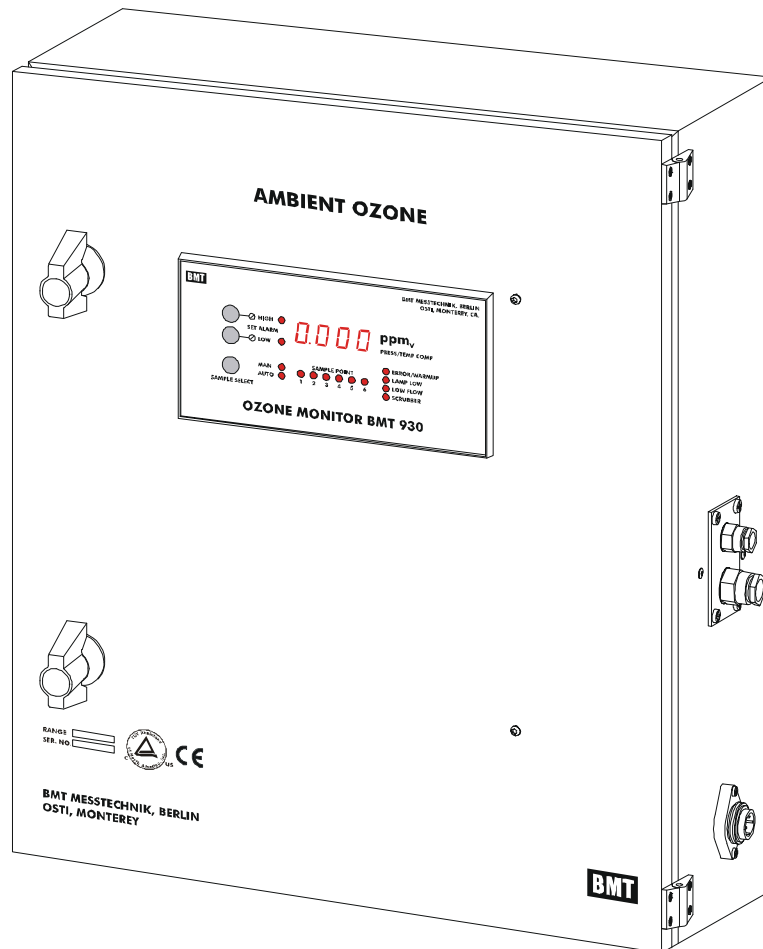
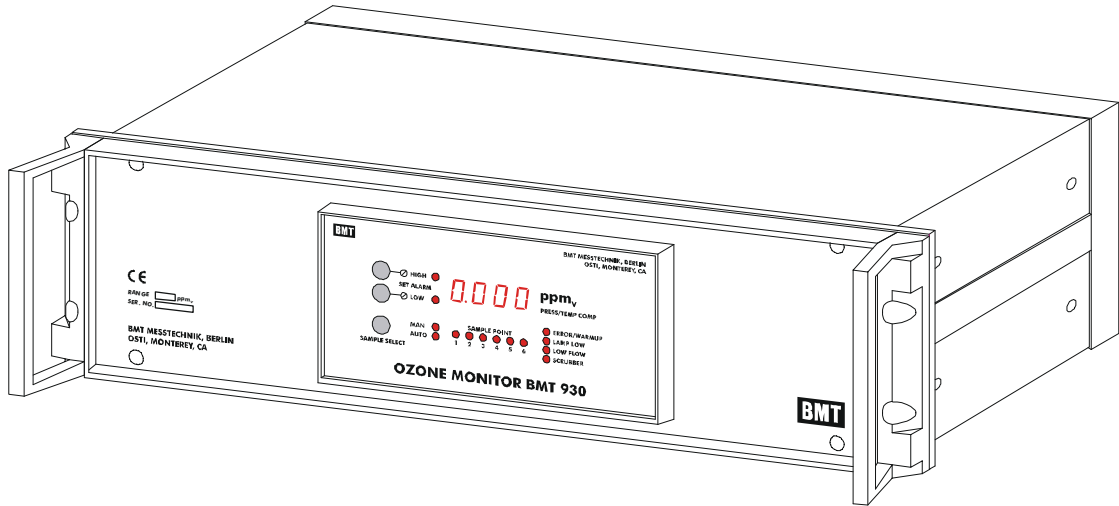


OZONE MONITOR BMT 930

Manual

Rev. 11/2013



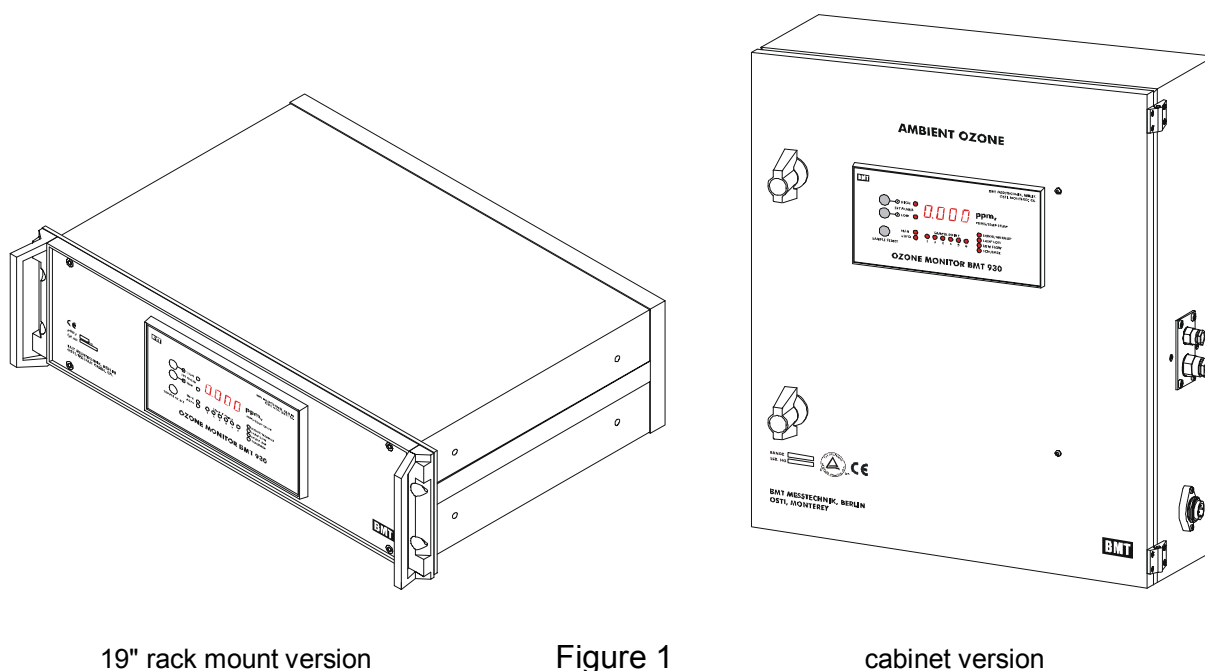
OZONE MONITOR BMT 930 Manual

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1 General Description

OZONE MONITOR BMT 930



19" rack mount version

Figure 1

cabinet version

The OZONE MONITOR BMT 930 is a state-of-the-art UV photometer for measuring and monitoring ozone content of the ambient air. The ozone content is displayed in ppm_v , a dimension requiring temperature and pressure compensation. This is the reason why the OZONE MONITOR BMT 930 is temperature and pressure compensated, of course.

The instrument may be ordered with 1, 3, or 6 sample channels. Switching from channel to channel is automatic, or manual via a push button.

Since the application of the BMT 930 mainly is TLV (Threshold Limit Value) monitoring, continuous and safe operation of the instrument is the predominant requirement. This is the reason why the BMT 930 has two scrubbers (the scrubber is one of the most important elements of an ambient ozone monitor). And it has a built-in ozone generator for intermittent automatic testing the function of the utility scrubber. When this scrubber fails in completely removing the ozone from the sample ozonated by the ozone generator, the instrument automatically switches from the utility scrubber to the reserve scrubber, and at the same time activates the warning signal SCRUBBER indicating a scrubber failure.

Simplicity of operation is a prerequisite for a safety monitor. This is the reason why the instrument has only three push buttons: two for setting one lower and one higher warning threshold, and one for selecting the sample channel manually, or to choose the automatic channel switching mode. The sample gas flow rate is maintained constant by a pump which is

automatically controlled by a built-in electronic flow meter. In case the pump fails and the flow rate drops, the warning signal LOW FLOW is activated indicating a pump failure.

The highly stable UV radiation source has a life expectancy of several years. Via an automatic control loop the radiation output of the UV lamp is precisely maintained constant during its service life. When the lamp's performance drops significantly, the early warning signal LAMP LOW is activated indicating that the lamp should be replaced by a new one during the next few weeks.

Any failure including the warning states mentioned above, and any electric failure will activate the ERROR/WARMUP warning signal; even power down is signalled by the error relay coupled with the failure warning. A "Relay Box" is built into the new OZONE MONITOR BMT 930 to offer electric contacts for each threshold, low and high, of each sample channel.

2 Features, Options

- UV photometer with temperature and pressure compensation
- ranges available: 1.000, 9.999, 99.99, 250.0 ppm_v
- resolution: 0.001 ppm_v (4-digit display)
- 19" rack mount, 132 x 300 mm (H x D), 10 kg
or wall mount cabinet NEMA 4X, 400 x 500 x 150 mm (W x H x D), 9 kg
- traceable to international standard (NIST)
- CE mark, cTUVus NRTL-listed
- 1, 3, 6 sample channels
- two threshold alarm levels (relay contacts)
- cycle time 20 s per channel
- two scrubbers (utility + reserve)
- ozone generator for automatically testing the utility scrubber every 24 hours
- reserve scrubber: automatically replaces the utility scrubber when it is faulty
- safety catalyst for the off gas
- sample gas flow 1 l/min, auto controlled via an electronic flow meter
- warnings: SCRUBBER, LOW FLOW, LAMP LOW, ERROR/WARMUP
- pre-filters + fittings included (one filter holder per channel + 200 inserts)
- analog outputs, isolated: 0-1 V, 0-10 V, 4-20 mA
- RS 232 serial interface
- hardware prepared for DeviceNet
- ambient temperature 0 - 45°C (non-condensing)
- universal line voltage (100 - 240 VAC, 60/50 Hz/35 VA)
- optional: 18-36 VDC, 35 W
- "Relay Box" (built in)
- also available as wall-mount cabinet

3 Accessories, Spare Parts

The OZONE MONITOR BMT 930 comes with all the accessories needed for its operation.

