

OZONE MONITOR BMT 932

Manual Rev. 02/21



OZONE ANALYZER BMT 932

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This manual describes the standard version of the analyzer.

For the **Cabinet** version BMT 932 C, please refer to the appendix at the end of this manual. It describes the associated differences.

1 General Description

The OZONE MONITOR BMT 932 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 or $\mu g/m^3$ (at 1 atm and 20°C), a dimension requiring temperature and pressure compensation. This is the reason why the OZONE MONITOR BMT 932 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.

The BMT 932 is designed to allow direct handling of three independent EMO circuits (Emergency Machine Off) with multi-channel monitors to facilitate the direct control of ozone generators in workplace safety applications.

Since the application of the BMT 932 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 932 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 Scrubber Alarm indicating a scrubber failure.

The ozone concentration is displayed on a two-line 40-character alphanumeric display. The concentration unit can be changed during operation. Additional modifiable parameters are among others :

- Alarm parameters (two alarm thresholds for each channel, alarm latching, audible, opening or closing relays, EMO circuit to alarm assignment)
- Date and time
- RS-232 interface parameters

These parameters can be set with the three pushbuttons on the front panel as well as by connecting the serial interface to a Windows-PC running the software BMT 932 Link, which is supplied with each instrument. Another way of configuring the instrument is to use the so-called Link Mode via the serial interface.

Active sample channels for automatic sampling can be chosen as desired. It is also possible to choose only one channel for measurement. Switching from automatic to single channel sampling is easily done by just pressing the ENTER key.

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 well over 5 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.

The OZONE MONITOR BMT 932 features a "Sniffer Mode" which suppresses the zero cycle. This mode which can be used for easy ozone leak detection.

The instrument has a built-in clock with calendar, which is used to provide time stamps for an Event-Log (103 entries, e.g. power on/off, alarms) and an Error-Log (16 entries, e.g. Overrange, Low Flow). These logs can be read out and printed via the serial interface with the mentioned software BMT 932 Link. A "Relay Box" built into the OZONE MONITOR BMT 932 is available to offer electric contacts for each threshold, low and high, of each sample channel, see Appendix R.

2 Features, Options

- UV photometer with temperature and pressure compensation
- ranges available: 1.0, 2.0, 5.0, 10.0, 20.0, 50.0, 100.0, 250.0 ppm_v
- unit µg/m³ selectable
- resolution: 0.001 ppm_v (2 line x 20 character display)
- 19" rack mount, 132 x 300 mm (H x D), 9 kg
- or wall mount cabinet NEMA 4X, 357 x 440 x 133 mm (W x H x D), 7 kg
- traceable to international standard (NIST)
- CE mark, cTUVus NRTL-listed
- 1, 3, or 6 sample channels
- two threshold alarm levels (relay contacts)
- three EMO circuits with 6 relays
- cycle time 20 s per channel
- sniffer mode
- 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 electric flow meter
- full internal diagnostics with event and error log
- pre-filters + fittings included (one filter holders per channel + 200 inserts)
- analog outputs, isolated: 4-20 mA, 0-1 V, 0-10 V
- isolated RS 232 serial interface, Windows software included
- firmware update by user with PC and serial cable
- ambient temperature 0 45°C (non-condensing)
- universal line voltage (100 240 VAC, 60/50 Hz/35 VA)
- optional: 18-36 VDC, 25 W
- "Relay Box" (optional)
- also available as wall-mount cabinet

3 Accessories, Spare Parts

The OZONE MONITOR BMT 932 comes with all the accessories needed for its operation. A Spare Parts Kit "932-SPARE" is available as an option, see page 38.

4 Cautions and Warnings



The **exclamation point** within an equilateral triangle is intended to alert the user to the presence of important operating and maintenance (servicing) instructions in the literature accompanying the instrument.

The **lightning flash** with arrowhead symbol, within an equilateral triangle is intended to alert the user to the presence of uninsulated "dangerous voltage" within the product's enclosure that may be of sufficient magnitude to constitute a risk of electric shock to persons.

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 932. **Caution:** 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.

Warning: Always disconnect the instrument from line power before opening it!

Warning: 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.

Warning: If the mains cable is replaced, the new cable shall have a current rating of at least 10 A.

C

This product has been tested to the requirements of CAN/CSA-C22.2 No. 61010-1, second edition, including Amendment 1, or a later version of the same standard incorporating the same level of testing requirements

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 932. 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 ultraviolet 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-violets peuvent endommger 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).

Att.: Si le câble d'alimentation est remplacé, le nouveau câble doit avoir un courant nominal de 10A ou plus.

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 1

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 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 $\mu g/m^3$ at $1 \text{ atm}/25^{\circ}C$, or at 20°C, or at 0°C. Actually the definition of $1 \text{mg}/\text{m}^3$ (1000 $\mu g/\text{m}^3$) at $1 \text{ atm}/20^{\circ}C$ (usually used in the European Community) is practically identical with 0.5 ppm_v.

7 The OZONE MONITOR BMT 932

The OZONE MONITOR BMT 932 has a cuvette 285 mm in length. The cuvette is an 6.3 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 aluminum 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 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 LAMP LOW WARNING 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 an electric 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 2

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, a solenoid valve 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 SCRUBBER WARNING 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 tube 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 13).

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 is 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 932 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 932 is in a 19" rack mount enclosure, 132.5 mm high, 300 mm deep (see Figure 3), or in a splash-proof wall mounted aluminium cabinet 357 x 440 x 133 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 3





10 Pneumatic Installation

The OZONE MONITOR BMT 932 has either 1, or 3, or 6, sample gas inlet fittings (according to the model ordered). The fittings are bulkhead compression fittings for 1/4" OD (.250" x .156"), or 6 mm OD (6 x 4 mm) tubing. The cabinet version BMT 932C accepts only 1/4" tubing (refer to Appendix C, page 48). Tubing material has to be 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 932 comes with one fitting (932-MALEFIT) per channel. This fitting provides fast connection between the sample tubing inlet and the filter holder

(932-HOLDER). This fast connection simplifies replacement of the filter inserts on a regular basis.

Caution: We strongly recommend not to use SS tubing. Use of SS tubing will most likely lead to measurement errors. Since in most installations of other ozone monitors there 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, preferably 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 932 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 should be vented to an exhaust.

10.1 Sample Gas Filters

It is very important that the sample gas tubes and the ozone monitor are kept clean inside. The OZONE MONITOR BMT 932 must always be operated with one clean sample gas filter (932-HOLDER) at the inlet of each sample gas line. One filter holder per channel, one fitting for mounting the filter holder, and 200 filter inserts



special mounting of filter in the sample gas line near the inlet of the tubing (order code: 932-ADAPT. Special inline filter on request, not included.

Please note: do not use the 932-HOLDER, it is not designed for inline configurations!)





932-HOLDER & 932-MALEFIT:

BMT 932)

standard mounting of filter at the inlet of the sample gas tubing (included with every

932-HOLDER

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 replaced on a regular basis. The replacement interval strongly depends on the quantity and the kind of the dirt to be retained by the filter. Each user has to find out the interval optimally adapted to his specific situation.

Caution: The BMT 932 is designed to measure ozone in ambient air at the workplace. Placing an ozone sample port in a corrosive and/or contaminated environment could cause damage to the instrument and affect the accuracy of measurements.

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 1/4" (OD) or 6 mm, respectively (BMT 932C: 1/4" only). We strongly recommend to use tubing material which is transparent like FEP. Transparency is important in case some dirt - namely droplets of condensated water - would travel along the tubing. With an intransparent tubing (e.g. PTFE) droplets are invisible.



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. 932-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 neccessity of drying the sample gas, and it has held back the condensate and thus has protected the OZONE MONITOR BMT 932. 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 932 includes a 3-wire power receptacle. The instrument will work from any mains voltage in the range of 100 to 240 VAC. Power consumption is less than 35 VA. The instrument contains Universal Modular Fuses, which allow global operation without having to make a decision between IEC and UL type fuses. Fuses cannot be replaced by the user. The wall mount cabinet version BMT 932C 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.

Warning: If the mains cable is replaced, the new cable shall have a current rating of at least 10 A.

The BMT OZONE MONITOR 932 with (optional) power 24 VDC (18-36 VDC) has a three pole terminal block for connection of the power supply:

1Protective Ground -DC power connector:2Positive3Negative(18-36 VDC, 25 W SELV-supply)

11.2 Output and Control Terminals

The following signals are available at the green terminal block named "SIGNALS" on the rear panel of the OZONE MONITOR BMT 932:

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

Signal Name	Pin No.	Description
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

<u>Relay Outputs:</u> the Alarm Relay contacts will operate at a max. voltage of 28 V (DC or AC) and a max. current of 1 A. Further details of the Alarm Relays operation are described in section 15 on page 31. The Error Relay and Lamp Low Relay will switch 28 V (AC or DC) at a max. current of 1 A. All relays are in the alarm/error position if no power is applied to the instrument.

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

The voltage outputs are isolated voltage signals 0 to 10 V and 0 to 1 V, proportional to the concentration (actually the 0 - 10V signal swings down to about -0.25 V below zero). 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 (with an offset of 4 mA). Input resistance of the load should be less than 600 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 Channel Identification

The green terminal block named "CHANNEL ID" provides six semiconductor relay contacts with information on which sample channel the analog output concentration signal corresponds to. A closing relay identifies a channel.

