OZONE ANALYZER BMT 961

Installation and Application

1994

(scanned & converted to PDF: January 2002)

Contents

1 General Description

The OZONE ANALYZER BMT 961 is a panel instrument for measuring and displaying high ozone concentrations in air or in oxygen. The standard ranges are 50, 100, and 200 g/m³.

The instrument is a photometer using the direct UV-photometric method for the measurement of gaseous ozone, according to VDI regulation No. 2468/6, and the standard procedure 002/87 (F) of the IOA. The absorption coefficient programmed in the instruments computing circuit is 134 l/(bar cm), which is known with an uncertainty of 1%. Measurement uncertainty of the OZONE ANALYZER BMT 961 is only 1,5 %.

The UV-photometric measurement principle is "blind" to gases other than ozone. It measures the mass of ozone contained in a certain volume [g/m³], independently of the pressure and temperature of the gas mixture.

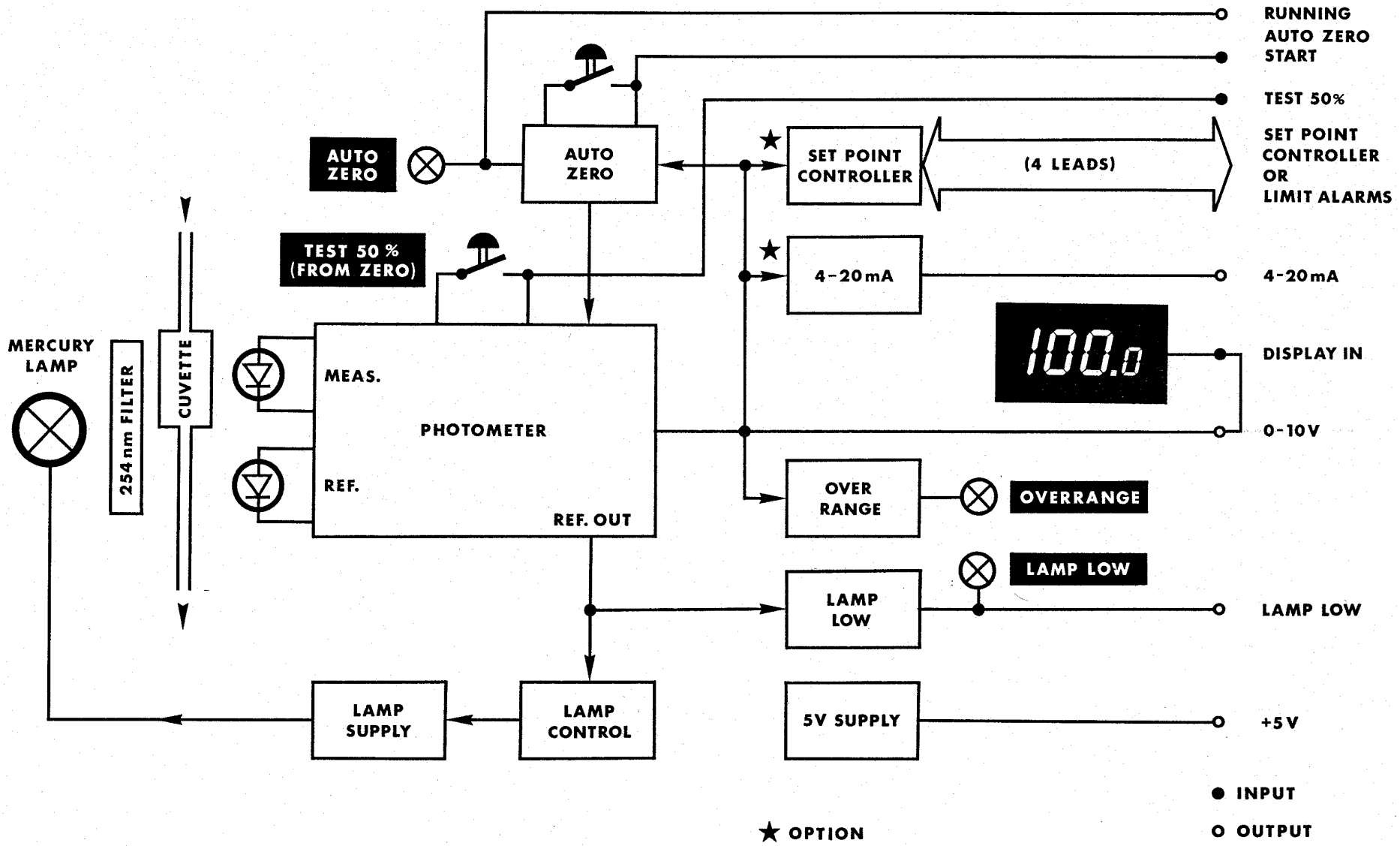
The OZONE ANALYZER BMT 961 is a split beam photometer. The UV radiation of a low pressure mercury lamp is filtered by a two stage filter to achieve high spectral purity at 254 nm. This filter does not age. The 254 nm radiation is measured by a reference detector. An automatic control circuit holds the radiation output of the mercury lamp constant over its lifetime (of approx. 20.000 hours). The end of life of the mercury lamp is indicated on the front panel of the instrument as well as by an electrical signal.