A Spare Parts Kit "930-SPARE" is available as an option, see page 27.

4 Cautions

Ozone may be dangerous and harmful, even at a low concentration. The 8-hour exposure to ozone should not be to a higher ozone content than in the order of 0.1 ppm_v.

Ozone in the sample gas is automatically destroyed after passage through the OZONE MONITOR BMT 930. Since the sampling tube could contain ozone in a dangerous concentration, be careful to not open the sample gas lines leading to the instrument whilst the ozone producing system is on.

When the instrument is opened without disconnecting it from line power, two dangers are present: UV radiation from the UV lamp, and high voltage from the power line and from the internal high voltage power supply of the UV lamp.

Always disconnect the instrument from line power before opening it!

UV radiation can cause eye damage. Do not look into the UV lamp without proper eye protection.

Warning: This product relies on the building's installation for short-circuit (overcurrent) protection. Ensure that a fuse or circuit breaker no larger than 15 A at 120 VAC (10 A at 240 VAC) is used on the phase conductor. Required nominal wire size is 1 mm².

Précaution:

L'ozone peut être dangereux pour la santé, même à faible concentration. La concentration sur votre lieu de travail ne devrait pas dépasser 0,1 ppmv pendant 8 heures. L'ozone est intégralement détruit après avoir passé le BMT 930. Mais comme les conduites de gaz à mesurer peuvent le contenir à forte concentration, il faut veiller à ne pas ouvrir les conduites de gaz à mesurer qui mènent à l'appareil pendant que le générateur d'ozone est en fonction dans le système.

Si l'appareil est ouvert pendant qu'il est en marche, deux dangers doivent être pris en compte : le rayonnement ultra-violet de la lampe à ultra-violet, la tension du secteur et la haute tension sur le module à haute tension de la lampe.

Attention: Avant d'ouvrir l'appareil débrancher le secteur.

Les rayons ultra-violet peuvent endommager la vue. ne jamais regarder la lampe sans protection adéquate.

Attention : Ce produit se sert de l'équipement de protection de votre installation électrique concernant les surcharges et les courts-circuits. Vous devez vous assurer que l'intensité de la fusible ou du disjoncteur protégeant le conducteur de phase ne dépasse pas 15 A à 120 VAC (10 A à 240 VAC).

5 Ozone Photometry

UV radiation with wavelengths below 300 nm is dramatically decreased by the passage through ozone gas. This is one reason for the existence of life on earth. UV radiation coming from the sun converts oxygen into ozone in the higher regions of our atmosphere, and hence provides protection of our planet from exactly this UV radiation.

Between 200 and 300 nm wavelength (Hartley band) ozone has one of its strongest absorption bands. The maximum absorption in this band occurs at about 254 nm. It happens that the strongest mercury line (the wavelength of the highest radiation intensity produced by mercury plasma) is at 253.7 nm. This is the reason why the radiation of a mercury lamp is exceptionally well suited for photometric detection of ozone.

In the year 1729 Pierre BOUGUER, a professor of hydrography, published his "Essai d'Optique, sur la Gradation de la Lumière". He already knew that light passing through a medium is decreased logarithmically. In the year 1760 Johann Heinrich LAMBERT published his "Photometria sive de mensura et gradibus luminis, colorum et umbrae". Based on Bouguer's findings, he described the passage of light through a medium more mathematically. BEER alleged in 1852 that, when the product of concentration and pass length is constant, extinction is also constant. This is an important statement for general photometry, but is less important for ozone measurement with UV radiation.

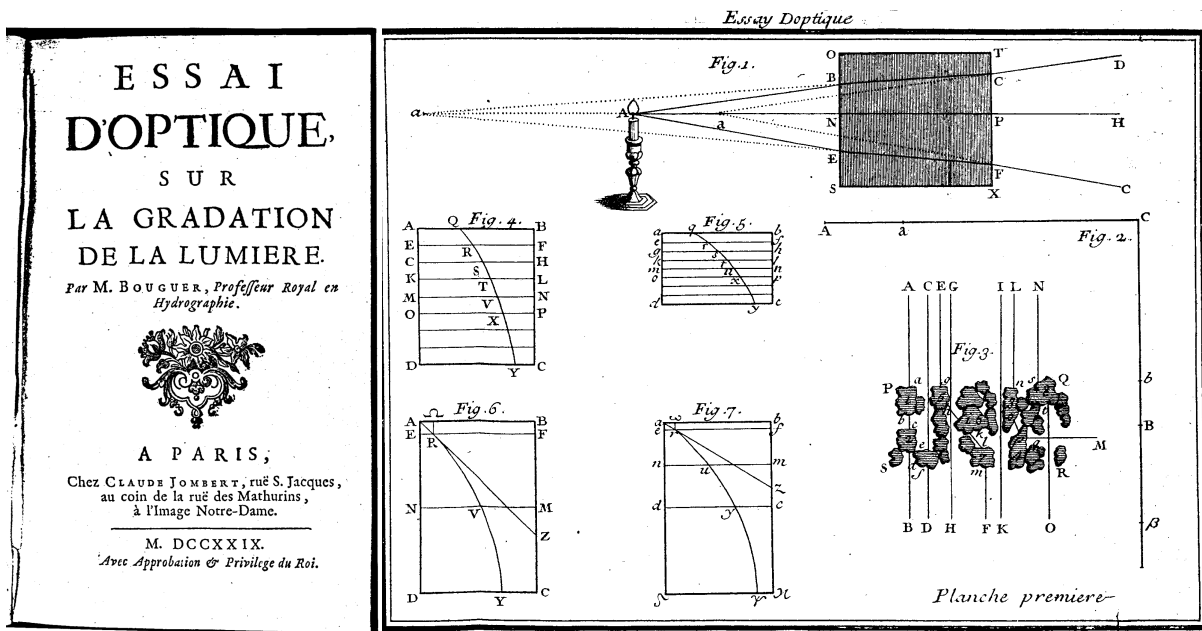


Figure 2

The law of BOUGUER-LAMBERT says that the product of the concentration, e.g. of ozone in air, and the cuvette length, is proportional to the logarithm of the quotient of both light intensities, at the input to the cuvette and at the output. This logarithm is also referred to as the extinction.

The coefficient of proportionality for ozone at 254 nm wavelength has been investigated thoroughly by many scientists. The different results agree to about plus/minus one percent. The actual number of the extinction coefficient depends upon the definition of "concentration", and upon the dimensions chosen. The number recommended by the IOA (International Ozone Association) is 3000 ltr/cm mol with the concentration in mol/ltr at 1 atm and 0°C.

To measure ozone content in a sample gas, an ozone monitor has to measure the extinction of UV radiation of high spectral purity at 254 nm wavelength during its passage through the cuvette of well known length. At the same time the monitor has to measure temperature and pressure of the sample gas in the cuvette, because the ozone "concentration" to be evaluated would be meaningless without the knowledge of the thermodynamic condition of the sample. Actually the temperature during measurement usually is around 293 K (20°C), but the pressure may vary dramatically with the altitude and with the inevitable pressure drop in the sampling tube.

6 Units of Measure: ppm_v, µg/m³ (1 atm/different temperatures)

The internationally agreed upon definition of ozone content in the ambient air is ppm_v (parts per million, volume of ozone per volume of sample gas). The International Standard ISO/FDIS 13964 of 1998 defines ambient ozone content as µg/m³ at 1 atm/25°C, or at 20°C, or at 0°C. Actually the definition of 1mg/m³ (1000 µg/m³) at 1 atm/20°C (usually used in the European Community) is practically identical with 0.5 ppm_v.

7 The OZONE MONITOR BMT 930

The OZONE MONITOR BMT 930 has a cuvette 310 mm in length. The cuvette is a 7.4 mm ID PTFE tube. The tube is mounted inside a thick-walled aluminium tube as the rigid optical bench. Sample gas temperature is measured in the highly thermally conductive aluminium tube. Sample gas pressure is measured directly inside the cuvette.

The low pressure mercury lamp is mounted directly to the aluminium optical bench. The UV radiation passes a band limiting filter and a semi-reflective mirror, through which the radiation intensity is measured by the reference detector just before entering the cuvette through a quartz window. At the other end of the cuvette the measuring detector is mounted behind another quartz window. The reference intensity signal is used to auto control the power to the lamp to precisely stabilize the UV radiation. A warning light LAMP LO is activated when the UV lamp is near the end of its service life.

Sample gas is sucked through the cuvette by a silent membrane pump. The flow rate is measured by a thermal flow meter. A control loop holds the mass flow rate constant at 1 l/min by controlling the power to the pump, automatically stabilizing the flow.