Signal Name	Pin No.	Description
Channel 1	1	Output from sample on Channel 1
Channel 2	2	Output from sample on Channel 2
Channel 3	3	Output from sample on Channel 3
Channel 4	4	Output from sample on Channel 4
Channel 5	5	Output from sample on Channel 5
Channel 6	6	Output from sample on Channel 6
Common	7	Common contact for all relays

CHANNEL ID relays may carry a max. current of 0.5 A at a voltage of 28 V (AC or DC). **Caution**: CHANNEL ID relays are protected by a 1 A fast-blow fuse at the Common contact, so care should be taken not to overload these outputs. For the physical connection of the wires to the spring cage contacts a screw driver 0.4 x 2.0mm is provided in the accessories.

11.4 Emergency-Off Relays

The OZONE MONITOR BMT 932 provides three logical EMO functions (Emergency Machine Off) for multi-channel operation. Hardware for each of these three EMO functions consists of 2 independent relays. All 12 relay contacts (six relays with two contacts each) are available at the terminal block named "EMO". Two relays of each logical EMO function, which are driven by separate software functions, can be connected in series in order to provide enhanced safety against "hanging" relays.

Note: For single-channel operation use terminals 1 to 6 instead (connector "SIGNALS": High & Low Alarm).

All concentration alarms (max.12) can be assigned to each of the three logical EMO functions. If an alarm assigned to an EMO function becomes active (concentration is above threshold), the corresponding two relays will open. Assignment of alarms to logical EMO functions can be done on the front panel and with the software BMT 932 Link provided with the instrument. Max. current is 1 A (AC or DC) at a voltage of 28 V.

Example: three generators with two sample points each have to be monitored by one OZONE MONITOR BMT 932. In the event of an ozone leak in one generator only this generator shall be switched off by the instrument. One logical EMO function is available for each generator, so the four high and low alarms responsible for the two sample ports from each generator can be assigned to one logical EMO function individually, which means that an alarm on one generator will not stop operation of the other two generators.

Signal Name	Pin No.	Description
G1R1a	1	EMO Group 1 Relay 1 Contact a
G1R1b	2	EMO Group 1 Relay 1 Contact b
G1R2a	3	EMO Group 1 Relay 2 Contact a
G1R2b	4	EMO Group 1 Relay 2 Contact b
G2R1a	5	EMO Group 2 Relay 1 Contact a
G2R1b	6	EMO Group 2 Relay 1 Contact b
G2R2a	7	EMO Group 2 Relay 2 Contact a
G2R2b	8	EMO Group 2 Relay 2 Contact b
G3R1a	9	EMO Group 3 Relay 1 Contact a
G3R1b	10	EMO Group 3 Relay 1 Contact b
G3R2a	11	EMO Group 3 Relay 2 Contact a
G3R2b	12	EMO Group 3 Relay 2 Contact b

All EMO-Relays are in the open position if no power is applied to the instrument. A relay contact will only close if all channels with assigned alarms were sampled and concentrations were found below thresholds.

Shielded cables should be used on all connectors. The shields should be connected to the ground connector (\pm) at the rear panel. For the physical connection of the wires to the spring cage contacts a screw driver 0.4 x 2.0mm is provided in the accessories.

11.5 Serial Interface

The bidirectional isolated serial interface is used for communication with a PC or other automation components in an industrial environment. Software updates can also be performed over this interface. A serial cable for connection to a PC is a standard accessory.

Connection:

Pin	Function	Description
1		
2	TxD	Data sent
3	RxD	Data received
5	GND	RS-232 ground

The data format used is eight bits, one stopbit, no parity (8N1). See page 27 for configuration of the interface, page 29 for its usage.

12 Switching On the Instrument

After application of power the instrument will display the following:

```
Bootloader VX.XX
Checking Flash:
```

VX.XX denotes the software version of the Bootloader. The Bootloader is a small application which is run first. It checks the contents of the main flash memory for integrity, which takes a few seconds. The Bootloader is also responsible for updating the firmware via the serial interface (see p. 18). In case no problems are found it releases control to the main application. The following is displayed:

BMT 932 VX.XX

VX.XX denotes the software version of the main application. After this the concentration range is displayed. If the instrument is cold or has not been used in a while,

Waiting for Lamp

could be displayed, which will be followed by an indication of the measurement range.

This display is followed by a warmup period, the duration of which is being determined by the state of the lamp. During warmup the Error Relay is switched to error. All other relay contacts are open. The analog outputs put out 1 V, 10 V and 20 mA respectively. The serial interface (see page 29) puts out max. concentration and the code for the warmup-state. The time left for

change into normal operating mode is displayed and counted down, giving an indication on when warmup will end. The time period between switching on and normal operating mode can last between 40 s and 420 s. During this time the front panel keys are deactivated. Serial communication is possible. Warmup will end with the display:

Waiting for first result

At the end of the warmup period, the Error Relay, the Lamp Low Relay, and the Low and High concentration alarm relays will switch to their normal position (non-error).

The EMO-Relays will only close if the corresponding sample concentrations were found to be below the assigned alarm thresholds (see pages 31 and 25). This means, that it can take an additional two minutes when using a six channel instrument before equipment (ozone generators) connected to the EMO-outputs are allowed to start operation.

13 Front Panel Operation

The front panel consists of a two line x 20-character alphanumeric display (LCD with white backlight illumination) and three pushbuttons. The concentration display will be updated whenever a new concentration measurement result is available, i.e. every 20 s. All other messages (errors, warnings, concentration alarms) will be displayed immediately.



In normal operation the display shows the mode of operation and channel information in the first line, while ozone concentration is displayed in the second line.

The pushbuttons can be used to perform the following operations:

- Switch between automatic sampling mode and manual sampling of a single channel
- View parameters
- Change the parameters

The following diagram shows the functions of the main menu:



Expressions printed **bold** in the following sections of text always relate to the contents of the instrument menus.

The button SCROLL / SET moves to the right within the menu, the key ENTER downwards and the button BACK moves upwards. The SCROLL action will continue on the left side, once it has reached the right side of the diagram. This is also valid for the later explained menus **View Parameters** and **Set Parameters**.

From now on, when relating to the multi-functional key SCROLL / SET only the function meant in the context will be mentioned.

In multi-channel instruments, the two measurement modes available are Auto and Manual. In Auto mode the monitor will sequently measure concentrations on all active channels (see p. 28) in 20 s intervals. If in Auto mode the ENTER button is pressed the instrument will change to Manual mode, meaning that only one channel will be sampled continuously. Each time ENTER is pressed in Manual mode, the monitor will select the next active channel. If ENTER is pressed while the highest active channel is selected, the instrument will return to Auto mode.

Coming from Auto mode, the display will show concentrations on the different channels, when pressing the ENTER key. This is a convenient way to do a fast check on concentrations on sample channels, without having to wait for measurement cycles to complete.

In single-channel instruments, the ENTER key does not provide the functions described above.

Starting with **Concentration** pressing the button SCROLL will lead to View Parameters. After pressing ENTER the parameters can be viewed, but they cannot be changed. The BMT 932 will go on measuring concentrations in all position of the menu system.

Changing Parameters

If in the menu position **View Parameters** the button SCROLL is pushed <u>briefly</u>, the instrument resumes display of the ozone concentration (Menu position **Concentration**).

In order to move from View Parameters to Set Parameters the SCROLL button has to be held down for at least 2 seconds.

The menu **Set Parameters** is used to change properties of the instrument, like units, alarms etc. In order to protect the instrument and the components connected to it from unqualified handling, the above mentioned procedure has to be performed. In addition, the instrument configuration can be protected by a 4-digit PIN. This PIN is factory set to 0000, which means that after pressing the SCROLL button for 2 s, properties can be changed freely. The Windows software BMT 932 Link can be used to change this PIN to any other 4-digit number. If the PIN is different from 0000, pressing the SCROLL key for 2 s will lead to the display of:

```
Enter PIN 0000:
```

Only the correct PIN will allow entry to **Set Parameters**, any other number will lead back to the display of ozone concentration. The PIN is entered digit by digit, by using the SET key to change digits and using the ENTER key to move from one digit to another and finishing PIN entry.

View Parameters and **Set Parameters** will be described on the following pages. During viewing and setting of parameters the instrument continues measuring, i.e. new measurement results are sent out on the analog outputs and the serial interface continuously.

The Menu View Parameters

In the menu **View Parameters** the configuration of the BMT 932 can be viewed, but it cannot be changed.



*: Select Channel by pressing SCROLL, then ENTER

The following parameters are shown:

Unit Ozone

Unit of ozone concentration (ppmv or $\mu g/m^3$)

• Alarms

Activation, thresholds, and latching for each channel or all channels ot once, assignent of the available alarms to the three EMO groups, closing or opening of Alarm Relays

• RS-232

Baud rate, periodic transmission or polling, time interval of periodic transmission

- Gas Parameters normalizing temperature and pressure
- Time / Date

The meaning of these parameters is explained in greater detail on the following pages. An additional point in the menu **View Parameters** is **Other Parameters**:



Explanations:

- Active Channels: shows which channels are active
- Alarm Beep On/Off: info on audible signal
- Range: max. ozone concentration
- Sniffer On/Off: status of Sniffer mode
- Serial No.: the serial number
- Operating Hours: since calibration

The Menu Set Parameters



In order to move from View Parameters to Set Parameters the SCROLL button has to be held down for at least 2 seconds.

