SYCOS KT-O3

Portable Ozone Calibration System

INSTRUCTION MANUAL

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Revision history

Release 1.0	August 2022	Initial Release
Release 1.1	December 2023	Pictures updated

TABLE OF CONTENTS

1. General Instructions

1.1. Indications

This manual contains important information for the operation of **SYCOS KT-O3** Ozone Calibration System.
To assure operator safety and the proper use of the instrument, please read, understand, and follow the contents of this manual.

Non-observance of these instructions can result in personal injury or death. Non-observance of these instructions may also lead to the loss of right to claim for damages or warranty!	

Meaning of signs used in this instruction manual:

 : Indication of particular importance

 : Warnings

Please follow the instructions given. Warnings denote a potential hazard associated with the use of **KT-O3** system.
Non-observance of warnings can result in personal injury or damages to the instrument.

 : Avoid actions marked with this sign

Please follow the instructions given. This symbol denotes potential hazard associated with the use of **KT-O3** system. Non-observance of the instructions can result in personal injury or death.

1.2. Safety Precautions And Important Instructions

The **KT-O3** system is designed for producing concentration levels of Ozone.

The **KT-O3** system is not designed for use in potentially explosive environments. Never place and operate the **KT-O3** in areas with a potentially explosive atmosphere!

Exhaust gases may contain harmful concentrations of Ozone.

If the unit is not connected to an analyzer, ensure that all exhaust gases are safely discharged.

Before opening the unit, switch off the mains button on the backside and pull out the mains cable.

Never pull out the UV lamp when it is in operation and never look into the burning UV lamp. This can cause permanent damage to the eyes. Wear special glasses with UV-opaque lenses against extremely short-wave light (180nm).

2. Functional Description

The **Sycos KT-O3** is a portable and battery powered calibration system for ambient air quality measuring instruments for Ozone.

Because of the build-in battery **Sycos KT-O3** can be operated for a certain time without mains.

Sycos KT-O3 produces Ozone in user configurable concentrations by partial UV ozonisation of cleaned/clean ambient air (zero air).

The unit can be operated in a manual or automatic mode, while the automatic mode offers independent correction of pressure and temperature influences. Further more the automatic mode can handle up to 10 self programmed ozone concentration levels.

Sycos KT-O3 is built in two different designs. It can be equipped with mounted adsorber cartridges for production of the necessary zero air (usually filled with Silica Gel and Activated Carbon). Alternatively the device is available without cartridges, here the zero air has to provided external.

2.1. Dynamic Dilution

The volumetric flow of the zero and dilution gas is produced by the internal gas pump and measured by a mass flow meter (MFM). Based on the gas flow set (by user or automatic) the internal electronics control the speed of the gas pump. Possible range is approx. 0.5 Nl/min up to 5 Nl/min.

Volume flow always refers to normalized conditions. 273°K (0°C) and 1013 mbar	

2.2. Zero Gas Production

Units with mounted adsorber cartridges produce zero gas from ambient air. The air is passing through particle filter (on all units) and Activated Carbon. The partial flow for the ozone generator is additionally dried using Silica Gel (see chapter 5. Maintenance).

2.3. Ozone Generation

Ozone is generated with a heated and current stabilized UV lamp (low-pressure mercury lamp). For this purpose a partial volume flow of zero gas is branched off behind the mass flow meter to the UV generator. This partial flow should always set to approx. 20 l/h with the needle valve on the front plate flow meter.

Set the flow on the front plate flow meter to approx. 20 l/h. This is usually done in lab and should be leveled as soon as gas flow changes.	

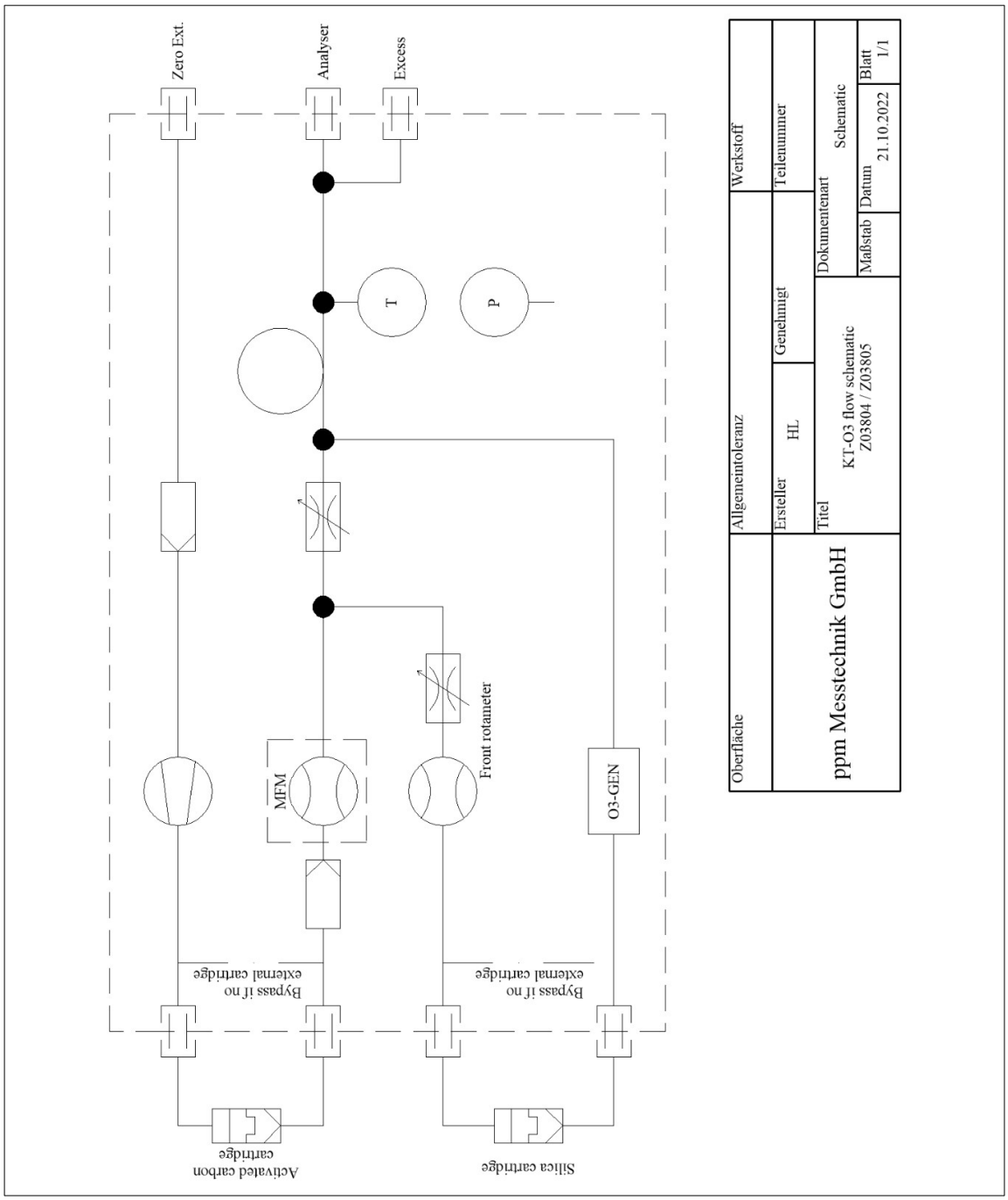
The indicated gas flow on the LC-Display always shows the total volume flow at the gas calibrators outlets.	

