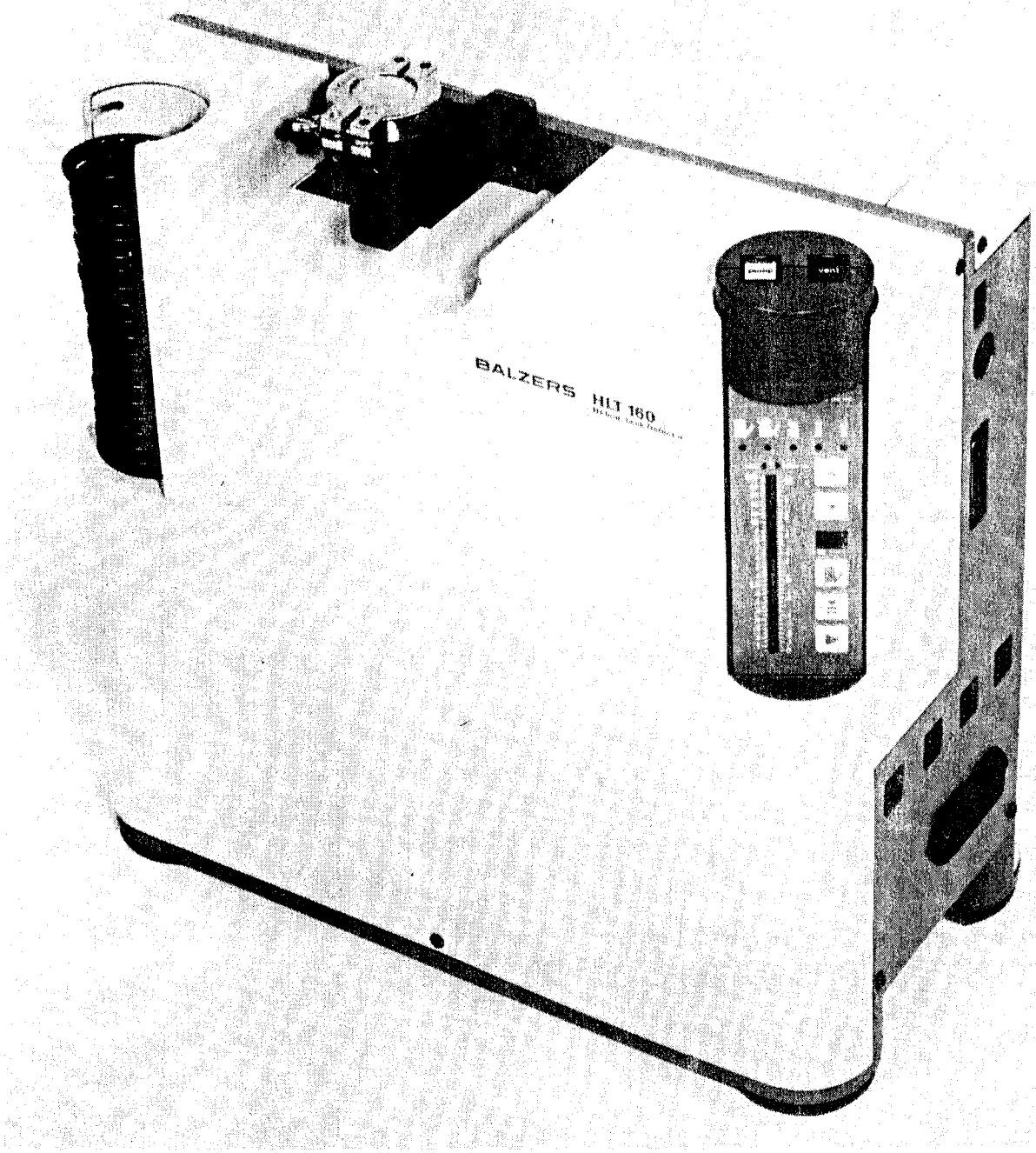
Helium leak detector

HLT 160



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Mnemonic

set point (switching thresholds for the relay outputs)

Transmit: SPn [,x,y.yE-yy] <CR> [<LF>]

- Threshold
- Operating mode: 0 = off
  1 = offset - setpoint, ⊗ ↑
  2 = offset - setpoint hold, ⊗ ↑ hold
  3 = absolute - setpoint, ⊗ ↑ ↓
  4 = absolute - setpoint hold, ⊗ ↑ ↓ hold
  5 = ready to **measure**
  6 = ready to pump
- 1 = Setpoint No. 1
  2 = Setpoint No. 2
  3 = Setpoint No. 3

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>

Transmit: <ENQ>

Receive: x,y.yE-yy <CR> <LF>

- Threshold
- Operating mode: 0 = off
  1 = offset - setpoint, ⊗ ↑
  2 = offset - setpoint hold, ⊗ ↑ hold
  3 = absolute - setpoint, ⊗ ↑ ↓
  4 = absolute - setpoint hold, ⊗ ↑ ↓ hold
  5 = ready to **measure**
  6 = ready to pump

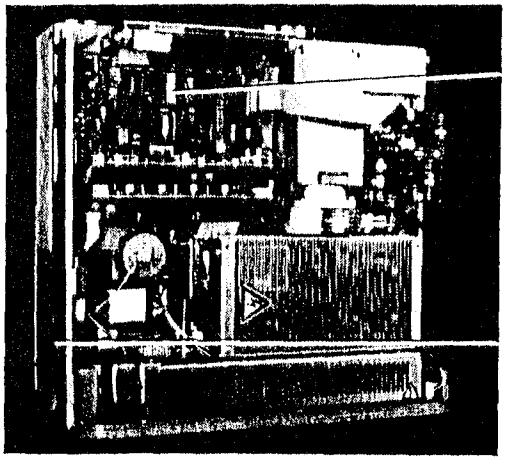
3 Changing the EPROM

DANGER

The EPROM may only be changed by persons with suitable technical training.

Procedure

- Note the parameter settings (the new EPROM loads default parameters).
- Switch off the HLT 160 and wait for approx. 3 minutes until the venting process is completed.
- Disconnect all cables, finishing with the mains cable.
- Remove the rear cover (→ fig. 1).



EPROM

Cables removed

Fig. 1

2. The operating mode selection unit's service level (Service overlay)

The second level (service level) of the operating mode selection unit supports the retrieval and modification of data and functions not listed in 4.1.2 of the short operating instructions.

To activate the service level, press <enter> and then the < ▶ > key. The «overlay active» LED (1/10) turns on, indicating that the service level is active.

To operate the mode selection unit at the service level, place the service overlay foil (usually stored in the cover of the operating mode selection unit) over the control panel so that the keys remain free.