The configuration of the BMT 932 can be changed here. The diagram shows the selectable parameters. In order to change a setting, the ENTER button has to be pressed. Logical variables, as e.g. **Enabled/Disabled** are configured with the SET button. Numerical values as e.g. **Threshold** are changed digit by digit. To change a digit, the SET button is used. The digit to be changed is marked by a cursor beneath it. In order to move to the next digit, the ENTER button has to be pressed. The procedure can be stopped at any time by pushing the BACK button. After complete setting of the parameter the ENTER button has to be pressed again, the display

Saving...

appears for a short time and the parameter is saved. To leave the menu press the back button several times.

This is an example for changing a logical variable: the unit of ozone concentration shall be changed from ppm to $\mu g/m^3$:

Button	Display
	0.000 ppm
SCROLL	View Parameters
SCROLL (>2 s)	Set Parameters
ENTER	Set Ozone Unit
ENTER	Ozone: ppm
SET	Ozone: µg/m³
ENTER	Ozone: µg/m³ Saving
BACK	Set Ozone Unit
BACK	Set Parameters
BACK	0 µg/m³

One more example: the numerical parameter **High Alarm - Threshold** (determines the threshold, above which a High Alarm occurs) shall be changed from 0.3 ppm to 0.52 ppm only for channel 2:

Button	Display
	0.000 ppm
SCROLL	View Parameters
SCROLL (> 2s)	Set Parameters
ENTER	Set Ozone Unit
SCROLL	Set Alarms
ENTER	Set All High Alarms
SCROLL	Set High Alarm Ch1
SCROLL	Set High Alarm Ch2
ENTER	Enable/Disable
SCROLL	Set Hi-Threshold
ENTER	Hi: <u>0</u> .300 ppm
ENTER	Hi:0. <u>3</u> 00 ppm
SET	Hi:0. <u>4</u> 00 ppm
SET	Hi:0. <u>5</u> 00 ppm
ENTER	Hi:0.5 <u>0</u> 0 ppm
SET	Hi:0.5 <u>1</u> 0 ppm
SET	Hi:0.5 <u>2</u> 0 ppm
ENTER	Hi:0.52 <u>0</u> ppm

ENTER	Saving	
	Hi:0.52 <u>0</u> ppm	
BACK	Set Hi-Threshold	
BACK	Set High Alarms	
BACK	Set Alarms	
BACK	Set Parameters	
BACK	0.000 ppm	

On the following pages you can find a detailed description of all configurable parameters. Change of one parameter may lead to the automatic change of other parameters. Except for Sniffer Mode the stored parameter information is not lost when the instrument is switched off.

Unit Ozone

This will set the unit of ozone concentration. You can choose between:

- ppm
- μg/m³

If the concentration unit is changed the range will change, too:

ррт	µg/m³	Range-ID
1.000	2000	1
10.000	20000	2
50.00	100000	3
100.0	200000	4
250.0	500000	5
2.000	4000	6
5.000	10000	7
20.00	40000	8

The thresholds of all High and Low Alarms are recalculated automatically.

Alarms

High-Alarms

High Alarms can be configured for each channel individually or for all channels at once. Only active channels (see p. 28) can be configured.

These alarms occur if **Enable/Disable** on a certain channel is activated and the limit stored under **Threshold** is exceeded. The High-Alarm-Relay switches to the alarm position. At the same time a High-Alarm-Event is entered into the Event-Log. The display alternates between the measurement result and the message

High Conc. Alarm on

Channel 2 3 6

showing on which channel the alarms have occured. In this example Channels 2, 3 and 6 have a High Alarm.

If **Alarm Beep** is activated, there is also an acoustic signal, which may be stopped using the BACK key, if the front panel menu is on its basic level, showing concentrations. The BACK button does not clear a latched alarm, though.

If ozone concentration falls below **Threshold** –0.002 x range (hysteresis) the alarm state is ended if **Latching** is set to Not-Latching. The High-Alarm-Relay falls back into its normal state, the error message and the acoustic signal disappear. The end of the alarm state is entered into the Event-Log.

In case **Latching** is activated, the alarm will not go away until it is acknowledged by pressing the ENTER button, even if concentration falls below the mentioned threshold. The end of alarm will be entered into the Event-Log when the button is pushed.

A high alarm threshold can never be set below the low alarm threshold on a certain channel.

Low-Alarms

Low Alarms can be configured for each channel individually or for all channels at once. Only active channels (see p. 28) can be configured.

These alarms occur if **Enable/Disable** on a certain channel is activated and concentration is above the limit stored under **Threshold**. The Low-Alarm-Relay switches to the alarm position. At the same time a Low-Alarm-Event is entered into the Event-Log. The display alternates between the measurement result and the message

Low Conc. Alarm on Channel 1 4

showing on which channel the alarms have occured. In this example Channels 1 and 4 have a Low Alarm.

If **Alarm Beep** is activated, there is also an acoustic signal, which may be stopped using the BACK key, if the front panel menu is on its basic level. The BACK button does not clear a latched alarm, though.

If ozone concentration decreases below **Threshold** $-0.002 ext{ x}$ range (hysteresis) the alarm state is ended if **Latching** is set to Not-Latching. The Low-Alarm-Relay falls back into its normal state, the error message and the acoustic signal disappear. The end of the alarm state is entered into the Event-Log.

In case **Latching** is activated, the alarm will not go away until it is acknowledged by pressing the ENTER button, even if concentration decreases below the mentioned threshold. The end of alarm will be entered into the Event-Log when the button is pushed.

A low alarm threshold can never be set higher than the high alarm threshold on a certain channel.

Set EMOs

All available low and high alarms (max. 12) can be assigned to the three logical EMO functions, which drive the EMO relays (see p. 17). There are six different menues, each showing low or high alarms of active channels (see p. 28) to be assigned. The display e.g. looks like this.

EMO 1 Low Alarms: 1N 2Y 3Y 4Y 6N

In this case low alarms from channels 2, 3, or 4 will lead to an opening of the two relays driven by logical function EMO1 (contacts 1-2 and 3-4 will open). Low alarms from channels 1 and 6 will have no influence on these contacts. Channel 5 is not shown, because in this case it is not activated.

Input/Output

Simulate Analog Out

For test purposes the analog outputs can be set to their max. (10 V / 1 V / 20 mA) respectively min. (0 V / 4 mA) values. With the software BMT 932 LINK any voltage and current can be put out.

RS-232

This menu item is used to configure the serial interface. The **User-Baud rate** can be set to one of the following values:

- 2400 Baud
- 4800 Baud
- 9600 Baud (default)
- 19200 Baud
- 38400 Baud

The setting of **Timed/Polled** decides, if the output of data on the serial interface is done automatically in a certain time interval (Timed) or if a block of data is sent only on request (character '?', without CR). If the operating mode is set to Timed, a data block is sent every **Time Interval**. Minimum interval is 1 s, max. interval is 99 s. A detailed description of the serial interface can be found on page 29.

Test Scrubber

This will start the scrubber test. This test can last from 20 s to 1 minute. It displays: Testing Scrubber Please wait

After test completion the result is displayed:

Testing Scrubber Scrubber is OK

If a faulty scrubber was found there will be a Scrubber Alarm.

See p. 10 and 34 for a more detailed desripton of scrubber operation.

Time/Date

Time

Here the time of day is set in the format hh:mm:ss.

Date Format

Display of date can be switched from European (DD.MM.YY) to American (MM/DD/YY) notation.

Date

During entry the date will be constantly tested on conformance to the calender rules, so it is not possible e.g. to enter the date 29.02.01. In order to make this test possible, first the year, then the month and then the day has to be set.

Other Parameters

Set Active Channels

This item can be used to select the channels which shall be sampled. Non-active channels are skipped in Auto mode and are not selectable in Manual mode. Concentration alarm setups and EMO assignment are only possible for active channels. The display reads:

Set Active Channels 1Y 2Y 3Y 4Y 5N 6Y

In this example all channels except channel 5 are active.

Set Sniffer On / Off

Sniffer mode can be activated here. When entering this mode, the instrument completes one last zero cycle and then displays concentrations in 1 s intervals. This is useful for finding ozone leaks by using a PTFE tube (with sample gas filter attached) and "sniffing" in the area of an installation where a leak is suspected. Channels can still be changed in Sniffer mode. A channel change will lead again to one single zero cycle. Because the instrument will show a zero drift in this mode,

zeroing can be initiated manually by pressing the SCROLL button. The display shows e.g.:

```
Sniffer Channel 1
0.003 ppm
```

Return to normal operation can be achieved by entering this menu item again.

Alarm Beep

If this item is set to Enabled, the BMT 932 emits an acoustic signal during Lowor High-Alarms. This beeper may be stopped using the BACK button, if the front panel menu is on ist basic level.