The intensity of the UV lamp and thus the amount of ozone produced is determined by the current through the lamp. In manual mode the current can be set directly in the range of 0.0 mA up to 500 mA. In automatic mode the lamp current is controlled by the **KT-O3** to compensate the influence of pressure and temperature.

The concentration of ozone can not directly be calculated from the displayed UV lamp current. It has to be determined in lab experimentally according to a standard laboratory procedure. **For automatic mode the determined levels are stored in the configuration of the KT-O3.**	

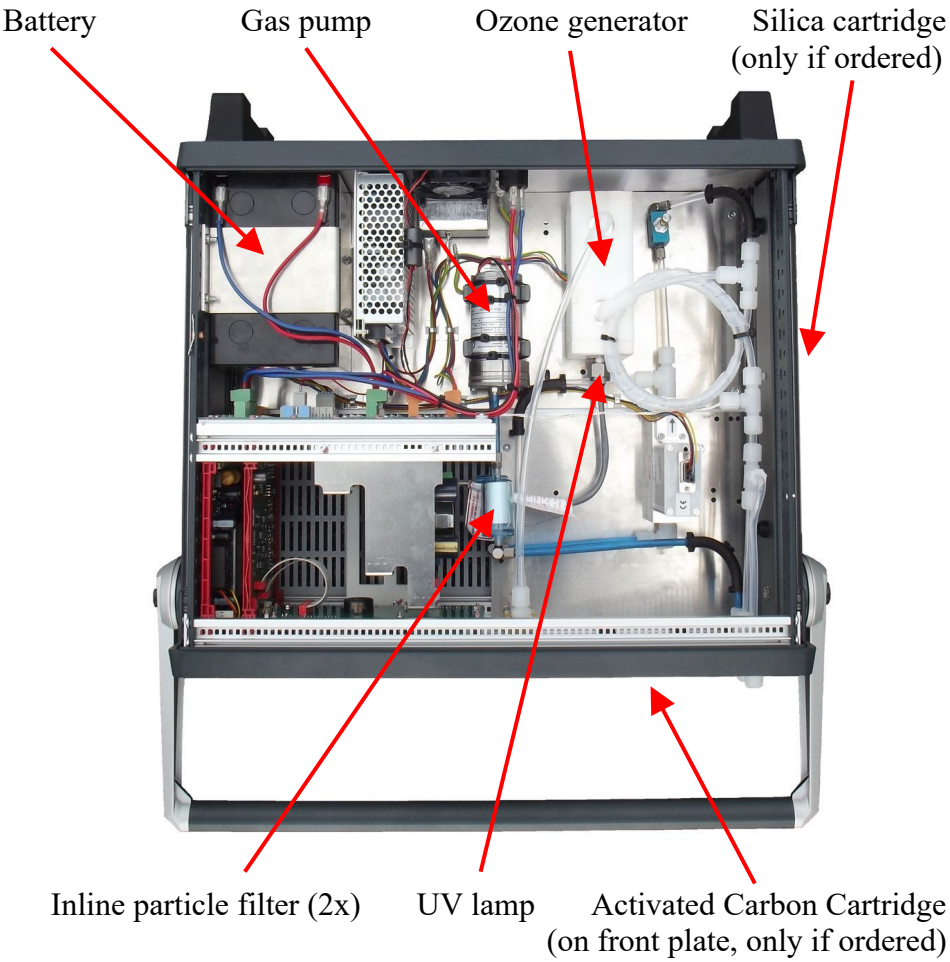
3. Instrument Description

3.1. Gas Flow Diagram



3.2. Internal Structures

Disconnect mains before opening the housing! **Always ensure the housing is proper grounded** **(green/yellow earth cables connected).** **Non-observance can lead to injury or even death!**	

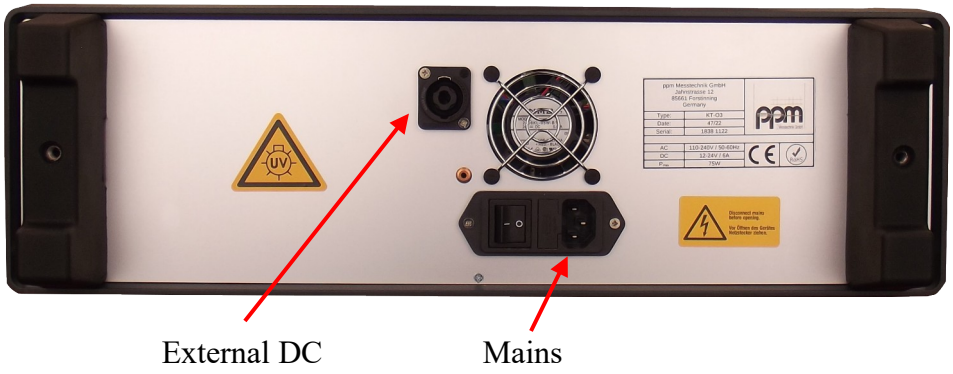


The **SYCOS KT-O3** is constructed in a maximum service friendly manner. Everything is easy accessible for exchange of tear and wear parts.

Take care for **ELECTROSTATIC DISCHARGE !** **Never touch the electronics if you are not proper grounded!** **This may damage or destroy electronics. Oberserve ESD guidelines!**	

The cartridges for Silica Gel and Activated Carbon (if installed) can be removed by pressing the quick release fittings (see chapter 5. Maintenance for service intervals).

3.3. Voltage Supply



To offer an uninterrupted operation of the **KT-O3** and to keep the ozone oven always in stable and warm condition the unit can be powered in different ways.

3.3.1. Mains AC

Mains can be supplied with a standard IEC cable on the dedicated socket. The input is fuse protected (2 Ampere / 230 Volts). The fuses are installed directly in the socket. Input voltage may vary between 110 – 240 Volts / 50-60 Hertz.

Blown fuses may only be replaced by the same type! **Non-observance can lead to serious damage to the device.**	

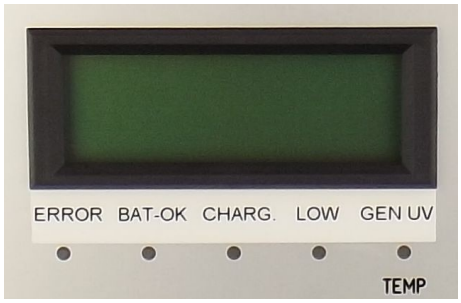
3.3.2. External DC

Each unit has a special input (Speakon power connector) to be supplied by DC voltage. The voltage has to be in the range of 9 – 24 Volts. Care must be taken that the DC supply is able to handle the maximum necessary power of the unit (see chapter 3.4., Technical Data). This input is also fuse protected, the fuse is mounted on the power supply circuit board and should only be exchanged by authorized service.