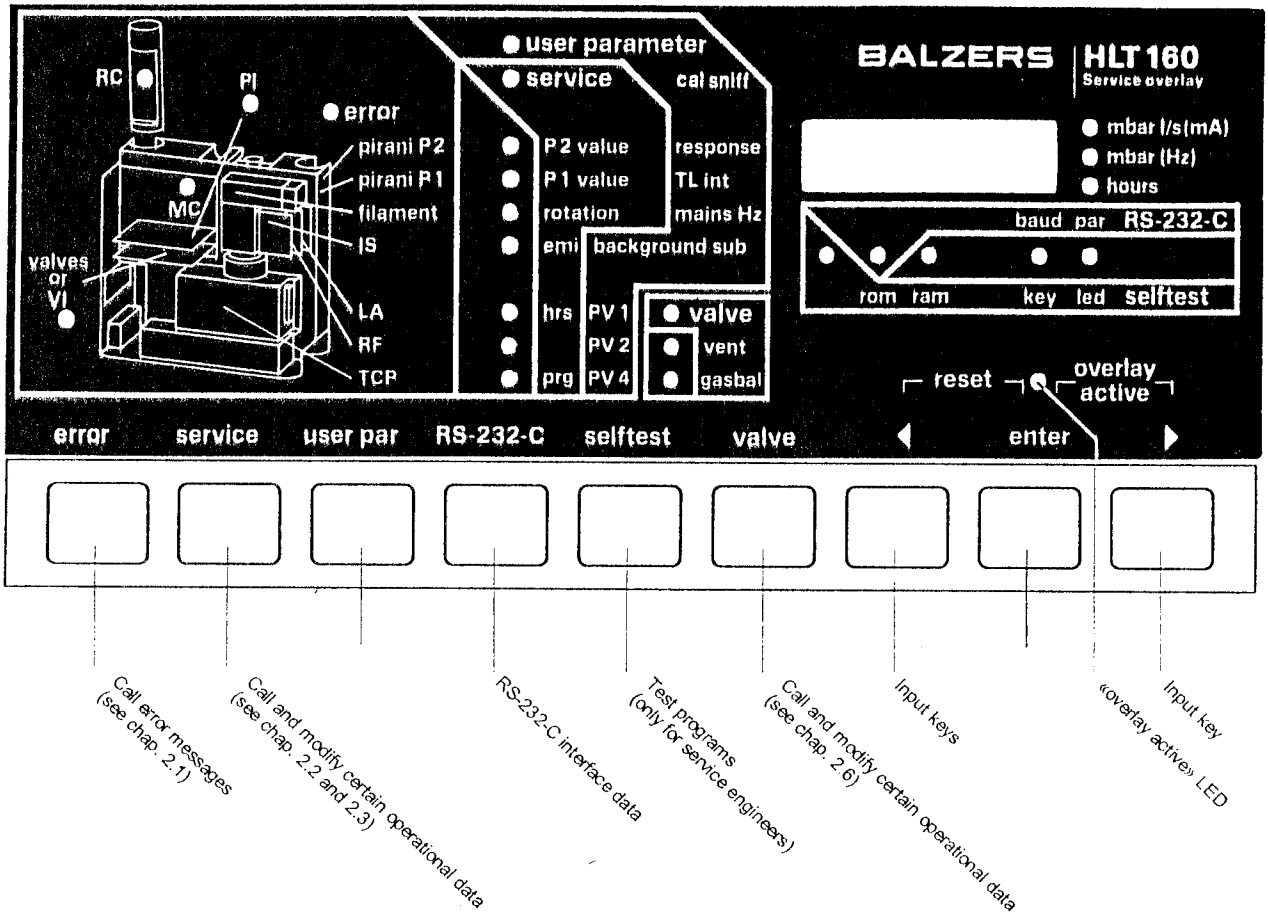


Fig. 1 Service overlay

2.1 «error» messages

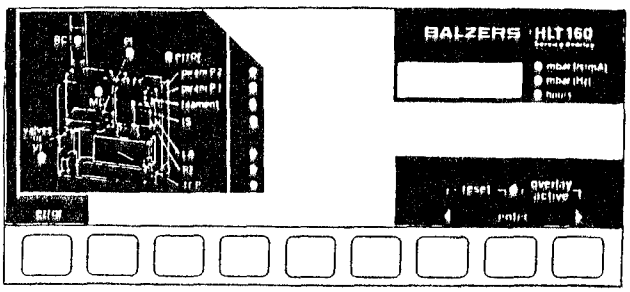


Fig. 2

Press <enter> and < ▶ >, place the overlay foil on the control panel.

If an error exists, the LED of the corresponding assembly turns on in the system diagram, and the error number is shown on the combination display.

It is possible to call extended error number «Enn,xx» on the combination display for several error types by pressing <error> repeatedly. The <error> LED indicates that an error message has been called.

2.2 «service» data

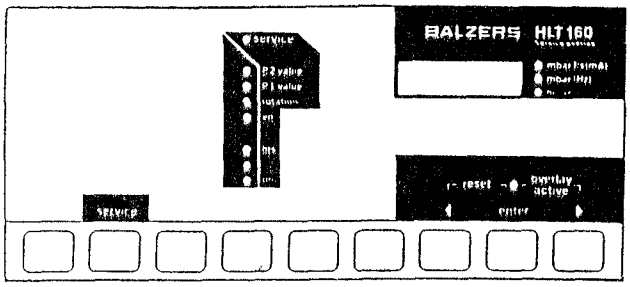


Fig. 3

Press <enter> and < ▶ >, place the overlay foil on the control panel and press <service>.

The «service» LED turns on, indicating that the service data have been called and that the LED display refers to the parameters in the corresponding column.

The required parameter can be retrieved by pressing <service> repeatedly until the corresponding LED turns on.

2.2.1 «P2» value

Roughing pump inlet pressure in mbar.

(A displayed value of 0.0×10^{-2} mbar corresponds to $<1 \times 10^{-2}$ mbar).

2.2.2 «P1» value

Turbopump exhaust pressure in mbar.

(A displayed value of 0.0×10^{-2} mbar corresponds to $<1 \times 10^{-2}$ mbar).

2.2.3 «rotation»

Turbopump speed in revolutions per second (Hz).

2.2.4 «emi»

Display (in mA) and modification of the emission current. Two different emission currents are used in measurement mode.

The setpoint for the higher value (flashing «H» on the combination display) is between 0.650 and 0.750 mA (set with potentiometer R7 (see Fig. 4), adjustment range approx. 0.630 to 0.980 mA).

The lower value (flashing «L» on the combination display) is between 0.01 and 0.1 mA (adjustment with potentiometer R4 (see Fig. 4)). This value must be set individually for each analyzer. The lower emission value must also be realigned after work has been carried out on the ion source (filament replaced, etc.).

If the lower emission value is not correctly aligned, an incorrect leak rate is displayed for hydrogen in general and for helium when larger leaks (from approx. 1×10^{-6} mbar l/s for objects on test port 1) occur. If the «L» value is too low, the HLT can continually switch between «H» and «L» at certain leak rates (unstable display).

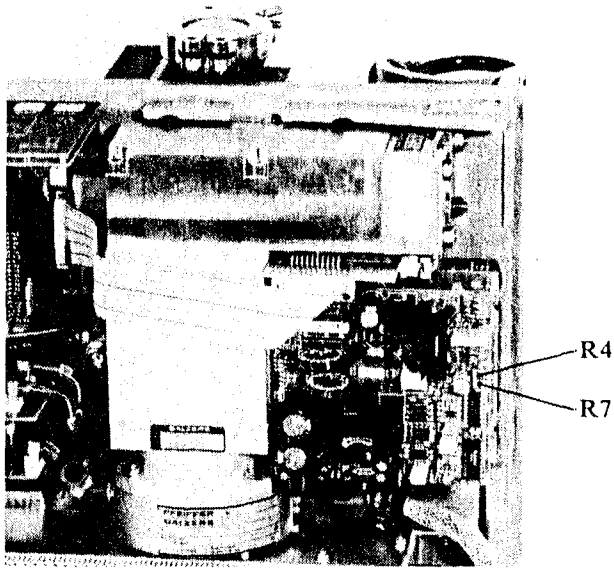


Fig. 4

R4 (lower emission value)
R7 (higher emission value)

Procedure for aligning the lower emission value

A helium leak of approx. 6×10^{-7} mbar l/s is required for aligning the lower emission value. If a calibrated leak is not available, it is possible to use a needle valve (EVN 010) set to an air inlet rate of approx. 0.1 mbar l/s. The HLT should have been turned on for at least 1 hour before the emission value is aligned.

Place the service overlay foil on the control panel.

Remove the rear housing shell.

⚠ **DANGER:**
Do not touch any parts on current.

2.2.4.1 Alignment with He calibrated leak

a) Activate «Test port 1», mass «4» and «gas» equivalent (see 4.5.1, 4.5.6 of the short operating instructions).

b) Press <vent> and connect the open leak to test port 1.

c) Press <pump>, allow the displayed leak rate value to stabilize (approx. 10 minutes) and write this value down.

d) Press <enter> and < ▶ >: The «service» and «overlay active» LEDs turn on.

e) Press <service> repeatedly until the «emi» LED turns on. The momentary emission value appears on the combination display; for the higher emission value this is normally «H0.750».

f) Press <enter>: The lower emission is turned on. The combination display alternately shows the lower emission value, (flashing «L» and «0.0 nn») and the leak rate value, each for approx. 2 s.

«or» on the combination display indicates that the lower emission value is set too high or that the calibrated leak value is too high. Press <enter> to return to the higher emission value. If «or» is also shown there, the calibrated leak value is too high. (For an extremely sensitive analyzer (calibration factor below 0.3), a test leak with a rate of less than 6×10^{-7} mbar l/s should be used).

Otherwise proceed as follows:

g) Wait approx. 1 minute and then align the leak rate value on potentiometer R4 (see Fig. 4) to the value previously measured for the higher emission. Turning the potentiometer clockwise increases the value, turning it counterclockwise decreases the emission and leak rate value.

h) Press <enter>: The display changes to the higher emission value and its corresponding leak rate. It can take several minutes for the leak rate value to stabilize. Check that the measured value is the same for both the higher and the lower emission values.(Press <enter> to change between the higher and lower emission values).

The emission alignment procedure is now completed.

i) Press <reset> to return to the measurement mode.

NOTE:
The required value for the lower emission limit depends, among other factors, on the radial filament position: If the highest possible value (approx. 100 µA) is still too low or the smallest possible value (10 µA) is still too high, the filament position must be changed (refer to sections 3.1 and 3.2).