Reset Parameters

This will set all Parameters described above back to factory settings. When pressing ENTER, the instrument displays

Are you sure?

If ENTER is pressed again, parameters are set as described in the following table:

Parameter	Setting
Ozone Unit	ppm
All High Alarm Limits	30 % of Range
High Alarms enabled	Yes
High Alarms latched	No
Low Alarm Limits	10 % of Range
Low Alarms enabled	Yes
Low Alarms latched	No
Date Format	dd.mm.yy
RS-232 user output	Timed
RS-2323 user output interval	1 s
User Baud Rate	9600 Baud
Alarm Beep	On
EMOs	All enabled (All relays will open if any alarm occurs)

14 The Serial Interface

The BMT 932 has a bidirectional serial interface. In principle there are two different operating modes: User-Mode and Link-Mode.

In User-Mode all relevant measurement data and status information are sent out in one single line. As inputs only polling of this single line is possible. In the more complex Link-Mode it is possible to view and change many parameters interactively.

Data transmission on the serial interface are always ended with a Carriage Return (CR, dec. 13).

User-Mode

If **Timed/Polled** is set to Timed, there is an output every **Time Interval** seconds (s. configuration of the RS-232 on p. 27). In case Polled is set, the BMT 932 expects the input of a questionmark ('?', without CR), to which it responds with a block of data. User mode data output always follows the format in the following example:

26.04.07,13:54:22,0.001ppm,0.000ppm,0.000ppm,0.000ppm,N/A, 0.000 ppm,0000

Data are separated by commas. Contents of a data block:

- Date (format as set in **Date Format**)
- Time as hh:mm:ss
- Six Ozone concentrations including unit, depending on the setting of **Units-Ozone** (position of decimal point depends on range). Six blocks of concentration data are always shown, even in one or three channel instruments, starting with channel one and ending with channel six. If there are no data available, "N/A" is displayed instead of a concentration value. This could have the following reasons:
 - Channel does not exist (1 or 3 channel instruments)
 - Warmup
 - No result available yet
- 16-Bit status information coded hexadecimally

The 16 bits of the status info have the following meaning:

Bit	Meaning
0 (LSB)	Lamp Low Warning
1	
2	
2	
3	Utility Scrubber Error
4	Reserve Scrubber Error
5	Overpressure Error
6	Overrange Error
7	EEPROM Error
9	Warmup
10	Lamp High Error
11	Low Flow Error
12	Lamp High
14	Low Alarm
15	High Alarm

Bits 8, 12 and 13 are not used. A more detailed description of these errors is found on p. 32.

Link-Mode

This mode allows interactive access to measurement results and the change of all parameters also accessable from the front panel. Communication in Link-Mode always obeys the following format. All communication has to be initiated from the outside:

```
*Command Number#[optional parameter]
```

The BMT 932 always responds after completion of the instruction with

```
*Command Number#[optional parameter]
```

The optional parameter can have different decimally coded formats:

- Byte: Range 0 .. 255. Byte is also used for the configuration of binary parameters; in this case Byte can only take the values 0 and 1. If a binary variable is set to 1, the corresponding function or property is activated.
- Word: Range 0 .. 65535
- Long: Range 0 .. 99999999
- Float: Range –99999999 .. 999999999 (floating point number as e.g. 1.234567, max. 8 characters including the decimal point)

It is very important to wait for confirmation from the BMT 932 once a command is sent. Link-Mode is started by sending the following command:

*0#DKONHF

The BMT 932 responds with

*0#DL7ZN

The User-Mode described above is now deactivated. The BMT 932 contains a Link-Mode timer. Timeout can be set by a Link-Mode command. This timer is reset by the sending of Link-Mode commands to the BMT 932. The instrument will fall back into User-Mode automatically, if this timer runs out due to Link-Mode commands not being received.

Caution: If the BMT 932 is connected to a programmable component (a PC or a PLC), care has to be taken that the program does not reconfigure the BMT 932 in an endless loop. The internal non-volatile memory will only tolerate a limited (1,000,000) number of write cycles. Reading commands can be used infinitely.

A detailed description of Link-Mode commands can be found in Appendix A.

15 Use of the Limit-Alarms

The BMT 932 supplies two Limit-Alarms. These alarms are activated if concentration on any channel rises above the High Alarm threshold (High Alarm) or the Low Alarm threshold (Low Alarm). On every triggering of an alarm, the corresponding contact of its Alarm Relay opens or closes (Pins 1-2-3 and Pins 4-5-6). The relays are in the alarm position with no power applied. If **Alarm Beep** is activated, an acoustic signal will be sent out with the alarm. Alarm activation and alarm clearing are documented with time and date in the Event-Log.

To enable an alarm, its parameter **Threshold** has to be set to a valid alarm threshold and **Enable/Disable** has to be set to Enabled. The Low-Alarm threshold always has to be below the High-Alarm threshold.

Both alarms are equipped with a hysteresis, which means an alarm ozone concentration has to fall 0.2 % of range below the threshold, before the alarm is cleared.

Whether an alarm will be cleared also depends on the setting of **Latching**: if set the alarm will continue, also if the triggering condition (concentration above threshold) does not exist anymore. The alarm can be cleared by pressing the button ENTER. To only stop the beeper without clearing the alarm, the BACK key may be used in case the menu on the front panel is on its basic level. For operation of the Relay Box see Appendix R.

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 an the following:

In many countries regulations require the workplace ozone concentration never to exceed 0.1 ppm. In the United States OSHA (<u>www.osha.gov</u>) has established a Permissable 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 (<u>www.acgih.org</u>) for light work and NIOSH (<u>www.niosh.org</u>).

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.

16 Error Handling

The BMT 932 has divers possibilities to recognize errors, to signal them and to early-warn against them. Warnings and errors are displayed on the front panel. Depending on the importance of the error, the Error Relay (pins 14-15-16) as well as the error contact Lamp Low (Pins 12-13) are activated. Warnings and errors are always accompanied by an acoustic signal. In case the menu on the front panel is on its basic level, the BACK key may be used to stop the beeper.

During warmup or with no power applied the Error Relay is in the error position.

Warnings and Errors are also sent out over the serial interface (s. p. 30) and are documented in the Error-Log. The actual status can be read out in Link-Mode with the command *86#.

The following conditions will lead to warnings respectively errors:

Lamp Low Warning

This warning usually will occur before a Lamp Low Error. The message

Warning:Lamp Low

is shown on the first line of the display, alternating with the display of the actual channel. The error contact Lamp Low opens, but the Error Relay stays in its normal state. A Lamp Low Warning should be a hint to the user, that due to aging the UV-lamp has become weaker and that at the next opportunity it should be replaced by a new one. Measurement accuracy is not impaired in this state.

Lamp Low Error

Additionally the Error relay indicates Error. The message

```
Error: Lamp Low
```

is displayed on the first line. Accuracy can be impaired in this state.

Lamp Off Error

The UV-lamp does not work any more. The message

```
Error: Lamp Off
```

is shown constantly. All three analog outputs are set to their max. values (10 V respectively 20 mA), because the instrument is not able to aquire concentration data without a lamp. Lamp Low contact and Error Relay indicate error.

Lamp High Error

In case the lamp becomes too bright for some reason this error is activated. Concentration data are inaccurate.

Error: Lamp High

is shown on the first line of the display.

The Error Relay indicates an error. The instrument should be thoroughly checked by BMT MESSTECHNIK (s. also Chapter Trouble).

Lamp High Warning

The Firmware version 1.16 for the OZONE MONITOR BMT 932 introduces the Lamp High Warning as a new Warning in order to warn the user before the unit fails with Lamp High Error.

The warning is issued at an A/D converter threshold of 8,200,000, which is 50,000 below the Lamp High Error threshold. This warning does not affect the output relays, so production is not interrupted. The warning will be shown on the display, together with an acoustic signal. This gives time to prepare for a planned replacement.

This warning usually will occur before a Lamp High Error. The message

Warning:Lamp High

is shown on the first line of the display, alternating with the display of the actual channel.

The new firmware is in production since mid May 2015.

The warning signal is also available on the serial interface, both in User Mode and in Link Mode (command *86#), and in the Error Log. Bit 12 is used for Lamp High Warning (0x1000, 4096 decimal).

The Windows software BMT 932 Link up to V1.21 will run, but will not show the warning. The log from the old software shows "Unknown Error".

CAUTION: The UV radiation power output of the UV lamp is less than 1 Watt. Avoid dismantling of the instrument with mains power applied. The lamp contains 5 milligrams of mercury. Mercury is a poison. Dispose lamp at a waste disposal place which is qualified to handle mercury containing lamps. If you cannot find such a place, please return the lamp to BMT MESSTECHNIK GMBH.

Scrubber Error

The utility scrubber is checked every 24 hours for its ability to remove ozone from the sample gas by means of a small ozone generator contained in the OZONE MONITOR BMT 932. If the utility scrubber fails the test,

Error: Scrubber

is displayed 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,

Error: Res. Scrubber

is displayed and the analog outputs put out the maximum possible values (1 V, 10 V and 20 mA).

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 932 which contaminated the scrubber. In this case, the reagent should be removed from the sample gas stream before replacing the scrubber.