The stability of the OZONE ANALYZER BMT 961 is so high that zero adjustment is necessary only once a day (if the cuvette windows are not soiled). The sensitivity of ozone measurement practically does not drift if zero adjustment is correct. The sensitivity can be checked by a push button ("TEST 50 %, FROM ZERO").

The only routine test that must be made is to check the display for a zero reading at zero ozone concentration. To achieve zero ozone concentration inside the cuvette, the instrument's pathway has to be purged with pure feed gas (or ambient air) containing no ozone. After a few seconds the cuvette will be free of ozone, and the zero reading may be checked, or the automatic digital zeroing function may be activated by a push button ("AUTO ZERO"), or an electric signal, or a contact closure. Automatic zeroing will be completed in about three seconds. The range of zero compensation is approx. 30% of the measurement range.

The OZONE ANALYZER BMT 961 measures continuously - without any interruptions. The rise time of the concentration signal is less than 0.3 s (after a step change of ozone concentration inside the cuvette).

Thus the instrument is well suited for fast acting automatic control of an ozone generator's concentration output.


RUNNING
AUTO ZERO
START
TEST 50%
SET POINT
CONTROLLER
OR
LIMIT ALARMS
AUTO
ZERO
AUTO
ZERO
SET POINT
CONTROLLER
(4 LEADS)
TEST 50 %
(FROM ZERO)
4-20mA
4-20mA
100.0
DISPLAY IN
MERCURY
LAMP
254 nm FILTER
CUVETTE
MEAS.
PHOTOMETER
REF.
REF. OUT
0-10V
OVER
RANGE
OVERRANGE
LAMP LOW
LAMP
LOW
LAMP LOW
LAMP
SUPPLY
LAMP
CONTROL
5V SUPPLY
+5V
● INPUT
○ OUTPUT
★ OPTION

To cooperate with programmable controllers, the OZONE ANALYZER BMT 961 has a number of input and output lines:

- remote control of automatic zeroing (AUTO ZERO)
- remote control of self test (TEST 50%, FROM ZERO)
- warning signal for end of life of UV lamp (LAMP LOW)
- warning signal for impossible auto zero
- concentration output signal 0-10V
- concentration output signal 4-20mA (or 0-20mA)
- input to the digital display
  (in order to display set point instead of actual concentration)

Reliability of the OZONE ANALYZER BMT 961 is high. Each device has been aged and tested for 300 hours in the factory. Thus the probability of an early failure is low. The lifetime of the UV lamp is 20.000 hours, nominally. The lifetime of the radiation filters is unlimited. The elastomeric sealings are made of KALREZ . Therefore routine maintenance of the instrument consists only of replacing the UV lamp after two years of continuous service.

2 Power Connection

The POWER SUPPLY BMT 961 P has been separated from the OZONE ANALYZER BMT 961, to prevent heat from influencing the analyzer. For this reason the temperature inside the measuring cuvette is only about 10 K higher than the ambient.

The power supply should be mounted in the vicinity of the analyzer, but care should be taken that it does not heat the analyzer. The ribbon cable which connects the power supply with the analyzer has a standard length of 45cm. Other cable lengths are available on request.

