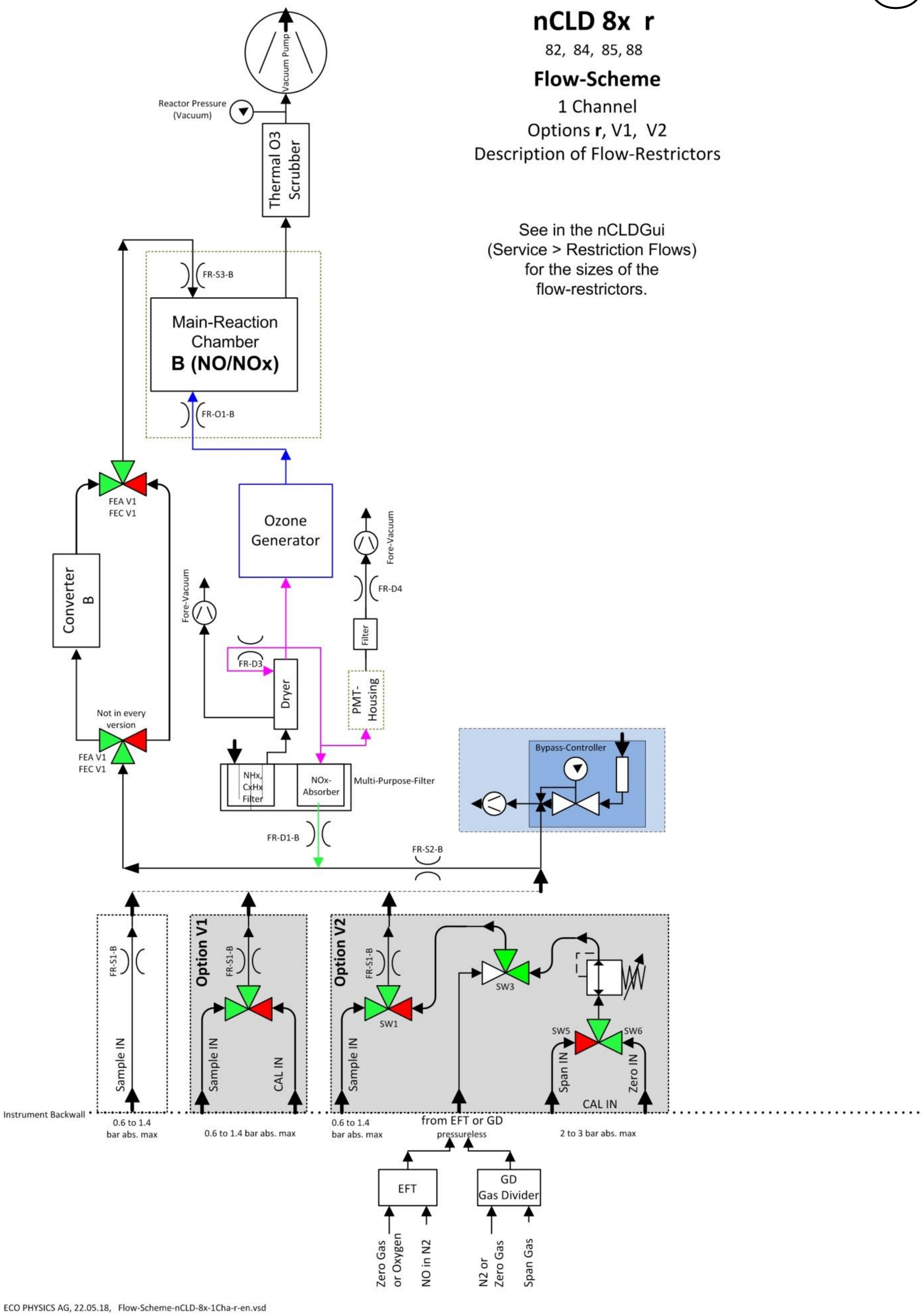
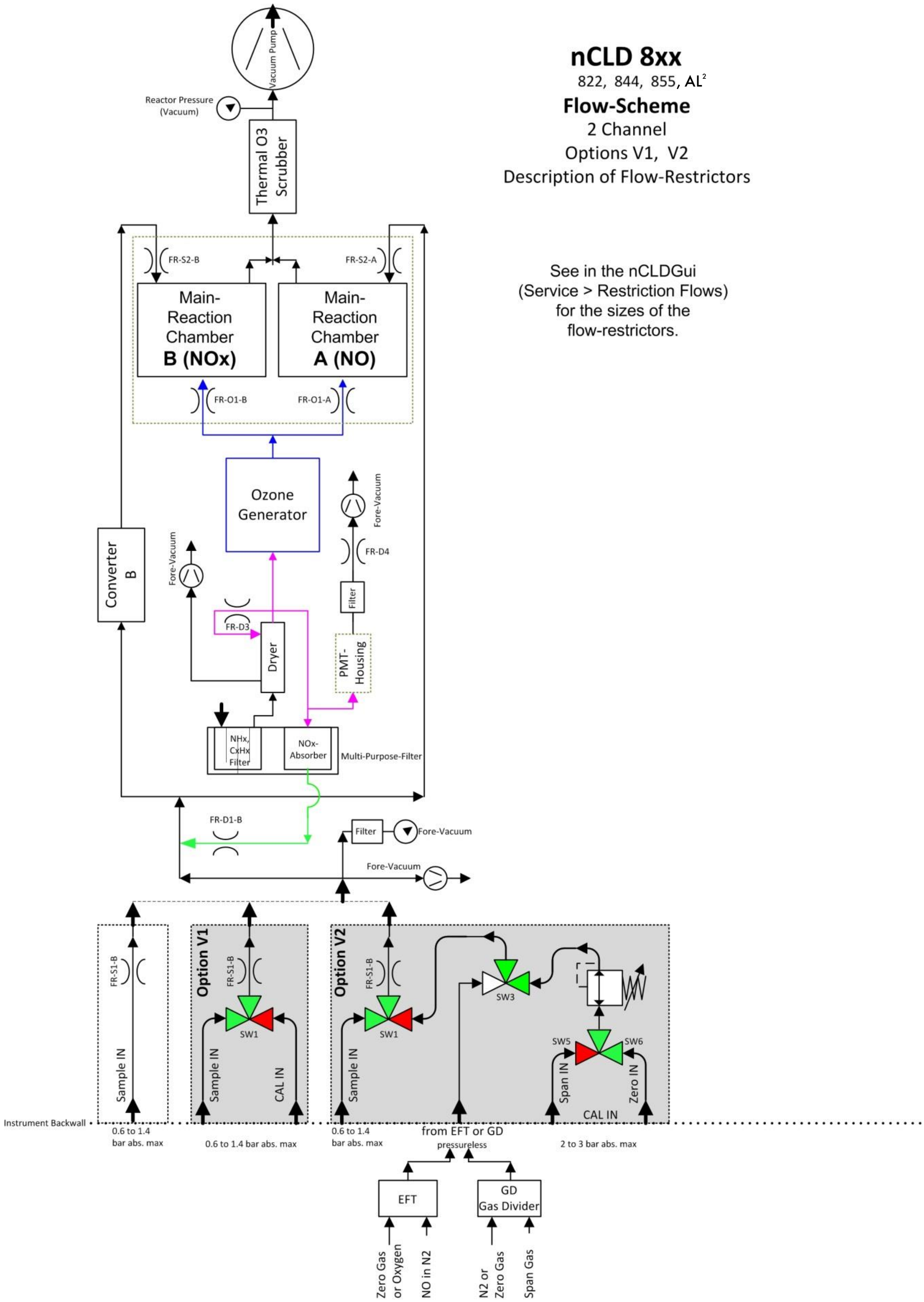
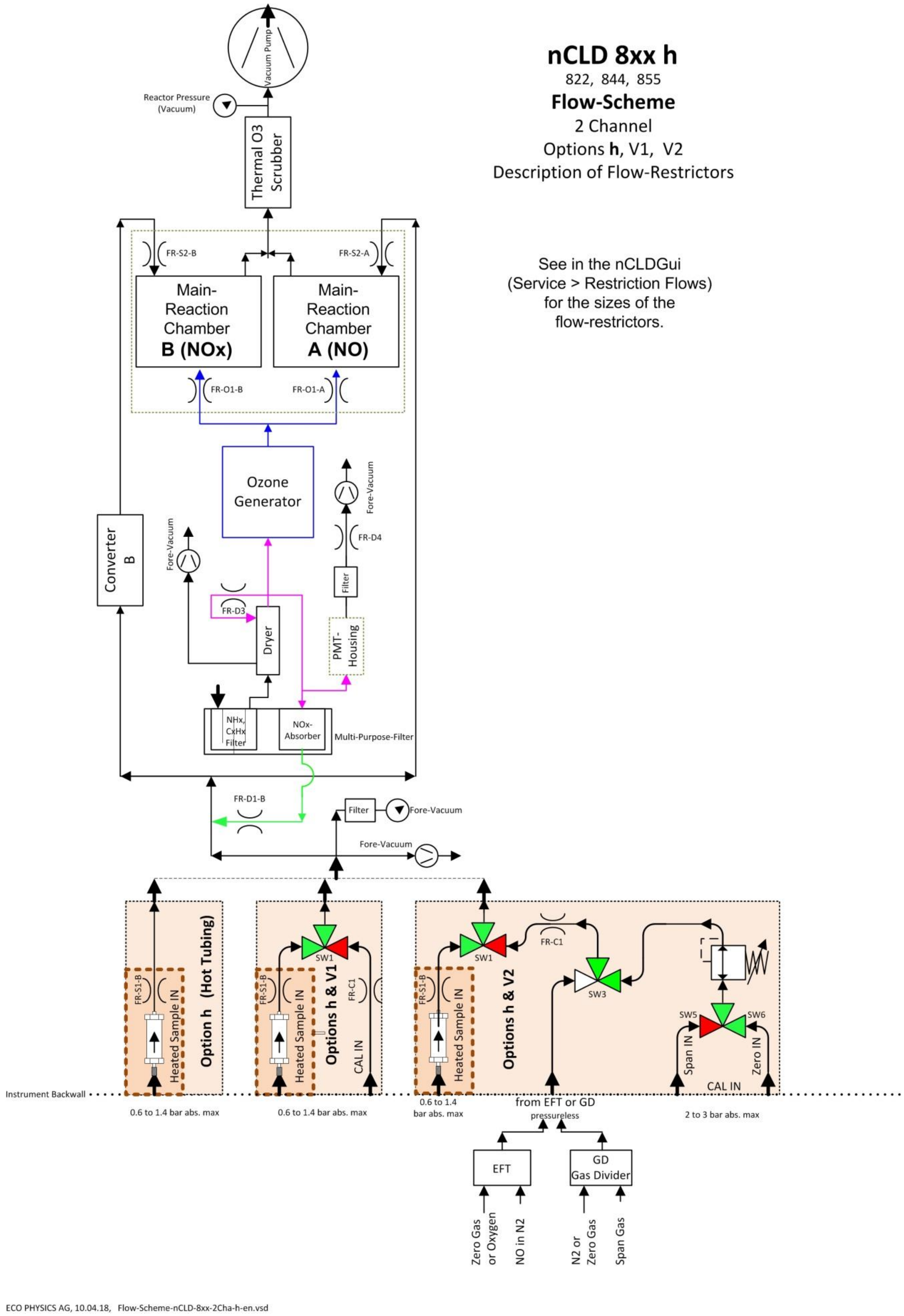

nCLD 8x r
82, 84, 85, 88
Flow-Scheme
1 Channel
Options r, V1, V2
Description of Flow-Restrictors
See in the nCLDGui
(Service > Restriction Flows)
for the sizes of the
flow-restrictors.
Vacuum Pump
Reactor Pressure (Vacuum)
Thermal O3 Scrubber
FR-S3-B
Main-Reaction Chamber
B (NO/NOx)
FR-O1-B
Ozone Generator
Fore-Vacuum
FR-D4
Filter
PMT-Housing
FR-D3
Dryer
Converter B
FEA V1
FEC V1
Not in every version
NHx, CxHx Filter
NOx-Absorber
Multi-Purpose-Filter
Bypass-Controller
FR-D1-B
FR-S2-B
FR-S1-B
Sample IN
Option V1
CAL IN
Option V2
SW1
SW3
SW5
SW6
Span IN
Zero IN
CAL IN
Instrument Backwall
0.6 to 1.4 bar abs. max
0.6 to 1.4 bar abs. max
0.6 to 1.4 bar abs. max
from EFT or GD pressureless
2 to 3 bar abs. max
EFT
GD Gas Divider
Zero Gas or Oxygen
NO in N2
N2 or Zero Gas
Span Gas
ECO PHYSICS AG, 22.05.18, Flow-Scheme-nCLD-8x-1Cha-r-en.vsd

Fig. 3.4f



ECO PHYSICS AG, 10.04.18, Flow-Scheme-nCLD-8xx-2Cha-en.vsd

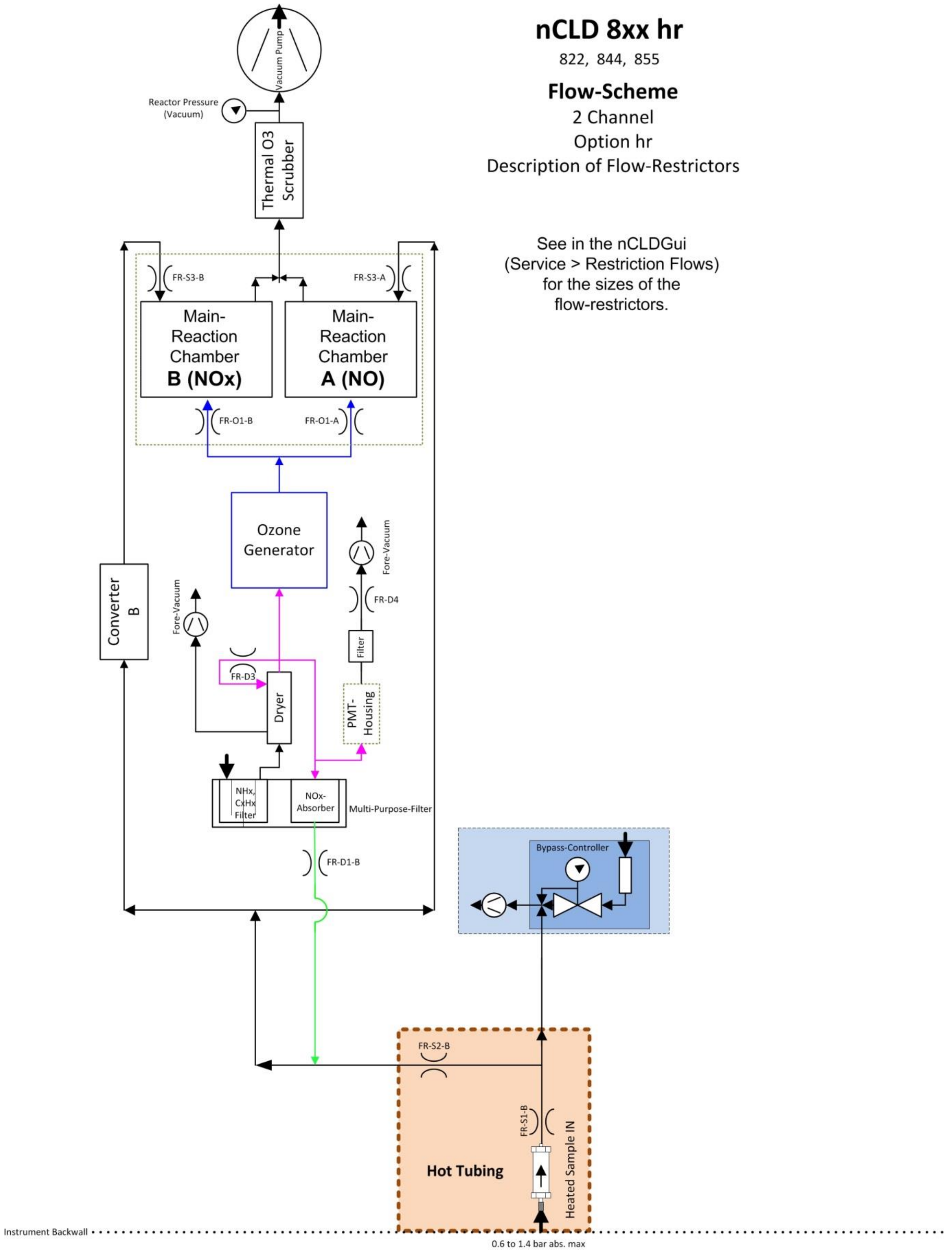
Fig. 3.4g



nCLD 8xx h
822, 844, 855
Flow-Scheme
2 Channel
Options h, V1, V2
Description of Flow-Restrictors
See in the nCLDGui
(Service > Restriction Flows)
for the sizes of the
flow-restrictors.
Vacuum Pump
Reactor Pressure (Vacuum)
Thermal O3 Scrubber
FR-S2-B
FR-S2-A
Main-Reaction Chamber B (NOx)
Main-Reaction Chamber A (NO)
FR-O1-B
FR-O1-A
Ozone Generator
Fore-Vacuum
FR-D4
Converter B
Fore-Vacuum
Filter
FR-D3
Dryer
PMT-Housing
NHx, CxHx Filter
NOx-Absorber
Multi-Purpose-Filter
FR-D1-B
Filter
Fore-Vacuum
Fore-Vacuum
Option h (Hot Tubing)
FR-S1-B
Heated Sample IN
SW1
Options h & V1
FR-C1
CAL IN
SW1
FR-C1
Options h & V2
SW3
SW5
SW6
Span IN
Zero IN
CAL IN
Instrument Backwall
0.6 to 1.4 bar abs. max
0.6 to 1.4 bar abs. max
0.6 to 1.4 bar abs. max
from EFT or GD pressureless
2 to 3 bar abs. max
EFT
GD Gas Divider
Zero Gas or Oxygen
NO in N2
N2 or Zero Gas
Span Gas
ECO PHYSICS AG, 10.04.18, Flow-Scheme-nCLD-8xx-2Cha-h-en.vsd

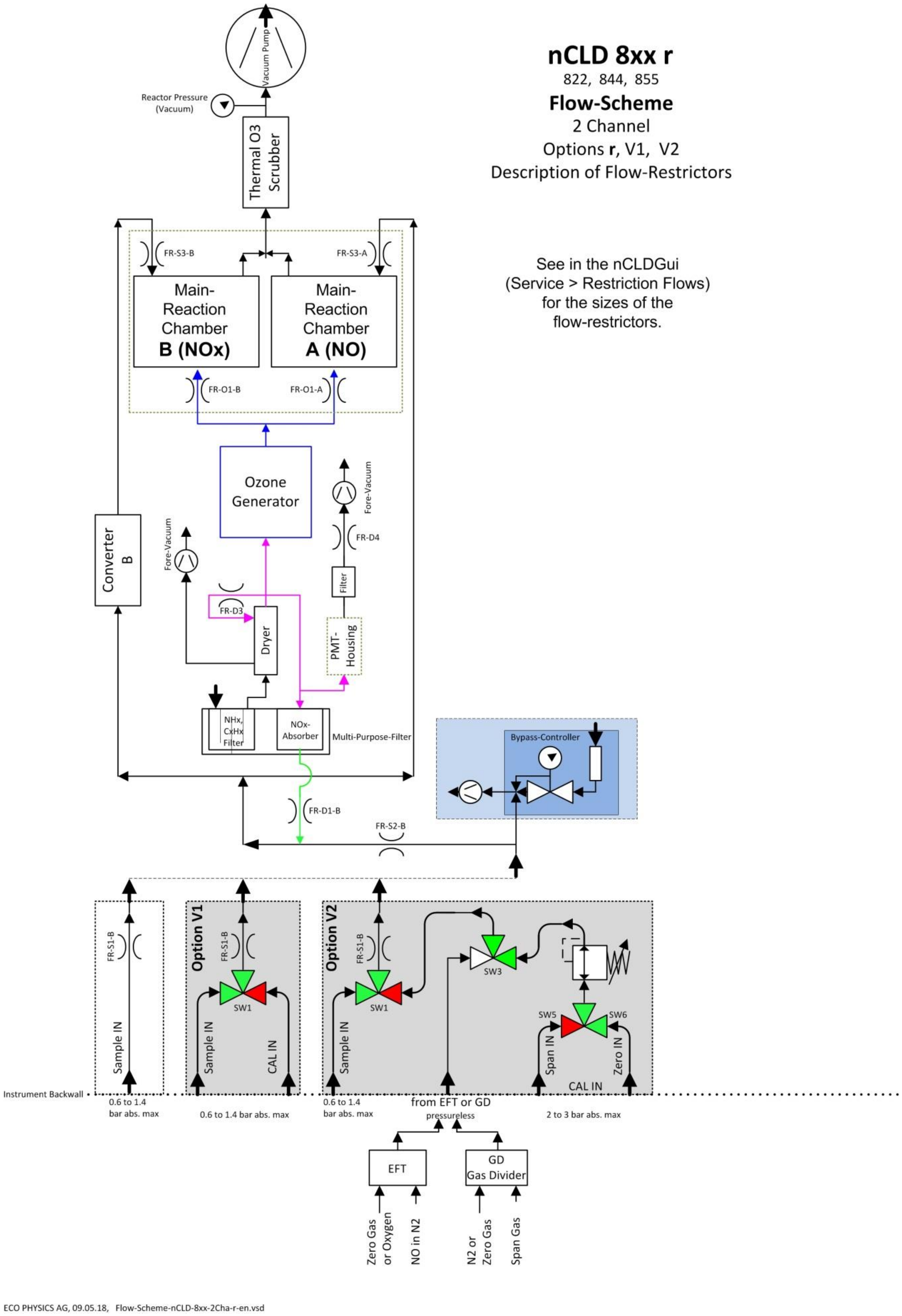
Fig. 3.4h

3.2



ECO PHYSICS AG, 10.04.18, Flow-Scheme-nCLD-8xx-2Cha-hr-en.vsd

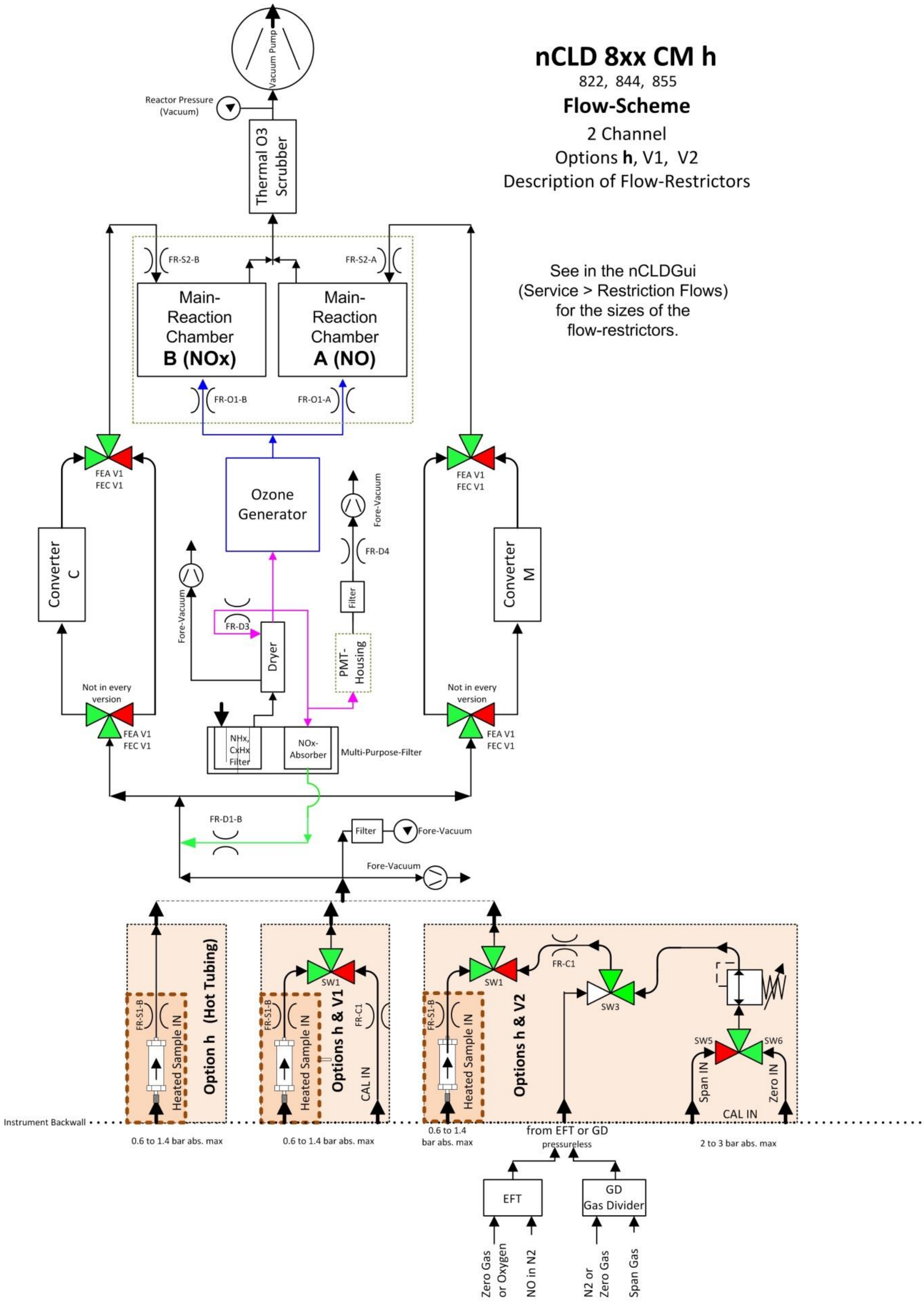
Fig. 3.4i



nCLD 8xx r
822, 844, 855
Flow-Scheme
2 Channel
Options r, V1, V2
Description of Flow-Restrictors
See in the nCLDGui
(Service > Restriction Flows)
for the sizes of the
flow-restrictors.
Vacuum Pump
Reactor Pressure
(Vacuum)
Thermal O3 Scrubber
FR-S3-B
FR-S3-A
Main-Reaction Chamber B (NOx)
Main-Reaction Chamber A (NO)
FR-O1-B
FR-O1-A
Ozone Generator
Fore-Vacuum
FR-D4
Filter
Converter B
Fore-Vacuum
FR-D3
Dryer
PMT-Housing
NHx, CxHx Filter
NOx-Absorber
Multi-Purpose-Filter
Bypass-Controller
FR-D1-B
FR-S2-B
FR-S1-B
Sample IN
Option V1
SW1
CAL IN
Option V2
SW3
SW5
SW6
Span IN
Zero IN
CAL IN
Instrument Backwall
0.6 to 1.4 bar abs. max
0.6 to 1.4 bar abs. max
0.6 to 1.4 bar abs. max
from EFT or GD
pressureless
2 to 3 bar abs. max
EFT
GD
Gas Divider
Zero Gas or Oxygen
NO in N2
N2 or Zero Gas
Span Gas
ECO PHYSICS AG, 09.05.18, Flow-Scheme-nCLD-8xx-2Cha-r-en.vsd

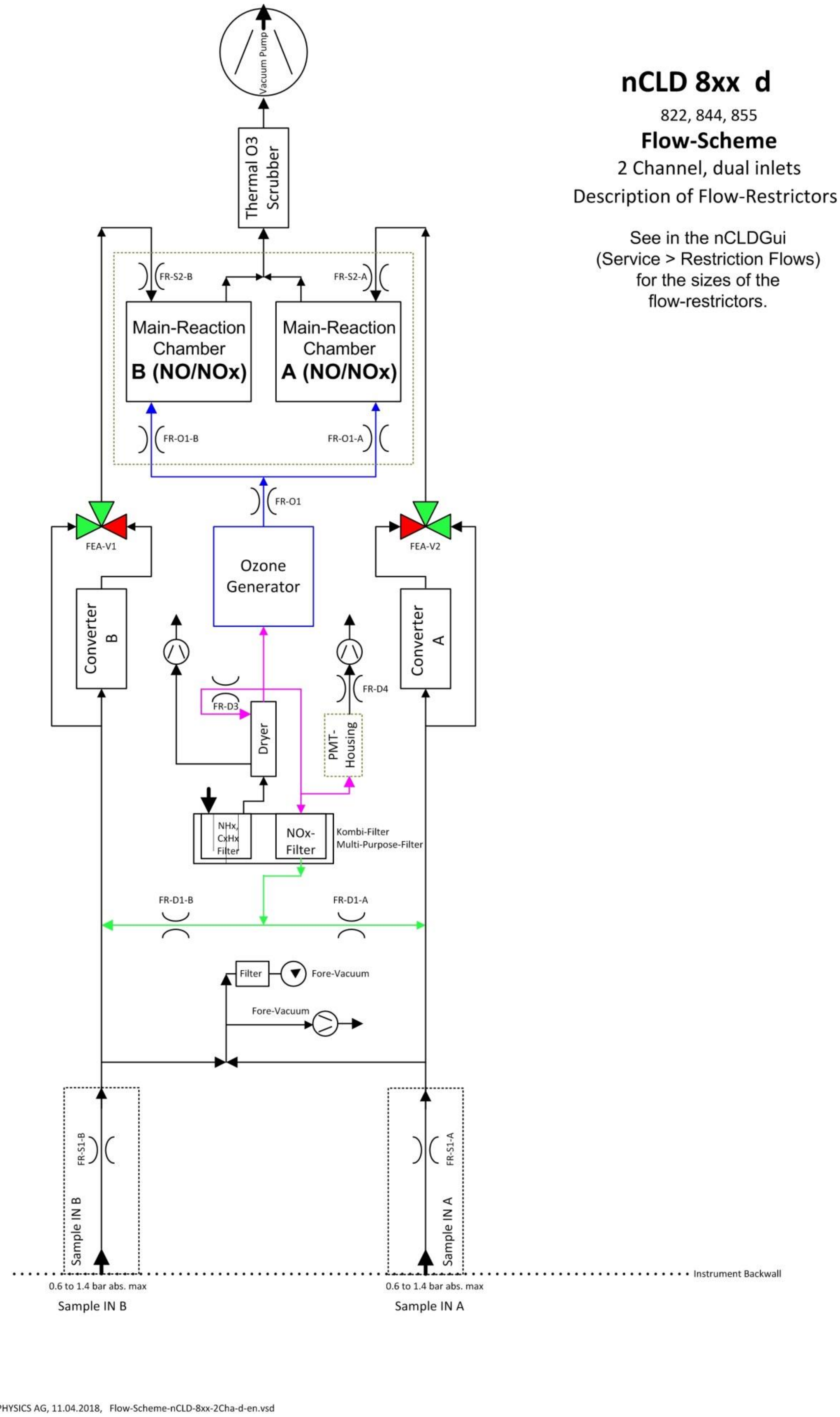
3.2

Fig. 3.4j



ECO PHYSICS AG, 10.04.18, Flow-Scheme-nCLD-8xx-2Cha-CMh-en.vsd

Fig. 3.4k



nCLD 8xx d
822, 844, 855
Flow-Scheme
2 Channel, dual inlets
Description of Flow-Restrictors
See in the nCLDGui
(Service > Restriction Flows)
for the sizes of the
flow-restrictors.
Vacuum Pump
Thermal O3 Scrubber
FR-S2-B
FR-S2-A
Main-Reaction Chamber B (NO/NOx)
Main-Reaction Chamber A (NO/NOx)
FR-O1-B
FR-O1-A
FR-O1
FEA-V1
FEA-V2
Ozone Generator
Converter B
Converter A
FR-D3
FR-D4
Dryer
PMT-Housing
NHx, CxHx Filter
NOx-Filter
Kombi-Filter
Multi-Purpose-Filter
FR-D1-B
FR-D1-A
Filter
Fore-Vacuum
Fore-Vacuum
FR-S1-B
FR-S1-A
Sample IN B
Sample IN A
Instrument Backwall
0.6 to 1.4 bar abs. max
Sample IN B
0.6 to 1.4 bar abs. max
Sample IN A
ECO PHYSICS AG, 11.04.2018, Flow-Scheme-nCLD-8xx-2Cha-d-en.vsd

3.2

Fig. 3.4 l

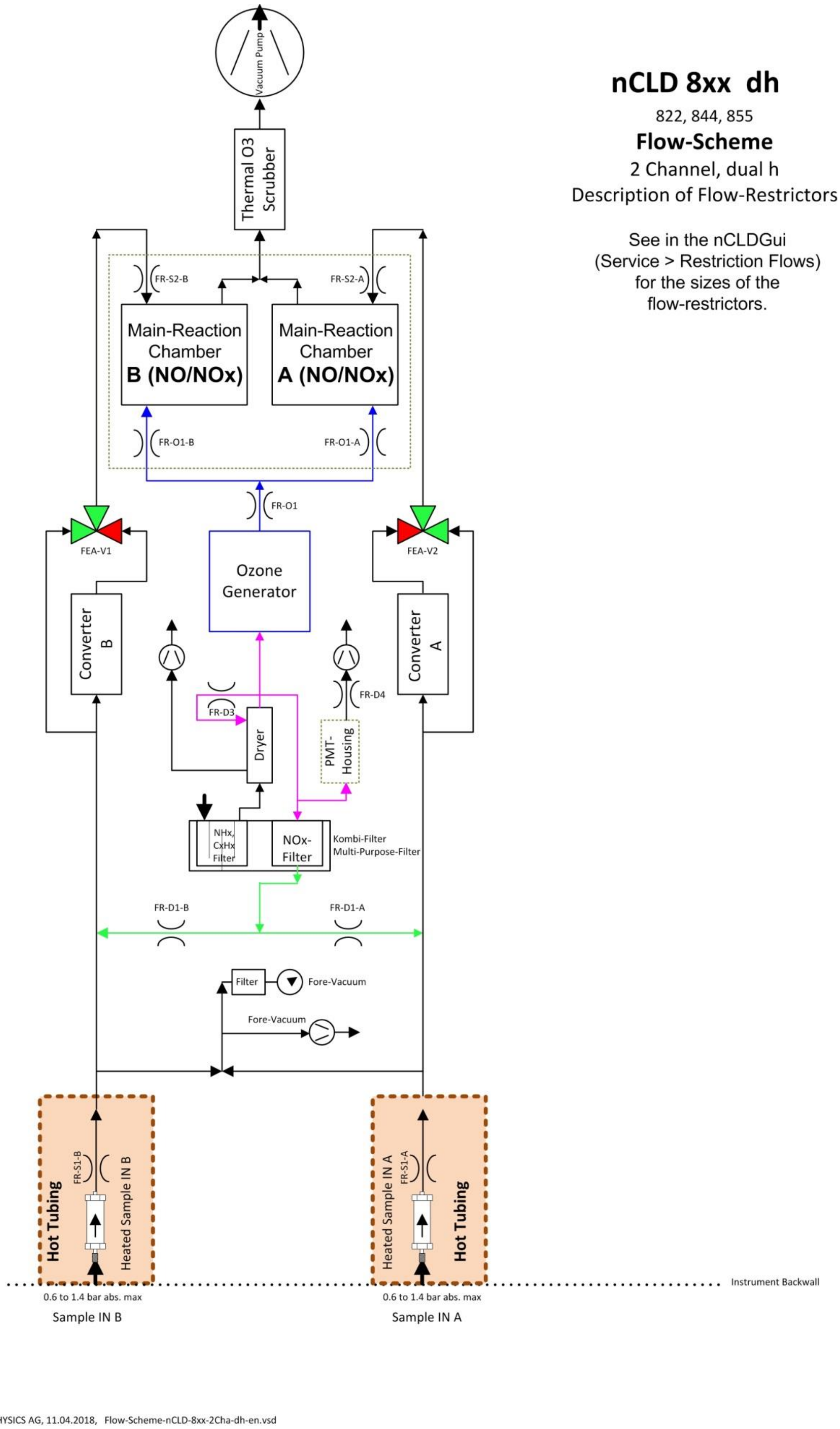
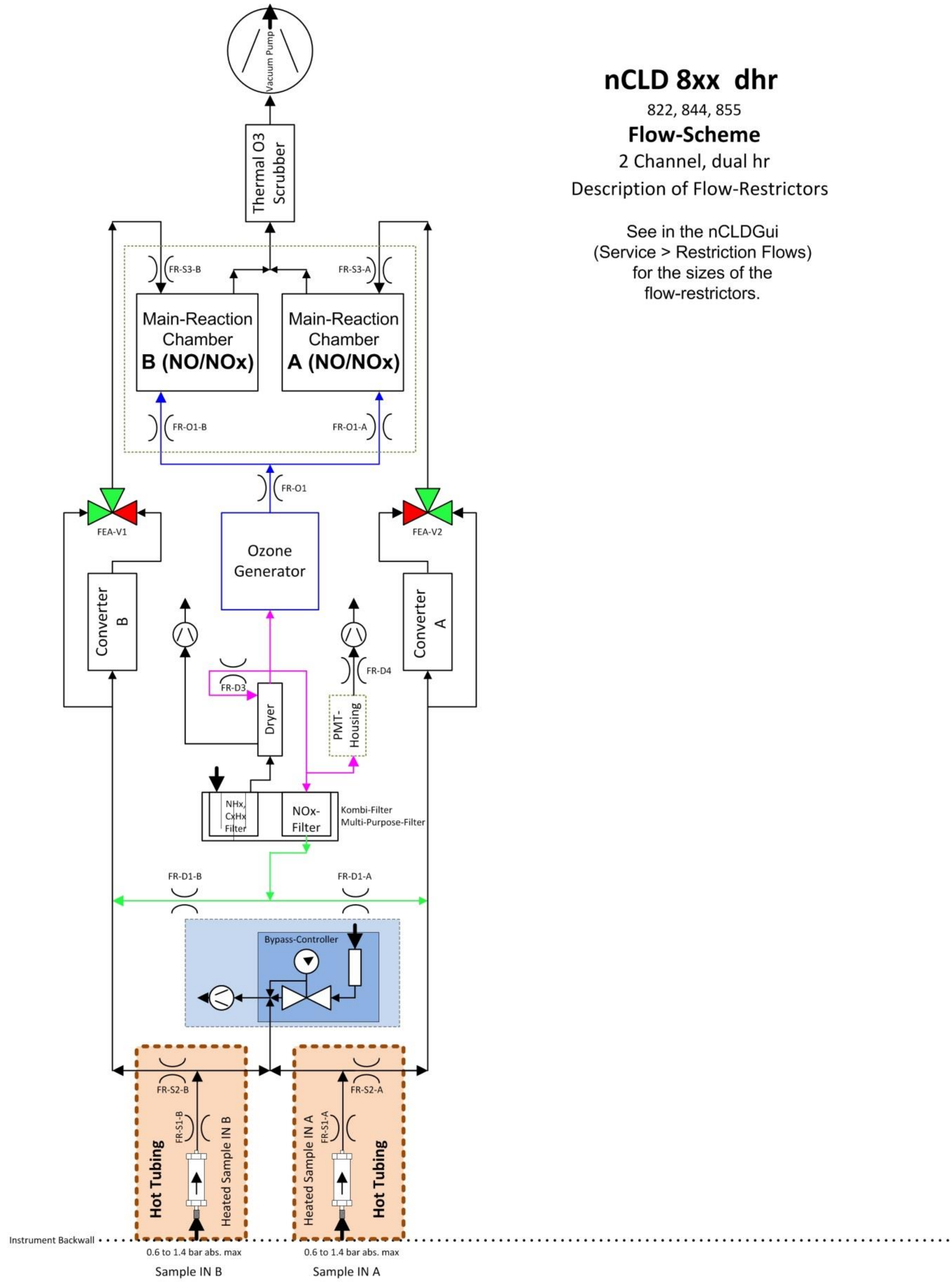

nCLD 8xx dh
822, 844, 855
Flow-Scheme
2 Channel, dual h
Description of Flow-Restrictors
See in the nCLDGui
(Service > Restriction Flows)
for the sizes of the
flow-restrictors.
Vacuum Pump
Thermal O3 Scrubber
FR-S2-B
FR-S2-A
Main-Reaction Chamber B (NO/NOx)
Main-Reaction Chamber A (NO/NOx)
FR-O1-B
FR-O1-A
FR-O1
FEA-V1
FEA-V2
Ozone Generator
Converter B
Converter A
FR-D3
FR-D4
Dryer
PMT-Housing
NHx, CxHx Filter
NOx-Filter
Kombi-Filter
Multi-Purpose-Filter
FR-D1-B
FR-D1-A
Filter
Fore-Vacuum
Fore-Vacuum
Hot Tubing
FR-S1-B
Heated Sample IN B
Heated Sample IN A
FR-S1-A
Hot Tubing
Instrument Backwall
0.6 to 1.4 bar abs. max
Sample IN B
0.6 to 1.4 bar abs. max
Sample IN A
ECO PHYSICS AG, 11.04.2018, Flow-Scheme-nCLD-8xx-2Cha-dh-en.vsd

Fig. 3.4m



nCLD 8xx dhr

822, 844, 855

Flow-Scheme

2 Channel, dual hr

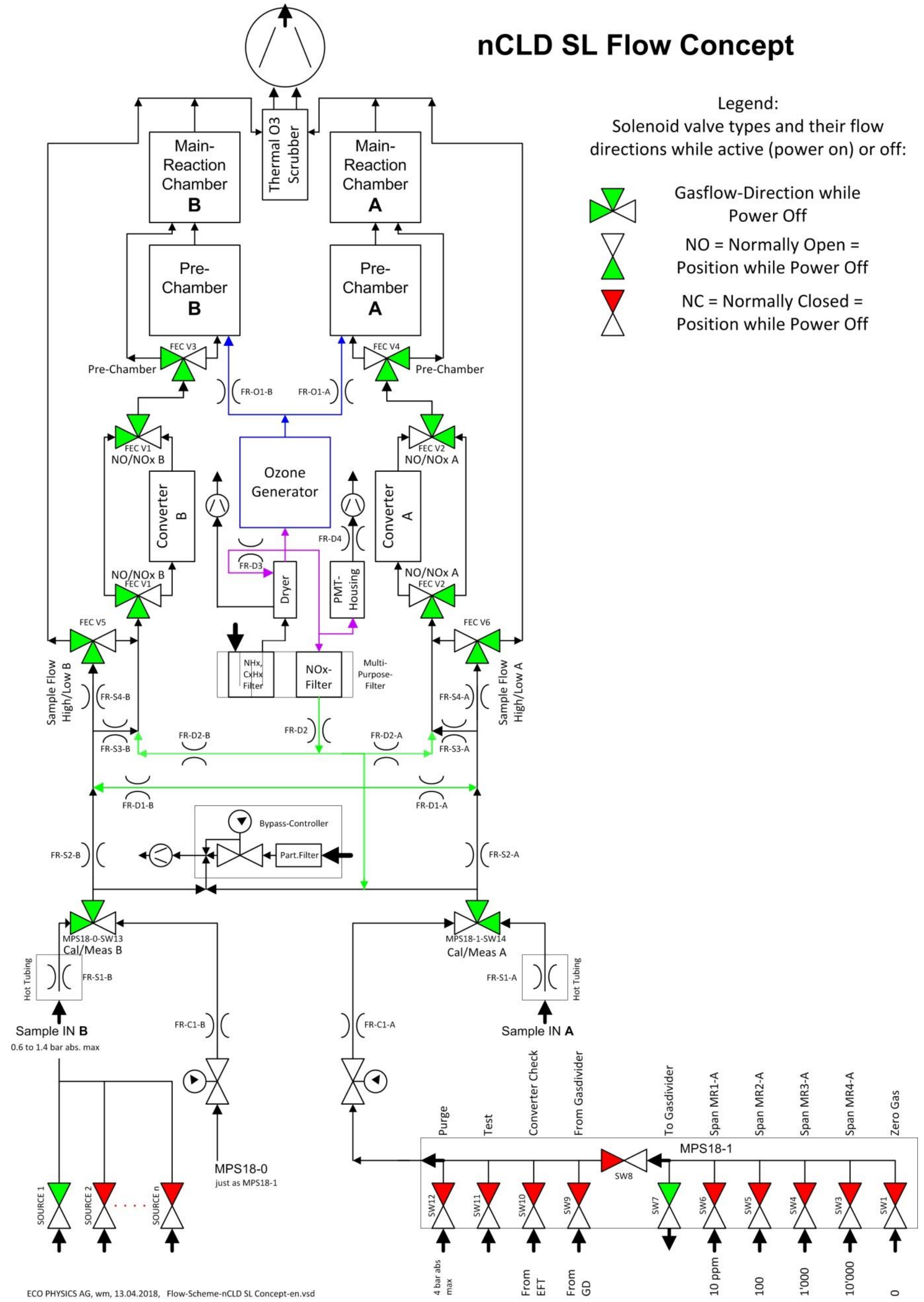
Description of Flow-Restrictors

See in the nCLDGui
(Service > Restriction Flows)
for the sizes of the
flow-restrictors.

ECO PHYSICS AG, 11.04.2018, Flow-Scheme-nCLD-8xx-2Cha-dhr-en.vsd

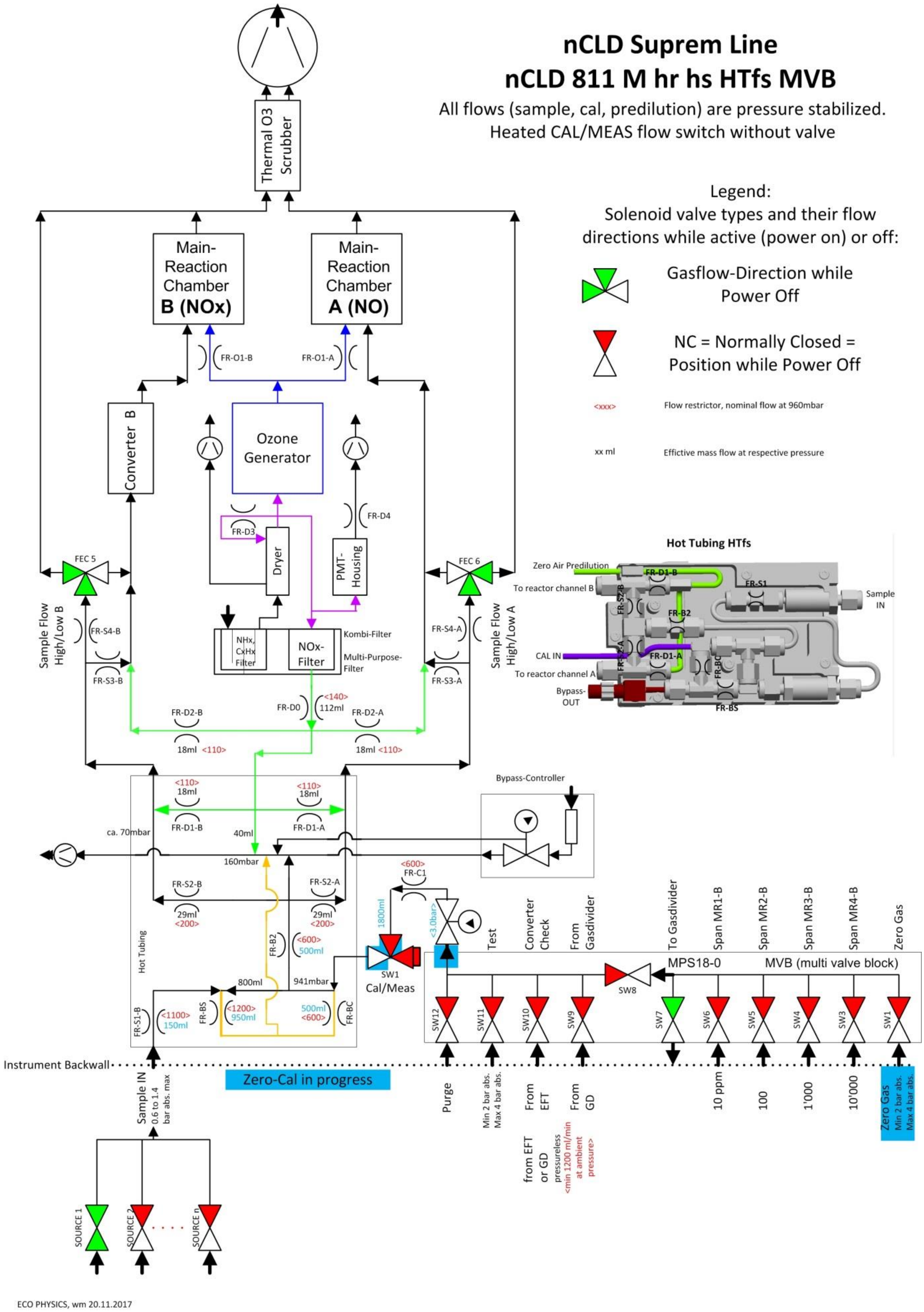
3.2

Fig. 3.5a


nCLD SL Flow Concept
Legend:
Solenoid valve types and their flow directions while active (power on) or off:
Gasflow-Direction while Power Off
NO = Normally Open = Position while Power Off
NC = Normally Closed = Position while Power Off
Main-Reaction Chamber B
Thermal O3 Scrubber
Main-Reaction Chamber A
Pre-Chamber B
Pre-Chamber A
FEC V3
FEC V4
Pre-Chamber
Pre-Chamber
FR-O1-B
FR-O1-A
FEC V1
NO/NOx B
FEC V2
NO/NOx A
Ozone Generator
Converter B
Converter A
FR-D4
FR-D3
Dryer
PMT-Housing
NO/NOx B
FEC V1
NO/NOx A
FEC V2
FEC V5
FEC V6
NHx, CxHx Filter
NOx-Filter
Multi-Purpose-Filter
Sample Flow High/Low B
Sample Flow High/Low A
FR-S4-B
FR-S4-A
FR-D2
FR-S3-B
FR-D2-B
FR-D2-A
FR-S3-A
FR-D1-B
FR-D1-A
Bypass-Controller
FR-S2-B
Part.Filter
FR-S2-A
MPS18-0-SW13
Cal/Meas B
MPS18-1-SW14
Cal/Meas A
Hot Tubing
FR-S1-B
FR-S1-A
Hot Tubing
Sample IN B
0.6 to 1.4 bar abs. max
Sample IN A
FR-C1-B
FR-C1-A
MPS18-0
just as MPS18-1
SOURCE 1
SOURCE 2
SOURCE n
Purge
Test
Converter Check
From Gasdivider
To Gasdivider
Span MR1-A
Span MR2-A
Span MR3-A
Span MR4-A
Zero Gas
MPS18-1
SW8
SW12
SW11
SW10
SW9
SW7
SW6
SW5
SW4
SW3
SW1
4 bar abs max
From EFT
From GD
10 ppm
100
1'000
10'000
0
ECO PHYSICS AG, wm, 13.04.2018, Flow-Scheme-nCLD SL Concept-en.vsd

3.2

Fig. 3.5b


nCLD Suprem Line
nCLD 811 M hr hs HTfs MVB
All flows (sample, cal, predilution) are pressure stabilized.
Heated CAL/MEAS flow switch without valve
Legend:
Solenoid valve types and their flow directions while active (power on) or off:
Gasflow-Direction while Power Off
NC = Normally Closed = Position while Power Off
<xxx> Flow restrictor, nominal flow at 960mbar
xx ml Effective mass flow at respective pressure
Thermal O3 Scrubber
Main-Reaction Chamber B (NOx)
Main-Reaction Chamber A (NO)
Ozone Generator
Converter B
Dryer
PMT-Housing
NOx-Filter
Kombi-Filter
Multi-Purpose-Filter
Hot Tubing HTfs
Zero Air Predilution
To reactor channel B
CAL IN
To reactor channel A
Bypass-OUT
Sample IN
Bypass-Controller
MPS18-0
MVB (multi valve block)
SW1 Cal/Meas
Instrument Backwall
Zero-Cal in progress
Sample IN 0.6 to 1.4 bar abs. max
Purge
Test
Converter Check
From Gasdivider
To Gasdivider
Span MR1-B
Span MR2-B
Span MR3-B
Span MR4-B
Zero Gas
10 ppm
100
1'000
10'000
from EFT or GD
ECO PHYSICS, wm 20.11.2017

3.2

Fig. 3.5c

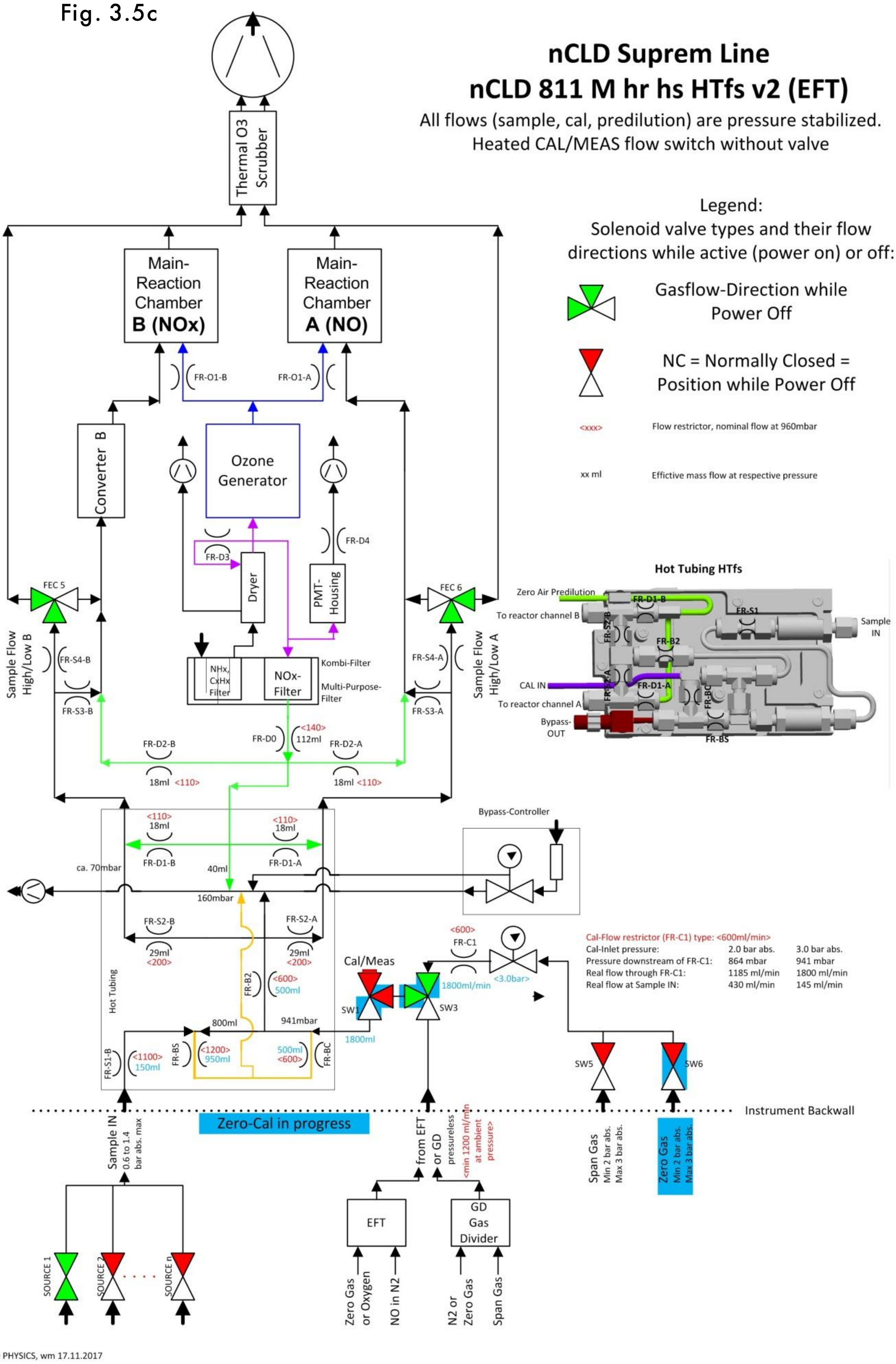
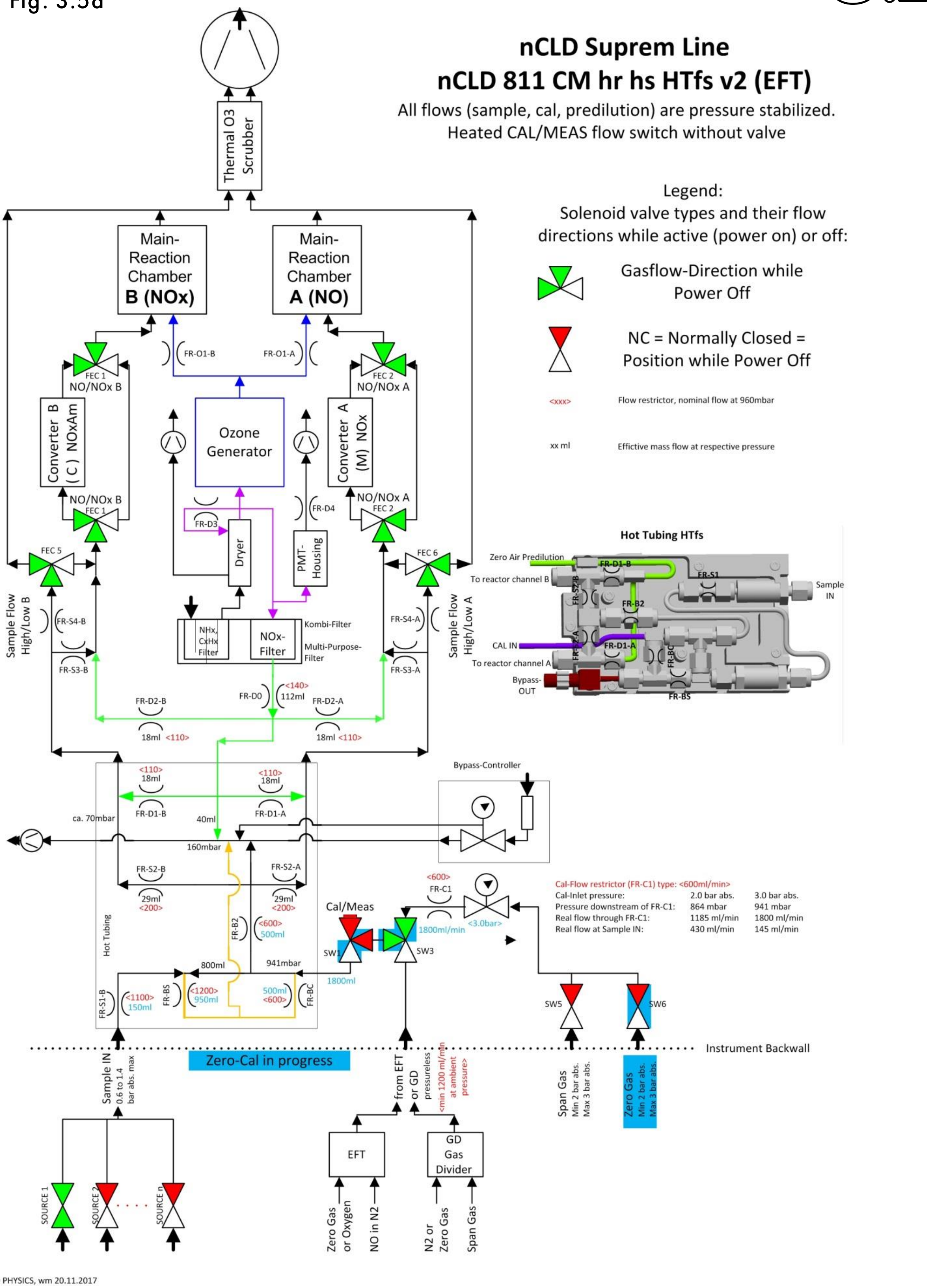
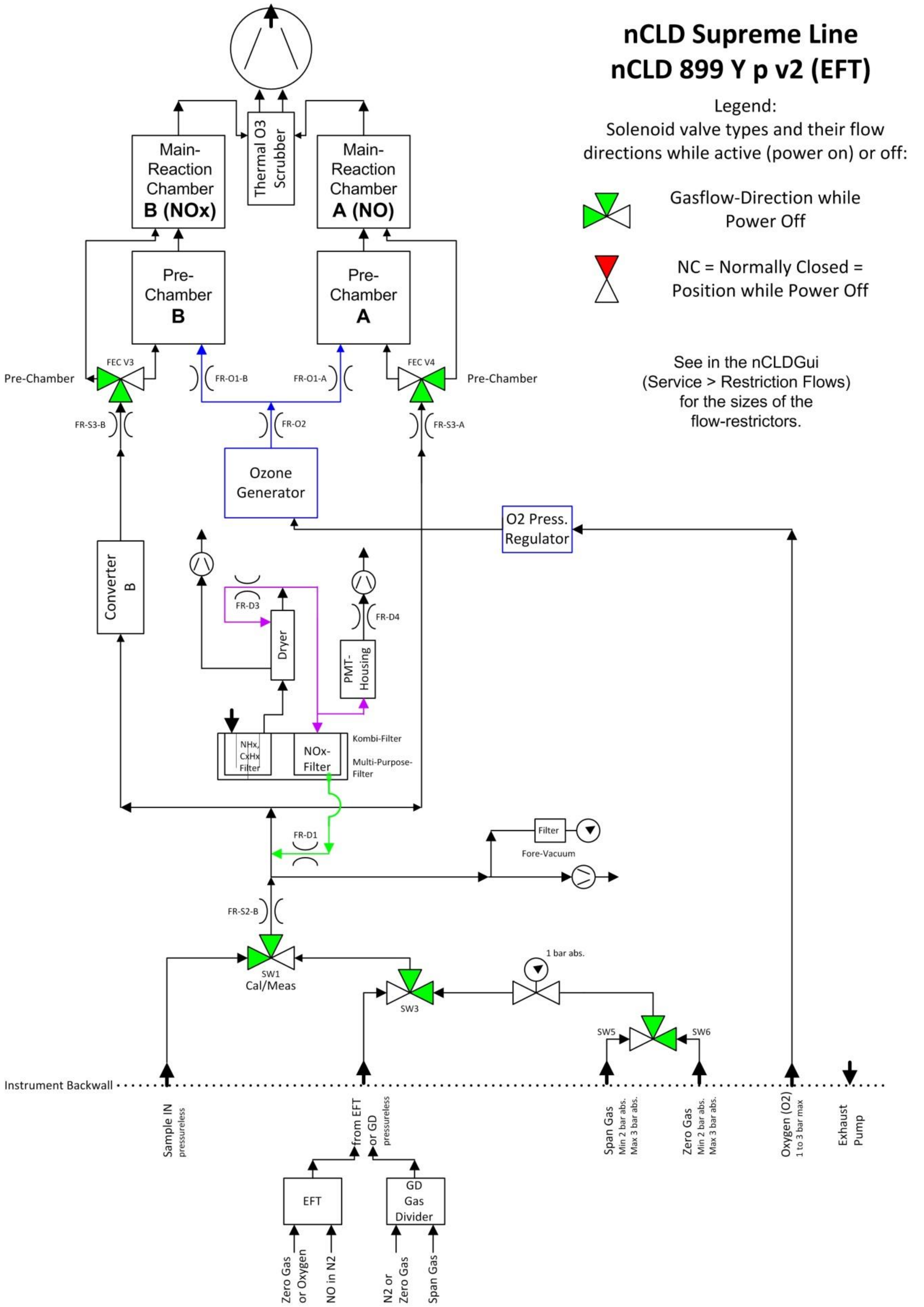

nCLD Suprem Line
nCLD 811 M hr hs HTfs v2 (EFT)
All flows (sample, cal, predilution) are pressure stabilized.
Heated CAL/MEAS flow switch without valve
Legend:
Solenoid valve types and their flow directions while active (power on) or off:
Gasflow-Direction while Power Off
NC = Normally Closed = Position while Power Off
<xxx> Flow restrictor, nominal flow at 960mbar
xx ml Effective mass flow at respective pressure
Thermal O3 Scrubber
Main-Reaction Chamber B (NOx)
Main-Reaction Chamber A (NO)
Converter B
Ozone Generator
Dryer
PMT-Housing
Kombi-Filter
Multi-Purpose-Filter
NHx, CxHx Filter
NOx-Filter
FEC 5
FEC 6
Sample Flow High/Low B
Sample Flow High/Low A
Hot Tubing HTfs
Zero Air Predilution
To reactor channel B
To reactor channel A
Sample IN
CAL IN
Bypass-OUT
Bypass-Controller
Hot Tubing
Cal/Meas
Cal-Flow restrictor (FR-C1) type: <600ml/min>
Cal-Inlet pressure: 2.0 bar abs. 3.0 bar abs.
Pressure downstream of FR-C1: 864 mbar 941 mbar
Real flow through FR-C1: 1185 ml/min 1800 ml/min
Real flow at Sample IN: 430 ml/min 145 ml/min
Instrument Backwall
Zero-Cal in progress
Sample IN 0.6 to 1.4 bar abs. max
from EFT or GD pressureless <min 1200 ml/min at ambient pressure>
Span Gas Min 2 bar abs. Max 3 bar abs.
Zero Gas Min 2 bar abs. Max 3 bar abs.
EFT
GD Gas Divider
Zero Gas or Oxygen
NO in N2
N2 or Zero Gas
Span Gas
SOURCE 1
SOURCE 2
SOURCE n
ECO PHYSICS, wm 17.11.2017

Fig. 3.5d


nCLD Suprem Line
nCLD 811 CM hr hs HTfs v2 (EFT)
All flows (sample, cal, predilution) are pressure stabilized.
Heated CAL/MEAS flow switch without valve
Legend:
Solenoid valve types and their flow directions while active (power on) or off:
Gasflow-Direction while Power Off
NC = Normally Closed = Position while Power Off
<xxx> Flow restrictor, nominal flow at 960mbar
xx ml Effictive mass flow at respective pressure
Thermal O3 Scrubber
Main-Reaction Chamber B (NOx)
Main-Reaction Chamber A (NO)
Ozone Generator
Converter B (C) NOxAm
Converter A (M) NOx
Dryer
PMT-Housing
Kombi-Filter
Multi-Purpose-Filter
NOx-Filter
Hot Tubing HTfs
Zero Air Predilution
To reactor channel B
To reactor channel A
CAL IN
Bypass-OUT
Sample IN
Bypass-Controller
Cal/Meas
Cal-Flow restrictor (FR-C1) type: <600ml/min>
Cal-Inlet pressure: 2.0 bar abs. 3.0 bar abs.
Pressure downstream of FR-C1: 864 mbar 941 mbar
Real flow through FR-C1: 1185 ml/min 1800 ml/min
Real flow at Sample IN: 430 ml/min 145 ml/min
Zero-Cal in progress
Instrument Backwall
Sample IN 0.6 to 1.4 bar abs. max
from EFT or GD pressureless <min 1200 ml/min at ambient pressure>
Span Gas Min 2 bar abs. Max 3 bar abs.
Zero Gas Min 2 bar abs. Max 3 bar abs.
EFT
GD Gas Divider
Zero Gas or Oxygen
NO in N2
N2 or Zero Gas
Span Gas
SOURCE 1
SOURCE 2
SOURCE n
ECO PHYSICS, wm 20.11.2017

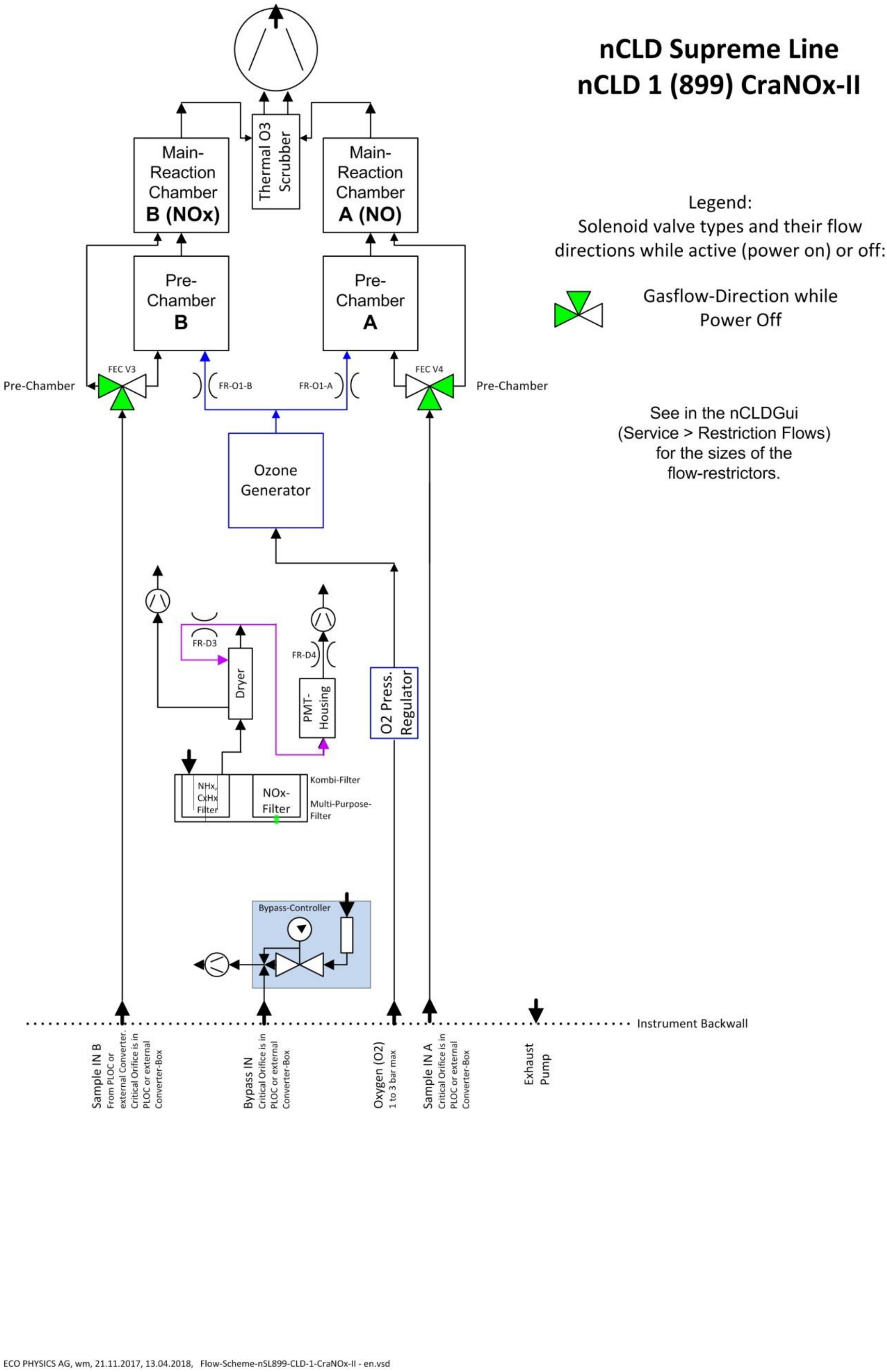
3.2

Fig. 3.5e



ECO PHYSICS AG, wm, 11.04.2018, Flow-Scheme-nSL899Yv2EFT-2018-04-11-en.vsd

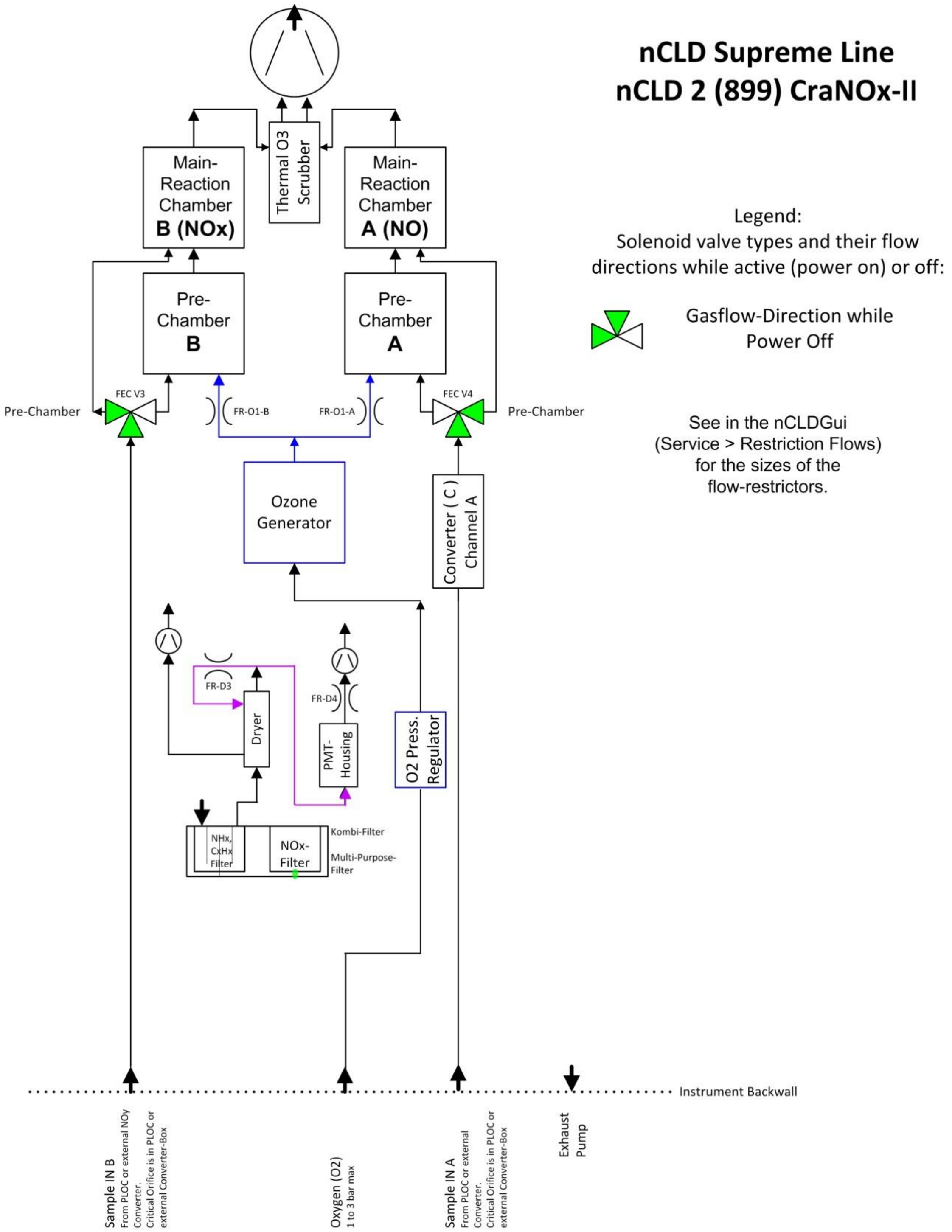
Fig. 3.5f



nCLD Supreme Line
nCLD 1 (899) CraNOx-II
Thermal O3 Scrubber
Main-Reaction Chamber B (NOx)
Main-Reaction Chamber A (NO)
Pre-Chamber B
Pre-Chamber A
Legend:
Solenoid valve types and their flow directions while active (power on) or off:
Gasflow-Direction while Power Off
Pre-Chamber
FEC V3
FR-O1-B
FR-O1-A
FEC V4
Pre-Chamber
See in the nCLDGui (Service > Restriction Flows) for the sizes of the flow-restrictors.
Ozone Generator
FR-D3
Dryer
FR-D4
PMT-Housing
O2 Press. Regulator
NHx, CxHx Filter
NOx-Filter
Kombi-Filter
Multi-Purpose-Filter
Bypass-Controller
Instrument Backwall
Sample IN B
From PLOC or external Converter. Critical Orifice is in PLOC or external Converter-Box
Bypass IN
Critical Orifice is in PLOC or external Converter-Box
Oxygen (O2)
1 to 3 bar max
Sample IN A
Critical Orifice is in PLOC or external Converter-Box
Exhaust Pump
ECO PHYSICS AG, wm, 21.11.2017, 13.04.2018, Flow-Scheme-nSL899-CLD-1-CraNOx-II - en.vsd

3.2

Fig. 3.5g



ECO PHYSICS AG, wm, 21.11.2017, 13.04.2018, Flow-Scheme-nSL899-CLD-2-CraNOx-II-en.vsd

4. INSTALLATION

Read the safety rules first
(Section 1.2)

4.1

4.1 Unpacking

Please check when unpacking that all the parts listed below are present and show no sign of transport damage.