Overpressure

Cuvette pressure is above the allowed maximum pressure (1.15 bar). The instrument displays

Error: Overpressure

Due to the fact that reliable pressure data are not available, the displayed ozone concentration is wrong. The Error Relay is in its error position.

Overrange

Ozone concentration is above the range of the instrument. An alternating display of

Error: Overrange on Channel X Y Z

and ozone concentration range is shown. The Error Relay is set to error. The analog outputs are on their maximum values the last meaurement result led to an overrange.

EEPROMError

This error shows that there is something wrong with the internal non-volatile memory. Since this memory stores important calibration data, the instrument should be thoroughly checked by BMT MESSTECHNIK (s. also Chapter Trouble). The Error Relay indicates an error.

Low Flow Error

The BMT 932 has an internal sample gas flow meter, which is constantly checking the sample gas flow rate. This flow meter is also used by the internal pump controller, which makes sure that the flow rate is always 1 l/min. If e.g. the sample tube is clogged or the pump is faulty, the Low Flow Error will occur, as soon as the flow rate drops below 0.8 l/min. The display shows

```
Error: Low Flow on
Channel X Y Z
```

indicating the channels with low flow. The Error Relay will be in its error postion. Measurement results will be inaccurate (low).

17 Event- and Error-Log

These two logs are stored by the BMT 932 and document important events and errors. The last 103 events and the last 16 errors are stored, which means that the oldest entries are overwritten when new entries are stored. Both logs are read out via the serial interface. For this purpose the software BMT 932 LINK or the Link-Mode command *49# respectively *50# can be used. Each entry in these logs has a time stamp, which means that date and time are recorded with a resolution of 1s. The user is responsible for setting the internal clock. Life expectancy of the battery is 10 years or more. An empty battery will only result in erroneous time stamps in the logs.

The Error-Log documents all errors described in chapter Error Handling with date and time. The picture is a view of the Error-Log in the software BMT 932 LINK.

01: 07.07.2011, 14:01:51, Error 1024: Low Flow Error	
02: 07.07.2011, 15:22:07, Error 16384: Low Alarm	
03: 07.07.2011, 16:39:36, Error 49152: Low Alarm / High Alarm	
04: 07.07.2011, 17:11:25, Error 32768: High Alarm	
05: 07.07.2011, 17:15:34, Error 16384: Low Alarm	
06: 07.07.2011, 17:28:09, Error 0: (none)	

The Event-Log documents the following events and additional data:

- Switching on of the BMT 932, cuvette pressure at this time
- Switching off of the BMT 932, temperature at next switching on
- High Alarm, Concentration and Channel, on which alarm occured
- High Alarm cleared, Concentration and Channel

- Low Alarm Concentration and Channel, on which alarm occured
- Low Alarm cleared, Concentration and Channel

On the right is an Event-Log example as displayed by the software BMT 932 LINK.

Error- and Event Log play an important role in troubleshooting.

01: 07.07.2011, 13:57:48. Event 64: Switched on, at 1013	3.9 bar
02: 07.07.2011, 15:22:07, Event 2: Low Alarm Ch 2	
03: 07.07.2011, 16:37:57, Event 4: Low Alarm Ch 3	
04: 07.07.2011, 16:39:36, Event 1042: Low Alarm Ch 2 & 1	5 / High Alarm Ch 3
05: 07.07.2011, 17:11:25, Event 1024: High Alarm Ch 3	
06: 07.07.2011, 17:15:34, Event 4: Low Alarm Ch 3	
07: 07.07.2011, 17:16:42, Event 6: Low Alarm Ch 2 and 3	
08: 07.07.2011, 17:22:06, Event 4: Low Alarm Ch 3	
09: 07.07.2011, 17:41:28, Event 128: Switched off, at 30:	1.2 K
	6 hor

18 The Software BMT 932 Link

On the CD delivered with the instrument you will find the Windows software BMT 932 LINK. It has been designed for Windows 95/98/ME/NT/2000/XP/Vista/7/8/10. For installation of the software, simply unzip the ZIP archive if necessary, and execute the Installer 'setup.exe', then follow the instructions on the screen. See the file readme.txt on the CD for further informations. Look at <u>http://www.bmt-berlin.de/software.html</u> for new versions of the software.

The instrument's serial interface has to be connected to one of the serial ports of a PC via a standard RS-232 cable (max. length 10 m). USB-to-serial adapters will work, too. Configuration of the communication parameters (Link Baud rate etc.) is automatic.

Among other features, the software allows:

- easy configuration of all parameters of the BMT 932. With a few mouse clicks you can view respectively change e.g. the unit of ozone concentration, alarm parameters, EMO settings, date and time and other parameters, displayed are also serial number, operating hours, etc.
- storing of all modifiable charcteristics in configuration files. In order to configure several instruments with the same set of parameters, only the corresponding file has to be loaded
- recording (logging) of selectable measurement results or parameters, such as concentrations, alarms, etc. in an ASCII file on the PC
- view and printout of all internal system data for diagnostics and documentation

The main screen shows the basic measurements of the ozone. From the View menu, you may choose the Parameter window, which shows all settings of parameters that may be changed, sorted in tabs named the same as in the front panel menu. As a start, you should check the units used by the analyzer, and set the date & time according to the local time in your area. This is the time used in the Error- and Event Log (built-in clock of the BMT 932).

Also in the main menu, you'll find a Monitor window, designed to be enlarged so that you may watch the measurements from distance. A Diagnostics window, summarizing all internal data is mainly needed for troubleshooting by BMT. Other than that, the Error- and Event Log may be loaded from the instrument to the screen via the View menu.

The options in the main menu let you set your preferences concerning the software itself, e.g. the COM port parameters. It also lets you switch on or off the Logger function, which is used to log measurement data every few seconds into a file.

On some screens, you'll find a print function for two different printouts, one summarizing the settings and measurement for documentation, one for troubleshooting by BMT. The latter should be faxed to us in case of problems. The printouts include both the Error- and Event Log.

The Save and Load functions in the main menu under File are used to save configurations of the BMT 932 onto your PC and load it again at a later time. This helps configuring all monitors with the same parameter set in different locations within one project.

For a more detailed description of the software, please refer to the helpfile (bmt932.chm, to be opened with F1 within the software program or double click the file in the Windows Explorer).

19 Accessories and Spare Parts



item	part		order number
	Accessories shipped with the instrument:		
1	set of filter holders		932-HOLDER
2	box with filter inserts (200 pcs.)		932-INSERTS
3	tweezers for filter inserts		932-TWEEZERS
4	set of mounting fittings for filter holders		932- MALEFIT
5	16-pole output connector		932-TERM/16
	12-pole EMO connector	incl. screw driver 0.4 x 2.0mm	932-TERM/12
	7-pole Channel ID connector	for spring cage contacts	932-TERM/7
	50-pole D-Sub connector (RelayBox option)		932-DSUB/50
6	screws and nylon washers (set of 4)	USA: 10-32 x ¾	932-SCREW/10-32
		Europe: M6 x 16	932-SCREW/M6
	set of number stickers for sample point		932-STICKER
	set of number bracelets for sample point		932-BRACELET
7	4-pole RS-232 connector		932C-TERM/4
	mains connector	BMT 932C only	CONN-MAINS
	tube cutter	<pre></pre>	932C-CUT
	Optional Spare parts "932-SPARE":		
8	UV lamp		932-LAMP
9	scrubber		932-SCRUBBER
10	additional set of filter holders		932-HOLDER

20 Trouble Shooting

19.1 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.

In case the BMT 932 has to be sent in for service, please use the following addresses:

BMT MESSTECHNIK GmbH Hamburger Strasse 19 D-14532 Stahnsdorf, Germany Tel. +49 - 3329 - 696 77 - 0, Fax +49 - 3329 - 696 77 - 29 http://www.bmt-berlin.de service@bmt-berlin.de

North America

OSTI Inc. P.O. Box 3320 Monterey, CA 93940, U.S.A. Tel. +1 - 831 - 649 1141, Fax +1 - 831 - 649 1151 http://www.osti-inc.com

Please contact BMT MESSTECHNIK or OSTI Inc. before you send in any instruments.

21 Maintenance

20.1 Replacement of UV Lamp and Scrubber

When the error message LAMP LOW or SCRUBBER is displayed the UV lamp or the utility scrubber have to be replaced. The BMT 932 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 (black), two on each side. After removal of these screws the upper shell can be lifted upwards.

The UV lamp is located at the left end (seen from the front panel) of the black cuvette assembly. Remove both screws holding the black lid **A** using the Allen wrench clipped to the cuvette **E**. Lift up lid **A** and remove the UV lamp as follows, the type of mounting depends on the date of production:

Before autumn 2017, the lamp is just snapped into two elastic clips. Simply pull it upwards to remove it.

After autumn 2017 the lamp is mounted as shown on the right:

Caution: The quartz glass tube of new UV lamp should not be touched. Use a soft cloth for installing the new lamp! Finally replace the black L-shaped lid and insert and fasten both screws.

The UV lamp itself is held by two lamp holders **B** and **C** which are not identical.