Blown fuses may only be replaced by the same type! **Non-observance can lead to serious damage to the device.**	

The DC input is basically intended to be used in combination with the 12V supply voltage from a car. The enclosed cable is designed for this purpose.

3.3.3. Internal Battery



To bypass situations where no mains or no DC voltage is available (for example on the way from lab to car) **KT-O3** can take power of the internal lead acid gel battery.

If the instrument is already warmed up, the internal battery can cover up to 3 hours in standby. If the instrument is also warmed up from battery or operated from battery the working time is about 1 hour.

LED “BAT OK”: Battery is charged and ready if steady. If the LED is blinking the unit is running on battery without mains nor DC voltage, or the battery is not fully charged and charging is ongoing.

LED “BAT CHRG”: The unit is connected to mains and battery charging is ongoing.

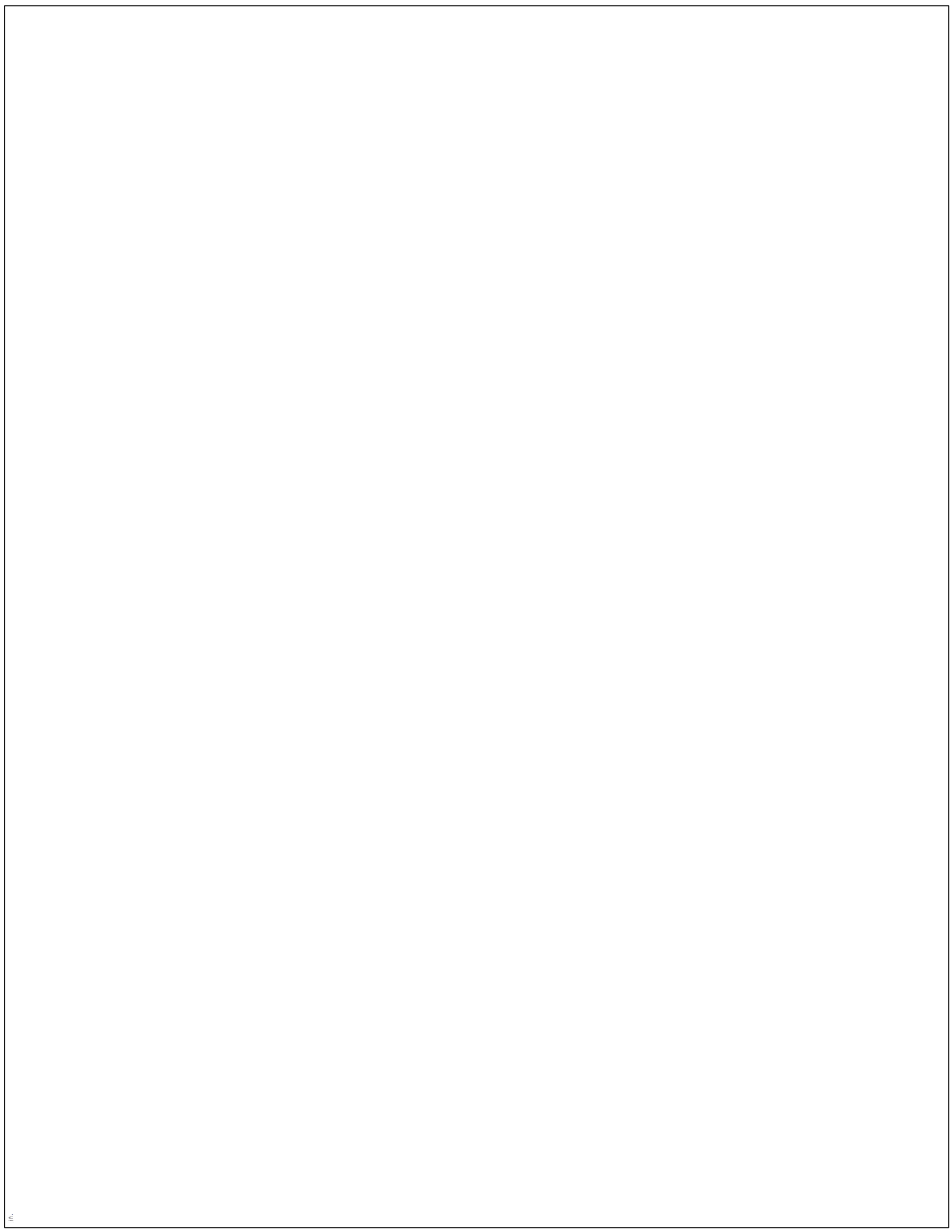
LED “BAT LOW”: The battery is empty. A warning signal is sounded. Immediately connect the unit to mains or DC voltage. If the unit is not connected within 5 minutes to mains or DC voltage the unit will switch off by itself to protect the battery from deep discharge.