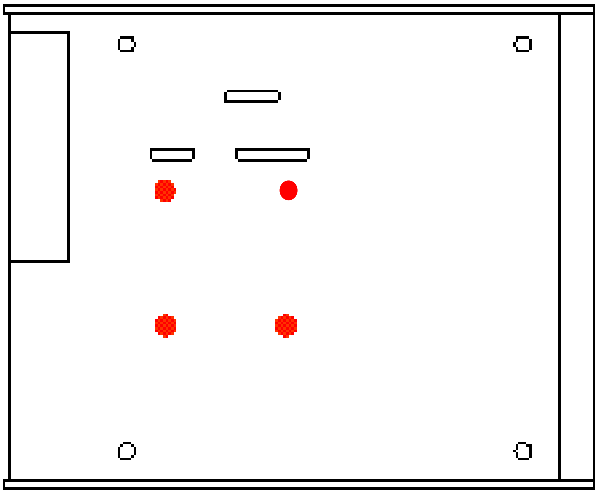
- 1 Analyser
- 1 Quick Guide
- 1 Analyser power cable
- 1 USB-to-LAN interface adapter
- 1 Interface cable USB to RS232 (USB Null-Modem FTDI for RS 232)
- 1 Micro-HDMI to HDMI adapter
- 1 x 1/4"and 1 x 1/8"Swagelok reserve
- as per analyser configuration 1 to 4 additional 1/8"reserves (Swagelok) for each actually used gas inlet
- for nCLD6x: - external power supply
  - external pump with connecting tubing
- Options as ordered together with analyser, e.g. USB analog box, etc.

Warning: Remove the four (red) screws at the bottom of the nCLD8xx or the two nails at the left side of the nCLD-SL before operating the analyser. See Fig 4.1 >>
No transport without tightened screws or nails!
NEVER do turn the analyser to the side or upside town.

4.1

Fig. 4.1

a) nCLD8xx: Position of the four transport screws at the bottom of the instrument.



b) nCLD-SL: Position of the two transport spikes (nails) at the left side of the analyser.

4.2

4.2 Installing the nCLD and its peripherals

4.2.1 Location

When selecting a location for the installation of the analyser, it is important to ensure that there is sufficient ventilation from the front panel to the analyser rear panel.

4.2.2 Fitting Instructions for Swagelok connectors

a) First time assembly:

1. Tubing must be passed through all three pieces of the Swagelok fitting as shown in Figure 4.1. Make sure the tube end is pushed home into the threaded counter-fitting. The nut (2) should now be threaded finger tight onto the counter-fitting.

2. a) For 1/4″ fittings the nut needs to be tightened a further 1 1/4 (= 5/4) turns.

   b) For 1/8″ fittings the nut needs only a further 3/4 turn from finger tight.

b) Re-assembling:

1. Tighten nut finger tight.
2. Make a further 1/4 turn max with a wrench to tighten (1/8″ size tube fittings only 1/8 turn).

4.2

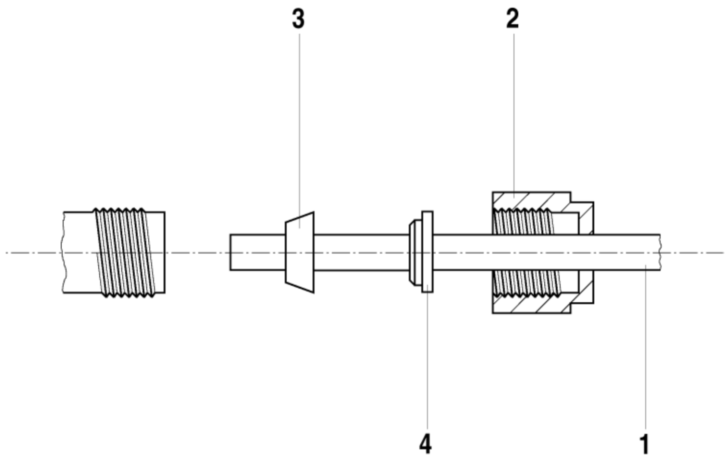


Fig. 4.2
"Swagelok tube fittings"

1 Tube
2 Nut
3 Front ferrule
4 Back ferrule

4.2

4.2.3 Installing the gas tubing between the nCLD and its peripherals

WARNING:
Vent the analyser exhaust outdoors using a tube of at least 6 mm inner diameter. Ensure that there is no counterpressure in the vent. If possible, have a low vacuum in the vent. Pressure variations inside the vent may affect measurement result.

4.2.3.1 Sample gas inlet

WARNING!

The analyser must NEVER be used without a 3–7 μ filter in the sample gas tubing – not even for a short duration using clean room air!

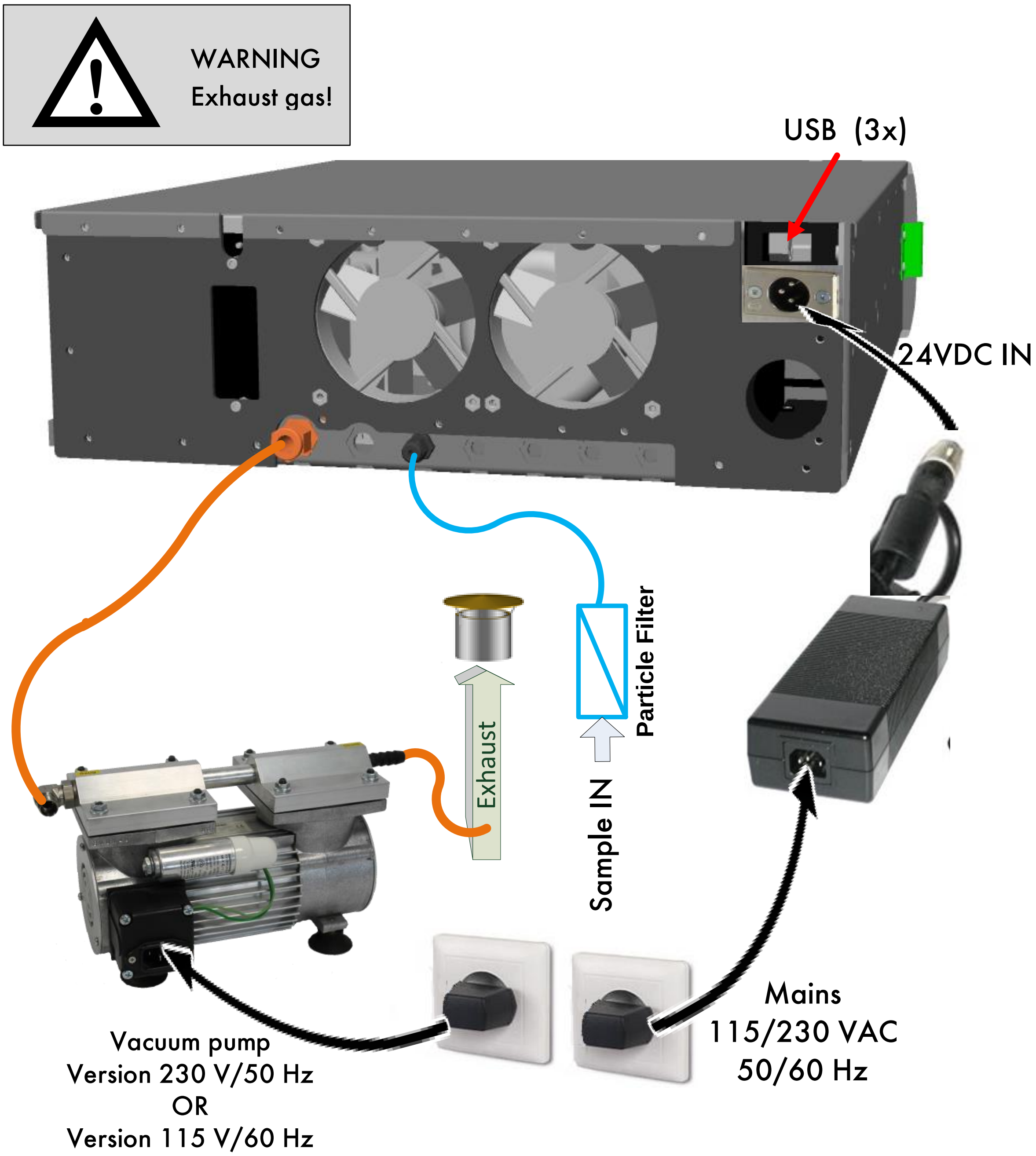
If explicitly nothing else is written or agreed a nCLD without the "Hot Tubing" option (h or hr) must never be used for hot wet gases without a front-end gas cooler or dilution system!

For any monitoring, it is of importance to completely avoid any condensation of water and hydrocarbons in the sampling line (see section 7.1). For exhaust measurements, a heated line (inner tubing of Teflon or stainless steel) must be used from the sampling point to the nCLD or to the sample gas conditioner. The sample line between the gas conditioner and the analyser should also be of Teflon or PFA and not be heated.

Warning: If the nCLD have not got calibration gas inlet valves (option v2) the zero and span gases must be supplied at the sample gas inlet using the same pressure level (± 3 mbar) than the sample gas in order to meet the specifications.

4.2

nCLD6x without any calibration gas inlet option



Do not apply pressure at the sample inlet – ambient pressure only!

4.2.3.2 Calibration gas supply

According to the analyser specific option the calibration gas connections can differ considerably. Without any further remarks, the allowed calibration gas input pressure is at maximum three bar absolute (30 PSIG). This is different than from analysers of the old CLD series (CLD8xx).

Option v1

If the analyser is equipped with this option, two separate inlets for sample gas and any kind of calibration gas are available. In this case the calibration gas inlet CAL works at ambient pressure only.

WARNING

Gas Cylinder

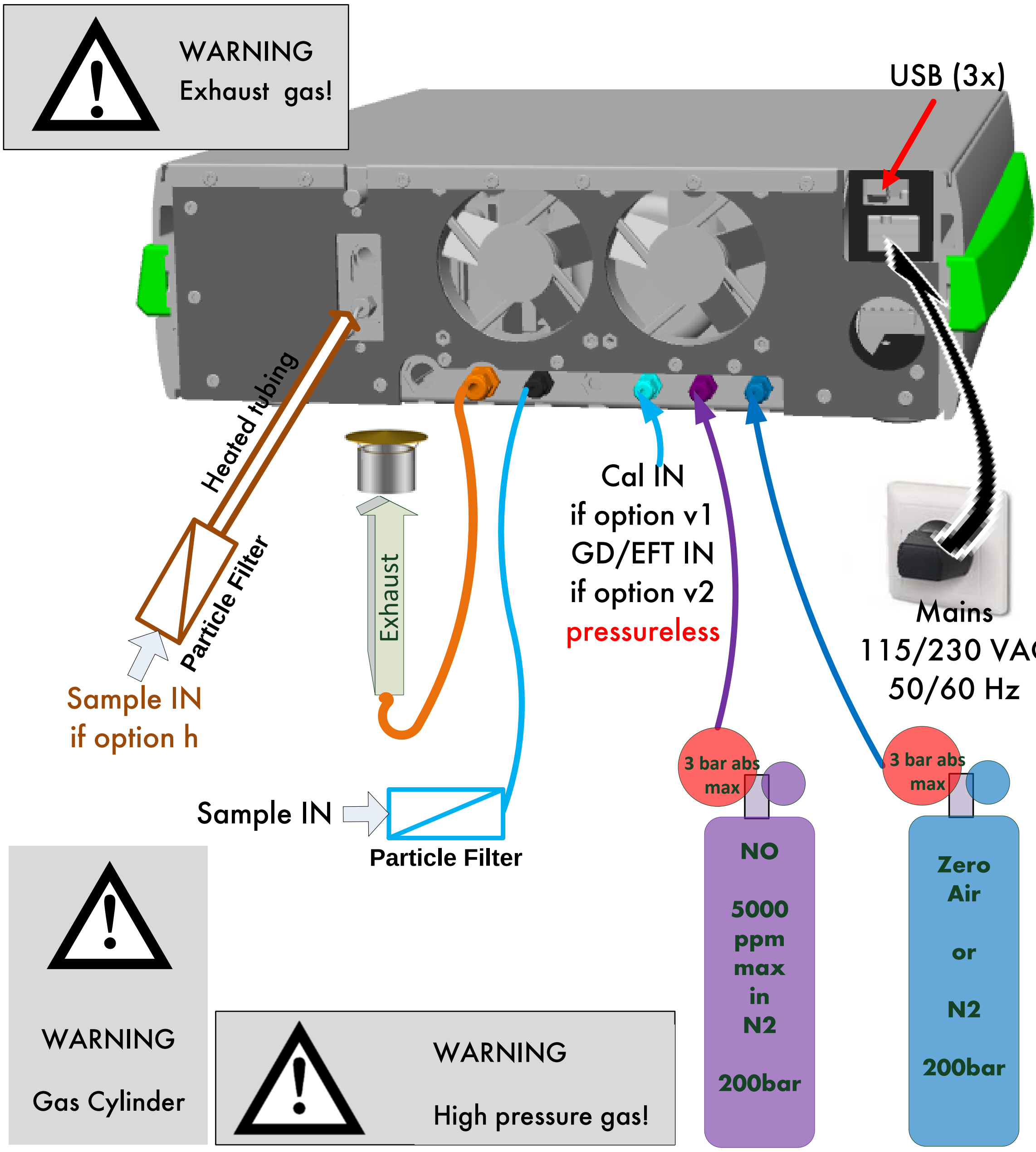
4.2

Option v2

If the analyser is equipped with this option, two separate pressurized inlets for zero and span calibration gas are available. The maximum allowed inlet pressure is 3 bar (30 PSIG) absolute. Use two stage pressure reduction valves at the calibration gas bottles. At the third inlet a gas divider (GD) or converter efficiency tester (EFT) can be connected. GD and EFT gas must be pressureless (ambient pressure).

Fig 4.3 Installation of the most important gases

Example nCLD822



Option v8

If the analyser is equipped with this option, separate span calibration gas inlets for each of the four measurement ranges and one zero gas inlet are available. The maximum allowed inlet pressure for these five inlets is 4 bar absolute. In addition, at least connections for a gas divider and a converter efficiency test unit are available which pressureless inlets!

See Fig 3.5b ………….. >>

4.3

4.3 Initial Startup

When all needed gas tubings are connected according to Fig 4.3 (>>) connect the mains power cable (Fig. 4.3) from the external power supply and external pump (for nCLD6x only) or direct from the analyser (for nCLD8xx and SL) with the home mains socket (230VAC 50Hz or 115VAC 60Hz).

The red steady LED lights at the upper right side of the analyser front (behind the ventilation grid) indicate that the analyser is electrically connected but not switched on. The display remains dark, the analyser is sleeping. If the analyser was not used for a long time (for weeks or months) or if it is the very first initial powering, keep the analyser electrically connected for at least 30 minutes before you switch it on. This helps to load the internal battery.

> *IMPORTANT*
>
> *For the first initial start-up do connect only the most important gas tubings, e.g. sample line and calibration gases. Do not already connect peripheral and optional instruments.*

Press 4 seconds the power button on the left front top and wait 15 seconds until the display shows the first startup screen.

Main Power Switch

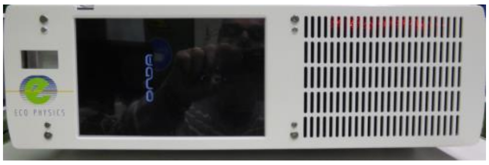
Steady red if plugged to home mains socket but instrument is not started.

Flash red light during power-up (PowerUP)

Steady green if ready to measure ("ready" or "measurement")

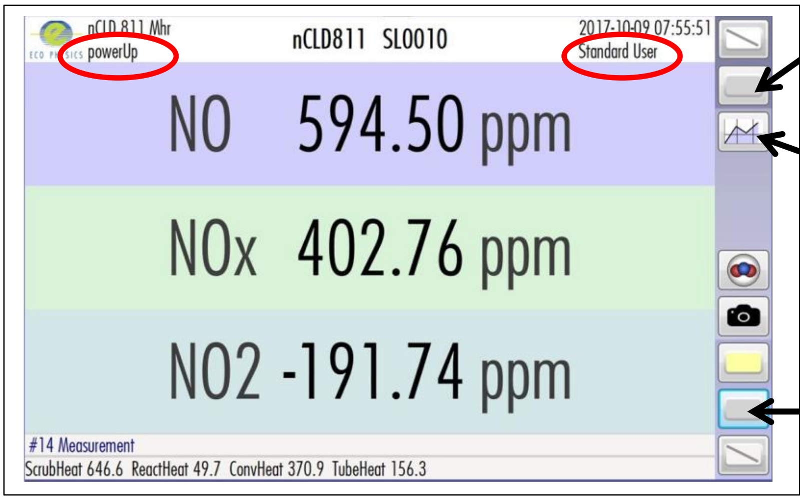
4.3

Several screens follow and indicate the start-up process.




Keep patient and do not touch the screen within the first 2 minutes until the main screen is displayed.

> NOTE:
>
> In case the instrument was off for a very long time and if - after the battery charging and the 4 seconds power button click - the display does not start up, press the power button down again for about 15 seconds, release it and wait.

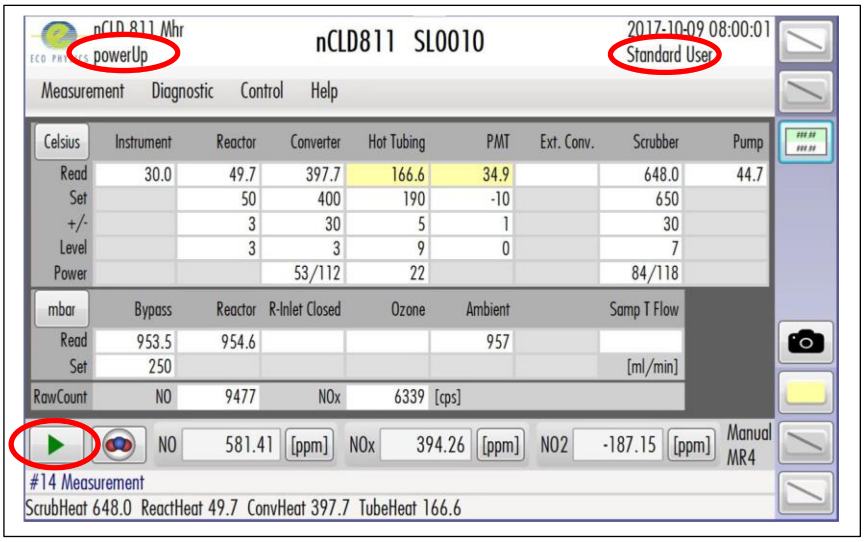


Click here in order to show the menu bar

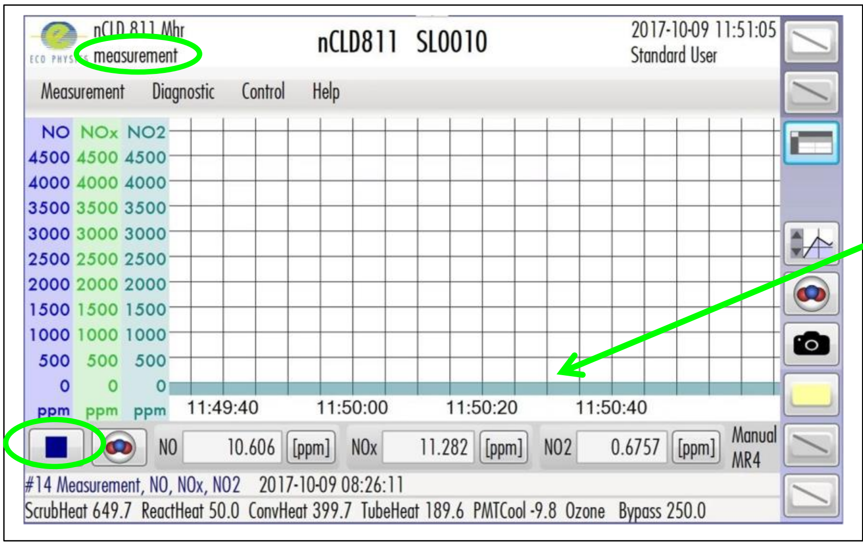
Click to show internal instrument operating parameters

Click to show the measurement value bar

4.3



The analyser powers always up as "Standard User". The "powerUp" phase is indicated in the upper left corner of the main window and lasts around 50 minutes. After that the analyser switches automatically to the "ready" state, begins to measure and shows the live graphical measurement values. The running measurement is indicated at the lower left corner by the square blue button and by "measurement" in the upper left corner of the display. Now the LED behind the ventilation grid is steady green.



Live measurement graph, moving from right to left

4.4

4.4 Installing additional peripheral auxiliary equipment

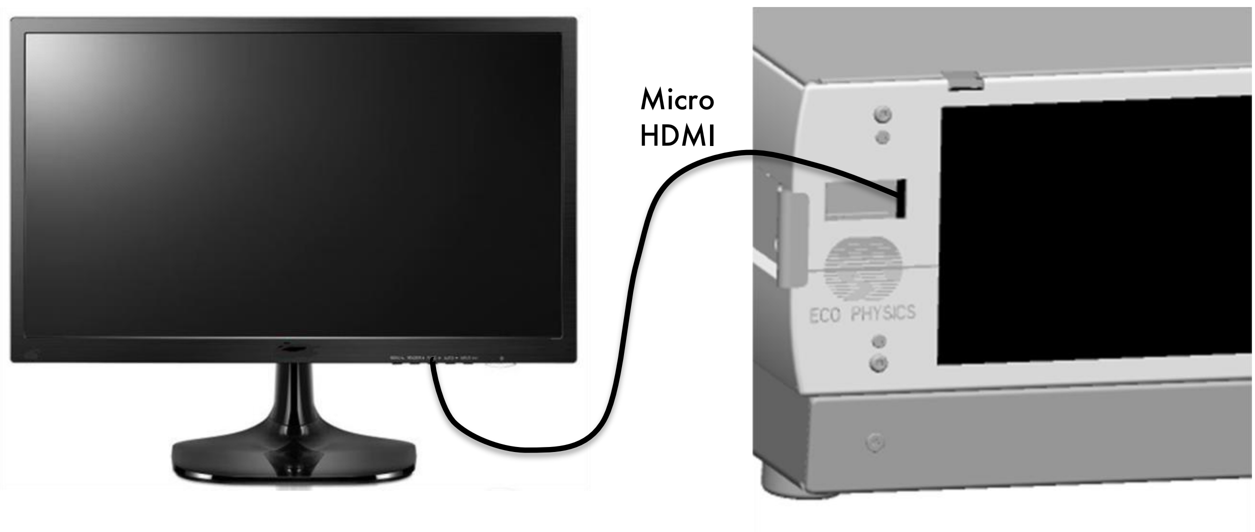
As required the followed auxiliary equipment can be installed:

- external monitor. The micro HDMI-socket is at the left side of the screen in a small bay. Use the short Micro-HDMI to HDMI adapter.
- wired network connection by Ethernet LAN cable. Use the white USB-to-LAN adapter
- WiFi wireless network
- external keyboard (Bluetooth) and mouse (Bluetooth)
- remote control PC by RS232. Use the Null-Modem-USB cable (FTDI USB)
- several I/O USB-boxes for e.g. analog output signal, digital input/outputs, relais power switches etc.

See Fig 4.4.2 ...... >>

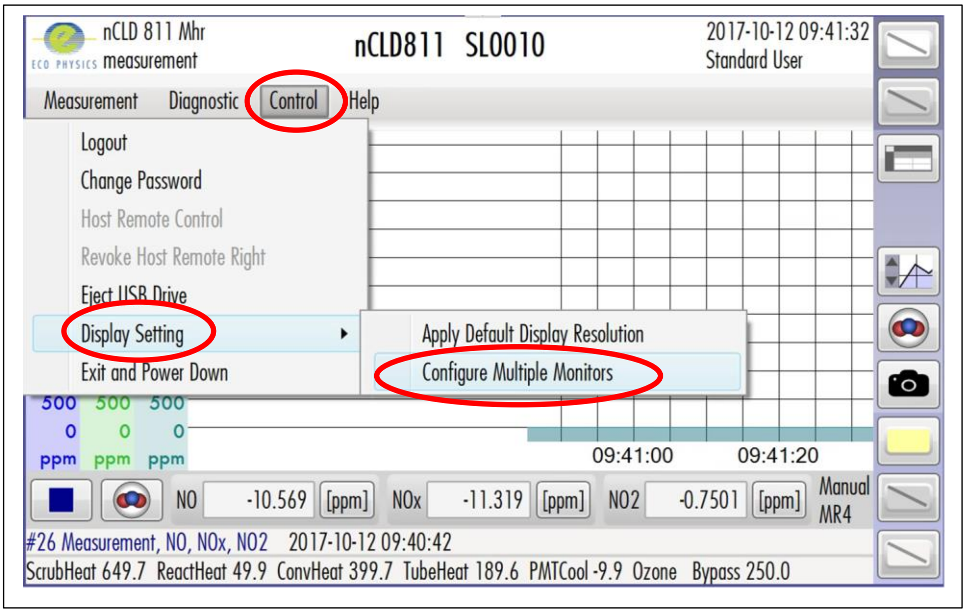
4.4.1 How to connect an external monitor

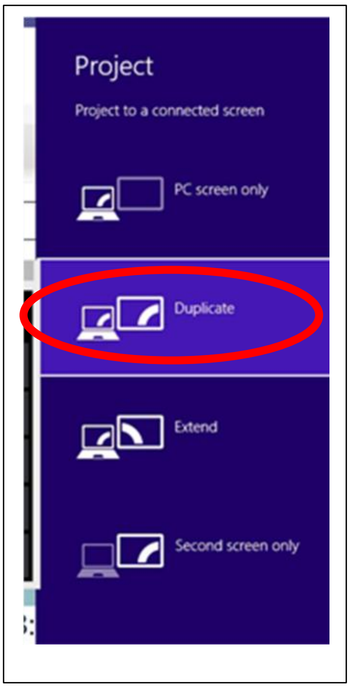
Fig. 4.4.1



4.4

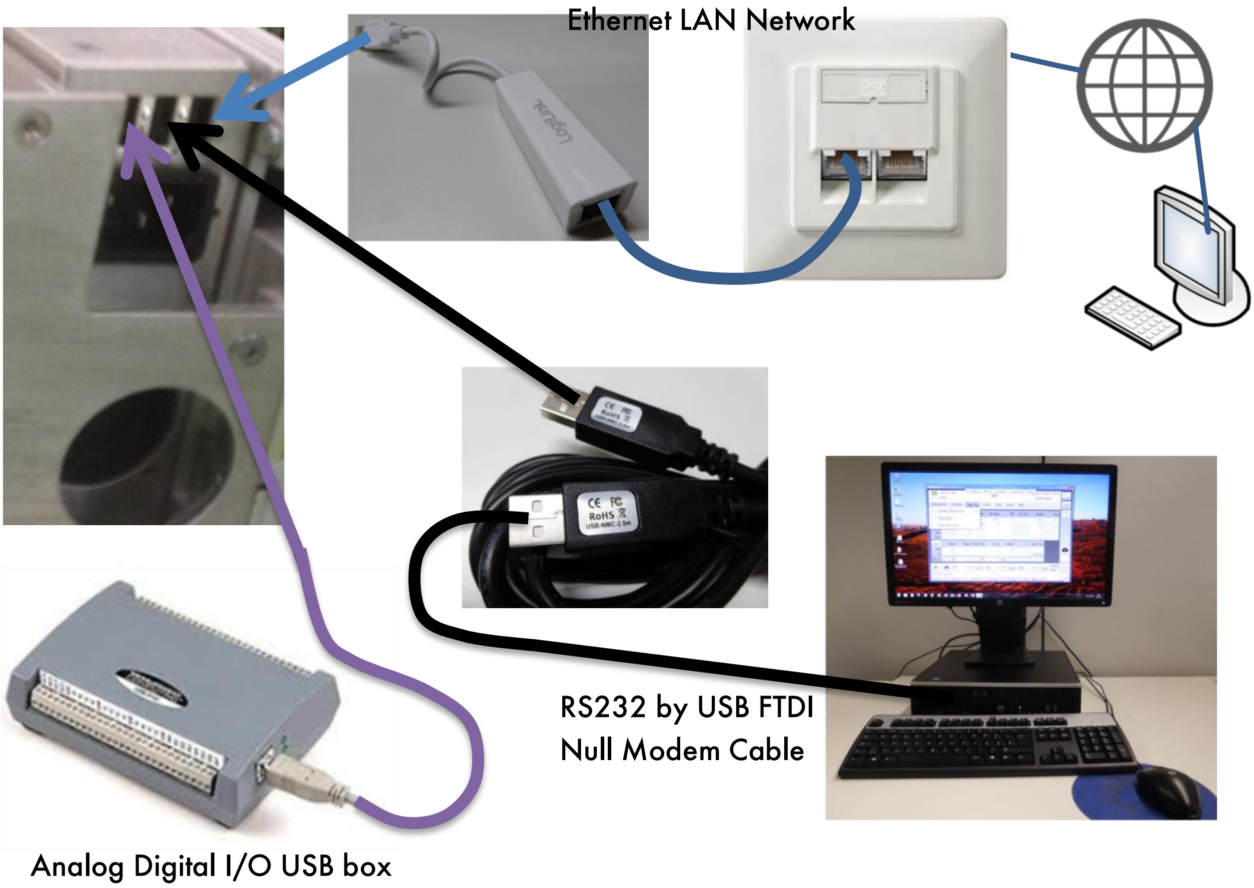
In order to connect an external monitor a HDMI compatible monitor is needed. Connect the micro HDMI plug of the delivered micro-HDMI-to-HDMI adapter into the socket at the small bay at the left side of the analyser display and use a standard HDMI cable from the adapter to the monitor socket. The drivers are already pre-installed at the analyser. Switch the monitor manually to the HDMI source input if the monitor is not equipped with an automatic source detection (see in the operating manual of the external monitor). After the correct cabling the monitor must be activated from the analyser display. From the menu bar select "Control", "Display Setting" and "Configure Multiple Monitors". This will open the Windows Project bar. Select "Duplicate"





4.4.2 How to use the USB-ports.

Fig 4.4.2



4.4.3 Wired network connection (LAN)

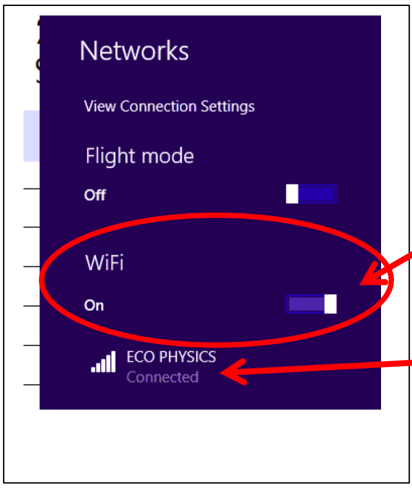
Use the USB-LAN network adapter of the original ECO PHYSICS accessories. It is always delivered together with the analyser. The drivers are already pre-installed. Connect the adapter into one free USB-port at the back of the analyser. Plug in an original Ethernet LAN cable from the adapter to your home network socket. See fig. 4.4.2.

4.4.4 Wireless network connection WiFi

This should be done by a trained IT-specialist only.

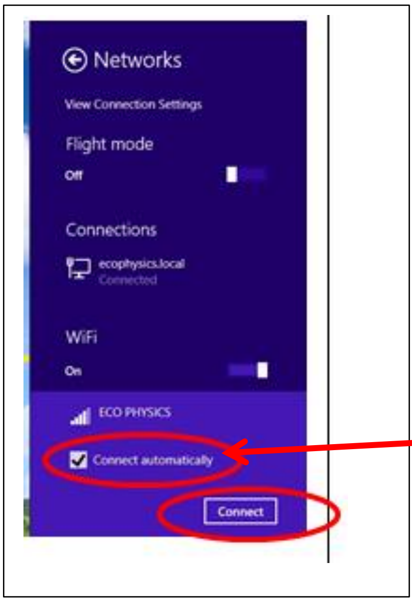
Login as System Operator.

In the menu bar navigate to Service > Network,Bluetooth,Mouse and tap "Connect to a Network". The right Windows Charms bar "Networks" will open. Move the button "WiFi" to right, in case WiFi was "Off", and select your favorite WiFi-network. Enter the password if needed. Set a check mark, if the analyser shall automatically connect the network each time it is available. At the end click "Connect". Close the Windows charms bar by touching the center of the screen.



Move the button "WiFi" to right, in case WiFi was "Off".

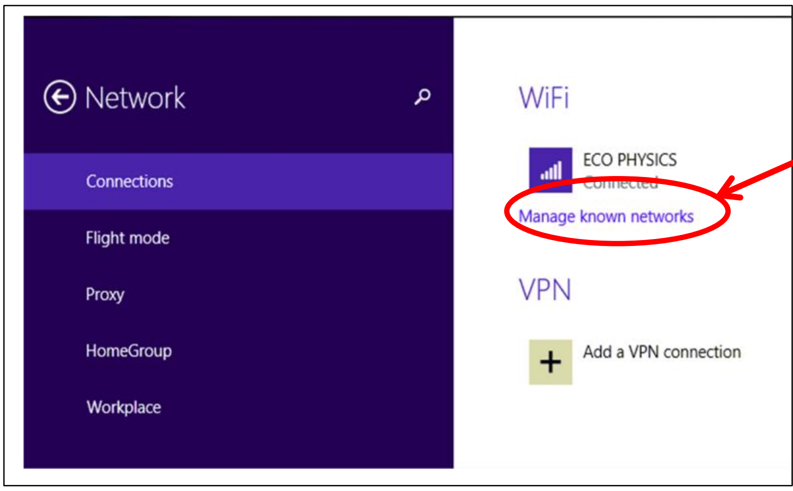
Select your favorite WiFi-network. Enter the password if needed.



Set a check mark, if the analyser shall automatically connect the network each time it is available. At the end click "Connect".

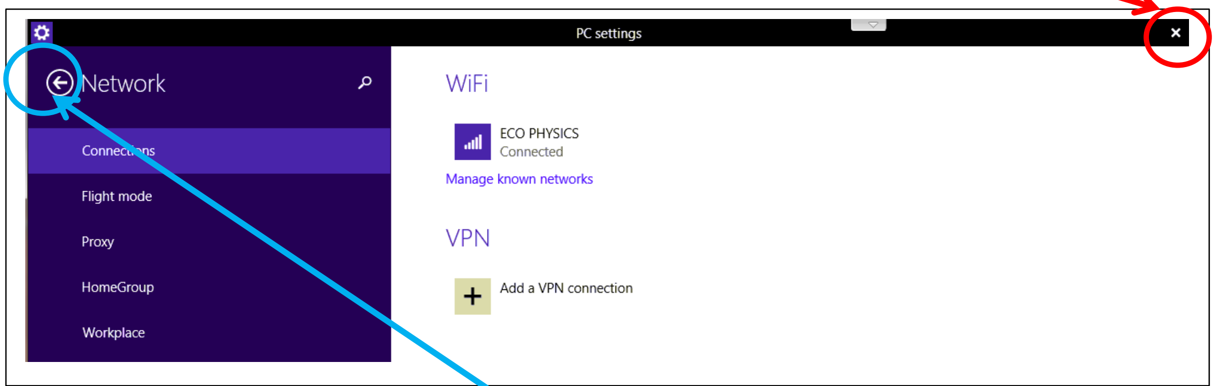
4.4

For further network configurations navigate in the menu bar to Service > Network,Bluetooth,Mouse and tap "Network Settings".

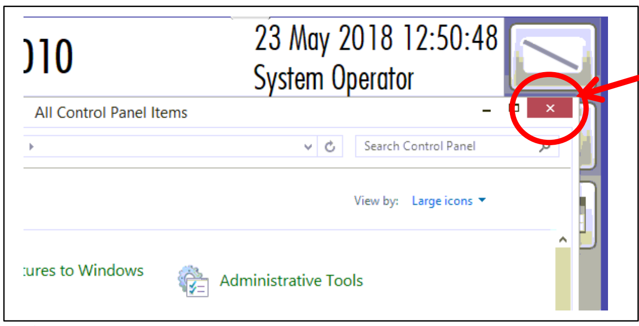


As an example tap "Manage known networks" in order to delete your old WiFi hotspots.

If you have a mouse connected move to the top edge of the screen. A small bar pops down. Click onto the white cross in the upper right corner in order to close the window.



Without a mouse, tap onto the arrow left of Network. In the next window tap "Control Panel" in the lower left corner and close the pop-upped control panel with a tap onto the white-red cross in the upper right corner

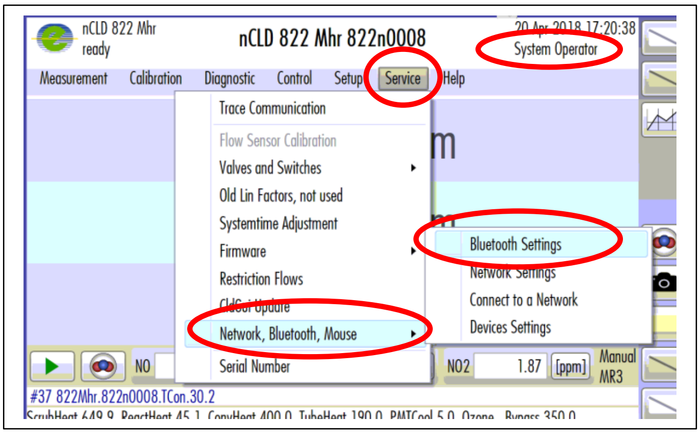


4.4.5 How to connect a wireless Bluetooth keyboard and mouse

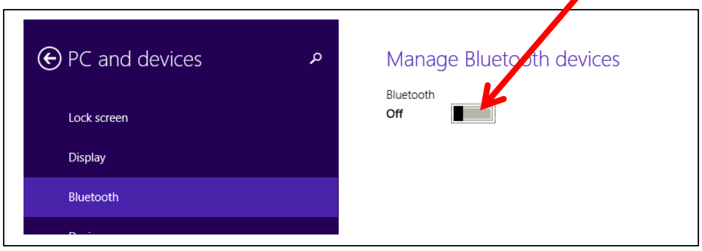
Please read the operating manual of the Bluetooth equipment. The analyser has a Bluetooth 4.0 interface and is pre-configured. For an easy coupling it is recommended to use the original ECO PHYSICS accessory. Using wireless Bluetooth keyboard and mouse help to keep enough USB-ports available for another equipment. Before you start to connect the Bluetooth keyboard ensure to have (good) batteries in the accessory. The following description shows the coupling of an original ECO PHYSICS accessory.

Connecting a Bluetooth Mouse or Keyboard:

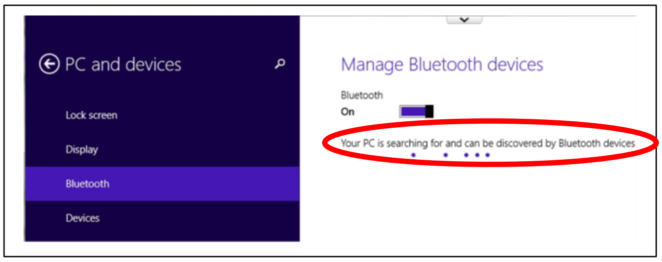
Login as System Operator. In the menu bar go to Service, select "Network, Bluetooth, Mouse" and tap "Bluetooth Settings".



Wait for the next window. If Bluetooth is "off" tap or move the slide to the right to activate it.

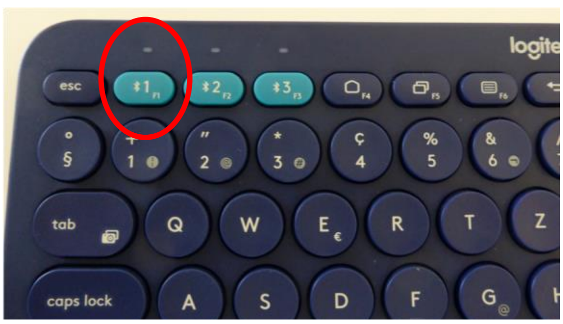


The display is now searching for Bluetooth devices.

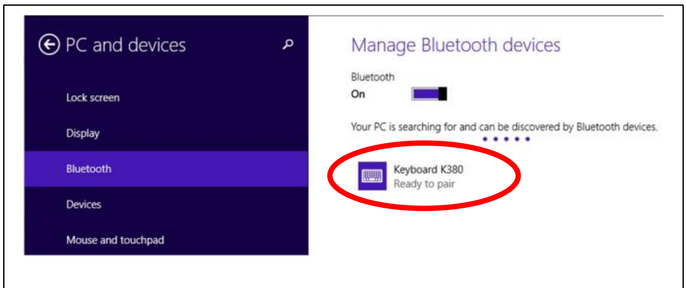


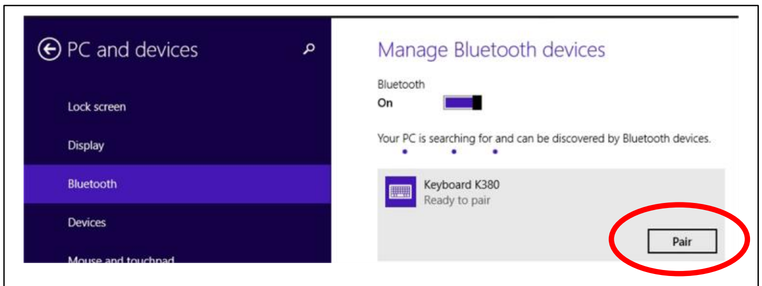
The Bluetooth function shows now „On“. The running dots indicate, that the nCLD is searching any external Bluetooth equipment.

This is the right moment to switch on the keyboard with its slide on the left side. It must be green.

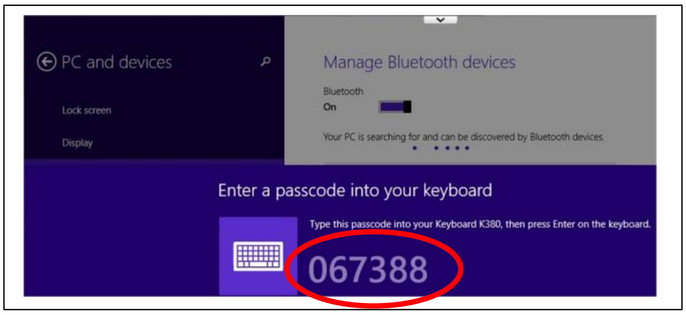


The keyboard shown in the picture to the left is recommended and is able to get paired with three nCLDs. In order to pair it press one of the bright blue keys, e.g. #1, until the LED begins to flash. Wait until the nCLD did find the keyboard and informs to be ready to pair. Now click „Keyboard, Ready to pair“

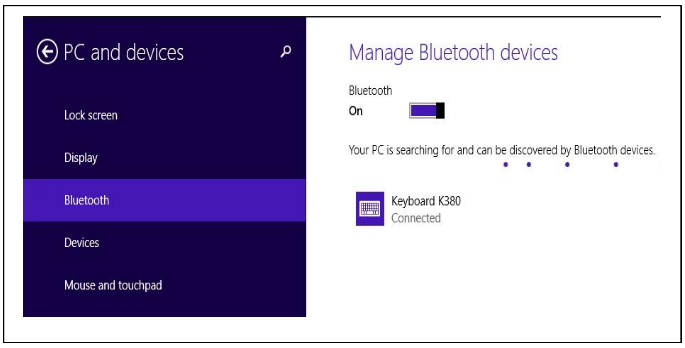


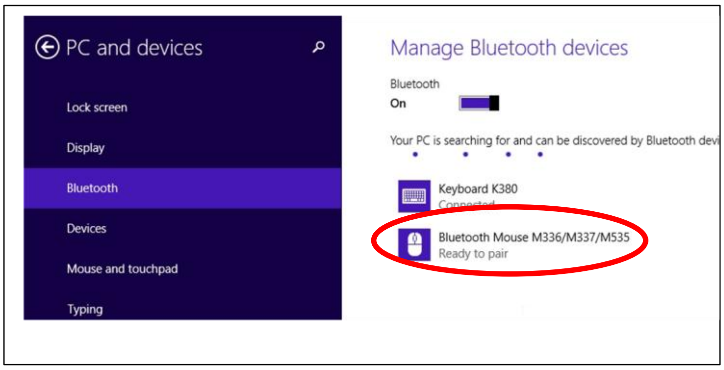


Click „Pair“

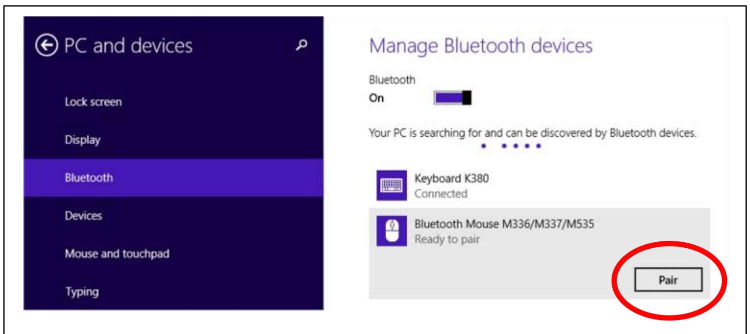


Enter the displayed code by the Bluetooth keyboard and wait patiently until „Keyboard Connected“ is displayed.



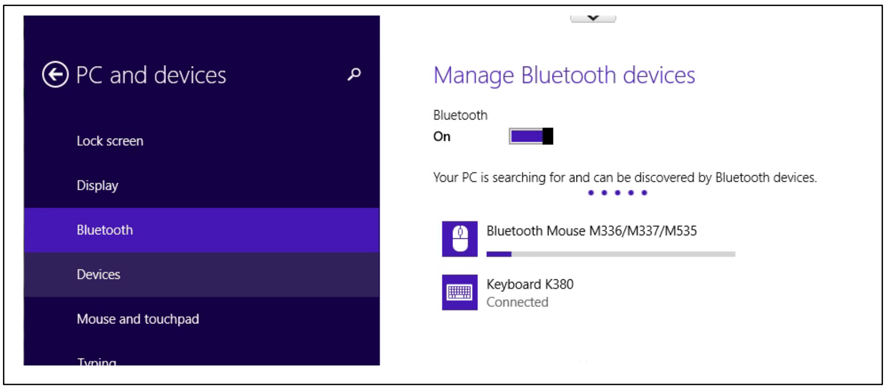


The running dots indicate the searching for further Bluetooth equipment, e.g. a mouse. If wished now switch on the Bluetooth mouse. The slide is at the bottom of the mouse. It must be green. Press the small pairing knob next to the slide of the mouse until on the top of the mouse a blue LED begins to flash. Now wait until the nCLD has detected the mouse and shows „Ready to pair“.

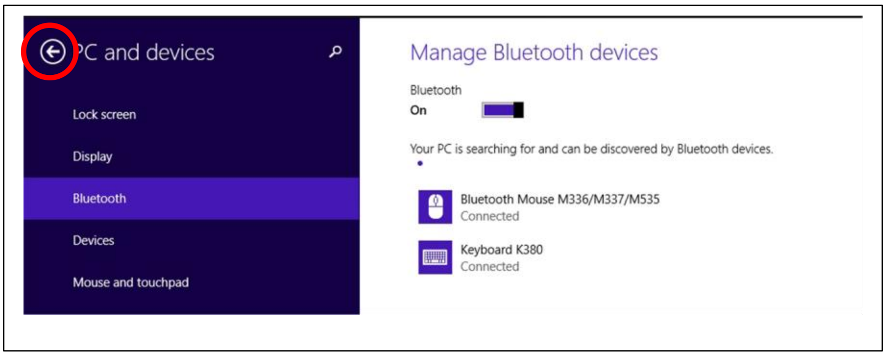


Click „Pair“ .

4.4



Wait patiently until the mouse is connected. Lasts approximately one minute.



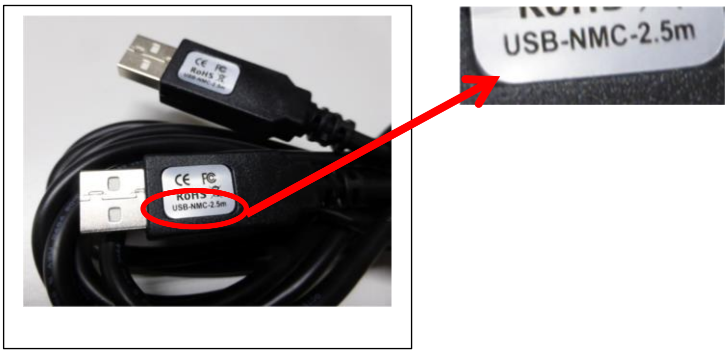
Close the window by the arrow at the upper left corner and select „Control Panel".

Close the control panel window.

4.4

4.4.6 RS232 interface with USB

The analysers of the nCLD families are equipped with up-to-date and state-of-the-art USB-based RS232 interfaces. The use of the special USB-FTDI- null-modem-cables provide interference free connections over a long distance in a simple way, without the need of the old fashioned 9-pin DSUB-connectors. The USB null-modem-cable is equipped with a special micro-processor, a so called FTDI chip. Each cable is unique and has its well-defined ID. The analyser nCLD is pre-configured for the use of this USB-FTDI-null-modem-cable; the needed drivers are installed and virtualize a normal RS232-COM-port as soon as a USB-FTDI-null-modem-cable is connected. Another big benefit of this technology is the well-defined and fix COM-port.

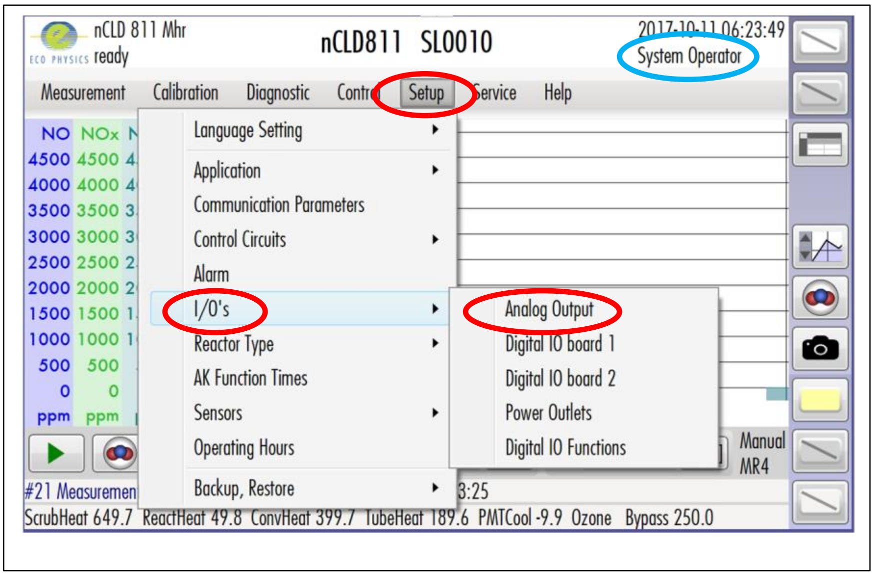


Connect the cable in a free USB-Port at the back of the analyser and to your remote-control PC. The remote-control PC must be connected to the internet in order to be able to automatically download the needed drivers for the remote control PC, in case it is not already installed. For more information about the RS232 interface and the implemented ECO PHYSICS RS232 protocol read chapter 8.

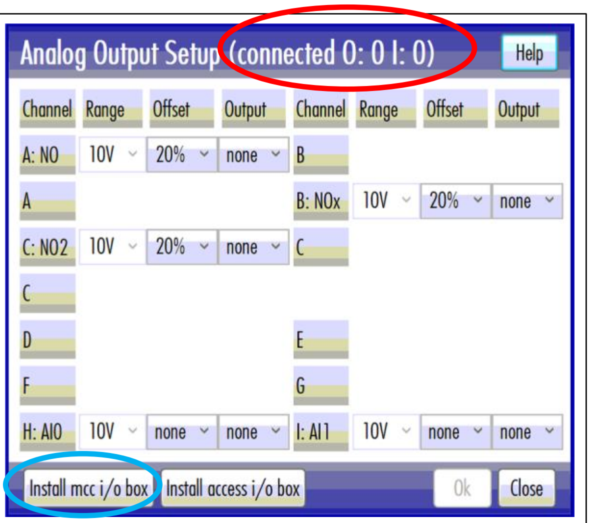
4.4.7 Analog Signal Outputs and digital I/O’s

The nCLDs are equipped with all modern serial interfaces, e.g. wired LAN network, wireless WiFi, Bluetooth, USB, RS232. Nevertheless, if an analog signal output is requested, as an example because still an old analog data logger without any serial interface is the only available equipment in order to receive data from the analyser, in such a situation a serial digital to analog signal converter is needed. The nCLD’s are pre-configured for a different number of such USB-based boxes. The big benefit of such a USB-I/O-box instead of the old style analyser internal analog signal outputs is, that not a high number of signal cables from the analyser to an external data logger (PLC) are needed. All these can be achieved by one well shielded USB-cable being protected against electromagnetic interferences, and for a long distance. Place the USB-I/O-box as closed as possible to your external equipment (data logger, PLC) and simply use voltage signals. If a user insists on mA signals, no problem, there are such boxes available providing such signals.

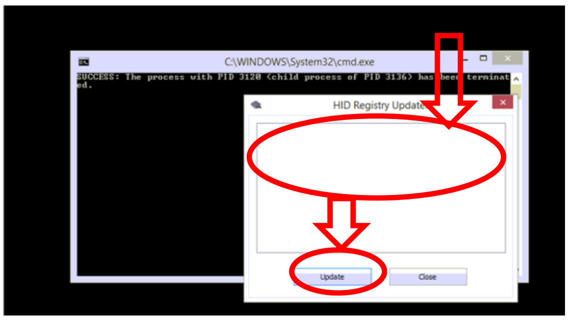
The following description explains the process of connecting such an USB-analog signal output box (short: USB-Box) to the USB-port of the nCLD. The followed steps need “System Operator” access rights, so log in at the nCLD as System Operator. Stop a running measurement process. Connect the USB-box to one of the USB-ports at the rear of the analyser. The LED will most probably shortly be on. In the menu bar navigate to Setup > I/O’s and tap “Analog Output”.



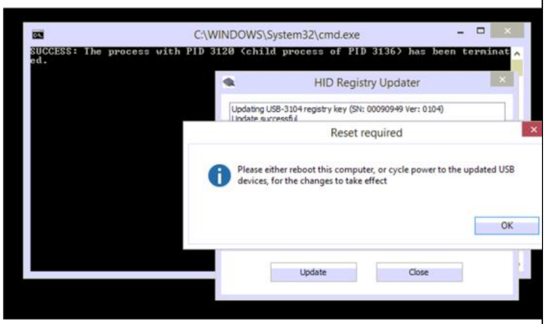
4.4

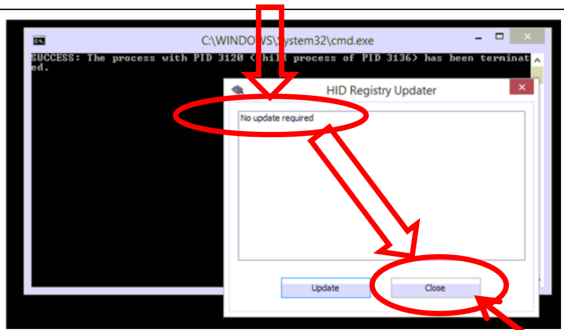


(If in the header a value higher than 0 is shown for O or I then the analog box is already correctly connected and ready to use.) The analyser is prepared for two different box labels, mcc and access i/o. Do not try to use any other than the originally recommended boxes (ask your ECO PHYSICS agent). All drivers are preinstalled by the analyser manufacturer ECO PHYSICS AG. Do never install different or new drivers by yourself. If your box is a "mcc" box (e.g. 3102, 3104, etc.) tap to "Install mcc i/o box" in the lower left corner of the window. If your box is an "access i/o" box, use the other button. Follow the instructions. Several windows will pop up stepwise.



For the mcc i/o box when the window "HID Registry Updater" pops up tap "Update". Repeat this until you see "No update required". If you see the following window tap OK. In the "HID Registry Updater" window tap again "Update".





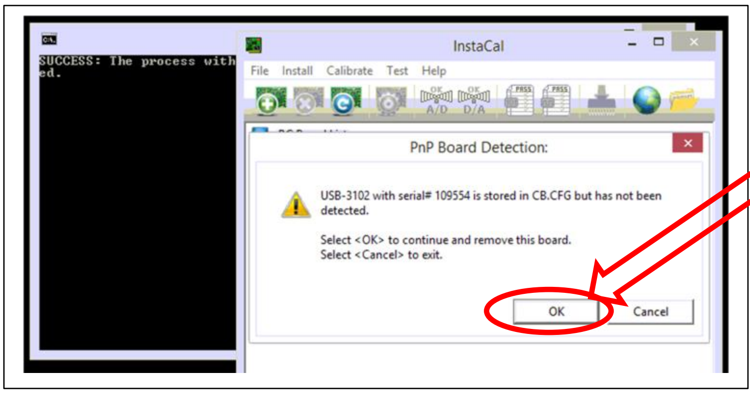
When you see „No update required" tap „Close"

A short video guides you through the next step:

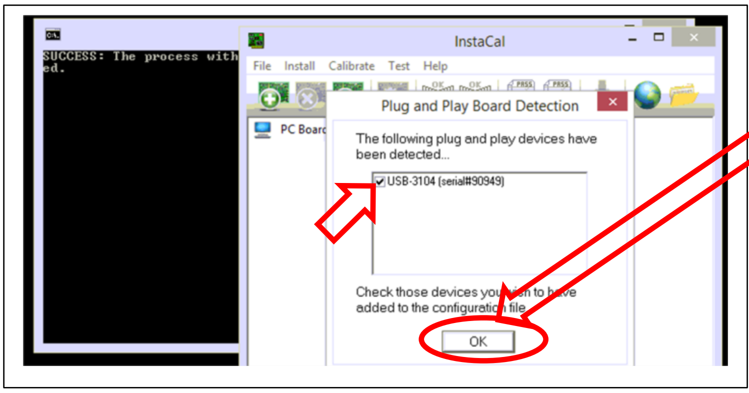
Unplug and plug the USB-cable at the analog box.

4.4

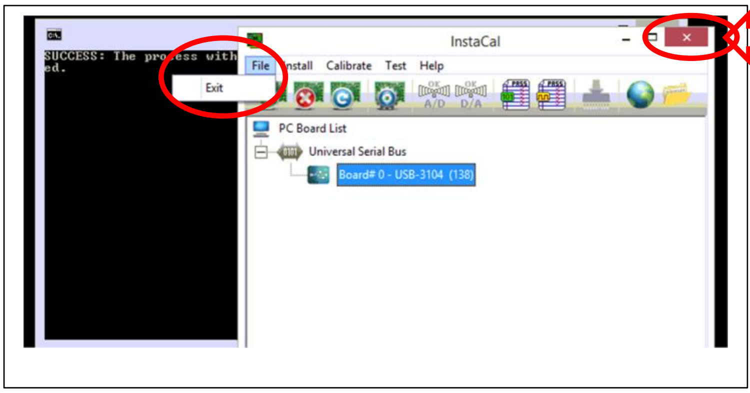
After the USB-cable is unplugged and plugged again close the video player by the white-red-cross in the upper right corner or by File > Exit. Wait until the next window pops up.



Wait until the InstaCal program is started and running. If already another box (board) is found that was configured in the past but not currently connected, remove it by the OK button.



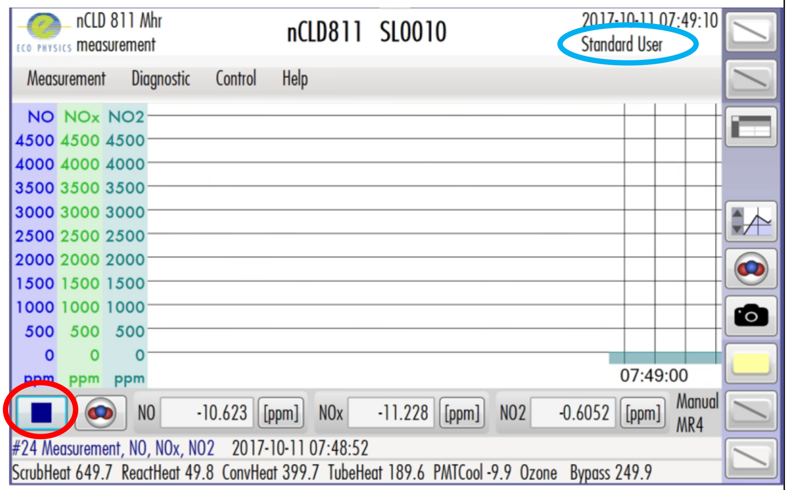
When the new box is found ensure that the check mark is set and accept it by the OK button.