Lamp holder **B** has a slot **L**, which holds the lamp wire by a grub screw **M** reaching into the slot. The opposite lamp holder **C** has a plug-in contact, which in turn holds the UV lamp's wire.

Caution: Do not touch the grub screw on the lamp holder C !

- Using the 1.5 mm Allen wrench (supplied with the lamp box), loosen the grub screw of the slotted lamp holder **B** only;
- Grab the UV lamp D at the left end and carefully take it out of the slotted lamp holder, at the same time pull the lamp out of the contact in the opposite holder C

Care must be taken to not bend the lamp's wire in holder C

• Take the new UV lamp out of the box and note its serial number on the box

Attention: Do not touch the radiating area, or use textile gloves

- First, carefully insert one end of the UV lamp into the contact in holder **C**, and second, place the other end of the UV lamp into slot **L** of holder **B**
- Turn the UV lamp until the exhaust nipple points away from cuvette E
- Now slightly tighten the grub screw in holder **B**: limit the force, by using two fingers, only



Holder B

• Apply some LOCTITE to the grub screw in holder **B**

Scrubbers

Both scrubber capsules (utility scrubber and reserve scrubber) are positioned near the UV lamp in the short bar of the black Tee. The reserve scrubber is the capsule nearer to the short bar of the Tee. The other capsule is the utility scrubber. Withdraw the black Viton tubing from the scrubber capsule and screw the capsule out like a big screw. The new scrubber capsule is installed backwards: Screw it in and push the black Viton tubing on the grey nipple on top of the scrubber capsule.

The wall mount cabinet BMT 932C may be opened only after it had been disconnected from the mains power line. The special mains connector may not be disconnected before mains voltage has been interrupted. When the door is open replacement procedures for UV lamp replacement and scrubber replacement are as described above.

20.2 Optical System: Disassembling, Cleaning

To internally clean the cuvette and the cuvette windows the cuvette tube (the long bar of the Tee) has to be removed from the cuvette assembly. First disconnect the clear FEP tubing from the SS one-touch fitting (elbow) by pushing the ring and, at the same time, pulling out the FEP tubing. Then pull the black Viton tubing off of the grey plastic nipple (other end of the long bar of the Tee). Remove both screws using the Allen wrench clipped to the cuvette tube. Now the cuvette tube can be lifted and removed. The end caps can be removed from the cuvette tube after removal of the two screws inside of each cap.

Attention: Do not mix up the caps! The depth of the caps is different: The shorter cap belongs to the SS one-touch fitting (elbow) and the longer cap belongs to the grey plastic nipple.

Now you can clean the quartz cuvette windows using a lint-free tissue (e.g. Kimwhipe "R") and alcohol. The PTFE inner surface of the cuvette tube has to be cleaned using a lint-free tissue, wetted with alcohol, which shall be pushed through the tube several times. Before re-assembly wait thirty minutes for evaporation of alcohol residues.

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

22 Specifications

Measurement principl	е	Dual-beam UV photometer (254 nm)
UV lamp		Low pressure mercury lamp, long life design, burnt-in for 300 h
Display		2x20 character alphanumeric backlit LCD
Concentration range		1, 2, 5, 10, 20, 50, 100, 250 ppm _v
Selectable units		ppm _v and μ g/Nm ³
Noise		±0.001 ppm
Min. detectable Conc.		0.002 ppm
Accuracy		± 1%, traceable to NIST
Response time		20 s (0 – 95 %)
Temperature compen	sation	Standard
Pressure compensation	on	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		> 8 years (safety monitor operation)
Threshold alarms		Two, adjustable for each sample port. Three EMO circuits. Threshold alarm relays for each sample port (if optional Relay Box has been ordered)
Error relay		Indicating any instrument failure, including
		Lamp low (easy lamp replacement)
		Low flow
		• Scrubber failure (tested for every 24 h. reserve scrubber takes over automatically)
		• Warmup
Gas ports		Compression type for $\frac{1}{4}$ or $4x6$ mm FEP tubing
		Cabinet version: 1/2" OD only
		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
		EMO
Control output		Lamp low (relay contact, 30 V, 1 A)
Digital interface		RS-232, isolated, showing concentration, alarms, errors, Provides connection to Win-
Ū		dows software BMT 932 Link
Accessories included		One filter holder with mounting fitting per channel, 200 filter inserts, tweezers for filter
		inserts, screw driver for set points, number stickers & bracelets, connectors, spare fuses,
	I)	mounting screws & nylon washers
Spare parts kit (option	nal)	UV lamp
		Scrubber
		Additional filter holder per sample port
		200 filter inserts
Warmup time		7 min. max., 4 min. typical
Power		Universal line voltage: 100 – 240 VAC, 35 VA, 50/60 Hz
		optional: 18-36 VDC, 25 W
Ambient temperature		0 - 45 °C (non-condensing)
Dimensions (H	l x D)	132 x 300 mm (19 " rack mount)
(V	V x H x D)	357 x 440 x 133 mm (wall mount BMT 932 C)
Weight		9 kg (19" rack mount)
		less than 7 kg (wall mount BMT 932 C)
Compliance		CE-marked (EMC and safety), cTUVus NRTL-listed

Appendix A: Link-Mode Commands

The following table describes all available Link-Mode commands. Commands with questionmarks retrieve information from the BMT 932.

Caution: This set of commands should only be used by programmers who have a good understanding of the BMT 932 and ozone measurement in general!

Cmd	Meaning	PC->932	932->PC
0	Start Link Mada		*0#DL77N
0	Statt Link-Woode		0#DL7ZN
2	byte 1 Banga ID (and table on page 25)	Z#	Z#Dyte1,
	byte 1. Kange-iD (see table on page 25)		bytez
	0. ppm		
2		*2#b.#e	*2#
3	Set ozone unit	"3#byte	"3#
	Meaning of byte:		
	U: ppm		
	1: µg/m³	* 4 //	***
4	Low alarms?	*4#	*4#byte
	Bits 05 show Low Alarms on Channels 1 to 6		
5	High alarms?	*5#	*5#byte
	Bits 05 show High Alarms on Channels 1 to 6		
6	Serial number?	*6#	*6#long
8	Auto/Manual?	*8#	*8#word
	If Bit 7 of this word is set, Manual Mode is selected		
9	Concentration?	*9#	*9#float,byte
	float: Concentration		
	byte: Unit:		
	0: ppm		
	1: µg/m³		
11	Temperature?	*11#	*11#float
	float: in Kelvin		
12	Operating hours?	*12#	*12#long
14	Get Scrubber Test Interval (normal 24h) 199h	*14#	*14#byte
15	Set Scrubber Test Interval (normal 24h) 199h	*15#byte	*15#
16	Get Scrubber Test Timer (how many minutes until Scrubber Test)	*16#	*16#word
17	Set High Alarm Latching	*17#byte	*17#
	Bits 05 set High Alarms Latching on channels 16		
18	Set Low Alarm Latching	*18#byte	*18#
	Bits 05 set Low Alarms Latching on channels 16		
19	Set High Alarm Enabled	*19#byte	*19#
	Bits 05 set High Alarms Enabled on channels 16		
20	Set Low Alarm Enabled	*20#byte	*20#
	Bits 05 set Low Alarms Enabled on channels 16		
21	Normalizing temperature?	*21#	*21#float
	float: in Kelvin		
22	Set PIN (prevents changing parameters)	*22#word	*22#
	0: no PIN protection	(09999)	

Cmd	Meaning	PC->932	932->PC
23	Sat Low Alarm EMO Mask 1	*22#byto	*03#
23	Set Low Alarms to logical EMO 1, cotting hits 0, 5 assign Low	23#byte	23#
	Alarms on channels 16 to this function		
24	Set High Alarm EMO-Mask 1	*24#byte	*24#
	Assign High Alarms to logical EMO 1, setting bits 05 assign High		
	Alarms on channels 16 to this function		
25	Set Low Alarm EMO-Mask 2	*25#byte	*25#
	Assign Low Alarms to logical EMO 2, setting bits 05 assign Low Alarms on channels 16 to this function		
26	Set High Alarm EMO-Mask 2	*26#byte	*26#
	Assign High Alarms to logical EMO 2, setting bits 05 assign High Alarms on channels 16 to this function		
27	Set Low Alarm EMO-Mask 3	*27#byte	*27#
	Assign Low Alarms to logical EMO 3, setting bits 05 assign Low Alarms on channels 16 to this function		
28	Set High Alarm EMO-Mask 3	*28#byte	*28#
	Assign High Alarms to logical EMO 2, setting bits 05 assign High Alarms on channels 16 to this function		
29	Time?	*29#	*29#byte,byte,byte
	hh,mm,ss		
30	Set Hour	*30#byte	*30#
31	Set Minute	*31#byte	*31#
32	Set Second	*32#byte	*32#
33	Date Format?	*33#	*33#byte
	0: DD.MM.YY		
	1: MM/DD/YY		
34	Set Date Format	*34#byte	*34#
	0: DD.MM.YY		
	1: MM/DD/YY		
35	Date?	*35#	*35#byte,byte,byte
	DD,MM,YY		
36	Set Day	*36#byte	*36#
37	Set Month	*37#byte	*37#
38	Set Year (YY)	*38#byte	*38#
39	RS-232 Timed/Polled?	*39#	*39#byte
40	U. Polled	*40#buta	*40#
40	1: Timed	40#byte	40#
11	DS 232 Interval2 (if Timed)	*/1#	*/1#hyto
41	hute Seconds	41#	4 1#Dyte
42	Set RS-232-Interval (wenn Timed)	*42#byte	*42#
	byte Seconds		יישד
43	Set Analog Output (Simulation)	*43#float	*43#
	Range 0.0: 0 V/ 4mA 1 0: 10V /20 mA	10/mode	
	2.0: normal operation		
46	Alarm Beep?	*46#	*46#bvte
	1: On		
	0: Off		