2.2.4.2 Alignment with needle valve

a) With the HLT in <vent> status, connect the open needle valve to test port 1.

b) Press the <gas in> and <enter> keys to activate the «sniffer» function.

c) Continue pressing the <masses> key until mass «4» and leak evaluation «gases» flash, then press <enter>.

d) Press <enter> and < ▶ > and place the overlay foil on the control panel. The combination display now shows pressure P2.

e) Press <pump>; turn the knob on the needle valve until pressure P2 reads 0.4 mbar.

f) Press <service> repeatedly until the «emi» LED turns on. The combination display now shows the momentary emission current.

g) Press <enter> twice: The combination display alternately shows the emission current (typically H0.750) and the leak rate (typically approx. 1×10^{-6} mbar l/s). Wait several minutes until the leak rate value stabilizes, and then write the value down.

h) Proceed as described in 2.2.4.1 (from step f onward).

2.2.5 «hrs»

Duty time (sum of all the times the system was powered up) in hours.

2.2.6 «prg»

Display of the software version.

2.3 «user par» operating parameters

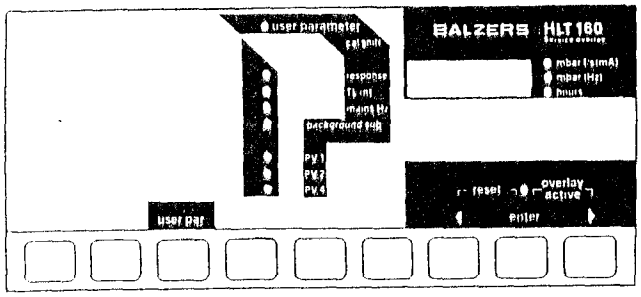


Fig. 5

Press <enter> and < ▶ >, place the overlay foil on the control panel and press <user par>.

The «ur parameter» LED turns on to indicate that the "user" parameters have been called and that the LED display refers to the parameters in the corresponding column.

2.3.1 «cal sniff» correction factor in sniffer mode

The following formula applies to the leak rate indication in sniffer mode:

$$LR_{Display} = \text{cal sniff} \times (LR_{Measurement} - LR_{Background})$$

$LR_{Background}$ is determined by the calibration.

When the sniffer probe is held against a test leak, the measured leak rate ($LR_{Measurement}$) will be too low, depending on the flow splitting of the LP 166. If $LR_{Display}$ should correspond to the test leak value $LR_{Testleak}$, «cal sniff» must be calculated according to the following formula and then entered:

$$\text{cal sniff}_{new} = \frac{LR_{Testleak}}{LR_{Display}} \times \text{cal sniff}_{old}$$

2.3.2 Time constant for the measured value filter «response»

The background noise becomes more noticeable, the lower the leak rate signal becomes. On the HLT various filter time constants can be selected to optimize either the measured value stability (resolution) or the signal response time, depending on the application.

For leak rates above approx. 10^{-8} mbar l/s on test port 1, the filter time constants are ≤1.2 s and have virtually no effect. The filter time constants for lower leak rates are as follows:

	«response» Filter		
Leak rate	«FAST»	«StAnd»	«Slo»
$<10^{-9}$	1,2 s	10 s	40 s
10^{-9} ... 10^{-8}	0,3 s	2.4 s	10 s

The response times when closing a ^{4}He calibrated leak of 4×10^{-10} mbar l/s is typically:
- 5 s in "Slo"
- 2 s in "StAnd" and
- 1 s in "FAST" mode.

If the leak rate signal (for example, on test port 1) rises above 10^{-9} mbar l/s for helium, a correspondingly smaller lower time constant is automatically used for the measured value. (The leak rate limits are higher for other measuring methods).