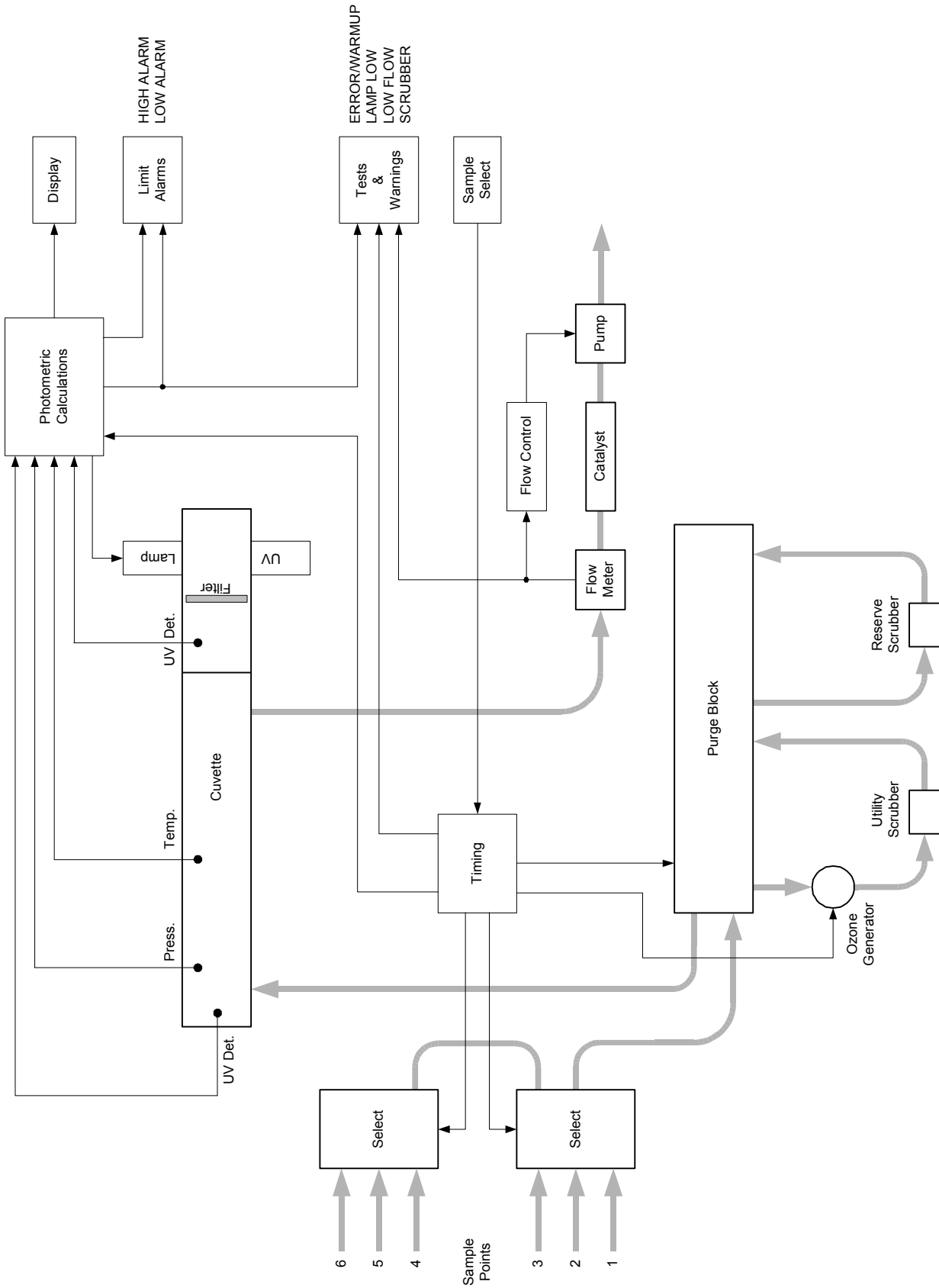


Figure 3

By means of a solenoid valve assembly, the sample gas is delivered directly to the cuvette, or via an ozone scrubber with high selectivity to ozone alone. During this phase (with no ozone in the cuvette) the photometric ozone signal is set to zero. The scrubber thus is the element which shall give the zero ozone reference. From time to time, the solenoid valve assembly switches an ozone generator in front of the scrubber to check its ability to remove any ozone from the sample.

In case the utility scrubber fails to remove the ozone completely, another scrubber (the reserve scrubber) is switched into the circuit, and a warning light SCRUBBER is activated to tell the user that the utility scrubber has to be replaced soon. The OZONE MONITOR contains an ozone destruct to remove any ozone from the sample leaving the instrument. But it does not contain a sample gas filter. The reason is that any sample filtering should be performed at the inlet of the sampling tube to protect the inner surfaces from becoming dirty. The sample gas filters shipped with the instrument have to be provided at the inlets of the sample tubes, and have to be replaced on a regular basis (see page 12).

8 Scrubber

The scrubber is one of the most important elements of an ambient ozone monitor. It shall remove any ozone in the sample gas whilst it shall not affect any other substances which could produce an extinction of the UV radiation. Perhaps not any kind of scrubber really fulfills these demands perfectly.

The non-ideal behaviour of a scrubber material of course depends upon the species and quantities of substances contained in the sample air which may be affected by the scrubber. In other words: The optimal choice of a scrubber material always depends upon the situation in which the ozone monitor shall be operated.

For ambient ozone monitoring (instruments with measurement range 1 ppm_v) we are using the scrubber material which seems to be the best choice today. But we are continuously looking for the performance of our scrubber in order to eventually find even better solutions.

ATTENTION: The ambient scrubber material is a consumable. Excessive ozone concentrations can dramatically shorten the scrubber life. Therefore, during startup, if there are gross ozone leaks, it may be necessary to replace the ambient scrubber several times.

For all applications of the OZONE MONITOR BMT 930 which are not for ambient monitoring (TLV monitoring), and for all ranges higher than 1 ppm_v, we are using a catalytic scrubber material which is not a consumable, but eventually can be destroyed or deteriorated, of course.

9 Mechanical Installation

The OZONE MONITOR BMT 930 is in a 19" rack mount enclosure, 132.5 mm high, 300 mm deep (see Figure 4), or in a splash-proof wall mounted aluminium cabinet 400 x 500 x 150 mm. Additional room for cables and tubing should be provided about 120 mm behind the back panel of the rack mount instrument. Free air circulation should be provided around this instrument for convection cooling. Temperature of the ambient air should be in the range of 0 to 45°C (non-condensing).

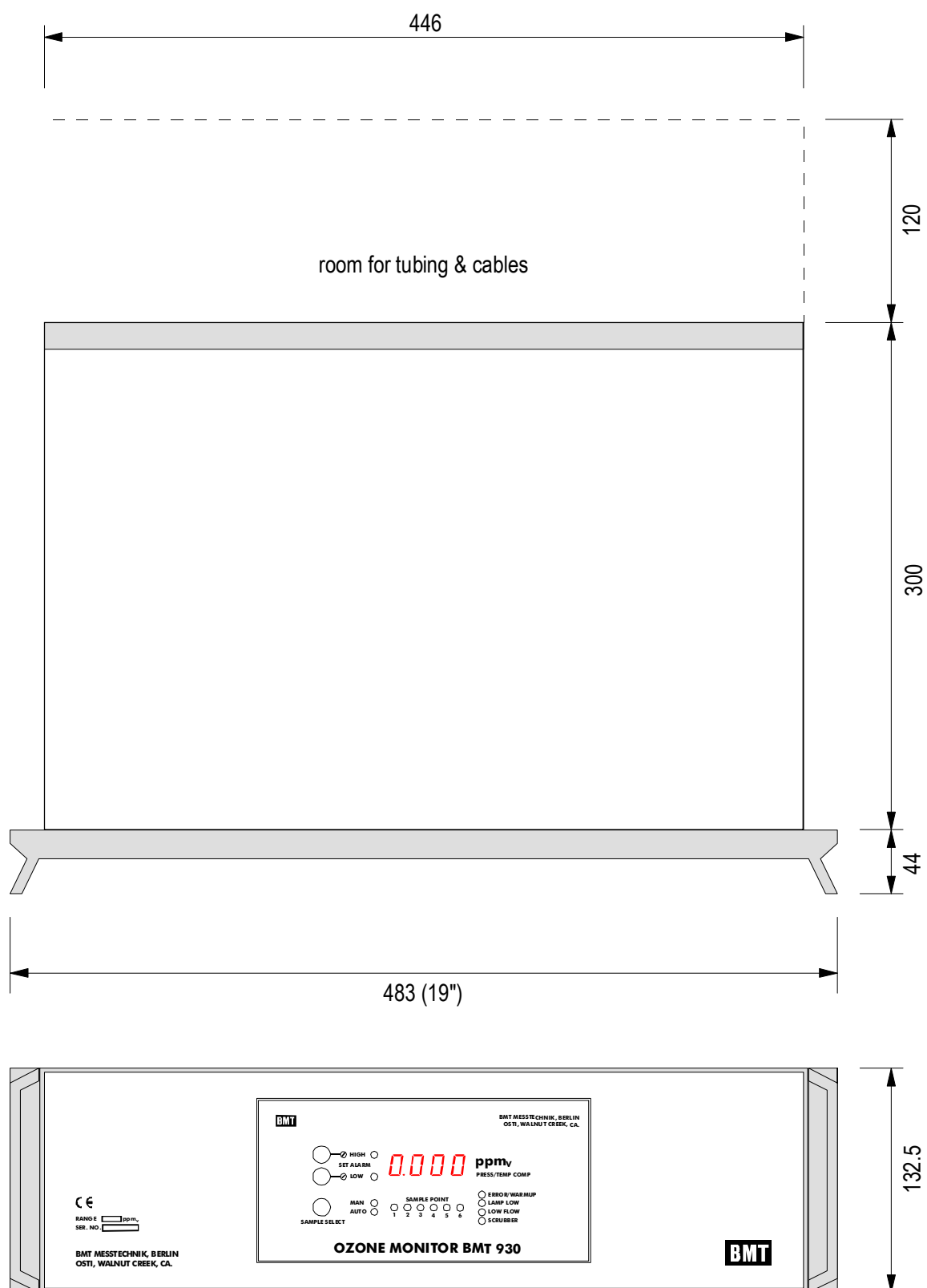


Figure 4

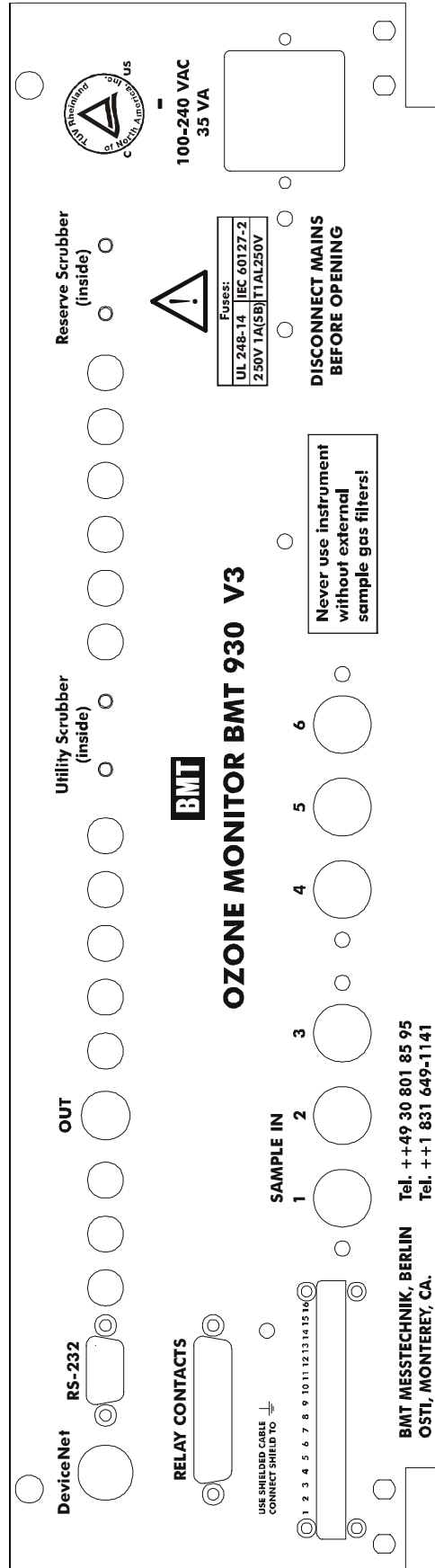
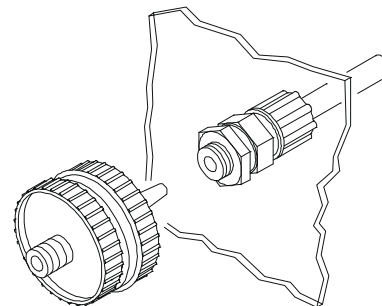


Figure 5

10 Pneumatic Installation

The OZONE MONITOR BMT 930 has either 1, or 3, or 6 sample gas inlet fittings (according to the model ordered). The fittings are compression fittings for 1/4", or 6 mm OD tubing. Tubing material has to be a fluorinated plastic, preferably transparent FEP to make any internal droplets or coarse dirt visible. Sample tubing length should be as short as possible. Maximum recommended length is 20 m.