Cmd	Meaning			PC->932	932->PC
47	Set Alarm	Been		*47#byte	*47#
	1: On	Doob		11 11 0 10	
	0: Off				
48	Start Scrub	obertest		*48#	*48#
49	Send Error	· Log (max. 16 Entries)		*49#	*49#byte1,
	Format: Y	(,MM,DD,HH,MM,SS,Error			byte2,byte3,
	Error has t	he same format as described in t	able on page 30		byte4,byte5, byte6 word#
50	Send Ever	it Log (max. 103 Entries)		*50#	*50#byte1,
	Format: Y	(,MM, DD,HH,MM,SS, Word, Flo	at		byte2,byte3,
	The 16 bits	s in word have the following mean	ning and are sent with the		byte4,byte5, byte6 word float#
	following fl	oat parameter:			hvte1
	7-Bits	Meaning	float Parameter		by to 1,
	0	Low Alarm status Channel 1	Concentration		
	1	Low Alarm status Channel 2	Concentration		
	2	Low Alarm status Channel 3	Concentration		
	3	Low Alarm status Channel 4			
	4	Low Alarm status Channel 5	Concentration	_	
	5	Low Alarm status Channel 6	Concentration		
	6	Switched on	pressure [bar]	_	
	7	Switched off	Temperature when switched on [K]		
	8	High Alarm status Channel 1	Concentration		
	9	High Alarm status Channel 2	Concentration	_	
	10	High Alarm status Channel 3	Concentration	_	
	11	High Alarm status Channel 4	Concentration	_	
	12	High Alarm status Channel 5	Concentration		
	13	High Alarm status Channel 6	Concentration	_	
	14	High Alarm, any Channel	Concentration	_	
	15	Low Alarm, any Channel	Concentration		
54	Reset all p	arameters to standard factory se	tting	*54#	*54#
66	Active Cha	innels?		*66#	*66#byte
	Shows whi	ch channels are active, returns C	05 for channels 16		
67	Set Active	Channels		*67#byte	*67#
00	Bits 05 st	and for channels 16. This may i	never be zero	*00.11	*00///
68	Low Alarm	EMO-Mask 1?	101 hits 0 5 act show	*68#	*68#byte
	assignmen	assignment of Low Alarms to EN t of Low Alarms on channel 16			
69	High Alarm	n EMO-Mask 1?		*69#	*69#byte
	Reads out	assignment of High Alarms to El	MO 1, bits 05 set show		
	assignmen	t of high Alarms on channel 16			
73	Low Alarm	EMO-Mask 2?		*73#	*73#byte
	Reads out	assignment of Low Alarms to EN	IO 2, bits 05 set show		
74	assignmen	It of Low Alarms on channel 16		*71#	*71#6.4-
/4	High Alarm	I EIVIU-IVIASK Z?	102 hits 0 5 act change	["] /4#	~/4#byte
	assignmen	assignment of High Alarms to El it of high Alarms on channel 16			
75	Low Flow /	Alarms?		*75#	*75#byte
	Shows Low	v Flow Alarms as bits 05 for cha	annel 16		

Cmd	Meaning	PC->932	932->PC
76	Set Auto/Manual	*76#	*76#byte
	Has the same effect as pressing "ENTER" on the front panel. Changes		
	Auto/Manual mode and goes through active channels in Manual mode.		
	in Auto or Manual mode.		
77	Low Alarm EMO-Mask 3	*77#	*77#byte
	Reads out assignment of Low Alarms to EMO 3 bits 05 set show		
	assignment of Low Alarms on channel 16		
78	High Alarm EMO-Mask 3	*78#	*78#byte
	Reads out assignment of High Alarms to EMO 3 bits 05 set show		
02	Set Spiffer Mede	*02#buto	*02#
03		oo#byte	03#
85	Firmware-Version?	*85#	*85#float
86	From Status (binary coded, as decribed in table on page 30):	*86#	*86#word
Q1	Set Link-Mode Timeout (after switching on always 10 s)	*91#hvte	*91#
	byte: Seconds		51#
95	Set User Baud Rate	*95#bvte	*95#
	0: 2400		
	1: 4800		
	2: 9600		
	3: 19200		
	4: 38400		
98	High Alarm Parameter Channel 1?	*98#	*98#float,
	float: Limit in present unit		byte1,byte2
	byte1: Enabled 1 = true		
	byte2: Latching 1= true		
99	High Alarm Parameter Channel 2?	*99#	*99#float,
	parameters as above	* 100 //	byte1,byte2
100	High Alarm Parameter Channel 3?	*100#	*100#float,
404	parameters as above	*404.0	
101	High Alarm Parameter Channel 4?	^101#	"101#TIOat, byte1 byte2
102	High Alarm Parameter Channel 52	*102#	*102#float
102	narameters as above	102#	byte1.byte2
103	High Alarm Parameter Channel 62	*103#	*103#float
	parameters as above	100//	byte1,byte2
104	Low Alarm Parameter Channel 1?	*104#	*104#float.
	float: Limit in present unit		byte1,byte2
	byte1: Enabled 1 = true		
	byte2: Latching 1= true		
105	Low Alarm Parameter Channel 2?	*105#	*105#float,
	parameters as above		byte1,byte2
106	Low Alarm Parameter Channel 3?	*106#	*106#float,
	parameters as above		byte1,byte2
107	Low Alarm Parameter Channel 4?	*107#	*107#float,
	parameters as above		byte1,byte2
108	Low Alarm Parameter Channel 5?	*108#	*108#float,
	parameters as above		byte1,byte2
109	Low Alarm Parameter Channel 6?	*109#	*109#float,
	parameters as above		Dyte I, Dyte2

Cmd	Meaning		PC->932	932->PC
110	Last Values Channel 1?		*110#byte	*110#float
	float: the last concentration measured on	channel 1		1 ionnoac
111	Last Values Channel 2?		*111#byte	*111#float
	float: the last concentration measured on	channel 2		
112	Last Values Channel 3?		*112#byte	*112#float
	float: the last concentration measured on	channel 3		
113	Last Values Channel 4?		*113#byte	*113#float
	float: the last concentration measured on	channel 4		
114	Last Values Channel 5?		*114#byte	*114#float
	float: the last concentration measured on	channel 5		
115	Last Values Channel 6?		*115#byte	*115#float
	float: the last concentration measured on	channel 6		
116	Set High Alarm Limit 1	(High Limit > Low Limit!)	*116#float	*116#
	(retrieve concentration unit first)			
117	Set High Alarm Limit 2	(High Limit > Low Limit!)	*117#float	*117#
	(retrieve concentration unit first)			
118	Set High Alarm Limit 3	(High Limit > Low Limit!)	*118#float	*118#
	(retrieve concentration unit first)			
119	Set High Alarm Limit 4	(High Limit > Low Limit!)	*119#float	*119#
	(retrieve concentration unit first)			
120	Set High Alarm Limit 5	(High Limit > Low Limit!)	*120#float	*120#
	(retrieve concentration unit first)			
121	Set High Alarm Limit 6	(High Limit > Low Limit!)	*121#float	*121#
	(retrieve concentration unit first)			
122	Set Low Alarm Limit 1	(High Limit > Low Limit!)	*122#float	*122#
	(retrieve concentration unit first)			
123	Set Low Alarm Limit 2	(High Limit > Low Limit!)	*123#float	*123#
	(retrieve concentration unit first)			
124	Set Low Alarm Limit 3	(High Limit > Low Limit!)	*124#float	*124#
	(retrieve concentration unit first)			
125	Set Low Alarm Limit 4	(High Limit > Low Limit!)	*125#float	*125#
	(retrieve concentration unit first)			
126	Set Low Alarm Limit 5	(High Limit > Low Limit!)	*126#float	*126#
	(retrieve concentration unit first)			
127	Set Low Alarm Limit 6	(High Limit > Low Limit!)	*127#float	*127#
	(retrieve concentration unit first)			

Appendix C: Cabinet Version BMT 932 C

C1 General Description

The OZONE ANALYZER BMT 932 C (cabinet version) is housed in a splash-proof IP 65 (NEMA 4X) cabinet, and functionally identical to the 19" version BMT 932.



For sample gas connection FEP or PTFE tubing should be used, which will be supplied on request. The power connector is water-proof.

Dimensions of the cabinet are $357 \ge 440 \ge 133 \text{ mm}$ (W $\ge H \ge D$), and weight is less than 7 kg. The cabinet must be wall mounted using the four brackets provided at the rear (four mounting holes are 6 mm ID, spaced 307 $\ge 465 \text{ mm}$, W $\ge H$).