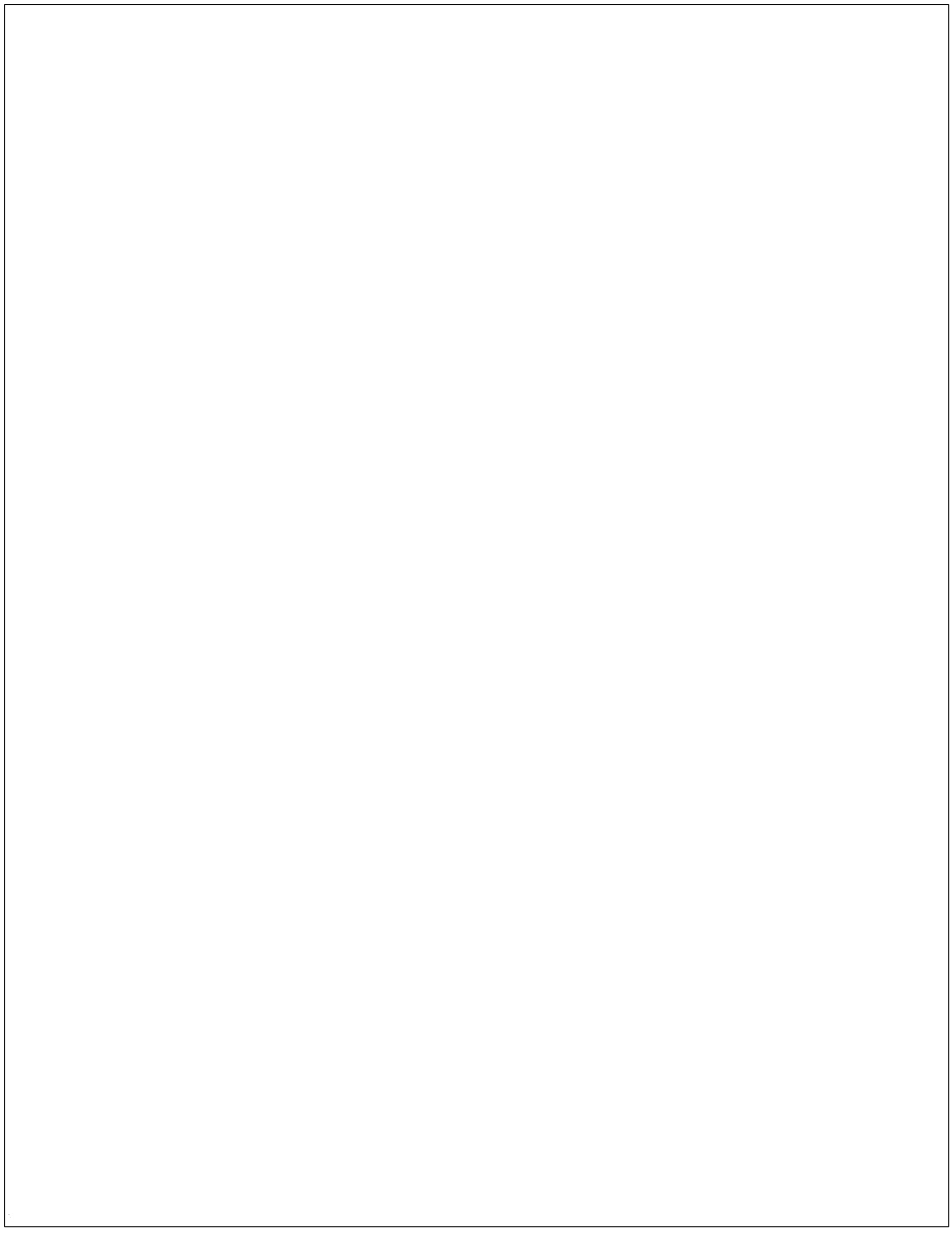
To charge the battery it is sufficient to connect the KT-O3 to mains and switch on the power on the plug (backside). **It is not necessary to completely switch on the unit on the front.**	

3.4. Technical Data

Dimensions:	19” Modular Portable Housing	
	Height approx.:	155 mm
	Width approx.:	525 mm
	Depth without handle approx.:	445 mm
	Depth with handle approx.:	560 mm
Weight:	approx. 16 kg (with adsorber cartridges) approx. 15 kg (without adsorber cartridges)	
Power mains:	Wide range input ~ 110 – 240 Volts AC - 50/60 Hertz	
Power external:	12 – 24 DC / 6 Amps	
Power consumption:	max. 75 Watts	
Temperature range:	during storage:	-10°C to +60°C (+14°F to +140°F)
	during operation:	+10°C to +40°C (+50°F to +104°F)
Air moisture range:	0 to 95%, non condensing relative humidity	
Protection class:	IP20D	
Gas flow range:	0.5 – 5 Nl/min. (1013 mbar / 0°C)	
Gas flow accuracy:	± 0.1 Nl/min	
O3 range:	0 – 500 ppb	
O3 accuracy:	1% of generated value plus ± 1 ppb at initial startup after 30 minutes during operation after 15 minutes	
O3 stability:	± 1 ppb	

3.5. CE-Declaration





4. Operation

4.1. Set-Up / Start

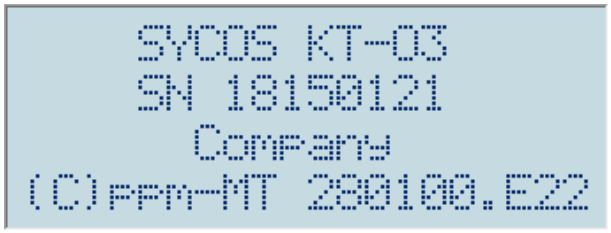
Electrical connection:
Connect the instrument to proper mains or external power source. Of course startup from internal battery is possible, too. In this case it is of utmost importance to have the battery well charged. If connected to mains, switch on the main button on the mains plug.

Gas connection:
For connection of the gas flow use only hoses of suitable kind. It is mandatory that those hoses do not adsorb or absorb possible disturbing molecules. Best results are given with PTFE or FEP hoses. Connect the measuring gas line of the analyser to the outlet ANALYSATOR of the **SYCOS KT-O3**.

The OVERFLOW outlet carries the excess gas, containing ozone, and must be safely discharged into the exhaust air or into a fume cupboard!	

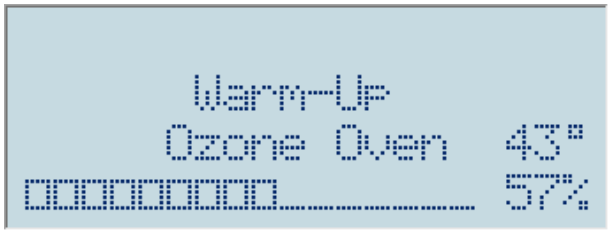
Start:
To start the unit, press the start button on front of the instrument. The instrument will start immediately. To switch off the instrument, press the button for at least 3 seconds.

For the first few seconds **KT-O3** will indicate some basic informations. Beside the kind of instrument those are the serial number, owning company and software release.

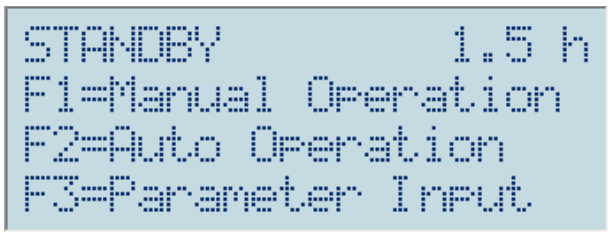


Instruments with software release LOWER THAN xxxxxx.x23 do not support automatic switch off to prevent deep discharge of battery!	

The unit starts with the warm-up of the ozone generator oven to a temperature of approx. 63°C. Empiric measurements indicate that at this temperature the ozone oven has the best efficiency. Warm up takes usually 15 minutes.



As soon as the oven has reached the working temperature **KT-O3** turns into standby and offers all possibilities to the user. Furthermore the working hours of the instrument are indicated. The GEN UV / TEMP indicator on the front is now green.