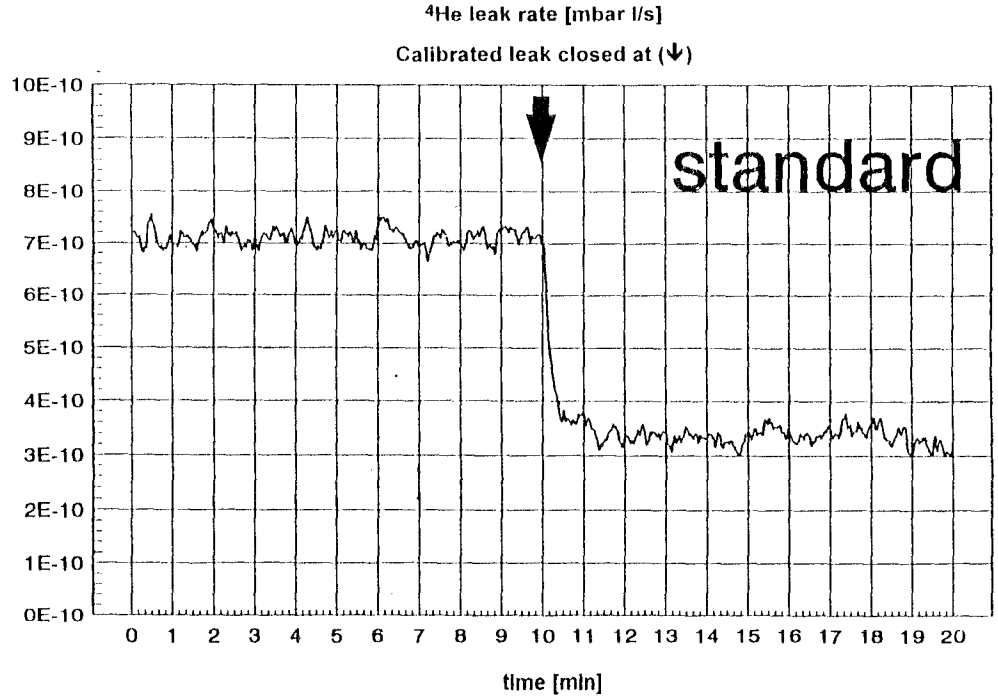


Fig. 6a

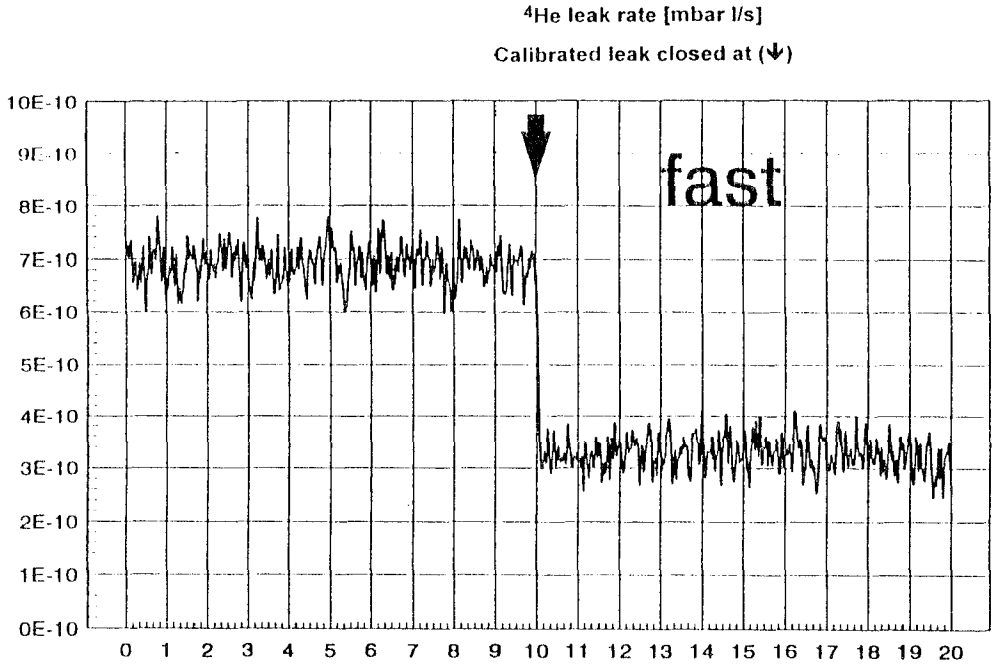


Fig. 6b

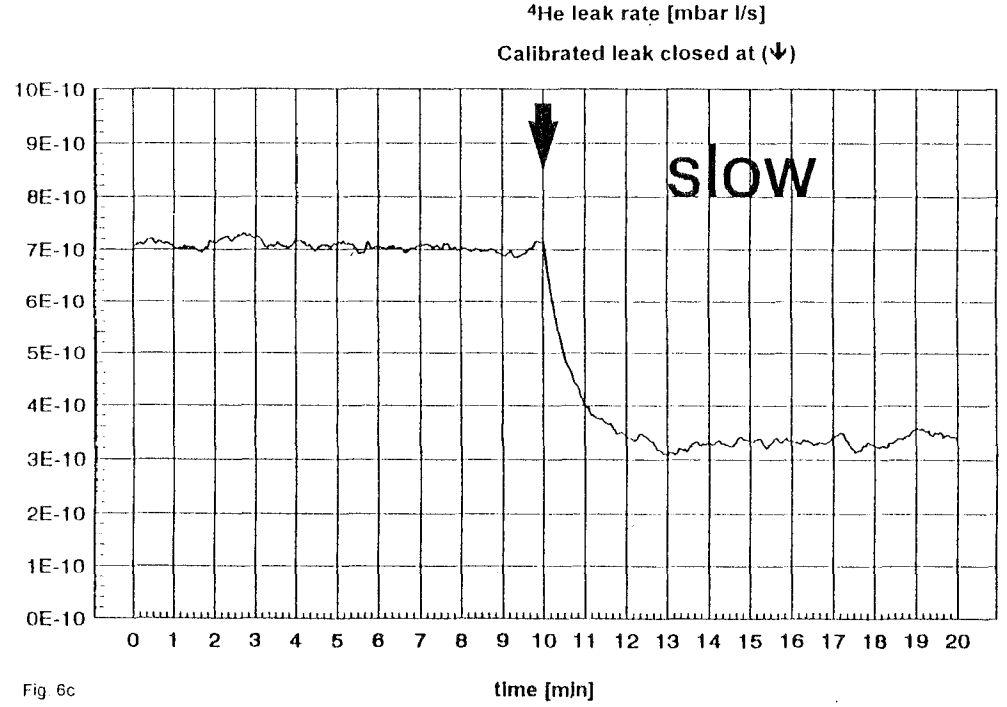


Fig. 6c

Stability of the measured values at low leak rates (calibrated leak 3.7×10^{-10} mbar l/s ^{4}He on test port 1) and various time constants (typical behavior).

The detection sensitivity in «Slo» (i.e. "minimal detectable leak rate" according to AVS 2.1 Rev. 1973) in this case it is approx. 5.5×10^{-11} mbar l/s helium leak rate.

Changing the time constants

a) Press <enter> and < ▶ >, place the overlay foil on the control panel.

b) Press <user par> until the «response» LED flashes. The stored filter time value lights up on the combination display.

c) Press <enter>: A filter time value flashes on the combination display.

d) To accept the filter time constant shown: Press <enter>.

   To change the filter time constant: Press < ◀ > repeatedly until the required filter time is shown flashing. Press <enter>. The filter time constant now lights up continuously to indicate that it has been accepted.

e) Return to the normal operating level using the <reset> function.

2.3.3 Internal calibrated leak «TL int»

The HLT can calibrate itself fully automatically with the built-in calibrated leak (TI int). The temperature of the calibrated leak is taken into account in this process.

Whether or not a calibrated leak is configured must be defined in the «user parameter» and «TL int» with «on» or «oFF». If a calibrated leak is defined, the He leak rate for the calibrated leak at 20 °C must also be entered.

The current leak test temperature can be output on the combination display (see step f).

The error message «or °C» means:
The sensor is not connected or the temperature is below 0 °C or over 70 °C.

NOTE:
At room temperature, the helium flow of the calibrated leak decreases by approx. 2% p.a., and if the HLT is switched on by approx. 3% p.a. For maximum calibration accuracy the stored calibrated leak value should be occasionally corrected.

«TL int» should not be activated when no internal leak has been installed (possible source of malfunction).

Entering parameters for the internal calibrated leak

a) Press <enter> and < ▶ > and place the overlay foil on the control panel.

b) Press <user par> repeatedly until the «TL int» LED flashes. The value stored for the internal calibrated leak is shown on the combination display.

c) Press <enter>: «on» or «oFF» flashes on the combination display.

d) Either press <enter> to enter the status shown on the display; or press < ◀ > to change to the other status and then press <enter> to accept that status.

e) If «on» was entered, a calibrated leak value will flash on the combination display. If this value equals that of the installed calibrated leak when it is at 20 °C, you can accept it by pressing <enter>. Otherwise change the values using the < ▲ > or < ▼ > key, and then press <enter>. The entered value now lights continuously.

f) To see the current calibrated leak temperature (typically 18 °C above the ambient temperature), press <enter> again.

g) Return to the normal operating level using the <reset> function.

2.3.4 Mains power frequency «mains Hz»

To function correctly, the HLT must be set to the frequency of the mains power on which it is being operated (50 or 60 Hz). Otherwise the measurement values shown can be incorrect.

a) Press <enter> and < ▶ > and place the overlay foil over the control panel.

b) Press <user par> repeatedly until the «mains Hz» LED flashes.

c) 50 or 60 Hz will be shown on the combination display. Press <enter>: the frequency starts to flash. Enter the correct value using the < ◀ > key and press <enter>.

d) Return to the normal operating level using the <reset> function.

2.3.5 Background subtraction «background sub»

Normal air contains 5.2 ppm helium. In areas where helium is used as a tracer gas, the concentration can be considerably higher. This helium penetrates the analyzer principally due to permeation and the finite compression of the pump system and it becomes noticeable in the background (typically 5×10^{-10} mbar l/s He). When the background subtraction function is switched «on», the background leak rate is deducted from the measured leak rate; when the background subtraction is switched «oFF», the uncorrected value is displayed.

Switching the background subtraction on/off

a) Press <enter> and < ▶ > and put the overlay foil in place.

b) Repetitively press <user par> until the «background sub» LED flashes.

c) Press <enter>. The displayed value flashes. Select a new value by pressing < ◀ > and confirm it with <enter>.

d) Press <reset> to return to the normal operating level.

When the background subtraction function is on, operate the leak detector in the vent state long enough (>1 min) to allow the background value to stabilize.

2.3.6 Switching thresholds «PV1, PV2, PV4»

When certain set point values are reached (PV1, PV2, PV4), valves in the HLT are opened or closed. For optimal adjustment to a particular measurement job, PV2 and PV4 can be changed.

2.3.6.1 «PV1»

Fixed pressure parameter (0.5 mbar) to determine if the HLT is ready for operation and tracer gas can be admitted to the analyzer.

2.3.6.2 «PV2»

Switchover from test port 2 (capillary) to test port 1 in split flow mode (refer to the description in 6.7.6 of the short operating instructions).

Variable between 1.0×10^{-5} and 9.9×10^{-5} mbar l/s.

For high PV2 values and very demanding pumping conditions (moist or very large test objects) the gas load for test port 1 may be too high so that the HLT changes back and forth between test port 1 and test port 2 frequently. For low PV2 values, the HLT may take too long measuring at test port 2 when the background is higher. (Measurement on test port 2 in split flow mode is less accurate and should only be on for as short a time as possible).

Usual setting for PV2: 4×10^{-5} mbar l/s.

Changing the value for PV2

a) Press <enter> and < ▶ > and place the overlay foil on the control panel.

b) Press <user par> repeatedly until the PV2 LED flashes.

c) The switching threshold value is shown on the combination display.

   You can accept this value using the <reset> function or change it as follows:

d) Press <enter>: The switching threshold value flashes and can be changed digit for digit using the < ◀ > and <enter> keys.

e) Return to the normal operating level using the <reset> function.

2.3.6.3 «PV4»

Change from counter flow to turbo counter flow measurement.

Standard: 9.9×10^{-2} mbar, variable to 3×10^{-2} mbar.

In quick pump mode (refer to the description in 6.7.5 of the short operating instructions) the auxiliary pump will be cut off at this pressure. If a very high gas load occurs at this point (very moist or very large test object, »10 l) the HLT may return to the pumping phase automatically. To prevent the HLT from returning to the pumping phase you can adjust the value for PV4 correspondingly. Since slight oil backstreaming can occur already in the 10^{-2} mbar range, the value entered for PV4 should not be lower than absolutely necessary. When the lower PV4 value is no longer required or when you exit quick pump mode, you should reset the value to the normal 9.9×10^{-2} mbar.

Changing the value for PV4

Proceed as described in 2.3.6.2.

2.4 «RS-232-C» interface data

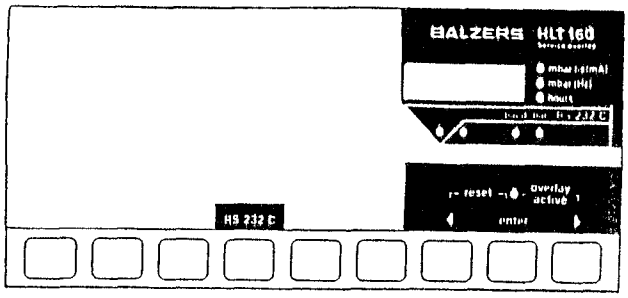


Fig. 7

The correct Baud rate must be entered (300, 1200, 2400, 4800, 9600) to allow operation with the RS-232-C interface. In addition you have the options of selecting parity «OFF», «En» (for even) or «odd».

a) Press <enter> and < ▶ >and place the overlay foil on the control panel.

b) Press <RS-232-C> repeatedly until the LED next to the parameter values you want to change – either «baud» (Baud rate) or «par» (parity) – flashes.

c) Select the currently set parameter by pressing <enter>. The corresponding LED will light continuously. A "value" is shown on the combination display.

d) Press < ◀ > repeatedly until the required value flashes.

e) Press <enter> - the value lights on the combination display.

f) Return to the normal operating level using the <reset> function.