The instrument intentionally has no internal dust filter. The reason is that the dust filter has to protect not only the ozone monitor, but also has to protect the inner surface of the sample gas tubing leading to the monitor. Thus the filter has to be mounted at the inlet of the sample tubing. The OZONE MONITOR BMT 930 comes with one fitting (930-FITTING) per channel. This fitting provides fast connection between the sample tubing inlet and the filter holder (930-HOLDER). This fast connection simplifies replacement of the filter insert on a regular basis.



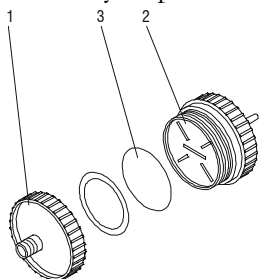
930-HOLDER & 930-FITTING: standard mounting of filter at the inlet of the sample gas tubing (included with every BMT 930)

Caution: We strongly recommend not to use SS tubing. Use of SS tubing will most likely lead to measurement errors. Since in installations of other brand ozone monitors there usually are no sample gas filters provided at the sample tubing inlets, this older tubing probably is more or less dirty inside resulting in more or less ozone destruction in the sample gas. This is the reason why we strongly recommend that old tubing be removed and replaced by transparent FEP tubing. We strongly recommend to replace SS tubing by FEP tubing in older installations.

One outlet fitting is provided for the sample gas after being measured. The outlet fitting is also for 1/4" (or 6 mm) tubing. Inside the OZONE MONITOR BMT 930 an ozone catalyst is installed to remove ozone from the sample gas released from the outlet fitting. From this catalyst particles might come which then are contained in the out gas. In very clean environments the sample gas outlet thus should be vented to an exhaust.

10.1 Sample Gas Filters

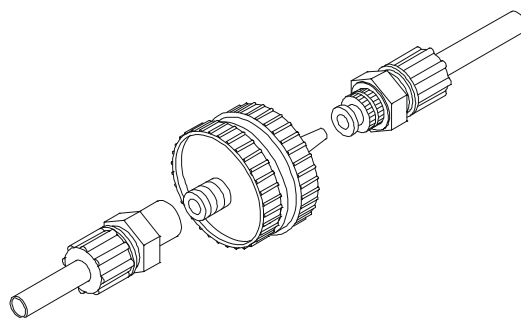
It is very important that the sample gas tubing and the ozone monitor are kept clean inside. The OZONE MONITOR BMT 930 must always be operated with a clean sample gas filter at the inlet of each sample gas line. Shipped with the instrument are coming: one filter holder (1) & (2) per channel, one mounting fitting (thread ISO G-1/8, or 1/8 BSPP) for mounting the filter holder, and 200 filter inserts (3). The filter inserts are of fine pure glass fiber to remove nearly any aerosol particles from the sample without affecting the ozone. This latter property may decrease with increasing amount of dirt retained by the filter. This is the reason why the filter inserts should be checked and replaced on a regular basis. The replacement interval strongly



930-HOLDER

depends on the quantity and the kind of dirt to be retained by the filter. Each user has to find out the interval optimally adapted to his specific situation.

Caution: The BMT 930 is designed to measure ozone in ambient air at the workplace. Sampling in a corrosive and/or contaminated environment could affect the accuracy of the measurement and cause damage to the instrument.



special mounting of filter in the sample gas tubing near the inlet of the tubing (order code: 930-ADAPT, holder not included)

10.2 Tubing

We strongly recommend not to use SS tubing. Use of SS tubing will most likely lead to measurement errors. Sample tubing has to be 5/32" (ID) x 1/4" (OD) or 4 x 6 mm, respectively. We strongly recommend to use tubing material which is transparent like FEP. Transparency is important in case some dirt - namely droplets of condensed water - would travel along the tubing. With an intransparent tubing (e.g. PTFE) droplets could not be recognised.

10.3 Moist Sample Gas

When the sample gas contains water vapour at a dew point temperature higher than the ambient temperature around the sample tubing, condensation will occur inside the tubing. This has to be avoided strictly!

Concerning Moist Sample Gas please refer to our TechNotes TN-1 (page 6) and TN-3, to be found on our website www.bmt-berlin.de

If it is not clear whether or not condensation might occur we recommend to include a WATER TRAP (part no. 930-WATER TRAP) into the sample tubing line. When no condensate will form over an extended period of time (one year, or more) the WATER TRAP will remain empty, and thus demonstrate that the sample gas is dry enough. The WATER TRAP then should be removed. If condensate will be observed in the WATER TRAP the value of the TRAP now was twofold: it has shown the necessity of drying the sample gas, and it has held back the condensate and thus has protected the OZONE MONITOR BMT 930. If the sample gas would need drying please refer to our Peltier-electric Sample Gas Dryers DH3b-LC and DH5-LC.

11 Electrical Installation

11.1 Power Connections

The rear panel of the 19" rack mount version of the OZONE MONITOR BMT 930 includes a 3-wire power receptacle with an integrated fuseholder. The instrument will work from any mains voltage in the range of 100 to 240 VAC. It consumes less than 35 VA. The fuseholders will accept European (5 x 20 mm, IEC 60127-2) or American style fuses (1/4" x 1 1/4", UL 248-14),

depending on the fuseholder inserts. Additional inserts are available from BMT MESSTECHNIK. Fuses are rated 250 V / 1 A slow blow.

The wall mount cabinet version BMT 930C has a special water-proof mains receptacle on the right side. The according special water-proof connector comes with the instrument.

Warning: This product relies on the building's installation for short-circuit (overcurrent) protection. Ensure that a fuse or circuit breaker no larger than 15 A at 120 VAC (10 A at 240 VAC) is used on the phase conductor.

The power receptacle or the mains socket-outlet the instrument is connected to should be easily accessible for fast interruption of power, or other means for switching off power should be provided.


The BMT 930 OZONE MONITOR with (optional) power 24 VDC (18-36 VDC) has a special round power connector instead of the mains power receptacle:

DC power connector: 1 positive } (18-36 VDC, 35 W SELV-supply)
 2 negative }
 3 (free)
 \perp Protective Ground

11.2 Output and Control Terminals

The following signals are available at the green terminal block in the rear panel of the BMT 930:

Signal Name	Pin No.	Description
Alarm Low Common	1	Relay contact
Alarm Low Closed	2	Pins 1-2 closed when LOW alarm
Alarm Low Open	3	Pins 1-3 opened when LOW alarm
Alarm High Common	4	Relay contact
Alarm High Closed	5	Pins 4-5 closed when HIGH alarm
Alarm High Open	6	Pins 4-6 opened when HIGH alarm
4-20 mA (GND)	7	Current loop output return
4-20 mA	8	Current loop output
Voltage Outputs (GND)	9	Voltage outputs return
Voltage Output 1 V	10	Max. concentration Range = 1 V
Voltage Output 10 V	11	Max. concentration Range = 10 V
Lamp Low	12	Relay contact
Lamp Low	13	Pins 12-13 open when LAMP LOW
Error Common	14	Relay contact
Error Closed	15	Pins 14-15 closed when error
Error Open	16	Pins 14-16 opened when error

A shielded cable should be used. The shield should be connected to the ground connector () at the rear panel.

Relay Outputs: the Alarm Relay contacts will operate at a max. voltage of 48 V (DC or AC) and a max. current of 1 A. Further details of the Alarm Relays operation are described in section 13.1 on page 18. The Error Relay will switch 30 V (AC or DC) at a max. current of 1 A.

Analog Outputs: The analog outputs are updated with every new measurement (about every 20 seconds).

The voltage outputs are isolated voltage signals 0 to 1 V and 0 to 10 V, respectively. Voltages are proportional to the concentration. Input resistance of the load should be higher than 1 k Ω .

The current output is an isolated current signal 4 to 20 mA, proportional to concentration. Input resistance of the load should be less than 650 Ω (optional 1350 Ω). The current output provides the energy for the current loop. **Attention:**

The current output must not be connected to an external power supply!

11.3 Serial Interface

The serial (RS-232) interface of the OZONE MONITOR BMT 930 provides output information about

- Operating mode
- Concentration on each sample point
- Cuvette pressure and temperature
- Lamp status
- Threshold alarms
- Error messages

The serial interface consists of a female 9-pole D-SUB connector (or screw terminals in the Cabinet version) with the following pinout:

Pin 2: Transmit Data

Pin 3: Receive Data

Pin 5: Ground

Data is transmitted in the following format:

9600 Baud, 8 bit, no parity, 1 stop bit.

There is no hardware or software protocol. Output data is transmitted as ASCII text, so a fast checkup of the interface can be done on a PC, e.g. with a simple terminal program.

Data is sent out when new measurement results are available (about every 20 seconds). Each line of data is terminated with the ASCII characters CR LF (13, 10). Two blocks of data look like this:

```
Mode = Auto
C4 = 0.011 ppm
Pressure = 1.009 bar
Temperature = 296.4 K
No lower limit alarms
No higher limit alarms
No Errors
```

```
Mode = Auto
C5 = 0.010 ppm
Pressure = 1.009 bar
Temperature = 296.4 K
No lower limit alarms
No higher limit alarms
No Errors
```

The first line of the example shows the operating mode (automatic or manual sample point selection). The second line displays the concentration on the last sample point measured. The digit behind the letter 'C' denotes the number of the sample point. The following two lines indicate pressure and temperature within the cuvette. The rest of the data block provides information on threshold limit alarms and instrument errors.