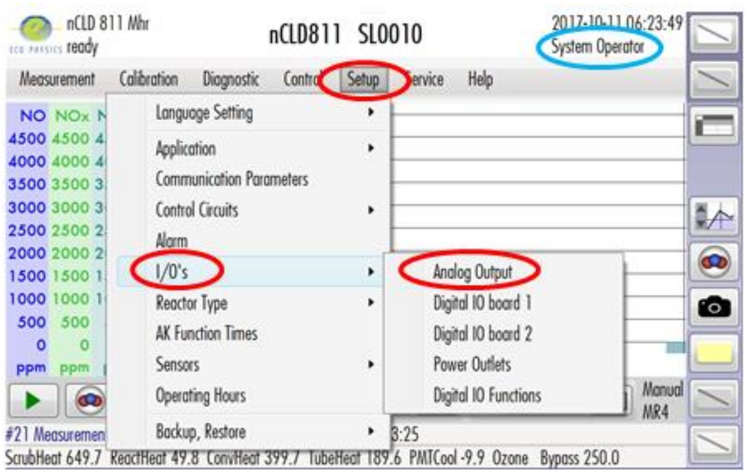
When the new (or previous) box is correctly connected and ready you will see it in the InstaCal. Now you can close the InstaCal pro-gram by the white-red cross in the upper right corner or by File > Exit.

The CLDGui will automatically restart .

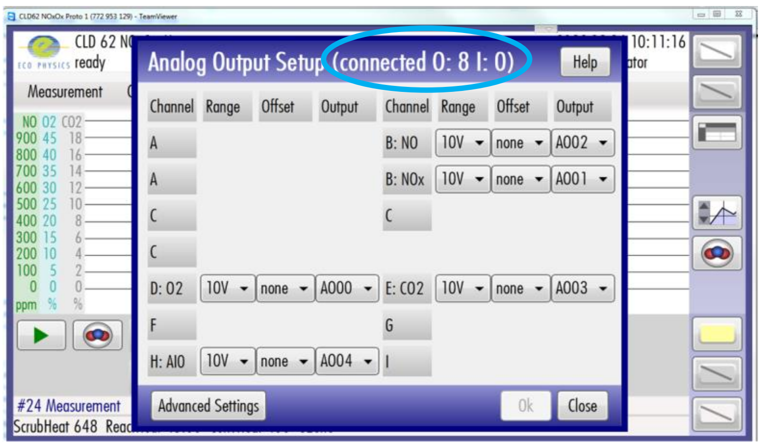
4.4



The nCLDGui starts always as „Standard User“ and starts automatically a measurement. Stop this measurement by a click onto log out and in again as „System Operator“. Stop again the newly started measurement.



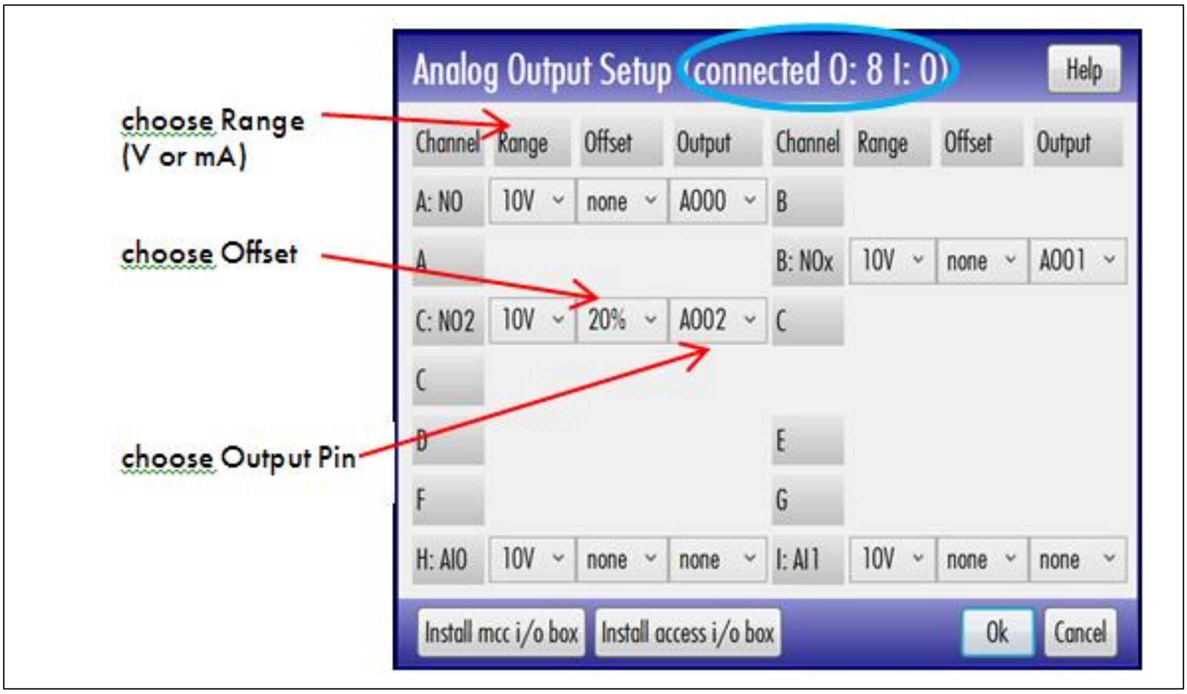
Open the „Analog Output“ function.



Check:

A correctly connected analog-box "mcc3104" shows in the window header 8 outputs und 0 inputs, shortly O:8 I:0. mcc3102 shows O:4 I:0

4.4



Consider which kind of outputs you have to use from the USB-Box. Under Range you can choose between a current output which provides a 20mA output and a voltage output which provides 10V. Check on your data logger if you have a current input or a voltage input.

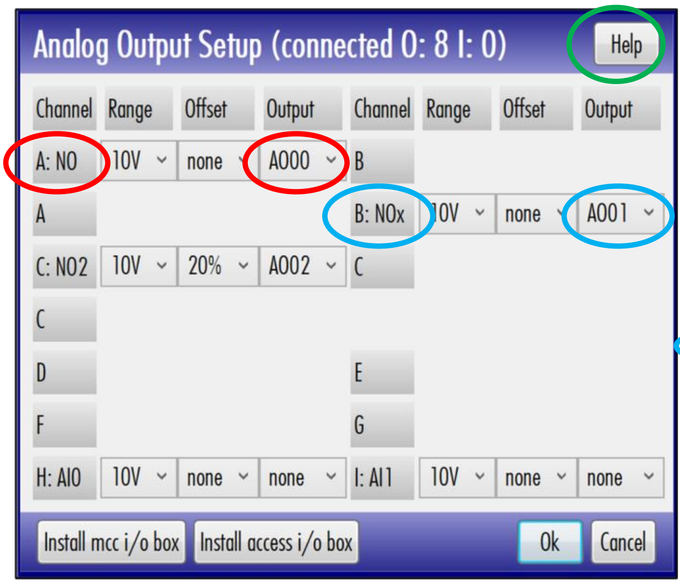
In the picture above the voltage output is chosen.

If an offset is needed you can add an Offset of 20%. This function allows the analyser to send potential negative signals which can be read by the analog-board. If it is set to 20%, the measured value of 0 will not send a 0V signal, but it will send 20% of the 10V, meaning 2V. If there should appear any negative values, for example -1, the signal is positive (1V) and can be read by the board.

After selecting the offset, the output on which the signal from the USB-Box appears must be chosen too (A000 refers to the Pins IOUT0and VOUT0 on the USB-Box).

The selection of the output defines which VOUTX (output with voltage) or IOUTX (outputs with amperage) must be connected to the data logger in hardware.

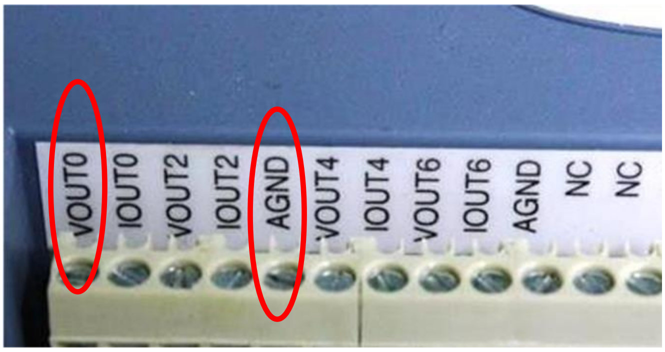
Save the settings with 'Ok'. If you don't want to change anything, quit the window by pressing 'Close'. When all software settings are done continue with the hardware installation.



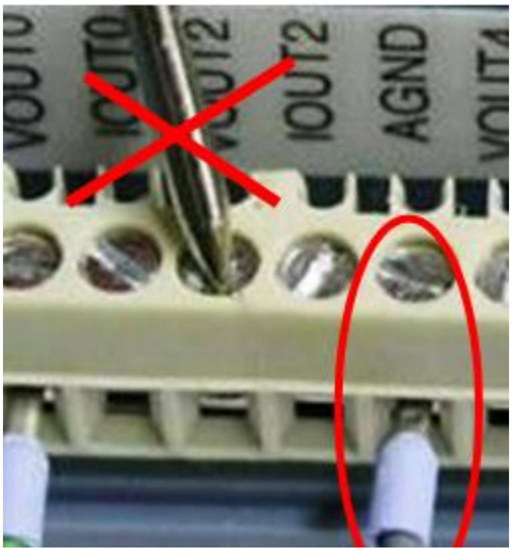
Assign the pin outs of the box to the measured gas. The picture to the left shows the box-output A000 = VOUT0 to be assigned to NO. It is configured as 10V signal without offset

NOx is A001 = VOUT1. Use the corresponding analog-ground-pins of the box.

Get more info about the USB-analog box by a click to Help



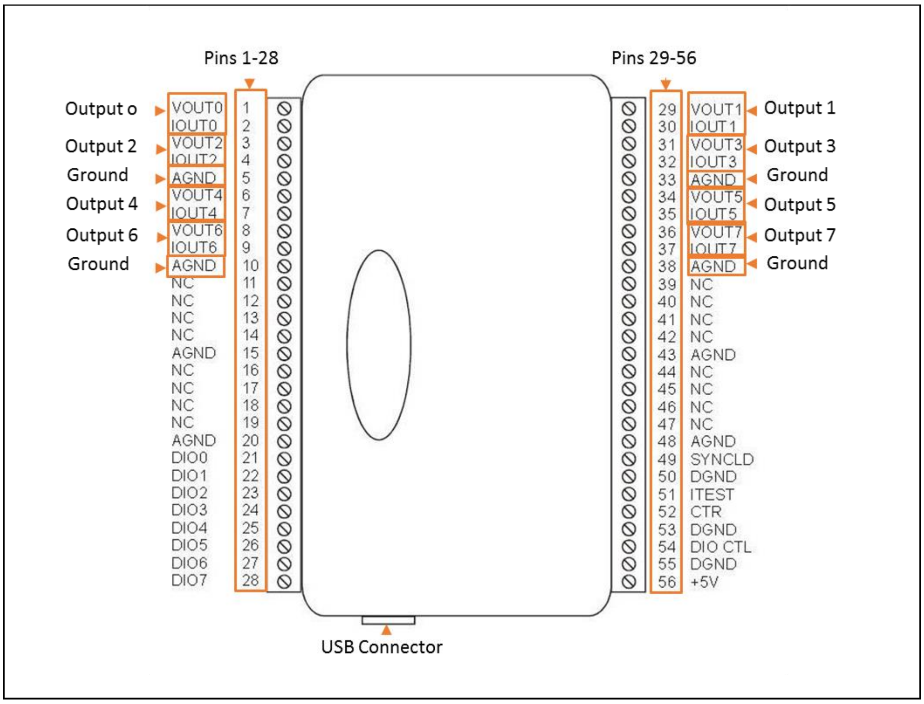
All odd outputs are at one side, all even outputs at the other side of the box.



The screws are not electrically contacted without a cable in the socket.

If you wish to check the running output by a multimeter connect a cable into the target socket and fix it by the screw.

Note that a measurement must run in order to get signals at the outputs of the box.



The following three pictures illustrate the wiring from the USB-analog-signal box to the data logger. Keep always the cables from the box to the data logger as short as possible (few cm) and use the USB-cable for the long wiring distance. In other words, place the box as closed as possible to the data logger's inputs.

The next picture illustrates how the date logger should be connected to the USB-Box in hardware for V signals.

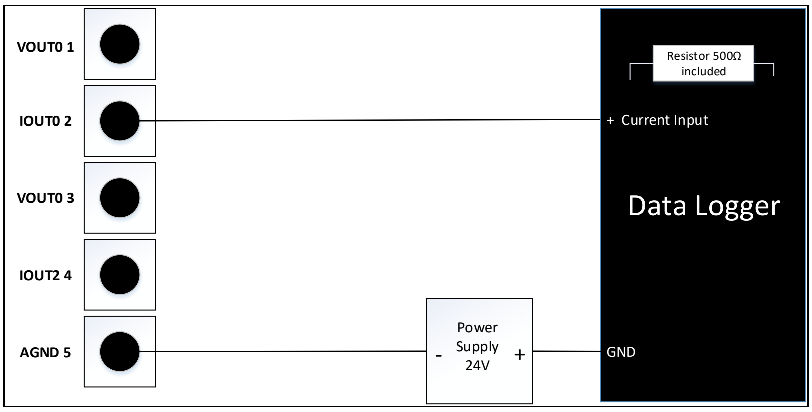
Note:

There is no need for mA signals.

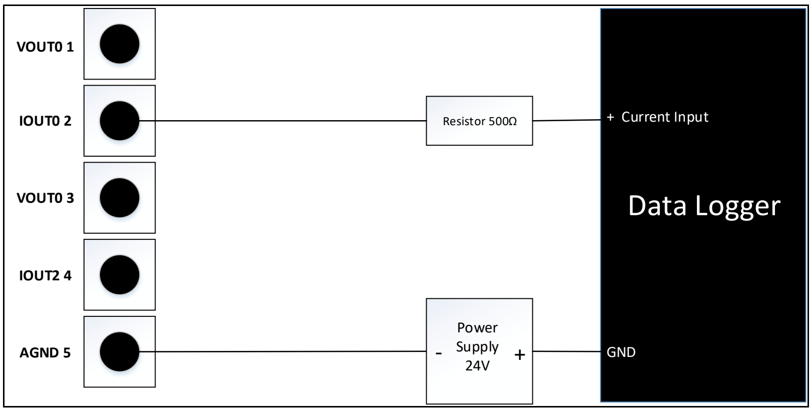
mA signals do not give better or more stable signals than V if the wiring is done as recommended:

4.4

The next picture illustrates how the data logger should be connected to the USB-Box in hardware for mA signals if the shunt (500 Ohm) is already implemented in the data logger's current input. If the data logger does not provide 24VDC output you must use an additional external power supply.



The next picture illustrates how the data logger should be connected to the USB-Box in hardware for mA signals if the data logger does not already have the resistors implemented in the current input line.



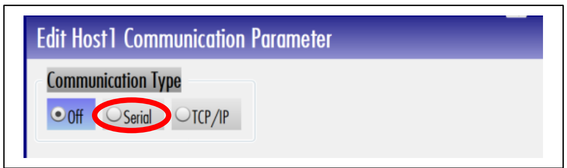
4.4

4.4.8 Digital Serial Signal through RS232

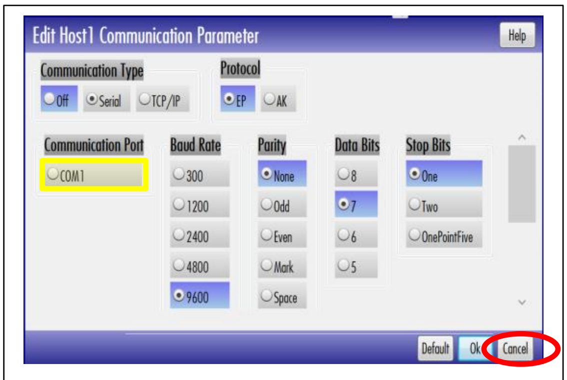
By default, the analyser is configured in such-away that it gives out any kind of measurement signal as soon as it is powered up and ready. At the RS232 port the analyser sends the measurement data with 10 Hz by a simple protocol. There is no need from the host PC to send a request for data at the RS232.

In order to use the RS232 log in as System Operator, stop any running measurement event, before the RS232-cable between the analyser and the Host PC is connected. From the operation menu select Setup > Communication Parameters.

Open Host 1

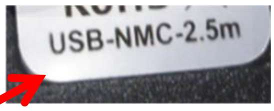


Select Serial



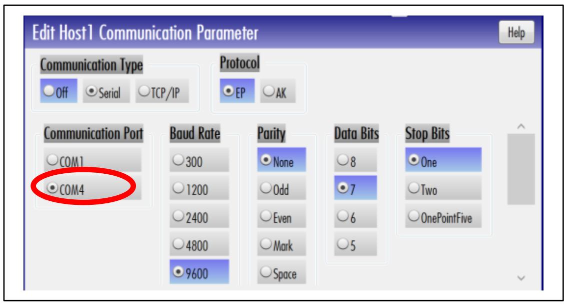
Check the Communication Port and memorise it on a piece of paper. Do not tap on any shown COM ports. Tap Cancel in the lower right corner and OK in the next shown window in order to come back to the main screen.

Now connect the delivered original FTDI-USB-to-USB-RS232 cable (also named as USB Null Modem cable with FTDI Chip) at one of the three USB-ports at the rear of the analyser and wait until the cable is recognized.



4.4

Now again open Setup > Communication Parameter, open Host 1 and select Serial as described above. Now you should see an additional COM port with a number higher than 3, e.g. 4 or 5 etc.



Select the new COM-port, usually 4. Do not use COM1 or COM2 or COM3 if shown.

Recognize the default parameters for Baud Rate, Parity, Data Bits and Stop Bits.

Now connect the second end of the FTDI-USB-to-USB-RS232 cable to a free USB-port at the Host PC. The Host PC should have internet connections, because the first time the cable is connected most probably the drivers must be installed. Commonly the drivers are automatically downloaded. (Remember: No drivers must be installed at the analyser because they are preinstalled). Connecting this cable will automatically install and provide a new COM-port. Check the COM port in the device manager of your host PC. It might be that you must actualize the drivers in the device manager of your host PC, often you must do it twice.

Use any kind of terminal program on your host PC, configure the parameter of the COM port with the same values than of the Host 1 of the analyser (see picture above), start the terminal program on your host PC and start a measurement event on your analyser and you will receive the measurement data in the following format. Each line represents one measurement. The measurement values are separated by a comma:

b1,b2,a1,a2,c1,c2,c3,s1,s2,s3,s4,s5,s6,cdj,vvvv,hxf,eeee,wwww,iott(tt)(tt)

where

b1	=	NO from Channel B
b2	=	NOx from Channel B
a1	=	NO from Channel A
a2	=	NOx from Channel A
c1	=	NO2
c2	=	NH3
c3	=	

values s1 to s6 are reserved for additional channels. A * is given if the value is not available. All other bytes show the state of the analyser. For more information see in chapter 8 of the operating manual.

A standard two channel NO, NOx, NO2 analyser transfers the data as followed:

```
  NOx      NO       NO2                    analyser state
   ↓        ↓        ↓
*,1.9554,0.0117,*,1.9437,*,*,*,*, *,*,*,*,OvB,@@@@,_M@,0000,0000,@@@@
*,1.9563,0.0120,*,1.9443,*,*,*,*, *,*,*,*,OvB,@@@@,_M@,0000,0000,@@@@
*,1.9553,0.0112,*,1.9441,*,*,*,*, *,*,*,OvB,@@@@,_M@,0000,0000,@@@@
```

In order to control the analyser by the RS232 commands see in chapter 8 of the operating manual.

4.4

4.4.9 USB connection example if more than three USB ports would be needed

5. OPERATING GUIDE

Read the safety rules first
(Section 1.2)

5.1

5. Operating Guide

5.1 Startup Procedures

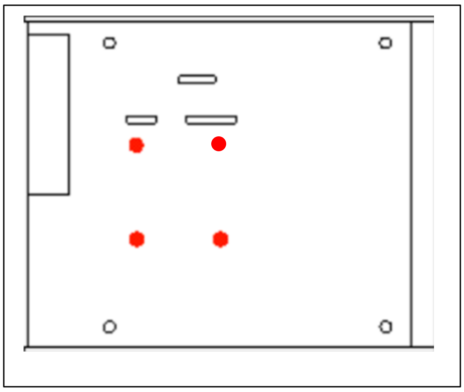
Attention:
Connecting the analyser to a source of wet, corrosive sample gas, special care must be taken to ensure the correct sequence of steps in powering up the system.

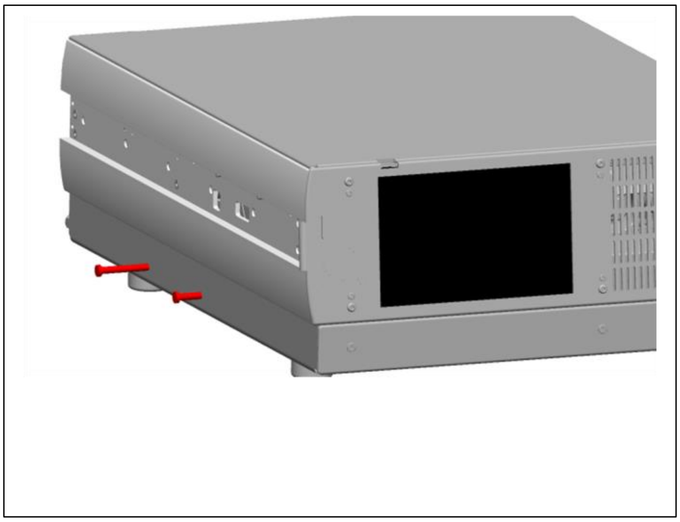
Damages to the nCLD may occur due to condensation of the warm humid sample gas in the instrument, in case these procedures are not carried out exactly as specified.

Important!
The nCLD must NEVER be operated without a 3–5 µ filter in the sample line. This includes short periods of operation sampling "clean" room air!
The nCLDs without option "h" (heated inline) may never measure hot gases without a front-end gas cooler or dilution system!

When the analyser and its peripherals are installed in accordance with section 4 of this operating manual, the following procedure applies:

1. Before switching on the analyser make sure that
   a. the transport lock is removed (nCLD8xx: four red marked screws from the bottom completely removed. nCLD-SL: two nails completely pulled out at the left side).





b. all peripheral gas equipment and gas-delivery systems (for example particle filter, heated tubing, gas coolers, O2 supply gas, etc.) are connected, switched on and able to deliver the needed amount of the requested gases.

2. Connect the main power cable of the analyser to the home power socket. At the instrument front on the right side behind the ventilation grid a red steady light indicates, that the power is connected. Wait 10 seconds and press for 4 seconds the main switch at the front, at the upper left side.

→ During the initialization process several windows are displayed. The process lasts around 2 minutes. During this phase do not touch the screen. Stay patiently. There is not any login needed. The nCLD logs automatically in as a “Standard User”. The nCLD is factory-configured in such a way that automatically a measurement is started as soon as the power up is finished. The power up lasts around 50 minutes and is indicated by “powerUp” in the upper left corner of the main screen.

5.2

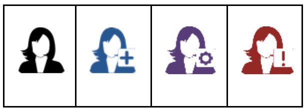
5.2 Operating the analyser

5.2.1 Introduction

This chapter provides the basics and an overview about the instruments general graphical user interface (GUI). Detailed information is available in the help menu.

Some of the following described functionalities of the GUI are instrument version dependent and might vary from version to version.

The nCLD has a built-in touch screen and a virtual keyboard for operation. There are USB connectors at the back of the instrument. Some self–explaining icon-buttons make operation and navigation intuitional. A selectable main screen appearance provides information according to the situation. User-dependent functional access protects the system from unauthorized operation. User interactions such as calibration, linearization and measurements are logged and are fully traceable. Time or event triggered pre-defined sequences for calibration, linearization measurement and I/O handling turns the instrument into a powerful guidance system without the presence of an additional PLC. The main screen menu gives access to various analyser functions and a variety of sub-menus according the chosen user-level. Refer to the chapter 'security' for details.



The user symbols throughout this document are:

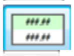
Standard User 

Extended User 

Maintenance 

System Operator 

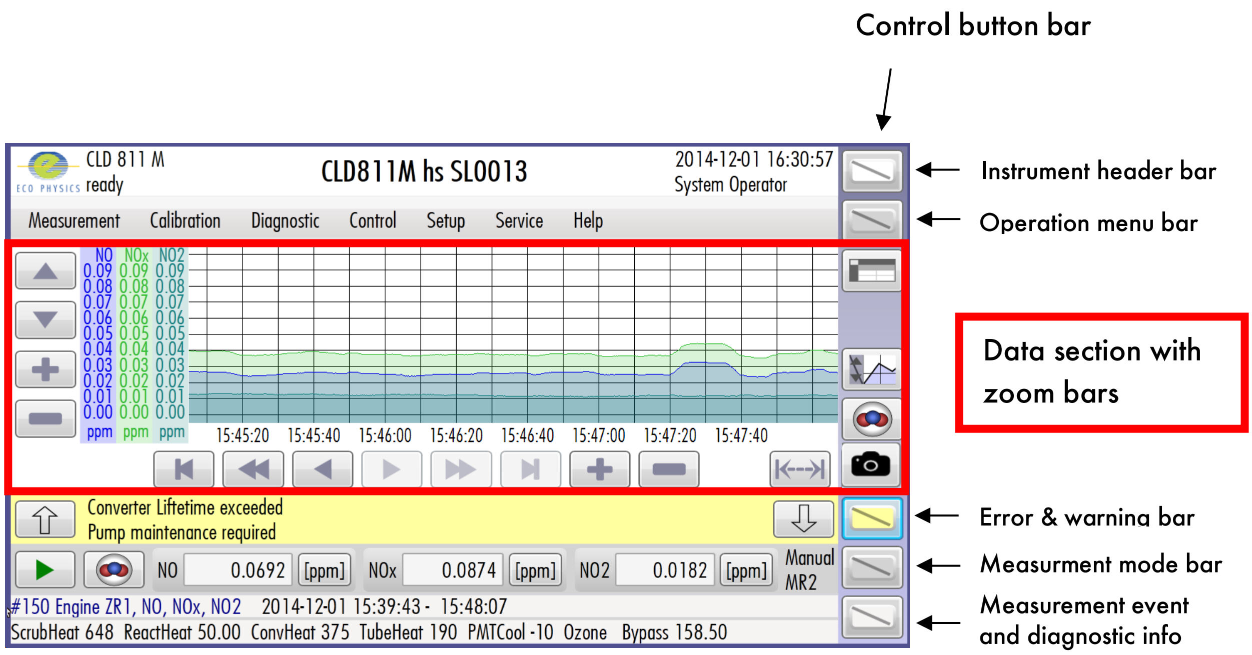
5.2.2 Icon-Buttons

	Edit		Select Main Screen Diagnostic
	Delete		Select Main Screen Graph
	Selection of displayed measurements		Enable View
	Start Measurement		Disable View
	Stop Measurement		Scroll Up
	Graph Zoom		Scroll Down
	Select Main Screen Numeric		Change unit ([ppb], [ppt], [%])
	Print Screen (Screenshot) on Main Window		

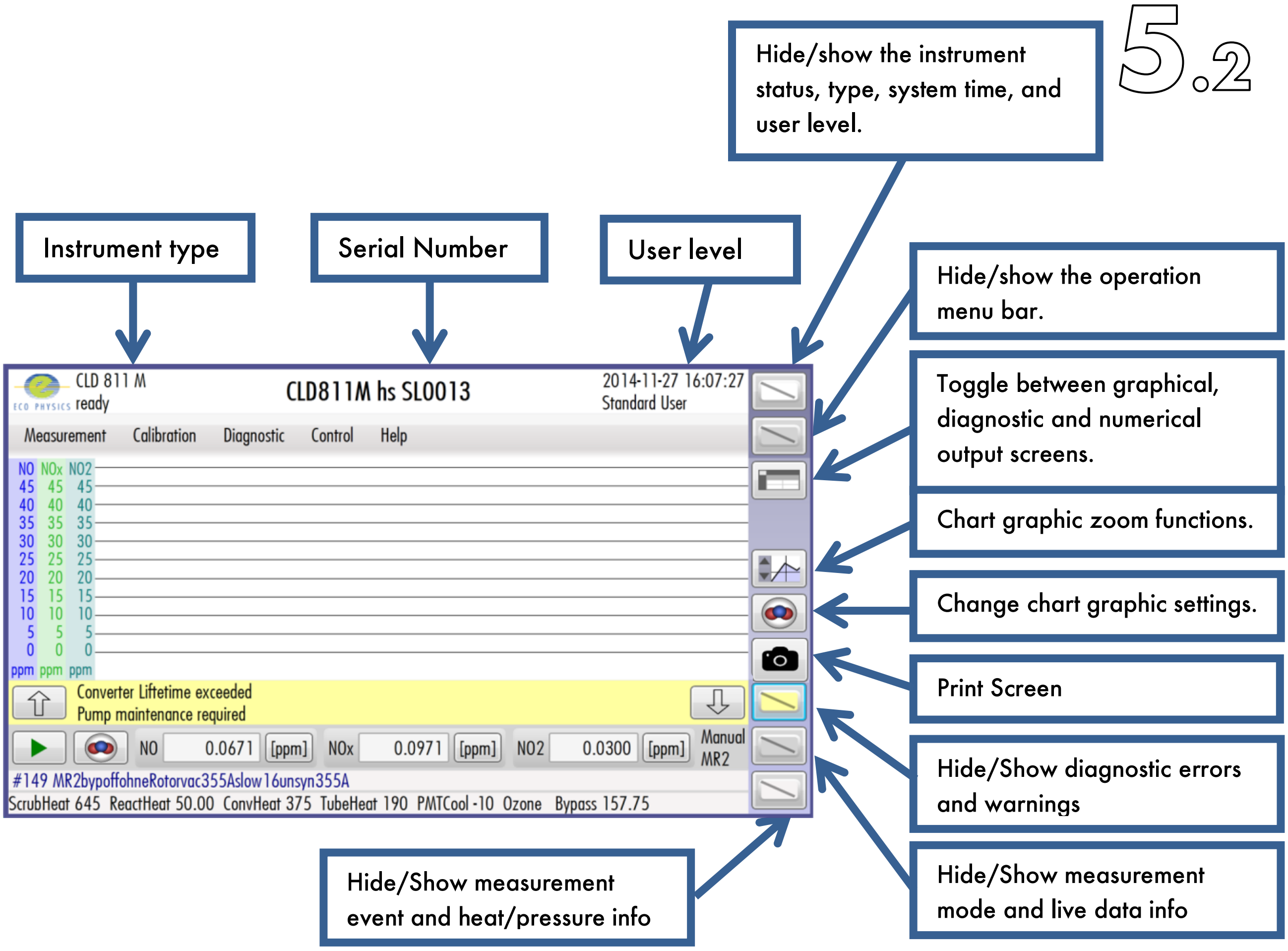
5.2.3 Main Window

The main window is divided into sections:

- Five horizontal function bars display general instrument information, instrument status and data information and function menus.
- The data section shows the measurement data or the most important diagnostic data
- On the right side is a vertical function bar containing the control buttons in order to hide and show the appropriate horizontal function bars, to zoom the graphical data output and to make a print screen.

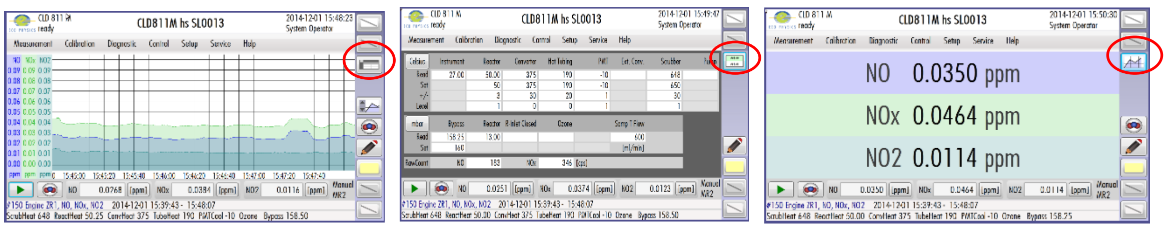


5.2

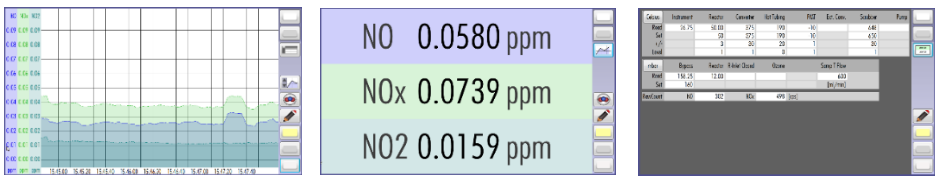


Toggle between graphical, diagnostic and numerical output screens:

Graphical output Diagnostic output Numerical output



Same as above with hidden function bars:



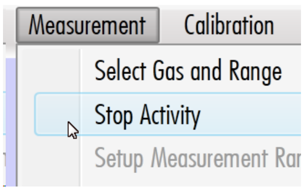
5.2

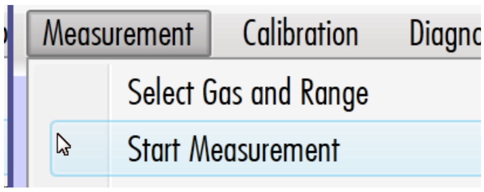
5.2.5 Controlling measurement events

A measurement event is actuated by the start soft key 

A running measurement can be stopped by the stop soft key 

Alternatively, a measurement event can be started by selecting "Measurement" > "Start Measurement" and "Measurement" > "Stop Activity" respectively.



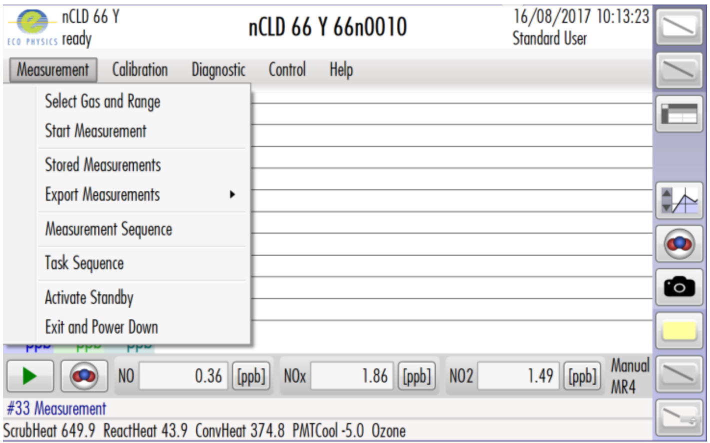


5.3. Main Menu

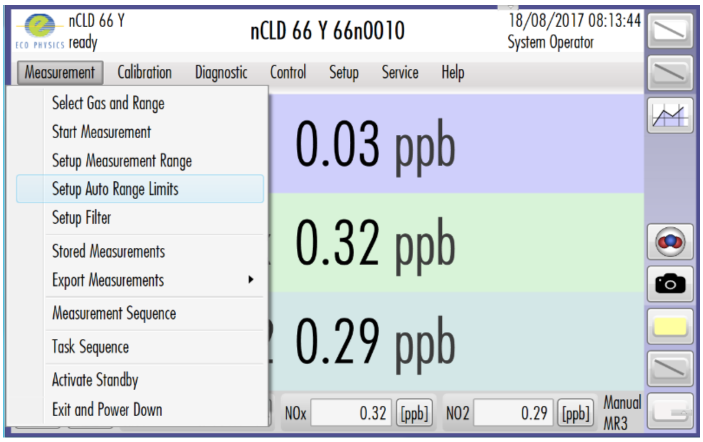
5.3.1 Measurement Menu

5.3.1.1 Measurement window

Standard user:

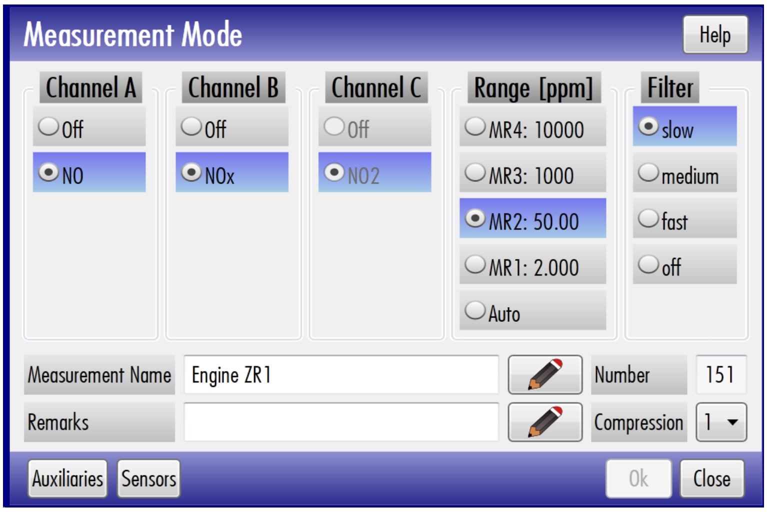


System operator:



5.3.1.2 Select Gas and Range

From the main window select "Measurement" > "Select Gas and Range". Alternatively, you can use the soft button in the lower left corner of the main window for fast access. Now the Measurement Mode window is displayed. Depending on the instrument model and type it might be similar like this:



Choose the gas for each channel . Some channels, e.g. C, show calculated gases which cannot be selected. Depending on the selection in the channels A and B, it will automatically choose either 'off' or 'NO2'.

Select a range This selection is simultaneously valid for all channels.

Select the predefined data filters , slow, medium or fast or disable the data averaging (off).

Optionally enter or edit the measurement event name. The number right next to it, is defined for every single measurement. It will automatically raise for every new event.

Optionally enter or edit some additional remarks to the measurement event.

Select one of the factory defined data storage frequencies, named as data compression. Higher compression values reduce the data storage size.

Selecting 1 stores the data with 10 Hz (every 100 milliseconds)

Selecting 40 stores the data with 0.25 Hz (every 4 seconds)

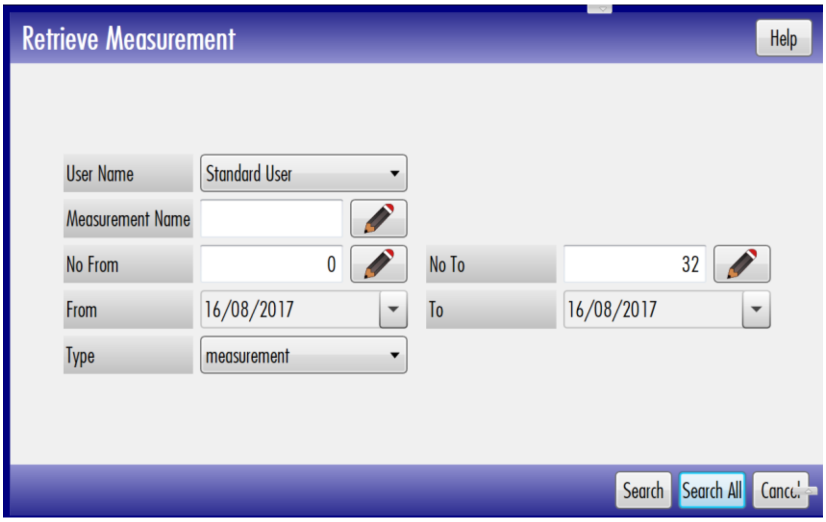
Selecting 400 stores the data with 0.025 Hz (every 40 seconds)

Selecting 2400 stores the data every 4 minutes

Higher selectable compressions are 24000, 48000, 72000 and 144000.

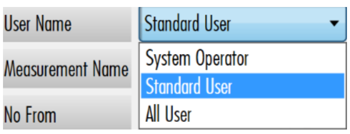
5.3.1.3 Stored measurements

From the main window select “Measurement” > “Stored measurements”.



Search here for previous recorded events.

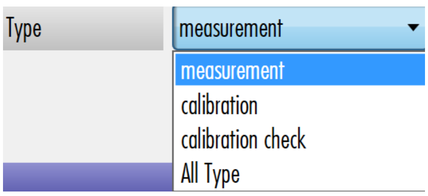
For specific results select the ‘user name’ which has made the measurement or just click ‘all User’.



Eventually enter the ‘Measurement Name’  if you know it for more specific results.

Eventually enter ‘No From’ and ‘No To’ . These are the numbers which are specific for every single event. Select a range for more specific results.

Eventually select a period from date to date for more specific results.
Eventually choose a type of event which you are looking for.



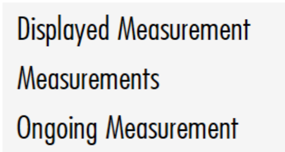
By clicking ‘Search’ the program will search the events according to your input above.

By clicking ‘Search All’ the program will search for all previous events.

5.3.1.4 Export measurements

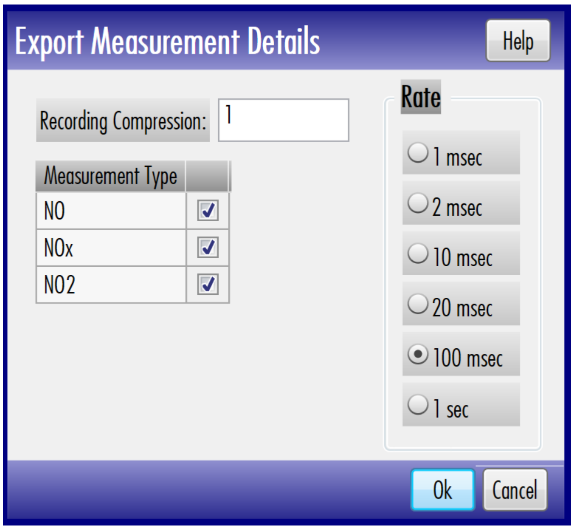
From the main window select "Measurement" > "Export Measurement".

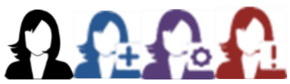
There are three possibilities to export the data.



"Displayed Measurement" for the current displayed and selected measurement. Be aware that this selection can only be chosen if you have a finished measurement on the screen, which means you selected a done measurement by the function "Stored Measurements", see chapter 5.3.1.3. This functions exports one done measurement event only. It allows a selected time part of a done measurement event.
"Measurements" for all previous events. You will be leaded to the 'Retrieve Measurement' window, the same as with 'Stored Measurements'. Search your event(s) as described in chapter 5.3.1.3 'Stored Measurements'. After selecting the events, press 'Ok'. Note that this function allows the export of more than one complete measurement events at the same process.

After pressing 'Ok' there will pop up a new window.





Under Measurement Type chose the measured gases, e.g. 'NO' and/or 'NOx' and/or 'NO2' depending on which data you want to export.

5.3

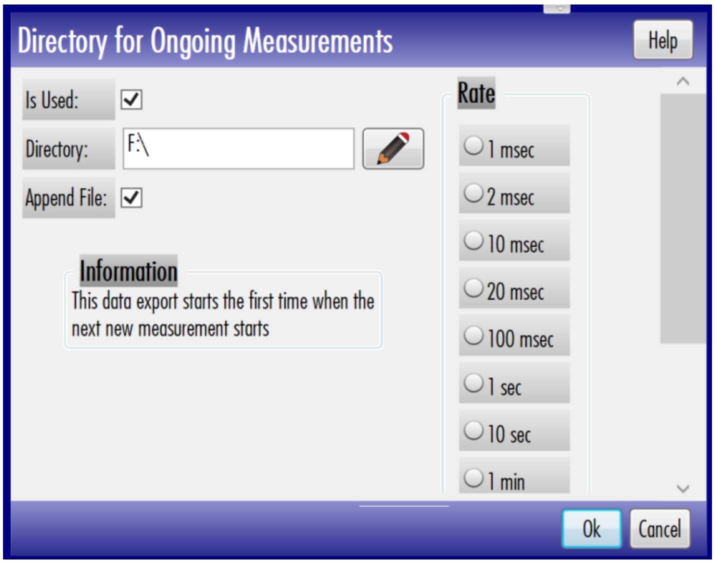
Chose a rate. This rate defines the frequency of the exported data. If you select 1 sec it exports the measurement data of each second. This rate is not necessarily identical with the compression rate of the data storage of measurement events.

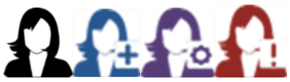
Example:
Compression rate 1 stores the measured data by 10 Hz, every 100 millisecond one measurement value. Exporting the data by a selected rate of 100 msec exports exactly the values that were stored in the data base during the measurement. Exporting the data by a selcted rate of 10 msec will interpolate the data from the database and export 10 times more datapoints as really measured. On the other way exporting the data by a selected rate of 1 sec does reduce the amount of exported data by a factor of 10 by averageing the stored data values.

Depending on how long the measurement is, it will suggest faster or slower rates.

5.3

"Ongoing Measurements" for the now recording measurement.





'Is Used' signifies that live-data are directly exported.

Enter a path to export the data in 'Directory'.

'Append File' shows that upcoming, ongoing events will be connected and stored together in the already used (previous) data file. Otherwise a new data file is generated each time a measurement event is started.

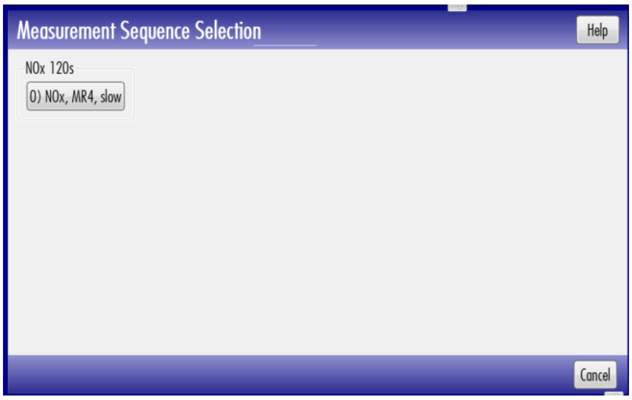
Choose rate between 1 msec and 1 hour.

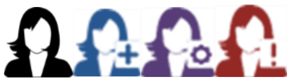
Press 'Ok'. Ok

Tip: The data export starts the first time when the next new measurement starts, but only if 'Is Used' is marked. By preparing the 'Directory' and 'Rate' section but not marking the 'Is Used' it is not going to export. As soon as you want to start exporting you will just have to put a mark at 'Is Used' and press 'Ok' and it will start.

5.3.1.5 Measurement Sequence

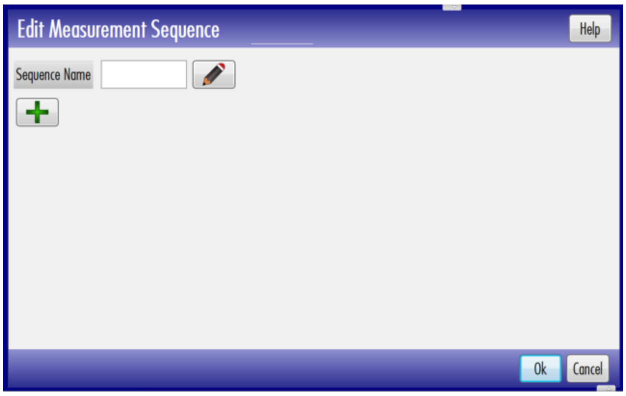
From the main window select "Measurement" > "Measurement Sequence". You are now able to choose different measurement sequences which have been created by a system operator. Look in chapter 5.3.1.6 'Add new measurement sequence' to see how it is created. To start a measurement, press on the field named with the kind of gas, the range and the rate of the filter. To leave the window without any action, press Cancel.





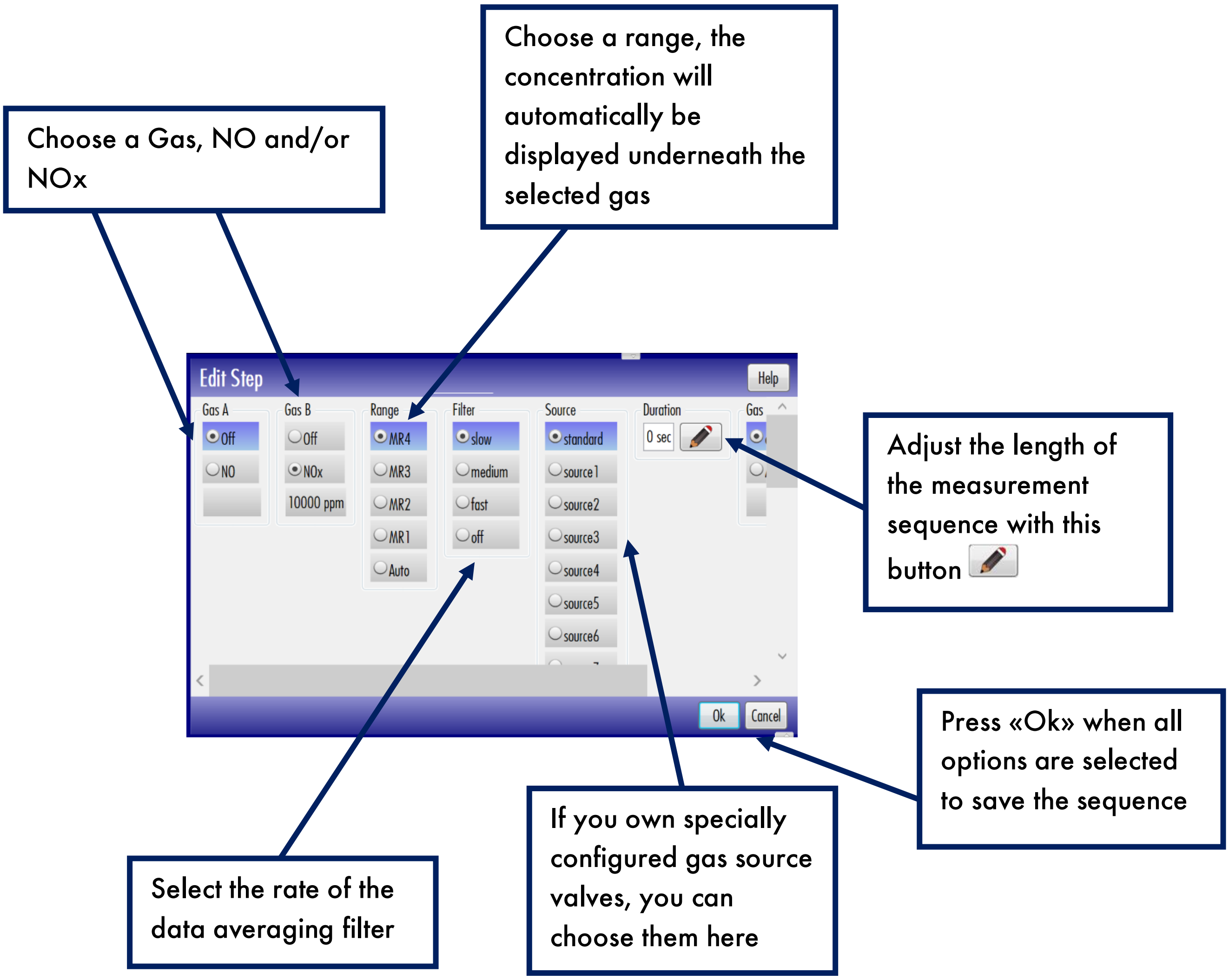
5.3.1.6 Add new Measurement Sequence

Select from the main window "Measurement" > "Measurement Sequence" and press in the 'Add Sequence' area. A new window opens:



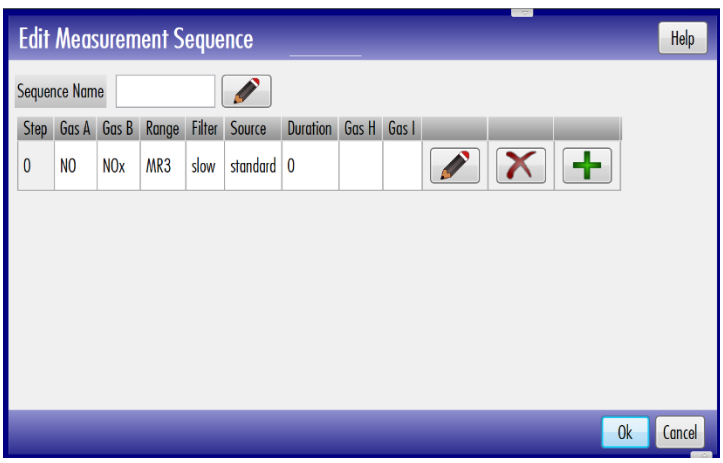
Letter the sequence with a name.

Press again to get to the editing window.



You will be returned to the same window as before but with a new sequence.

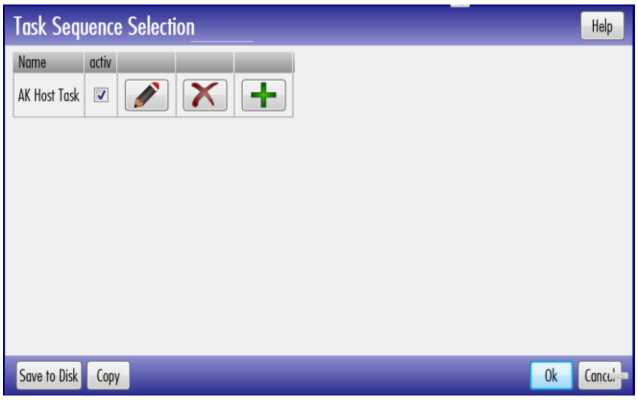
Edit the task with , delete it with or add another step in the sequence with . Quit the window with to save the sequence or press to discard changes.



5.3.1.7 Task Sequence

From the main window select “Measurement” > “Task Sequence”. Use this option to create consecutive and timely scheduled tasks.

There will be a task ‘AK Host Task’ that cannot be deactivated.



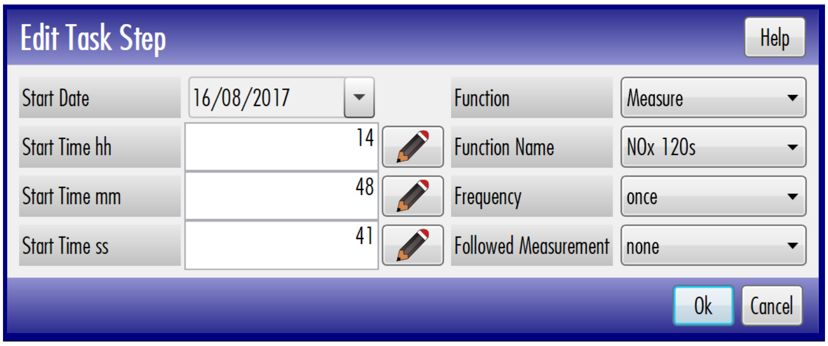
To create a new task press .

Afterwards, there will be opened a new window.

Choose a task sequence name .

Press  to edit the task (required).

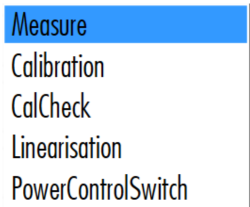
To edit the task, there opens another new window:



Set a start date.

Set start time (hours, minutes, seconds).

Chose the function of the task.



Choose a Function name, frequency and a followed measurement.

Click ‘Ok’.

Activate or deactivate the task.

Eventually delete the created task with this button.

Eventually edit the task if you want to change something.

Store the task to the database by pressing .

Optionally you can save a programmed task by pressing to an additional storage path.

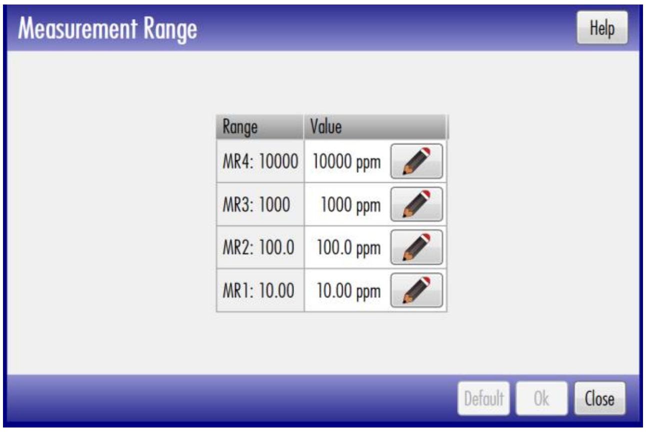
Then choose a File Name and the Directory.

Finish by pressing .

Eventually copy a task by pressing .

5.3.1.8 Setup Measurement Range

Select from the main window "Measurement" > "Measurement Range". A new window opens where different Measurement Ranges can be adjusted.



Press to individually set measurement ranges. In general, all measurement ranges almost achieve equally good results.

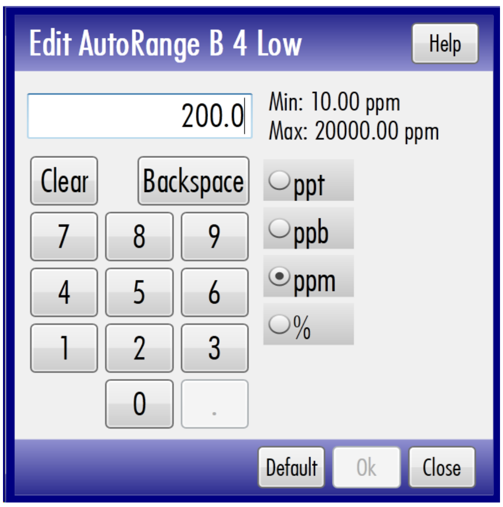
Press subsequently Ok to save the adjustment. If you want to leave the window without doing any changes, press Close.

5.3.1.9 Setup Auto Range Limits

From the main operation menu bar select “Measurement” > “Setup Auto Range Limits”. Now the Auto Range Limits window is displayed:

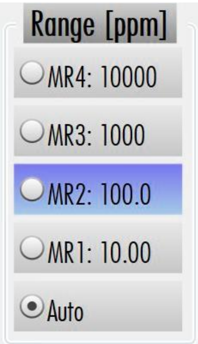
Each range has two range change limits, named as “Low” and “High”. In auto range mode if the measured signal is lower than the Low limit then the analyser automatically changes to the next lower range, e.g. from M4 = 10000ppm to M3 = 1000ppm. In auto range mode if the measured signal exceeds the High limit, then the analyser automatically changes to the next higher range.

Edit  the auto range limits within the given Min and Max limits and choose  the wanted unit (ppt, ppb, ppm or %). Store the new setting by the OK button. By the Default button the factory default auto range limit can be set. To leave the window without doing any changes, press .



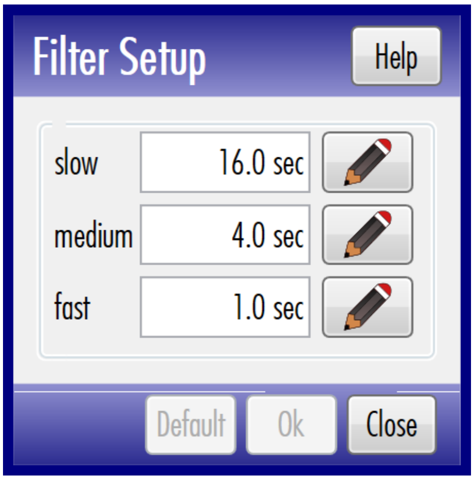
Press afterwards Ok . To leave the window without doing any changes, press Close.

The preinstalled limit value will automatically be executed as soon as you choose «Auto» in the range selection.



5.3.1.10 Setup Filter

Select from the main window "Measurement" > "Setup Filter". Set the length for the measurement data filter.



To change the length for the slow, medium and fast filter, press .

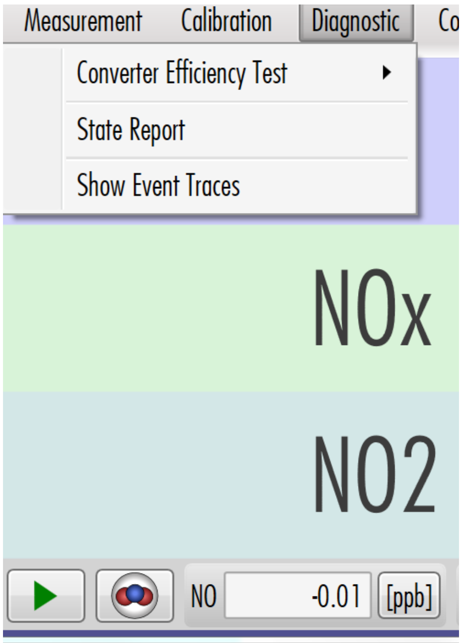
Press afterwards . By the Default button the factory default auto range limit can be set. To leave the window without doing any changes, press .

5.3

5.3.2 Calibration Menu

The operating guide for the calibration menu can be found in chapter 6.

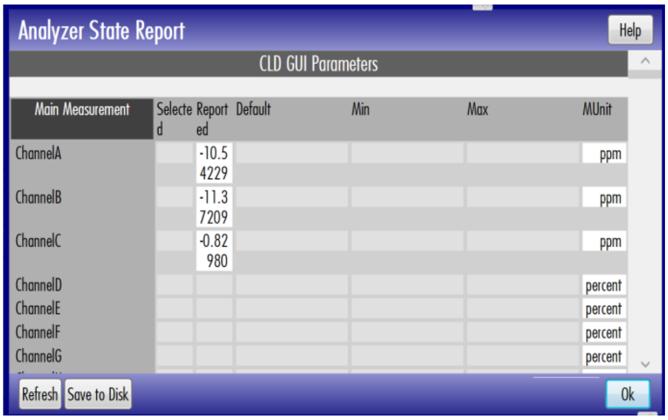
5.3.3 Diagnostic Menu

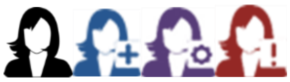


The diagnostic menu shows failures and state of the analyser. In addition, a converter efficiency test can be performed if you have access to the system operator level.

5.3.3.1 State Report

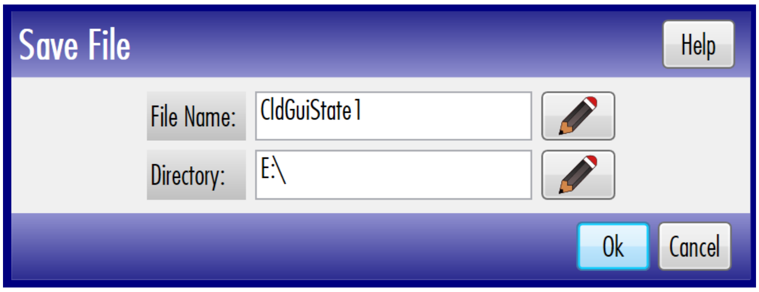
Select from the main window “Diagnostic” > “State Report”. Afterwards a new window appears.





To actualize the state report to the newest version, press Refresh.

To save the report, press Save to Disk.



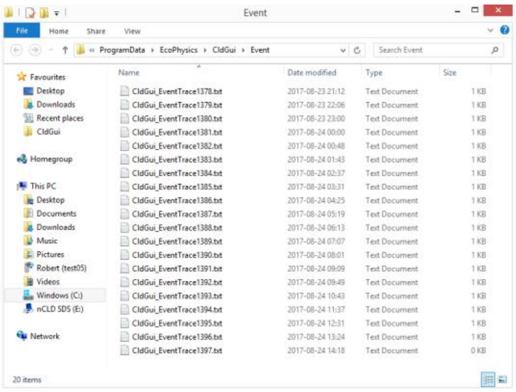
Name the report ✎ and choose a directory ✎. Finish the setting with Ok. If you don’t want to save the report, press Cancel.

Close the following window with Ok. You can now send the report to ECO PHYSICS AG (support@ecophysics.com) to capture and solve potential problems.

5.3

5.3.3.2 Show Event Traces

Select from the main window “Diagnostic” > “Show Event Traces”.



You will now get to the Explorer. By default, the last 20 events will be showed. To see details, double-click on a certain event. There will now be blended a chart where all defective columns are marked.

```
2    =              =================29/08/2017 - 63n0009=================
     Alarm 1 Alarm 2 E01     E02     E03     E04     E05     E06     E07     E08     E(
```

To decode the numeric meaning, use the following chart.

E-01	Setup and Cal. data lost
E-02	Vacuum failure
E-03	Malfunction of a sensor or regulation loop
E-04	Scrubber heating failure
E-05	Ozonator high voltage failure
E-06	Bypass pressure out of Range
E-07	Flow sensor not calibrated
E-08	Peltier cooler failure
E-09	Converter heating failure
E-10	Reactor heating failure
E-11	Tubing heating failure
E-12	Sample / Cal flow out of Range
E-13	Hardware def.! I-Type changed!
E-14	Calibration error
E-15	Inlet pressure O3 out of range
E-16	PMT error

W-01	Converter Lifetime exceeded
W-02	Pump maintenance required
W-03	Instrument Temperature: low
W-04	Instrument Temperature: high
W-05	Bypass out of allowed pressure
W-06	Inlet pressure O3 too low
W-07	not used
W-08	not used
W-09	Range overflow! Change Range.
W-10	O3 up. Ozon not constant!
W-11	not used
W-12	not used
W-13	Range B overflow! Change Range
W-14	not used
W-15	not used
W-16	not used

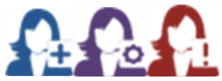
Press × to leave the windows.

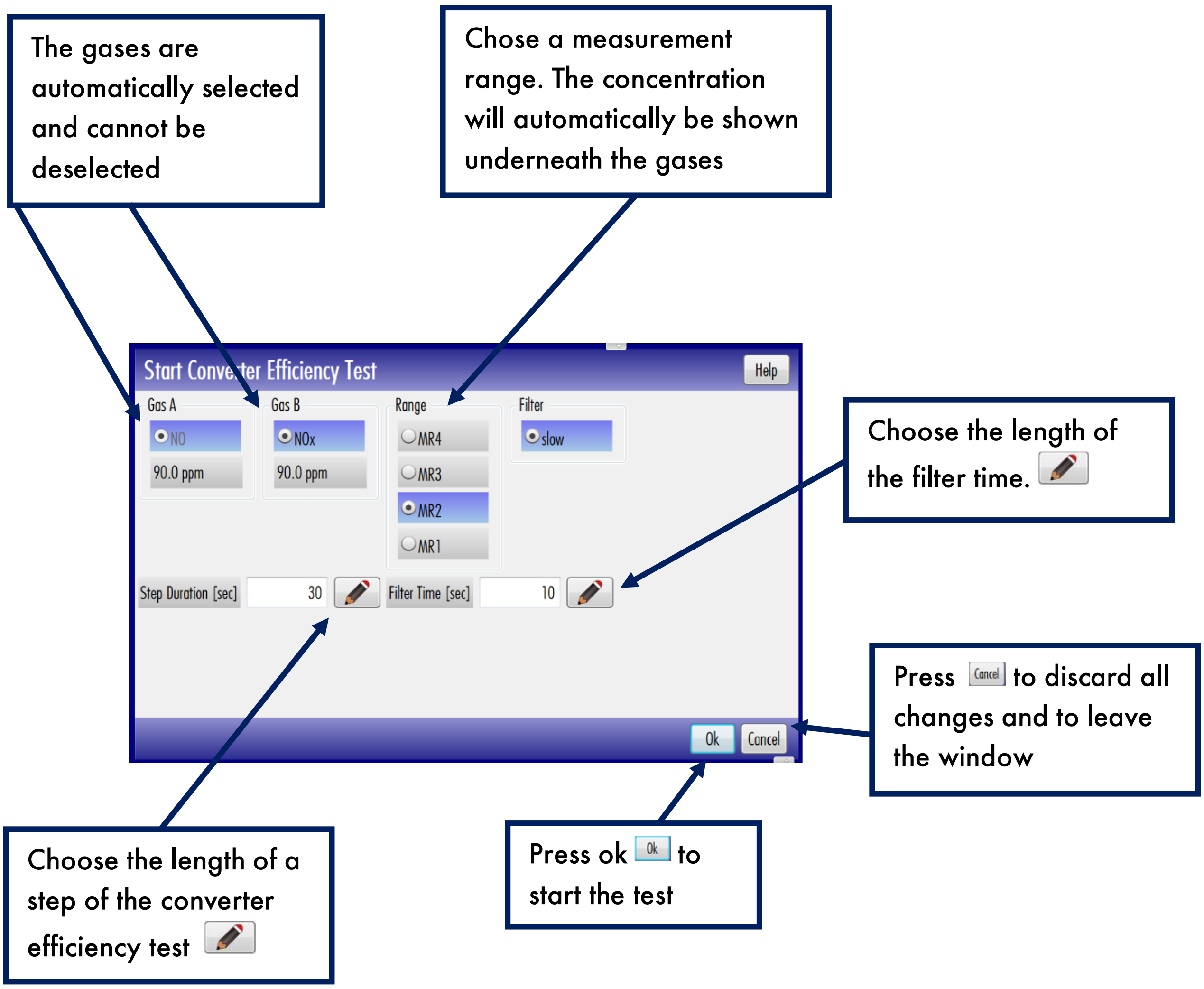
5.3.3.3 Converter Efficiency Test

Note:

This test needs an optional external equipment, a converter efficiency test instrument (EFT). Connect it to your nCLD as described in the operating manual of the EFT. During the test procedure the EFT will be fully controlled by the nCLD:

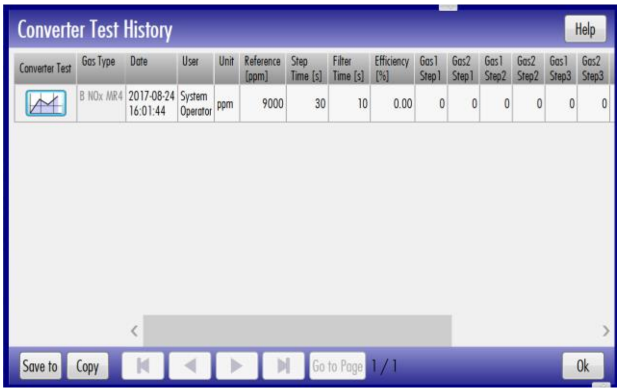
To execute such a converter efficiency test, select from the main window “Diagnostic” > “Converter Efficiency Test” > “Start Test”.