2.5 «Selftest» routines

These internal self-test routines are only for use by Balzers service engineers or those users who have completed a Balzers service course.

If you enter this mode by accident, you can exit it using the <reset> function.

2.6 «valve» vent valve and gas ballast valve control

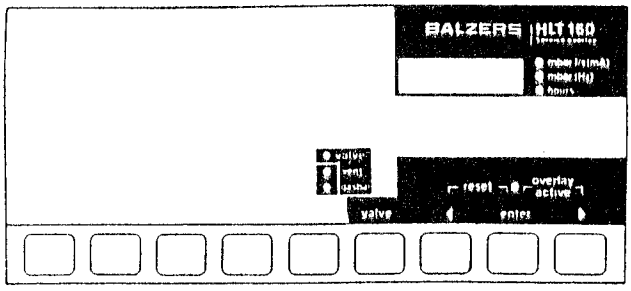


Fig. 8

a) Press <enter> and < ▶ >, put the overlay foil in place and press <valve>.

   The «valve» LED turns on to confirm that the "user" operating parameters have been called and indicates the column in which these parameters are found.

2.6.1 «vent» vent valve control

There are two states for the «vent» valve parameters: «auto» and «cloSd».

	«auto»	«cloSd»
Press the <vent> RC key	Vent valve V3 opens Test port 1 is vented	Vent valve V3 remains closed Test port 1 is not vented

If the HLT is connected to a vacuum system via test port 1, «cloSd» prevents inadvertent venting of the system when the <vent> key is pressed.

Changing the vent valve control

a) Press <enter> and < ▶ > and put the overlay foil in place.

b) Press <valve>: The «valve» LED turns on and the «vent» LED flashes.

c) The combination display shows auto or «cloSd».

   Press <enter>: The displayed state flashes. Select the required state by pressing < ◀ > and confirm with <enter>.

d) Press <reset> to return to the normal operating level.

2.6.2 «gasbal» gas ballast valve control

After periods of strong or prolonged helium flow there is usually an elevated helium background. If readings of over approx. 10^{-6} mbar l/s helium are obtained, the gas ballast valve in the roughing pump is automatically opened and the pump "purged" until the measured value drops below 10^{-8} mbar l/s (with «gasbal» set to «auto».

Prolonged purging can be activated with the «oPEn» function (suggested time approx. 20 min.).

There are four possibilities: «auto», «cloSd», «oPEn» and «SEtPt».

«auto»

The gas ballast valve opens when the background rises to a value above approx. 10^{-6} mbar l/s helium. The gas ballast valve closes again when the background drops to a value below approx. 10^{-8} mbar l/s.

«cloSd»

The gas ballast valve remains closed.

«oPEn»

(Opening time selectable from 0.01 to 99.99 h)

The gas ballast valve is open.

When the gas ballast valve is open, the background is higher by approx. 1×10^{-10} mbar l/s. The gas ballast valve should not be left open longer than necessary because oil can emerge from the oil mist filter after prolonged operation.

«SEtPt»

The response threshold of the gas ballast valve can be set manually within the range of 1.0 E-10 to 9.9 E+3 mbar l/s.

The gas ballast valve opens when the leak rate increases above the threshold and closes when the leak rate is 10% below the threshold.

Changing the gas ballast valve control

a) Press <enter> and < ▶ > and put the overlay foil in place.

b) Repetitively press <valve> until the «gasbal» LED flashes.

c) The combination display shows either «auto», «cloSd», «oPEn», or «SEtPt».

   Press <enter>: The displayed setting flashes. Change the setting by pressing < ◀ > and press <enter>.

   If «open» has been selected, the time during which the gas ballast valve should remain open must also be entered. If you select 99.99 h, the gas ballast valve remains open indefinitely. If «SEtPt» has been selected, the response threshold for the gas ballast valve must also be entered.

2.7 The manual valve control service level (Valve overlay)

The valve states and values for P1, P2, the turbo speed and the DUO voltage signal are displayed in the third level of the operating mode selection unit (valve overlay foil).

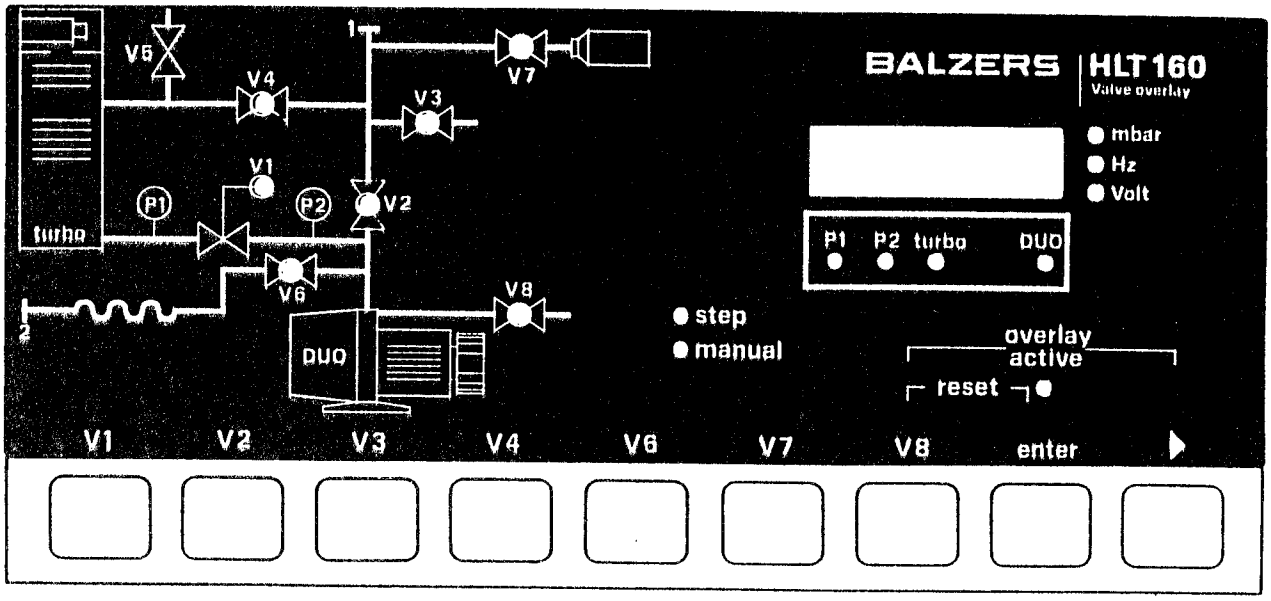


Fig. 9

Procedure

(Explanation of symbols: (Fig./item<input key>«status indication»)

a) Put the valve overlay foil in place.

b) Press <V8> and within 0.1 sec. also < ▶ > (overlay active)

«Code» appears in the display field.

LEDs light up in the vacuum diagram on the foil to indicate which valves are open.

⚠ **CAUTION:**
After the code has been entered, the valves can be actuated manually. To prevent damage to the HLT, the code is disclosed only to persons who have attended an HLT training course at Balzers. This code may not be used by anyone who has not received this training.

c) Press <enter> and <V8> (reset) to return to the normal operating level.

3. Maintenance

⚠ DANGER:
Pull the mains power supply plug before opening the unit! The HLT may only be opened by authorized personnel.

There is danger of electrical shock and injury from the cooling fan if the unit is connected to the mains power when it is open.

3.1 Replacing the filament

The filament must be replaced if it is defective (error message 12).

- Turn off the HLT and wait for the turbopump to come to a complete standstill.
- Unplug the mains power cable and wait 1 minute
- Remove the rear housing shell.
- Using a socket-head wrench, loosen the (10 mm) fastening nuts.
- Carefully remove the analyzer and set it up so it cannot fall over.
- Loosen screws (a) and remove the old filament (b).
- Install the new filament so that the arc is facing toward the analyzer connector plate (Fig. 10c).