Inputs:

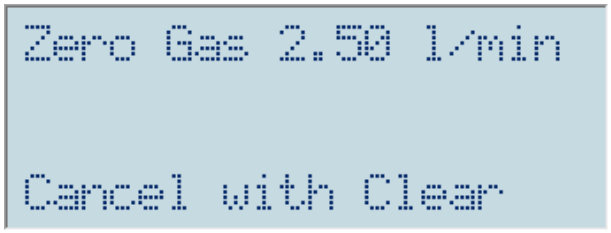
- An operating mode or input is always cancelled with “CLEAR”.
- Numbers are always entered or confirmed with “ENTER”.
- To restart a number entry a given input can be cleared to 0 by pressing the arrow key down “↓”.
- All numbers are right justified when entered. For example, to enter 1.53 l/min press the numbers “1”, “5”, “3” in the sequence. The format is predefined in each case with underscores.
- The decimal point is fixed in the predefined format (see above).
- The start of an operation after entering the numerical values always takes place with “ON”.
- The values of the last entry, which were confirmed with Enter, are retained in the memory so that these values are displayed after a renewed function call.

4.2. F1 Manual Operation

The concentration of ozone can not directly calculated from the displayed UV lamp current. It has to be determined in lab experimentally according to a standard laboratory procedure. **For automatic mode the determined levels are stored in the configuration of the KT-O3 and compensated for gas flow, pressure and temperature.**	

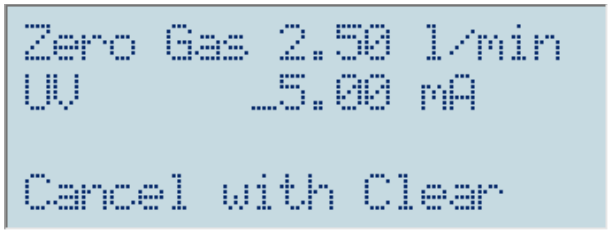
Adjust the total gas flow.

Press “ENTER” to confirm the values.

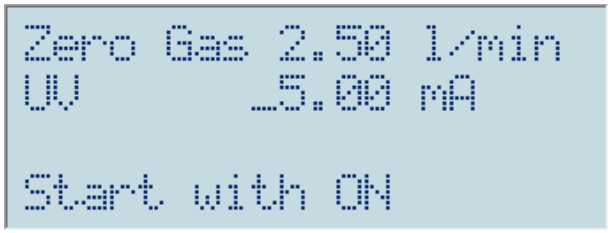


Enter the UV lamp current.

Press “ENTER” to confirm the values.



The levels set are indicated before operation.



The gas flow regulator and UV lamp regulator will start and bring both to the values set.

Furthermore the ambient pressure and gas temperature are indicated.

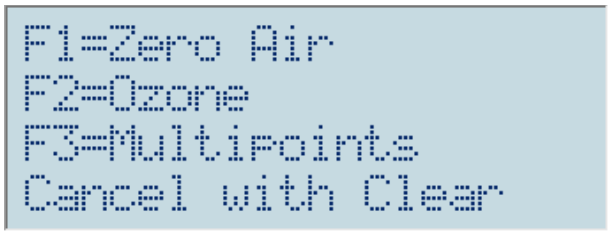
All operations can be quit at any time by pressing “CLEAR”.

4.3. F2 Auto Operation

In Auto Operation the concentration of ozone is compensated for gas flow rate, ambient pressure and gas temperature. Following the stored values in the settings, determined in lab, the ozone concentration is kept stable.	

The Auto Operation offers three more modes:

F1 → Zero Air of constant gas flow
F2 → O3 production, compensated
F3 → Multipoints

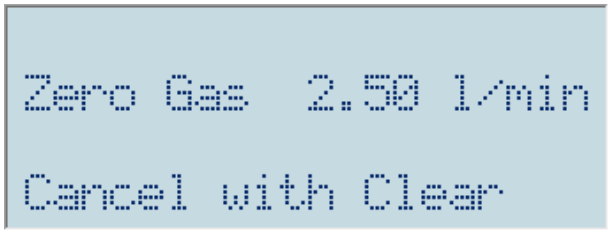


4.3.1. F1 Zero Air

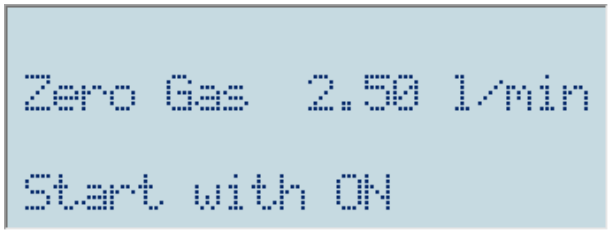
KT-O3 offers the possibility to supply zero air in the total gas flow range of 0.5 Nl/min up to 5 Nl/min.

Input the total gas flow, cancel the operation if necessary.

Press “ENTER” to confirm the gas flow entered.



The requested gas flow will be indicated once again before the gas production is started with “ON”.



Zero gas production starts and the gas flow will be leveled by the internal electronics.

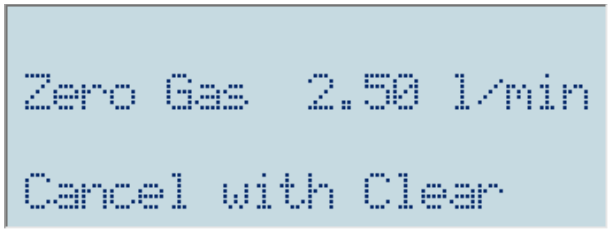
Additional ambient air pressure and gas temperature are indicated.

All operations can be cancelled by “CLEAR” at any time.

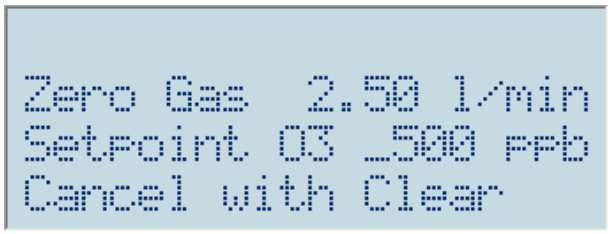
4.3.2. F2 Ozone

In the Automatic Mode ozone of a defined level can be produced.

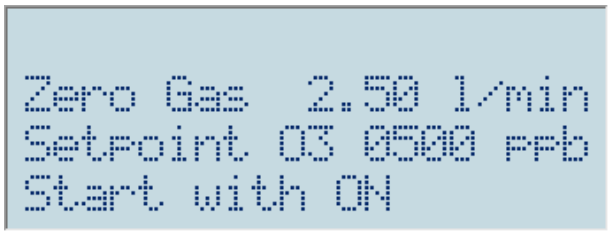
Enter the requested total gas flow. Confirm with “ENTER”.



Set the desired ozone concentration and confirm with “ENTER”.

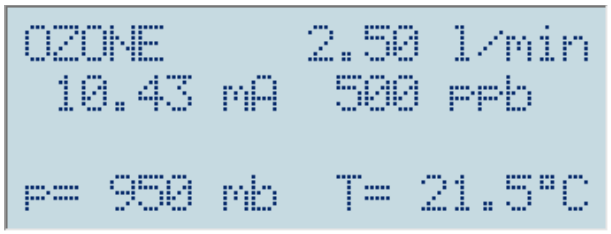


The requested values will be indicated once again before the gas production can be started with “ON”.