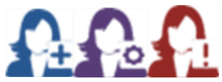




5.3

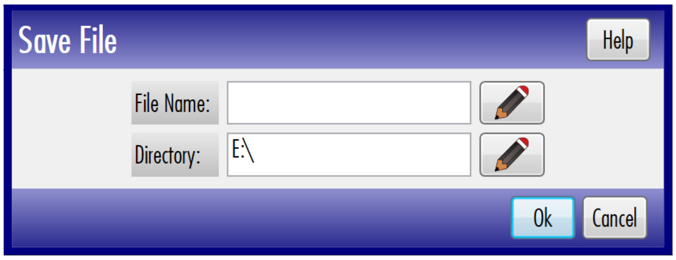
To show the results of the converter efficiency test, select from the main window "Diagnostic" > "Converter Efficiency Test" > "Test Results". Afterwards, a window appears with all details of the previous tests. Press to show the graph of a correspondent measurement.





Eventually copy a task by pressing Copy.

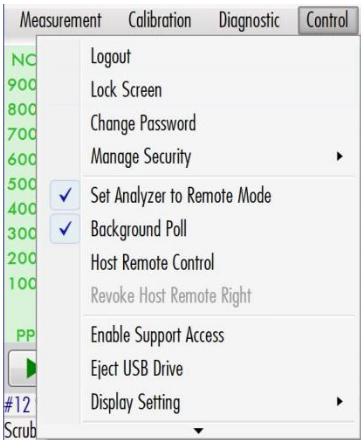
To save a task, press Save to Disk.



Name the file and choose a directory. Finish the setting with Ok. If you don't want to save the report, press Cancel.

5.3

5.3.4 Control Menu



You can find several self-explaining functions in the control menu to navigate the analyser, such as "Logout", "Change Password", "Enable Support Access" and "Eject USB Drive".

5.3.4.1 Manage Security

There are four user levels and 7 right levels. All users have the right "everyone" that contains basic functions. Each right level contains different functions.

The four users have the following right levels by default:

"Standard User" has two rights only: "everyone" and "operation"

"Extended User" has three rights: Same as Standard User plus the right "calibration".

"Maintenance User" has four rights: Same as Extended User plus the right "maintenance"

"System Operator" has six rights: Same as Maintenance User plus the rights "setup" and "security".

The rights contain the following functions, see the following listing:

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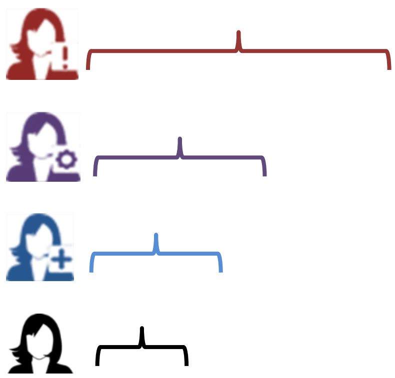

Access Rights							
Access Right --->	0	1	2	3	4	5	6
Functions	every one	operation	calibration	maintenance	setup	security	simulation
Operation							
Select Gas and Range		x					
Auxiliaries					x		
Sensor					x		
Start Measurement		x					
Setup Measurement Range					x		
Setup Auto Range Limits					x		
Setup Filter					x		
Stored Measurements		x					
Delete Measurements					x		
Export Measurements		x					
Displayed Measurement		x					
Measurements		x					
Ongoing Measurement		x					
Measurement Sequence		x					
Add / Edit / Delete Measurement Sequence					x		
Task Sequence		x					
Add / Edit / Delete Task Sequence					x		
Activate Standby		x					
Exit and Power Down		x					

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Access Rights			0	1	2	3	4	5	6
Access Right --->			0	1	2	3	4	5	6
Functions			every one	operation	calibration	maintenance	setup	security	simulation
Calibration									
	Calibration Sequence			x					
		Calibrate			x				
		Check		x					
		Add / Edit / Delete Calibration Sequence					x		
	Calibration Single Step			x					
		Calibrate			x				
		Check		x					
	Calibration Direct			x					
		Calibrate			x				
		Check		x					
	Calibration History			x					
	Calibration Setup					x			
		Phases Parameter Setup				x			
		Reference Gases Setup				x			
		GasDivider Gases Concentration Setup				x			
		Calibration Factors				x			
		Cal Switch Dynamics				x			
	Cal (Check) Result Overview			x					
		Zero-Point and Span Check Deviation		x					
		Calibration Correction Values		x					
	Linearization Sequence			x					
		Linearization			x				
		Linearization Check		x					
		Add / Edit / Delete Linearization Sequence					x		
	Linearization Single Step			x					
		Linearization			x				
		Linearization Check		x					
	Linearization History				x				
	Linearization Setup					x			
		Mode				x			
		Parameters Setup				x			
		Reference Gases Setup				x			
		GasDivider Gases Conencentration Setup				x			
		Linearization Factors				x			
	Lin Check with Cal. Gas				x				
		Lin Check Time			x				
		Current Values			x				
		Start Linearization			x				

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Access Rights

Access Right --->	0	1	2	3	4	5	6
Functions	every one	operation	calibration	maintenance	setup	security	simulation
Diagnostic	x						
Converter Efficiency Test			x				
Start Test			x				
Test Results			x				
State Report	x						
Show Event Traces					x		
Control	x						
Logout	x						
Lock Screen	x						
Change Password	x						
Manage Security						x	
Users						x	
Set Analyzer To Remote Mode					x		
Background Poll					x		
Host Remote Control		x					
Revoke Host Remote Right		x					
Enable Support Access				x			
Eject USB Drive		x					
Display Setting		x					
Apply Default Display Resolution		x					
Configure Multiple Monitors		x					
Exit To Operating System					x		
Exit and Power Down		x					

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Access Rights							
Access Right --->	0	1	2	3	4	5	6
Functions	every one	operation	calibration	maintenance	setup	security	simulation
Setup							
Language Setting					x		
English					x		
Deutsch					x		
Application					x		
Autostart Measurement					x		
Header Text					x		
GUI					x		
Main Window Settings					x		
Child Window Settings					x		
Graph Window Setting					x		
Trace File					x		
Show File Location					x		
MS Security Anti Virus					x		
Scale					x		
SclaeNext					x		
Safe Shut Down Mode					x		
Communication Parameters				x			
Edit Parameters					x		
Control Circuits				x			
Temperature				x			
Pressure				x			
Alarm					x		
I/O's					x		
Analog Output					x		
Digital IO board 1					x		
Digital IO board 2					x		
Power Outlets					x		
Digital IO Functions					x		
AK Function Times			x				
Sensors					x		
Slidefilters					x		
Sensors					x		
Operating Hours				x			
Backup, Restore				x			
Backup Settings				x			
Restore Settings				x			
Revert to Factory Settings						x	

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Access Rights							
Access Right --->	0	1	2	3	4	5	6
Functions	every one	operation	calibration	maintenance	setup	security	simulation
Service							
Trace Communication				x			
Flow Sensor Calibration				x			
Valves and Switches				x			
Valves				x			
Valves Dual				x			
Internal CLD Functions				x			
Switches Source-Valves				x			
Switches Power Control Out				x			
Old Lin Factors, not used				x			
Systemtime Adjustment					x		
Firmware				x			
Firmware Versions				x			
Firmware Update						x	
Restriction Flows				x			
Network, Bluetooth, Mouse					x		
Serial Number						x	

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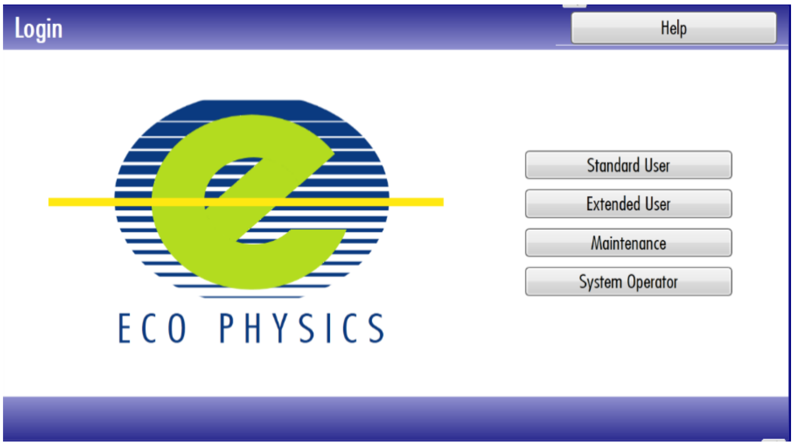
Access Rights										
Access Right --->				0	1	2	3	4	5	6
Functions				every one	operation	calibration	maintenance	setup	security	simulation
Simulation										x
	Simulation On									x
	Simulation NEP									x
	Simulation AI On									x
	Analyzer Type									x
		all types								x
	Max Measurement Range									x
		BhighAlow								x
		low								x
		high								x
	Reconnect									x
	Connected									x
	Ready									x
	Error/Warning									x
		Add Error								x
		Remove Error								x
		Add Warning								x
		Remove Warning								x
	Simulate Calibration Error									x
	Write Simulation to DB									x
Help				x						
	Help			x						
	Operating Manual			x						
	About			x						

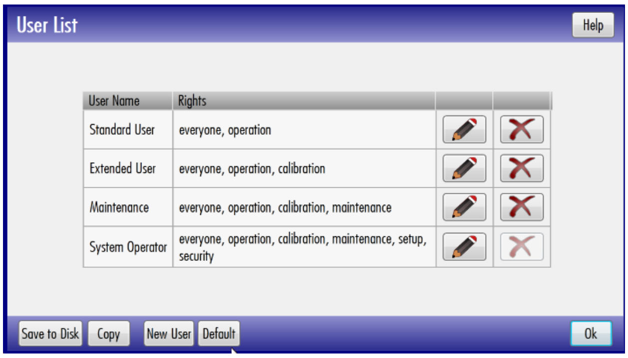


Standard passwords are:

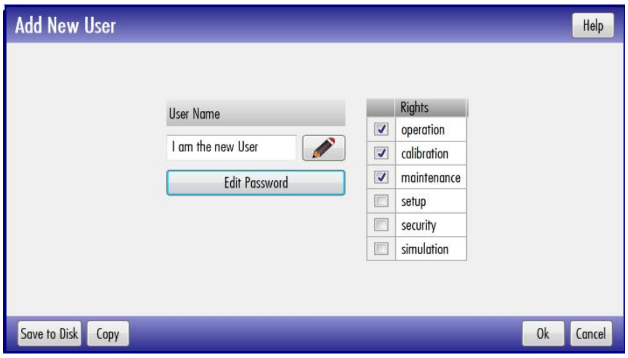
Standard User	"111"
Extended User	"222"
Maintenance	"333"
System Operator	"ITMgr"

It is recommended to change the password after the first power-up!

To add a new user, select from the main window "Control" > "Manage Security" > "Users".



Click «New User».

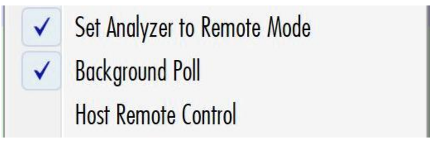


Edit a username . Choose the rights you want to give to the new user and enter a new password Edit Password. Confirm the adding with Ok. To discard the changes and leave the window, press Cancel.

Remark:

The Standard User cannot be deleted. But you can add additional rights to the standard user.

5.3.4.2 Host Remote



"Set Analyser to Remote Mode" and "Background Poll" must always be tagged with a ✓.

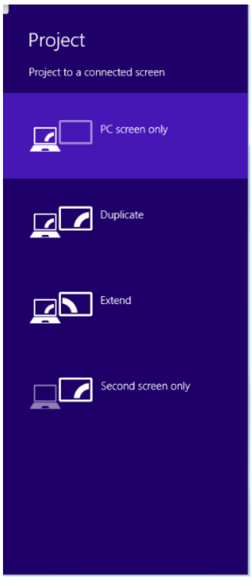
Press "Host Remote Control" to set the operating system into remote mode so you can control the analyser with an external program via RS232. Be aware that you are not anymore able to directly control the analyser with the screen. Put "Host Remote Control" off to be able to control the analyser via screen again.

5.4.4.3 Display Setting

Select from the main window «Control» > «Display Settings».

Apply Default Display Resolution is currently inactive.

To connect the screen of the analyser with another monitor, press «Configure Multiple Monitors». Then press an appropriate option for you.



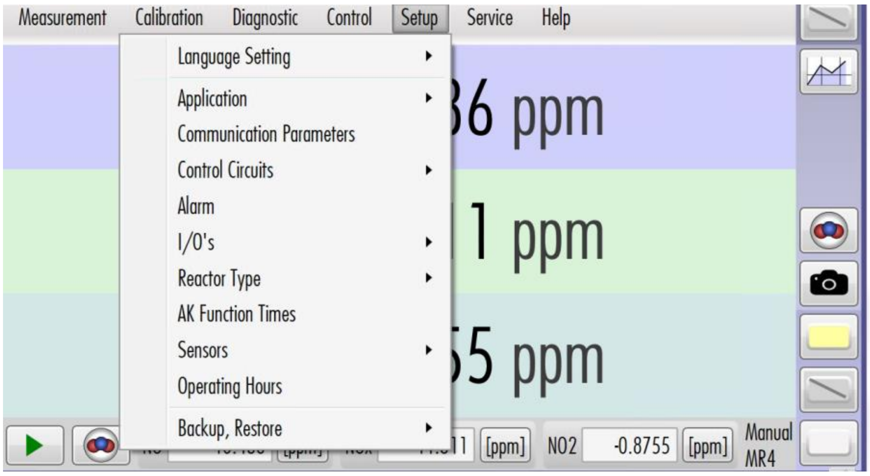
5.4.4.4 Exit to Operating System

To leave the ‘GUI’ to get to the desktop, select from the main window “Control” > “Exit to Control System”. There will pop up a warning window.

Be aware that the Analyser will continue to run but the measurement recording will be stopped. Continue with Ok or return to the GUI with Ok.

To return from the desktop to the ‘GUI’, double click on the CldGui application.

5.3.5 Setup Menu



5.3.5.1 Language Setting

Select from the main window "Setup" > "Language Setting" to choose between English or German. The operation menu will remain in English, but the help information will be shown in the corresponding language. This feature is not yet active.

5.3.5.2 AutoStart Measurement

Select from the main window "Setup" > "Application" > "AutoStart Measurement" to turn on the AutoStart function. It means that after the analyser is turned on the measurement will automatically begin. In the factory settings, this mode is turned on so that the analyser directly sends signals to the analog output and serial RS232 output.

Turned on: 

Turned off (press again on 'AutoStart Measurement'): 

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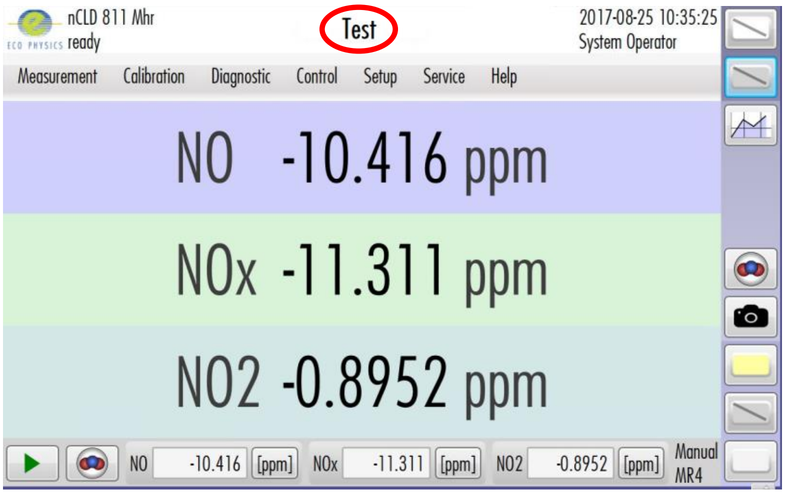
5.3.5.3 Edit Header Text

Select from the main window "Setup" > "Application" > "Header Text" to change the title of the main menu.

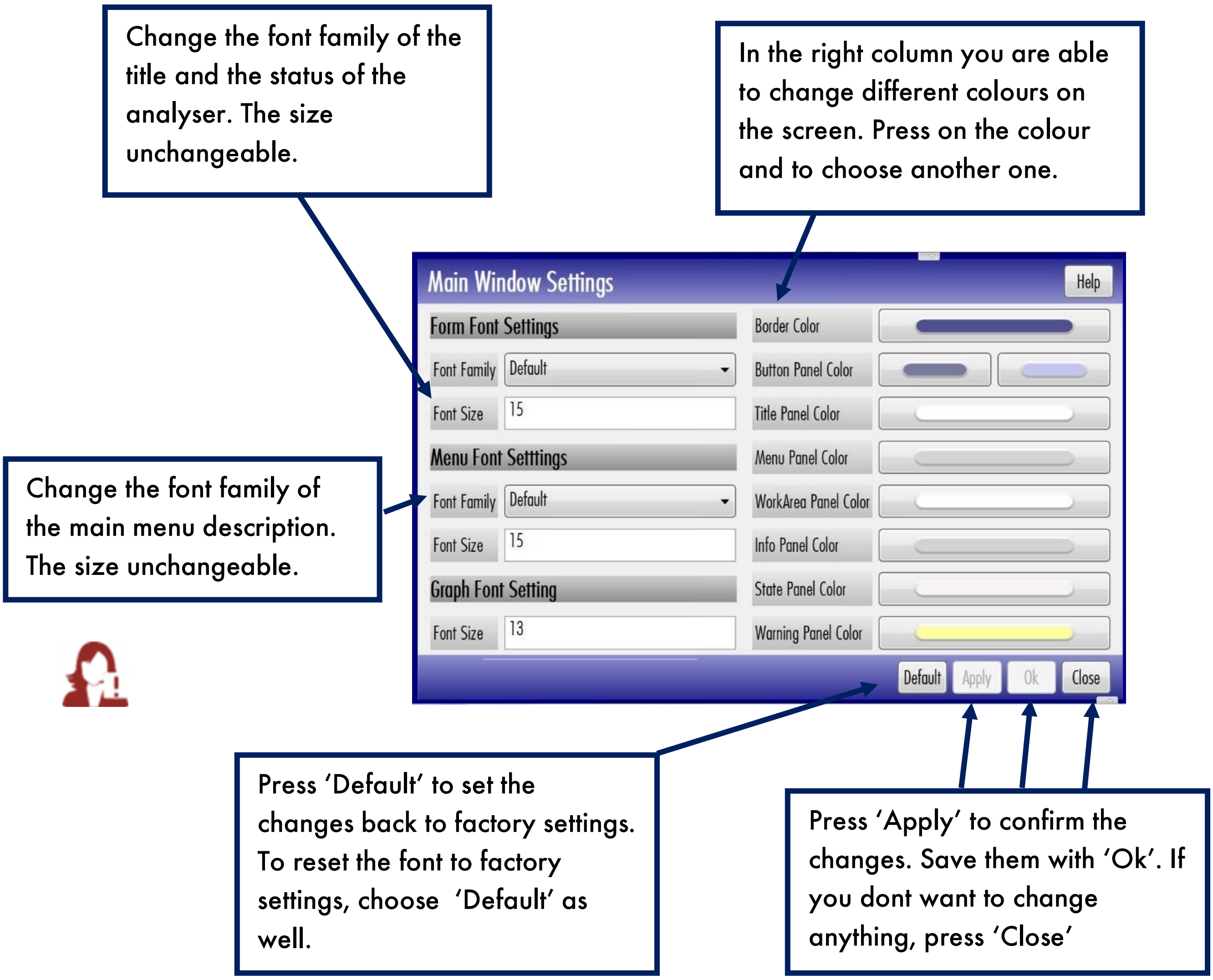
Type in a header text as desired. Confirm the change with Ok or return to the main menu and discard the changes with Cancel.

The new header text should then be apparent.



5.3.5.4 Main window settings

Select from the main menu "Setup" > "Application" > "GUI" > "Main Window Settings" to graphically change the main window.

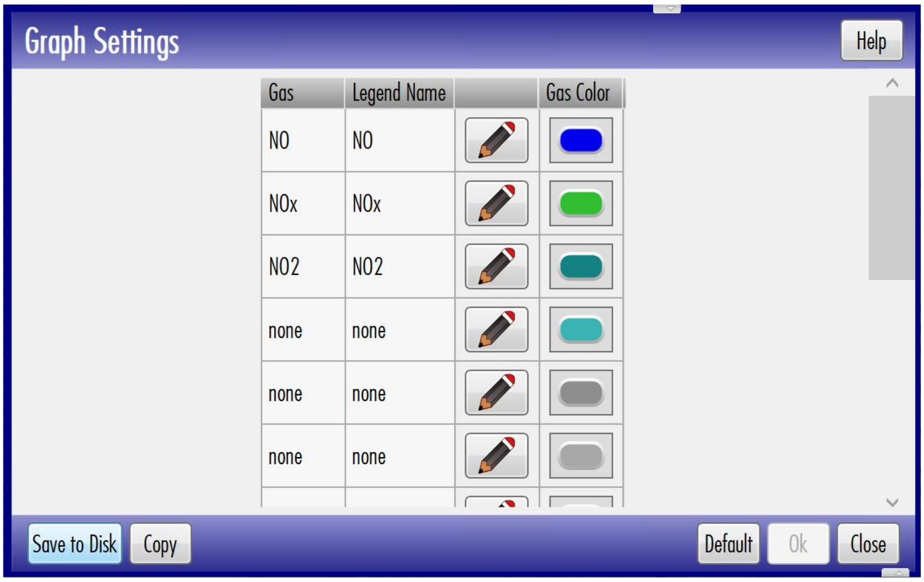


Select from the main window "Setup" > "Application" > "GUI" > "Child Window Settings" and the same window as before appears with the difference, that the child window is edited. For example, font and color of the editing window of a calibration or of a measurement sequence can be changed.

5.3

5.3.5.5 Graph Settings

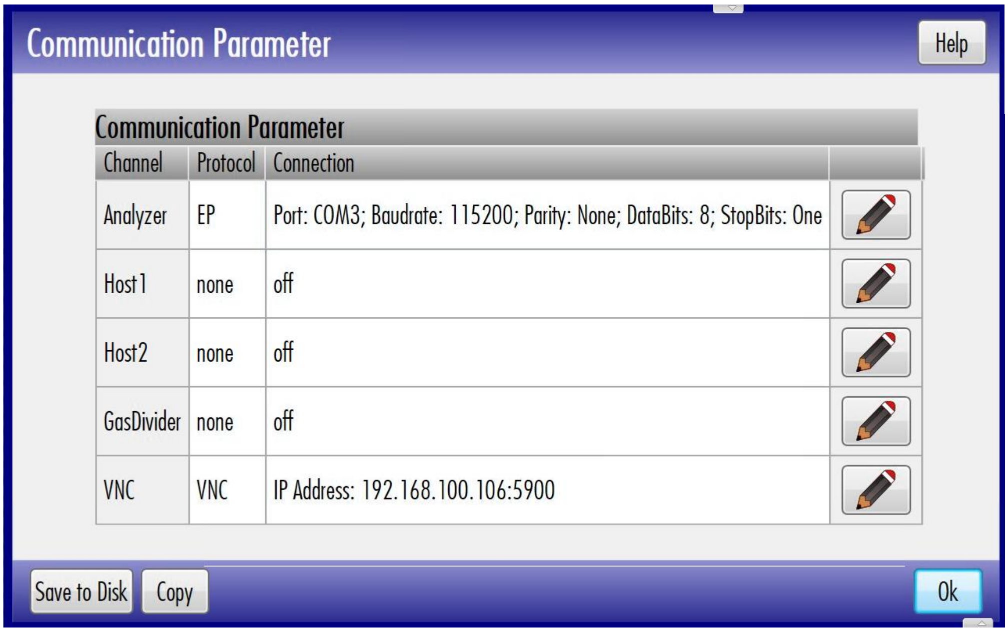
Select from the main window “Setup” > “Application” > “GUI” > “Graph Settings” to change the graph that is displayed in the graphical view.



Change the legend name by pressing . If you click on the color a color gradient appears. Choose an appropriate color for the different legends. Afterwards press ‘Apply’ to exert the change. Save the appliance with ‘Ok’. If you don’t want to change anything, press ‘Close’. To discard all changes and set the changes back to factory settings, press ‘Default’.

5.3.5.6 Communication Parameter

Select from the main window "Setup" > "Communication Parameters".



To change the communication parameters, press .

5.3

Press on the 'Analyser' line to adjust the communication of the analyser.

Choose the 'Communication Type' , the 'Communication Port' and if you want to activate the 'Timestamp' or not . Timestamp is used to note exact points of time when the measurement started and ended. Save the options with 'Ok'. If you don't want to change anything, quit the window by pressing 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

Attention! Do not choose «COM1in communication part!

5.3

To change the communication settings of 'Host 1' and 'Host 2', press on the main window of communication parameter. Choose a communication type, either 'Serial', 'TCP/IP' or 'off'. If the host is activated, you can not only control the Analyser with another computer, you are also able to save data on the host. The GUI then only transmits information and does not save anything.

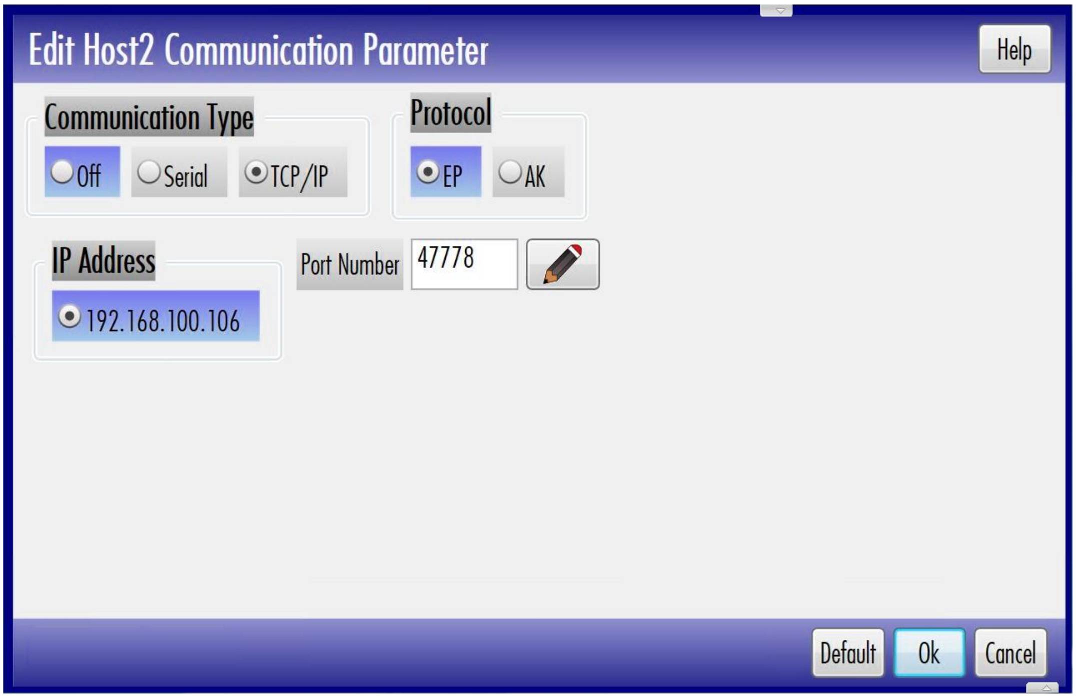
If you choose 'Serial' , the following settings will be displayed because the device is connected via RS232:

Choose your desired 'Protocol' , 'EK' and 'AK' already exist. Choose a 'Communication Port', but not 'COM1' or the computer will crash. Then select your desired 'Baud Rate', 'Parity', 'Data Bits' and 'Stop Bits' . Be aware that the host-device must have the same settings.

Save the options with 'Ok'. If you don't want to change anything, quit the window by pressing 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

5.3

To connect the analyser via LAN, choose 'TCP/IP' :



Choose your desired 'Protocol' , 'EK' and 'AK' already exist. Type in a desired port number . Be aware that the host-device must have the same settings.

Save the options with 'Ok'. If you don't want to change anything, quit the window by pressing 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

5.3

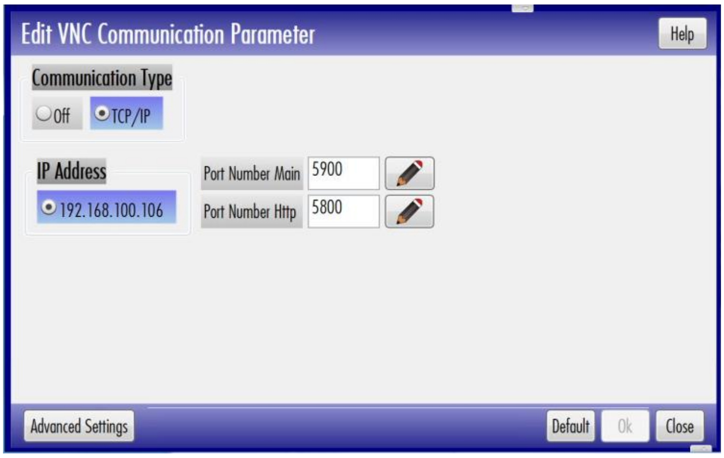
To connect the analyser with a Gas Divider, press on the ‘GasDivider’ channel. Edit the ‘Communication Parameter’, choose either ‘off’ for no connection or ‘Serial’. If you choose ‘Serial’, the following settings will be displayed:

Choose your desired ‘Protocol’, ‘AK’ already exist. Choose a ‘Communication Port’, but not ‘COM1’ or the computer will crash. Then select your desired ‘Baud Rate’, ‘Parity’, ‘Data Bits’ and ‘Stop Bits’. Be aware that the host-device must have the same settings.

Save the options with ‘Ok’. If you don’t want to change anything, quit the window by pressing ‘Close’. To discard all changes and set the changes back to factory settings, press ‘Default’.

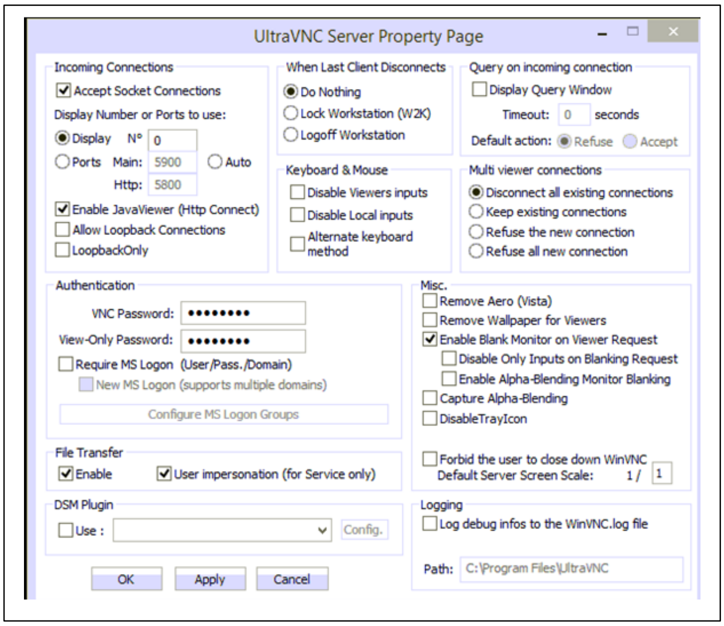
5.3

In order to get access to the nCLD from a remote computer in a way as you would stay in front of the nCLD simply use the 'VNC' technology. To edit the communication of the GUI with the 'Virtual Networking Connection' or short 'VNC', press on the corresponding channel .



Edit the 'Communication Parameter', choose either 'off' for no connection or 'TCP/IP' . You are now able to adjust the 'Port Number Main' and the 'Port Number Http' .

Press  for advanced settings, only IT-Specialists should continue with these settings.



The VNC default passwords is:

ECOnCLD

The default view-only-password is:

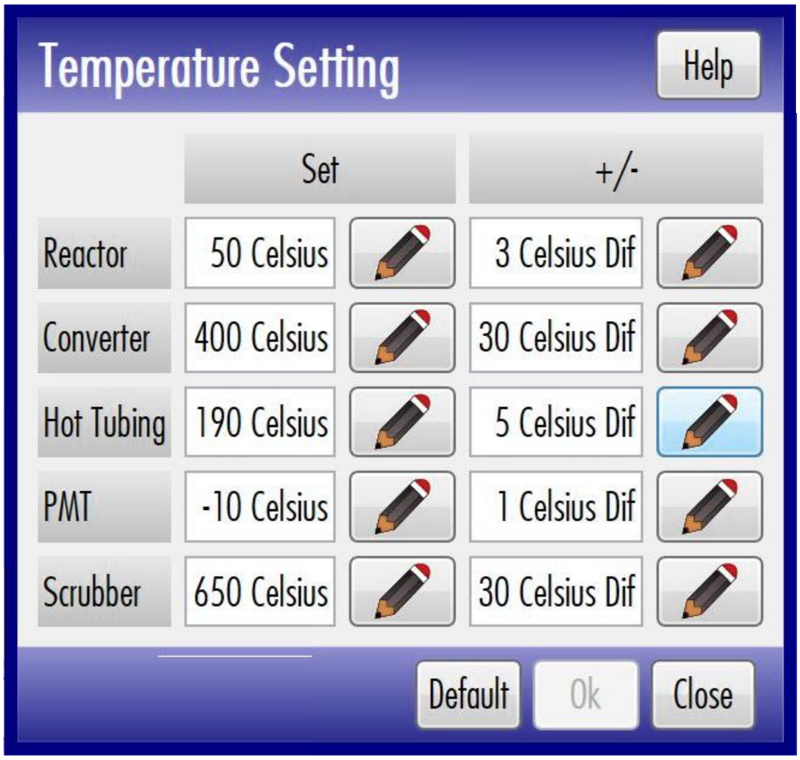
ECOnCLDvo

Save the options with 'Ok'. If you don't want to change anything, quit the window by pressing 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

5.3

5.3.5.7 Pressure and Temperature Settings

Select from the main menu "Setup" > "Control Circuits" > "Temperature" to edit the temperature settings.

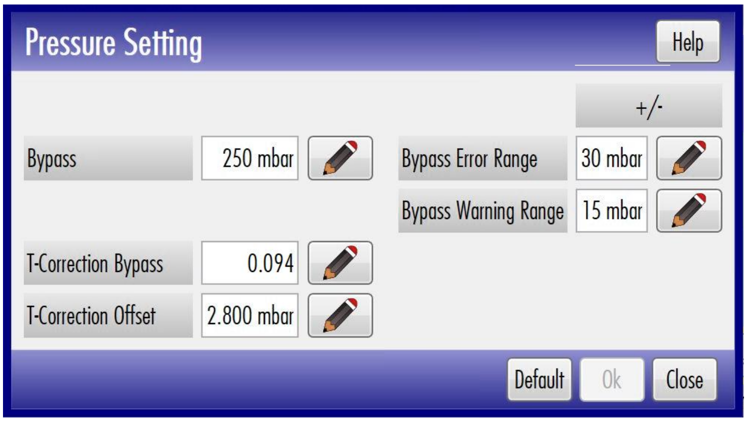


Press in the 'Set' column to adjust temperatures of the corresponding parts in the analyser. On the right side, set temperature differences you want to allow before the analyser sends out warn- and failure signals .

Save the options with 'Ok'. If you don't want to change anything, quit the window by pressing 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

5.3

Select from the main window "Setup" > "Control Circuits" > "Pressure" to edit the pressure settings.



Set the pressure of the bypass as desired. On the right side, you can adjust the bypass error range and warning range. At the point where they reach their limits, the analyser will automatically send failure and warn signals out.

Save the options with 'Ok'. If you don't want to change anything, quit the window by pressing 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

5.3

5.3.5.8 Alarm settings

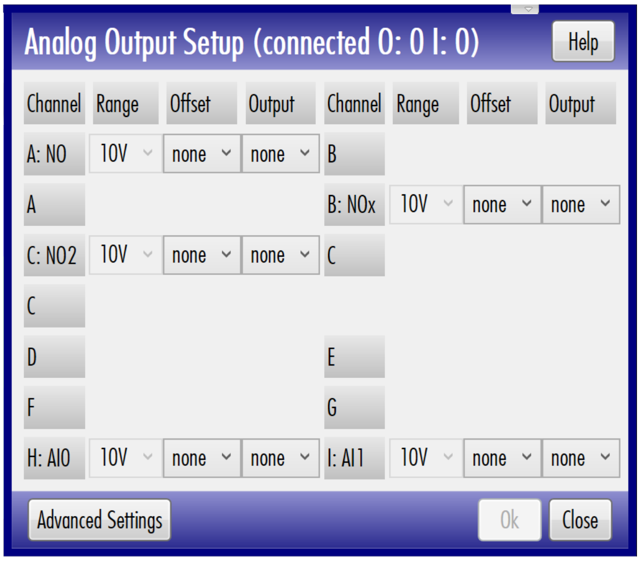
Select from the main window “Setup” > “Alarm” to get to the following window.

Adjust a lower and an upper limit of the concentration of the gases at ‘Lower Limit’ and ‘Upper Limit’ . Now turn on either alarm 1 or alarm 2 for each gas appearance to receive warning messages. It is recommended to set for example for lower limits alarm 1 and for upper limits alarm 2 or reverse. Choose ‘off’ if you don’t want to receive any alarm messages .

Save the settings with ‘Ok’. If you don’t want to change anything, quit the window by pressing ‘Close’. To discard all changes and set the changes back to factory settings, press ‘Default’.

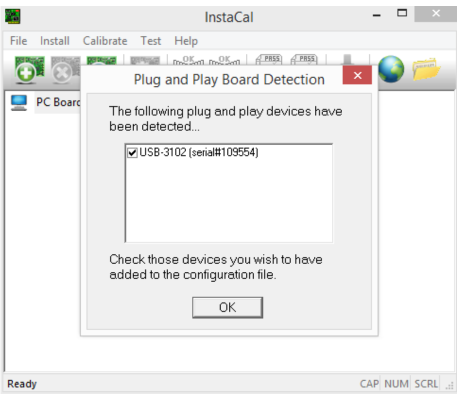
5.3.5.9 Analog Output

Select from the main window "Setup" > "I/O's" > "Analog Output" to configure analog outputs. It is required to have an analog board connected to the analyser. If you didn't connect a board but still open the described path, following window will open with the title "Analog Output Setup (connected O: 01: O).



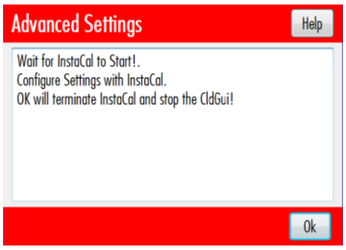
After connecting the analog board with the analyser, install the device as follows.

Press Advanced Settings. A warn signal occurs saying that the following settings should only be performed by an IT-Specialist. Continue with Ok. The program "InstaCal" will automatically be opened. Select the board connected to the analyser.

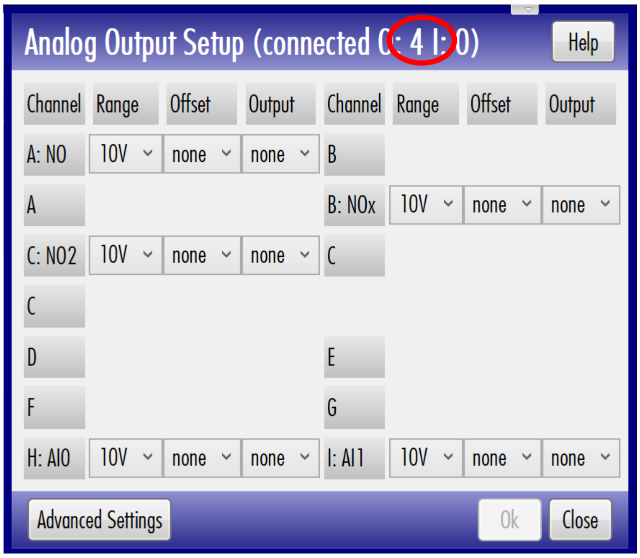


5.3

The analog board should now be displayed. Leave the window by pressing .
A new window occurs.



Confirm with 'ok'. InstaCal will terminate and stop the CldGui. You will automatically be logged in as "Standard User" after the GUI has restarted. Log out ("Control > "Logout") and relog as system operator. Then again choose in the main menu "Setup" > "I/O's" > "Analog Output". A new window occurs that shows in the title, how many potential connections your analog board contains. Our connected board in the example has four.

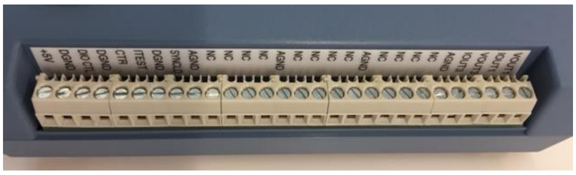


Adjust for every gas the range, meaning which kind of signals should be sent out, either 10Volt or 20mA signals.

In addition you can choose an 'Offset'. This function allows the analyser to send potential negative signals than can be read by the analog-board. If it is set to 20%, the measured value of 0 will not send a 0V signal, but it will send 20% of the 10V, meaning 2V. If there should appear any negative values, for example -1, the signal is positive (1V) and can be read by the board.

5.3

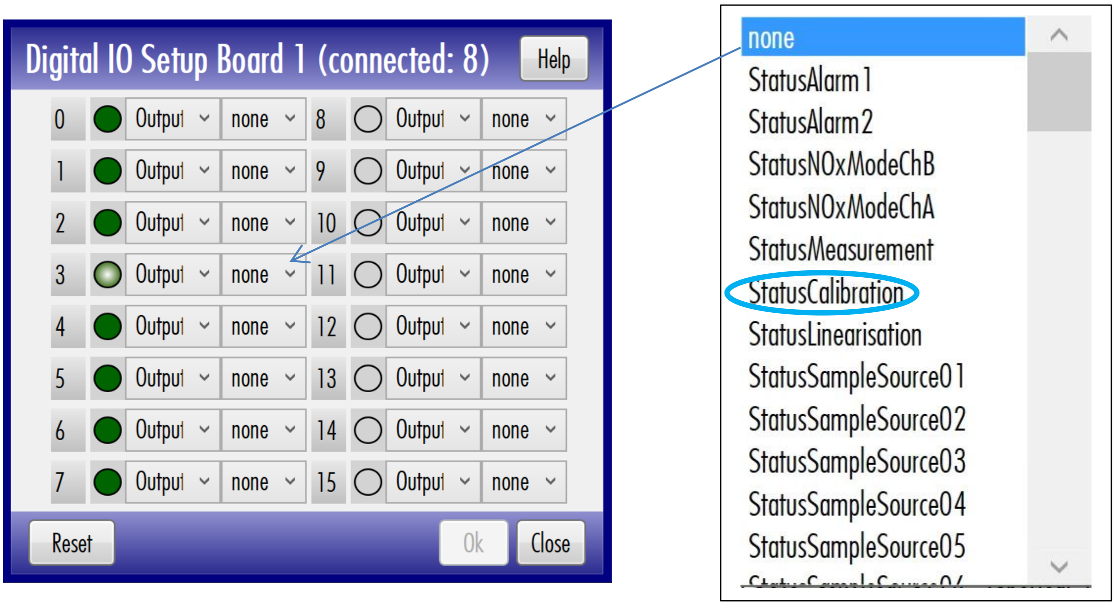
Indicate the selected 'Output' of the wire connected to the analog-board. Our device has 4 connection points, so there are '4 Outputs'. Choose therefore from A000 to A003. That is in our example VOUT0, VOUT1, VOUT2, VOUT3 for outputs with voltage as signal and IOUT0, IOUT1, IOUT2, IOUT3 for outputs with amperage as signal. The boards possess as much outputs as connection points.



Save the settings with 'Ok'. If you don't want to change anything, quit the window by pressing 'Close'.

5.3.5.10 Digital Outputs

Select from the main window “Setup” > “I/O’s” > “Digital Board 1” or “Digital Board 2” to configure the digital outputs. Digital board 1 has maximum 16 outputs and provides access to both digital and analog connections. Digital Board 2 has maximum 96 digital only outputs. Look in chapter 5.3.5.9 how to install these outputs. The board in our following example has 8 digital outputs. Occupied outputs are signalized with a green point.

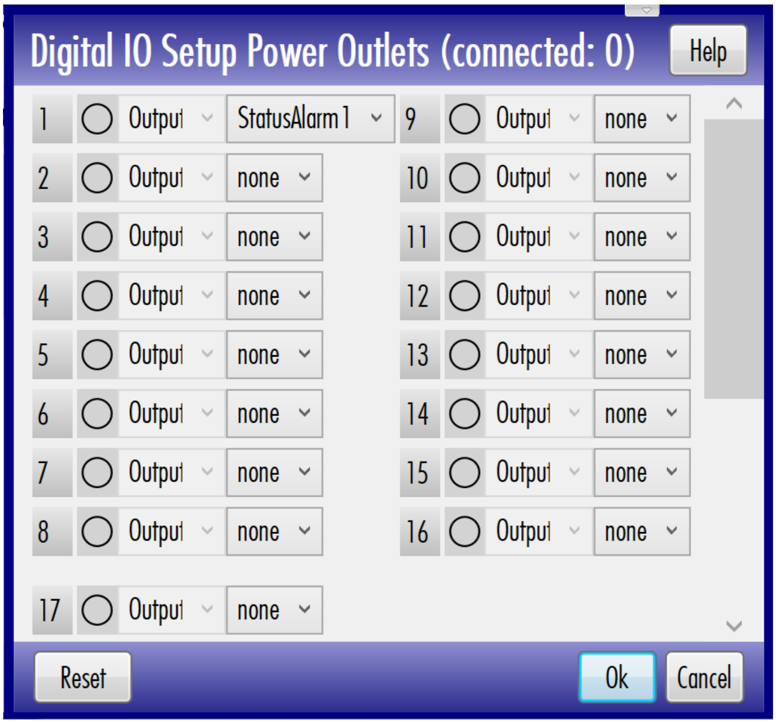


Choose if the board should serve as input or output, in our example it is connected as outputs. You can decide which function the out/input should have at the ‘none’ sections, for example “StatusCalibration” which means, that for an ongoing calibration the analyser automatically sends digital signals.

Save the settings with ‘Ok’. To discard all changes, press ‘Reset’. If you don’t want to change anything, quit the window by pressing ‘Close’.

5.3.5.11 Power Outlets

Select from the main window "Setup" > "I/O's" > "Power Outlets". Power outlets do not only transfer data, but they can also be linked with another electronical device.

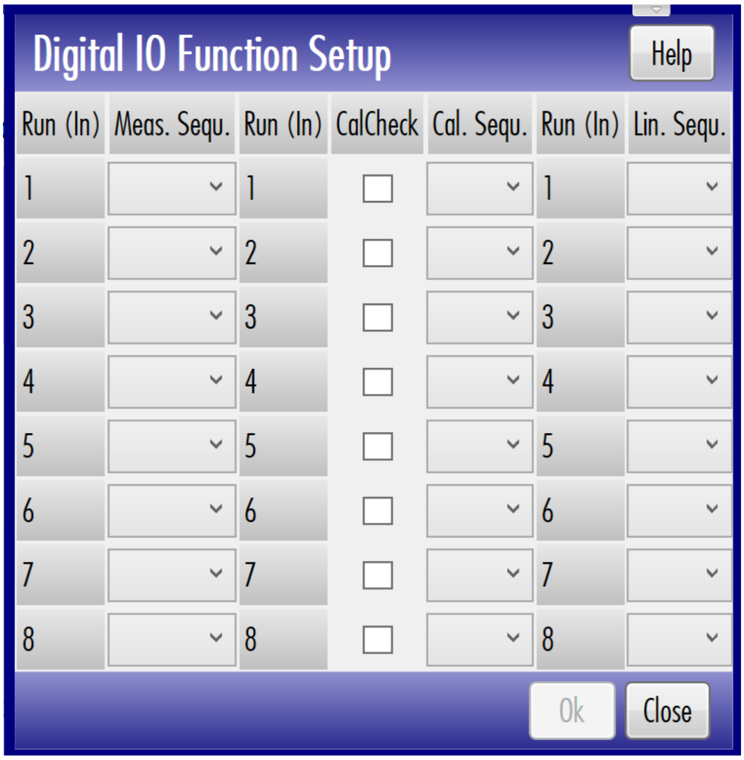


In this example 'StatusAlarm1' is selected at Output 1. Now you could for example link an alarm lamp with the analyser so that every time StatusAlarm1 occurs, the lamp starts to blink. That is a fast way to connect devices and to ease the application.

Save the settings with 'Ok'. To discard all changes, press 'Reset'. If you don't want to change anything, quit the window by pressing 'Close'.

5.3.5.12 Digital Input/output Function Setup

Select from the main menu "Setup" > "I/O's" > "Digital IO Functions" to configure digital in- and outputs. The following window conduces to control measurement, calibration and linearization sequences by sending input signals. The digital-board is equipped with the TTL-principle and can read signals under 0.8V or >2V-5.5V. To get more information about the boards, look it up in the corresponding manual by pressing the 'Help' button.

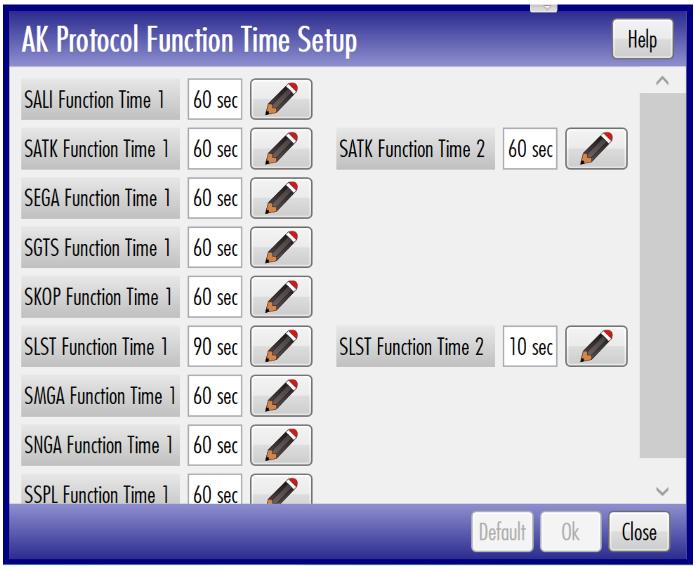


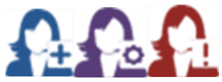
Choose which measurement, calibration and linearization sequence you want for which channel (1-8). Define if a calibration check should be executed as well by pressing 'CalCheck'.

Save the settings with 'Ok'. If you don't want to change anything, quit the window by pressing 'Close'.

5.3.5.13 AK Functions

Select from the main menu “Setup” > “AK Function Times” to edit the running times of the AK protocol. It is required that 'AK’ is selected in the host communication parameters (chapter 5.3.5.6). Then you can choose the length of the different AK-sequences.

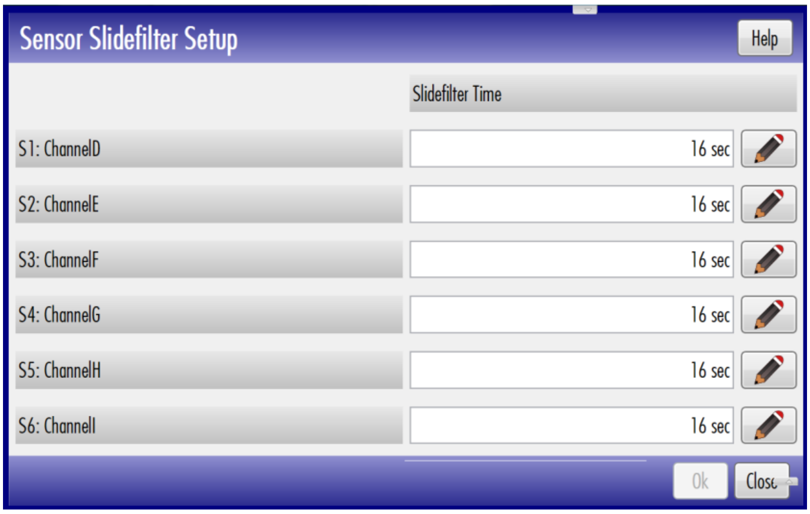




The meaning of the different AK-sequences is described in chapter 8. Save the appliance with ‘Ok’. If you don’t want to change anything, press ‘Close’. To discard all changes and set the changes back to factory settings, press ‘Default’.

5.3.5.14 Slidefilters

Select from the main window "Setup" > "Sensors" > "Slidefilters" to edit the slide filter for channel D to I.



To set the length of the filter for the corresponding channels, press . The longer the filter time, the exacter are the results but the longer takes the measurement.

Save the appliance with 'Ok'. If you don't want to change anything, press 'Close'.

5.3.5.15 Sensor Gas Setup

Select from the main window «Setup» > «Sensors» > «Sensors»

5.3.5.16 Operating Hours

Select from the main window “Setup” > “Operating Hours” to check the operating time of the analyser, the pump and the converter.

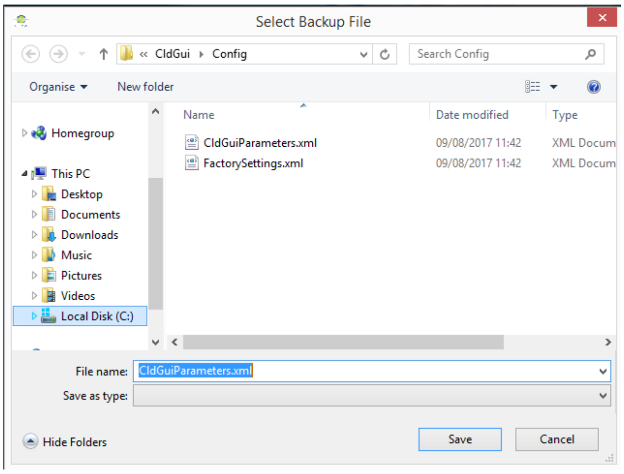
The unit of the numbers is hours. The Analyser section shows how long the analyser is in operation. This number cannot be changed.

The pump and converter operating hours are counting down from a preinstalled value to 0. In this example, the initial value is 10’000 hours. As soon as these 10’000 hours are reached, a warning occurs that the pump and the converter must be replaced. You can choose the length of this period by pressing .

Save the appliance with ‘Ok’. If you don’t want to change anything, press ‘Close’.

5.3.5.17 Backup and Restore Settings

Select from the main menu "Setup" > "Backup, Restore" > "Backup Settings" to perform a backup of the measurement data and configurations. You will be automatically leaded to the explorer.

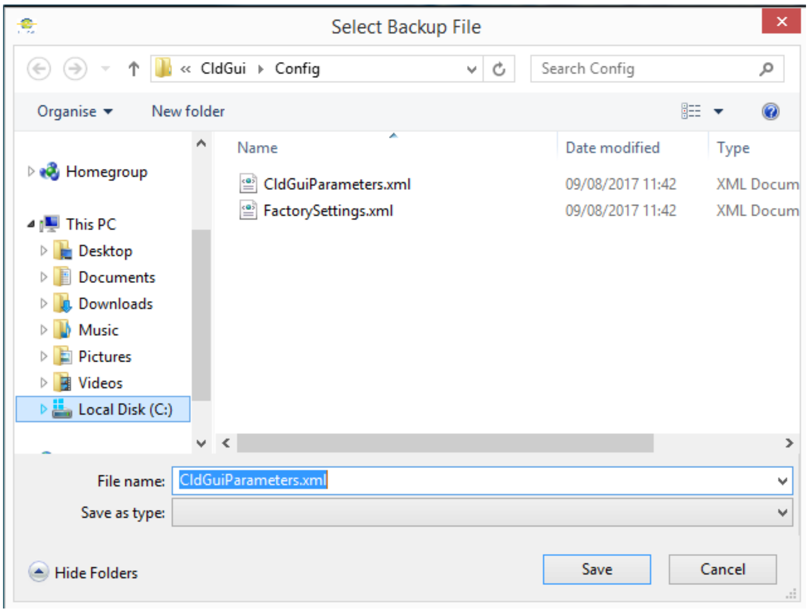


In the 'File Name' input field is the right path already written down. Press 'Save' to save your own backup. Do not press 'FactorySettings' or the factory will be overwritten, and it will not be able to set the device back to factory settings. To leave the window without saving, press 'Cancel'.

Attention! Do not press 'FactorySettings' or the factory will be overwritten, and it will not be able to set the device back to factory settings!

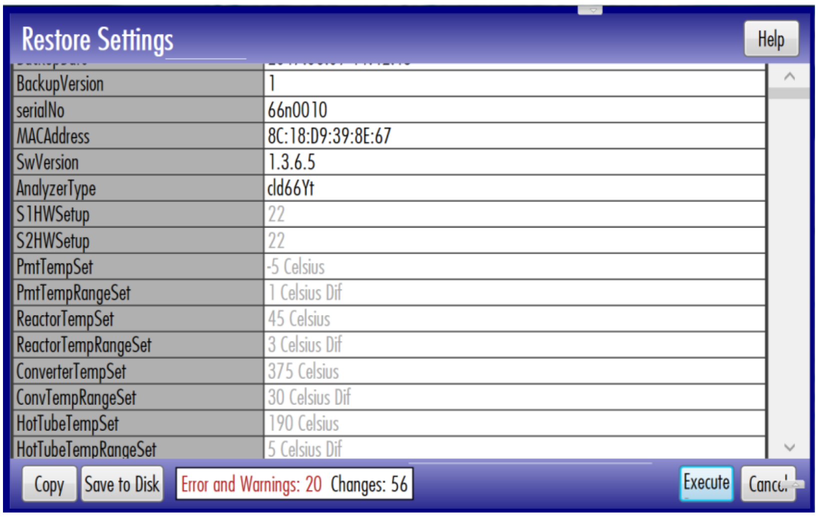
5.3

To replace your own backup with the actual data, select from the main window "Setup" > "Backup, Restore" > "Restore Settings".



Double-click on the given file name (CldGuiParameters) or press 'Save' to reset the device.

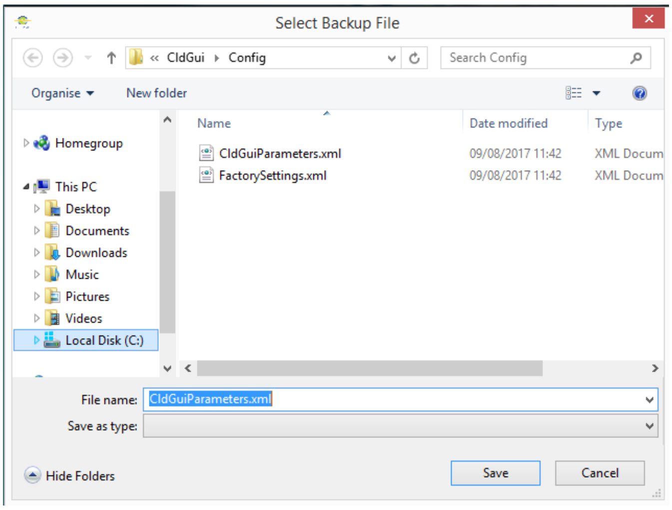
A new window appears:



To finish the backup, press Execute. To leave window without saving the recovery, press 'Cancel'.

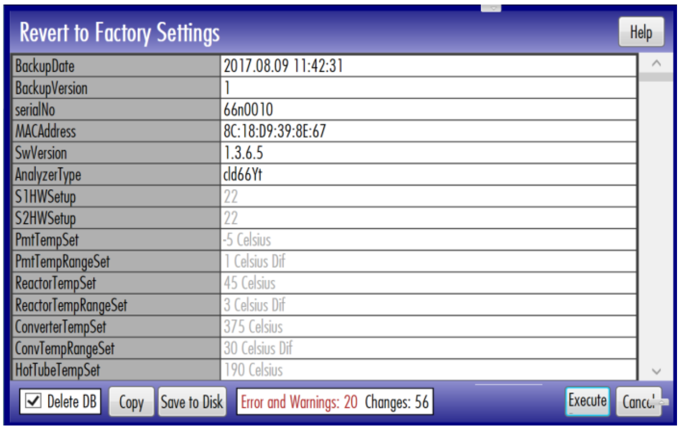
5.3

To set the analyser back to factory settings, select from the main window "Setup" > "Backup, Restore" > "Revert to Factory Settings".



Double-click on the given file name (FactorySettings) or press 'Save' to reset the device.

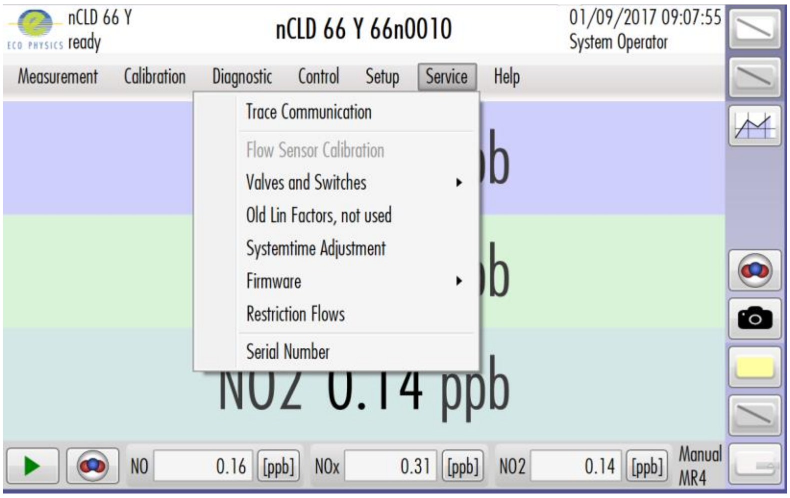
A new window appears:



If you want to additionally delete the whole database, to erase all saved data, press in the lower left corner and will appear a confirmation ☑ Delete DB. If you don't want to delete the data bank, press again so it looks like this ☐ Delete DB.

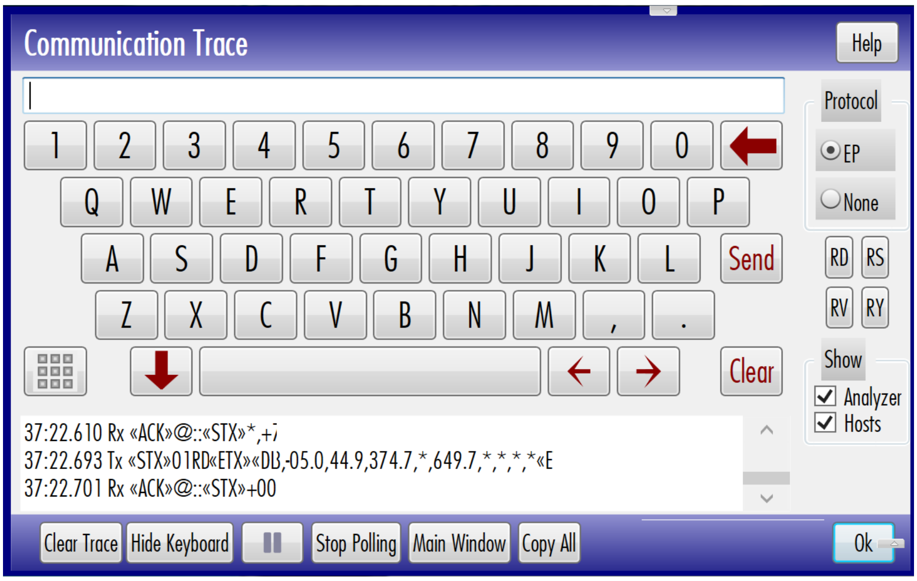
To finish the backup, press Execute. To leave window without saving the recovery, press 'Cancel'.

5.3.6 Service Menu



5.3.6.1 Trace Communication

Select from the main window "Service" > "Trace communication" to send tasks to the communication of the GUI and the analyser-processor by IT-Specialists only.

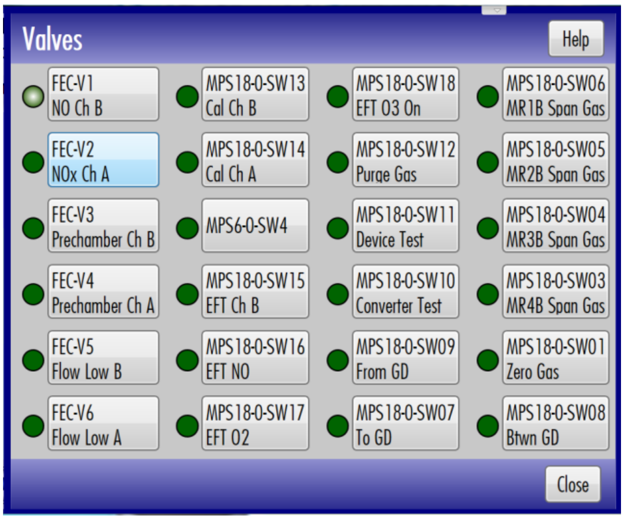


Quit the window by pressing 'Ok'.

5.3.6.2 Valves and Switches

Select from the main menu "Service" > "Valves and Switches" to get to settings of the valves and switches.

Press 'Valves' to depict the valves overview.

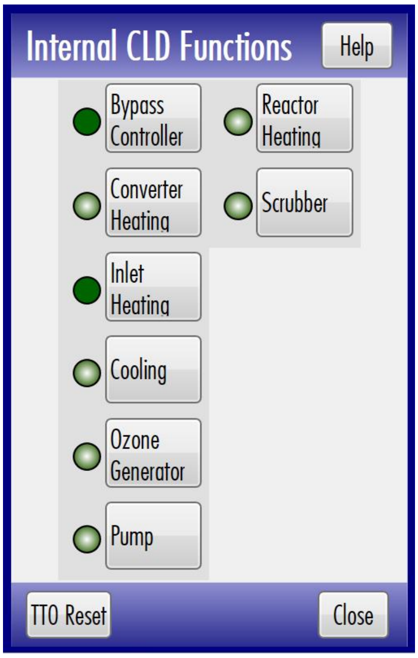


Press on different valves that are connected to the analyser to switch them on or off. If the green point is pale, the valve function is deactivated. Test the functionality of the valves by looking if they react when they are turned on.

Leave the window by pressing 'Close'.

5.3

Press ‘Internal CLD Functions” to control the components of the analyser.

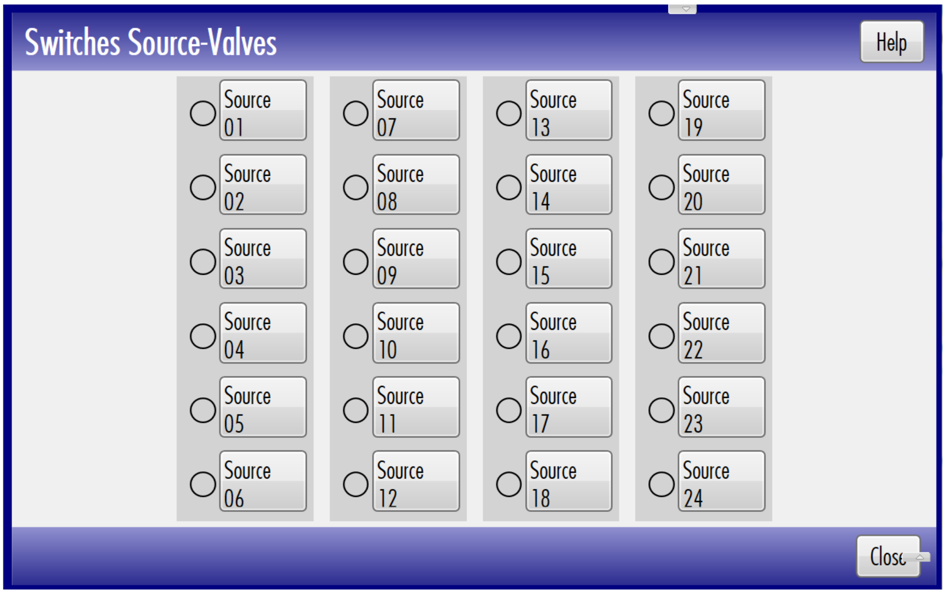


Switch the components on or off by pressing on the corresponding box. Pale green points signify that the devices are turned on. Be aware that arbitrary turning off the components can cause serious damage to the analyser, for example overheating.