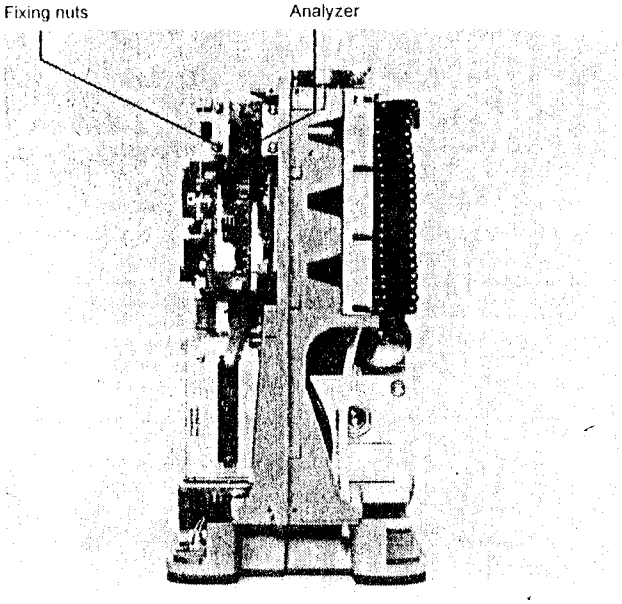


Fig. 10a

- Center the new filament to the analyzer axis and then screw it to pin (c). Carefully remove the transport protection ring (T) by cutting it off with small side cutting pliers. The filament can not be centered further by detaching one leg (b) from the pin and moving the filament with the leg into the desired position.
- Recheck the filament position. If the filament arc cannot be centered by this method, the filament position must be corrected by bending the sheet metal legs (b) with small flat-nose pliers.
- On completion of the installation the filament should be centered around the inlet opening and approx. 1.1 mm away from the axis. The diameter of the inlet orifice is 1 mm and this dimension can be used as a measuring aid.
- Before the system is installed, check the position of the filament relative to the Wehnelt plate and if necessary correct it by lightly pressing against the legs (b) (Fig. 10b).

  The filament should protrude from the Wehnelt plate in such a way that the distance to the plate is approx. 1 to 2 filament diameters (approx. 0.3 mm) (Fig. 10b).

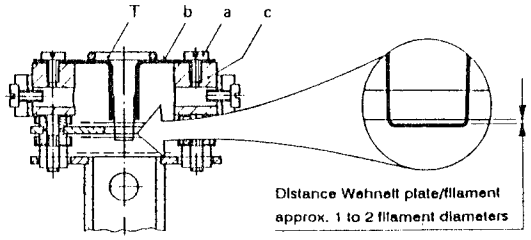


Fig. 10b

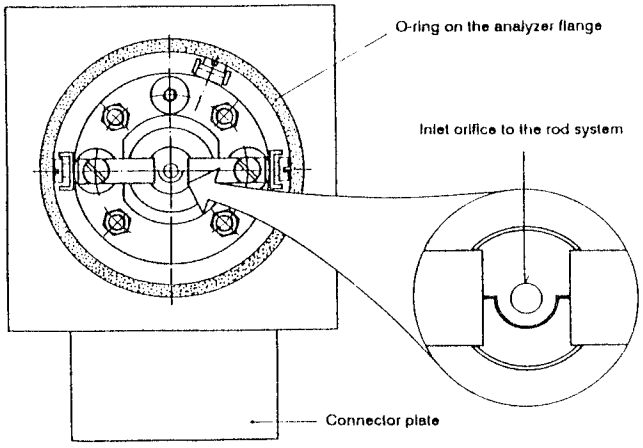


Fig. 10c

- The lower emission current must be readjusted for accurate measurement at higher leak rates.(refer to section 2.2.4).
- After a filament replacement or filament position change, the HLT must be recalibrated (refer to the short operating instructions, section 4.7).
- The required lower emission current depends, among other factors, on the axial distance of the filament:

  If the highest possible value (approx. 100 µA) is insufficient for alignment, the filament should be bent at the sheet metal legs in the direction of the axis; if the lowest emission current (10 µA) is still too high for alignment, the filament should be bent away from the axis (refer to the Short operating instructions, section 4.7).

3.2 Signal optimization/problems with measured values

Depending on the filament position, the annular magnet, the condition of the analyzer grid, and operating conditions such as temperature and inlet pressure, it may be possible to improve the measurement accuracy by changing certain ion source parameters. Tips on signal optimization are given below.

3.2.1 Background signal too high

(e.g. above 1 × 10^{-9} mbar l/s with background subtraction function off)

This phenomenon is normal immediately after the equipment has been turned on, however, after an operating time of approx. 1 hour, the background should be lower than 1 × 10^{-9} mbar l/s.

If the background does not drop below 1 × 10^{-9} mbar l/s, check for the following:

- HLT is not tight (locate the leak!)
- The ambient air contains a high amount of helium (accelerate the air exchange!).
- The inlet pressure is very high or the distance between the filament and the axis is too long. Reduce the inlet pressure or the filament distance.

  Another possibility is to decrease the field axis voltage for the analyzer (potentiometer R11, test points 9 and 10 in front of the RF 160 board which is the second one of the three analyzer boards (see Fig. 13)). With the calibrated leak connected, slowly decrease the field axis voltage from the standard 6 V setting until the displayed leak rate drops significantly. Then increase the voltage again to a point just before the maximum leak rate.

3.2.2 Background signal drops

After the HLT has been switched on, the background signal drops to a value below 1 × 10^{-9} mbar l/s He (background subtraction function switched off), but later it increases very slowly but significantly.

After a <vent>/<pump> cycle the background signal drops to a minimum and then increases slowly toward a final value. This situation occurs particularly with low ambient temperatures.

The elevated background can be lowered by reducing the high emission current «EH» to the (min. approx. 640 µA).

3.2.3 Improving the analyzer sensitivity when the filament is not optimally aligned

- If the distance between the filament arc and the analyzer axis is too short, the standard field axis voltage (6 V) may be too low. (In this case the required lower emission current «EL» is usually low, e.g. below 30 µA). Increasing the field axis voltage according to section 3.2.1 may improve the sensitivity (adjustment range approx. 3 to 10 V). However, if the field axis voltage is set too high, the background signal will be disproportionally high.
- If the distance between the filament and the axis is relatively large (required lower emission current is high, e.g. over 60 µA), the sensitivity can possibly be increased and the background signal reduced by decreasing the field axis voltage (refer to section 3.2.1).

Normally the filament should be adjusted to its nominal setting, i.e. a field axis voltage of approx. 6 V. (refer to section 3.1).

3.2.4 Lower emission setpoint outside the adjustment range

(10 to approx. 100 (µA) refer to section 3.1).

3.2.5 Sensitivity jump during the starting phase of the HLT

If the distance between the filament arc and the analyzer axis is too large, a jump in the helium sensitivity can occur during the starting phase of the HLT (up to approx. 30 min.). If this is the case, the distance between the filament and the axis must be reduced (refer to section 3.1).

A sensitivity jump can also occur after the evacuation has been started with <Pump>. This should also be remedied as described above.

3.3 Changing the oil

3.3.1 Intervals

DUO 1.5 A

- Oil level check when the pump is hot (sight glass) every 200 service hours.
- Annual oil change or when the oil is discolored/contaminated.

Under the following operating conditions stronger oil contamination or oil consumption occurs:

- Oil contamination is stronger when larger gas quantities are transported, e.g. in prolonged "sniffer mode" operation.
- Frequent evacuation of larger volumes causes heavier oil contamination.
- In frequent evacuation of larger vessels and prolonged operation with gas ballast, the pump consumes more oil. This can result in oil emerging from the oil mist filter. This oil should be conducted through a tube to a collection vessel. In long-term operation with gas ballast, the oil level should be checked more frequently and replenished as required.

  (Approximate oil consumption by the pump: 1 cm^3 of oil per pumped m^3 of air. The gas flow with open gas ballast valve is approx. 0.1 bar l/s).

DUO 016 B

- Oil level check when the pump is hot (sight glass) every 200 service hours.
- Annual oil change or when the oil is discolored/contaminated.

- Pump motor: every 10,000 service hours.

TPH 050 (with 060 rotor)

- Annual oil change or every 5,000 service hours.

NOTE:
We recommend replacing the bearings every 15,000 service hours

3.3.2 Procedure

3.3.2.1 DUO 1.5 A

- Remove the front housing shell.
- Change the oil by using the aids supplied with the pump.

  Also refer to the separate operating instructions for the DUO 1.5 A.

3.3.2.2 DUO 016 B

- Refer to the separate operating instructions of the DUO 016 B

3.3.2.3 TPH 050 (with 060 rotor)

- Remove the rear housing shell.
- Disconnect all electrical lines to the TCP 120 turbo power supply and remove the TCP.
- Cover the HLT supply with a piece of cloth and remove and treat the lubricating inserts as described in the TPH 050 operating manual.