The UV lamp current is leveled to a certain value in order to produce the requested ozone concentration.

Furthermore ambient pressure and gas temperature are indicated.



The operation can be cancelled by “CLEAR”.

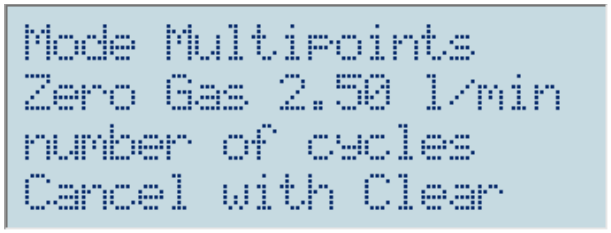
4.3.3. F3 Multipoints

The Multipoint Operation offers an easy way to produce up to 10 compensated, user defined ozone concentrations.

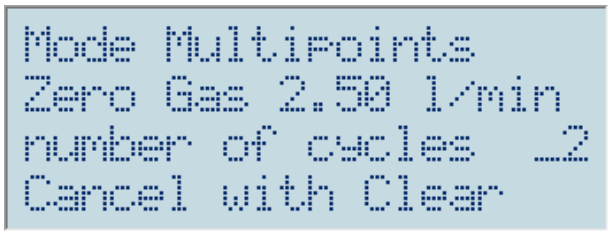
The ozone concentration levels are entered in the settings (see chapter 4.4.3., F3 Step Parameters). Furthermore the production time for a concentration level is adjusted in the settings (F3 Parameter Input → F3 Step Parameters).

In the following example two steps where defined in the Step Parameters (F3 Parameter Input → F3 Step Parameters):
50ppb and 100ppb.

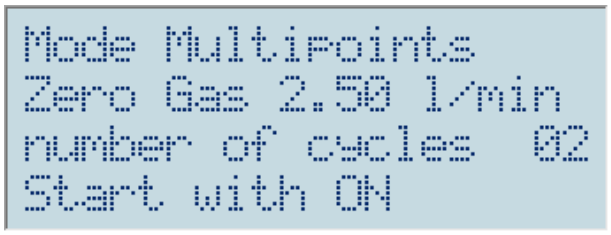
Enter the requested total gas flow, if different to the predefined gas flow in the step parameters.



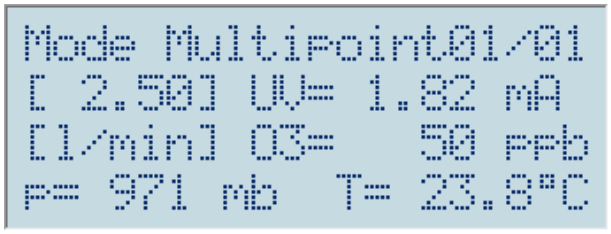
Enter the number of cycles how often the defined concentration steps shall be produced.



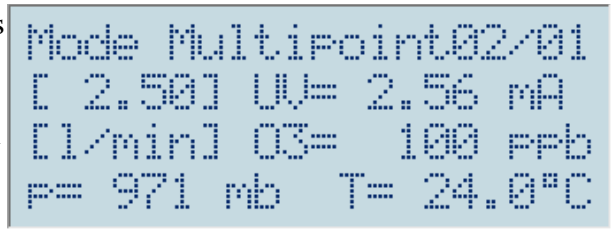
The values set are indicated again before operation are started with "ON".



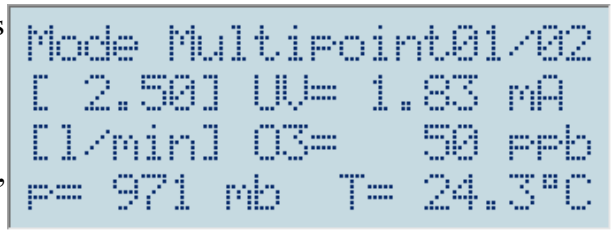
Multipoint Mode starts here with step 01 of cycle 01. In this example a concentration of 50ppb was set in the parameters.



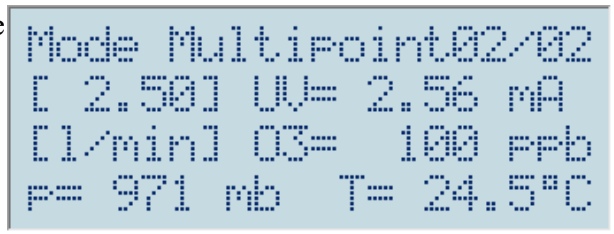
After the time set in the parameters KT-O3 jumps to the next step 02 of cycle 01. In this example a concentration of 100ppb was set in the parameters.



After the time set in the parameters KT-O3 jumps back to the first step 01, now of cycle 02 (only two steps where defined in F3 Parameter Input → F3 Multipoints, 50ppb and 100ppb.

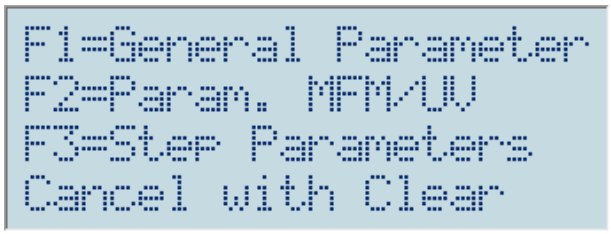


After the time set in parameters the last step is executed, step 02 of cycle 02. Again 100ppb are produced.



After the last step has been finished KT-O3 will stop to produce ozone, but keep the gas flow up in order to purge the pneumatic system with zero gas. Press “CLEAR” to stop the gas flow and to leave multimode.

4.4. F3 Parameter Input



In order to empower KT-O3 to produce ozone concentrations in defined values a few general informations are necessary.

Those informations are (set at F1):

- Ambient pressure at calibration of unit
- Gas temperature at calibration of unit
- Gas flow at calibration of unit

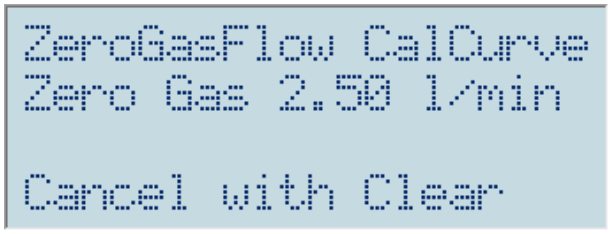
Further more the characteristics of the Mass Flow Meter and the UV lamp are necessary (set at F2).

The values at F1 (General Parameter, pressure and temperature) and F2 (Param. MFM/UV) shall be set immediately one after the other as readout may change because of temperature/pressure deviations from day to day.	

To use the Multipoints (F2 Ozone → F3 Multipoints) these steps have to be set at F3.