Before connecting mains and power ground to the power supply's terminals, make sure that the mains voltage corresponds to that indicated on the power supply module!

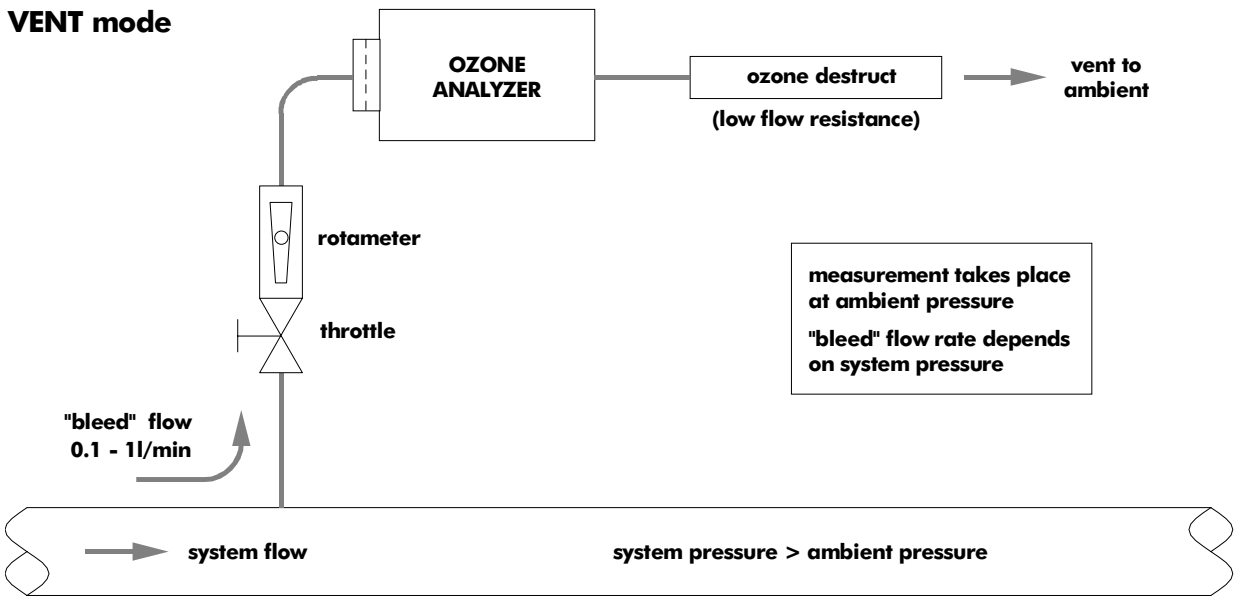
The mains fuse is a solid state PTC device (self-resetting). Three secondary fuses are provided (WICKMANN TR5-T, time lag, 0.lA and 1.25A). The POWER SUPPLY BMT 961 P has no mains switch because the analyzer usually is in continuous service.

At the side opposite to the mains terminals lies the terminal block with all the inputs and outputs of the OZONE ANALYZER BMT 961 (see sections 4. and 5.).

Note: The power supply should be connected to the analyzer (via the ribbon cable) *before* being connnected to the mains. Otherwise a malfunction could occur which can be removed by interrupting the mains connection for a few seconds.

3 Connection of Sample Gas Tubing

The inlet an outlet gas connections are located on the rear panel of the OZONE ANALYZER BMT 961 and are used for connecting the instrument to the sample gas circuit. The connections may be use in any direction of permeation, but we recommend that the sample gas source be connected to the "IN" port, and the "OUT" port used as an exhaust.