Leave the window by pressing ‘Close’.

5.3

Press 'Switches Source-Valves' to configure multiple sources of the valves.

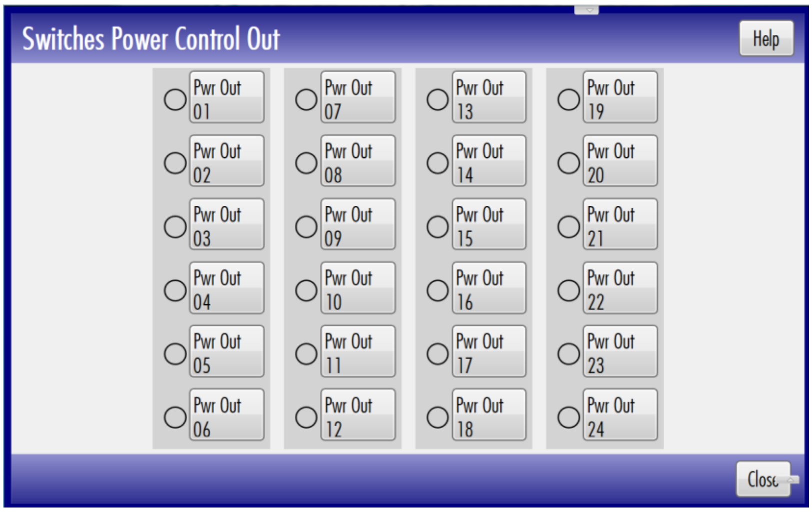


If something is connected to the valves, a green (turned on) or pale green (turned off) point appears in the corresponding box. Test the functionality of the valves by turning them on and off and see if something changes.

Quit the window by pressing 'Close'.

5.3

Press ‘Switches Power Control Out’ to test the devices connected to the power-board.

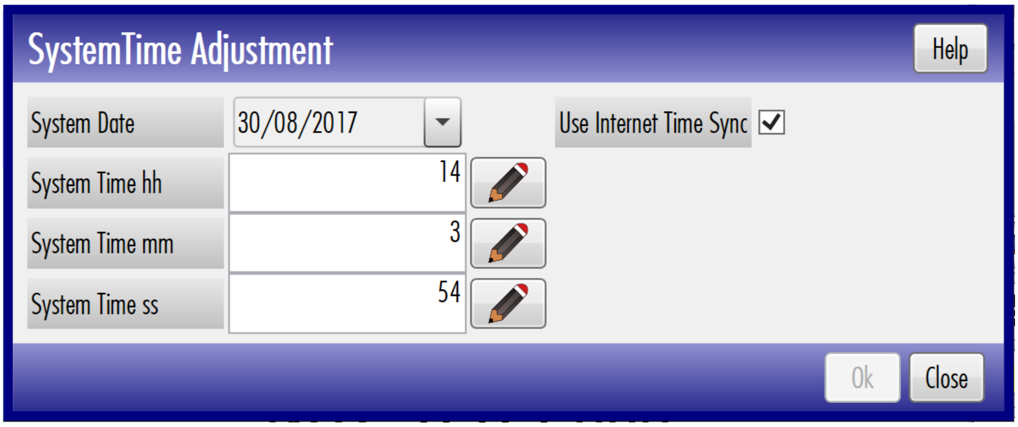


If something is connected to the valves, a green (turned on) or pale green (turned off) point appears in the corresponding box. Test the functionality by turning them on and off and see if something changes.

Quit the window by pressing ‘Close’.

5.3.6.3 System time Adjustment

Select from the main window "Service" > "System Time Adjustment" to set the time of the analyser.



Specify the current date .

Optionally indicate the system time manually (hours hh, minutes mm, seconds ss) .

If you are connected to internet, use internet time synchronization to automatically set the local time. Press on the white square Use Internet Time Sync so that a ✓ appears. Now the time is synchronized with the internet.

Save the appliance with 'Ok'. If you don't want to change anything, press 'Close'.

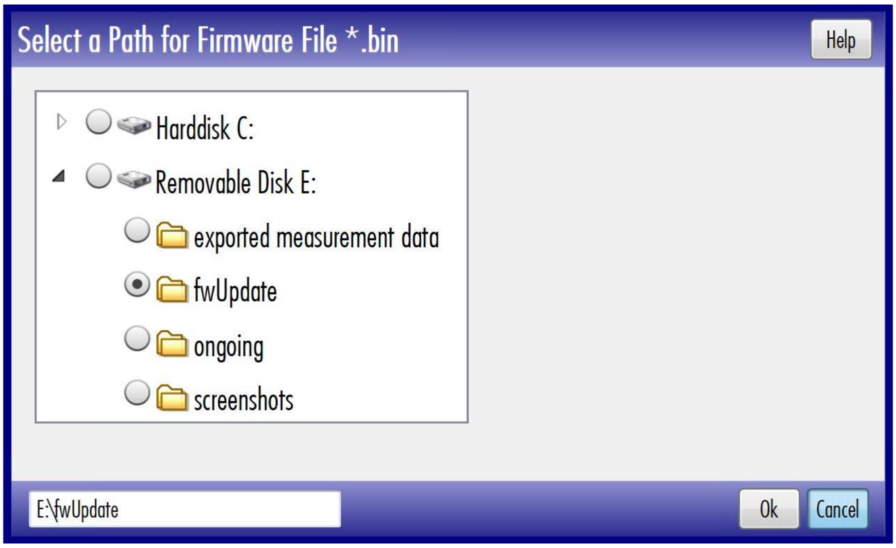
5.3.6.4 Firmware

Select from the main menu "Service" > "Firmware" > "Firmware Versions" to show the actual version of the firmware.

The actual versions are now displayed.

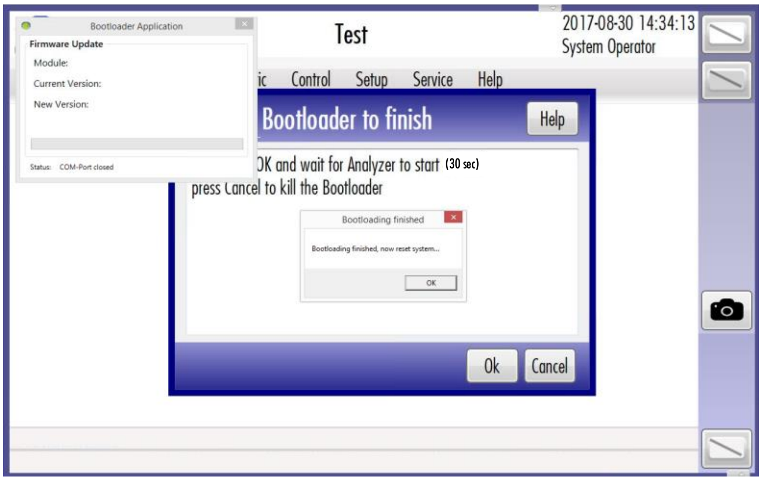
Quit the window by pressing 'Ok'.

Select from the main menu "Service" > "Firmware" > "Firmware Update" to conduct an update for the firmware.

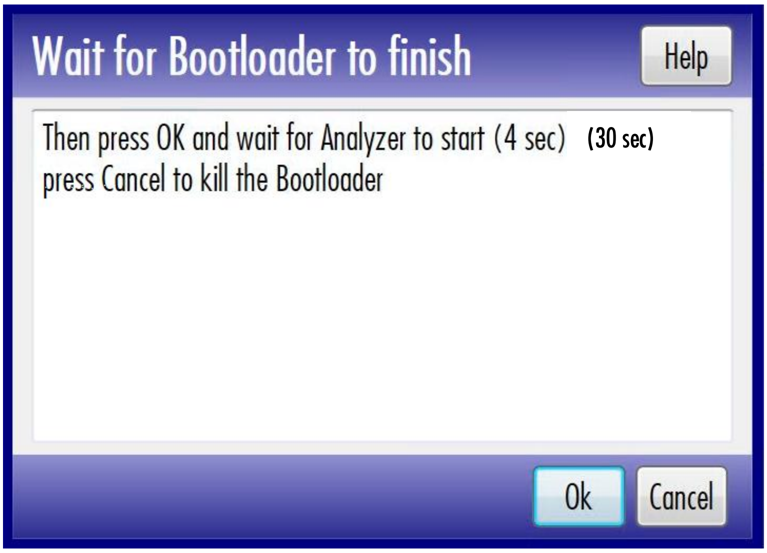


Choose a saved update, that you received from Eco Physics. Then press 'Ok' to confirm the update or press 'Cancel' to leave the window.

Press 'Ok' to continue with the update.

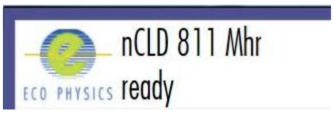


Press 'Ok' on the central window to continue.



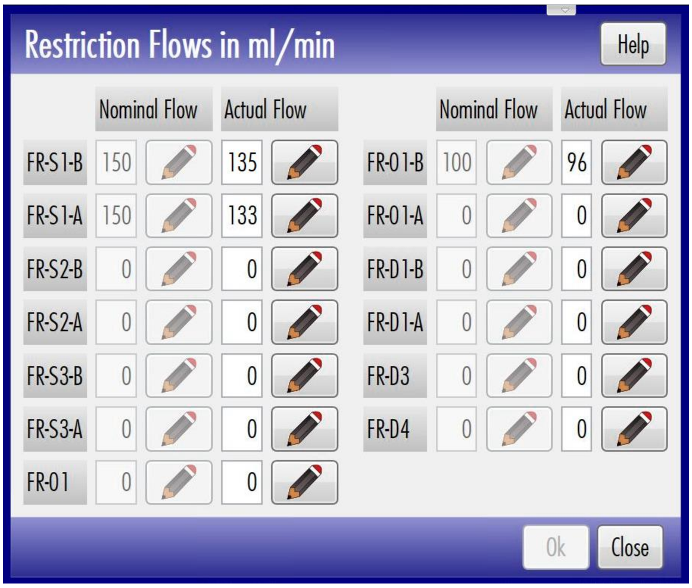
Then press 'Ok' and follow the instructions to finish the update or press 'Cancel' to kill the Bootloader and stop the Update.

After the update is finished, the analyser needs to restart. Wait until the status changes form 'powerUp' to 'Ready'.



5.3.6.5 Restriction Flows

Select from the main window "Service" > "Restriction Flows" to calculate the deviation of the critical orifice.

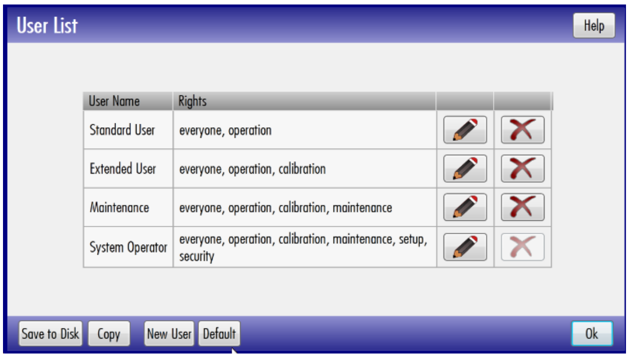


In the left column 'Nominal Flow' are the standardized values of the various critical orifices visualized. On the right side are the actual flow values visible. You are now able to edit the values. To calculate the deviation, subtract the actual flow from the nominal flow. If a high deviation occurs, you should change the orifice.

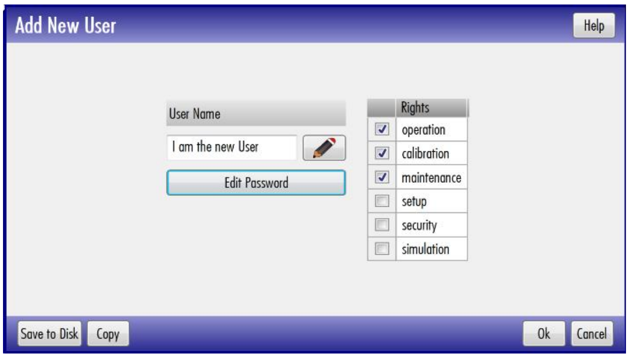
5.4

5.4 New user in user list

Select: "Control" → "Manage Security" → "Users"



Click "New User"

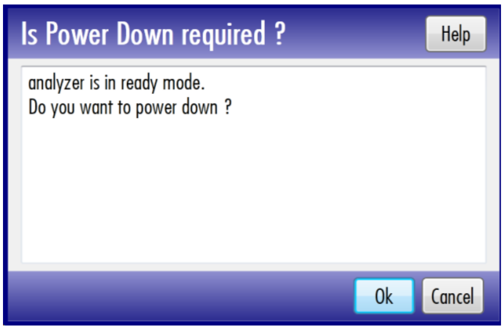


Edit  a username, select the corresponding rights and enter a new password in "Edit Password". Confirm and close by the OK button.

5.5 Interruptions of operation

5.5.1 Long interruptions

Select "Measurement" → "Exit and power down" in order to completely shut off the analyser. Alternatively, you can select "Control" → "Exit and power down". Confirm the activation of the complete power down by the OK button. If you don't want to power down the analyser push "Cancel".



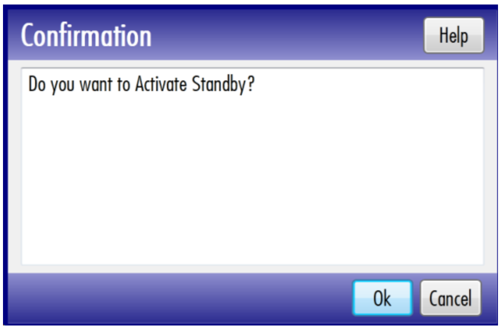
Wait 30 seconds to let flush out the remaining ozone from the analyser and tubing. Do not switch off the main switch at the back of the analyser before you have seen the message "No signal" on the display. After the complete power down process (about after 60 seconds) the instrument's display must be completely black. Now you can flip the main switch at the back of the instrument to "off" and remove the power cord to the pump.

Caution:
Never shut off the instrument by pulling out the main cord or simply by flipping the main switch to "off". Please perform always above procedure.

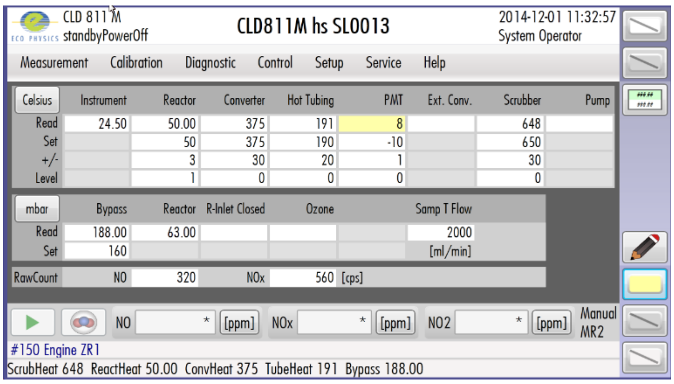
Caution:
Wait 3 minutes after a complete shut off before switching on the instrument again.

5.5.2 Short interruptions

Select “Measurement” → “Activate Stand-by”.
Confirm the activation of the Stand-by by the OK button.



The analyser stops the ozone production. At the upper left corner “standby” is displayed. The pump remains (or starts again) running for 30 seconds in order to flush out the remaining ozone from the analyser and tubing. After that the pump and the cooling system stop, but all the other operating temperatures of the various components are maintained. Now at the upper left corner “standbyPowerOff” is displayed.



To reactivate the analyser select “Measurement” → “End Standby (Reset)” and confirm it. After the “powerUp” phase the analyser is again ready to measure.

Note: Even after extended interruption of operation the last set values of all variables including calibration values are retained.

6. CALIBRATION

Read the safety rules first
(Section 1.2)

6.1

6.1 Introduction

Extreme care is necessary during calibration to ensure the accuracy of the measured data. The nCLD SL need to be calibrated with a two-point calibration (zero and span).

The Span calibration is performed by supplying the instrument with sample gas containing a known concentration of NO in N_2, while the Zero-point calibration is defined by using "Calibration Zero Gas". The gas for the Span check may be taken directly from a – suitable calibration cylinder or may be obtained by using a commercially available calibrator (or gas diluter) that can be set to give any required concentration within a given range. Calibration with NO gas may be a single point calibration (or "Span Check") or a multi-point measurement referred to as a "Linearity Check".

The accuracy of the NO_x measurement depends on the converter efficiency (CE), which decreases with the age of the converter. When CE falls below 90 % the error in the NO_x signal becomes unacceptably high and the converter cartridge must be replaced.

ECO PHYSICS considers that the only reliable method of determining the converter efficiency is by gas phase titration (GPT). This procedure involves titration a known concentration of NO with a smaller concentration of O_3. The O_3 reacts completely with the part of the NO to form NO_2. All other methods of generating NO_2 such as permeation tubes and NO_2-containing calibration gas supplies can show such great uncertainty in the NO_2 concentration that the error in measuring the CE is unacceptably high. ECO PHYSICS does therefore not recommend these methods. Section 6.2.5 contains a short, practical description of the GPT procedure. Section 6.2.6 describes how to check the conversion efficiency using NO_2 calibration gas from a cylinder.

Measurement of the zero-point of the nCLD SL does not take place automatically. The analyser zero point is normally stable over a wide range of operating conditions (ambient pressure, temperature, etc.), but because of "memory effects" and "hang-ups" the zero point appears to drift. It is therefore very important to flush the instrument thoroughly with Working or Calibration Zero Gas for as long as possible before the Zero-point calibration is performed. An incorrect Zero-point calibration produces an apparent non-linearity in the instrument response. An analyser may not show a response of exactly 0 after a Zero-point calibration, having been supplied with zero gas, for one of the following reasons:

- the Zero-point calibration was done too rapidly. Flush the system with zero gas for longer and repeat the calibration.
- the zero gas contains traces of NO or NO_2.

- the lining of the tubing used may be desorbing previously adsorbed NO or NO_2. This process may continue long after the gas supply is shut off.
- atmospheric air may be entering the reaction chamber through a leak at some point in the system.

It is recommended that a zero-point and span checks are performed daily, and the converter efficiency checked weekly. A multi-point calibration should be carried out periodically, i.e. at the same time as periodic maintenance is carried out.

WARNING

Toxic gases!

The tubing used to conduct the calibration gas to the analyser should be made only of inert materials such as fluorocarbons (PTFE or PFA) or stainless steel and should have a smooth inner bore. The standard nCLD SL analyser models have valve options v2 or v8. The nCLD8xx with option v2 has also internal calibration gas valves. With these internal valves, the calibration gases must be connected at the appropriate calibration gas inlet ports allowing the direct use of pressurized calibration gases from a bottle (zero and span) with a pressure not higher than 3 bar absolute. This is different to older ECO PHYSICS AG CLD models (e.g. 8 and 6 series) which have inlets for calibration gases at ambient pressure only (pressure less)! In order to reduce the possibility of changes occurring in the calibration gas on the way from the source to the analyser, it is recommended that the residence time of the gas in the tubing be minimized.

(Note: If your CLD SL is a special version not having internal calibration valves v2 or v8 the calibration gases must be connected to the sample gas inlet at ambient pressure. In this situation, the residence time in the tubings to the analyser can be minimized by a calibration gas flow that is at least 50 % more than that required by the instrument. The excess gas should be vented safely to the atmosphere or a fume-cupboard via a T-connector and pressure regulator. Use caution when venting the surplus gas as NITROGEN OXIDES ARE EXTREMELY TOXIC WHEN INHALED!)

6.2

6.2 Calibration Procedures

In the nCLD SL all the calibration values are stored separately. All the values, parameters and other specific data can be recalled in the calibration history.

There are different ways in which a calibration may be carried out:

- Single step calibration,
- Calibration sequence
- Linearization single step
- Linearization sequence
- Lin check with Calibration Gas

These five methods of calibration differ from each other in the degree of complexity.

Interval or time defined Automatic calibration allow a zero-point and span calibrations to be made in either NO and/or NO_x measurement mode, in a selected measurement range not necessarily the current range.

ECO PHYSICS highly recommends that a calibration be performed with a calibration gas whose concentration is about 90 % of the full-scale value of the range to be calibrated. If several ranges are to be used then the appropriate number of NO gas cylinders must be available, or a single calibration cylinder with a gas diluter and zero-air source must be used.

An example of a manual calibration is described in detail in the following section to give the user a clear idea of the steps to be followed during a calibration.

6.2

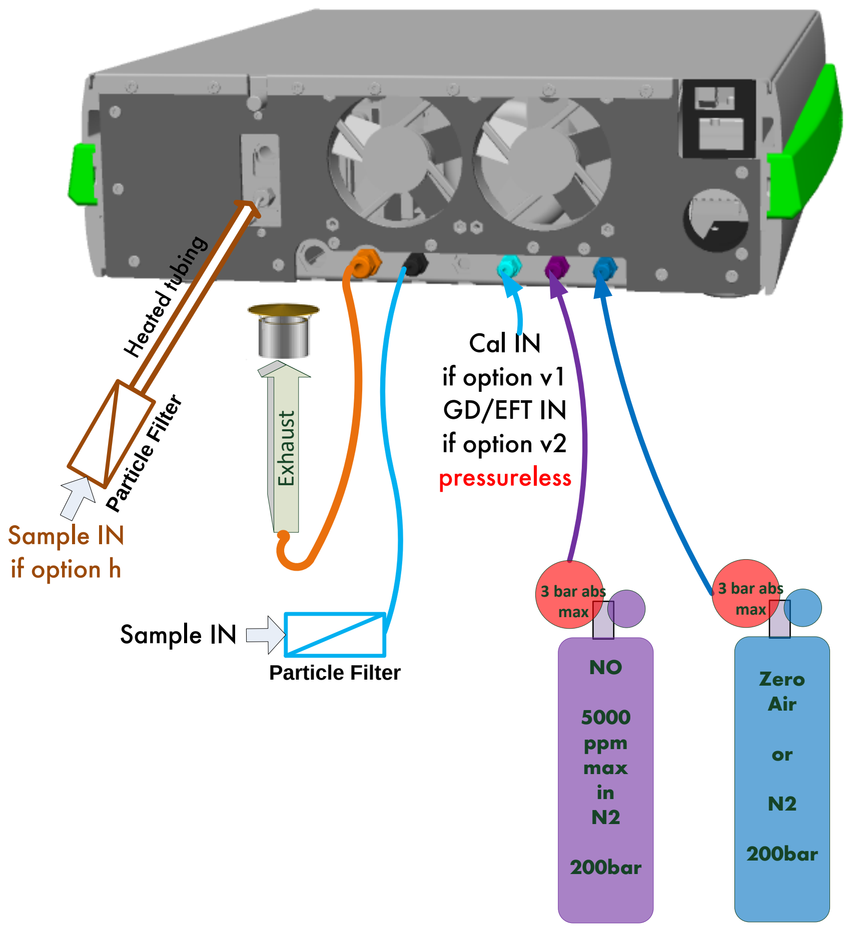
6.2.1 Preparation before Calibration

Caution! Minimum warm-up time before a calibration is 1h!

- The analyser must be calibrated for NO and NOx with a two-point calibration (zero and span).
- A NO and NOx span calibration is performed by supplying the instrument with calibration gas containing a known concentration of NO in N2, while a NO and NOx zero-point calibration is performed by using "Calibration Zero Gas".

Proceed according to the following steps.

Pneumatic connections for a nCLD822 with calibration valve option v2



6.2

6.2.2 Calibration Menu Navigation

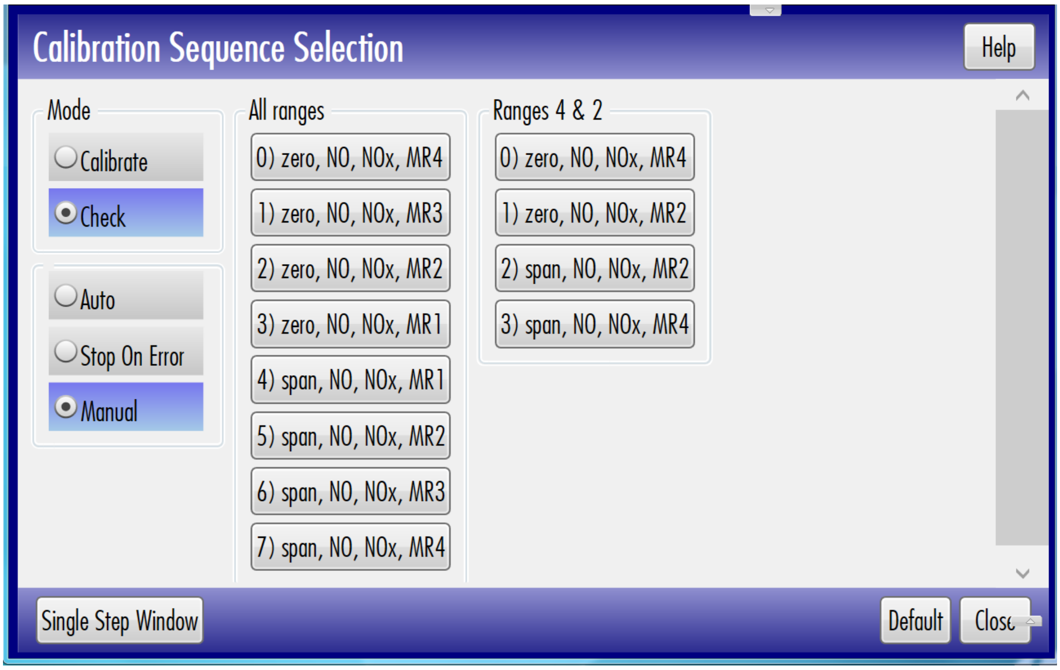
6.2.2.1 Calibration Sequence

From the main window select "Calibration" > "Calibration Sequence" or from the main window select "Calibration" > "Calibration Single Step" > "Sequence Window"

Choose a 'Mode' . Either 'Calibrate' for a completely new Calibration

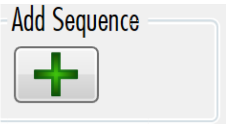
or 'Check' just for a simulation to see if there is any misalignment.
The ranges must be programmed by maintenance or service users. As standard user, you are only able to activate a calibration. In our example Ranges 4 & 2, in the picture below, were already set up by a higher-level account.

Choose a procedure under the 'Mode' field.
'Auto' for the whole run through all ranges.
'Stop on Error' for the whole run through all ranges until an error occurs.
'Manual' for a single range. After pressing Manual choose your range and the calibration will start automatically.

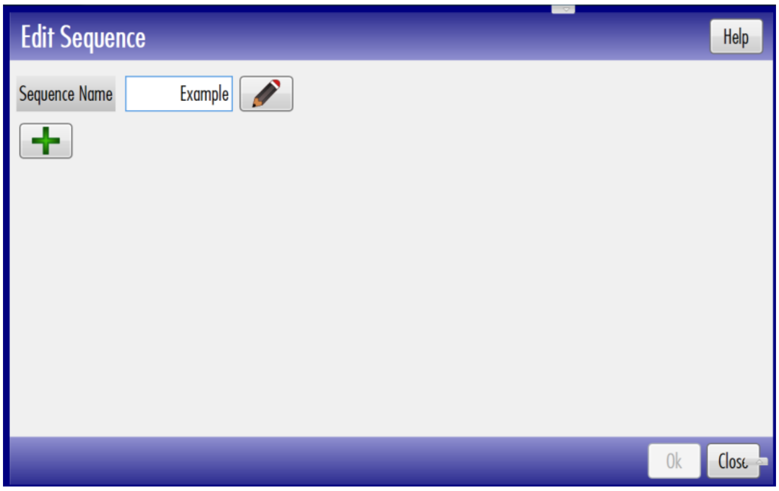


6.2.2.2 Add a new calibration sequence

To add a new sequence, select from the main window "Calibration" > "Calibration Sequence". Alternately select from the main menu "Calibration" > "Calibration Single Step" > "Sequence Window" to get to the same window. A new window, such as in chapter 6.2.2.1, opens with the difference that if you are logged in as system operator, there will be a 'Add Sequence' box in the lower left corner.



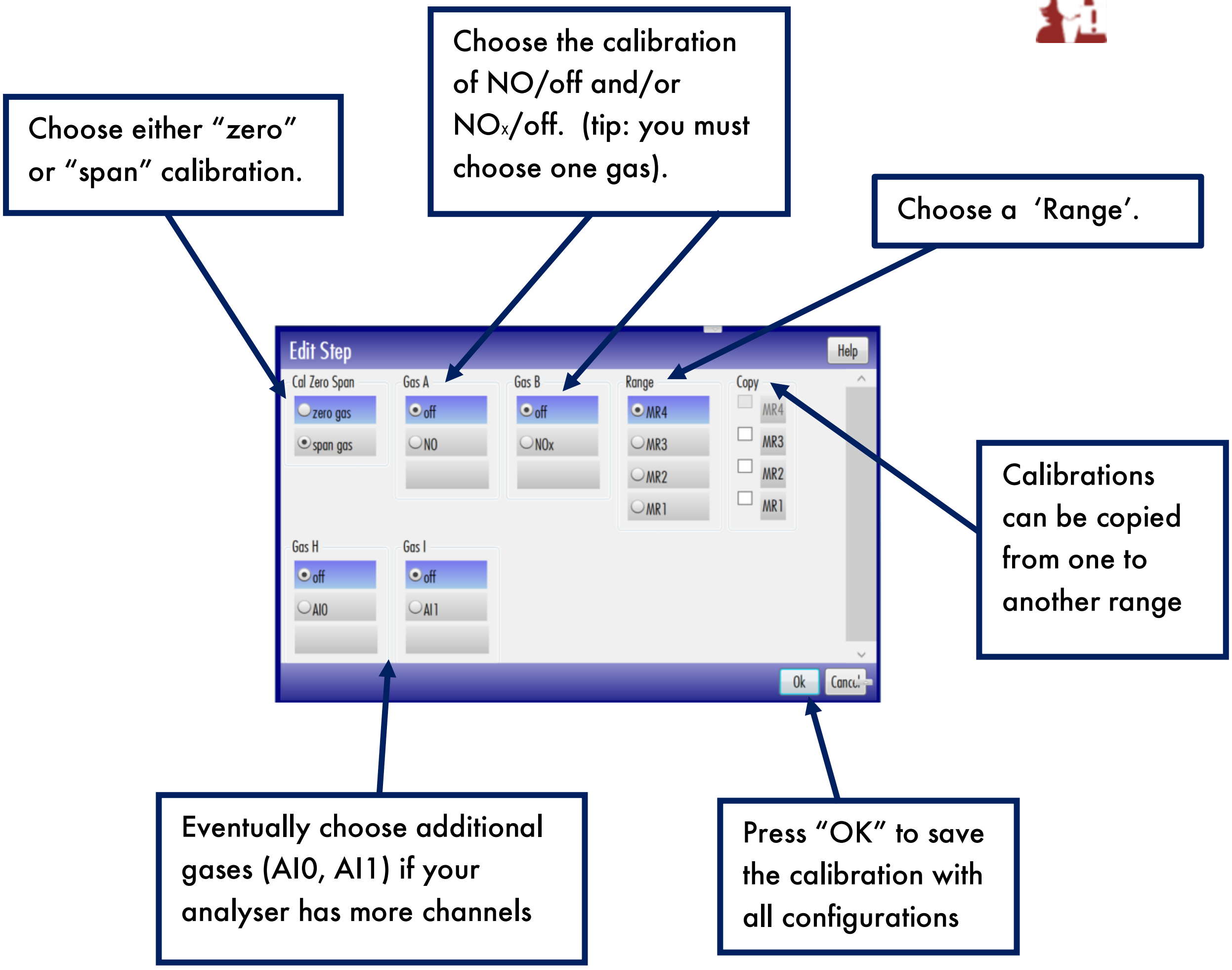
Press to open a new window.



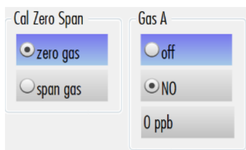
Name the new calibration sequence .

Press again to get to the editing window.

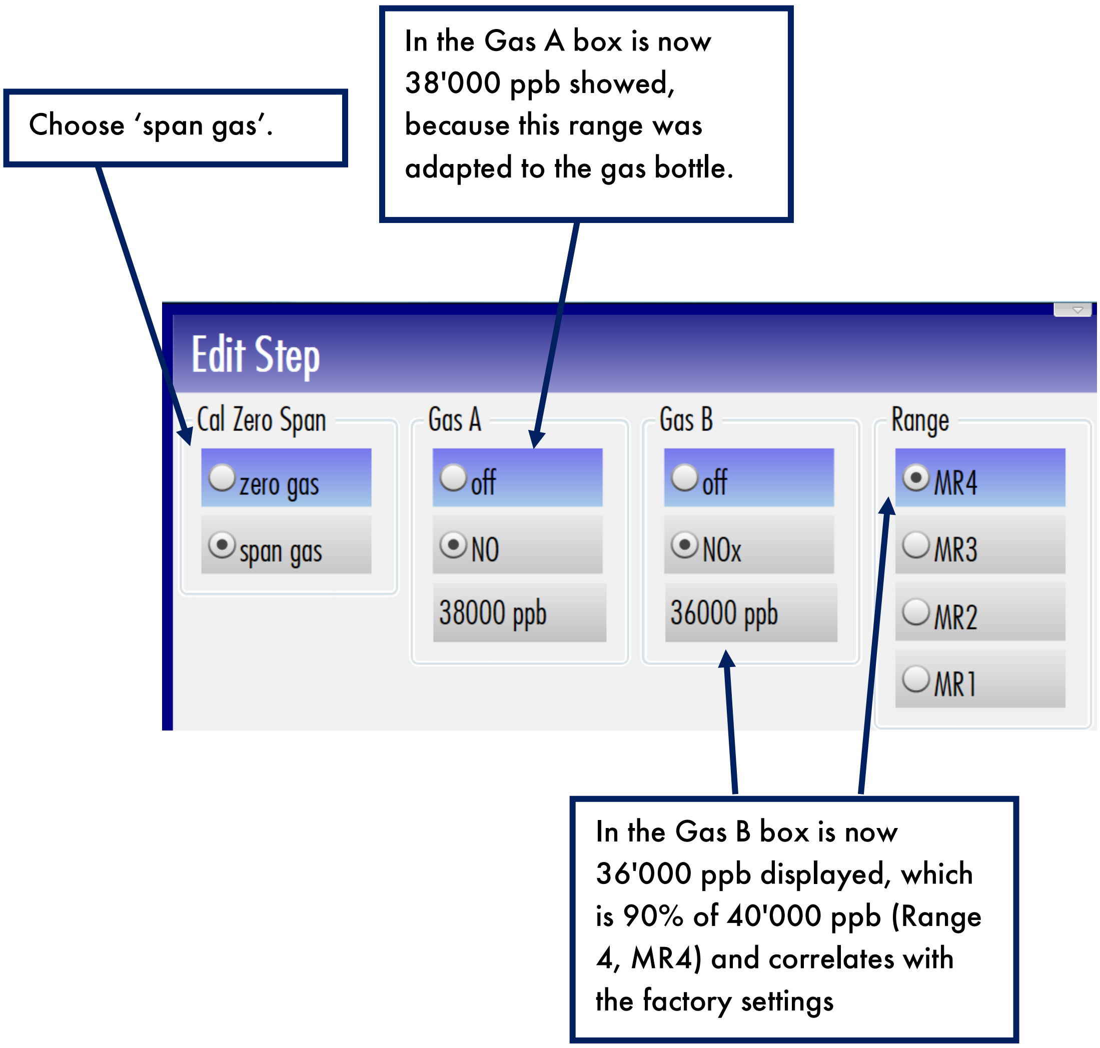
6.2



Tip: If you choose 'zero gas' the range will automatically be 0ppb.



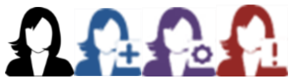
If you chose 'span gas', the computer will automatically calculate 90% of the selected range in "Measurement" > "Setup Measurement Range" (in the picture below the range is 40'000ppb in range 4 (MR4), look in chapter 5.3.1.8 how to set the measurement range, and that's why 36'000ppb is displayed below 'NOx') if you didn't change the 'span gas' in calibration setup (in the picture below is 38'000ppb displayed below 'NO' because it was manually modified). Look in chapter 6.2.2.7 'Reference Gases Setup' how to modify the range.



6.2

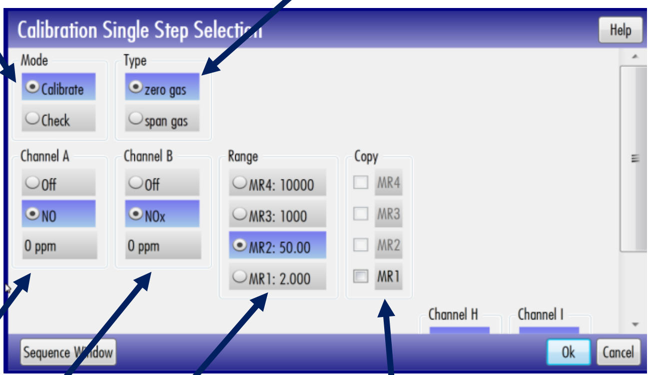
6.2.2.3 Procedure for a single step calibration

Choose from the main window selection “Calibration” > “Calibration Single Step” or from the main window select “Calibration” > “Calibration Sequence” > “Single Step Window” to set up the calibration parameters of either the zero or span value.

For checks: 

Default mode is “calibration,” choose “check” mode to perform calibration procedure without updating calibration factors.

Select between performing a “zero” or “span” calibration.



Choose calibration of the NO and/or NOx channel. Each channel has four ranges; the calibration factors are stored separately

Calibrations can be copied from one range to another.

Press “OK” to start the calibration when all options are selected.

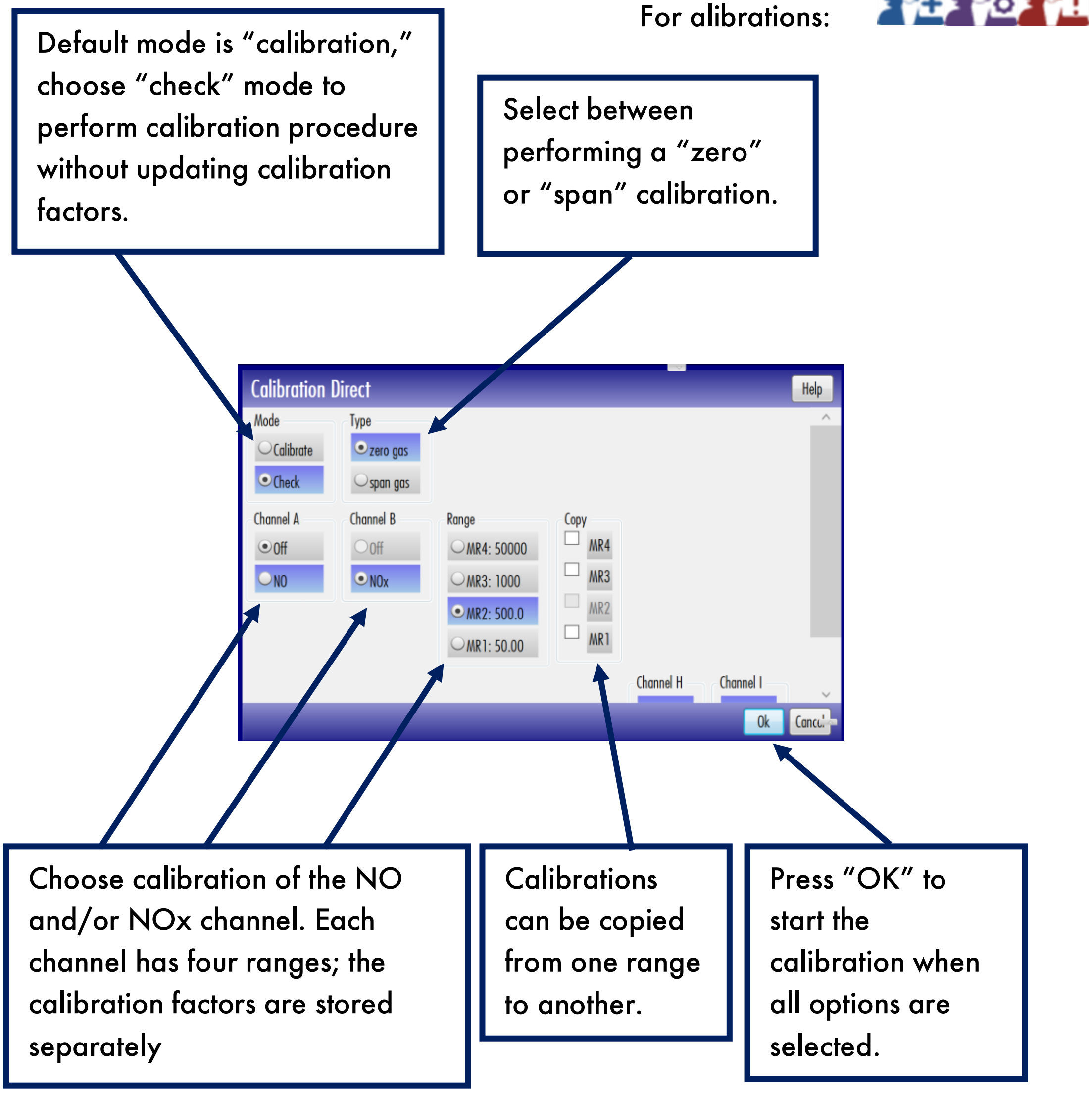
6.2.2.4 Calibration Direct

The “Calibration Direct” is a spontaneous calibration, which can be performed by all user-levels. Nothing is preconfigured like in all other calibration types. The predefined data in the other calibration types will not be lost when doing a “Calibration Direct”.

Choose from the main window selection “Calibration” > “Calibration Direct”.

For checks:

For alibrations:

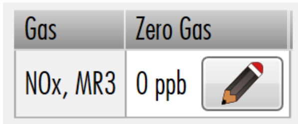


6.2

After pressing Ok , a new window appears.

Indicate the Concentration for the zero Gas calibration.

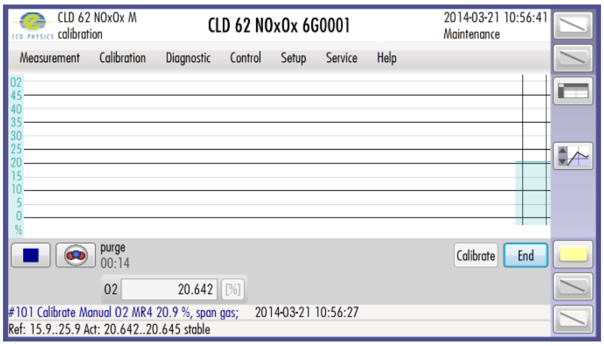
Then Press Ok , the calibration will begin.



6.2.2.5 Calibration Phases

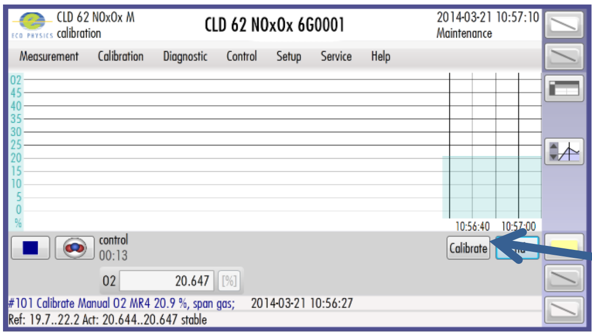
a) The Calibration process consists of the following four phases:

1) *Purge*



Make sure to run the calibration gas until a stable value is achieved. The purge phase lasts by default 30 sec. During this phase the software checks whether the difference between the measurement value and the reference gas concentration is within defined limits. After purging the analyser proceeds automatically to phase "Control"! If the deviation is not within the limits, the software will show an error message. Either try it again by clicking "redo" or stop calibration without calibration by clicking "Cancel".

2) *Control*



Press "Calibrate" to start calibration of the analyser.

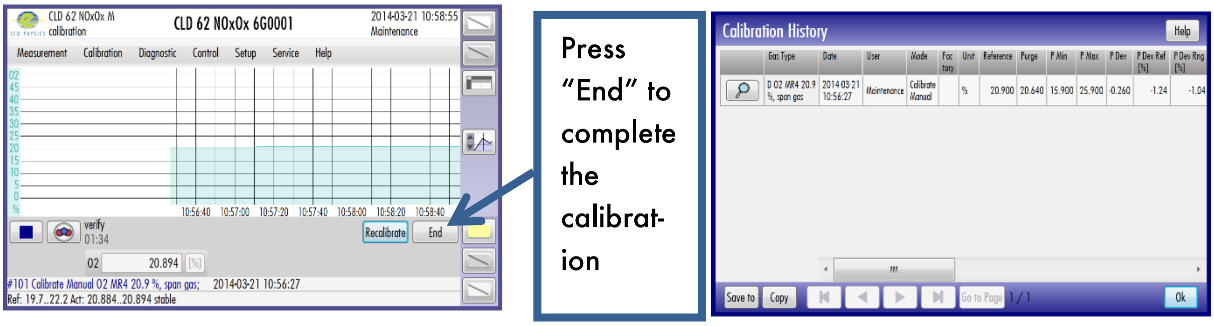
In this phase the stability of the measurement value before calibration is checked. If the Signal is not stable enough then an error message will be displayed. If the signal is stable start:

3) *Calibrate*

The analyser is calibrated and afterwards it is waited to get stable measurement values. The default calibration duration is 10 sec. "Verify"-phase is started automatically.

4) *Verify*

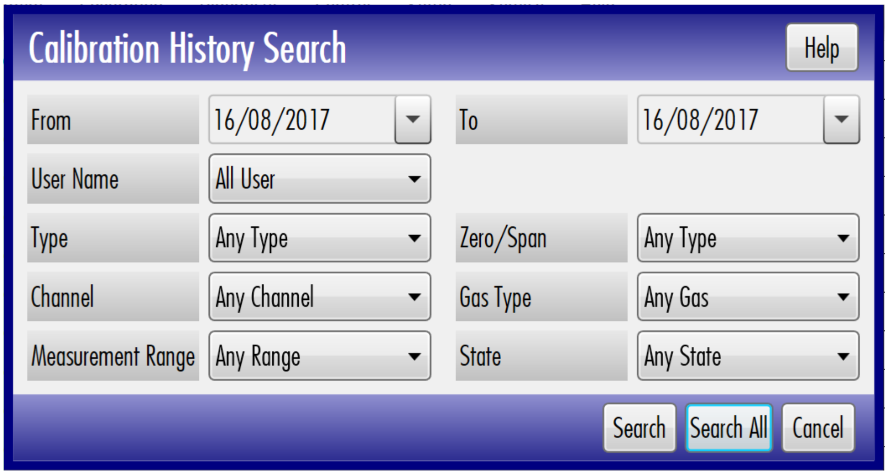
In this phase it is checked if the difference between the current value and the reference gas concentration is within the defined limits. Press the "End" button to accept the new calibration.



Once a calibration is completed or canceled, the calibration record is shown. All calibration records are stored in the database automatically.

6.2.2.6 Calibration History

Choose from the main window selection “Calibration” > “Calibration History”. Search here for previous calibration events to get detailed information.



Eventually select an interval when your wanted calibration was made.

Eventually select ‘User Name’, ‘Type’, ‘Zero/Span’, ‘Channel’, ‘Gas Type’, ‘Measurement Range’ and ‘State’ for your requested calibration for more specific results. Click Search.

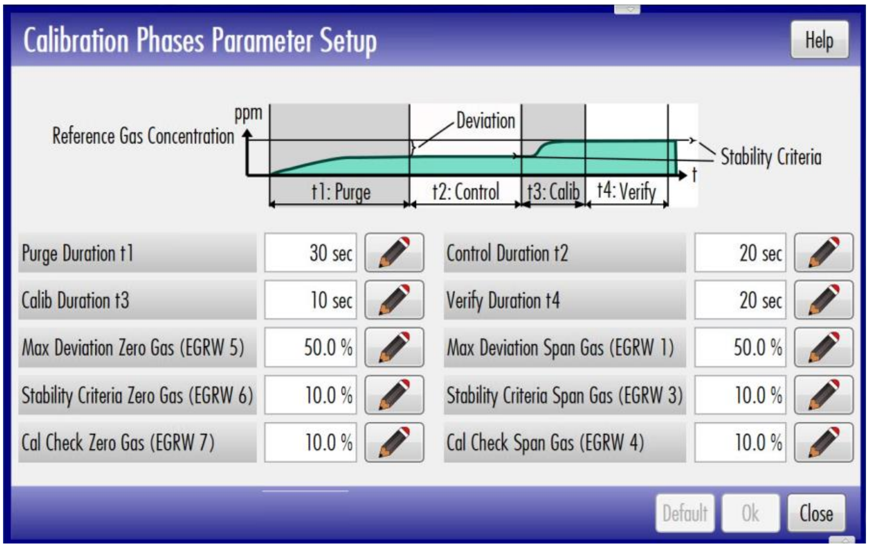
To see all previous calibrations, press Search All.

After finding results, press to get more specific details about a certain calibration.

6.2

6.2.2.7 Phases Parameter Setup

Select from the main window "Calibration" > "Calibration Setup" > "Phases Parameter Setup". This chapter shows how to edit the calibration phases.



There are four calibration phases in which the gas is getting calibrated with a 2-point calibration, the purge, control phase, calibration phase and verification phase.

Set the duration of the purging for the analyser at 'Purge Duraktiont1'.

Set the duration of the control phase, to measure the deviation of the reference gas to the measurement gas, at 'Control Duration t2'.

Set the duration of the calibration phase at 'Calib Duration t3'.

Set the duration of the verification phase, where possible deviations would be detected, at 'Verify Duration t4'.

Edit the deviation of the zero and the span gas. Press 'Max Deviation Zero Gas (EGRW 5)' respectively 'Max Deviation Span Gas (EGRW 1)' and type in the allowed deviation during the control phase (a big deviation is here allowed).

Press 'Stability Cirteria Zero Gas (EGRW)' respectively 'Stability Criteria Span Gas (EGRW 3)' to set the allowed deviation of the stability of the calibration  (small deviations suggested).

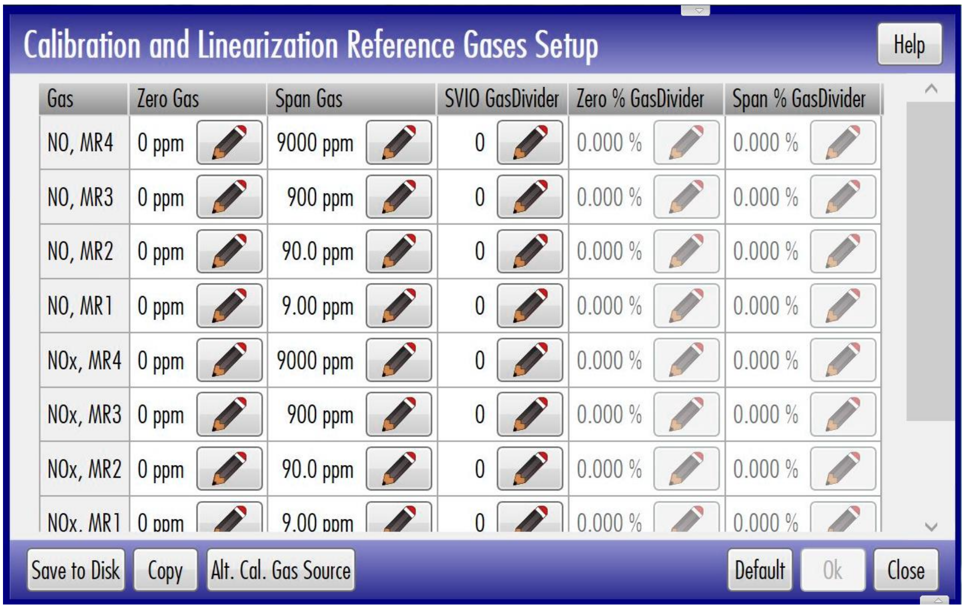
Finally press 'Cal Check Zero Gas (EGRW 7)' respectively 'Cal Check Span Gas (EGRW 4) to set the allowed deviation of the calibration check .

Save the appliance with 'Ok'. If you don't want to change anything, press 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

6.2

6.2.2.8 Reference Gases Setup

Choose from the main menu “Calibration” > “Calibration Setup” > “Reference Gases Setup” to set zero and span gas concentrations for calibration and linearization procedures.



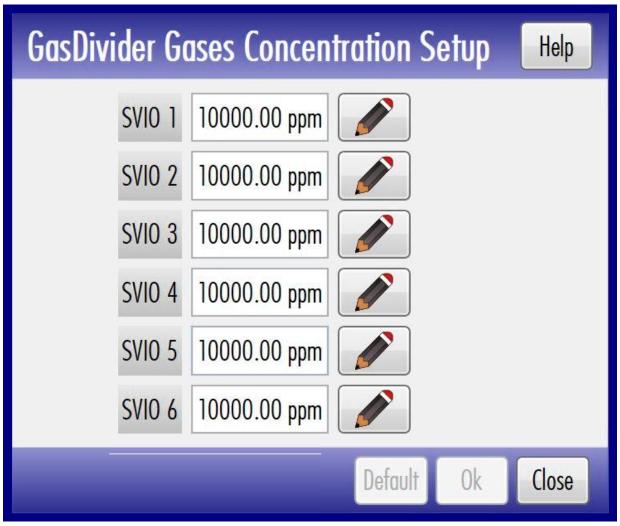
You are now able to edit every concentration of span and zero gas, which is visible on your gas bottle, for every single gas and measurement range .

If a gas divider is connected to your device, choose in the column ‘SVIO GasDivider’ the corresponding channel where the Gas divider is connected . Then the Gas divider will automatically mix the right concentration that you chose in the section ‘Span Gas’ and ‘Zero Gas’. You are now able to calibrate every measurement range that has a lower concentration than the used gas.

Save the appliance with ‘Ok’. If you don’t want to change anything, press ‘Close’. To discard all changes and set the changes back to factory settings, press ‘Default’.

6.2.2.9 Gas Divider Concentration Setup

Choose from the main menu "Calibration" > "Calibration Setup" > "GasDivider Gases Concentration Setup" to set the concentration for the gas divider.



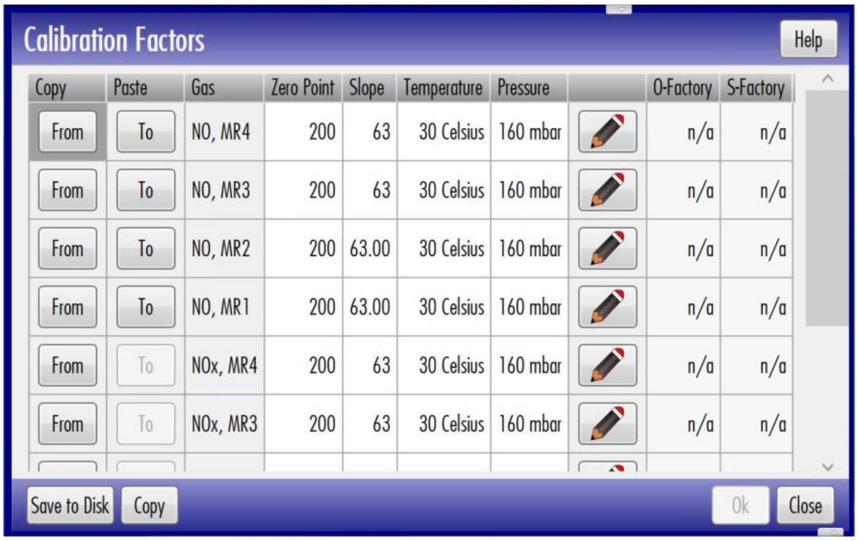
Select the concentrations of the gases that are connected to a certain channel of the gas divider in the corresponding field.

Save the appliance with 'Ok'. If you don't want to change anything, press 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

6.2

6.2.2.10 Calibration Factors

Select from the main menu “Calibration” > “Calibration Setup” > “Calibration Factors” to set the calibration factors.



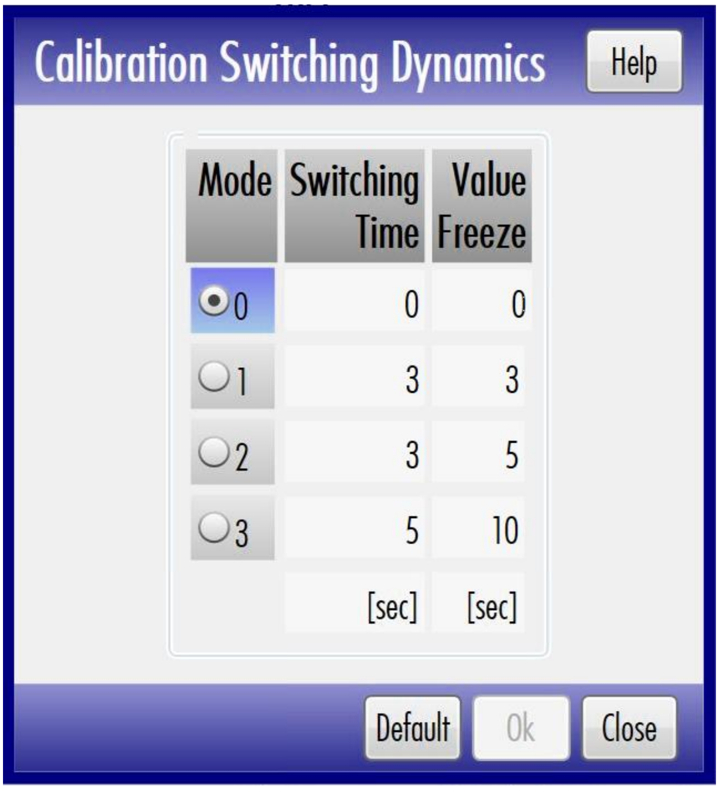
To copy values from one to another field, press From on the gas you want to copy and To to paste the copied values.

You can edit the calibration factory for every gas in a chosen measurement range.

In our example is NO, MR4 selected. Edit here the values for ‘Offset’, ‘Slope’, ‘Temperature’ and ‘Pressure’. Save the appliance with ‘Ok’. If you don’t want to change anything, press ‘Close’. To discard all changes and set the changes back to factory settings, press ‘Default’.

6.2.2.11 Calibration Switching Dynamics

Select from the main menu "Calibration" > "Calibration Setup" > "Cal Switch Dynamics" to set the duration of the interval of the gas switches.



Choose between the preinstalled options . 'Mode 2' is mostly the most accurate mode. Save the appliance with 'Ok'. If you don't want to change anything, press 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

6.2

6.2.2.12 Cal (Check) Result Overview

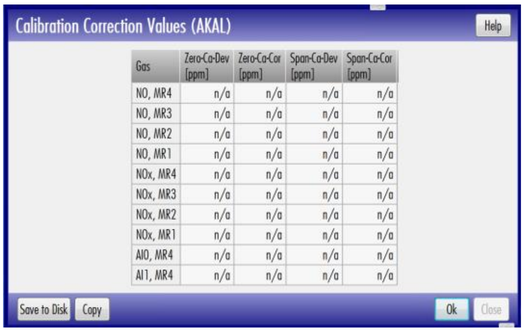
From the main menu select "Calibration" > "Cal (Check) Result Overview" > "Zero-Point and Span Check Deviations" or "Calibration Correction Values" to display a report of zero- and span gas deviations.

Zero-Point and Span Check Deviations (AANG, AAEG, AALI)

Gas	Zero Gas [ppm]	Dev. Zero [ppm]	Dev. Zero [%]	Span Gas [ppm]	Dev. Span [ppm]	Dev. Span [%]	AALI Zero [ppm]	AALI Span [ppm]
NO, MR4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NO, MR3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NO, MR2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NO, MR1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NOx, MR4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NOx, MR3	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NOx, MR2	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NOx, MR1	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AI0, MR4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
AI1, MR4	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

Optionally copy the report by pressing Copy and save by pushing Save to Disk. Give a name and a file location to save the report or press Cancel to leave the window.

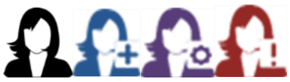
Choose from the main window «Calibration» > «Cal (Check) Result Overview» > «Calibration Correction Values» to display a report of calibration correction values.



Calibration Correction Values (AKAL)

Gas	Zero-Co-Dev [ppm]	Zero-Co-Cor [ppm]	Span-Co-Dev [ppm]	Span-Co-Cor [ppm]
NO, MR4	n/a	n/a	n/a	n/a
NO, MR3	n/a	n/a	n/a	n/a
NO, MR2	n/a	n/a	n/a	n/a
NO, MR1	n/a	n/a	n/a	n/a
NOx, MR4	n/a	n/a	n/a	n/a
NOx, MR3	n/a	n/a	n/a	n/a
NOx, MR2	n/a	n/a	n/a	n/a
NOx, MR1	n/a	n/a	n/a	n/a
AI0, MR4	n/a	n/a	n/a	n/a
AI1, MR4	n/a	n/a	n/a	n/a

Optionally copy the report by pressing Copy and save by pushing Save to Disk. Give a name and a file location to save the report or press Cancel to leave the window.

For checks: 

6.2

6.2.3 Zero-Point Calibration

For calibrations: 

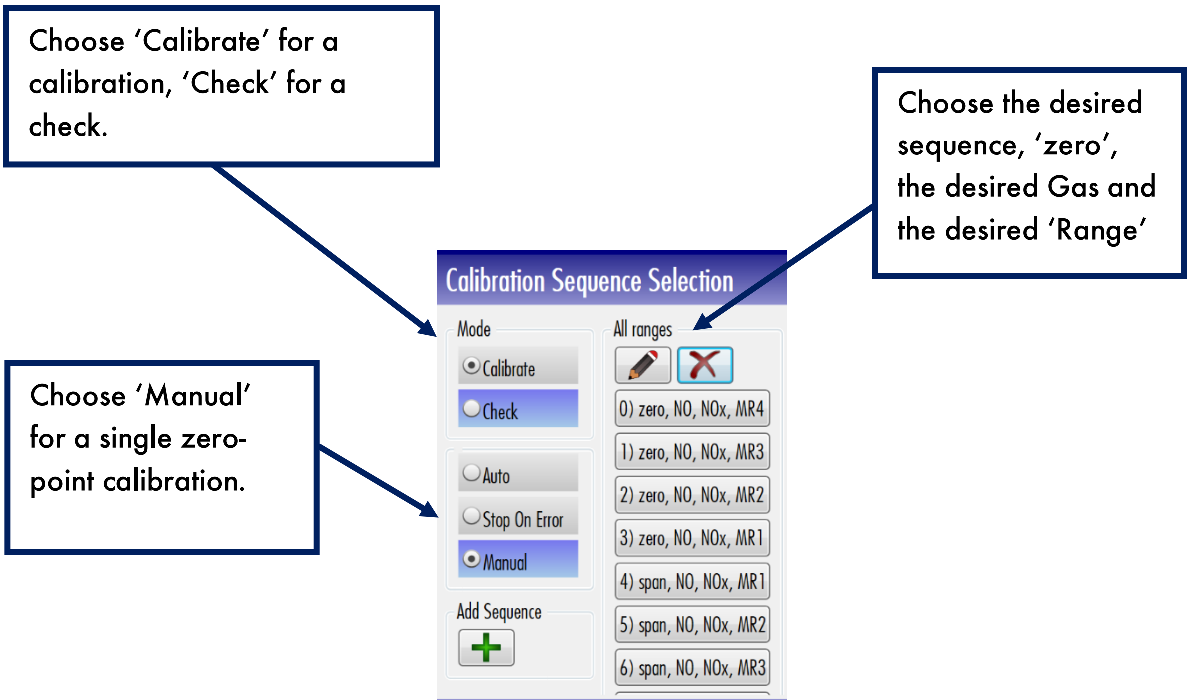
There are three different ways to perform a zero-point calibration.

- By 'Calibration Sequence'
- By 'Calibration Single Step'
- By 'Calibration Direct'

ECO PHYSICS AG recommends a zero-point calibration for all 4 ranges to perform an optimal calibration. Alternatively, it is possible to calibrate only one range and copy these values with the 'Copy' function. If you want to calibrate only one range, you should choose the smallest range to avoid bigger deviations.

6.2.3.1 Zero-Point Calibration by 'Calibration Sequence'

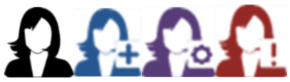
To perform a calibration by 'Calibration Sequence', chose from the main menu "Calibration" > "Calibration Sequence". The condition hereof is that a system operator has already created a sequence for the desired gas for the zero-point calibration. How to program such a sequence, read chapter 6.2.2.2. A sequence with all ranges already exists.

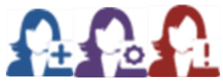


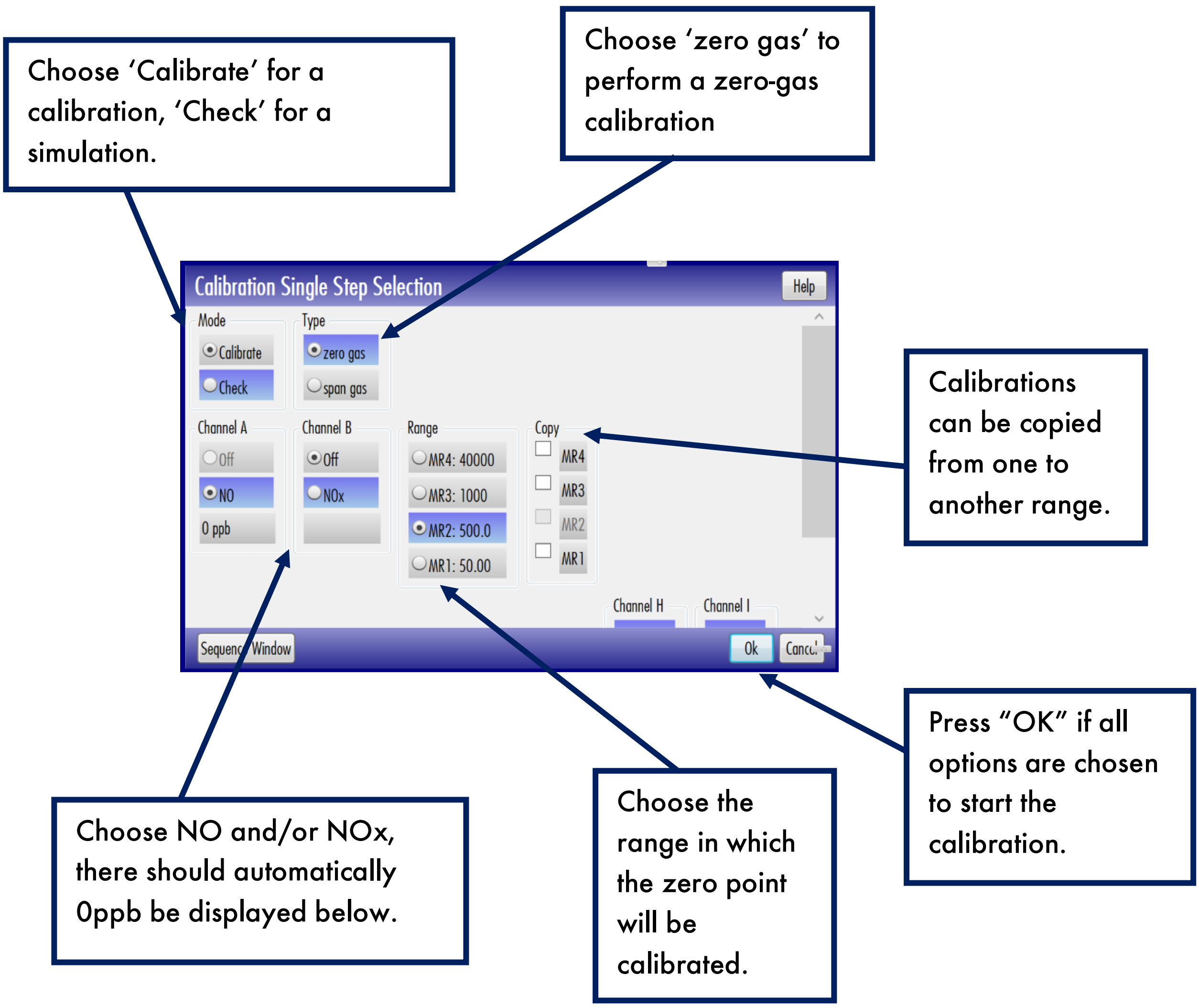
6.2

6.2.3.2 Zero-Point Calibration by 'Calibration Single Step'

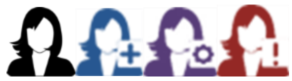
To perform a calibration by 'Calibration Single Step', chose from the main menu "Calibration" > "Calibration Single Step".