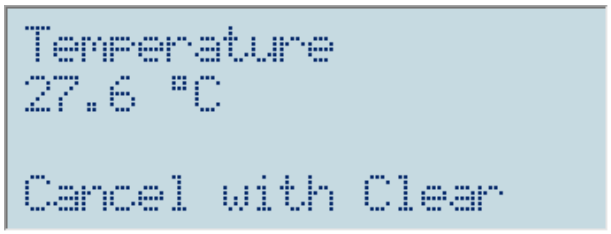
4.4.1. F1 General Parameter

Set the total gas flow where the concentration of ozone on the output ANALYSER was measured. Recommended value is 2.50 Nl/min.



Enter the ambient pressure as indicated by KT-O3 during gas production at calibration.

Enter the gas temperature as indicated by KT-O3 during gas production at calibration.

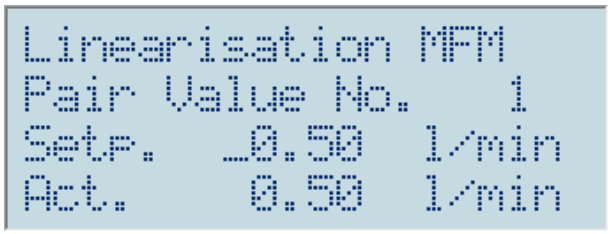


4.4.2. F2 Param. MFM/UV

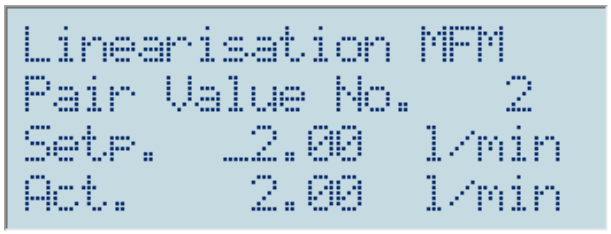
The recommended procedure to determine the values to be set in F2 Param. MFM/UV is described in chapter 4.5.

Linearisation is beginning with the set/actual deviation determination of the Mass Flow Meter.

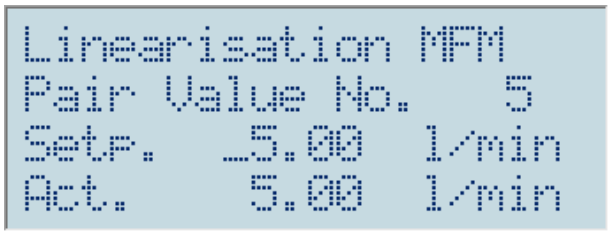
Parameter setup starts with the linearisation of the MFM. Enter the first gas flow set and the actual measured value. The first value should be the lowest.



After pressing “ENTER” the next value pair can be set in the same way.

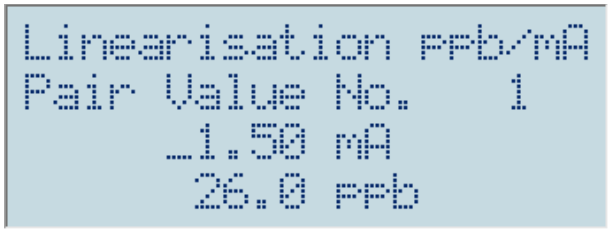


Proceed till MFM linearisation value pair 5. This is the last point.

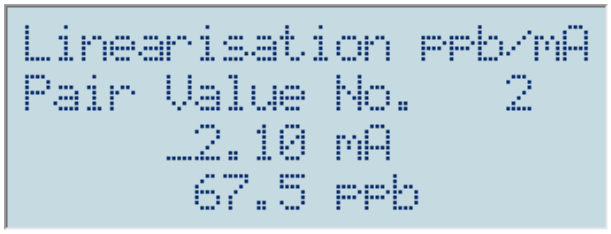


As soon as the last MFM point is set the UV Lamp characteristic settings will follow right away.

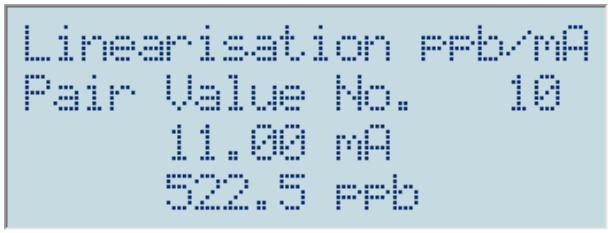
Enter the smallest lamp current used for the first ozone concentration.



Proceed with the following steps.



Last point for UV linearisation is the Pair Value No. 10.



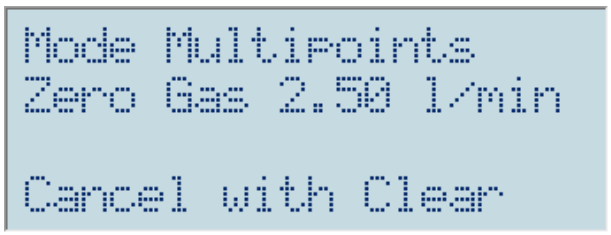
4.4.3. F3 Step Parameters

Multipoints offer an easy way for automatic production of up to ten ozone gas concentrations.

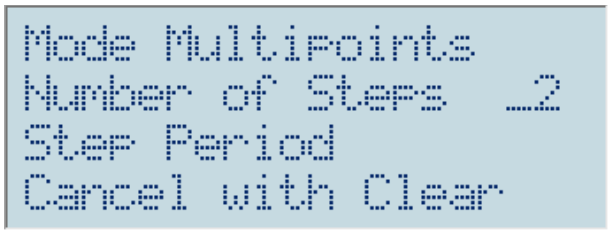
The steps for F2 Ozone → F3 Multipoints are set here.

If it is intended to produce ozone concentrations of less than 50ppb in Multipoint Mode it is recommended to start with higher ozone concentrations as previous step. This favors and stabilizes the ignition of the UV lamp.	

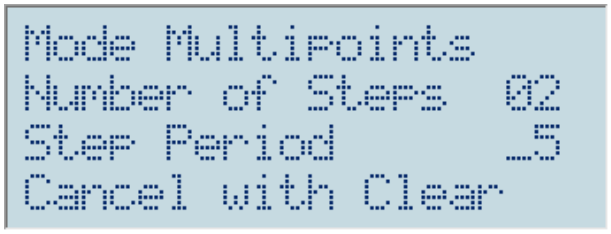
First a predefined gas flow is displayed. This gas flow can be changed prior to activation of multimode in F2 Ozone → F3 Multimode.



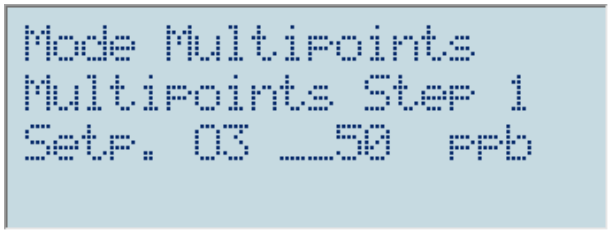
Next the total number of multimode steps has to be set (here: 2 steps).