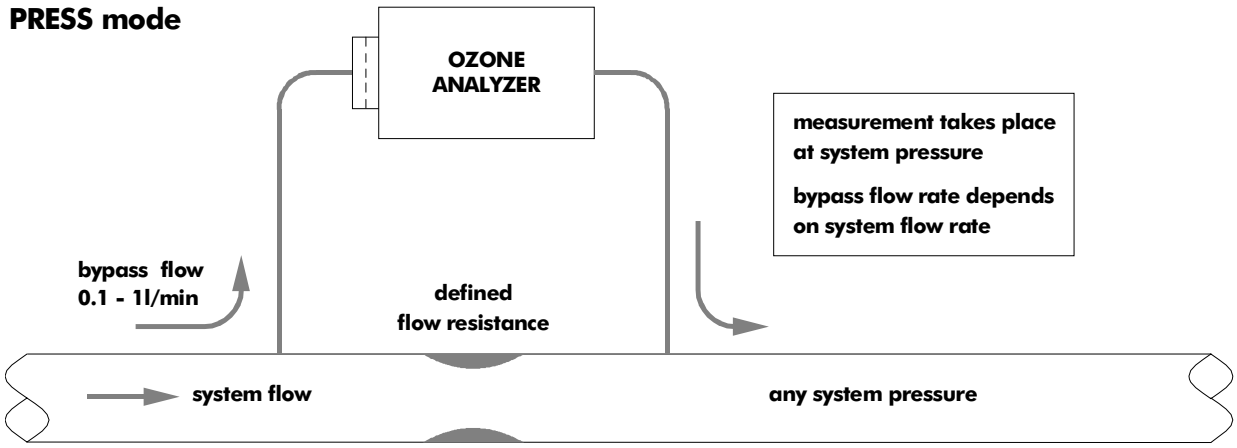
The stainless steel tube fittings are to suit 3x5 TEFLON® tubing (3mm ID, 5mm OD). Fittings and tubing can be delivered upon request.

The response time of the analyzer depends upon the sample gas flow. The internal gas volume between the "IN" port and the outlet of the cuvette is approx. 1 cm'. One meter of 3x5 tubing has an internal volume of approx. 7 cm^3. With a sample gas flow of 1 l/min (17 cm^3/s) and 1 m of 3x5 tubing the system's internal volume will be exchanged in about 0.5 seconds. The electrical time delay of the instrument is approximately 0.3 seconds. So, the total time lag (between a step change of ozone concentration and the analyzer's output) in this example will be approx. 0.8 seconds. Practically, you will have to wait about 2 seconds until the instrument's reading will show the new ozone concentration correctly.

Sample gas flow rate may be much lower than 1 l/min. The limit is given by the delay which can be accepted, and by the fact that the ozone may be destructed on it's way to the measuring cuvette. lt is recommended that you choose a sample gas flow rate between .3 and 1 l/min.

Pressure drop is quite low. E.g. with a flow rate of 1 l/min and 3x5 tubings (connected to the inlet and the outlet port) with a total length of 50cm, pressure drop on the passway of the sample gas (including the analyzer) will be about 5 millibars. With 3 m of tubing, pressure drop will be approx. 12 millibars.

Thus the OZONE ANALYZER BMT 961 may well be connected as a bypass in parallel to a throttling point in the main dtict of the ozone gas, as long as it is guaranteed that the pressure drop across this throttle is high enough to drive a sufficient flow through the bypass and the analyzer. With this configuration the sampie gas which has passed through the analyzer will be fed back into the main stream of the ozone gas. No ozone catalyzer is needed in this case. But the ozone concentration is measured at the arbitrary gas pressure inside the system.



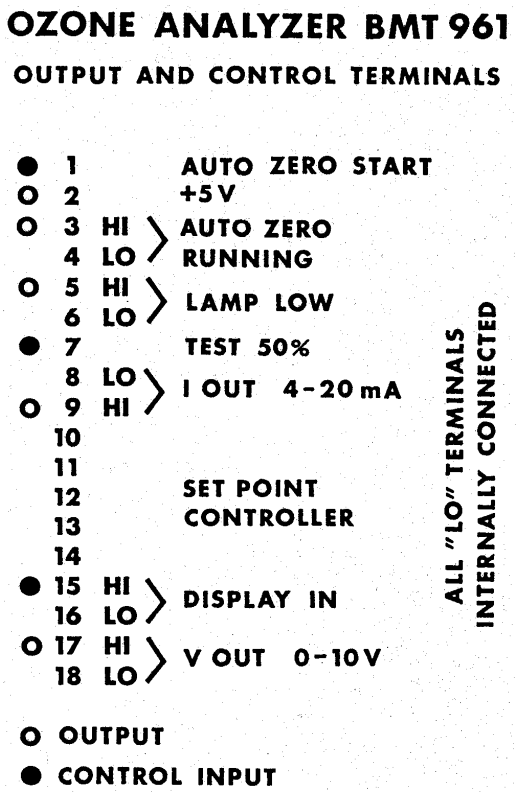
Note: The OZONE ANALYZER BMT 961 measures ozone concentration as the mass of ozone contained in a certain volume of carrier gas (g/m^3), independently of the mass of the carrier gas!