For checks: 

For calibrations: 

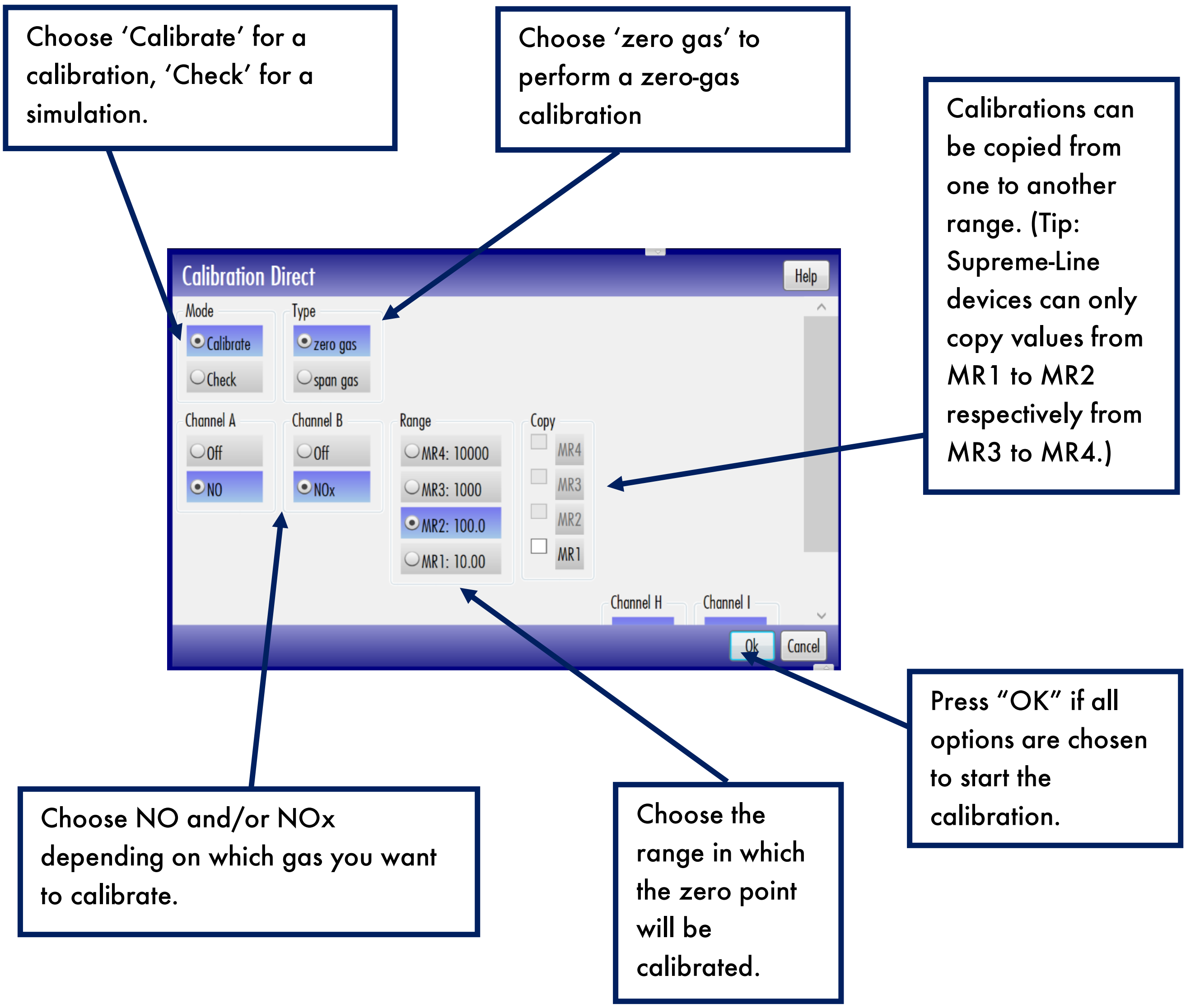


6.2.2.3 Zero-Point Calibration by 'Calibration Direct'

For checks: 

For calibrations: 

Select from the main menu "Calibration" > "Calibration Direct". The advantage of doing a calibration by calibration direct is that you can spontaneous select gas concentrations (ranges) without changing predefined values of other calibration types.



6.2

A new window opens which shows the selected gas and measurement range and where you can define the gas concentration of the zero-gas.

Gas	Zero Gas
NO, MR2	0 ppm 

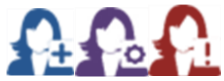
Press  and type in the concentration of the zero-gas specified on the gas bottle.

Additionally, you are able to save this setting by pressing Save to Disk. Type in a name and the desired file location.

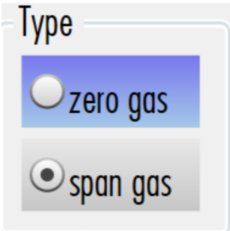
Continue with Ok. The zero-point calibration will start.

6.2.4 Span-Point calibration

For checks: 

For calibrations: 

Span-point calibrations are the same as zero-point calibrations. There are the same 3 ways as described in the chapters 6.2.3.1/6.2.3.2/6.2.3.3 to perform such a calibration. The only difference is that instead of selecting ‘zero gas’ you select ‘span gas’ .



6.2

6.2.5 Multi-point calibration (linearity check)

6.2.6 Checking the converter efficiency (CE) by GPT

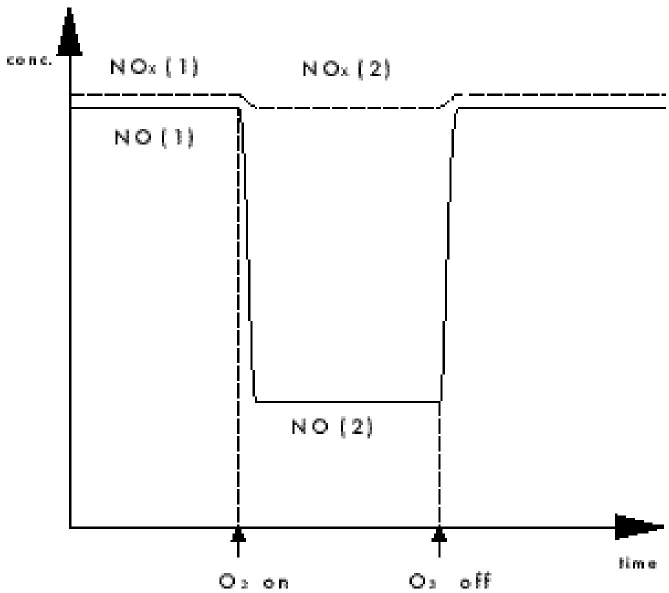
The operator must have the necessary equipment to mix and dose calibration gas and air. The flow rates of both gases need to be monitored by rotameters. An additional rotameter is connected to a bleed line that conducts the excess flow to the open or into a fume hood (Fig. 6.2).

Mass flow controllers could be used in lieu of the rotameters. Required ranges are 1.5 l/min NPT (for cal. gas) and 0.35 l/min NPT (for oxygen). The O_2line is connected to an ozone generator that has a regulated output and has a capacity to generate 0.05 to 0.18% ozone at 0.35 l/min O_2 at NPT.

The CE-System must be designed to produce the calibration gas mixtures of known concentration under pressurized condition (12 PSIG or higher) with negligible error.

Procedure:

1. The equipment set up shown in Fig. 6.2 should be connected with outlet (12) to the Filter (13) and this in turn to the sample gas inlet of the CLD SL. Also connect the strip chart recorder to the instrument analog outputs.
2. Switch the solenoid valve (16) to the Calibration Zero Gas position. Meter the Zero Calibration Gas with the needle valve (4). Adjust over flow (5) to approx. 0.3 l/min at NPT. Perform a Zero Point Calibration for both the NO and NO_x-measurement, respectively.



6.2

3. Switch the solenoid valve (16) to the GPT-Mixture position. Meter the NO calibration gas with the needle valve (4). Adjust over flow (5) to approx. 0.3 l/min at NPT. Perform a one-point calibration with O_2 valve closed and ozone generator turned off. Do the calibration for both the NO and NO_x-measurement, respectively.
4. Measure NO and NO_x with the same gas settings and conditions as before.
5. Switch to the NO-Measurement mode. Add O_2 slowly by opening the valve until the NO-concentration is reduced to 90 % of the original value (O_3-generator is off). Measure NO and NO_x. These concentrations are labeled NO(1), NO_x(1) respectively and are to be noted.
6. Switch to the NO-Measurement mode. Measure NO. Turn on the O_3-generator and adjust its output so that the NO-concentration falls to 20 % of the original value. Measure NO and NO_x. The new concentrations NO(2) and NO_x(2) should be noted.
7. As a cross check turn off the O_3-generator and note NO(1) and NO_x(1) again. The deviation between the first values (acquired under 5.) and the second values measured now should not exceed 2 %.
8. The converter efficiency CE is calculated as follows:

$$CE\ (\%) = \left(1 - \frac{NO_x(1) - NO_x(2)}{NO(1) - NO(2)} \right) \times 100$$

The calculated value should not be lower than 90 %. Otherwise the converter cartridge needs to be replaced.

The following conditions must be satisfied before the formula given can be correctly applied:

- NO_x(1) [ppm] concentration should not deviate more than 5 % from the NO(1) [ppm] concentration
- the fraction of NO_2 in the NO calibration gas <5 % of the NO concentration
- NO(2) conc. between 10 to 50 % of NO (1) conc.

6.2.7 Checking the converter efficiency (CE) using NO_2 calibration gas from a cylinder

If a GPT-system is not available, the efficiency of the converter can be checked using NO_2 calibration gas from a cylinder. This method will usually be less precise than the GPT method, for one or more of the following reasons:

- GPT is a relative measurement with respect to the original calibration, since it is based on the same standard (i.e. the same NO-calibration gas cylinder) which was used to calibrate the instrument itself. It is therefore an inherently accurate method. The only condition, which must be observed, is a correct calibration of both "NO" and "NO_x" measurement modes.
- the NO_2 gas cylinder used acts like a second calibration standard. Since the two cylinders have certain (non-identical) errors in concentration, this will result in reduced accuracy of the calculated CE value.
- experience has shown that NO_2 in a cylinder is less stable than NO. Possible reasons are chemical reactions between NO_2 and the inner surface of the gas cylinder.

These points must be taken into consideration when a measurement of the conversion efficiency is made using NO_2 calibration gas from a cylinder. If the use of NO_2 cannot be avoided then the recommended procedure is as follows:

1. Use the NO_2 cylinder only as a transfer standard or as a comparison standard.
2. Check the contents (NO_2 and NO concentrations) of the NO_2 cylinder used with an independent, accurate chemiluminescence NO/NO_x analyser (CLD), having a converter whose efficiency has been measured by the GPT method. It is recommended that this CLD be calibrated with the same NO cylinder as is used for the calibration of the CLD SL.
3. Calibrate the CLD SL for NO_x (see sections 6.2.1 and 6.2.2) with the same NO cylinder and the same calibration method (direct from a cylinder or via a calibrator) that was used for the reference NO/NO_x-analyser.
4. Connect the NO_2 gas cylinder as it is shown in Fig 6.1 to the sample inlet of the CLD SL and measure NO_x. Ensure that the inlet pressure is stable at ambient condition during the whole procedure.

6.2

5. Calculate the converter efficiency using the following formula:

$$CE\ (\%) = \left(\frac{NO_{X\ measured}}{NO_{2\ cylinder}} \right) \times 100$$

6. The converter efficiency CE should be higher than 90 %.

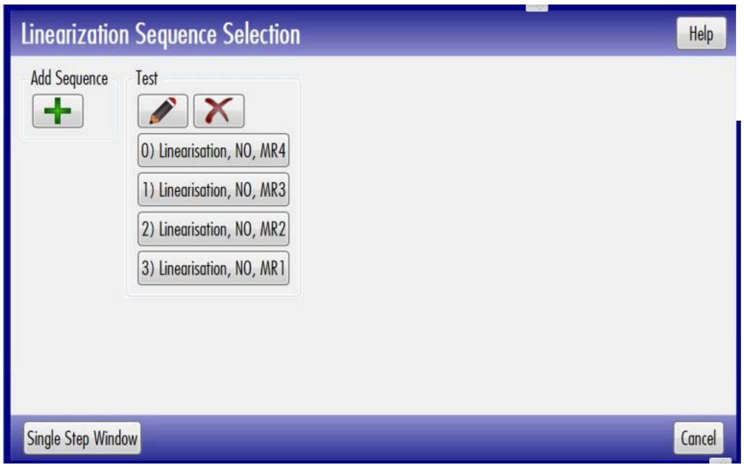
   If CE >100 % then the calibration of the analyser with NO or the certification of the NO_2 gas cylinder is incorrect. Check the calibration of the analyser and the NO_2 gas cylinder again as described above.

   If CE <90 % check the calibration of the analyser and the NO_2 gas cylinder again. If indeed CE is verified to be <90 % then exchange the converter cartridge.

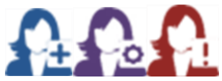
6.3 Linearization Procedures

6.3.1 Linearization Sequence

From main window select "Calibration" > "Linearization sequence". Such a linearization sequence must be created by a maintenance user or system operator. As standard user, you can just activate and deactivate linearization. In our example in the picture below was the column 'Test' already created by a system operator.



Linearization check: 

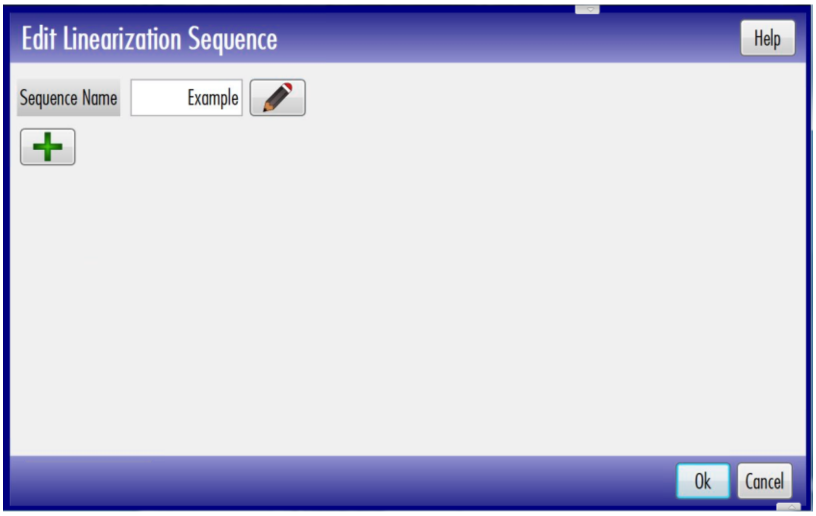
Linearization: 

Press on one of the preinstalled linearization to perform such one.

6.3

6.3.2 Adding a new Linearization Sequence

Select from the main menu “Calibration” > “Linearization Sequence” and press on ‘Add Sequence’ , a new window opens.



Name the sequence .

Press again to get to the editing window.

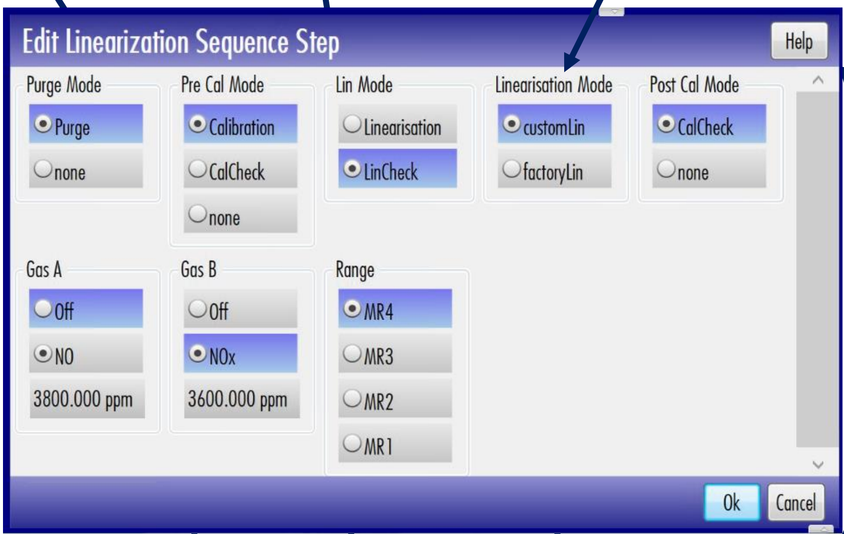
6.3

Choose a pre-calibration mode, that means if there should be performed a 'Calibration' or a 'Calibration Check' before the linearization.

Choose a post-calibration mode, that means if there should be performed a 'Calibration Check' after the linearization

Choose either 'Purge' for a purging interval or 'off'

Choose the linearization mode, standard-modus is "Linearization," choose "check" to perform a linearization without replacing the linearization factors

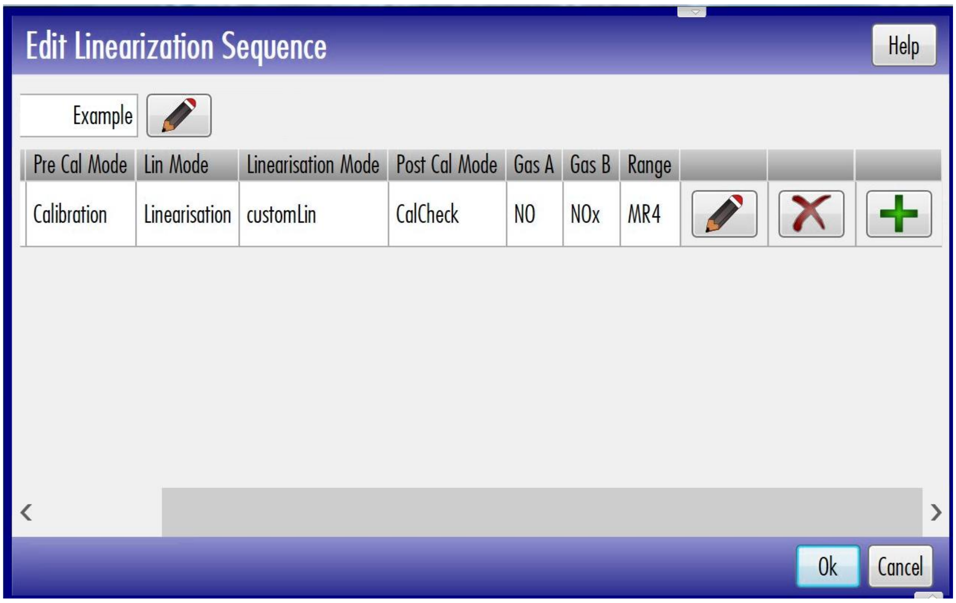


Choose the calibration of NO/off and/or NO_x/off. (Tip: You must choose one gas).

Choose a 'Range'.

Press "OK" if all options are selected to save the linearization

There are now automatically 90% of the selected range in "Measurement" > "Setup Measurement Range" (Chapter 5.3.1.8) below the gas selection of NO and/or NOx displayed (in the picture below is the range 4'000ppm in MR4, that's why 3'600ppm is displayed at NOx) if you didn't change the 'span' gas in the 'Calibration Setup' (in the picture is 3'800ppm visible at NO, what has been manually modified). Look in chapter 6.2.2.7 'Reference Gases Setup' how to change these.



The same window as before opens again, but it displays the just created sequence. To edit this sequence, press , to delete it press and to add another sequence press . Repeat the adding of sequences as before described. How to execute sequences, look in chapter 6.3.1.

(Tip: the first sequence will always begin with 0)

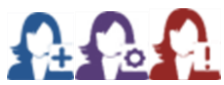
To save the sequence and to leave the window, press Ok. To discard the changes, press Cancel.

6.3.3 Linearization Single Step

Select from the main menu "Calibration" > "Linearization Single Step" to perform a single linearization. The linearization will be executed with the selected gas and range. You can set them at "Measurement" > "Select Gas and Range" or read the chapter 5.3.1.2.

Choose the linearization mode, standard-modus is "linearization" choose "check" to perform a linearization without replacing the linearization factors

Choose either 'Purge' for a purging interval or 'off'



Choose a pre-calibration mode, that means if there should be performed a 'Calibration' or a 'Calibration Check' before the linearization.

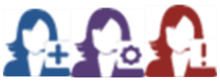
Choose a post-calibration mode, that means if there should be performed a 'Calibration Check' after the linearization

Press "OK" if all options are selected to save the linearization

6.3

6.3.4 Linearization History

Select from the main menu "Calibration" > "Linearization History". Search for previous linearization to get detailed information.



Eventually select an interval when your wanted linearization was made.

Eventually select 'User Name', 'Type', 'Mode', 'Gas', 'Measurement Range', 'State' and 'Channel' of your requested linearization for more specific results. Click Search.

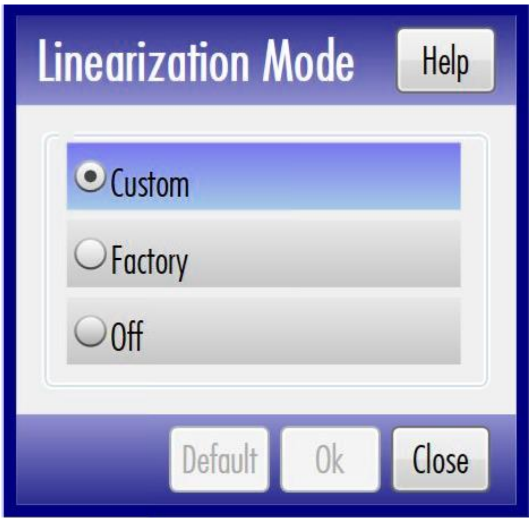
To see all previous calibrations, press Search All.

After finding results, press to get more specific details about a certain calibration.

6.3.5 Linearization Setup

6.3.5.1 Linearization Mode

Select from the main menu "Calibration" > "Linearization Setup" > "Mode". You can now decide between 'Factory', that ECO PHYSICS has created, and 'Custom', that you have created, linearization or you can deactivate the linearization modes by pressing 'Off'.



Save the appliance with 'Ok'. If you don't want to change anything, press 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

6.3

6.3.5.2 Linearization Parameters Setup

Select from the main menu "Calibration" > "Linearization Setup" > "Parameters Setup". To test a linearization of a measurement range different concentrations must be generated.

Choose the length of a linearization step at 'Step Duration', the length of the filter time before the linearization at 'Filter Time', the maximum allowed deviation of the linearization at 'Max. Deviation' and the length of the purging time of the span gas at 'PurgeTime GD Span' (short) and of the measurement gas at 'PurgeTime GD N2' (long).

If a gas divider is connected, choose the inlet where the gas is connected at 'GasDivider Inlet'. Choose additionally which carrier gas 'GasDiv. Carrier Gas' and which dilution gas 'GasDiv. Gas' should be used from the gas divider.

Then select channel and measurement range that should be linearized at 'Channel – Range'. A new window opens.

6.3

Choose how many concentrations you want to add for the linearization . We used 5 steps in our example. Be aware that you should not use different calibration gas bottles with different concentration because the deviation from bottle to bottle would be higher than the expected deviation of the linearization of the analyser. Therefor use a gas divider.

You can now add more steps by pressing . If you want to add another step for example between 25% and 50%, press at 25%. An exact similar step occurs.

Edit now the inserted step by and choose a desired value.

To delete steps, press .

6.3

Save the appliance with 'Ok'. If you don't want to change anything, press 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

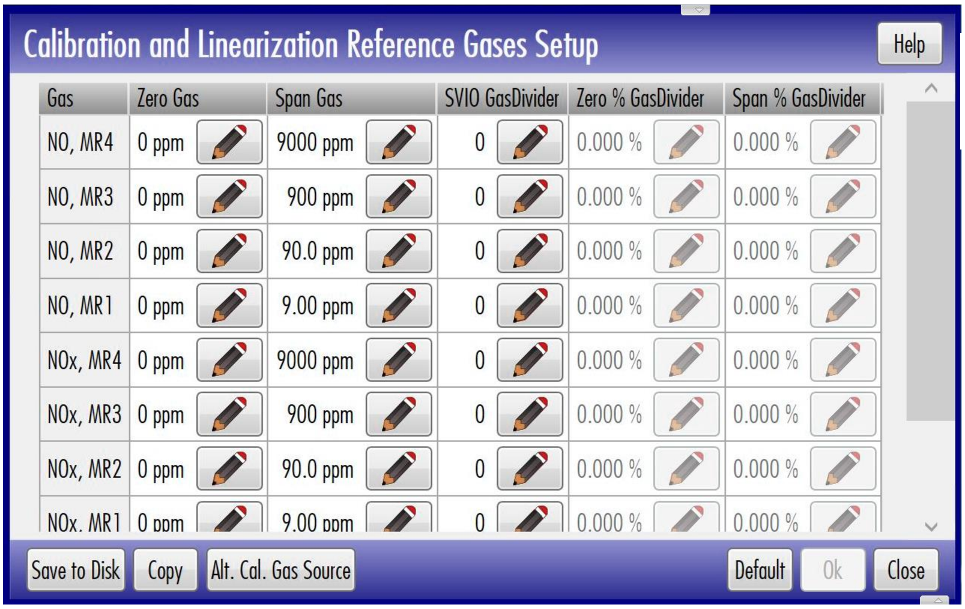
You will now be leaded to the previous window. Always do the same for both channels A and B, otherwise the linearization will not work.

Save the appliance with 'Ok'. If you don't want to change anything, press 'Close'.

Attention! Always set the linearization parameters for both channels A and B!

6.3.5.3 Reference Gases Setup

Select from the main menu "Calibration" > "Linearization Setup" > "Reference Gases Setup" to edit zero and span gas concentration of the linearization.



You are now able to edit every concentration of span and zero gas, which is visible on your gas bottle, for every single gas and measurement range .

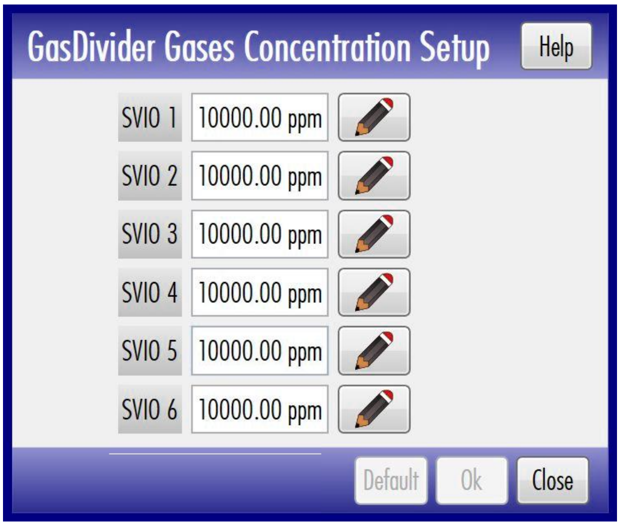
If a gas divider is connected to your device, choose in the column 'SVIO GasDivider' the corresponding channel where the Gas divider is connected . Then the Gas divider will automatically mix the right concentration that you chose in the section 'Span Gas' and 'Zero Gas'. You are now able to calibrate every measurement range that has a lower concentration than the used gas.

Save the appliance with 'Ok'. If you don't want to change anything, press 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

6.3

6.3.5.4 Gas Divider Concentration Setup

Choose from the main menu "Calibration" > "Calibration Setup" > "GasDivider Gases Concentration Setup" to set the concentration for the gas divider.



Select the concentrations of the gases that are connected to a certain channel of the gas divider in the corresponding field.

Save the appliance with 'Ok'. If you don't want to change anything, press 'Close'. To discard all changes and set the changes back to factory settings, press 'Default'.

6.3.5.5 Linearization Factors

Select from the main window “Calibration” > “Linearization Setup” > “Linearization Factors” to display a changeable list with linearization factors.

7.

PRACTICAL HINTS

Read the safety rules first
(Section 1.2)

7.1

7.1 Sampling

7.1.1 Emissions measurement without heated sample inlet

When sampling stack gases the sampling technique deserves great attention.

In the hot gases, there are condensable compounds like water vapor and hydrocarbons, and for this reason standard-wise the nCLD811 of the nCLD SL and nCLD8xx with options "h" and "hr" are equipped with a heated sample inlet. If your instrument is a nCLD6xx or nCLD899 or another model without option hr it cannot directly measure such "wet" samples. In that case an external gas conditioner must be inserted in the sample flow upstream the analyser, to re-move condensable substances.

Downstream of the gas conditioner, the dew point of the sample (usually 5 °C) is well below ambient temperature so no condensation can occur in the instrument.

A typical gas conditioner could be a gas cooler or a dilution system. Using a diluting-system consider that the sample dew point depends on the ambient air conditions (temperature, pressure, humidity), because the ambient air is used to dilute the raw exhaust emission.

To avoid condensation between the sampling point and the inlet to the gas conditioner, a heated (190 °C or higher) sampling line of stainless steel or Teflon is needed.

When the sample gas contains a high concentration of aggressive sub-stances such as ammonia, sulfur compounds, chlorinated and fluorinated compounds etc., successful extraction of the sample gas requires great care in the design of the installation, and it may even be necessary to use tubing heated to 280–300 °C.

To avoid particulate deposition in the sampling line a heated pre-filter

(3 – 7 μ) must be installed at the sampling point.

7.1.2 Emissions measurement with heated sample inlet ("Hot Tubing")

A nCLD with heated sample gas inlet (Option "Hot Tubing") like a nCLD811 or nCLD822Mhr can directly measure hot exhausts with condensable components such as water vapor and hydrocarbons. A gas conditioning device is not required as long as the amount of water vapor is below 15 %, which corresponds to a dew point of 54°C at atmospheric pressure.

Regarding the heating of sample tubing please refer to the data in the above section.

7.1.3 Ambient measurements

The sampling should be set-up with short tubing, smooth inner surfaces and materials like PTFE, PFA and glass.

If you should find particulate deposits on the inner surfaces the tubing must be cleaned or replaced.

The residence time of the sample gas inside sample tubing must be shortened because some NO may convert to NO2 due to the reaction of ozone with NO. In daylight, the opposite effect of NO2 photolysis takes place.

If the CLD 899 is to be integrated in a measuring system a common sample tubing is recommended in order to provide an increased flow and lower residence time in the tubing.

7.2

7.2 Quenching

Quenching is the reduction of the instrument signal caused by the presence of interfering components. As explained in section 3.1 the quenching phenomenon originates from the collision of excited NO_2 molecules with other molecules in the carrier gas.

The level of quenching depends heavily on the molecules involved. Also, the quenching components must exist in appreciable concentrations to produce measurable effects.

N_2 and O_2, the main constituents of the carrier gas air, also cause quenching. However, since calibration is usually performed with air as the carrier gas, this effect is "calibrated out" of the measurement.

Furthermore, it must be remembered that whilst calibration is invariably carried out with dry gas, the sample gas may contain varying concentrations of water vapor, which is also an effective quenching agent. Hence a decline in instrument sensitivity is to be expected when measuring humid samples. If a CLD SL is operated with an external sample conditioner (sample drier), which brings the sample dew-point to about 7 °C (about 1 vol%), the effect of quenching is at most 0,3 %, independent of the sample dew point between 7 and 45 °C. A standard nCLD811 is equipped with option hr and has an overall quenching effect of less than 3% for measurements of gasoline engine exhaust gases.

7.3

7.3 Interference

When an analytical method responds not only to the analyte of interest, but also to some other compounds, these other compounds are referred to as interference. In the case of the nCLD this means that certain interference compounds produce a false NO or a NOX signal.

When using NO/NOX chemiluminescence-based analysers with thermal converter, two different kinds of interference need to be distinguished:

- Components which react with ozone to produce a chemiluminescent signal e.g. hydrocarbons (ethylene, propylene etc.), and sulfides. Since combustion exhaust typically contains hundreds of different unidentified compounds, it is of no value to pick out individual hydrocarbons, which produce interfering signals and quantify this interference. Fortunately, the reaction kinetics of these interference is comparatively slow, and their chemiluminescent optical spectrum is different from that produced by the NO/O3 reaction. As a result they will not cause serious interference unless their concentration is of the order of 100 times higher than the N0X concentration in the sample gas.
- Another kind of interference occurs when other nitrogen compounds are converted to NO in the NO2-to-NO converter. Possibly important substance in this context are nitric acid (HNO3) and ammonia (NH3). Such compounds could produce an erroneously high NO2 measurement value depending on the type of converter. According to the application a special converter is appropriate (see technical data in section 2.2). The lower the temperature to convert NO2 the higher is the specific conversion to convert NO2 to NO. However, note also: The higher the converter temperature selected for conversion the more efficiently high NO2 concentration is it performed.

7.4/5

7.4 Special carrier gases

The nCLD899 is designed to measure NO_x in ambient air and the nCLD811n nCLD8xx and nCLD6x to measure exhaust gases. NO can also be measured in N_2O, CO_2 and noble gases. Because of the different qualities of the carrier gases there are changes of flows through restrictions and consequently the chamber pressure. This has an impact on the sensitivity of NO measurements. The nCLD may initially refuse a correct calibration. If so the first time before the analyser is calibrated the expected calibration factor can manually be entered. This prevents a calibration error message.

> *Caution:*
>
> *The user is solely responsible for ensuring that the carrier gas employed can safely be used with the ozone produced internally by the analyser.*
>
> *Failure to observe this precaution may cause danger to the user or bystander, or even lead to explosion!*

7.5 Hints regarding the measurement of Ammonia

In Practice, the measurement of ammonia (NH3) is very difficult. Due to its strong affinity with water gaseous ammonia converts in finest droplets and disappears in the tubing. Especially in lower concentrations flush times of up to one hour must be taken into account.

In addition, ammonia is ready to react with NO which causes fatal errors when the same channel of a gas divider is used for both gases in sequence. The build-up of ammonium nitrate can block the gas divider channel.

It does not make sense to regularly calibrate the analyser with ammonia.

8. INTERFACES

Read the safety rules first
(Section 1.2)

8.1

8.1 Introduction

The nCLD is equipped with a RS-232 interface and TCP/IP (LAN) which allows the instrument to be interfaced to a host computer. Thus, the instrument can be connected to a host computer system for data collection and remote control.

Please note that the information in this section relates to specialist programming, communications and electronics functions and is highly specific to the nCLD system. The information given is not meant to be a tutorial and is intended for use by experienced professionals only.

Currently are two different communication protocols available, the so-called EP and AK protocols. EP is the proprietary ECO PHYSICS interface protocol, the AK is defined by the "German Automobile Industry Working Group (AK)" and mainly used in the car manufacturing lines.

The section 8.2 describes the RS 232 interface hardware and wiring.

The sections 8.3 to 8.4 contain all necessary information required to interface the nCLD by the EP protocol via the serial port interface (RS 232) to a computer system, and to write a communications driver program.

The sections 8.7. to 8.8 contain all necessary information required to interface the nCLD by the AK protocol via the serial port interface (RS 232) to a computer system, and to write a communications driver pro-gram.

Furthermore, there is the possibility to connect USB-based external adapters in order to get digital/analog interfaces which offer measurement values as analog signals. Simple analyser status messages can be read from digital outputs. Details referring to electronics and functions can be found in section 8.5 and 8.6.

8.2 Interface hardware

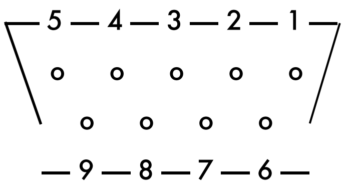
8.2.1 RS 232 interface specification

Type:	RS-232	*)
Baud rate:	300/1200/2400/4800/9600 Baud	*)
Start bit:	1	
Data bits:	7 / 8	*)
Parity:	odd/even/none	*)
Stop bits:	1 / 2	*)
Signal levels:	+/- 8 VDC	

*) parameters selectable by menu (see section 5.2.2.2)

8.2.2 Connector pin out

Front (pin) view of 9 pin DB9 connector on instrument rear panel.



Pin number	Signal	Signal type	Interface
1 RD0 / TD0	receive/transmit 0	bi-directional	RS-232 not avail.
2 RxD	received data	input	RS-232
3 TxD	transmit data	output	RS-232
4 DTR	data terminal ready	output	RS-232 not avail.
5 GND	signal ground		RS-232
6 RD1 / TD1	receive/transmit 1	bi-directional	RS-232 not avail.
7 RTS	request to send	output	RS-232 not avail.
8 CTS	clear to send	input	RS-232 not avail.
9 N.C.	not connected		RS-232 not avail.

8.2

8.2.3 Computer cable

Cable to a PC-compatible computer

Standardwise use the delivered USB to USB FTDI null modem RS232 cable. If you still need an old 9pin cable with 9pin-DSUB-connectors you need an USB to RS232 adapter (available from ECO PHYSICS as accessory, ECO PHYSICS article no 280.0208). The configuration of the old 9pin cable is as followed:

nCLD		PC
DB9 female		DB25 female
RxD 2	>... <	TxD 2
TxD 3	>... <	RxD 3
GND 5	>... <	GND 7
RTS 7*	>... <	CTS 5*
CTS 8*	>... <	RTS 4*
Screen	I I	Screen

Cable to an AT-compatible computer

nCLD		PC
DB9 female		DB9 female
RxD 2	>... <	TxD 3
TxD 3	>... <	RxD 2
GND 5	>... <	GND 5
RTS 7*	>... <	CTS 8*
CTS 8*	>... <	RTS 7*
Screen	I I	Screen

* Hardware handshaking not supported

8.3

8.3 RS 232 EP communications protocol

The master-slave principle with software handshaking protocol is used between the host computer and the nCLD. The nCLD (slave) transmits data only when the host (master) requests data.

The master sends a command telegram, the slave acknowledges the command with an answer telegram.

The nCLD offers two different protocols, the EP and AK protocol respectively. The following chapters describe the EP protocol only. The appropriate protocol has to be enabled in the nCLD's touch display in "Setup" > "Communication Parameters" > "Host x" by the EP circular button

8.3.1 Control signs

No signal handshake is supported by the CLD SL. Thus, a host computer must be fast enough to handle the nCLD data stream.

8.3.2 Communications protocol between the computer and the nCLD

a) Data block definition

Data block format

Computer → nCLD

Command message:

STX	ASCII character “STX”
Inst. address HI	2 byte ASCII ['00'...'99']
Inst. address LOW	
Command	Command code
Command	
Data	
Data Data	
ETX	ASCII character “ETX”
BCC	Block check character (XOR over above bytes)

Data block format

nCLD → Computer

Response to a valid or invalid command

ACK
Error code
ETX

Response to valid data request commands

ACK	
Error code	
STX	
Data	
Data Data	
ETX	
BCC	Block check character

Response to a corrupted message (see Error code definitions)

NAK
Error code
ETX

b) Data format definitions

Data are transferred in ASCII format. If more than one data item is re-quired, they are separated by commas. The field length of a data item is fixed. Numeric values are right justified. Spaces or zeros must be placed as leading characters. Refer to the command set.

Definitions:

"S"	means ASCII S (hex 53)
" "	means ASCII SP control character (hex 20)
<STX>	means ASCII STX control character (hex 2)

Example:

1. Set measuring range of instrument 12 to M3:
   <STX> “1” “2” “S” “R” “1” <ETX> <BCC>
2. Set analog output of instrument 3 to 0...20 mA full-scale, 0% offset operation:
   <STX> “0” “3” “S” “A” “2” “ ,” “0” “ ,” “0” <ETX> <BCC>

Error code definitions

The nCLD will respond to the host with an “NAK” message if any of the following conditions occur:

Block check error:

The received BCC did not correspond to the received data.

Command overflow:

The nCLD did not receive the ETX and BCC of a command and subsequently received a valid new command.

Error code byte definition:

7							0
	1	IE	IW		Comm.	error	code

bit 0...3:

bit 0...3:

Communication error code

0 no error

1 Block check error *)

2 Command overflow *)

3 Invalid command

4 Invalid operation

6 Command not allowed in current instrument mode

7 Reserved

bit 4:

IW Instrument warning bit

Set if any instrument warning pending. The "Report Status" (RS) command returns the warning code with the highest priority.

*) NAK acknowledge → repeat message

bit 5:

IE Instrument error bit

Set if any instrument error pending. The "Report Status" (RS) command returns the warning code with the highest priority

bit 6:

Always "1"

bit 7:

Not defined

Block check character

The BCC is generated by XOR-ing every message byte over the message block - including STX and ETX.

The resulting character is transmitted at the end of the message.

Only the lowest 7 bits are relevant.

8.3.3 Examples

a) Valid sequence

Control computer (Master)		nCLD (Slave)
→	STX, Address, Command,...Data..., ETX, BCC	→
←	ACK, Error code, ETX	←
or		
←	ACK, Error code, STX,...Data..., ETX, BCC	←

b) Transmission errors

The host sends a command to the CLD 8xx which receives the message corrupted and responds with a negative acknowledge.

The host repeats the message. The second trial is successful.

Control computer (Master)		nCLD (Slave)
→	STX, Address, Command,...Data..., ETX, BCC	→
←	NAK, Error code, ETX	←
Repeat		
→	STX, Address, Command,...Data..., ETX, BCC	→
←	ACK, Error code, ETX	←
or		
←	ACK, Error code, STX,...Data..., ETX, BCC	←

8.4

8.4 RS 232 EP command set

(nCLD: implemented by nCLDGui 1.0 or higher)

Caution: This is an open interface; all entries must be made according to their description. Example: a four-digit input parameter must always include four digits. It is the user's responsibility to transmit meaningful commands, settings, ranges and requests.

HR n Select "Remote" mode 2*)

n: 0 = off

1 = on

Before a host can control the nCLD the local user of the nCLD has to enable the function "Host Remote Control" in the register "control" of the CLDGui. After that the command HR1 sent by a host sets the analyser to Remote mode, indicated by the appearance of "Host remote active" in the upper left corner of the display. In this mode, most of the functions on the instrument's touch display (CLDGui) are disabled. To return the instrument to local mode (i.e. complete control via the touch display) the host must send the command HR0 by the appropriate interface, LAN or RS-232.

On power-up the analyser always automatically enters with the mode it had as it was switched off. The local operator has always the power to interrupt the host and to operate the analyser locally by disabling the function "Host Remote Control" in the register "control" of the CLDGui. Enabling this function will hand over the operation of the last active host, or makes it ready to a host, if never a host was active. If a new host can not get full access to the CLD the reason is most probably another host, that did not end its control by the command HR0. The local user can completely shut such an old host by clicking "control" > "Revoke Host Remote Right" in the CLDGui.

1*) Not accepted during "Power Up" phase

2*) Not accepted in calibration function

3*) Only accepted in calibration function

4*) Only accepted in "Remote" mode

8.4

a) "Set" commands

The instrument only accepts "Set" commands when in "Remote" mode (selectable with HR1). If the instrument is in "Local" mode an error message is returned. In "Remote" mode the analyser (CLD SL) is controlled by the Host. In "Local" mode the CLD SL is controlled by its graphical touch display (CLDGui).

SM n Set measurement mode 2,4*)

Only for two-converter or dual analyser. For all other types strictly use SM1 only!

	channel B	channel A
n:	0 = NO	NO
	1 = NO_x	NO
	2 = NO	NO_x
	3 = NO_x	NO_x

e.g. CLD811M or CLD899Y, M/Y converter is in chan B

	channel B	channel A
n:	1 = NO_x	NO

e.g. CM, or CY NH3-analyser, C converter is in channel B

	channel B	channel A
n:	0 = NO	NO
	1 = NO_xAm	NO
	2 = NO	NO_x
	3 = NO_xAm	NO_x

SR n Set measurement range 2,4*)

n:
- 0 = M4
- 1 = M3
- 2 = M2
- 3 = M1
- 4 = auto range

Dual analyser

n,m n: see above

m:
- 1 = Range for channel B
- 2 = Range for channel A

SX n,eeeee,(m) Set measurement range end-point value2,4*)

n: 0 = M4
1 = M3
2 = M2
3 = M1

eeeee: End point value in ppm or ppb,
(by five digits / floating point)
CLD811: (1.000 ... 10000) ppm
CLD899: (1.000 ... 01000) ppb

m: 1 = channel B (option dual only)
2 = channel A (option dual only)

ATTENTION: This function will also effect calibration gas reference values and autorange thresholds!

SB n,uuuuu,ooooo,(m) Set autorange thresholds 2,4*)

n: 0 = M4
1 = M3
2 = M2
3 = M1

uuuuu lower threshold (switching point) in ppm or ppb, switches to next lower range, (by five digits / floating point), default 2% of range

ooooo upper threshold (switching point) in ppm or ppb, switches to next higher range, (by five digits / floating point), default 95% of range

m: 1 = thresholds channel B (option dual only)
2 = thresholds channel A (option dual only)

SI[2] n Set filter (data averaging) 2,4*)

n: 0 = slow
1 = medium
2 = fast
3 = off

Dual Analyser

n,m n: 0 = slow channel B
1 = medium channel B
2 = fast channel B
3 = off channel B

m: 0 = slow channel A
1 = medium channel A
2 = fast channel A
3 = off channel A

SI[1] n,d(dddd) Set filter by analysers with prechamber 2,4*)

n: 0 = integration time [s]; ddddd: 0.200 to 999.0,
(five digits/floating point)
Default: 3
1 = p-frequency; dd: 00 to 99;
00 = no prechamber measurement
Default: 4
3 = flushtime [s]; ddddd: 1.000 to 9.000
(five digits/floating point)
Default: 2
4 = filter factor for pre-chamber; d: 1 to 9;
number of pre-measuring points to be averaged
Default: 5
5 = filter factor main chamber; dd: 01 to 99;
number of measuring cycles to be averaged (second, overlaid average)
Default: 9

SF[2] n,ddddd Set data averaging times of filters 2,4*)
n: 0 = slow (channel A + B)
1 = medium (channel A + B)
2 = fast (channel A + B)
ddddd: Data averaging time in seconds, (0.2 ... 180), (five digits/floating point)

SA m,o,f Set analog output mode 4*)
m: mode 0 = 0...1 V
1 = 0...10 V
2 = 0...20 mA
o: offset 0 = 0%
1 = 20%
f: Range 0 = 100%
full-scale 1 = 50%

SY yy,mm,dd,hh,mm Set date and time 4*)
(year, month, day, hour, minute)

SS n Activate "Standby" operation 2,4*)
n: 1 = Standby (ozone generator, Peltier and vacuum pump after 30 secs = off)
0 = return to measure mode (i.e. restart instrument)

[1] only for CLD899
[2] not used in CLD899

b) "Calibrate" commands

CS n,r,m,xxxxx Enter calibration gas concentration 2,4*)

n:	1 = NO	
	2 = NO_x	
	4 = S1	(optionally, NOxOx)
	5 = S2	(optionally, NOxOx)
	6 = S3	(optionally, NOxOx)
	7 = S4	(optionally, NOxOx)
	8 = AI0	(optionally with ext. D/A-I/O)
	9 = AI1	(optionally with ext. D/A-I/O)
r:	0 = measurement range M4 of channel B	
	1 = M3 of channel B	
	2 = M2 of channel B	
	3 = M1 of channel B	
	4 = M4 of channel A	
	5 = M3 of channel A	
	6 = M2 of channel A	
	7 = M1 of channel A	
m:	Cal. type:	0 = zero-point,
		1 = span
xxxxx:	concentration in ppm/ppb,	
(five digits/floating point)		
m = 0:		0...10%
m = 1:		25...100% Default: 90%
		(of the full scale)

CR n,r,m Return cal. gas concentration

n,r,m	see CS command	
n:	0 ... 9	
r:	0 ... 7	
m:	Cal. type:	0 = zero-point,
		1 = span
Reply:	xxxxx concentration in ppm/ppb (floating point)	

8.4

CP There are 5 different NO & NOx calibration procedures available as followed:

CP m Start automatic calibration procedure, 1,2,4*)
in current NO- or NO_x-measurement mode and set range.
The calibration is executed as it is locally defined in the "Calibration Phases Parameter Setup" of the CLDGui (see Calibration > Calibration Setup > Phases Parameter Setup) with one small difference: Verify lasts t3 + t4. CE1 and CE2 are not allowed. CE0 does cancel the process.

m: Cal. type:
0 = zero-point, both channels
1 = span, both channels
2 = zero-point channel A
3 = span, channel A
4 = zero-point, channel B
5 = span, channel B

8.4

CP m,0 Switch on calibration gases 1,2,4*)
(in current NO- or NO_x-measurement mode and range)
This process is unlimited. It MUST be stopped by the command CE1 or CE0. CE1 generates and stores calibration values and verify-values into the calibration history file. CE2 does not perform a "verify". By using the CE2-command a calibration can be performed without stopping the CPm,0-process. CE0 has to be sent after a CE2-command, in order to stop the running CPm,0-process.

m: Cal. type:
0 = zero-gas, both channels
1 = span-gas, both channels
2 = zero-gas channel A
3 = span-gas, channel A
4 = zero-gas, channel B
5 = span-gas, channel B

CP m,t Perform automatic calibration with given time. 1,2,4*)
(in current NO- or NO_x-measurement mode and range).
Purge-step lasts always 15 seconds. This calibration lasts totally t+4 seconds and automatically stops. CE1 and CE2 are not allowed. CE0 does cancel the process.

m: Cal. type:
0 = zero-gas, both channels
1 = span-gas, both channels

2 = zero-gas channel A
3 = span-gas, channel A
4 = zero-gas, channel B
5 = span-gas, channel B

t: Time for the calibration process in seconds.
Must be between 16 and 50’000

8.4

CP m,0,u Perform automatic calibration CHECK 1,2,4*)
with given time. (in current NO- or NO_x-measurement mode and range). Purge-step lasts always 15 seconds.
This calibration check lasts totally u seconds and automatically stops. CE1 and CE2 are not allowed. CE0 does cancel the process. There are no verify-values generated and stored into the calibration history file.

m: Cal. type:
0 = zero-gas, both channels
1 = span-gas, both channels
2 = zero-gas channel A
3 = span-gas, channel A
4 = zero-gas, channel B
5 = span-gas, channel B

u: Time for the cal check process in seconds.
Must be between 21 and 50’000

CP m,t,u Perform a time-controlled calibration 1,2,4*)
including a verification.
This calibration process lasts totally t + 2*u seconds and automatically stops. CE1 and CE2 are not allowed. CE0 does cancel the process.

m: Cal. type:
0 = zero-gas, both channels
1 = span-gas, both channels
2 = zero-gas channel A
3 = span-gas, channel A
4 = zero-gas, channel B
5 = span-gas, channel B

t,u: Times in seconds for the process steps
>15, < 50’000 seconds
The following 4 steps are done
t = purge
u = control
3 seconds = calibrate
u – 3 = verify

CG There are 5 different sensors calibration procedures available as followed: 8.4

CG m,s Start automatic calibration procedure, 1,2,4*)
in current sensor-measurement mode and set range.
The calibration is executed as it is locally defined in the "Calibration Phases Parameter Setup" of the CLDGui (see Calibration > Calibration Setup > Phases Parameter Setup) with one small difference: Verify lasts t3 + t4. CE1 and CE2 are not allowed. CE0 does cancel the process.

m:	Cal. type:	0 = zero-point, both channels
		1 = span, both channels
s:	Sensor	4 = sensor S1
		5 = sensor S2
		6 = sensor S3
		7 = sensor S4
		8 = sensor AI0
		9 = sensor AI1

CG m,s,0 Switch on calibration gases 1,2,4*) 8.4
(in current sensor-measurement mode and range)
This process is unlimited. It MUST be stopped by the command CE1 or CE0. CE1 generates and stores calibration values and verify-values into the calibration history file. CE2 does not perform a "verify". By using the CE2-command a calibration can be performed without stopping the CPm,0-process. CE0 has to be sent after a CE2-command, in order to stop the running CPm,0-process.

m:	Cal. type:	0 = zero-gas, both channels
		1 = span-gas, both channels
s:	Sensor	4 = sensor S1
		5 = sensor S2
		6 = sensor S3
		7 = sensor S4
		8 = sensor AI0
		9 = sensor AI1

CG m,s,t Perform automatic calibration with given time. 1,2,4*)

(in current sensor-measurement mode and range).
Purge-step lasts always 15 seconds. This calibration lasts totally t+4 seconds and automatically stops. CE1 and CE2 are not allowed. CE0 does cancel the process.

m:	Cal. type:	0 = zero-gas, both channels
		1 = span-gas, both channels
s:	Sensor	4 = sensor S1
		5 = sensor S2
		6 = sensor S3
		7 = sensor S4
		8 = sensor AI0
		9 = sensor AI1
t:	Time for the calibration process in seconds. Must be between 16 and 50’000	

CP m,s,0,u Perform automatic calibration CHECK 1,2,4*)
with given time, for sensors only. (in current sensor-measurement mode and range). Purge-step lasts always 15 seconds.
This calibration check lasts totally u seconds and automatically stops. CE1 and CE2 are not allowed. CE0 does cancel the process. There are no verify-values generated and stored into the calibration history file.

8.4

m:	Cal. type:	0 = zero-gas, both channels
		1 = span-gas, both channels
s:	Sensor	4 = sensor S1
		5 = sensor S2
		6 = sensor S3
		7 = sensor S4
		8 = sensor AI0
		9 = sensor AI1
u:	Time for the cal check process in seconds. Must be between 21 and 50’000	

CP m,s,t,u Perform a time-controlled calibration 1,2,4*)
including a verification, for sensors only.
This calibration process lasts totally t + 2*u seconds and automatically stops. CE1 and CE2 are not allowed. CE0 does cancel the process.

m:	Cal. type:	0 = zero-gas, both channels
		1 = span-gas, both channels
s:	Sensor	4 = sensor S1
		5 = sensor S2

6 = sensor S3
7 = sensor S4
8 = sensor AI0
9 = sensor AI1

t,u: Times in seconds for the process steps
>15, < 50'000 seconds
The following 4 steps are done
t = purge
u = control
3 seconds = calibrate
u – 3 = verify

CE n Finish calibration procedure 1,3,4*)
(if started with CP command)
n: 0 = escape from calibration procedure without storing calibration values
1 = Only allowed after CPm,0. Terminate calibration procedure and store calibration values. Switch valves back to measurement mode.
2 = Only allowed after CPm,0.
Calibrate, store calibration values, keep valves as they currently are and remain in the calibrationprocedure

SC n,r,xxxxx,yyyyy, Ttttt,Ppppp Set calibration values 2,4*)

n:
1 = NO
2 = NO_x
4 = sensor S1 (optionally, NOxOx)
5 = sensor S2 (optionally, NOxOx)
6 = sensor S3 (optionally, NOxOx)
7 = sensor S4 (optionally, NOxOx)
8 = sensor AI0 (optionally with ext. D/A-I/O)
9 = sensor AI1 (optionally with ext. D/A-I/O)

r: 0...7 = measurement range (see CS command)
if n = 5,6,7,8,9 then r does not affect anything but must be set.

xxxxx: zero point, (five digits/floating point), [ppm or ppb]

yyyyy: slope, (five digits/floating point), [ppm/cp0.1sec] or [ppb / cp0.1sec]

Ttttt: Temperature at time of calibration, (five digits/floating point), 0.000 ...63.00

Ppppp: Pressure at time of calibration, (five digits/floating point), 88.00 ... 344.0

RC n,r Return calibration values

n:
1 = NO
2 = NO_x
4 = sensor S1 (optionally, NOxOx)
5 = sensor S2 (optionally, NOxOx)
6 = sensor S3 (optionally, NOxOx)
7 = sensor S4 (optionally, NOxOx)
8 = sensor AI0 (optionally with ext. D/A-I/O)
9 = sensor AI1 (optionally with ext. D/A-I/O)

r: 0...7 = measurement range (see CS command)
if n = 5,6,7,8,9 then r does not affect anything but must be set.

Response: xxxxx,yyyyy,Ttttt,Ppppp

xxxxx: zero point, (five digits/floating point + sign)

yyyyy: slope, (five digits/floating point + sign)

Ttttt: Temperature at time of calibration, (five digits/floating point + sign)

Ppppp: Pressure at time of calibration, (five digits/floating point + sign)

c) "Test" commands

TT n Reset test function. Initiate common measurement mode 4*)
n: 0 = all components: on
valves: sample gas measurement = on
cal valves = off
meas. mode = the last selected

TV m,n Valve setting 4*)
m: 0 = calibration valve channel A&B[3], MV\, (on = position cal)
1 = NO/NO_x channel B, PB\, (on = NO_x)
2 = calvalve channel A, for dual analyser only, OUT17, (on = position cal)
3 = Sampleflow switching valve, OUT18, (on = small flow), for dual analyser channel B only
5 = NO/NO_x channel A, OUT20, (on = NO_x) for dual analyser only
6[1] = pre-/mainchamber valve, OUT14, (on = prechamber)
6[2] = O_2 on of EFT (converter efficiency test)

n: 0 = off (no current)
1 = on (pulled up)

TD[2] Display raw signal in counts 4*)
(normalized to 0.1 s, "*" if value not available)
Reply: xxxxxx,yyyyyy
xxxxxx = channel B (floating point + sign)
yyyyyy = channel A (floating point + sign)

TD[1] Display raw signal in counts, for diagnostic purpose only! 4*)
(normalized to 0.1 s, "*" if value not available)
Reply: i,xxxxxx,yyyyyy
i = Phase of measurement
0 = flushing
1 = pre-chamber
2 = flushing, start of a new cycle
3 = main chamber
xxxxxx = channel B (floating point + sign)
yyyyyy = channel A (floating point + sign)

[1] only for CLD899

[2] option for CLD811, not available for CLD899

[3] for dual analyser channel B only

d) "Return" commands

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"Return" commands are accepted in both "Remote" and "Local" modes.

RD n Display signals in ppm/ppb
Reply: floating point; "*" if value not available
n: 0 = all values b1,b2,a1,a2,d,e,f,g plus analyser status
Reply: b1,b2,a1,a2,d,e,f,g,cdj,vvvv,hxf,eeee,wwww,iott
Status bytes info see command RS
b1 : NO channel B (e.g. not available for CLD811M or CLD899Y)
b2 : converted measuring signal channel B (e.g. NO_x or NOxAm), depending on analyser type, e.g. for a CLD811M or CLD899Y = NO_x.
a1 : NO channel B
a2 : converted measuring signal channel A (e.g. NO_x), depending on analyser type, e.g. for a CLD811M or CLD899Y = "*", i.e not available.
d,e,f,g,h,i: additional sensor-channels, depending on configuration; d = S1, e = S2, f = S3, g = S4, h = AI0, i = AI1.

n: 1 = NO from channel B
Reply: b1
n: 2 = converted measuring signal (e.g. NO_x) from channel B
Reply: b2
n: 3 = NO from channel A
Reply: a1
n: 4 = converted measuring signal (e.g. NO_x)from channel A
Reply: a2
n: 8 = b1,b2,a1,a2,d,e,f,g
n: 9 = b1,b2,a1,a2,c1,c2,c3,c4,S1,S2,S3,S4,AI0,AI1,cdj,vvvv,hxf,eeee,wwww,iott

RR Return current measuring range
Reply: n,m,x,y
n: [0...3] see SR command (range for channel B)
m: [0...3] see SR command (range for channel A)
x: F or A for channel B
y: F or A for channel A
A = auto range
F = fixed range

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RI[4)] Report filter times and active filters
Reply: dl,dm,ds,n,m

dl:	slow filter time, [s], (five digits/floating point + sign)	
dm:	medium filter time, [s], (five digits/floating point + sign)	
ds:	fast filter time, [s], (five digits/floating point + sign)	
n:	active filter channel B, [0...3] see SI command	
m:	active filter channel A, [0...3] see SI command	

RI[1] n Report filter

n:	0 = integration time in secs (five digits/floating point + sign)	
n:	1 = p-frequency	
	Reply:	dd
n:	3 = flushtime in secs (five digits/floating point + sign)	
n:	4 = filter time for pre-chamber	
	Reply:	d[2]
n:	5 = filter time main chamber	
	Reply:	dd[3]

RM Report measure mode

Reply: n

n: [0..3] see SM command

RA Return current analog output settings

Reply: m,o,f see SA command

[1] only for CLD899
[2] number of pre-measuring points to be averaged (second average)
[3] number of measuring cycles to be averaged (second average)
[4] option for CLD811, not available for CLD899

RS Return current instrument status

Reply: cdj,vvvv,hxf,eeee,wwww,io

byte c: Configuration-byte hardwaretype
bit 0 = Additional converter available (1 = yes)
bit 1 = Hot tubing available (1 = yes)
bit 2 = Peltier cooler available (1 = yes)
bit 3 = Bypass Pressure regulator av. (1 = yes)
bit 4 = Multifunction board available. (1 = yes)
bit 5 = Prechamber available (1 = yes)
bit 6 = set
bit 7 = reserved

byte d: Configuration-byte reactortype
bit 0..2 = Reactor B (0 = none, 1 = 1000 ppb, 2 = 10000 ppb, 3 = 1000 ppm, 4 = 10000 ppm)
bit 3..5 = Reactor A (0 = none, 1 = 1000 ppb, 2 = 10000 ppb, 3 = 1000 ppm, 4 = 10000 ppm)
bit 6 = set
bit 7 = reserved

byte j: Configuration-byte jumpers
bit 0 = Ready for Synch
bit 1 = No converter in scrubberblock
bit 2 = Dual analyser
bit 3 = Ammonia analyser
bit 4 = Additional converter is steel
bit 5 = Two M-converter
bit 6 = set
bit 7 = reserved

Bytes v1v2v3v4: Valve-status

byte v1: bit 0 = MV\, Cal. valve (B) (1 = position cal)
bit 1 = PB\, NO/NO_x channel B (1 = NO_x)
bit 2 = OUT17, Cal. valve channel A, (1 = position cal), for dual analyser only
bit 3 = OUT18, sample flow channel B (1 = active = small flow)
bit 4 = OUT19, not used
bit 5 = OUT20, NO/NO_x channel A (1 = NO_x)
bit 6 = set
bit 7 = reserved

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byte v2: bit 0 = OUT1, EFT O3, (1= on)
bit 1 = OUT2, Purge, (1 = active)
bit 2 = OUT3, Instrument test, (1=active)
bit 3 = OUT4, EFT, (1 = on)
bit 4 = OUT5, from gas divider, (1 = active)
bit 5 = OUT6, to gas divider, (1 = active)
for dual analyser: sample flow channel A
(1 = active = small flow)
bit 6 = set
bit 7 = reserved

byte v3: bit 0 = OUT7, span gas range M1, (1=active)
bit 1 = OUT8, span gas range M2, (1=active)
bit 2 = OUT9, span gas range M3, (1 = active)
bit 3 = OUT10, span gas range M4, (1 = active)
bit 4 = OUT11, zero gas, (1 = active)
bit 5 = OUT12, (1 = active)
bit 6 = set
bit 7 = reserved

byte v4: bit 0 = OUT13, RO1, converter booster, (1 = active)
bit 1 = OUT14, RO2, EFT O_2 = on, (1 = active),
for CLD899: prechamber A&B, (1 = active)
bit 2 = OUT15, RO3, Alarm B, (1 = active)
bit 3 = OUT16, RO4, Alarm A, (1 = active)
bit 4 = reserved
bit 5 = reserved
bit 6 = set
bit 7 = reserved

byte h: bit 0 = Scrubber heating (1 = on)
bit 1 = Reaction chamber heating (1 = on)
bit 2 = Additional conv. heating (1 = on)
bit 3 = Hot Tubing-Heizung (1 = on)
bit 4 = Peltier cooling (1 = on)
bit 5 = reserved
bit 6 = set
bit 7 = reserved

byte x: bit 0 = Ozone generator (1 = on)
bit 1 = Cal. valve, MV\, (1 = position cal)
bit 2 = Vacuum pump (1 = on)
bit 3 = Bypass pressure regulation (1 = on)
bit 4 = Recorder (1 = on)
bit 5 = AUX device (1 = on)
bit 6 = set
bit 7 = reserved

byte f: bit 0 = Remote mode (1 = on)
bit 1 = reserved
bit 2 = Power up phase
bit 3 = calibration active (1 = currently active)
bit 4 = Stand by operation
bit 5 = not used
bit 6 = set
bit 7 = reserved

eeee: Instrument error code (2 byte ASCII, hexadecimal coded, i.e. error message error message E-01 = 0001 in hex (binary coded E-01 = 0000’0000’0000’0001)
E.g.: three error messages E-01, E-02 and
E-05 at the same time = 0013 in hex:
E-01 = 0000’0000’0000’0001
E-02 = 0000’0000’0000’0010
E-05 = 0000’0000’0001’0000
Total binary = 0000’0000’0001’0011
= decimal 19 = HEX 0013
All error messages simultaneously = FFFF in hex).
Every bit represents an error message.
E-01: „Setup and Cal. data lost“
E-02: „Vacuum failure“
E-03: „Malfunction of a sensor or regulation loop“
E-04: „Scrubber heating failure“
E-05: „Ozonator high voltage failure“
E-06: „Bypass pressure out of Range“
E-07: „Flow sensor not calibrated“
E-08: „Peltier cooler failure“
E-09: „Converter heating failure“
E-10: „Reactor heating failure“

8.4

E-11: „Tubing heating failure"
E-12: „Sample / Cal flow out of Range"
E-13: „Hardware def.! I-Type changed!"
E-14: „Calibration error"
E-15: „Inlet pressure O3 out of range"
E-16: „PMT error"

wwww: Instrument warning code (2 byte ASCII, hexadecimal coded, i.e. warning W-01 = 0001 in hex, three warnings W-01, W02 and W-05 at the same time = 013 in hex).
E.g.: three warning messages W-02, W-04 and W-08 at the same time = 008A in hex:

W-02 = 0000'0000'0000'0010
W-04 = 0000'0000'0000'1000
W-08 = 0000'0000'1000'0000

Total binary = 0000'0000'1000'1010 = decimal 138 = HEX 008A

Every bit represents a warning.
W-01: „Converter lifetime exceeded"
W-02: „Pump maintenance required"
W-03: „Instrument temperature: low"
W-04: „Instrument temperature: high"
W-05: „Bypass out of allowed pressure"
W-06: „Inlet pressure O_3 too low"
W-09: „Range overflow! Change Range."
W-10: „O_3-Up. Ozone not constant!"
W-13: „Range B overflow! Change Range."

byte i: bit 0 = D IN 1 (see section 8.5)
bit 1 = D IN 2
bit 2 = D IN 3
bit 3 = D IN 4
bit 4 = In1 of MFB8k
bit 5 = In2 of MFB8k
bit 6 = set
bit 7 = reserved

byte o: bit 0 = D OUT 1 (see section 8.6)
bit 1 = D OUT 2
bit 2 = D OUT 3
bit 3 = D OUT 4
bit 4 = D OUT 5
bit 5 = D OUT 6
bit 6 = set
bit 7 = reserved

byte t: additional info about E03 Device error
@ = ASCII 64 = converter temperature
B = ASCII 66 = Hot tubing temperature
V = ASCII 86 = Reactor temperature
X = ASCII 88 = Scrubber temperature
^ = ASCII 94 = Instrument temperature
\ = ASCII 92 = Cooler temperature
` = ASCII 96 = Bypass pressure
b = ASCII 98 = Flow
d = ASCII 100 = Reactor pressure

byte t: additional info about E03 error type
B = ASCII 66 = no cooler response or reverse cooler response
D = ASCII 68 = no heater response
F = ASCII 70 = sensor broken
H = ASCII 72 = sensor short circuit
J = ASCII 74 = overheating

RT[1] Return current temperature [°C]
T resolution of instrument temperature: 1°C
Reply: xxx,-xx,xx.xx,xxx,xxx,xxx,0,0
instrument internal, Peltier cooling, reaction chamber, converter, hot tubing, scrubber, external converter (PLC or CON), vacuum pump

RP[1] Return current pressure [mbar]
Seven digit floating point,xxxx,xxxx,xxxx
Reply: bypass regulation, reaction chamber, inlet pressure O_3, reaction chamber if inlet valve closed

[1] sensor not implemented will be replied by a " *" (star)

8.4

RF Sample gas flow
Reply: xxxx,yyy,zzz

xxxx	[l/min]	sample flow
yyy	[counts]	actual flow counts
zzz	[counts]	flow counts during flowcal

RY Return date and time
Reply: yy,mm,dd,hh,mm
(year, month, day, hour, minute)

RZ Device operating hours
Reply: hhhhh,hhhhh,hhhhh
Vacuum pump ("Count-down" hours), analyser ("Count-up" hours), converter ("Count-down" hours)

RX n Return measuring range full-scale value
n: [0...3] range M4 ... M1, see SR command
Reply: eeeee,fffff [ppm or ppb], five digit floating point + sign
eeeee: end-point value channel B
fffff: end-point value channel A

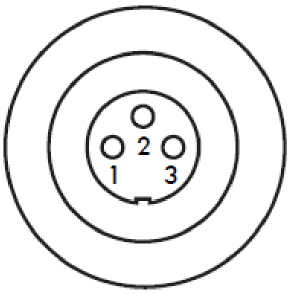
RB n Return autorange thresholds
n: [0...3] range M4 ... M1, see SR command
Reply: uuuuu,ooooo,lllll,hhhhh [threshold in ppm or ppb] five digit floating point + sign
uuuuu,ooooo: lower and upper threshold of channel B
lllll,hhhhh: lower and upper threshold of channel A

1*) Not accepted during "Power Up" phase
2*) Not accepted in calibration function
3*) Only accepted in calibration function
4*) Only accepted in "Remote" mode

8.5

8.5 Alarm connector

Front view of the socket for the two optional alarm outputs on the rear of the analyser.