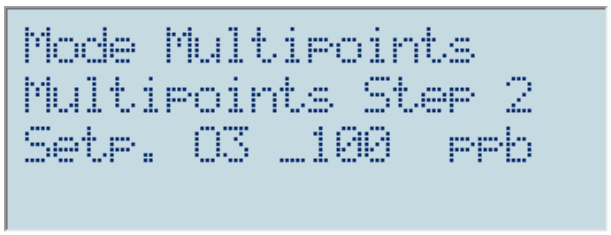
Afterwards the time period of a single step in minutes has to be set (here: 5 minutes).



Now the ozone level of the first step can be set (here: 50ppb).



Depending on the total amount of multimode steps set, the ozone level on the single steps have to be set (here: 100ppb as last step).



4.5. Parameter Determination

To determine the values to be set in F3 Parameter Input → F2 Param. MFM/UV the following procedure is recommended.

1. Determination of gas flow divergences

Prepare a suitable instrument to measure the normalized, summarized gas flow. Possible instrument is, for example, a DryCal Defender.

Close one of the two gas outlets (ANALYSER or EXCESS). Connect the gas flow calibrator to the open port.

Move to F3 Parameter Input → F2 Param. MFM/UV and update the MFM linearisation values, if necessary, to 1:1, 2:2, 3:3, 4:4 and 5:5 to reset any influence of a previous linearisation. Keep any UV values as they are.

Jump back to F2 Auto Operation → F1 Zero Air

As the linearisation of the Mass Flow Meter can hold up to five points and the usable flow range is between 0.5 up to 5 Nl/min. a step range of 1 Nl/min is recommended.

Start with a set gas flow of 1 Nl/min. and observe the readout of your measuring instrument. Note the readout and proceed with 2 – 3 – 4 – 5 Nl/min.

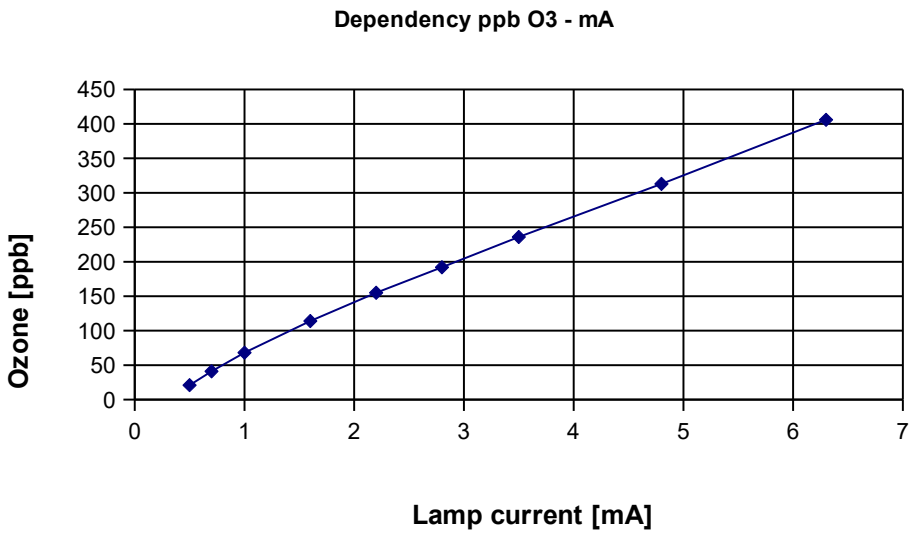
Move to F3 Parameter Input → F2 Param. MFM/UV and update the MFM linearisation values. Keep the UV values as they are.

Remove the blockage of the gas outlet.

2. Determination of UV lamp divergences

Prepare a suitable instrument to measure ozone concentrations. Possible instrument is, for example, a well calibrated Environnement O3-41.

The typical characteristic of the UV lamp is non linear.



As in the example above the ozone concentration at low UV lamp currents is usually not linear, but quickly changes to a linear behaviour.

Sycos KT-O3 offers up to 10 linearisation points to describe the relation between UV lamp current and ozone concentration.

The following UV lamp currents have been proven to define the behaviour. The easiest way is to prepare a table to fill in the measured values.

Set UV lamp current in mA	Measured ozone concentration
10.00	
8.00	
6.00	
4.00	
3.50	
3.00	
2.50	
2.00	
1.50	
1.00	

Move to F1 Manual Operation. Set a gas flow of 2.5 Nl/min. Start with the first (highest) UV lamp current. Observe the front rotameter and set it to a flow rate of approx. 20 Nl/h, if necessary.

Ozone gas concentration is a relation between gas flow through ozone generator and overflowing gas flow. **If the flow through the front rotameter was changed a full readjustment of UV lamp current for the use of the automatic mode is mandatory!**	

Each current/concentration level has to run for a minimum of 10-15 minutes for proper stabilisation.

Proceed with the next lower UV lamp current and note the achieved concentration until last step. Do not change the setting of the front rotameter.

Move to F3 Parameter Input → F2 Param. MFM/UV and update the UV linearisation values. Keep the MFM values as they are.

5. Maintenance

Consider to send the instrument to ppm Messtechnik GmbH for servicing.

Every approx. 72 operating hours:

Change/Refresh the silica gel in the ozone zero gas partial flow.
(only if instrument is equipped with dedicated cartridge)

Remove the adsorber cartridge by pressing the metal caps of the fast couplers. Screw off the PVC cover of the cartridge and remove the silica gel. Please pay attention to the O-ring that seals the cartridge against the cover which is located in a groove. Occasionally change the two white filter pads after visual inspection.

Every approx. 3-6 months operating time:

Change the activated carbon in the zero gas preparation.
(only if instrument is equipped with dedicated cartridge)

Remove the cartridge as described above.
Check all inline particle filters, replace if necessary.
Check the pump for constant regulated gas flow within ± 0.02 l/min in the range of 0.5 – 5 Nl/min.
Check the pump is able to keep a gas flow of 5 Nl/min. in general.

Every approx. 6 months:

Change all particle inline filters. Unscrew the fittings of the used up inline filters and reassemble those on the new filters. The housing material of the inline filters is brittle, take care to not break it during tighten of fittings.

After approx. 12 – 24 months:

If necessary, replace the UV lamp if it no longer burns stable or is defective. Insert the new lamp up to approx. 1mm to the end of the aluminium sleeve into the screw connection/holder. Clamp the lamp hand tight (Teflon clamping rings inside). Connect the lamp to the plug of the high voltage UV control card.

Never touch the UV control card during operation! **H I G H V O L T A G E !** **Non-observance can lead to injury or even death!**	

Never start the instrument with unconnected UV lamp! **This may damage or destroy electronics.**	

Consider to send the instrument to ppm Messtechnik GmbH for servicing.

6. Appendix

6.1. Spare Parts

Order Code	Description
T01229	Particle Filter 
G03598	Car Power Cable 
V01021	Activated Carbon 
V01022	Silica Gel