The dimensions in [mm] are outlined below:



C2 Pneumatic Installation

Pneumatic installation is simple. The sample tubing has to have an OD of 1/4". Tubing 6 mm OD may never be used!

As the tubing material we recommend the clear transparent 1/4" FEP tubing type TIHB07N by SMC Corporation. The tubing has to simply be pushed through the according cable feed-through¹ at the right side of the BMT 932 C cabinet. Inside of the cabinet - opposite to the feed-through - the tubing now has to be inserted into the according One-Touch-Fitting (SMC Corp.). Installation instructions by SMC are (essentially) as follows:

Installation of tubing

Take an FEP tubing 1/4" having no flaws on its periphery and cut it off at a right angle using the Tube Cutter TK-3. Hold the tubing and slowly insert it all the way into the fitting. Insertion depth is about 15 mm. After inserting the tubing, pull on it lightly to confirm that it will not come out.

Removal of tubing

Sufficiently depress the release bushing and tubing, making sure to apply even pressure around the release bushing. Pull out the tubing while depressing the release bushing so that it does not pop out. If the release bushing is not depressed sufficiently, there will be an increased bite on the tubing and it will become more difficult to pull out. When the removed tubing is reused, first cut off the section of the tubing which has been clamped. Reusing the clamped portion of the tubing can cause problems such as leakage, difficulties in removal.

In the OZONE MONITOR BMT 932C accessories kit a Tube Cutter TK-3 (SMC Corp.) is included. This cutter tool should be used to cut the front end of the tubing.

We strongly recommend installation of the BMT 932C together with new sample gas tubing. In case some old sample tubing is still in place from a former ozone monitor installation it should be replaced by a fresh FEP tubing TIHB07N (or equivalent).

The OZONE MONITOR BMT 932 intentionally has no internal dust filter. An external dust filter thus must be installed at the inlet port of each sample tube. These sample gas filters, and the according fittings, are provided with every instrument. Refer to chapter 10 (page 13).

C3 Electric Connections

All signalling connections are made inside the cabinet with detachable screw terminals. Splashproof feed-throughs are provided for the signal cables to be connected. Cable diameters should be 5-10 mm for the signal cables. Shielded cables must be used. Connect shields to housing inside the cabinet. Following is the layout of the terminals of the cabinet version:

Mains connector:

 1
 mains

 2
 mains

 3
 (free)

 Protective Ground

The installation of the mains connector has to be made by a person aquainted 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.

¹ To seal all those cable feedthroughs which are not used their central holes are closed with small rubber plugs. Before inserting a sample tubing this small plug has to be removed.

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.

Warning: Disconnect electrical power before opening the cabinet door.

Précaution: Couper l'alimentation avant d'ouvrier la porte d'analyseur.

Signal contacts (Connector "Output & Control") are as described on page 15. A splash-proof connector for connection of the supplied serial cable is provided.

The BMT 932 C can be ordered with the option 932C-HAR. This provides a relay which can switch an alarm horn in case of a High Concentration Alarm. Connection is made through an additional splash-proof feed-through to the two pole connector on the PCB labeled "Horn". Cable diameter shall be 6.5 to 10 mm.

Warning: The equipment connected to the option 932C-HAR shall be fused at 4 A. *Précaution:* Assurer la protection de l'équipment connecté au option 932C-HAR avec une fusible pour 4A.

C4 Operation

The operation of the BMT 932 C is the same as of the standard BMT 932.

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

Appendix R: Relay Box (Option)

The optional Relay Box may be built into the OZONE MONITOR BMT 932 (19" rack mount version only) 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. It is only available for three and six channel instruments. One channel instruments offer all contacts on the signal connectors, already.

This optional Relay Box is identical to that found in the OZONE MONITOR BMT 930 (copy exact). Order number is 932-RELAY.

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.

Sample	Sample ID		Low Alarm		-	High Alarm	1
	(closing)	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

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

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 page 28 under "Set Active Channels") will become inactive immediately after completion of warm-up.

If during operation of the OZONE MONITOR BMT 932 an instrument error occurs (e.g. Lamp Low, Low Flow), all threshold alarm contacts of the Relay Box will move into the alarm position.

Appendix U: UBA Certificate

Kalubration Certificate Statut Collbration Certificate Entroperation Total Data Section Certificate Entroperation Total Data Section Certificate Entroperation Total Data Section Certificate Entroperation BMT Messechnik Ginbh Entroperation BMT Messechnik Ginbh Entroperation BMT Messechnik Ginbh Entroperation Ginbh Entroperation Ginbh Entroperation Distance Entroperation <tr< th=""><th>Kalibrierschein Calibration Certificate Bundese CIPM MRA NATIONALES EU-REFERENZLABOR FÜR LUFTQUALITÄT</th><th>Kalibrieschein-Mr.: 062.2017 Seite Calibration certificate No: Page</th><th>Umgebungsbedingungen 21,0 °C; 1002,3 hPa Environmental conditions</th><th>Rückführung UBA SRP 29 Traceability</th><th>Dieser Kalibrierschein darf nur volktändig und unverändert weiterverbreitet werden. Auszüge und Änderungen bedürfen der ausdrüc</th><th>Genthmigung dos EU Referentations. This calibration certificate may not be reproduced other than in full except with the permission of the EU-Reference Laboratory.</th><th>Der Kalibrierschein ohne Unterschrift und Stempel hat keine Gültigkeit. Colibration Centrificate without signature and seal is nat volld.</th><th>Sed Automotion Datum Leiter EU-Referenziabor Bearbeiter/in Sed Automotion Date Head of the EU-Reference Laboratory Person in charge</th><th>(2 11.2017 HS WAY NO. Sere</th><th>Dr. Klaus Wirtz Verena Schinz</th><th>Zusatzinformationen zum angewandten Kalibrierverfahren</th><th>Konditionierung des Prüflings:</th><th>Messbereich Einstellung Prüfling: 0-1000 nmol/mol</th><th>Kalibrierfaktoren: 0Koeffizient (Gain): von 113,750 auf 112,229 ge</th><th>Kalibriergas/Matrix SRP 29: Synthetische Luft</th><th>Prüfgasfluss: 1.0 U/min bei 20 °C und 1013 hPa Prüfgaszuführung zum Prüfling: Drucklos über SRP Gasverteller</th><th>Für das Zertifikat wurden die analog erfassten Mes: des Prüffings verwendet. Der Analogkanal des Prüff</th><th>wurde mit einem digitalen Multimeter überprüft (D/ Kalibrierung Multimeter Metrahlt 30M: Kalibrierzeic</th><th>HW106_D-K-20313-01-00_2017-09). Die Ozonmes</th><th>sind gewogene Mittelwerte aus drei Messläufen. Pr Messlauf wurden 10 Finzelwerte nro Konzentration</th><th>gemessen. Die Messzeit für einen Einzelwert beträg</th><th>Sekunden. Die Messung der Konzentrationsstufen i</th><th>von tief nach hoch.</th><th>Bitte berücksichtigen Sie, dass die Zertifizierung nur unter den angegebenen Einstellungen gültig ist.</th></tr<>	Kalibrierschein Calibration Certificate Bundese CIPM MRA NATIONALES EU-REFERENZLABOR FÜR LUFTQUALITÄT	Kalibrieschein-Mr.: 062.2017 Seite Calibration certificate No: Page	Umgebungsbedingungen 21,0 °C; 1002,3 hPa Environmental conditions	Rückführung UBA SRP 29 Traceability	Dieser Kalibrierschein darf nur volktändig und unverändert weiterverbreitet werden. Auszüge und Änderungen bedürfen der ausdrüc	Genthmigung dos EU Referentations. 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. Colibration Centrificate without signature and seal is nat volld.	Sed Automotion Datum Leiter EU-Referenziabor Bearbeiter/in Sed Automotion Date Head of the EU-Reference Laboratory Person in charge	(2 11.2017 HS WAY NO. Sere	Dr. Klaus Wirtz Verena Schinz	Zusatzinformationen zum angewandten Kalibrierverfahren	Konditionierung des Prüflings:	Messbereich Einstellung Prüfling: 0-1000 nmol/mol	Kalibrierfaktoren: 0Koeffizient (Gain): von 113,750 auf 112,229 ge	Kalibriergas/Matrix SRP 29: Synthetische Luft	Prüfgasfluss: 1.0 U/min bei 20 °C und 1013 hPa Prüfgaszuführung zum Prüfling: Drucklos über SRP Gasverteller	Für das Zertifikat wurden die analog erfassten Mes: des Prüffings verwendet. Der Analogkanal des Prüff	wurde mit einem digitalen Multimeter überprüft (D/ Kalibrierung Multimeter Metrahlt 30M: Kalibrierzeic	HW106_D-K-20313-01-00_2017-09). Die Ozonmes	sind gewogene Mittelwerte aus drei Messläufen. Pr Messlauf wurden 10 Finzelwerte nro Konzentration	gemessen. Die Messzeit für einen Einzelwert beträg	Sekunden. Die Messung der Konzentrationsstufen i	von tief nach hoch.	Bitte berücksichtigen Sie, dass die Zertifizierung nur unter den angegebenen Einstellungen gültig ist.
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