A data block containing threshold limit alarms follows:

```
Mode = Auto
C1 = 0.715 ppm
Pressure = 1.009 bar
Temperature = 299.3 K
Low alarm on sample point(s): 1 3
High alarm on sample point(s): 1
No Errors
```

In this block both low and high limits were exceeded on sample point 1. A low limit alarm is active on sample point 3. Each data block will show all active threshold alarms, enumerating the sample point separated with spaces. For alarm threshold setup see page 18.

Typical instrument error messages are:

```
Error: Lamp Low
Error: Low Flow
Error: Scrubber
```

The Lamp Low error message will appear with the first warning (see page 21): LAMP LOW indicator flashing but error relay not active.

11.4 Relay Box

The Relay Box is built into the OZONE MONITOR BMT 930 allowing port identification signals and threshold alarm information for each sample point to be put out via relay contacts. A 50-pole D-SUB connector on the rear panel is used to interface the relays.

For each of the six sample points there are three relays available which put out the following information:

- Identification of the sample point providing a measurement result at the moment (closing contacts)
- Low alarm threshold exceeded (closing and opening contacts)
- High alarm threshold exceeded (closing and opening contacts)

Voltages of up to 30 V (DC or AC) can be applied. Current per relay should not exceed 1 A. Output data of the Relay Box will be updated with every completed measurement. If the instrument is powered off, the Low and High Alarms will be active.

The following table describes the pinout of the D-SUB connector:

Sample	Sample ID (closing)	Low Alarm			High Alarm		
		Common	Opening	Closing	Common	Opening	Closing
1	1 → 34	5	38	22	11	44	28
2	2 → 18	6	39	23	12	45	29
3	19 → 35	7	40	24	13	46	30
4	3 → 36	8	41	25	14	47	31
5	4 → 20	9	42	26	15	48	32
6	21 → 37	10	43	27	16	49	33

If the instrument is powered off, the Low and High Alarms will be active. Example for sample port 1, Low Alarm active: pins 5 and 38 are open, pins 5 and 22 are connected.

When Power is applied and the instrument is in AUTO mode, the low and high limit alarms on the Relay Box will remain active until an air sample having an ozone content below the set threshold has been measured on the corresponding sample port. Threshold alarms of disabled sample ports (see 13.2) will become inactive immediately after completion of warm-up.

If during operation of the OZONE MONITOR BMT 930 an instrument error occurs (e.g. Lamp Low, Low Flow), all threshold alarm contacts of the Relay Box will move into the alarm position.

12 Warm-Up

After connection of the OZONE MONITOR BMT 930 to the power line the display first will show a three digit number for about one second, which provides information about the software version used in the instrument. Then the instrument enters an initialization period, which lasts at least three seconds, waiting for the UV lamp to start. It will display four dashes during this period. The following warm-up can last up to five minutes, depending on prior use of the instrument. Usually warm-up will be finished within two minutes or less. The ERROR/WARMUP indicator will flash and the Error Relay signals an error. During warm-up

the display shows decreasing blinking numbers, which give an indication on how much warm-up time is needed. These numbers are results of drift measurements. The lower the values the less time is needed for warm-up. After warm-up the OZONE MONITOR BMT 930 enters the AUTO or MAN mode of operation, depending on the mode it was in before last switch-off. The ERROR/WARMUP indicator stops flashing and the AUTO or MAN indicator is on continuously. As long as the first measurement cycle is not finished, the instrument will again show four dashes and the SAMPLE POINT indicators remain off.

13 Front Panel Operations

13.1 Alarm Thresholds

The OZONE MONITOR BMT 930 provides two concentration alarm thresholds. Both can be set after the instrument has entered its normal mode of operation, i.e. either MAN or AUTO indicator is lit. Thresholds can be set within the measuring range of the instrument.

For workplace safety applications BMT Messtechnik recommends to use a low concentration alarm threshold of 0.1 ppm and a high alarm threshold of 0.3 ppm. When they leave the factory, the monitors are already set to these thresholds. These recommendations are based on the following:

In many countries regulations require the workplace ozone concentration never to exceed 0.1 ppm. In the United States OSHA (www.osha.gov) has established a Permissible Exposure Limit (PEL) of 0.1 ppm TWA (8 hour Time Weighted Average). This limit is federal law (29 CFR 1910.1000). The same threshold value is recommended by ACGIH (www.acgih.org) for light work and NIOSH (www.niosh.org).

In addition OSHA recommends a STEL (15 minute Short-Term Exposure Limit) of 0.3 ppm. Local regulations may require to set the alarm thresholds to other values.

To set the threshold alarm levels, the appropriate push-button (for HIGH or LOW alarm) has to be pushed. The display will show the alarm threshold, which can be adjusted to a new value by turning a potentiometer behind the front panel left of the words HIGH or LOW. This should be done with the small yellow screwdriver (accessories). The push-button has to be pushed all the time through setting the new threshold. The LOW threshold can not be adjusted to a higher value than the HIGH threshold and vice versa. After releasing the push-button, the threshold is stored in nonvolatile memory and the instrument continues measurements. Thresholds can not be altered without pushing the buttons. They are being recalled from memory after power-on. During threshold adjustments measurements are halted. They continue as soon as the push-button is released.

Once an ozone concentration exceeds a threshold, the corresponding alarm indicator starts flashing. The corresponding alarm relay contact will signal the alarm. Note: The LOW threshold

has to be exceeded in three consecutive samples on the same channel before a LOW alarm is being signalled. In AUTO mode, the indicators of those SAMPLE POINTS which exceeded a LOW or HIGH alarm threshold will flash, providing constant alarm information while the instrument goes on sampling other sample points. In MAN mode, only the alarm indicators will flash. The OZONE MONITOR BMT 930 also provides acoustic signalling of threshold alarms: During a LOW alarm, there will be an intermittent beep synchronous to the flash rate of the optical indicators. A HIGH alarm will have a doubled beep rate. For operation of the Relay Box see page 16.

Alarms remain active as long as ozone concentrations exceed thresholds. Once all concentrations fall below a threshold, the corresponding alarm will be cleared and the corresponding Alarm Relay will switch over. A change of operating mode (pressing SAMPLE SELECT) will NOT clear the alarms (Firmware versions ≥ 3.00).

13.2 Channel Select: Manual/Automatic

The OZONE MONITOR BMT 930 is available with 1, 3, or 6 sample points. Note: The front panel always has 6 sample point indicators, also in instruments with only one or three sample points. Sample points are numbered 1 to 6.

AUTO mode: After warm-up, the instrument will enter AUTO mode. The indicator AUTO is lit continuously. In this mode, the instrument will start sampling at channel 1, display the result, switch to channel 2 and so on. After reaching the maximum available SAMPLE POINT it will start over again at channel 1. The instrument always displays the last result with the corresponding SAMPLE POINT indicator on. Measuring a concentration value takes about 20s.

Change of operating mode: Operating mode of the OZONE MONITOR BMT 930 can be changed after completion of warm-up. To change from AUTO to MAN and vice versa, press the button SAMPLE SELECT. When changing operating mode, the threshold alarms will NOT be cleared (Firmware versions ≥ 3.00). In a single channel instrument, change of operating mode from AUTO to MAN will only make the MAN indicator flash. The behaviour of the instrument will not change in any other way.

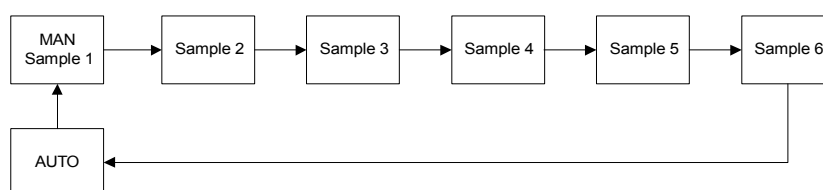


Figure 6

MAN mode: MAN mode allows a single SAMPLE POINT to be monitored continuously. When entering MAN mode (by pushing SAMPLE SELECT), the MAN indicator will start to flash. SAMPLE POINT is set to 1. The desired SAMPLE POINT can be selected by pushing

SAMPLE SELECT. Each push will increment SAMPLE POINT. When the maximum available channel is reached (3 or 6), a further push will set the operating mode back to AUTO.

If, before changing operating mode from AUTO to MAN, the instrument had the time to acquire concentrations from all available channels, these stored concentrations will appear on the display when stepping in MAN mode from channel to channel, thus providing a fast way to check concentrations at all SAMPLE POINTS without having to wait for measurements to complete in AUTO mode. If the instrument did not have the time to acquire a full set of concentrations, it will display four dashes until a measurement at the selected SAMPLE POINT is completed. After one completed measurement in MAN mode, memory data about the other SAMPLE POINTS will be erased.

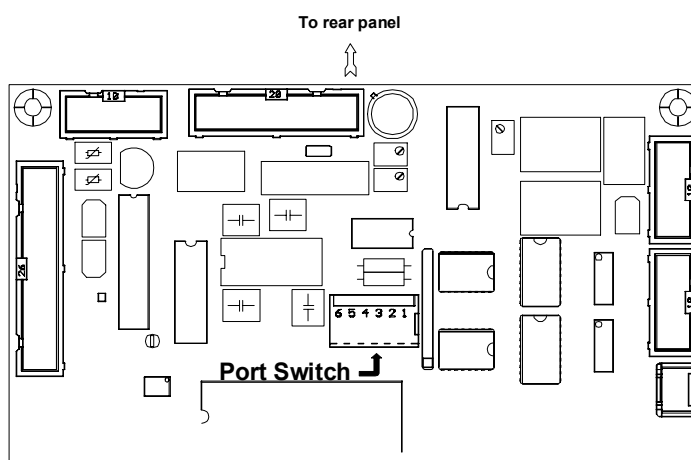


Figure 7

Skipping SAMPLE POINTS: In an instrument equipped with 3 or 6 sample points it is possible to deactivate certain channels. This can be done by disconnecting the OZONE MONITOR BMT 930 from the mains supply, opening the rear panel and setting the channel number to be deactivated on the switch on the Auxiliary PCB (see Figure 7) to "0". Deactivated SAMPLE POINTS will be skipped in AUTO and in MAN mode. In a single channel instrument the setting of this switch should not be changed. In a three channel instrument switch numbers 4-6 should not be changed.