1 Alarm B Output: +24 VDC / max. 1 A
2 Ground A + B
3 Alarm A Output: +24 VDC / max. 1 A

8.6

8.6 Digital/analog interface with relais (NOXIO)

8.6.1 USB analog and digital I/O boards

8.6

8.6.2 USB A&D-I/O board models and selection

nCLD analysers have extended and highly flexible analog and digital I/O functionalities. Instead of the old (instrument internal) IO-board a number of external USB A&D-I/O boards can be used. Up to three boards with different functions can be operated in parallel. All software drivers are pre-installed in the analysers. Select your favourite USB-boards according to your needs.

Box-analysers (analysers not having an integrated user-interface) can be fully operated and controlled by our user-interface "nCLDGui ©" installed on any MS-Windows (win-7 or higher) based external microcomputer (desktop, notebook, etc.). If the user-interface "nCLDGui©" is installed on an external microcomputer, then the USB A&D-I/O boards must be plugged to the USB-connector(s) of the external microcomputer.

8.6

The following boards from two suppliers (mcc and i/o-Acces) can be used.

Example 1.) Requested: 4 analog signal voltage outputs and few digital ins/outs
Recommended board: USB-3101 from mcc

Example 2.) Requested: 2 analog signal ins and 3 analog signal outs and some DIOs
Recommended board: SB-AO16-4A from i/o-Acces

Example 3.) Requested: 12 digital outlets and 12 digital inlets.
Recommended board: USB-1024HLS from mcc

Example 4.) Requested: 6 Relais Power switches to power on/off instruments.
Recommended board: USB-ERB08 from mcc

Analog and/or Digital USB-I/O-Boards Model	Comment	mcc USB-3101	mcc USB-3102	mcc USB-3103	mcc USB-3104	mcc USB-3105	mcc USB-3106	mcc USB-3110	mcc USB-3112	mcc USB-3114	i/o-Acces USB-AO16-4A	i/o-Acces USB-AO16-4E	i/o-Acces USB-AO16-8A	i/o-Acces USB-AO16-8E	i/o-Acces USB-AO16-16A	i/o-Acces USB-AO16-16E	mccUSB-1024HLS	mccUSB-DIO96H	i/o-Acces USB-DIO-32I	i/o-Acces USB-DIO-96	mcc USB-ERB08	mcc USB-SSR08	mcc USB-ERB24	mcc USB-SSR24
Important Option											**DIO PD**	**DIO PD**	**DIO PD**	**DIO PD**	**DIO PD**	**DIO PD**			**DIO PD**	**DIO PD**				
# of Analog OUTs	V	4	4	8	8	16	16	4	8	16	4	4	8	8	16	16								
	mA		✓		✓		✓																	
Analog INs	V										2		2		2									
# off Digital INs/OUTs	in CLDGui as Digital IO Board 1	8	8	8	8	8	8	8	8	8	16	16	16	16	16	16								
# of DIOs only	in CLDGui as Digital IO Board 2																24	96	32	96				
# of Relais resp. SolidState Outputs	in CLDGui as Power Outlets																				8	8	24	24

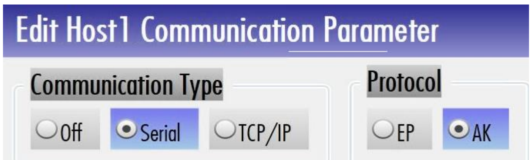
8.7

8.7 RS 232 AK communications protocol

The master-slave principle is used between the host computer and the nCLD. The analyser (slave) transmits data only when the host (master) requests data.

The master sends a command telegram, the slave acknowledges the command with an answer telegram.

The protocol has to be enabled in the nCLD's touch display in “Setup” > “Communication Parameters” > “Host x” by the AK circular button



8.7.1 Control signs

No signal handshake is supported by the nCLD. Thus, a host computer must be fast enough to handle the nCLD data stream.

8.7.2 Communications protocol between the computer and the nCLD

a) Data block definition

Data block format

Host computer → nCLD

Command message:

STX	Header
Blank	
Func. code 1	
Func. code 2	
Func. code 3	
Func. code 4	
Blank	Variable Data
"K"	
"0" or "1" or "2"	
Data	
Data	
ETX	End message

8.7

Data block format

nCLD → Host computer

Acknowledges each command

STX	Header
Blank	
Func. code 1	
Func. code 2	
Func. code 3	
Func. code 4	
Blank	Fixed Data
Error Status	
Data … Data	Variable Data
ETX	End message

b) Data format definitions

Implemented according to the recommendations of the German Automobile Industry Working Group (AK) in "Standardization of Exhaust Gas Monitoring", Ch. 90/0

Explanation of the variable names used throughout this document:

wxyz	:	Command code word, which when received by the analyser is returned in the acknowledgment string.
f	:	Error status byte, indicates the number of pending instrument errors *f* = 0 : no errors 1 < *f* <9 : number of pending errors
[...]	:	Optional parameter

Syntax Error1: Commands which could not be carried out return Syntax-Error1:

???? f Kn

???? : When the analyser receives an unknown command code word, Syntax Error1, 4x"?" is returned

Syntax Error2: Incomplete commands return Syntax-Error2 "SE":

wxyz f Kn SE

Data error: Data and parameter errors are indicated by the code "DF" in the data block of the acknowledgment string:

wxyzf Kn DF

Invalid interrogate data value: Missing data values are indicated by the character # (e.g. undefined settings), invalid data is preceded by the character #.

Analyser busy: if the analyser is sent a new command while it is still carrying out the current command, or if the new command cannot be executed in the current status of the instrument, the new command will not be performed and a Busy "BS" code will be returned in the datablock of the acknowledge message. The execution of the current function is not affected by this situation, except if it is a RESET or STANDBY command:

wxyzf Kn BS

8.7

Device addresses: Although the standard nCLD analyser has two reaction chambers and is called a two-channel analyser, it has one device address channel only (K0) and it communicates with the host computer (or test-bench control computer, PLR, if appropriate) exclusively via device address K0. But if the analyser is configured as a dual-channel analyser, it has three device address channels K0, K1 and K2. If the analyser receives commands with any other address the following message is returned:

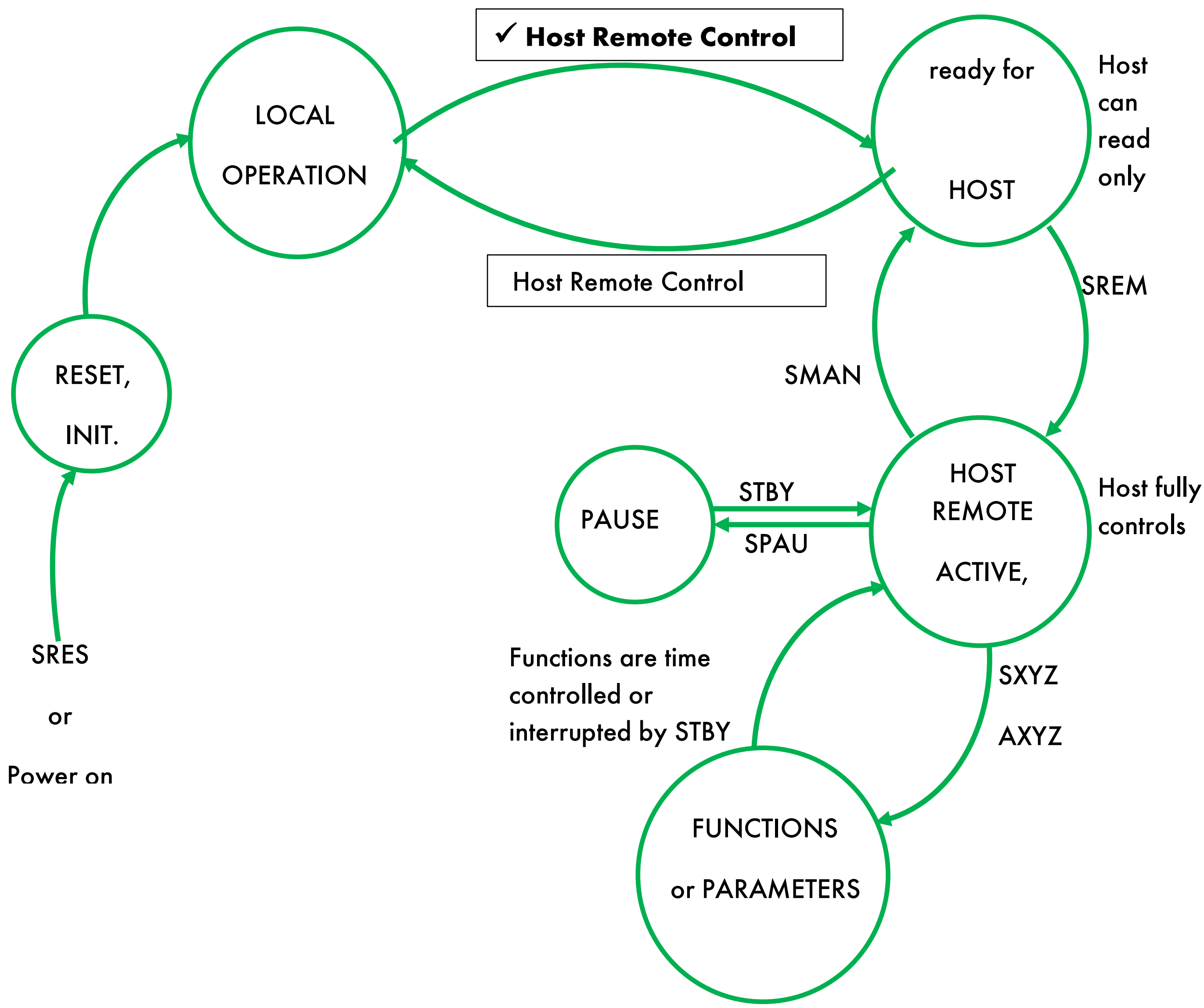
w x y z 0 Kn NA.

K0	:	One or both channel commands
K1	:	Only channel K1 commands
K2	:	Only channel K2 commands
– K255	:	Not available (NA)
K256 - ...	:	Syntax error (SE)

Command options for dual-channel analysers are written in blue colour in chapter 8.8 of this operation manual.

8.8 RS 232 AK command set

8.8.1 Analyser status diagram



8.8.1.1 Status control commands

SRES K0

(Dual-channel analyser: SRES K[1,2]. Acts simultaneously on both channels!)

RESET. The analyser interrupts current functions and returns to Standby mode via the initialization phase. The default operating mode is: Measure channel K0 NOx, last active measuring range (or Autorange) remains valid, standard T90 filter setting, integrator set to zero, delay mode off.

Returned message: SRES f

The analyser enters Standby mode even if the instrument operating temperatures have not yet been reached. If the host computer sends the "Return current status" command (ASTZ K0) when the analyser in not yet ready to measure then the string ASTZ 1 SMAN STBY SNOX SROF is returned (Standby mode with error). If operating temperatures have been reached, then ASTZ 0 SMAN STBY SNOX SROF is returned (Standby mode, no errors). If the host sends the "Return error status" command (ASTF K0) during the warm-up phase, then at least one error ASTF 1 3 (Error 3, Power-Up phase) is reported. The command SRES starts the analyser anew, causing it to execute its initialization procedure. For this reason, for a short time after receiving the RESET command the analyser cannot accept any further commands. Wait at least 8 seconds before sending another command.

SREM K0

(Dual-channel analyser: SREM K[1,2]. Acts simultaneously on both channels!)

REMOTE. The instrument enters the "host computer active" operating mode, but only when prior to that the "Host Remote Control" function was locally enabled (✓) in the Control menu of the CLD SL. In this mode, any commands from a host device (e.g. test cell control computer) are accepted and executed.

Acknowledgment: SREM f

SMAN KO (Dual-channel analyser: SMAN K[1,2]. Acts simultaneously on both channels!)

MANUAL. The instrument enters the local (manual) operating mode. The status in the upper left corner of the main display of the CLD SL will report "ready; Host remote".

Message returned: SMAN f

In this mode, parameter setting (EXYZ) and process commands (SXYZ) from a host device (e.g. test cell control computer) are NOT accepted or executed except SREM and SRES. On receipt of any other SXYZ command the instrument echoes this back to the host accompanied by the code "OF" (off-line):

w x y z f Kn OF

However report commands (AXYZ) are still answered. In order to totally disconnect the host disable the "Host Remote Control" function in the Control menu of the CLD SL and the status in the upper left corner of the main display of the CLD SL will change to "ready".

SPAU K0 (Dual-channel analyser: SPAU K[1,2]. Acts simultaneously on both channels!)

PAUSE. Instrument switches into paused state, deeper than in Standby mode - the ozone generator, vacuum pump, bypass flow and PMT cooling are switched off, but the scrubber, reaction chamber, hot tubing and converter heatings continue and these remain at operating temperature.

Message returned: SPAU f

If in the Paused state a "Return current status" command (ASTZ K0) is received, the instrument returns the message: ASTZ f SREM SPAU.

The SPAU command is only accepted when the instrument is already in Standby mode, and if this is not the case then a BS (Busy) code is returned. The Pause phase is ended by sending a STBY or SRES command.

STBY K0 (Dual-channel analyser: STBY K[1,2])

STANDBY. Interrupt current function. Bypass pump does not swith off and the current measurement mode (NO or NO_x) remains valid.

Message returned: STBY f

The analyser immediately enters Standby mode. The error messages "Bypass pressure deviation", "Bypass pressure error" and "Meas/Cal gas flow error" are suppressed. If the host computer sends the "Return current status" command (ASTZ K0) when the analyser is not yet ready to measure then the string ASTZ 1 SREM STBY ... is returned (Standby mode with error). If operating temperatures have been reached, then ASTZ 0 SREM STBY ... is returned (Standby mode, no errors). If the host sends the "Return error status" command (ASTF K0) during the warm-up phase, then at least one error ASTF 1 3 (Error 3, Power-Up phase) is reported.

SENO K0 (Dual-channel analyser: SENO K[1,2])

NO MEASURE MODE. Analyser switches appropriate channel to NO measurement mode. Other current settings and functions - e.g. measuring range - remain valid.

K1 and K2 are used for dual channel instruments. Use always SENO K0 for the standard two-channel analyser CLD 811. For the standard two-channel analyser NO is always measured in the measurement channel A.

Message returned: SENO f

SNOX K0 (Dual-channel analyser: SNOX K[1,2])

NO_x MEASURE MODE. Analyser switches appropriate channel to NO_x measurement mode. Other current settings and functions - e.g. measuring range - remain valid.

K1 and K2 are used for dual channel instruments. Use always SNOX K0 for the standard two-channel analyser CLD 811. For the standard two-channel analyser NOx is always measured in the measurement channel B.

Message returned: SNOX f

SENO and SNOX are important functions. The response of the analyser to many of the interrogative commands such as AAEG, AANG, ALIN, AKON, AIKO, AIKG and AKAL depends on the measurement mode (SENO or SNOX) selected by their use, as do the measurement and calibration parameters.

S2NO K0 NO and NOx MEASURE MODE. Analyser is switched to two-channel measurement mode. Other current settings and functions – e.g. measuring range – remain valid. This mode is not available in dual-channel analysers.

Message returned: SENO f

This function is not available in dual-channel analysers.

8.8

8.8.1.2 Status report commands

ASTZ K0 (Dual-channel analyser: ASTZ K[1,2]) RETURN CURRENT STATUS.

Message returned: ASTZ f srm sf [sf2] sfm sfn sfa sfi sfr sfl

srm : Status remote mode
srm= SREM : Instrument is in remote operating mode
sf : Current function:
sf = SPAU : Pause
sf = STBY : Standby, ready to measure
sf = SNGA : Zero point check using zero gas
sf = SEGA : Span check with span gas
sf = SATK : Calibration procedure executing
sf2 : Substatus SATK
sf2= SNGA : Switch on and measure zero gas
sf2 = SNKA : Calibrate zero point
sf2 = SEGA : Switch on and measure cal gas
sf2 = SEKA : Calibrate with cal. gas
sf = SSPL : Purge
sf = SMGA : Analyser measuring
sf = SLCH : Linearisation check is initialized
sf = SLIN : Linearisation is initialized
sf = SLST : Linearisation (check) in progress.
This state is indicated in addition to SLIN or SLCH
sf = SALI : Linearisation check with test gas in progress.
sf = SKOP : Converter test in progress
sf = SGTS : Instrument test in progress.

sfm
sfm = SENO: Analyser measuring NO concentration
sfm = SNOX: Analyser measuring NO_x concentration
sfm = S2NO: Analyser measuring NO and NO_x concentration
sfm = S1NO: Channel K1 measuring NO concentration
sfm = S1NX: Channel K1 measuring NO_x conc.

sfn
sfn = S2NO: Channel K2 measuring NO conc.
sfn = S2NX : Channel K2 measuring NO_x conc.

sfa : Autorange
sfa = SARA : Autorange off
sfa = SARE : Autorange on
sfi : Integrator status
sfi = SINT : Integrators on
sfr : Delay mode status
sfr = SROF : Delay mode off
sfr = SRON : Delay mode on
sfl
sfl = SLIE : Lin. polynomial coeff. set by user
sfl = SLID : Factory set lin. polynomial coeff.
sfl = SLIA : Lin. polynomial coeff. Deactivated

8.8.1.3 Error status interrogation commands

ASTF K0 (Dual-channel analyser: ASTF K[1,2])
RETURN ERROR STATUS.
Message returned: ASTF f fc1 ... fcn
f : Number of pending errors
fc1 ... fcn : Error code, max 2 digits

1 -> Meas/Cal gas flow error
2 -> Converter temperature error
3 -> Power-Up !
4 -> RAM error
5 -> Linearity test error
6 -> Calibration error
7 -> Measuring range overflow A
8 -> Ozone generator malfunction
9 -> Range overflow B

10 -> Chamber pressure error
11 -> Temperature error
12 -> Reserve
13 -> Flow sensor not calibrated
14 -> PMT cooling fault
15 -> Reactor heating fault
16 -> Hot tubing heating fault
17 -> Reserved
18 -> Bypass pressure error
19 -> Reserved

20 -> Reserved
21 -> Converter lifetime exceeded
22 -> Pump service due
23 -> Room temperature too low
24 -> Room temperature too high
25 -> Bypass pressure deviation
26 -> Ozone generator warm up
27 -> Not used

30 -> Reserve
31 -> Reserve

50 -> NO (Channel K2) Zero gas calibration error M4
51 -> NO_x (Channel K1) Zero gas calibration error M4
52 -> NO (Channel K2) Span gas calibration error M4
53 -> NO_x (Channel K1) Span gas calibration error M4
54 -> NO (Channel K2) Zero gas calibration error M3
55 -> NO_x (Channel K1) Zero gas calibration error M3
56 -> NO (Channel K2) Span gas calibration error M3
57 -> NO_x (Channel K1) Span gas calibration error M3
58 -> NO (Channel K2) Zero gas calibration error M2
59 -> NO_x (Channel K1) Zero gas calibration error M2

60 -> NO (Channel K2) Span gas calibration error M2
61 -> NO_x (Channel K1) Span gas calibration error M2
62 -> NO (Channel K2) Zero gas calibration error M1
63 -> NO_x (Channel K1) Zero gas calibration error M1
64 -> NO (Channel K2) Span gas calibration error M1
65 -> NO_x (Channel K1) Span gas calibration error M1
69 -> Span gas reference = 0!

70 -> NO (Channel K2) Linearity error M4

71 -> NO_x (Channel K1) Linearity error M4
72 -> NO (Channel K2) Linearity error M3
73 -> NO_x (Channel K1) Linearity error M3
74 -> NO (Channel K2) Linearity error M2
75 -> NO_x (Channel K1) Linearity error M2
76 -> NO (Channel K2) Linearity error M1
77 -> NO_x (Channel K1) Linearity error M1

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80 -> NO (Channel K2) Zero gas cal check error M4
81 -> NO_x (Channel K1) Zero gas cal check error M4
82 -> NO (Channel K2) Span gas cal check error M4
83 -> NO_x (Channel K1) Span gas cal check error M4
84 -> NO (Channel K2) Zero gas cal check error M3
85 -> NO_x (Channel K1) Zero gas cal check error M3
86 -> NO (Channel K2) Span gas cal check error M3
87 -> NO_x (Channel K1) Span gas cal check error M3
88 -> NO (Channel K2) Zero gas cal check error M2
89 -> NO_x (Channel K1) Zero gas cal check error M2

90 -> NO (Channel K2) Span gas cal check error M2
91 -> NO_x (Channel K1) Span gas cal check error M2
92 -> NO (Channel K2) Zero gas cal check error M1
93 -> NO_x (Channel K1) Zero gas cal check error M1
94 -> NO (Channel K2) Span gas cal check error M1
95 -> NO_x (Channel K1) Span gas cal check error M1

If Error 1, 2, 3, 7, 10, 14, 15, 16, 18, 25 or 26 occurs, then the measurement value displayed is preceded by the character #. The analyser continues to measure. When Error 4, 8, 10, 11 or 12 occurs the analyser switches to PAUSE mode.

8.8.2 Functions

The following functions are available:

SNGA	:	Zero-point check using zero gas
SEGA	:	Span check using Span gas
SATK	:	Calibration procedures
SSPL	:	Purge
SMGA	:	Measure sample gas
SGTS	:	Instrument test
SKOP *)	:	Converter test *)
SLCH *)	:	Linearity check *)
SLIN *)	:	Linearity *)
SALI *)	:	Linearity check using test gas *)

*) Can only started in STBY mode.

Functions are initiated by sending the appropriate control command and in general can be halted with the STBY command. All functions except for calibrations, linearization and converter tests are time-continuous and if one of these commands is sent to the instrument when another is already executing, then the old function is replaced by the new. Functions may be executed for defined durations using the EFDA command. SATK, SEGA, SNGA, SLCH, SLIN and SALI may only be executed when operating temperatures have been reached (no Error 3 pending), and will only correctly terminate (i.e. the measured concentration data correctly processed and saved) if the set function duration has expired without interruption by another control command (STBY, SRES, etc.).

8.8.2.1 Function commands

EFDA K0 sxyz fd [fd2] (Dual-channel analyser: EFDA K[1,2] sxyz fd [fd2])

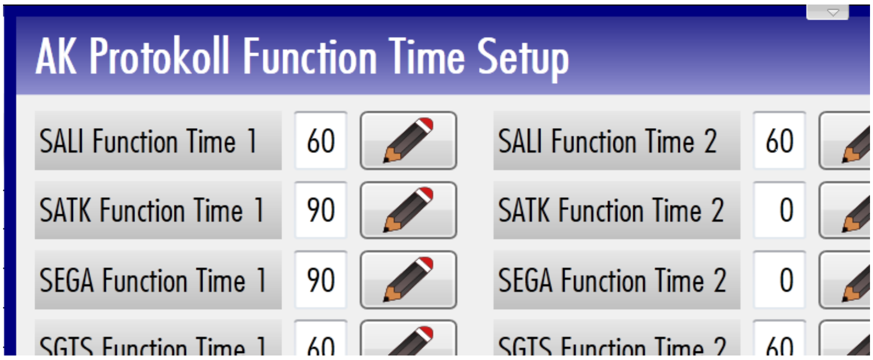
DEFINE FUNCTION DURATION.
Message returned: EFDA f
sxyz : Function code
fd : Function duration
fd = 0 : Function runs continuously
fd <= 65535: Function duration in seconds
fd2 : Additional function duration or auto. calibration
fd2 = 0 or none : Calibration duration defined above (*fd*)
fd2 <= 65535: Duration of signal stability check in seconds (see section 8.8.2.6 Calibration)

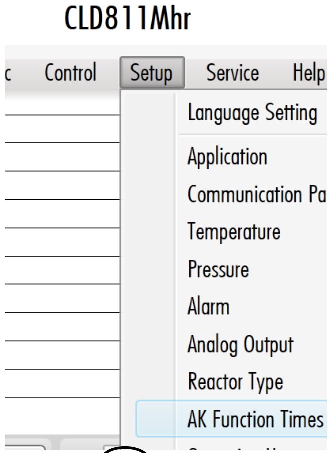
The functions which may be executed for a programmable duration are:
SMGA, SNGA, SEGA, SATK, SKOP, SSPL, SGTS, SLIN, SLCH, SALI.
The user-set duration of each function remains stored in memory even when the analyser is switched off. After a Factory-Reset however the duration of all functions is set to the Factory-Default value of 60 seconds.

AFDA K0 sxyz (Dual-channel analyser: AFDA K[1,2] sxyz)

RETURN FUNCTION DURATION.
Message returned: AFDA f fd
fd <= 65535 : max. function duration in secs.
fd = 0 : Function runs continuously
If automatic calibration is determined by a signal stability check (by means of the function EFDA SATK fd1 fd2) then the AFDA function returns a second value fd2 which is the stability control check duration in secs.

These function durations are also locally displayed in the "AK Protocol Function Time Setup"-window (from menu Setup > AK Function Times)





8.8

EZEI K0 sxyz jjmmtt hhmmss fd (Dual-channel analyser: EZEI K[1,2] sxyz jjmmtt hhmmss fd)

SET FUNCTION START TIME. Starts a function at a set clock time, and allows the function duration to be set independently of any other duration set with the EFDA command. The EZEI function may be used up to four time per command, each time a different time/day may be selected. If instead of a date the # character is entered, then the command is executed daily at the given time. An entry is deleted when the function it calls up begins executing or the EZEI command is executed with new (possibly all values set to 0) start times.

Message returned: EZEI f

jjmmtt : Year, Month, Day (each 2 digits, no spaces)
hhmmss : Hour, Minute, Second (each 2 digits, no spaces)
fd> 0 : Function duration in secs, max. 65525 secs.
fd= 0 : Unlimited duration (i.e. function executes continuously).

The following commands can be started with the EZEI function:
SATK (set time calibration), SALI, SEGA, SGTS, SMGA, SNGA, SPAU, SSPL, STBY, SRES.

AZEI K0 sxyz (Dual-channel analyser: AZEI K[1,2])

RETURN FUNCTION DURATION.

Message returned: AZEI f jjmmtt hhmmss fd

sxyz : Command code
jjmmtt : Year, Month, Day (each 2 digits, no spaces)
hhmmss : Hour, Minute, Second (each 2 digits, no spaces)
fd> 0 : Function duration in secs, max. 65525 secs.
fd= 0 : Unlimited duration (i.e. function executes continuously).

8.8.2.2 Measurement functions and their associated commands

SMGA K0 (Dual-channel analyser: SMGA K[1,2]. Acts simultaneously on both channels!)

MEASURE SAMPLE GAS. Depending on the valve-configuration (model options) the sample gas valves are opened. The analyser starts measuring the NO or NO_x concentration of one or both channels, depending on which mode is active. Only the activated concentration value(s) can be accessed by using e.g. the AKON command.

Message returned: SMGA f

AKON K0 (Dual-channel analyser: AKON K[1,2])

RETURN MEASURED VALUE. The currently valid concentration values of one or both channels are returned. If the channel was previously sent a SENO command, then the data represents the NO concentration. Similarly, if the channel was previously sent a SNOX command, then the data represents the NO_x concentration.

Message returned: AKON f kw

kw : Concentration in ppm [0.001 ... 10000].

In two-channel measurement mode (S2NO) both values are returned together:

Message returned: AKON f NOx-kw NO-kw

An invalid concentration is preceded by the symbol #. This may occur due to the analyser being in Standby or Power-up mode, during measurement initialization, or when an error has occurred. Also this may occur when the selected channel of SMGA and AKON do not correspond.

SINT K0 (Dual-channel analyser: SINT K[1,2])

START INTEGRATOR. Sets the concentration value integrators to zero then executes the function.
Message returned: SINT f

Four integrators are available:
NO integrator (AIKO if SENO active)
NO integrator total (AIKG if SENO active)
NO_x integrator (AIKO if SNOX active)
NO_x integrator total (AIKG if SNOX active)

Dual-channel analyser:
Eight integrators are available, four per channel:stf

AIKO K0 (Dual-channel analyser: AIKO K[1,2])

RETURN CONCENTRATION INTEGRAL VALUE. The mean values of one or both channels are returned and the integrator reset to zero and restarted. If the channel was previously sent a SENO command, then the data represents the NO concentration. Similarly, if the channel was previously sent a SNOX command, then the data represents the NO_x concentration.
Message returned: AIKO f kw
kw : Concentration in ppm [0.001 ... 10000]

In two-channel measurement mode (S2NO K0) both values are returned together:
Message returned: AIKO f NOx-kw NO-kw

An invalid concentration is preceded by the symbol #. This may occur due to the analyser being in Standby or measurement initialization mode, or when an integrator overflow occurs. Also this may occur when the selected channel of SMGA and AIKO do not correspond.

8.8

AIKG K0 (Dual-channel analyser: AIKG K[1,2])
RETURN TOTAL CONCENTRATION INTEGRAL VALUE. The mean values of one or both channels are returned, but the integrator is restarted only after receipt of SINT command. If the channel was previously sent a SENO command, then the data represents the NO concentration. Similarly, if the channel was previously sent a SNOX command, then the data represents the NO_x concentration.
Message returned: AIKG f kw
kw : Concentration in ppm [0.001 ... 10000].

In two-channel measurement mode (S2NO K0) both values are returned together:
Message returned: AIKG f NOx-kw NO-kw

An invalid concentration is preceded by the symbol #. This may occur due to the analyser being in Standby or measurement initialization mode, or when an integrator overflow occurs. Also this may occur when the selected channel of SMGA and AIKG do not correspond.

ACOU K0 (Dual-channel analyser: ACOU K[1,2])
RETURN RAW MEASUREMENT VALUES IN CPS. The unprocessed raw data values in counts per second of one or both channels are returned.
Message returned: ACOU f c

In two-channel measurement mode (S2NO K0) both values are returned together:
Message returned: ACOU f NOx-kw NO-kw

An invalid value is preceded by the symbol #. This may occur when the selected channel of SMGA and ACOU do not correspond.

8.8.2.3 Purging

SSPL K0 (Dual-channel analyser: SSPL K[1,2]. Acts simultaneously on both channels!)

PURGE. The purge valve (OUT 2) is opened. This function may be interrupted by a new control command (SRES, STBY, SEGA, SNGA, SGTS) or terminates at the end of the time set using the EFDA K0 SSPL n (secs) function. After the purge function terminates the analyser enters Standby mode.

Message returned: SSPL f

8.8.2.4 Checking and calibrating the zero point

SNGA K0 [Mn] (Dual-channel analyser: SNGA K[1,2] [Mn])

MEASURE ZERO GAS. The zero gas valve (OUT 11) is opened. The zero point concentrations (NO or NO_x depending on whether SENO, SNOX or SMGA of the concerned channel K0, K1 or K2 is active) measured in the specified ranges are determined and saved. The function terminates successfully at the end of the time set using the EFDA K0 SNGA n (secs) function, when the measured concentrations for each specified range are saved and the analyser enters Standby mode. Other commands may interrupt this function before it has terminated successfully, and if this occurs then the concentrations will NOT be saved.

Message returned: SNGA f

AANG K0 (Dual-channel analyser: AANG K[1,2])

RETURN ZERO POINT DEVIATION. The values returned by this function are based on the last successfully finished or failed zero gas measurement (SNGA) or last successfully finished or failed stability-controlled calibration (SATK) as appropriate (but not to the last time-controlled calibration). The returned values also relate to the currently measurement mode, SNOX or SENO.

Message returned: AANG f M1 kw aw ap M2 kw aw ap M3 kw aw ap M4 kw aw ap

kw : Zero gas concentration in ppm

aw : Deviation from expected value on linearization curve (= 0) in ppm.

ap : Deviation from expected value on linearization curve as percent of range full-scale.

In two-channel measurement mode (S2NO K0) both channel values are returned together:

Message returned: AANG f M1 kwnox awnox apnox kwno awno apno M2 kwnox awnox apnox kwno awno apno M3 kwnox awnox apnox kwno awno apno M4 kwnox awnox apnox kwno awno apno

kwnox : NOx – Zero gas concentration in ppm

awnox : NOx – Deviation from expected value an linearization curve (=0) in ppm.

apnox : NO_x – Deviation from expected value on linearization curve as percent of range full-scale.

kwno : NO-Zero gas concentration in ppm.

awno : NO-Deviation from expected value on linearization curve (=0) in ppm.

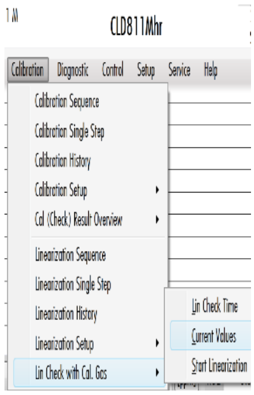
apno : NO-Deviation from expected value on linearization curve as percent of range full-scale.

8.8

The AANG values are also displayed in the user display in the window Zero-Point and Span Check Deviations (AANG, AAEG, AALI). See the submenue Current Values in the menue Lin Check with Cal. Gas of the register Calibration.

Zero-Point and Span Check Deviations (AANG, AAEG, AALI)

Gas	Zero Gas [ppm]	Dev. Zero [ppm]	Dev. Zero [%]	Span Gas [ppm]	Dev. Span [ppm]	Dev. Span [%]	AALI Zero [ppm]	AALI Span [ppm]
	AANG			AAEG			AALI	
NO, MR4	0.3441	0.3441	0.003441	9920.4	20.4	0.20606	0.3441	20.4
NO, MR3	-0.4089	-0.4089	0.04089	991.27	21.271	2.1929	-0.4089	21.271
NO, MR2	0.0011	0.0011	0.0011	87.594	-11.624	11.715	0.0011	-11.624
NO, MR1	0.1057	0.1057	1.057	9.3036	6.3036	210.12	0.1057	0.4629
NOx, MR4	0.6664	0.6664	0.006664	9901	-19	0.19153	0.6664	-19
NOx, MR3	-0.3061	-0.3061	0.03061	984.27	4.2699	0.4357	-0.3061	4.2699



SNUL K0 (Dual-channel analysers: SNUL K[1,2])

ZERO POINT CALIBRATION DURING SNGA. During a zero point measurement with SNGA, the SNUL function may be used to perform a zero point calibration of the analyser in the active range of one or both channels. This calibration becomes valid immediately after the SNUL command is executed, i.e. the zero calibration value so determined is used as the offset for the measured value. Similarly the span calibration factor will be corrected.
Message returned: SNUL f

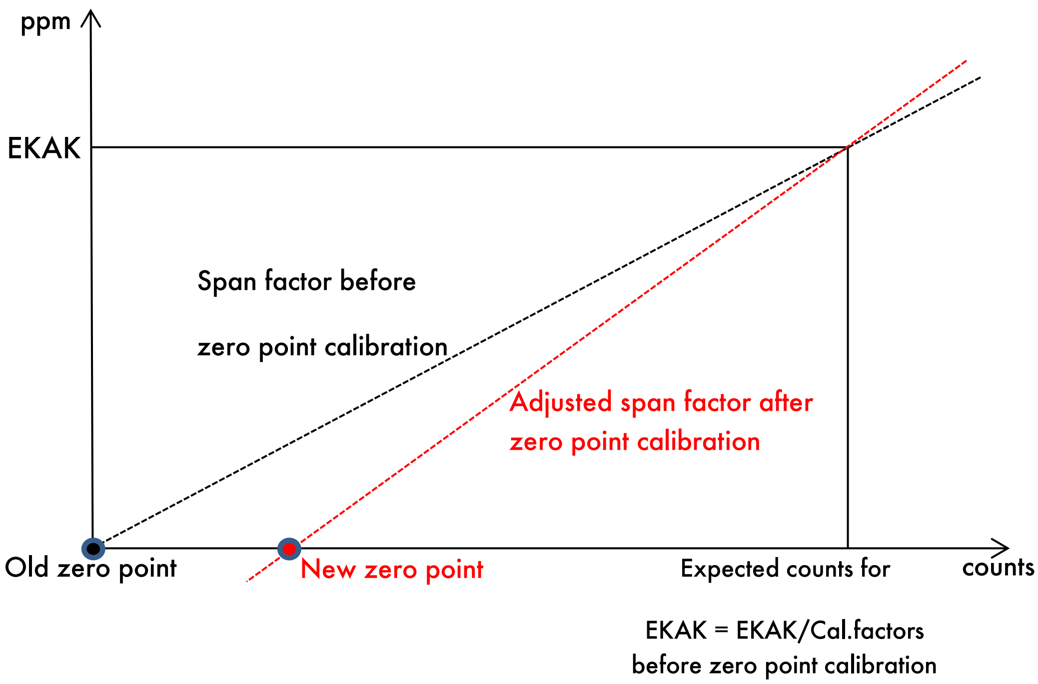
8.8

Formula used to calculate the new zero point (for K1 and K2 channels individually):

$$\text{Zero\_new\_counts} = \frac{\text{Meas.value\_Zerogas\_netto\_ppm}}{\text{Cal.factor\_current}} - \text{Zero\_old\_count}$$

After each zero calibration, the analyser span factor is automatically adjusted to ensure that the end point (EKAK) remains unchanged. The correction formula applied to the channel K1 or K2 calibration factor is:

$$\text{Cal.factor\_new} = \frac{\text{EKAK-Ref.\_ppm}}{(\text{EKAK-Ref.\_ppm/Cal.factor\_old}) - \text{Zero\_new\_counts} - \text{Zero\_old\_counts})}$$



Zero calibration is performed using a pressure and temperature corrected measurement value. The pressure correction is based on the pressure and temperature values during the last span calibration (SATK or SPAN). The zero offset so determined will be adjusted to allow for a different temperature and pressure at the next span calibration.

8.8.2.5 Span Check

SEGA K0 [Mn] (Dual-channel analyser: SEGA K[1,2] [Mb] [Ma])

MEASURE SPAN GAS. The external valves for the calibration gas K1 to K4 appropriate to the specified measuring range and channels are opened and the concentration measured. The calibration measurement values relate to one or both channels depending the currently active measurement mode (SNOX, SENO or SMGA). The function terminates successfully at the end of the time set using the EFDA K0 SEGA n (secs) function, when the measured concentration is saved to the range specific register and the analyser enters Standby mode. Other commands may interrupt this function before it has terminated successfully, and if this occurs then the concentrations will NOT be saved.

Message returned: SEGA f

AAEG K0 (Dual-channel analyser: AAEG K[1,2])

RETURN SPAN GAS DEVIATION. The values returned by this function are based on the last span gas measurement (SEGA) or last stability-controlled calibration (SATK) as appropriate (but not to the last time-controlled calibration). The returned values also relate to the currently active measurement mode, SNOX or SENO.

Message returned: AAEG f M1 kw aw ap M2 kw aw ap M3 kw aw ap M4 kw aw ap

kw : Span gas concentration in ppm

aw : Deviation from cal. gas concentration

ap : Deviation from cal. gas concentration as percent of range full-scale.

8.8

In two-channel measurement mode (S2NO K0) both channel values are returned together:

Message returned: AAEG f M1 kwnox awnox apnox kwno awno apno M2 kwnox awnox apnox kwno awno apno M3 kwnox awnox apnox kwno awno apno M4 kwnox awnox apnox kwno awno apno

kwnox : NOx – Span gas concentration in ppm

awnox : NOx – Deviation from cal. gas concentration in ppm.

apnox : NO_x – Deviation from cal. gas concentration as percent of range full-scale.

kwno : NO-Span gas concentration in ppm.

awno : NO-Span from cal. gas concentration in ppm.

apno : NO-Span from cal. gas concentration as percent of range full-scale.

The AAEG values are also displayed in the user display in the window Zero-Point and Span Check Deviations (AANG, AAEG, AALI). See the submenue Current Values in the menue Lin Check with Cal. Gas of the register Calibration. See also command description AANG.

SPAN K0 (Dual-channel analyser: SPAN K[1,2])
SPAN CALIBRATION DURING SEGA. During a span gas measurement with SEGA, the SPAN function may be used to perform a span calibration of the analyser in the active range of one or both channels, as with SATK. This calibration becomes valid immediately after the SPAN command is executed (value according to EKAK).
Message returned: SPAN f

8.8.2.6 Calibration

EKAK K0 M1 kw [M2 kw M3 kw M4 kw]

(Dual-channel analyser: EKAK K[1,2] M1 kw [M2 kw M3 kw M4 kw])

ALLOCATE CALIBRATION GAS CONCENTRATIONS TO RANGES. The EKAK calibration gas concentration values can be independently allocated to each range for the currently active measurement mode, SENO or SNOX of one or both channels. If the analyser is in NO measuring mode, the concentration values entered with the EKAK command will only be used to calibrate the NO channel, and similarly when in NO_x mode. The calibration gas concentration value must be within the defined range (25 (resp. 50) to 100% of set measurement range). Entering the value 0 is not allowed.

Message returned: EKAK f

kwn : Cal. gas concentration values in ppm. M1...M4: [25% of M1 ... 100% of M4, ppm]

The allocation of different gas concentration values for both channels (NO_x and NO) in the measurement mode S2NO K0 is possible in only one step when the following command format is used:

EKAK K0 M1 kwnox kwno [M2 kwnox kwno M3 kwnox kwno M4 kwnox kwno]

kwnox : NO_x - Cal. gas concentration values in ppm. M1...M4: [25% of M1 ... 100% of M4, ppm]

kwno : NO - Cal. gas concentration values in ppm. M1...M4: [25% of M1 ... 100% of M4, ppm]

AKAK K0 (Dual-channel analyser: AKAK K[1,2])

RETURN CALIBRATION GAS CONCENTRATIONS. The returned values relate to the currently active measurement mode, SNOX or SENO:

Message returned: AKAK f M1 kw M2 kw M3 kw M4 kw

kw : Cal. gas concentration values in ppm for the appropriate measuring range.

8.8

In two-channel measurement mode S2NO both channel values are returned together by AKAK K0:
Message returned: AKAK f M1 kwnox kwno M2 kwnox kwno M3 kwnox kwno M4 kwnox kwno

kwnox : NO_x - Cal. gas concentration values in ppm for the appropriate measuring range.

kwno : NO - Cal. gas concentration values in ppm for the appropriate measuring range.

SATK K0 [Mn] (Dual-channel analyser: SATK K[1,2] [Mn])

AUTOMATIC CALIBRATION. Starts the analyser's automatic calibration routine to determine the correction factors needed in the calculation of the measured concentrations (zero offset, slope value). The calibration is made in the currently valid range and channel specified in the SATK command. If no range is specified, then all ranges will be calibrated. Occurs an error during a calibration's purge step, the calibration for that range is skipped and the previous factors remain, but the process continues .
Message returned: SATK f

Formula used to calculate the span calibration factor (slope):
Slope_new = Meas.value_ppm / Rawcounts_netto
Rawcounts_netto = Rawcounts_brutto – Zero_Offset
Meas.value_ppm = (Slope_previous*Rawcounts_netto) filtered

a): Stability-controlled calibration, single measuring range only

Condition for stability-controlled procedure: EFDA SATK $t1_{AK}$ $t2_{AK}$, where $t2_{AK} \neq 0$, $t1_{AK} > 15$ and $t2_{AK} > 5$

Note: These durations are different from the local operation calibration duration t1 to t4, but the functional times relate as followed:

$t1_{AK} = t1$

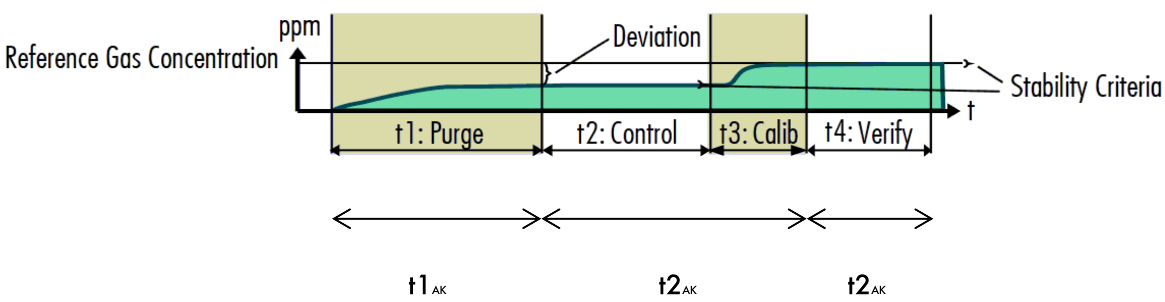
$t2_{AK} = t2 + t3 = t4$

8.8

Start: SATK K[0,1,2] Mx

Internal function execution:

Start:	Funct. duration:	Activity:	Status indication:
SNGA Mx	$t1_{AK}$ (purge)	zero gas flows	SATK SNGA
SNKA Mx	$t2_{AK}$ (control + cal)		
		Adjust zero point	SATK SNKA
SNGA Mx	$t2_{AK}$ (verify)	Meas. zero gas Signal stability insufficient: set appropriate error	SATK SNGA
SATK Mx	$t1_{AK}$	cal. gas flows	SATK SEGA
SATK Mx	$t2_{AK}$	Adjust slope. Signal stability insufficient or deviation from EGRW value set during last valid calibration excessive: set appropriate error and do not calibrate.	SATK SEKA
SEGA Mx	$t2_{AK}$	Meas. cal. gas Signal stability insufficient: set appropriate error	SATK SEGA



8.8

b) Stability-controlled calibration, over all measuring ranges M1 to M4, automatically

Condition for stability-controlled procedure: EFDA K0 SATK $t1_{AK}$ $t2_{AK}$, where $t2_{AK} \neq 0$, $t1_{AK} > 15$ and $t2_{AK} > 5$

Note: These durations are different from the local operation calibration duration t1 to t4, but the functional times relate as followed:

$t1_{AK} = t1$

$t2_{AK} = t2 + t3 = t4$

Start: SATK K[0,1,2]

Internal function execution:

Start:	Funct. duration:	Activity:	Status indication:
SNGA M1	$t1_{AK}$	Zero gas flows.	SATK SNGA
SNKA M1	$t2_{AK}$	Adjust zero points M1 ... M4	SATK SNKA
SNGA M1	$t2_{AK}$	Meas. zero gas Signal stability insufficient: set appropriate error	SATK SNGA
SATK M1	$t1_{AK}$	Cal. gas flows.	SATK SEGA
SATK M1	$t2_{AK}$	Adjust slope value. Signal stability insufficient or deviation from EGRW value set during last valid calibration excessive: set appropriate error and do not calibrate.	SATK SEKA
SEGA M1	$t2_{AK}$	Meas. cal. gas Signal stability insufficient: set appropriate error	SATK SEGA
SATK M2	$t1_{AK}$	Cal. gas flows.	SATK SEGA
SATK M2	$t2_{AK}$	Adjust slope value. Signal stability insufficient or deviation from EGRW value set during last valid calibration excessive: set appropriate error and do not calibrate.	SATK SEKA

SEGA M2	$t2_{AK}$	Meas. cal. Gas Signal stability insufficient: set appropriate error	SATK SEGA
SATK M3	$t1_{AK}$	Cal. gas flows.	SATK SEGA
SATK M3	$t2_{AK}$	Adjust slope value. Signal stability insufficient or deviation from EGRW value set during last valid calibration excessive: set appropriate error and do not calibrate.	SATK SEKA
SEGA M3	$t2_{AK}$	Meas. cal. gas. Signal stability insufficient: set appropriate error	SATK SEGA
SATK M4	$t1_{AK}$	Cal. gas flows.	SATK SEGA
SATK M4	$t2_{AK}$	Adjust slope value. Signal stability insufficient or deviation from EGRW value set during last valid calibration excessive: set appropriate error and do not calibrate.	SATK SEKA
SEGA M4	$t2_{AK}$	Meas. cal. gas. Signal stability insufficient: set appropriate error	SATK SEGA

c): Time-controlled calibration, single measuring range
Condition for time controlled calibration: EFDA K0 SATK $t1_{AK}$ $t2_{AK}$, where $t2_{AK}$ = 0 or not specified
Note: These durations are different from the local operation calibration duration t1 to t4, but the functional times relate here as followed:
$t1_{AK} = t1 + t2 + t3$
Start: SATK K[0,1,2] Mx

Internal function execution:

Start:	Funct. duration:	Activity:	Status indication:
SNKA Mx	$t1_{AK}$	Adjust zero points Mx	SATK SNKA
SATK Mx	$t1_{AK}$	If deviation (EGRW 4) from last cal. OK: Save new slope value Mx, otherwise: set appropriate error and do not calibrate.	SATK SEKA

d): Time-controlled calibration, over all measuring ranges M1 to M4, automatically
Condition for time controlled calibration: EFDA K0 SATK $t1_{AK}$ $t2_{AK}$, where $t2_{AK}$ = 0 or not specified
Start: SATK K[0,1,2] (no measuring range entered)

Internal function execution:

Start:	Funct. duration:	Activity:	Status indication:
SNKA Mx	$t1_{AK}$	Adjust zero points M1 ... M4	SATK SNKA
SATK M1	$t1_{AK}$	If deviation (EGRW 4) from last cal. OK: Save new slope value M1, otherwise: set appropriate error and do not calibrate.	SATK SEKA
SATK M2	$t1_{AK}$	If deviation (EGRW 4) from last cal. OK: Save new slope value M2, otherwise: set appropriate error and do not calibrate.	SATK SEKA

SATK M3	$t1_{AK}$	If deviation (EGRW 4) from last cal. OK: Save new slope value M3, otherwise: set appropriate error and do not calibrate.	SATK SEKA
SATK M4	$t1_{AK}$	If deviation (EGRW 4) from last cal. OK: Save new slope value M4, otherwise: set appropriate error and do not calibrate.	SATK SEKA

The calibration function ends automatically after the procedure shown above has been executed, and can only be interrupted with the SRES or STBY commands. The correction values produced by the calibration are saved to the parameter memory only after the successful completion of a calibration step. The command EGRW 4 may be used to set the maximum allowable deviation from the last calibration value.
If during the calibration procedure over all ranges a calibration error should occur, then the calibration procedure will always continue to completion, and if an error occurs during the calibration of a particular range then the calibration data of this range will also be saved.

8.8

AKAL K0 (Dual-channel analyser: AKAL K[1,2])

RETURN CALIBRATION CORRECTION VALUES.

The returned values relate to the currently active measurement mode SNOX or SENO (per channel). A range must be linearised, calibrated and checked for linearity (LinCheck), before AKAL values are generated after a new calibration. The LinCheck must be complete regardless of passed or failed. It's recommended to perform a Lin-Check including a precalibration (PreCal):

Message returned: AKAL f M1 kn gan ke gae M2 kn gan ke gae M3 kn gan ke gae M4 kn gan ke gae

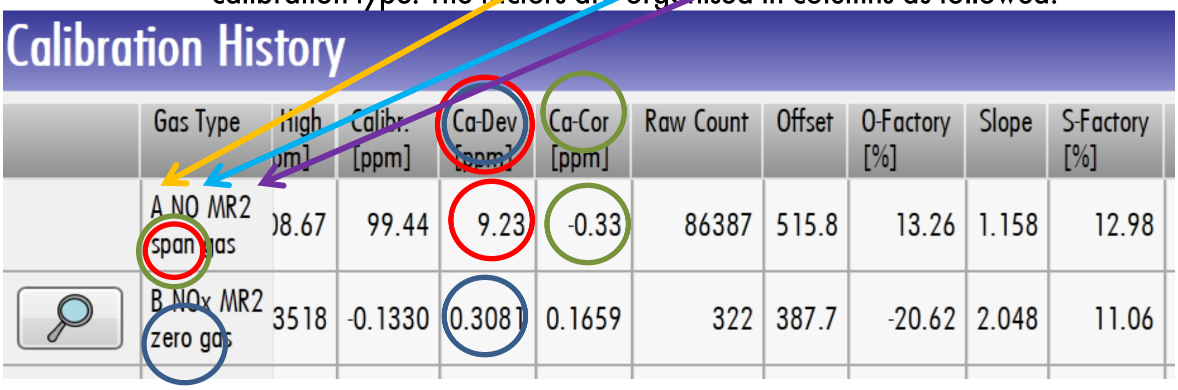
kn : Zero point correction value in ppm referred to last calibration.
Ca-Dev = ((rawcount_zerocal_actual minus rawcount_zerocal_previous) * slope / c)
{c depends on analysertype,
e.g. c = 1000 for CLD811}

gan : Total deviation of zero point since last LinCheck.
Ca-Cor = ((rawcount_zerocal_actual minus rawcount_zerocal_before_last_LinCheck)*slope/c)

ke : Span gas correction value in ppm referred to last calibration.
Ca-Dev = ((rawcount_spancal_actual minus rawcount_spancal_previous) * slope / c)

gae : Total deviation from span calibration since last Linearity-Check (SLCH).
Ca-Cor=((rawcount_spancal_actual minus rawcount_spancal_before_last_LinCheck)*slope/c)

These AKAL values are also displayed in the user display in the menue Calibration History of the register Calibration. The calibrations are organised in rows per channel, gas, range and calibration type. The factors are organised in columns as followed:



In two-channel measurement mode (S2NO) both channel values are returned together:
Message returned: AKAL f M1 knnox gannox kenox gaenox knno ganno keno gaeno M2 knnox gannox kenox gaenox knno ganno keno gaeno M3 knnox gannox kenox gaenox knno ganno keno gaeno M4 knnox gannox kenox gaenox knno ganno keno gaeno

EGRW K0 1 pw (Dual-channel analyser: EGRW K[1,2] 1 pw) SET CALIBRATION LIMITS.
Message returned: EGRW f
pw : maximal allowed deviation from the cal. gas concentration or from zero for which a calibration step may be successfully completed, in % of EKAK value. [0 ... 50].

AGRW K0 1 (Dual-channel analyser: AGRW K[1,2] 1)
RETURN CALIBRATION LIMITS.
Message returned: AGRW f 1 pw
pw : maximal allowed deviation from the cal. gas concentration for which a calibration step may be successfully completed, in % of EKAK value.

EPAR K0 M1 pw [M2 pw M3 pw M4 pw]
ENTER NO_2 CONTAMINATION VALUE.
This command is not available for a dual-channel analyser.
This command allows the user to enter the NO_2 contamination in the calibration gas, which is used to calculate a revised cal. (span) gas concentration. If the entered value is positive, the NO_x calibration gas concentration is calculated. If the entered value is negative, the NO calibration gas concentration is calculated. The values entered by this function can be checked using the AKAK command.
Message returned: EPAR f
pw : NO_2 contamination in cal. gas in %. M1..M4: [- 10 .. +10]

8.8.2.7 Linearisation and linearity check

The measurement technique employed by the CLD SL analysers is inherently linear, therefore the linearization procedure (SLIN) may only bring slight benefits. For this reason it is only seldom necessary. Full verification of the instrument linearity can be made with the linearity check function (SLCH).

SLID K0 (Dual-channel analyser: SLID K[1,2])
USE ANALYSER FACTORY DEFAULT POLYNOMIAL COEFFICIENTS. The measurement values (AKON, AIKO, AIKG) of both channels are linearised by the factory defaults polynomial coefficients.
Message returned: SLID f

SLIA K0 (Dual-channel analyser: SLIA K[1,2])
SWITCH OFF ALL LINEARISATION CORRECTION FUNCTIONS. This command deactivates all correction polynomial coefficients. The measurement values (AKON, AIKO, AIKG) of both channels are not linearised.
Message returned: SLIA f

SLIE K0 (Dual-channel analyser: SLIE K[1,2])
USE COSTUMER POLYNOMIAL COEFFICIENTS. The measurement values (AKON, AIKO, AIKG) of both channels are linearised by the costumer polynomial coefficients (set by EGRD).
Message returned: SLIE f

SLIN K0 Mn (Dual-channel analyser: SLIN K[1,2])
PERFORM COSTUMER LINEARISATION. This command executes an analyser linearisation procedure in the user selected measurement mode (SENO, SNOX, S2NO) and measurement range (SEMB). Measurement mode and range and linearisation type (SLIE) must be set prior to SLIN. The required equipment (gasdivider, calibration gases) must be made ready. Until this function is completed unlinearised values are given out. Prior to SLIN is sent the (span) calibration reference gas values must be set by EKAK. Immediately after SLIN the commands ELST and SLST must follow.

The amount of SLST commands is defined by ELST. SLIN is finished when last linearization step triggered by last SLST is finished.
Message returned: SLIN f

SLCH K0 Mn (Dual-channel analyser: SLCH K[1,2])
PERFORM LINEARITY CHECK. This command executes a check of the analyser's linearity in the user selected linearization type (SLIE, SLID or SLIA), measurement mode (SENO, SNOX, S2NO) and measurement range (SEMB). Linearisation type, measurement mode and range must be set prior to SLCH. The required equipment (gasdivider, calibration gases) must be made ready. Also prior to SLCH is sent the (span) calibration reference gas values must be set by EKAK. Immediately after SLCH the commands ELST and SLST must follow. The amount of SLST commands is defined by ELST. SLCH is finished when last linearization step triggered by last SLST is finished.
Message returned: SLIN f

ELST K0 1 xy 2 xy ... tn xy (Dual-channel analyser: ELST K[1,2])
SET NUMBER AND DEFINE LINEARISATION STEPS. Define the number of gas divider steps for the linearisation process, and the percentual distribution of each step.
Message returned: ELST f

xy	:	concentration of step in % of full scale
tn	:	last step number [1 .. 16]

This function must always follow the SLIN or SLCH command, otherwise the linearity (SLIN) or the linearity check (SLCH) procedure will not execute correctly.

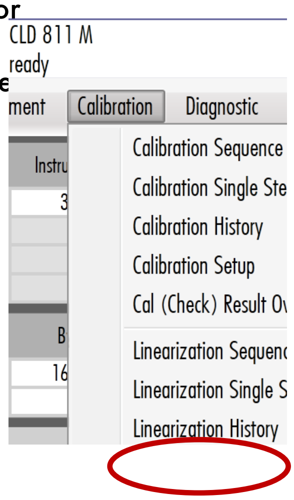
SLST K0 tn (Dual-channel analyser: SLST K[1,2])
LINEARISATION OF THE nth STEP. The measurement values (AKON, AIKO, AIKG) of both channels are linearized by the costumer polynomial coefficients (set by EGRD). The SLIN or SLCH function (with subsequent linearization step definition via the ELST function) must precede the SLST command, otherwise a BS (instrument busy) code will be returned.
Message returned: SLST f

tn	:	Linearisation step number [1 .. 16]

Any linearization procedure must begin with step 1, and proceed in ascending step order. After the last step is successfully linearized (defined by the ELST function), the procedure ends automatically (→ STBY). The linearisation check (SLCH) procedure can only be successfully completed when the tolerance band defined with the EGRW 2 function is not exceeded. If the tolerance bands are violated then the appropriate error is generated.

ALCH K0 Mn (Dual-channel analyser: ALCH K[1,2])
RETURN SAVED LINEARITY CHECK VALUES.
The values returned by the ALCH function relate to the currently active measurement mode, SNOX or SENO.
The values are the result of a linearisation check.
Message returned: ALCH f ck aaa AAA AaA bbb BBB BbB ...

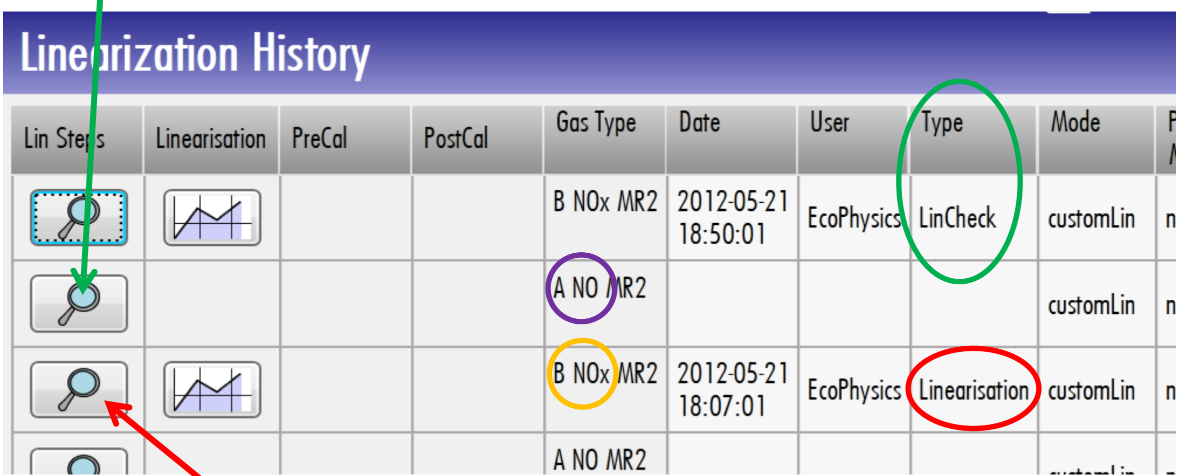
n : Number of the range in question [1...4]
ck = IO : Difference lies within user-set tolerances (no linearity check error pending)
ck = NO : Difference lies outside user-set tolerances (linearity check error)
aaa AAA AaA : 1^{st} value triplet
aaa : NO(x) calculated reference value M1 in ppm (ELST)
AAA : NO(x) measured linearity check value M1 in ppm
AaA : Difference M1= AAA minus aaa
bbb BBB BaB : 2^{nd} value triplet
... ... : nth value triplet (n max =16)



The ALCH and ALIN values are also displayed in the user display in the menu Linearization History of the register Calibration:

ALCH K0 M2 SENO

Click here to see ALCH values of NO (Linearization Type must be "LinCheck")



Click here to see ALIN values of NOx (Linearisation Type must be "Linearisation")

ALCH K0 M2 SNOX

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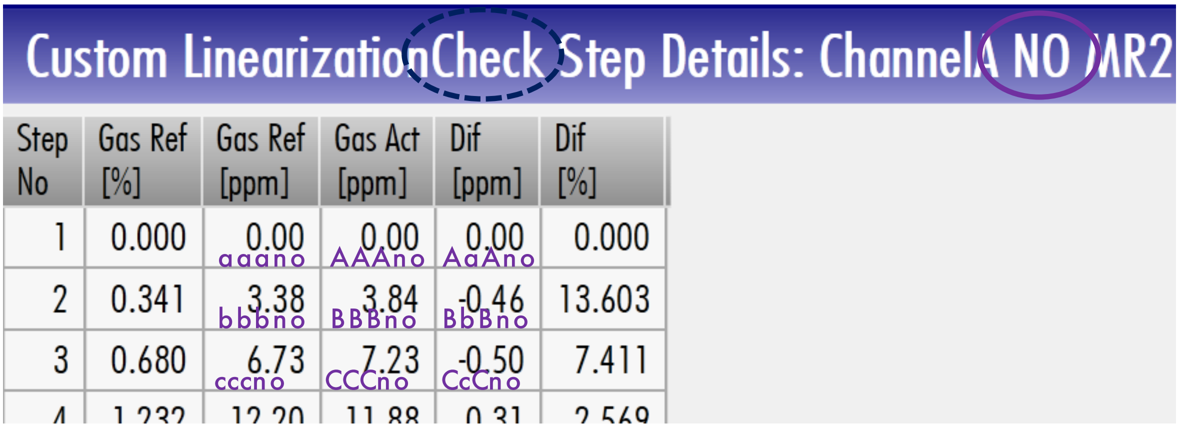
In the two-channel measurement mode (S2NO) both channel values are not returned together, because this would exceed the maximum allowable length of a string. Therefore, to obtain the values in two-channel measurement mode it is necessary to add to the ALCH command the parameter SNOX or SENO:

ALCH K0 Mn SNOX
Message returned: ALCH f ck aaanox AAAnox AaAnox bbbnox BBBnox BbBnox ... ...

ALCH K0 Mn SENO
Message returned: ALCH f ck aaano AAAno AaAno bbbno BBBno BbBno ... ...


Custom LinearizationCheck Step Details: ChannelA NO MR2

Step No	Gas Ref [%]	Gas Ref [ppm]	Gas Act [ppm]	Dif [ppm]	Dif [%]
1	0.000	0.00	0.00	0.00	0.000
2	0.341	3.38	3.84	-0.46	13.603
3	0.680	6.73	7.23	-0.50	7.411
4	1.232	12.20	11.88	0.31	2.569

ALIN K0 Mn (Dual-channel analyser: ALIN K[1,2])
RETURN SAVED LINEARISATION VALUES.
The function returns the linearity data of the instrument, depending on the linearity mode (SLIE, SLID). The values returned by the ALIN function relate to the currently active linearity mode (SLIE, SLID) and measurement mode (SNOX or SENO). The values are the result of a linearization.
Message returned: ALIN f aaa AAA bbb BBB ...
n : Number of the range in question [1...4]
aaa AAA : 1st value pair
aaa : NO(x) calculated reference value M1 in ppm (ELST)
AAA : NO(x) measured value M1 in ppm
bbb BBB : 2nd value pair
... ... : nth value pair (n max =16)

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In the two-channel measurement mode (S2NO) both channel values are returned together:

Message returned: ALIN f aaanox AAAnox aaano AAAno bbbnox BBBnox ... ...

n : Number of the range in question [1...4]

aaanox AAAnox : 1st value pair NOx

- aaanox : NO(x) calculated reference value M1 in ppm (ELST)
- AAAnox: NO(x) measured value M1 in ppm

aaano AAAno : 1st value pair NO

- aaano : NO(x) calculated reference value M1 in ppm (ELST)
- AAAno : NO(x) measured value M1 in ppm

bbbnox BBBnox : 2nd value pair NOx

... ... : nth value pair (n max =16)

The ALIN values are also displayed in the user display in the menue Linearization History of the register Calibration.

Custom Linearization Step Details: Channel B NOx MR2

Step No	Gas Ref [%]	Gas Ref [ppm]	Gas Act [ppm]	Gas x2 [ppm]	Dif x2 [ppm]	Dif x2 [%]	Gas x3 [ppm]	Dif x3 [ppm]	Dif x3 [%]	Ga [p
1	0.000	0.00 aaanox	0.14 AAAnox	0.14	-0.14		0.14	-0.14		
2	0.341	3.38 bbbnox	3.65 BBBnox	3.61	-0.23	6.931	3.58	-0.21	6.096	
3	0.680	6.73 cccnox	6.91 CCCnox	6.83	-0.10	1.418	6.78	-0.05	0.718	
4	1.232	12.20	12.17	12.05	0.15	1.241	11.98	0.22	1.788	1

Custom Linearization Step Details: Channel A NO MR2

Step No	Gas Ref [%]	Gas Ref [ppm]	Gas Act [ppm]	Gas x2 [ppm]	Dif x2 [ppm]	Dif x2 [%]	Gas x3 [ppm]	Dif x3 [ppm]	Dif x3 [%]
1	0.000	0.00 aaano	0.14 AAAno	0.14	-0.14		0.14	-0.14	
2	0.341	3.38 bbbno	3.60 BBBno	3.63	-0.25	7.478	3.79	-0.42	12.326
3	0.680	6.73 cccno	6.58 CCCno	6.63	0.11	1.566	6.89	-0.16	2.405
4	1.232	12.20	10.70	10.77	1.42	11.674	11.14	1.06	8.659

AGRD K0 Mn (Dual-channel analyser: AGRD K[1,2] Mn)

RETURN ANALYSER POLYNOMIAL COEFFICIENTS.
The function returns the polynomial coefficients of the current linearization mode (SLID, SLIA or SLIE), depending on the measurement modes (SNOX or SENO) and measurement range:
Message returned: AGRD f a0 a1 a2 a3 a4

In two-channel measurement mode (S2NO) both channel values are returned together:
Message returned: AGRD f $a0_{NOx}$ $a1_{NOx}$ $a2_{NOx}$ $a3_{NOx}$ $a4_{NOx}$ $a0_{NO}$ $a1_{NO}$ $a2_{NO}$ $a3_{NO}$ $a4_{NO}$

In a dual channel analyser the values are returned per channel (AGRD K[1,2]) depending on linearization mode, measurement mode and measurement range.

a0...a4 : Polynomial coefficients for linearization, $y=a0+a1*x^1+a2*x^2+a3*x^3+a4*x^4$
All Formats (integer, float, E-format) are allowed with max 15 characters per value; e.g. 0 1.0 -0.0001 -1.02345E-07 7.89001234E+06

EGRD K0 Mn a0 a1 a2 a3 a4

(Dual-channel analyser: EGRD K[1,2] Mn a0 a1 a2 a3 a4)
ENTER ANALYSER POLYNOMIAL COEFFICIENTS. The costumer polynomial coefficients (SLIE) for the linearization function can be entered per measurement range depending on measurement mode (SENO, SNOX). The analyser activates the new values immediately (AKON, AIKO, AIKG).