If one needs the ozone concentration measured at atmospheric pressure, one must usually expand the sample gas before it passes through the analyzer. The gas leaving the analyzer has to be catalyzed (to convert the ozone) in a catalyzing cartridge and then vented to the atmosphere.

Zero drift of the OZONE ANALYZER BMT 961 is very low (less than .2 % per day), as long as the cuvette remains clean. If the cuvette windows become soiled, e.g. by dust produced by the ozone Generation, the zero reading will be shifted as further soil deposition increases. To compensate for this shift, the cuvette has to be purged with pure air or oxygen (sample with no ozone), and then the "AUTO ZERO" function of the instrument has to be activated to automatically zero the photometer (see section 6.). For this reason it is very important to prevent the cuvette windows from being soiled by any substances, including water vapor. lt is recommend that you use a sample gas filter in front of the analyzer, which will dramatically increase the zeroing intervals as well as the service intervals. We offer such a filter with inserts made of pure glass fibre. Flow resistance of this filter is only 4 millibars at 1 l/min.

4 Analog Output Signals

At one side of the POWER SUPPLY BMT 961 P (opposite to the mains terminals) lies the terminal block (with 18 terminals) for all output and control signals of the OZONE ANALYZER BMT 961.



All signals are referenced to LO (terminals 4, 6, 8, 16, 18). But **LO is not connected with power ground!** The capacity between the power lines and LO is only approx. 150 pF.

All LO terminals are connected internally. But it is recommended that LO connections are made only with those LO terminals which correspond to the according signal terminals (see table "OUTPUT AND CONTROL SIGNALS", and section 5.). This is particularly important for terminals 8 and 9 (**I OUT 4-20 mA**) because currents in excess of 20 mA may flow here.

The analog voltage corresponding to the ozone concentration is connected to terminal 17 (**VOUT 0-IOV**, 1OV at 100% of concentration range). Terminal 17 has to be connected to terminal 15 (**DISPLAY IN**) to activate the digital display.

Note: Do not remove the jumper wire between terminals 15 and 17 (except with the optional LIMIT ALARM BMT 961 LA)!

5 Control Inputs and Alarm Outputs

Access to the control signals of the OZONE ANALYZER BMT 961 is via the same terminal block as for the analog output signals (see section 4.).

AUTO ZERO START is activated as terminal 1 is momentarily connected to terminal 2 (+5 V).

AUTO ZERO RUNNING (terminal 3) goes HI (+5 V) as long as the AUTO ZERO function is activated (normally for about 3 seconds after AUTO ZERO START). If zeroing is not possible (e.g. when ozone is in the measuring cuvette) terminal 3 remains HI, and the red light emitting diode "**AUTO ZERO**" does not stop blinking.

Note: The AUTO ZERO function should only be activated when it is guarranteed that ozone concentration inside the cuvette is zero! Otherwise the analyzer's reading will be biased to an arbitrarily wrong zero reference.

LAMP LOW (terminal 5) is HI (+5 V) if the UV intensity of the mercury lamp is less than one third of it's initial value. In steady state this means that the mercury lamp has to be replaced within the next weeks (see section 7.). But the LAMP LOW warning signal is activated, too, for several seconds after the instrument has been switched on, because the mercury lamp needs some time to reach it's full UV radiating power. The LAMP LOW signal appears also quite naturally - when the mercury lamp does not function at all. This case (total outage of the mercury lamp) can only be recognized by the fact that the instrument can not be zeroed: The display will show a huge negative value, or the light emitting diode "**OVERRANGE**" does not stop blinking.

TEST 50% (FROM ZERO) will be activated when terminal 7 is connected to terminal 2 (+5 V). This test is meaningful only if: 1) the cuvette is free of ozone, and 2) the instrument has been zeroed correctly. As long as TEST 50% is activated, the instrument should display (and produce an output signal according to) 50 % of measuring range. E.g. an analyzer with a 200 g/m^3 range should display 100.0 g/m^3 as long as TEST 50 % is activated.