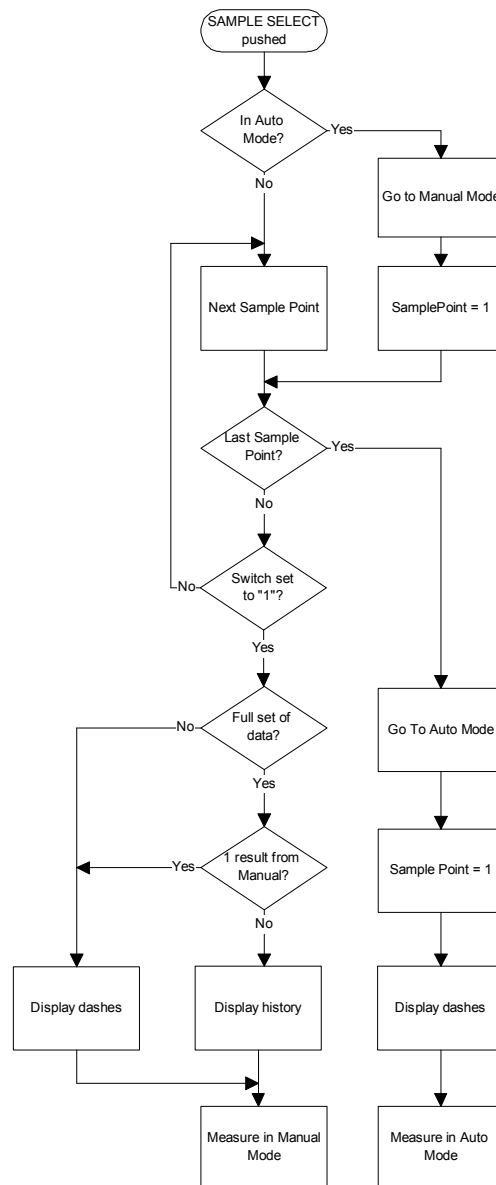


Figure 8

14 Error Messages

LAMP LOW: The OZONE MONITOR BMT 930 will give a warning near the UV lamp’s end of life by LAMP LOW flashing. The relay contact Lamp Low will open. The accuracy of measurement is not impaired. As to our experience there is enough time to prepare for a replacement of the UV lamp. If the aging goes too far, the Error Relay changes to its error state and ERROR/WARMUP is flashing. In this mode of operation results will still be displayed and put out, but inaccuracies may occur.

When the UV lamp fails completely the display will be blanked. The analog outputs will put out their maximum values (1 V, 10 V and 20 mA, respectively).

For replacement of the UV lamp see page 25.

LOW FLOW: Sample gas flow rate is held constant at 1 l/min by the OZONE MONITOR BMT 930. In case the flow rate drops below 0.8 l/min (e.g. caused by a clogged sample tube or inlet filter), LOW FLOW and ERROR/WARMUP will flash and the Error Relay changes to ist error state. Measurement results will no more be accurate, with the error depending on the flow rate. Check for obstructions in the sample tubes and filters.

SCRUBBER: The utility scrubber is checked every 24 hours for ist ability to remove ozone from the sample gas by means of a small ozone generator contained in the OZONE MONITOR BMT 930. If the utility scrubber fails the test, SCRUBBER and ERROR/WARMUP will flash and the Error Relay signals an error. The instrument will continue operating with the reserve scrubber. Measurement results will be correct but the utility scrubber should be replaced as soon as possible. The reserve scrubber will also be tested in this mode of operation every 24 hours. If it fails the test, too, the numeric display will be switched off and the analog outputs put out the maximum possible values (1 V, 10 V and 20 mA).

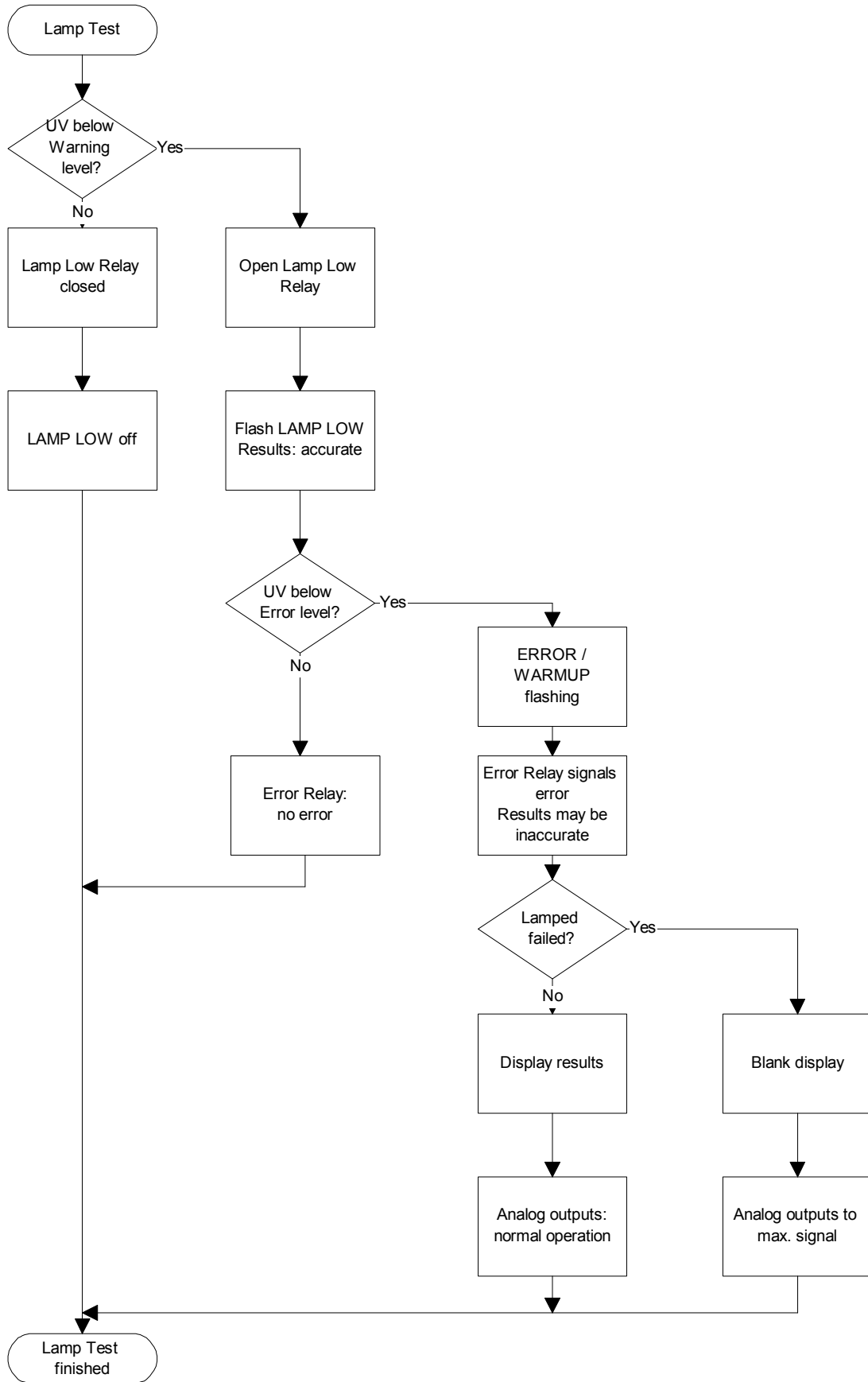


Figure 9

The information that the utility scrubber has failed will be stored in nonvolatile memory. If power is removed from the instrument the information will not be lost: the instrument will conduct a scrubber test after warmup to check if the scrubber was replaced in the meantime. If the scrubber passes the test the instrument will resume normal operation, if not, it will stay in the error state described above.

A scrubber failure could have been caused by some reagent entering the OZONE MONITOR BMT 930 which contaminated the scrubber. In this case, the reagent should be removed from the sample gas stream before replacing the scrubber.

For replacement of the scrubber see page 25.

Overrange: If the measured concentration exceeds the range of the OZONE MONITOR BMT 930, the four digits will flash. The value displayed equals the maximum range of the instrument. The Error Relay will switch to its active state and ERROR/WARMUP will blink. Because it is not possible to set the limit alarm thresholds above maximum range the instrument will also show both limit alarms active. Changing the SAMPLE POINT (manual or automatic) will reset the overrange condition.

Other Errors: Aside from the errors described above, internal diagnostics of the OZONE MONITOR BMT 930 constantly check the overall health of the instrument. Other errors occurring will lead to ERROR/WARMUP flashing and to the display of the letter 'E' followed by a two digit number shortly before a new concentration is being displayed. The error relay will be in its error state. Please contact the service department at BMT MESSTECHNIK (see Chapter Service on page 28).

14.1 Error Relay Contacts

The Error Relay will be in its error state whenever there are no valid results available and when the mains power is off. Additionally, it will also be in that state when there is a SCRUBBER warning. To detect a broken wire we recommend using the opening contact.

15 Trouble Shooting

15.1 Negative Ozone Concentration Values

Negative ozone concentration values do not exist, of course. But an ozone monitor actually can display negative values. The reason is not fully understood. The mechanism probably is as follows: The scrubber is converting substances contained in the sample to something which produces an extinction of the UV radiation in the range of 254 nm used to measure the ozone. During the zeroing cycle the zero ozone reference is taken with this contaminated sample. During the measuring cycle the contamination above is no more present (because the scrubber is

no more included in the sample gas line) and the sample is more transparent than before which means: the concentration measured seems to be lower than it really is, even negative.

A wrong positive ozone concentration can be displayed by an ozone monitor when 1) the sample contains substances which produce an extinction in the UV range around 254 nm, and 2) the scrubber retains these substances partly or completely. Even without any ozone contained in the sample, the extinction at about 254 nm is lower during the zeroing cycle than during the measuring cycle which leads to a positive ozone concentration displayed which actually does not exist.

The problems mentioned above demonstrate the high importance of using a scrubber material which is well adapted to the specific circumstances of the atmosphere in which the ozone content shall be measured.

16 Maintenance

16.1 Replacement of UV Lamp and Scrubber

When the error message LAMP LOW or SCRUBBER is given on the front panel the UV lamp or the utility scrubber has to be replaced. The BMT 930 rack-mount instrument now has to be withdrawn from the 19" rack after all tubings and cables have been disconnected. The upper shell of the enclosure is held by four screws, two on each side. After removal of these screws the upper shell can be lifted upwards. To open the rear panel, first unscrew the two screws in the upper corners using a screw driver. Then fold the rear panel down.