  NOTE:
  When reinstalling the TCP, take care that it remains far enough away from the turbo.

3.4 Replacing the rotary vane vacuum pump

- Switch off the HLT and wait until the turbopump has come to a complete standstill.
- Disconnect the mains plug and wait 1 minute.
- Remove the front housing shell.
- Unfasten the Serto fitting on the oil mist filter.
- Unscrew the two threaded taper pins on the oil mist filter.
- Remove the oil mist filter.
- Remove the oil retaining valve from the pump fitting.
- Unscrew the two threaded taper pins at the bottom of the valve block (metal bellows mounting).
- Lift the pump slightly and pull it out halfway.

  CAUTION:
  Do not damage the metal bellows.
- Detach the electrical connection to the motor.
- Detach the electrical connection to the gas ballast valve (plug type connection).
- Lift the pump slightly and take it out of the housing.

  NOTE:
  If the gas ballast valve must be detached from the pump, please note the exact mounting plane. If the gas ballast valve is mounted at too steep an angle, it will be difficult to reinstall the housing shell because the valve touches the intermediate bottom. If the valve is mounted at too shallow an angle, it will touch the housing wall.

  NOTE:
  When removing/reinstalling the fan please note: The clearance from the fan face to the HLT housing should be between 3 ... 8 mm when the pump is installed.

- Reinstall the pump by following the above steps in reverse order.

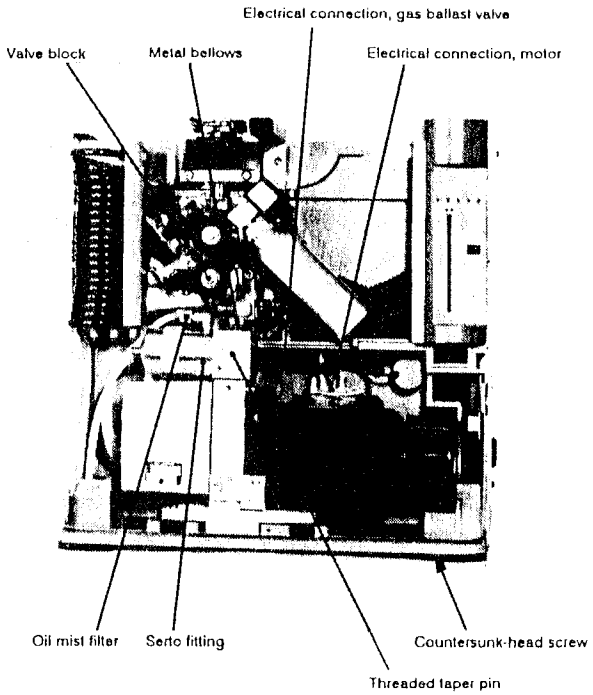


Fig. 11

3.5 Cleaning the ONF 010 oil mist filter

The degree to which oil collects in the oil mist filter depends on the working pressure of the rotary vane vacuum pump. If the oil level in the rotary vane pump sight glass has dropped significantly, the filter insert must be replaced or cleaned.

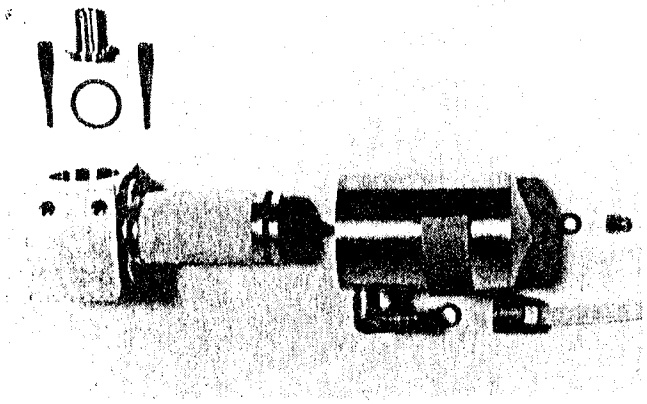


Fig 12

- Remove the front housing shell.
- Unfasten the Serto fitting on the oil mist filter.
- Unscrew the two threaded taper pins on the oil mist filter.
- Remove the oil mist filter.
- Remove the oil retaining valve from the pump fitting.
- Remove the cap nut on the oil mist filter.
- Remove the hood.
- Remove the nut on the filter.
- Remove the filter.
- Clean the hood, the oil retaining valve and the filter.

Organic solvents should be used to clean the filter.

The easiest method for cleaning is to submerge the filter insert in the solvent for approx. 12 hours, and then blowing the solvent out of the filter with a low pressure jet of air.

⚠ **DANGER:**
Explosive gas mixtures can occur if flammable solvents are used. If you use a flammable solvent, we recommend drying the insert under vacuum.

Spare parts	Ordering number
Filter insert	PK 002 009 -T
Flat seal for filter insert	P 0920 035 E

3.6 Cleaning the ONF 025 oil mist filter

Refer to separate user's guide ONF 025.

3.7 Notes on the TPH 050 turbomolecular pump (with 060 rotor)

The turbomolecular pump used in the HLT is a special version.

For this reason the separate operating instructions for the turbomolecular pump apply only to a certain extent.

It is especially important that only Balzers service engineers or customers who have completed a service training course change the bearings.

4. Troubleshooting

4.1 Error messages

A distinction is made among four categories of HLT errors.

- Operator errors:

  Operation not allowed in the current operation state:

  → Audible alarm on the remote control

  → «oP.Err.» flashing for 2 s on the operating mode selection unit

- Warnings:

  Errors that briefly disturb the proper functioning of the HLT:

  → Audible alarm on the remote control

  → Steady display of the error message

  → Reset to the basic "vent" state

  → Error message is cancelled automatically

- Calibration errors:

  See Section 4.7 in the short operating instructions (Calibration)

- Problems with measured values:

  Refer to Sections 3.2 and 4.3

- Fatal errors:

  → Audible alarm on the remote control

  → Flashing display of the error message

  → The leak detector remains in the initialization state until the error message is cancelled

  → The error message can only be cancelled with the <reset> function from the operating mode selection unit

- The error messages are always shown on the operating mode selection unit as an "error number". The "Service Overlay" offers an additional, detailed error message with information on the assembly in which the malfunction is suspected.

4.2 Error codes shown on the operating mode selection unit

⚠ CAUTION:
With the exception of the maintenance work described in Section 3, all steps to correct errors may only be carried out by properly trained personnel. Before correcting an error by replacing a part or an assembly, contact your nearest BALZERS Service center.

Please contact Balzers also if you wish to enrol in a training course on leak detection and HLT repair.

"E" and "H" flashing alternately on the remote control indicate a malfunction. When the «init» phase (6.7.1 in the short operating instructions) has been completed, the following error messages can appear on the operating mode selection unit:

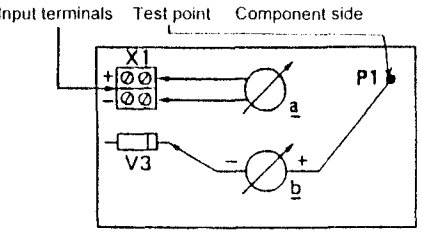
Error message	Possible cause	Correction
Error 00 «r.lost»	"User" parameter memory empty	(disappears when the «init» phase is completed and the unit defaults to the "factory" parameter set)
Error 01	Interference on the cable to the RC (RC shows «E» and «c»)	Use the <reset> function. Reduce external parasitic electrical signals.
Error 05	Inrush of gas at the test port	Disappears when the «init» phase is run through again
Error 06	Software execution interrupted	Use the <reset> function
Error 07	Roughing pump too slow: • Oil colder than 12 °C	Allow the roughing pump to warm up, then press reset
	Mains voltage too low: Roughing pump not running	Refer to the operating instructions for the DUO 1.5 A
	• Roughing pump running, speed signal missing	Check that the speed signal on the pump (connector) is available. It should be 5 to 7 VAC. Check the connection line to the MC Tacho generator defective, replace the pump
	DUO 1.5 A exhaust plug has not been removed	Remove the exhaust plug
Error 08	Emission current too low:	Replace the assembly
	• Emission board defective	Replace the IS 160
	• Filament position incorrect	Adjust the distance to the Wehnelt plate
	• Grid not at nominal voltage	Feeder line
	• Short circuit in analyzer	Remedy the short circuit or replace the analyzer
Error 09 immediately after init 0	Fault in the turbopump control Mains voltage too low	Switch the HLT off and switch it on again after 1 minute
Error 09 during init 1 or 2	Pressure in turbopump too high: • Valve V1 does not open (init 1) • Valve V5 does not close (init 2)	
	• TCP 120 defective	Replace the TCP 120
	• Turbopump defective	Check the turbopump and replace it, if necessary
Error 09 during operation	TCP 120 defective	Replace the TCP 120
	Turbopump defective	Replace the turbopump
Error 10 immediately after init 0	PI measurement card, Pirani sensor P2 (see Service Mode) or electrical connection defective	Replace
Error 11	PI measurement card, Pirani sensor P1 (see Service Mode) or electrical connections defective	Replace
Error 12	Break in the filament:	Replace the analyzer filament, see 3.1
	• Emission board defective	Replace IS 160
	• Short-circuit on the filament terminals	Remedy the short-circuit or replace the analyzer
Error 13	Analyzer or RF electronics defective	Replace