6 Operation, Displays, and Controls

After the OZONE ANALYZER BMT 961 has been installed, operating the instrument only means that zero adjustment has to be made from time to time, whilst the ozone concentration inside the cuvette is zero. We recommend that zero adjustment is made once a day.

T'he most simple way to generate zero ozone concentration is to switch off the ozone Generator but not to interrupt the gas flow: After a while ozone concentration will become zero. If this is not possible, the cuvette has to be purged particularly with feed gas or ambient air (filtered, to remove dust). When the cuvette is free of ozone, the instrument should display 00.0. If this is not the case, the **"AUTO ZERO"** push button has to be pressed momentarily (with the tip of a ball pen, through the small hole in the front panel) to activate the instrument's digital zeroing mechanism. The push button has been "hidden" behind the front panel to prevent it from beeing pressed inadvertently, when the cuvette is not free of ozone.

Automatic zeroing takes about three seconds. Meanwhile a red indicating light is blinking, to show that the auto zero function is activated and still working. If the instrument can not be zeroed the indicating light does not stop blinking. This will be the case, when the cuvette is soiled too much, when the instrument is defective, or simply when ozone is inside the cuvette. Except in the latter case, the instrument will need service or repair when the **"AUTO ZERO"** light will not stop blinking (see section 7.).

If the OZONE ANALYZER BMT 961 should be monitored and controlled by a programmable controller, the AUTO ZERO function may be started by connecting terminal 1 of the terminal block with +5 V (terminal 2), or any other +5 V source with the same common. The voltage at terminal 3 (AUTO ZERO RUNNING) is +5 V as long as AUTO ZERO is running, and remains +5 V if zeroing is not possible.

The complete procedure of zero adjustment (purging the cuvette and auto zeroing the analyzer) can be made automatic with our TIMER BMT 961 T or the TIMER / INTERFACE BMT 961 TI. Both instruments use a solenoid valve

and a gas pump to purge the cuvette. They may be programmed for an interval of 2 to 24 hours after which zero adjustment will be repeated automatically.

Concerning the **"TEST 50% (FROM ZERO)"** function refer to section 5.

When the measured conceniration rises above 110% of range, the red indicating light **"OVERRANGE"** starts blinking.

Concerning the **"LAMP LOW"** red warning light refer to section 5. If this warning light does not disappear a few minutes after the analyzer has been switched on, the mercury lamp is at the end of it's life and should be replaced as soon as possible (see section 7.)

7 Maintenance and Repair

Maintenance of the OZONE ANALYZER BMT 961 consists of cleaning the cuvette windows (if necessary), and replacing the mercury lamp (after about 20.000 hours of service).

Whether the cuvette windows need to be cleaned, and how often, depends upon the impurities contained in the sample gas. We recommend the use of a sample gas filter in front of the analyzer, to prevent the cuvette windows from being soiled (see section 3.). When the "AUTO ZERO" lamp will not stop blinking (with zero gas in the cuvette!) the cuvette is severely solled.

Electrical check of cuvette windows:

1. Press the AUTO ZERO push button. Make sure that zero gas is flowing through the cuvette. Keep the button pressed.
2. If the cuvette is clean the display will show about 23 - 25% of range (e.g. 12 g/m^3 with an instrument with measuring range 50 g/m^3).

   If the cuvette windows are soiled the reading will be higher. A reading of 30 - 40% of range indicates a dirty cuvette. If the reading would be higher than about 50% of range, the AUTO ZERO will no more be able to cancel out the zero offset by dirty cuvette windows.

   If the display is blinking and is not readable, the windows are very dirty.
3. Release the AUTO ZERO push button.
   (These instructions apply to instruments with measuring ranges of 5 to 200 g/m^3)

After replacement of the mercury lamp, the instrument should be readjusted.

We recommend that for any maintenance and repair, the OZONE ANALYZER BMT 961 be sent back to the factory:

BMT MESSTECHNIK GMBH
Argentinische Allee 32a
D-14163 Berlin (GERMANY)
phone (030) 801 85 95
fax (030) 802 23 62

We will service an instrument normally within three days, and return the device immediately.