The UV lamp is located at the right end of the black cuvette assembly inside the instrument. Pull out the plug of the cable leading to the lamp. Then turn the knurled plastic screw at the UV lamp one turn counter-clockwise and pull the UV lamp out. Replace the lamp by a new one, fasten the knurled screw and plug in the lamp cable.

The scrubbers are positioned on the inside of the rear panel. To replace a scrubber, pull it out of the plastic mounting clip and remove the (color-marked) plastic tubings at both ends of the scrubber. Clip in a new scrubber and fit both plastic tubings.

The wall mount cabinet BMT 930C may be opened only after it had been disconnected from the mains power line by unplugging the special mains connector. When the door is open replacement procedures for UV lamp replacement and scrubber replacement are as described above.

16.2 Optical System: Disassembling, Cleaning

To internally clean the cuvette and the cuvette windows the cuvette assembly has to be removed from the instrument. Access is via the top cover which can be removed after loosening four lateral black screws (two from the right, and two from the left). The cuvette assembly is mounted in the frame with two "golden" screws at each end. Before loosening these four screws, both

tubings (in and out) must be removed, and the flat cable must be disconnected from the PC board mounted under the cuvette assembly. Then the cuvette assembly can be taken out of the instrument. The UV lamp cable (black with white connector) and both detector cables (red with black connectors) then have to be disconnected from the PC board. To open the cuvette at both ends both end pieces have to be removed by loosening every four "golden" screws at each end (only "golden" screws shall be removed!).

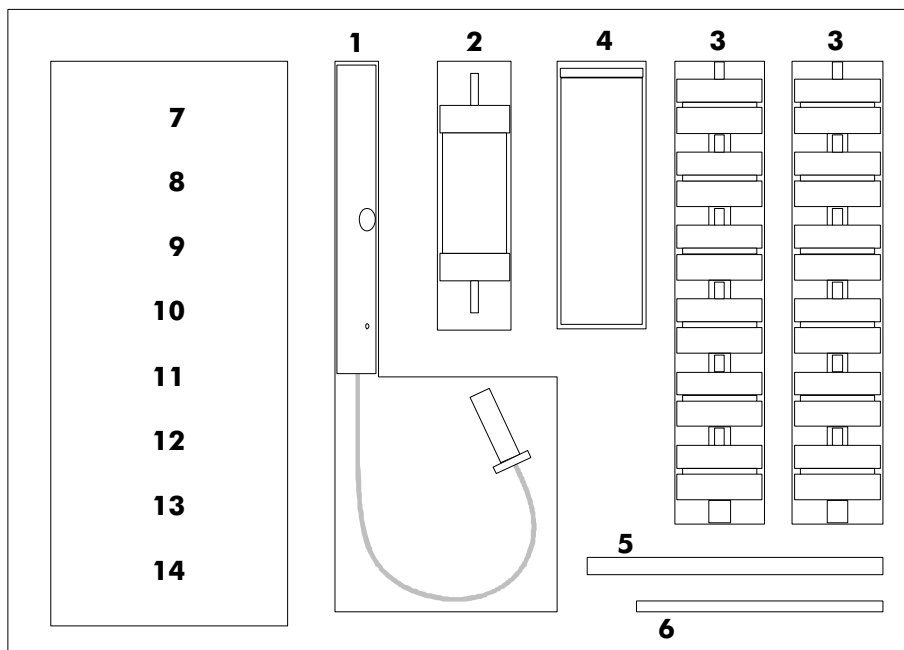
UV detector end piece (right hand, seen from the front panel): The quartz window of the UV detector has to be cleaned using a lint-free tissue (e.g. Kimwipe®) and alcohol. The sealing O-ring must be kept in place (end of the cuvette tube).

UV lamp end piece (left hand, seen from the front panel): The quartz window in the UV lamp end piece has to be cleaned using a lint-free tissue and alcohol. The sealing O-ring has to be kept in place (other end of the cuvette tube).

Cuvette tube (inner surface): The inner surface of the cuvette tube has to be cleaned using a lint-free tissue, wetted with alcohol, which several times shall be pushed through the tube. Before reassembly wait ten minutes for evaporation of alcohol residues.

For complete re-assembly go through the above steps in reverse order.

17 Accessories and Spare Parts



item	part	order number	'930 kit	'930C kit
	Accessories and spare parts (19" or Cabinet: pls. specify)	930-PARTSKIT		

Accessories shipped with the instrument:

3	filter holder (one per channel)	930-HOLDER	x	x
4	box with filter inserts (200 pcs.)	930-INSERTS	x	x
5	screw driver for setpoints	930-SCREWDRIVER	x	x
6	tweezers for filter inserts	930-TWEEZERS	x	x
7	set of mounting fittings for filter holders	930-FITTING	x	x
8	set of number stickers for sample point	930-STICKER	x	x
9	set of number bracelets for sample point	930-BRACELET	x	x
10	16-pole output connector (screw terminals) 16-pole signal connector (Cabinet, screw terminals) two 14-pole Relay A connector (Cabinet, screw terminals) two 10-pole Relay B connector (Cabinet, screw terminals) 3-pole RS232 connector (Cabinet, screw terminals)	930-TERM/16 930C-TERM/16 930C-TERM/14 930C-TERM/10 930C-TERM/3	x	x x x x
11	9-pole D-Sub connector (serial port)	930-DSUB/9	x	
12	50-pole D-Sub connector (Relay Box)	930-DSUB/50	x	
13	set of 2 fuses (mains, 1 A, slow blow) set of 2 fuses (Cabinet, mains, 1 A, slow blow)	930-FUSE 930C-FUSE	x	x
14	set of 4 screws + 4 nylon washers USA: 10-32 x 3/4 Europe: M6 x 16	930-SCREW/10-32 930-SCREW/M6	x x	

Optional Spare parts "930-SPARE" (optional):

1	UV lamp	930-LAMP	x	x
2	scrubber	930-SCRUBBER	x	x
3	additional filter holder (one per channel)	930-HOLDER	x	x

Not included in the kits:

	sample gas pump	930-PUMP		
--	-----------------	----------	--	--

18 Service

In case there are warnings, or errors, or when the displayed ozone concentration does not match the expectation and the BMT 930 has to be sent in for service or repair, you do not need an RMA, but please keep the following procedure:

Service: Checklist

<input type="checkbox"/> fill out and sign the Hazardous Material Certification below	
by all means include in all paperwork accompanying your shipment:	
<input type="checkbox"/> your contact details: delivery & invoicing address, phone number, EMail address	
<input type="checkbox"/> serial number of the instrument	
<input type="checkbox"/> reason for return:	
<input type="checkbox"/> ship to one of the following addresses:	
BMT MESSTECHNIK GmbH Attn.: Service Güterfelder Damm 87-91 D-14532 Stahnsdorf, Germany	http://www.bmt-berlin.de service@bmt-berlin.de Tel. +49-3329-696 77-0 Fax +49-3329-696 77-29
For North America, Central America, Pacific Rim:	
OSTI Inc. 99 Pacific Street, Suite 555H Monterey, CA 93940, USA	http://www.osti-inc.com vciufia@osti-inc.com Tel. +1-831-649-1141 Fax +1-831-649-1151

Hazardous Material Certification:

For the protection of BMT employees we need to know about any possible hazardous contamination outside and inside of our products prior to any repair and service.

Instruments not free of such substances **may be rejected by BMT.**

Type of product:
Serial number(s):

Please describe the status of the returned instrument regarding hazardous substances below:

<input type="checkbox"/> The products have not been exposed to any hazardous substance at any time
<input type="checkbox"/> The products have been completely decontaminated and contain no residual hazardous substances
<input type="checkbox"/> The remaining contamination is not unhealthy, toxic, carcinogenic, radioactive, microbiologic, explosive, corrosive or caustic, it is harmless and contains (insert here):

Herewith, I certify that the products being returned to the factory are **free of any hazardous substances**, as stated above:

Undersigned:	Your Company:
Date & Signature:	

19 Specifications

Measurement principle	Dual-beam UV photometer (254 nm)
UV lamp	Low pressure mercury lamp, long life design, burnt-in for 300 h
Display	7-segment, bright red LED (13 mm), 4 digits
Concentration range	1 ppm
Optional ranges	9.999, 99.99, 250 ppm
Noise	±0.001 ppm
Min. detectable Conc.	0.002 ppm
Accuracy	± 1 %, traceable to NIST
Response time	20 s (0 – 95 %)
Temperature compensation	Standard
Pressure compensation	Standard
Flow rate	1 l/min, automatically controlled by an electronic flow meter
Sample ports	1, 3 or 6 (please specify), automatic and manual selection of sample port
Scrubber life	> 4 years (safety monitor operation)
Threshold alarms	Two, adjustable, with threshold alarm relays (Relay Box) included for each sample port
Error relay	Indicating any instrument failure, including <ul style="list-style-type: none"> • Lamp low (one reserve lamp included, easy lamp replacement) • Low flow • Scrubber failure (tested for every 24 h, reserve scrubber takes over automatically) • Warmup
Gas ports	Compression type for ¼" FEP tubing Safety catalyst for off gas included
Signal outputs	Concentration 4-20 mA (isolated, active) Concentration 0-1 V, 0-10 V (isolated) Sample port identification by Relay Box (if 3 or 6 channels)
Control output	Lamp low (relay contact, 30 V, 1 A)
Digital interface	RS-232, showing concentration, threshold alarms, and error messages Hardware prepared for DeviceNet
Accessories included	One filter holder with mounting fitting per channel, 200 filter inserts, tweezers for filter inserts, screw driver for set points, number stickers and bracelets, connectors, spare fuses, mounting screws & nylon washers
Spare parts kit (optional)	<ul style="list-style-type: none"> • UV lamp • Scrubber • Additional filter holder per sample port • 200 filter inserts
Warmup time	5 min. max., 2 min. typical
Power	Universal line voltage: 100 – 240 VAC, 35 VA, 50/60 Hz optional: 18-36 VDC, 35 W
Ambient temperature	0 - 45 °C (non-condensing)
Dimensions (H x D) (W x H x D)	132 x 300 mm (19" rack mount) 400 x 500 x 150 mm (wall mount BMT 930 C)
Weight	10 kg (19" rack mount) 9 kg (wall mount BMT 930 C)
Compliance	CE-marked (EMC and safety), cTUVus NRTL-listed