In two-channel measurement mode (S2NO) both channel values can be entered together:
EGRD K0 Mn $a0_{NOx}$ $a1_{NOx}$ $a2_{NOx}$ $a3_{NOx}$ $a4_{NOx}$ $a0_{NO}$ $a1_{NO}$ $a2_{NO}$ $a3_{NO}$ $a4_{NO}$

Message returned in all cases: EGRD f

a0...a4 : Polynomial coefficients for linearization, $y=a0+a1*x^1+a2*x^2+a3*x^3+a4*x^4$
All Formats (integer, float, E-format) are allowed with max 15 characters per value; e.g. 0 1.0 -0.0001 -1.02345E-07 7.89001234E+06

AKLE K0 (Dual-channel analyser: AKLE K[1,2]. Acts simultaneously on both channels!)
RETURN ANALYSER MAX. CONCENTRATION VALUE. The highest concentration, which the analyser is capable of measuring, is returned.
Message returned:e.g. CLD811: AKLE f 10000

ARMU K0 (Dual-channel analyser: ARMU K[1,2])
RETURN UNLINEARIZED RAW MEASUREMENT VALUES. Returns the raw measurement values normalized as % of max. measurable concentration value, independent of range selected.
Message returned: ARMU f pw

pw : current measurement value in % of max. measurable concentration value (NO or NO_x depending on measurement mode selected (SENO, SNOX))

In two-channel measurement mode (S2NO) both channel values are returned together:
Message returned: ARMU f pw b pw a

pwb : current measurement value NOx in % of max. measurable concentration value

pwa : current measurement value NO in % of max. measurable concentration value

EGRW K0 2 pw (Dual-channel analyser: EGRW K[1,2] 2 pw)
ENTER LIMITS FOR LINEARISATION CHECK.
Message returned: EGRW f

pw : maximum permitted deviation of the measurement value during the linearization check, as % of reference point concentration (ELST) value (except for zero point). [0 ... 20].

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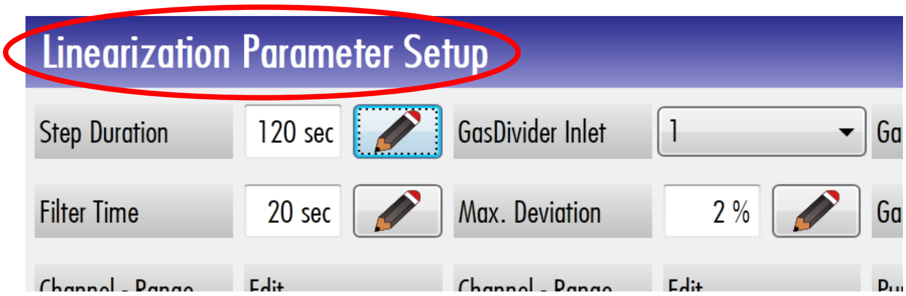
AGRW K0 2 pw (Dual-channel analyser: AGRW K[1,2] 2 pw)

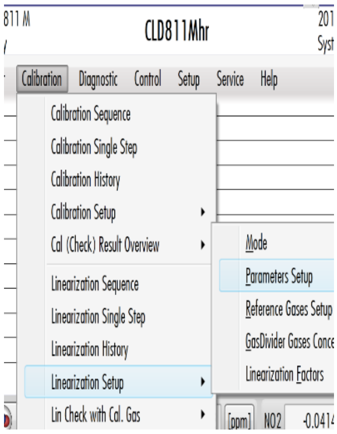
RETURN LIMITS FOR LINEARISATION CHECK.

Message returned: AGRW f 2 pw

pw : maximum permitted deviation of the measurement value during the linearization check, as % of reference point concentration (ELST) value (except for zero point).

This value is also displayed in the user display in the Linearization Parameter Setup window in the register Calibration.





8.8.2.8 Linearization check with zero and span gas

SALI K0 [Mn] (Dual-channel analyser: SALI K[1,2] [Mn])

LINEARISATION CHECK WITH ZERO AND SPAN GAS.
The instrument automatically executes a linearization check with zero and span gas appropriate to the selected range and measurement mode (SENO, SNOX, S2NO). The deviation from the expected value is returned by the AALI command.
Note: Ensure that the appropriate span gas is connected at the right calibration gas inlet, depending on the analyser model and option.
Message returned: SALI f
n : Measurement range number [1 ... 4]

If no measurement range number is specified with the SALI command the following procedure is executed:
SALI M1 (zero gas and span gas M1), SALI M2 (span gas M2 only), SALI M3 (span gas M3 only), SALI M4 (span gas M4 only). The zero-gas measurement made in range M1 is used for the offset calculation in the other ranges.

AALI K0 (Dual-channel analyser: AALI K[1,2])

RETURN SAVED DIFFERENCE VALUES OF LINEARISATION CHECK WITH ZERO AND SPAN GAS.
The values returned by this function relate to the currently active measurement mode, SNOX or SENO.
Message returned: AALI f M1 x0 xe M2 x0 xe M3 x0 xe M4 x0 xe
x0 : Measured zero gas value
xe : Difference between measured span gas and calibration reference gas concentration.

In two-channel measurement mode (S2NO) both channel values are returned together:
Message returned: AALI f M1 x0nox xenox x0no xeno M2 x0nox xenox x0no xeno M3 x0nox xenox x0no xeno M4 x0nox xenox x0no xeno

x0nox	: Measured zero gas value in NOx-channel
xenox	: Difference between measured span gas and calibration reference gas concentration in NOx-channel.
x0no	: Measured zero gas value in NO-channel
xeno	: Difference between measured span gas and calibration reference gas concentration in NO-channel.

The AALI values are also displayed in the user display in the window Zero-Point and Span Check Deviations (AANG, AAEG, AALI). See the submenu Current Values in the menu Lin Check with Cal. Gas of the register Calibration. See also AANG command.

8.8.2.9 Instrument test function

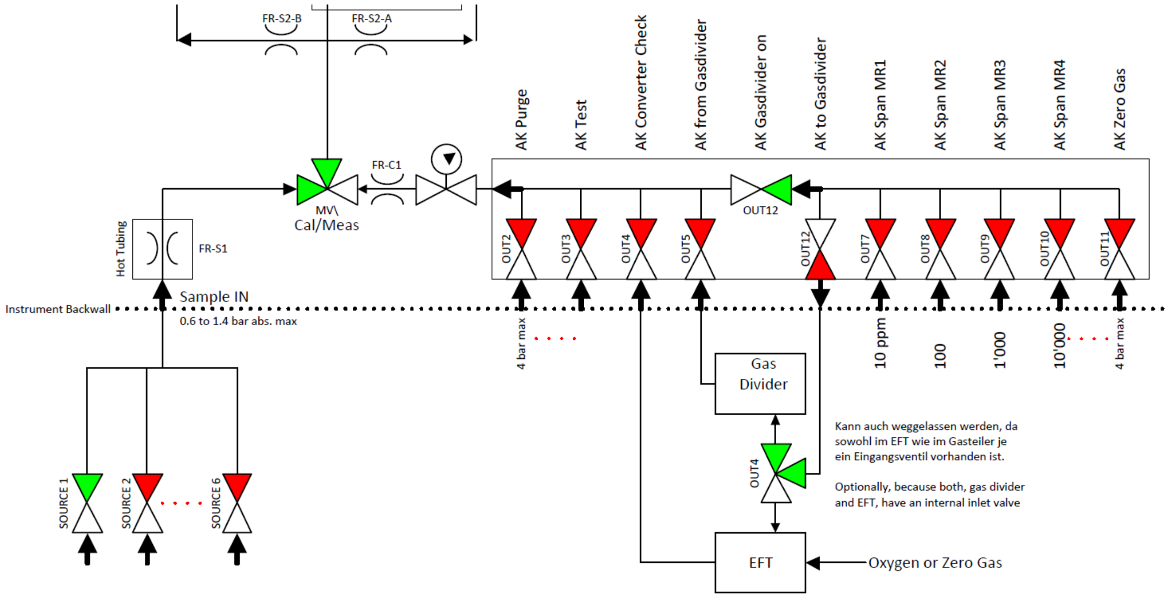
SGTS K0 (Dual-channel analyser: SGTS K[1,2])
TEST INSTRUMENT. Open Test valve.
Message returned: SGTS f

8.8.2.10 Converter efficiency test

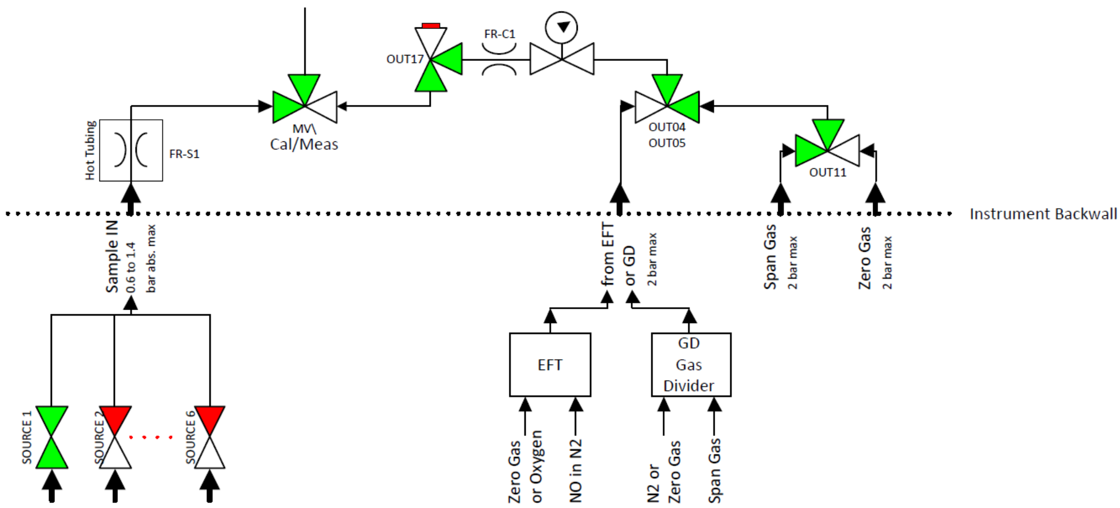
SKOP K0 [Mn] (Dual-channel analyser: SKOP K[1,2] [Mn]) CONVERTER EFFICIENCY CHECK. Automatic determination of converter efficiency. The result of the check is returned by the AKWG function. If no range is specified, the check is executed in the currently selected range. All ranges M1 to M4 may be specified. This test is performed as a two-channel (NO + NOx) operation and reported as such in the ASTZ function. With single channel instruments each individual step is repeated with the measurement mode being switched between steps.
Message returned: SKOP f
This check requires a converter efficiency test device (EFT, e.g. EFT 700). Ensure that this is correctly connected to the analyser. The actual test procedure (initiated with the SKOP command) consists of six equal duration steps (duration length is set with the EFDA function). In this time the two-channel analyser operates in two-channel mode with the signal filter set to slow.

1. Only NO calibration gas is supplied.
2. The NO calibration gas flow is blended by zero air or oxygen (O2). The added flow is about one tenth of the NO calibration gas flow, so that the measured NO and NOx values fall by about 10%.
3. The ozone generator in the EFT 700 is switched on. The NO concentration should fall by about 90% since NO_2 is now being produced by the NO. The CLD should now indicate about 10% of the NO concentration displayed in step 2. Ideally, the NOx concentration remains the same as in step 2. If the NOx concentration is lower than in step 2 then the converter efficiency is less than 100%.
4. Same as step 3.
5. The ozone generator in the EFT 700 is switched off, i.e. as in step 2.
6. The zero-air flow is stopped, i.e. as in step 1.

After the test is completed the instrument switches to Standby mode. The entire test takes six times the duration set in the EFDA command (with a one-channel instrument twelve times as long). The analyser draws NO calibration gas from the span gas supply for the current measuring range and feeds it to the EFT 700. The solenoid valves in the EFT 700 are completely controlled by the nCLD.


FR-S2-B
FR-S2-A
AK Purge
AK Test
AK Converter Check
AK from Gasdivider
AK Gasdivider on
AK to Gasdivider
AK Span MR1
AK Span MR2
AK Span MR3
AK Span MR4
AK Zero Gas
FR-C1
MV\
Cal/Meas
OUT12
Hot Tubing
FR-S1
OUT2
OUT3
OUT4
OUT5
OUT12
OUT7
OUT8
OUT9
OUT10
OUT11
Sample IN
0.6 to 1.4 bar abs. max
Instrument Backwall
4 bar max
10 ppm
100
1'000
10'000
4 bar max
Gas Divider
Kann auch weggelassen werden, da sowohl im EFT wie im Gasteiler je ein Eingangsventil vorhanden ist.
Optionally, because both, gas divider and EFT, have an internal inlet valve
OUT4
EFT
Oxygen or Zero Gas
SOURCE 1
SOURCE 2
SOURCE 6

Or


OUT17
FR-C1
MV\
Cal/Meas
Hot Tubing
FR-S1
OUT04
OUT05
OUT11
Instrument Backwall
Sample IN
0.6 to 1.4
bar abs. max
from EFT
or GD
2 bar max
Span Gas
2 bar max
Zero Gas
2 bar max
EFT
GD
Gas
Divider
Zero Gas
or Oxygen
NO in N2
N2 or
Zero Gas
Span Gas
SOURCE 1
SOURCE 2
SOURCE 6

AKWG K0 (Dual-channel analyser: AKWG K[1,2])
RETURN CONVERTER EFFICIENCY CHECK RESULT.
Message returned: AKWG f wg AA aa BB bb CC cc DD dd EE ee FF ff

wg	:	NOx converter efficiency in percent
AA	:	NOx value during 1st step.
aa	:	NO value during 1st step.
BB	:	NOx value during 2nd step.
bb	:	NO value during 2nd step.
CC	:	NOx value during 3rd step.
cc	:	NO value during 3rd step.
DD	:	NOx value during 4th step.
dd	:	NO value during 4th step.
EE	:	NOx value during 5th step.
ee	:	NO value during 5th step.
FF	:	NOx value during 6th step.
ff	:	NO value during 6th step.

8.8.3 Setting parameter values

8.8.3.1 Measurement range

SEMB K0 Mn (Dual-channel analyser: SEMB K[1,2] Mn)
SET ACTIVE MEASUREMENT RANGE (M1, M2, M3, M4).
The specified range become active.
Message returned: SEMB f
n : Measurement range number [1 ... 4]
If this command is received when the instrument is in auto range mode then auto range is terminated and the entered measurement range becomes active.

AEMB K0 (Dual-channel analyser: AEMB K[1,2])
RETURN ACTIVE MEASUREMENT RANGE (M1, M2, M3, M4).
Message returned: AEMB f Mn
n : Measurement range number [1 ... 4]

EMBE K0 M1 ew [M2 ew M3 ew M4 ew]
(Dual-channel analyser: EMBE K[1,2] M1 ew [M2 ew M3 ew M4 ew])
SET MEASUREMENT RANGE FULL-SCALE VALUES.
Each time an entry is made with this function, the range-change threshold values for the auto range function are internally adjusted - the switchover to the next higher range occurs if the signal exceeds 95% of the current range, or to the next lower range if the signal drops below 8% of the current range. This automatic choice of values prevents the situation whereby a change of range end point without an explicit accompanying change in range-change thresholds results in senseless auto range changeover points. These internally generated thresholds may, however, be overwritten at any time by the user with the EMBU command.
Message returned: EMBE f
ew : Measurement range full-scale value in ppm [1 ... 10'000]

The signal generated by the analog output is scaled to this value.

AMBE K0 (Dual-channel analyser: AMBE K[1,2])
RETURN MEASUREMENT RANGE FULL-SCALE VALUES.
Message returned: AMBE f M1 ew M2 ew M3 ew M4 ew
ew : Measurement range full-scale value in ppm

8.8.3.2 Autorange

SARE K0 (Dual-channel analyser: SARE K[1,2])
AUTORANGE ON. The analyser automatically selects the measuring range most appropriate to the currently measured gas concentration. In the two-channel measurement mode (S2NO) both channels switch together. In this case the NOx-channel triggers the range-change.
Message returned: SARE f
The channels of a dual-channel analyser select the ranges independent on each other.

SARA K0 (Dual-channel analyser: SARE K[1,2])
AUTORANGE OFF. The auto range function (of one or both channels) is disabled. The currently active measurement range when this command is executed remains active.
Message returned: SARA f

EMBU K0 Mn abw aufw (Dual-channel analyser: EMBU K[1,2] Mn abw aufw)

SET UPPER AND LOWER AUTORANGE THRESHOLDS.

Message returned: EMBU f

n : Measuring range number [1 ... 4]

abw : Threshold concentration in ppm at which analyser switches to next lower range.

aufw : Threshold concentration in ppm at which analyser switches to next higher range.

Note: Each time an entry is made with the EMBE function, the range-change threshold values for the auto range function are internally adjusted – the switchover to the next higher range occurs at 95% of full-scale, and to the next lower range at 8% of full-scale. This automatic choice of values prevents the situation whereby a change of range end point without an explicit accompanying change in range-change thresholds results in senseless auto range change-over points. These internally generated thresholds may, however, be overwritten at any time by the user with the EMBU command.

AMBU K0 (Dual-channel analyser: AMBU K[1,2])

RETURN UPPER AND LOWER AUTORANGE THRESHOLDS.

Message returned: AMBU f M1 abw 1 aufw 1 M2 abw 2 aufw 2 M3 abw 3 aufw 3 M4 abw 4 aufw 4

abw1 ... abw4 : Threshold concentrations in ppm at which analyser switches to next lower range.

aufw1 ... aufw4 : Threshold concentrations in ppm at which analyser switches to next higher range.

8.8.3.3 T90-Times

ST90 K0 zs — (Dual-channel analyser: ST90 K[1,2] zs)
SELECT T90 FILTER SETTING.
Message returned: ST90 f

zs	:	T90 filter setting		
		S	=	fast
		M	=	medium
		L	=	slow

The channels of a dual-channel analyser select the T90-filters independent on each other.

ET90 K0 tl tm ts — (Dual-channel analyser: ET90 K[1,2] tl tm ts. Acts simultaneously on both channels!)
SET T90 TIMES.
Message returned: ET90 f

tl	:	slow T90 time in secs. [0.2 ... 180]
tm	:	medium T90 time in secs. [0.2 ... 180]
ts	:	fast T90 time in secs. [0.2 ... 180]

There is only one set of T90 times for both channels. For a dual-channel analyser this command acts for both channels, e.g. ET90 K1 tl tm ts sets internally also ET90 K2 tl tm ts.

AT90 K0 — (Dual-channel analyser: AT90 K[1,2])
RETURN T90 TIMES for both channels.
Message returned: AT90 f tl tm ts zs

tl	:	slow T90 time in secs.
tm	:	medium T90 time in secs.
ts	:	fast T90 time in secs.
zs	:	current filter setting.

8.8.3.4 Delay mode

SRON K0 (Dual-channel analyser: SRON K[1,2])
DELAY MODE ON. Measured and integral concentration values are delayed by a synchronization period defined in the EVEZ function. Analog output signals are not delayed.
Message returned: SRON f

SROF K0 (Dual-channel analyser: SROF K[1,2])
DELAY MODE OFF. Concentration values are output without any synchronization delay.
Message returned: SROF f

EVEZ K0 vz sz (Dual-channel analyser: EVEZ K[1,2] vz sz)
SET DELAY AND SYNCHRONISATION TIMES. The user may define the time by which the start of the SINT function is delayed and the synchronization period for the delay mode.
Message returned: EVEZ f

vz : Time [0 .. 999] in secs, by which start of SINT function is delayed. After Reset: *vz*= 0.

sz : Synchronization time [0 ... 9] in seconds. Duration of the measurement and integrator values for RETURN MEASUREMENT VALUE-type commands AKON, AIKO or AIKG. After Reset: sz = 0.

AVEZ K0 (Dual-channel analyser: AVEZ K[1,2])
RETURN DELAY AND SYNCHRONISATION TIMES.
Message returned: AVEZ f vz sz

vz : Time in secs, by which start of SINT function is delayed.

sz : Synchronization time in secs. Duration of the measurement and integrator values for RETURN MEASURMENT VALUE-type commands AKON, AIKO or AIKG.

8.8.3.5 Interface parameters

SCOM K0 b l s p (Dual-channel analyser: SCOM K[1,2])

SET INTERFACE PARAMETERS. The serial interface parameters may be entered with this function. The factory setting is 5 1 0 0.

Message returned: SCOM f

b	:	Baud
b = 0	:	115200
b = 1	:	57600
b = 2	:	38400
b = 3	:	19200
b = 4	:	14400
b = 5	:	9600
b = 6	:	4800
b = 7	:	2400
b = 8	:	1200
b = 9	:	300
l	:	Length
l = 0	:	7 Bit
l = 1	:	8 Bit
s	:	Stop
s = 0	:	1 Bit
s = 1	:	2 Bit
p	:	Parity
p = 0	:	off
p = 1	:	odd
p = 2	:	even

ACOM K0 (Dual-channel analyser: SCOM K[1,2])

RETURN INTERFACE PARAMETERS. Returns the serial interface parameter settings.

Message returned: ACOM f b l s p

b, l, s, p as in SCOM command above.

8.8.3.6 Analog output

SREC K0 m b f

(Dual-channel analyser: SREC K[1,2] m b f. Acts simultaneously on both channels!)

SET ANALOG OUTPUT PARAMETERS. The analog output parameters may be entered with this function. The factory setting is m=1, b=0 and f=0.

Message returned: SREC f

m		:	Mode
	m = 0	:	0 ... 1 V
	m = 1	:	0 ... 10 V
	b = 2	:	0 ... 20 mA
b		:	Offset
	b = 0	:	none
	b = 1	:	20%
f		:	Fullscale
	f = 0	:	100%
	f = 1	:	50%

There is only one set of analog output parameters for both channels. For a dual-channel analyser this command acts on both channels, e.g. SREC K1 m b f sets internally also SREC K2 m b f.

NOTE: The analog output signal is for instrument test purposes only, because it is not linearized, delayed, synchronized and additionally filtered. It is a calibrated raw ppm signal.

AREC K0

(Dual-channel analyser: AREC K[1,2])

RETURN ANALOG OUTPUT PARAMETERS. Returns the analog output parameter settings, valid for both channels.

Message returned: AREC f m b f

m, b and f as in SREC command above.

8.8.3.7 Set values and limits

ESOL K0 p sw (Dual-channel analyser: ESOL K[1,2] p sw. Acts simultaneously on both channels!)
SET TEMPERATURES. Enter the target temperature values for temperature regulation systems.
Message returned: ESOL f

p : Device parameter

p = 1 : Hot tubing
p = 2 : Photomultiplier
p = 3 : Reactor
p = 4 : Converter
p = 5 : Converter efficiency

sw : Target temperature in Kelvin

ASOL K0 p (Dual-channel analyser: ASOL K[1,2] p)
RETURN SET TEMPERATURES AND LIMITS.
Message returned: ASOL f sw ug og

p : Regulation system

p = 1 : Hot tubing
p = 2 : Photomultiplier
p = 3 : Reactor
p = 4 : Converter
p = 5 : Converter efficiency

sw : Target temperature in Kelvin
ug : lower limit to generate error
og : upper limit to generate error

8.8

EGRW K0 n pw (Dual-channel analyser: EGRW K[1,2] n pw) SET LIMITS.

Message returned: EGRW f

n = 1 : SET CALIBRATION LIMITS

pw : maximum allowable deviation from calibration reference span gas during purge phase of calibration process for which a calibration step can be successfully completed, in % of measurement range full-scale value EMBE, [0 ... 50].

See Calibration History
EGRW 1

n = 2 : SET LIMITS FOR LINEARISATION CHECK

pw : maximum allowable deviation of gas concentration during linearity check, in % of reference point concentration (ELST) value, except for zero point. [0 ... 10].

n = 3 : SET STABILITY CRITERIA FOR SPAN GAS

pw : maximum allowable deviation from calibration reference span gas during control and verify phase of calibration process (stability controlled SATK) for which a calibration step can be successfully completed, in % of EMBE value [0 ... 50].

See Calibration History
EGRW 3

n = 4 : SET LIMIT FOR CAL CHECK SPAN GAS

pw : maximum allowable deviation from last span calibration for which a check is passed, e.g. during a time-controlled calibration (SATK with $t2_{AK}$ = 0) for which a span calibration can be successfully completed, in % of EMBE value [0 ... 50].

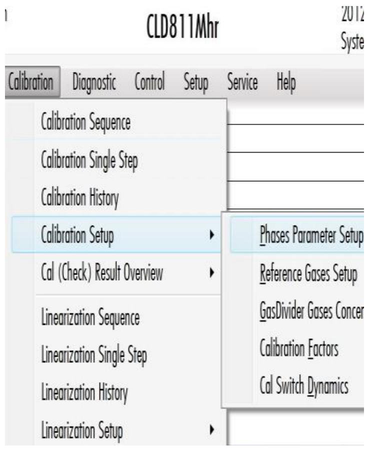
8.8

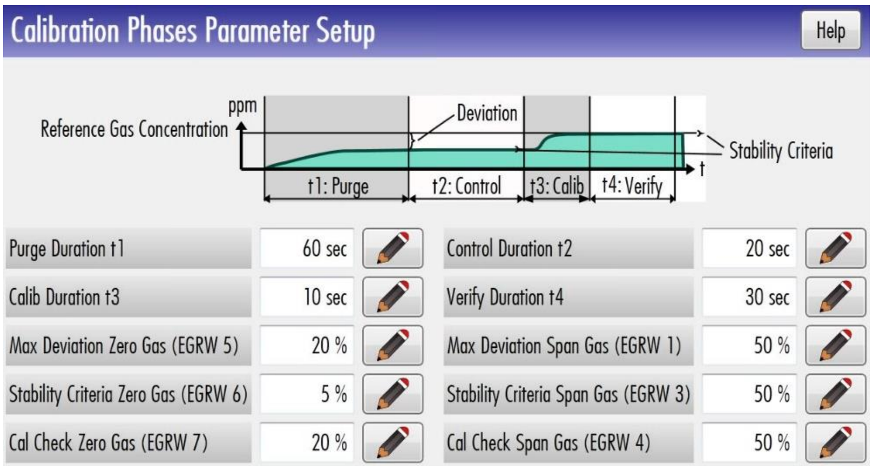
n = 5 : SET MAX DEVIATION ZERO GAS
pw : maximum allowable deviation from reference zero point during purge phase of calibration process for which a zero-point calibration step can be successfully completed, in % of measurement range full-scale value (EMBE) value [0 ... 20].

n = 6 : SET STABILITY CRITERIA FOR ZERO GAS
pw : maximum allowable deviation from reference zero point during control and verify phase of calibration process for which a calibration step can be successfully completed, in % of measurement range full-scale value (EMBE) value [0 ... 5].

n = 7 : SET LIMIT FOR CAL CHECK ZERO GAS
pw : maximum allowable deviation from last zero-point calibration during a calibration check for which a check is passed, in % of EMBE value [0 ... 20].

These values can also be set and are displayed in the user display in the Phases Parameter Setup in the menu Calibration Setup in the register Calibration.





AGRW K0 n (Dual-channel analyser: AGRW K[1,2] n)
RETURN LIMITS.
Message returned: AGRW f n pw
pw : limit value in %
n, pw as in EGRW command above.

8.8.3.8 System time

ESYZ K0 jjmmtt hhmmss (Dual-channel analyser: ESYZ K[1,2] jjmmtt hhmmss. Acts simultaneously on both channels!)
SET SYSTEM TIME.
Message returned: ESYZ f
jjmmtt : Year, Month, Day (each 2-digits, no spaces)
hhmmss : Hour, Minute, Second (each 2-digits, no spaces)

ASYZ K0 (Dual-channel analyser: ASYZ K[1,2])
RETURN SYSTEM TIME.
Message returned: ASYZ f jjmmtt hhmmss
jjmmtt : Year, Month, Day (each 2-digits, no spaces)
hhmmss : Hour, Minute, Second (each 2-digits, no spaces)

8.8.3.9 Device identification

EKEN K0 gk (Dual-channel analyser: EKEN K[1,2] gk. Acts simultaneously on both channels!)
ENTER DEVICE IDENTIFICATION STRING.
Message returned: EKEN f
gk : Device identification string (up to 40 characters long). A device identification string may only be entered if the current entry is *CLD8....* A new ID must begin with CLD8.

AKEN K0 (Dual-channel analyser: AKEN K[1,2])
RETURN DEVICE IDENTIFICATION STRING.
Message returned: AKEN f gk
gk : Device identification string

8.8.3.10 Operating hours counter

ABST K0 (Dual-channel analyser: ABST K[1,2])
RETURN ANALYSER OPERATING HOURS.
Message returned: ABST f m p c
m : Analyser operating hours
p : Next pump service due in p hours
c : Converter lifetime ends in c hours

8.8.3.11 Instrument temperatures

ATEM K0 m s (Dual-channel analyser: ATEM K[1,2] ms)
RETURN TEMPERATURES.
Message returned: ATEM f tw

ms	: Point of measurement
tw	: Temperature at point of measurement in Kelvin
ms = 0	: returns all temperatures as listed below
ms ≠ 0	: returns requested temperature

ms = 1	: Hot tubing
ms = 2	: Photomultiplier
ms = 3	: Reactor
ms = 4	: Converter
ms = 5	: Instrument internal temp.
ms = 6	: Scrubber
ms = 7	: NA
ms = 8	: NA

8.8.3.12 Instrument gas flow rate

ADUF K0 m s (Dual-channel analyser: ADUF K[1,2] ms)
RETURN FLOW RATE.
Message returned: ADUF f fw

ms	: Point of measurement
fw	: Flow rate at point of measurement

ms = 1 : Flow in l/min
ms = 2 : Flow counts

8.8.3.13 Instrument pressure

ADRU K0 ms (Dual-channel analyser: ADRU K[1,2] ms)
RETURN PRESSURE VALUE.
Message returned: ADRU f dw
ms : Point of measurement
dw : Pressure at point of measurement in Pascal

ms = 0 : returns all pressures
ms = 1 : Bypass
ms = 2 : Reactor
ms = 3 : NA
ms = 4 : NA

8.8.3.14 Other commands

SDEF fc [d] (Dual-channel analyser: SDEF K[1,2] fc)
SET SPECIAL.
Message returned: SDEF f
Function accessible only with instrument in Standby mode.
fc : Special function code

fc= 4 : Start flow sensor calibration
fc= 5 : Terminate flow sensor

8.8.4 Command set index

8.8.4.1 Return parameter value commands

8.8.4.2 Parameter setting commands

8.8

8.8.4.3 Control commands

9. PERIODIC MAINTENANCE

Read the safety rules first
(Section 1.2)

9.1

9.1 Annual maintenance

nCLD6x

Once per year

- the multipurpose filter behind the front-panel of the analyser,
- the dust filter behind the ventilation grid at the front-panel of the analyser,
- the ozone filter inside the analyser,
- every membrane and valve of the vacuum pump,
- the converter cartridge, but not later than with an insufficient converter efficiency (see section 6.2.5),

should be checked and replaced.

nCLD8xx and nCLD-SL

Once per year

- the multipurpose filter behind the front-panel of the analyser,
- the dust filter behind the ventilation grid at the front-panel of the analyser,
- the ozone filter inside the analyser,
- every membrane and valve of the vacuum pump,
- the converter cartridge, but not later than with an insufficient converter efficiency (see section 6.2.5),
- the silencer (if installed), but not later than with a partially (less than 25 %) whitened filling (upon use the filling changes color from red to brown and eventually to white),
- the particulate filter of the optional bypass pressure regulation system, but not later than with a partially dust charged filter which may require its replacement more often,

should be checked and replaced.

ECO PHYSICS recommends that you contact your regional representative to let perform service work by qualified personnel only.

Warning:
Before any maintenance or repair work is performed on an opened instrument, the power plug must be disconnected.

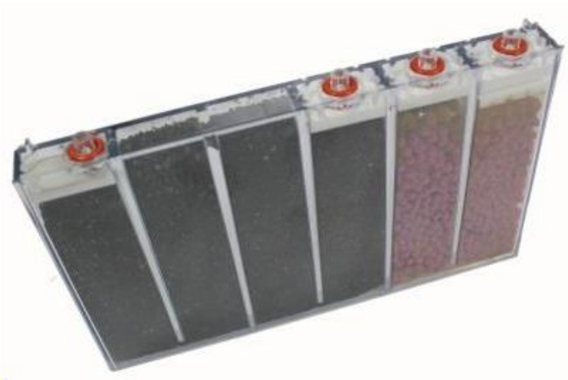
Any repair and adjustment work on the open and powered up instrument shall only be performed by qualified personnel who are fully trained and familiar with the dangers involved!

The dispose of the exchanged parts must respect the current environmental, safety and technical regulations.

9.1

How to exchange the multi-purpose filter

- The filter is on the left side at the instrument front behind the display.
- Set the analyser to the standby mode. In the nCLGui go to Measurement > Activate Standby and wait until the pump has stopped running (around 60 seconds)
- Unscrew the big (not the small) four screws at the front panel around the display. Carefully flap the front-panel down. Take care to the cable to the display.
- Grab the bottom of the filter from both sides by using both hands. Pull the filter out. Check that all 4 (red) O-rings are still on its position on top of the filter.
- The new filter is delivered including the O-rings.



- Before installing the new filter check that all 4 (red) O-rings are on top of the filter inlets.
- The red filter material must be to the right side.
- Bring the new filter to its position of the upper holder by carefully moving up. If in position push it horizontally to the instrument front until it locks in place.

9.2 Quarterly maintenance (nCLD)

- Exchange the multipurpose filter.

- Exchange the particulate filter (left to the multipurpose filter) of the bypass pressure regulation system.

- Exchange the dust filter behind the ventilation grid at the front-panel.

10. TROUBLESHOOTING

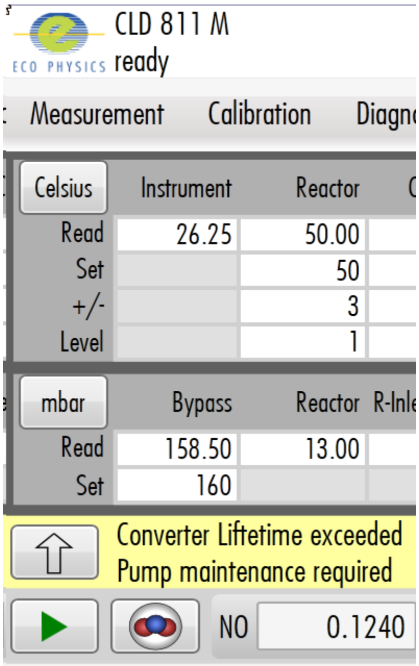
Read the safety rules first
(Section 1.2)

10.1

10.1 Error messages and correction procedure

10.1.1 Error messages

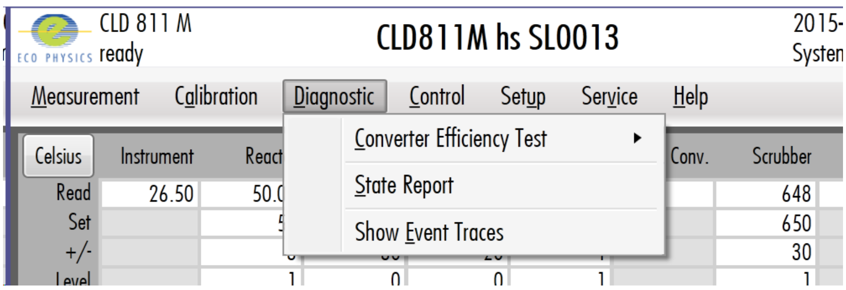
> *WARNING!*
> *Before performing any maintenance with the covers removed, the mains power connector MUST be unplugged from the instrument. Repairs and adjustments, which must be made with the instrument powered-up, may only be performed by trained personnel who are aware of the dangers involved.*



Errors and Warnings are displayed in the horizontal yellow display bar in the CLDGUI main window. The messages automatically disappear when the problem is solved or the value that caused the message goes back within the allowed limits.

Use the up  and down  arrows to scroll between all displayed error and warning messages.

All errors and warnings are logged in event-log-file. The file names of these event-log-files is "CldGui_EventTracexxxx". Each time a warning or error occurs, and after that when it disappears, it is written into the file with date and time. In the CLDGui go to Diagnostics > Show Event Traces, select the appropriate event-log-file and open it.



The maximum size and the amount of stored log-files can be configured in Setup > Application > Trace File as "Line Tracer". Each time a new general log-file is stored, also a new event-log-file is created. The general log-file has another name than the event-log-file and another path. It is recommended not to change the default paths and names.

E-01: "Setup and Cal. Data lost"
Setup and calibration data stored in RAM has been lost. This error message appears when the RAM back up battery is exhausted (the life expectancy of battery is about 10 years). Then battery needs to be replaced by a service technician.

Caution: After replacement the analyser is reset to the manufacturer's defaults.

(Remark: E-01 is rarely caused by other problems.)

E-02: "Vacuum Fail (Reactor-Pressure)"
Error message, if reaction chamber pressure >64 mbar.

Greatly varying pressure indications during the test mode or a pressure between 65 and 255 mbar signifies a defective gas flow system or pump.

If there is no fault on pump and gas flow system a faulty pressure sensor circuit board is suggested. A service call is needed.

E-03 indicates a malfunction of one of the temperature control circuits of various temperature, flow or pressure sensors. E.g. Converter Heater Circuit Error indicates an error of the converter heating device.

Abbreviations used are e.g. "Reac" for reactor, "Scrubber" for ozone destroyer and "Converter" for converter.

When an E-03 occurs, for safety reasons the analyser switches automatically to the following status:

- stand-by mode
- all heating devices are switched off
- strobe for main heating relays is switched off
- continuous beeping tone emitted

E-03: "Dev. Sensor Error"

The respective temperature, flow or pressure sensor has been short-circuited or disconnected.

E-03: "Dev. Heater Circuit Error"

The temperature of the respective heater circuit does not rise, indicating a fault condition.

Possible causes:

- temperature sensor damaged
- temperature sensors interchanged
- heater disconnected
- heaters interchanged
- heating element damaged

E-03: "Dev. Overheating"

The temperature of the respective heater circuit exceeds the following values:

- for Peltier temperature = set-point + 2.5 °C
- for reactor temperature = set-point + 5 °C
- for hot tubing temperature = set-point + 10 °C
- for converter or scrubber temperature = set-point + 60 °C

This error message appears whenever the ozone destroyer temperature deviates from its set-point (default value 650 °C) by more than 30 °C. A service technician is required.

E-05: "Ozonator High Voltage Fail"

Erroneous operation of the ozone generator module. Module needs to be checked by a service technician.

10.1

E-06: "Bypass Pressure out of Range"

The internal pressure regulator deviates from its set-point (nCLD811: 160 mbar absolute. nCLD899 CraNOx: 200mbar absolute, nCLD8xx with option "r": 350mbar) by more than 30 mbar. The measurement has got limited value. The sample gas pressure and the calibration gas pressure must be checked at the inlet. They should be in the range from 600 to 1200 mbar absolute. If the error remains the particulate filter of the pressure regulation unit must be checked and replaced. This is a service condition.

E-07: "Flow Sensor not calibrated"

Analysers equipped with an internal pressure regulation can display this error

E-08: "Peltier Cooler Fail"

Valid for analysers with a PMT cooling device. This error message refers to a deviation of the Peltier temperature by more than 1.25 °C from its set-pint (°C default value is model dependent). Check the reached cooling temperature in the CLDGui. If the analyser is located in an environment with a temperature higher than 35°C, reduce the PMT-set temperature in the nCLDGui. Alternatively the bandwidth for the error limit can be changed. (Go to Setup > Control Circuits > Temperature. After the temperature settings are changed, the analyser will automatically restart.). If the error remains, a service technician must be called.

E-09: "Converter Heating Fail"

Error message, if converter temperature deviates from set-point ± 30°C (default value depends on the installed converter type. Typical values are: S = 650, M = 400, Y = 375). A service technician must be called.

E-10: "Reactor Heating Fail"

Error message, if reaction chamber temperature deviates from set-point by 3 °C (default value: 45°C). A service technician must be called.

E-11: "Tubing Heating Fail"

Valid for analysers with a heated sample gas inlet. This error message refers to the deviation of the hot tubing temperature from its set-point (default value 190 °C) by more than 10°C. A service technician must be called.

E-12: "Sample / Cal Flow out of Range"
Only analysers with an internal pressure regulation can display this error.

E-13: "Hardware def.! I-Type changed!"
At start-up some parts of the configuration do not work properly. A service technician must be called.

E-14: "Calibration Error"
The values measured during calibration deviate so strongly from the reference values that the calibration is rejected.

A span calibration is only accepted if the net counts are between 25 % and 600 % of the theoretically expected value (net counts are the gross counts at the span gas measurement minus zero-point counts with a real zero gas):

Analyser type	expected net counts	at span gas concentration
nCLD6x		
nCLD8xx		
nCLD 811	>xxx	10'000 ppm
nCLD 899	>xxx	1'000 ppb

Using a ten-fold lower span gas concentration the expected net counts are accordingly ten times lower. First check that the input reference concentrations are in fact correct (e.g. cylinder concentration, dilution factor etc.). If the reference values are correct and if the inlet pressure is also correct a service technician must be called.

E-15: "Inlet pressure O3 out of range"
This error can only occur in analysers equipped with an internal pressure regulation unit for the O2 supply gas for the ozone generator, such as the nCLD899. Check the O2 supply gas, e.g. the O2 bottle pressure. If the O2 inlet pressure is OK, a service technician must be called.

E-16: "PMT error" The raw counts must be higher than 0 for both channels. A service technician must be called.

10.1.2 Warning messages

W-01: "Converter Lifetime exceeded"

Replacement of the converter is necessary.

Note: this indication only disappears by initializing the converter operating hours counter. In the nCLDGui go to Setup > Operating Hours and enter a value greater than 0. A value of 8000 is the expected lifetime (in hours) of a new converter cartridge.

W-02: "Pump Maintenance required"

Maintenance on vacuum pump necessary.

Note: this indication only disappears by initializing the pump operating hours counter. In the nCLDGui go to Setup > Operating Hours and enter a value greater than 0. A value of 8000 is the expected lifetime (in hours) of new pump membranes and pump valves and therefore the recommended maintenance interval for the pump.

W-03: "Instrument Temperature: LOW"

Warning, if instrument internal temperature <10 °C

The ambient temperature of the analyser is too low. If this is not in fact the case the analyser must be serviced.

W-04: "Instrument Temperature: HIGH"

Warning, if instrument internal temperature >51 °C.

The internal temperature of the analyser is too high. If this is not in fact the case the analyser must be serviced.

W-05: "Bypass out of allowed Pressure"

The internal pressure regulation deviates from its set-point (nCLD811: 160 mbar absolute. nCLD899 CraNOx: 200mbar absolute, nCLD8xx with option "r": 350mbar) by more than 15 mbar. The measurement has got limited value only.

10.1

W-06: “Inlet pressure O3 too low”

This warning can only occur in analysers equipped with an internal pressure regulation unit for the O2 supply gas for the ozone generator, such as the nCLD899. A typical situation is an empty O2 bottle. Check the O2 supply gas, e.g. the O2 bottle pressure. If the O2 inlet pressure is OK, a service technician must be called.

W-07, W-08: not used

W-09: “Range A Overflow!”

The signal value exceeds the range full-scale value. If possible, set the instrument to a range with a higher full-scale value.

W-10: “O3-Up. Ozone not Constant!”

The W-10 phase lasts approx. 3 minutes after starting the ozone generator. Since the ozone concentration has not yet stabilized, the measurement values are also unstable, and therefore must be used with caution until the warning message is automatically cleared.

W-07, W-08: not used

W-13: “Range B Overflow!”

The signal value exceeds the range full-scale value. If possible, set the instrument to a range with a higher full-scale value.

10.1.3 Other possible failures

If when the analyser is connected to the main power, the red light at the front behind the ventilation grid does not go on red something must be wrong with the power source or the power supply unit. Contact your local service agency.

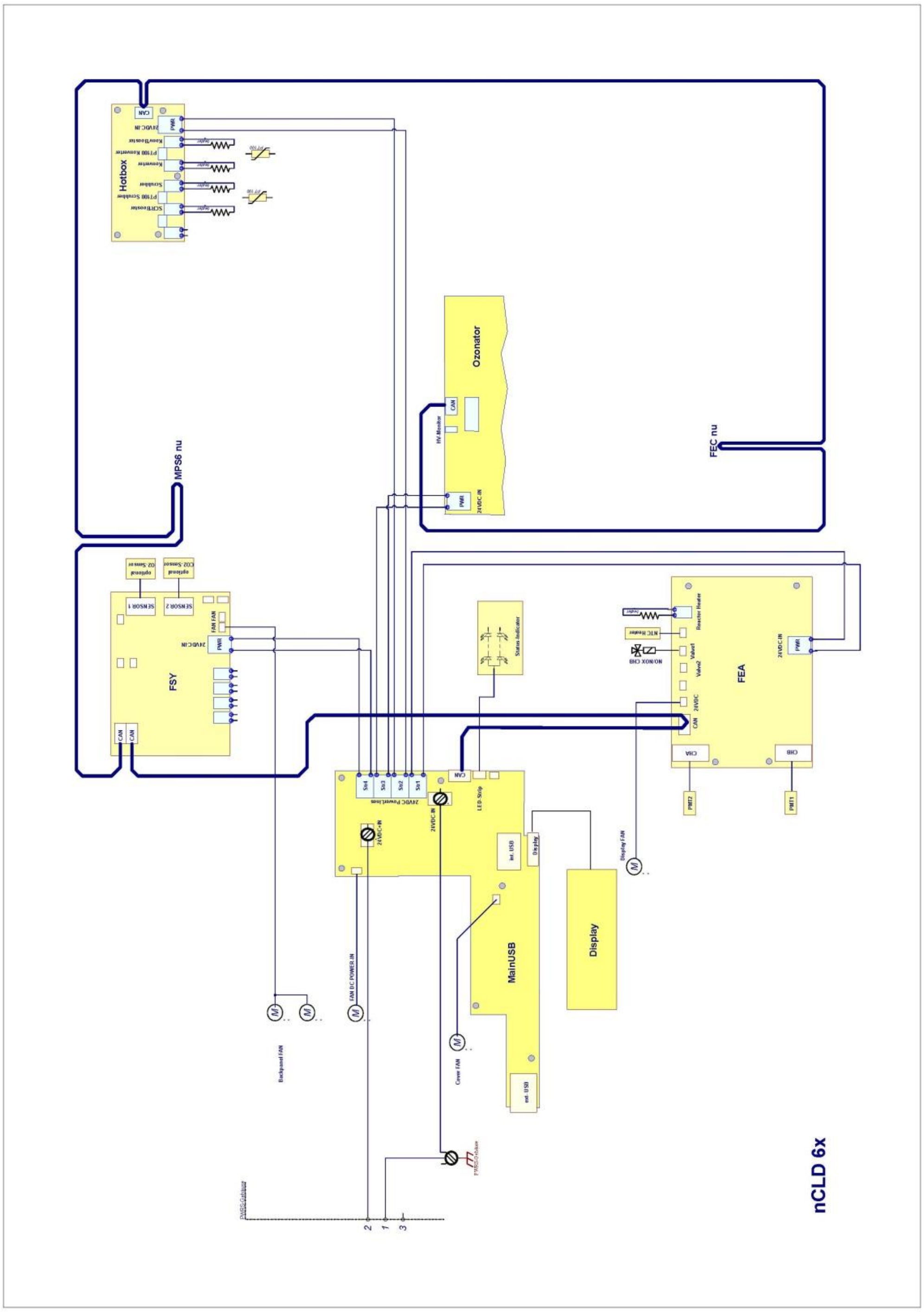
Note: The nCLDs do not have any fuses. All power consumption parts are internally electronically controlled and protected.

If after pressing the main power switch at the front panel there is no reaction on the display, but the LED light is illuminated steady red, contact your local service agency.

Some more warnings are displayed in pop-up-windows in the nCLDGui. Such messages must be manually closed by the user.

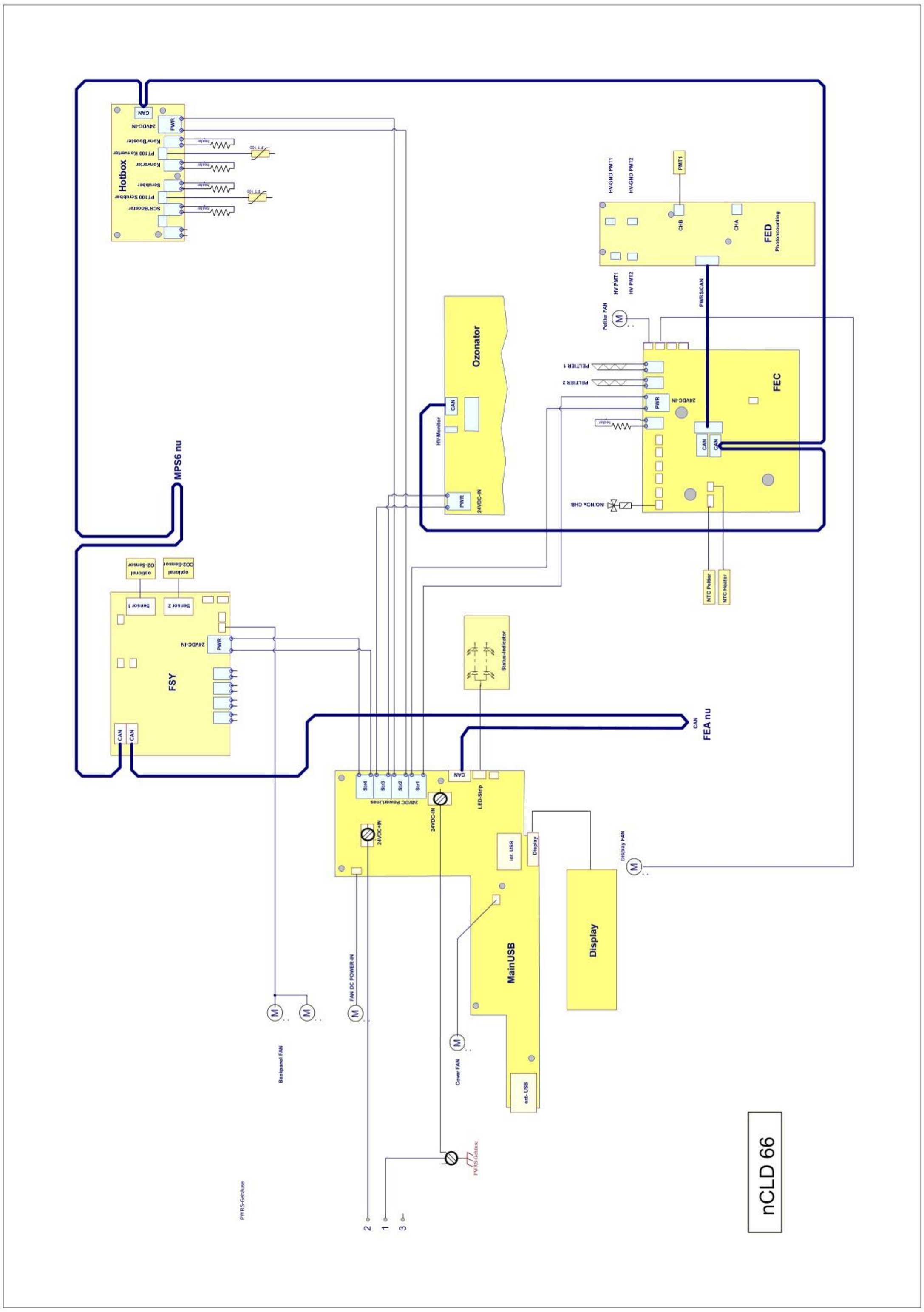
10.2 Electronic Block Diagrams

10.2.1 nCLD 6x

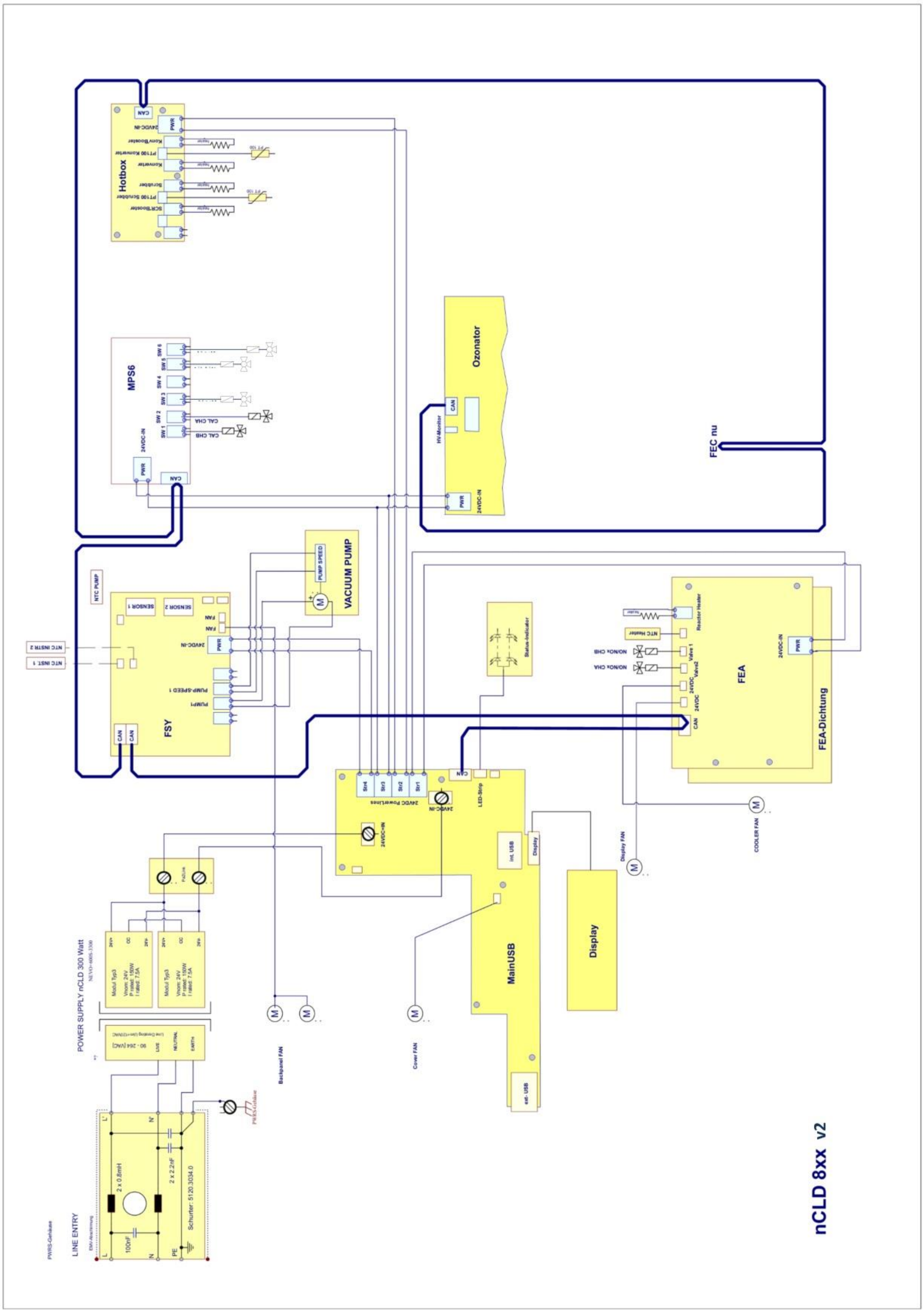


10.2

10.2.2 nCLD 66

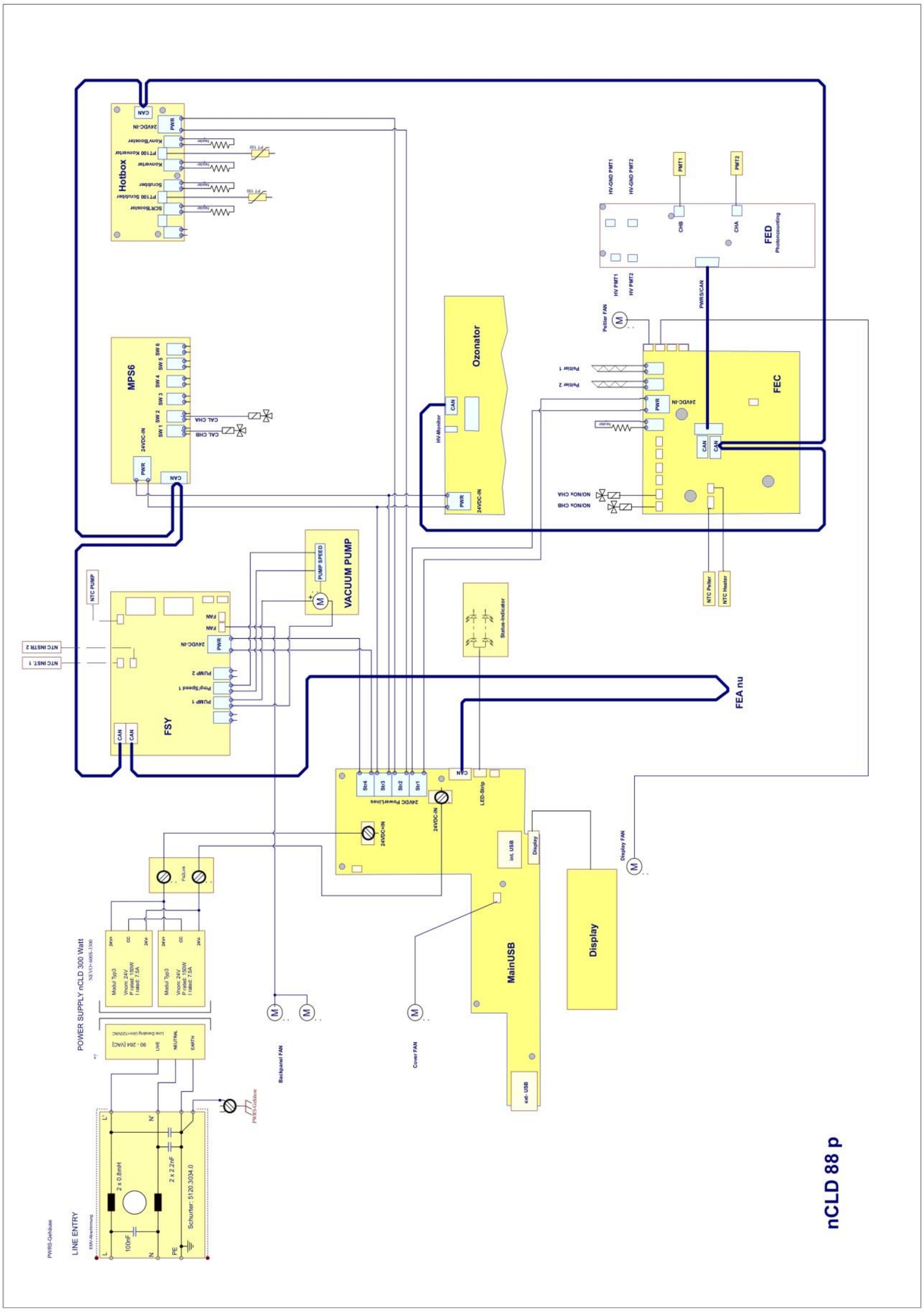

Hotbox
Ozonator
FED
FEC
MPS6 nu
FSY
FEA nu
MainUSB
Display
nCLD 66

10.2.3 nCLD 8xx v2

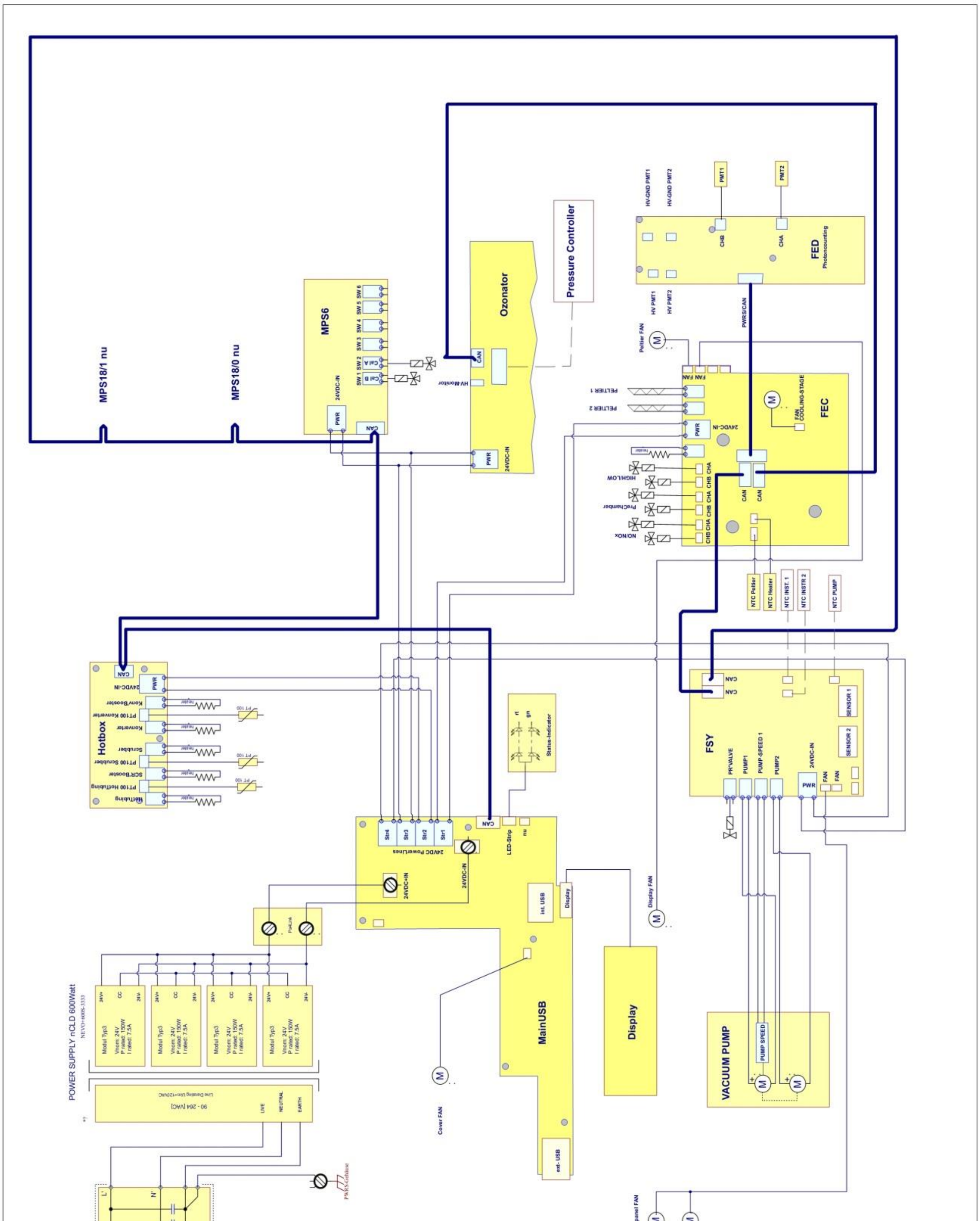


10.2

10.2.4 nCLD 88

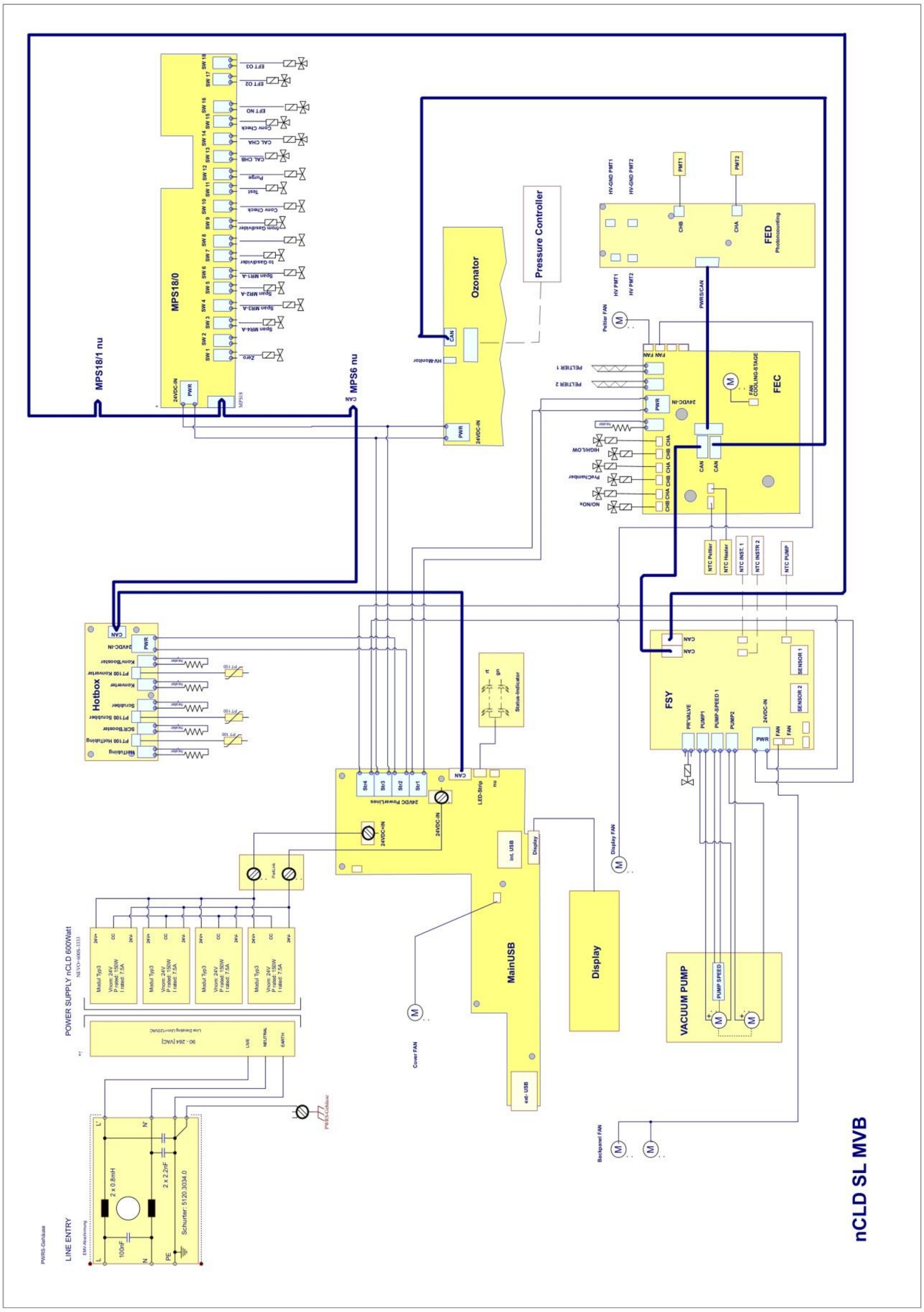


10.2.5 nCLD SL


MPS18/1 nu
MPS18/0 nu
MPS6
Ozonator
Pressure Controller
FED
FEC
Hotbox
FSY
MainUSB
Display
VACUUM PUMP
POWER SUPPLY nCLD 600Watt
LINE ENTRY
nCLD SL

10.2

10.2.6 nCLD SL v8



11.

Read the safety rules first
(Section 1.2)

DISPOSAL

11.

11. Disposal

Within EU the regulation RoHS: restriction of the use of certain hazardous substances in electrical and electronic equipment (2002/95/EG) and WEEE: waste electrical and electronic equipment (2002/96/EG) are defining the use and proper handling of used electronic equipment as well as hazardous substances.

Dispose all parts removed from the device according to your institution's protocol and local laws. Follow applicable regulations regarding disposal or recycling. If neither end user nor local supplier can dispose suitable, you may choose to return the product freight prepaid to the manufacturer clearly marked "for disposal".

Electrical and electronic equipment and parts labeled with the symbol must be collected separate from normal waste!

Dispose of the instrument safely, as electronic waste, except as follows:

- The main electronic board is fitted with a lithium battery (part of RAM module), which must be separately disposed of.
- The Peltier cooler, the photo multiplier, the display and other non-electronic parts may be separated according to materials of construction and disposed of appropriately according to local regulations (ferrous and non-ferrous metals, etc.)

The pump of the standard delivery contains no oil and can be disposed of in the electronic waste or metal recycling.