Appendix A: Cabinet Version BMT 930 C

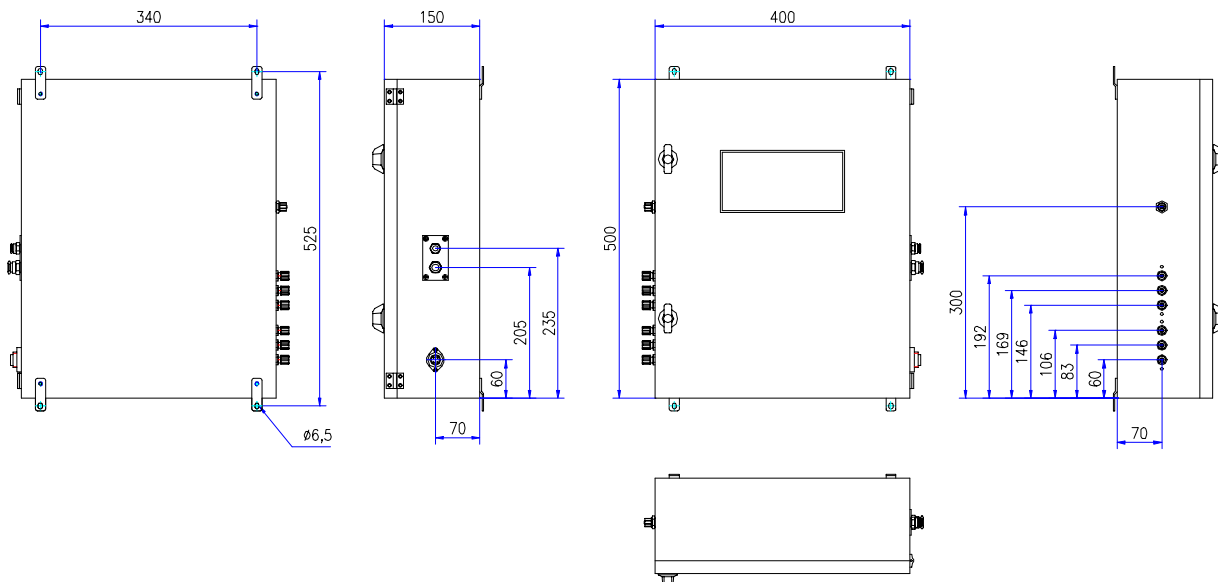
A1 General description

The OZONE ANALYZER BMT 930 C (cabinet version) is housed in a splash-proof IP 65 (NEMA 4X) cabinet, and functionally identical to the 19" version BMT 930.

For sample gas connection 1/4" OD FEP or PTFE (or 4 x 6 mm) tubing should be used, which will be supplied on request. The power connector is water-proof.

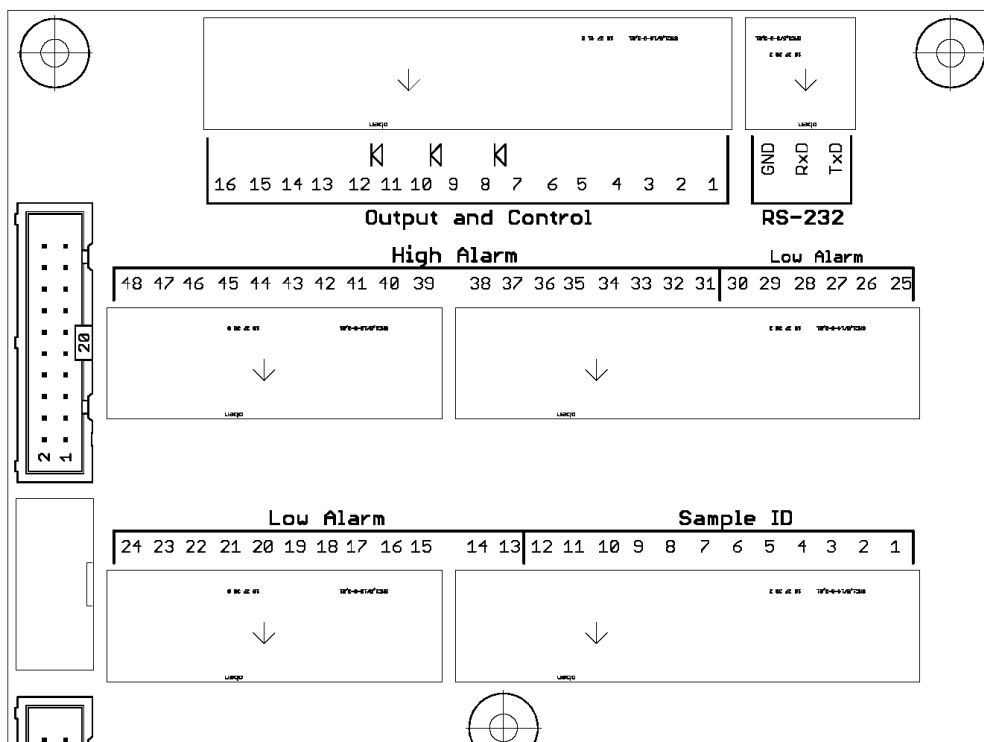
Dimensions of the cabinet are 400 x 500 x 150 mm (W x H x D), and weight is about 9 kg. The cabinet must be wall mounted using the four brackets provided at the rear (four mounting holes are 6 mm ID, spaced 340 x 525 mm, W x H).

The dimensions are outlined below:




A2 Electric connections

All signalling connections are made inside the cabinet with detachable screw terminals. Splash-proof feed-throughs are provided for the signal cables to be connected. Cable diameters should be 3-6.5 mm for the RS-232 cable and 5-10 mm for the signal cable. Shielded cables must be used. Following is the layout of the terminals of the cabinet version:



The installation of the mains connector has to be made by a person acquainted with the safety problems involved. Do not connect or disconnect the voltage carrying connector, except in an emergency.

The power connector should be easily accessible for fast interruption of power, or other means for switching off power should be provided.

Mains connector:	1	mains	} (100 to 240 VAC, 35 VA, 50/60 Hz)
	2	mains	
	3	(free)	
		Protective Ground	

Signal contacts (Connector "Output & Control") are as described on page 13.

The numbering of the Relay Box contacts in the Cabinet is **different** compared to the standard BMT 930. Please refer to the following table for the pinout (V3):


Sample	Sample ID (closing)	Low Alarm			High Alarm		
		Common	Closing	Opening	Common	Closing	Opening
1	1 → 2	13	15	14	31	33	32
2	3 → 4	16	18	17	34	36	35
3	5 → 6	19	21	20	37	39	38
4	7 → 8	22	24	23	40	42	41
5	9 → 10	25	27	26	43	45	44
6	11 → 12	28	30	29	46	48	47

A3 Operation

The operation of the BMT 930 C is the same as of the standard BMT 930.

For further description of the functions and properties of the cabinet version please refer to the main part of this manual.

Appendix B: UBA Certificate



Kalibrierschein-Nr.: 049-2010
Certificate No.

Umwelt Bundes Amt
Für Mensch und Umwelt

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Umwelt Bundes Amt
Für Mensch und Umwelt

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Kalibrierschein
Calibration Certificate

NATIONALES EU-REFERENZLABOR FÜR LUFTQUALITÄT

Kalibrierschein-Nr.: 049-2010
Certificate No.

Umwelt Bundes Amt
Für Mensch und Umwelt

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Umwelt Bundes Amt
Für Mensch und Umwelt

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Umgebungsbedingungen 20,4 °C; 987,4 hPa
Environmental conditions

Rückführung UBA-SRP 29
Traceability

Dieser Kalibrierschein darf nur vollständig und unverändert weiterverbreitet werden. Auszüge und Änderungen bedürfen der ausdrücklichen Genehmigung des EU-Referenzlabors.
This calibration certificate may not be reproduced other than in full except with the permission of the EU-Reference Laboratory.

Der Kalibrierschein ohne Unterschrift und Stempel hat keine Gültigkeit.
Calibration Certificate without signature and seal is not valid.

Stempel
Seal



Datum
Date

02.12.2010

Leiter EU-Referenzlabor
Head of the EU-Reference Laboratory

Dr. Klaus Wirtz

Bearbeiter
Person in charge

Schinz


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Für Mensch und Umwelt

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Für Mensch und Umwelt

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Umweltbundesamt, Dienstgebäude Langen
Paul-Ehrlich-Straße 29
D-63225 Langen
Tel. +49(0)6103 704-0
Fax +49(0)6103 704-147



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Auftraggeber
Customer

BMT Messtechnik GmbH
Herr Christopher
Güterfelder Damm 87-91
14532 Stahnsdorf

Auftragsnummer
Order Number

447

Gegenstand
Object

Ozon Analytator

Typ
Type

BMT 930

Serien-Nr.
Serial-Number

001

Hersteller
Manufacturer

BMT

Datum der Kalibrierung
Date of Test

01.12.2010

Angewandtes Verfahren
Method of execution

Kalibrierung mit primärem NIST-Standardreferenzphotometer. Messprinzip ist die UV-Photometrie nach ISO 13964

Ergebnis
Result

Messung Nr.	SRP 29 nmol/lmol	BMT 930 001 nmol/lmol
1	0,1	0,4
4	99,4	98,0
2	196,5	196,9
5	298,3	296,1
3	398,7	396,9
7	494,8	493,2
6	596,6	596,5
8	0,0	0,3

Messunsicherheit
Uncertainty of measurement

Messung Nr.	nmol/lmol
1	1,1
4	2,6
2	4,6
5	6,8
3	9,0
7	11,1
6	13,4
8	1,1

95 % Vertrauensbereich)

This Calibration Certificate is consistent with the calibration and the test methods that are included in Appendix C of the Mutual Recognition arrangement (MRA) drawn up by the International Committee for Weights and Measures (CIPM). Under the MRA, all participating institutes recognize the validity of each other's calibrations and measurement uncertainties for and within the ranges specified in Appendix C (for details see <http://www.bipm.org>).

The user is obliged to have the object recalibrated at appropriate intervals.

Bearbeiter
Person in charge

Schinz

Umwelt Bundes Amt
Für Mensch und Umwelt

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Umwelt Bundes Amt
Für Mensch und Umwelt

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Paul-Ehrlich-Straße 29
D-63225 Langen
Tel. +49(0)6103 704-0
Fax +49(0)6103 704-147