Error message	Possible cause	Correction
Errors 14 and 15	MC electronics defective	Replace
Leak rate display does not respond at all or only very weakly	Incorrect mass number set	Check the mass number setting
	Ion source in the spectrometer severely contaminated	Clean or replace the analyzer
	Lock-in amplifier defective	Replace the LA board
	Valve V1 or V4 does not open	Check the electrical connection Check the valve board and replace it, if necessary
Leak rate display continually shows «o.r.» (over range)	Manually set leak rate range exceeded	Switch to a less sensitive range
	Leak rate too high	Set a lower tracer gas concentration
	Preamplifier in spectrometer defective	Replace the preamplifier
	Lock-in amplifier defective	Replace the lock-in amplifier

4.3 Malfunctions

⚠ **DANGER:**
Disconnect the mains power cable before handling any fuses in the HLT.

Error message	Possible cause	Correction
The displays on the operation mode selection and remote control units are all dark	Mains fuses: (Roughing pump is not running)	Check mains power fuses F1 and F2: 220 ... 240 VAC : 4 A slow blowing 110 VAC : 8 A slow blowing
	Power supply PS: (Roughing pump is running)	Check the PS fuses
The displays on the RC remote control are dark	Cable to the remote control	Check the plug connections and the cable itself
	Operating unit defective • Displays on the operating mode selection unit are functioning	Replace the RC remote control
«init» lights continuously after the unit is turned on	Error in pumping system (e.g. in control)	Check
After power up, the display continually shows «init 1» (p2 >0.1 mbar) **NOTE:** If the HLT is working correctly, the "init 1-3" states are passed through within 3 minutes, after which the unit is ready for operation	Valve V2 not tight	Clean the valve seat V2
	Valve V1 or V6 not tight	Clean the valve seat V1 or V6
	DUO 1.5 A roughing pump does not attain the ultimate pressure	Check the oil level through the pump sight glass and replenish the oil if necessary
	Pump oil contaminated or saturated with water vapor	Check the oil discoloration through the pump sight glass. If the discoloration is not severe, clean through gas ballast mode
	Safety valve in the roughing pump does not open	Refer to the operating instructions for the DUO 1.5 A

Error message	Possible cause	Correction
After power up, the display continually shows «init 2» (p1 >0.1 mbar)	Vent valve V5 open • TCP 120 defective • Valve board VD defective • Valve coil V5 defective	1. Put your finger against valve opening V5 (filter) and check if there is any suction. If there is no suction, the valve is closed, otherwise: Y 2. Measure the supply voltage on the VD valve board at the input terminals (a). (It should be approx. 38 VDC). If the 38 VDC are not available, check the TCP 120 (F2). If 38 VDC is measured: Y connect the voltmeter to the valve board VD, test points P1 and V3/K (b) and measure the voltage  Valve board VD When the HLT is switched on, the valve voltage must be approx. 38 VDC (pick-up voltage) for 120 seconds. After this time the VD valve board switches to a holding voltage of approx. 9 VDC. If the valve board does not perform this function when the input voltage is available (pos. 2) the board is defective and must be replaced. Before you replace the board check the valve coil with the ohmmeter (approx. 330 Ω) and replace it if there is discontinuity
	Valve V4 not tight	Clean the valve seat V4
	Valve V1 does not open (p1 >> p2)	Check the electrical connection
	Valve board V1 defective	The pilot lamp on the valve board V1 should briefly light up whenever the valve switches. If necessary replace the valve board V1
	Roughing pump oil contaminated with water vapor	Run the HLT for a while in vent mode (gas ballast mode)
After power on the display continually shows «init 3» (without error 09) (turbo speed <1400 Hz)	Error in the frequency-to-voltage converter in the TCP 120	Replace the TCP 120
	MC electronics defective	Replace the MC board
	Pressure in the turbo pump too high: • Poor pumping capacity	Exchange the roughing pump oil (gas ballast mode)
	• . Leak in HLT	Clean the valve seats
	• Increased gas desorption in the HLT	Gas ballast mode
During «pump» the pressure indication P2 is not below 0.5 mbar	Test object has a large leak	Check Test port 1 or 2 blanked off
Test port 1	Vent valve V3 not tight	Check Close the venting port (hose nipple)
	Connection of test port 1 to valve block not tight	Check the connection
Test port 2	Test port 2 bellows to small flange or valve block not tight	Retighten the union nuts (by hand)

Setpoints for low emission outside the adjustment range	Filament position incorrect	Adjust (refer to 3.1)

Error message	Possible cause	Correction
Continuous switching between high and low emission	Low emission set incorrectly	Adjust (refer to 2.2.4)
After power up, a background reading of approx. 1×10^{-6} mbar l/s He is displayed	Low emission set too high	Adjust (refer to 2.2.4)
During the initial phase after start or "pump" the helium sensitivity jumps suddenly	Distance filament-axis too large	Reduce the distance (refer to 2.2.4)
Leak rate display does not respond or responds only weakly to the admittance of tracer gas	Mass number selected incorrectly on the operating mode selection unit	Check the mass entered, refer to 4.5.6 in the short operating instructions
	Incorrect calibration	Refer to 4.7 of the short operating instructions
	Ion source in the analyzer is heavily contaminated or the analyzer is defective	Replace
Leak rate display continually shows «o.r.» (over range)	The manually set measurement range has been exceeded	Switch to a less sensitive range, refer to 4.8.1 in the short operating instructions
	Leak rate too high	Lower the tracer gas concentration, refer to 4.4.3 in the short operating instructions
	Analyzer defective	Replace
Display remains very long on «init 2,3» p1 >0.1 mbar	Outgassing of the turbopump after long idle time	Allow the pump to run longer
	Valves V2, V4, V5 V6 not tight	Check these valves for leaks → Balzers training

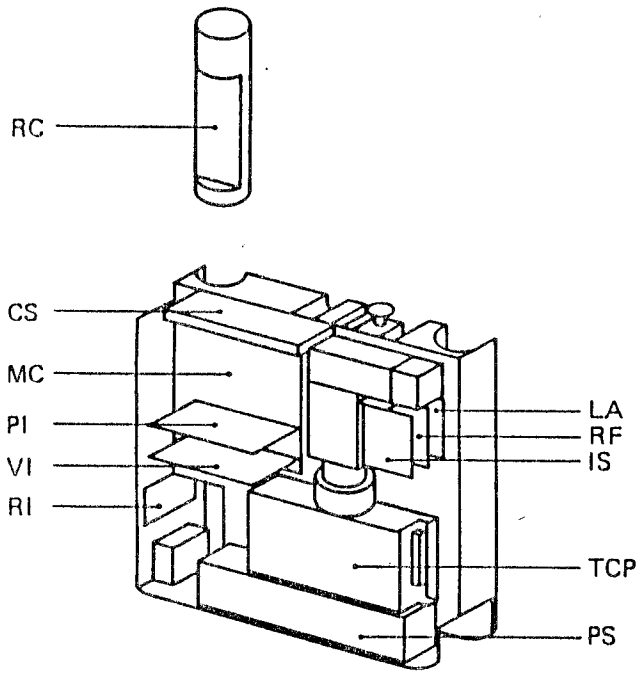


Fig. 13

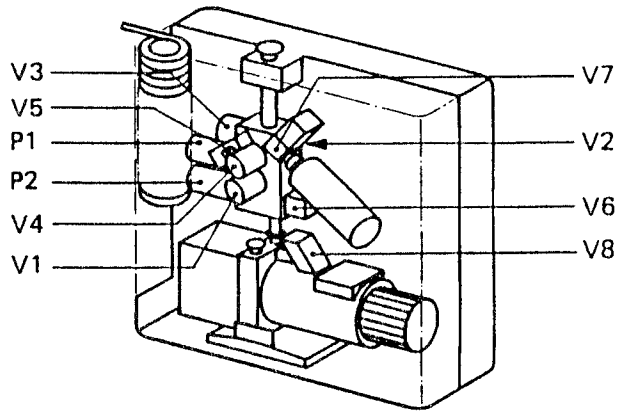


Fig. 14

5. Accessories

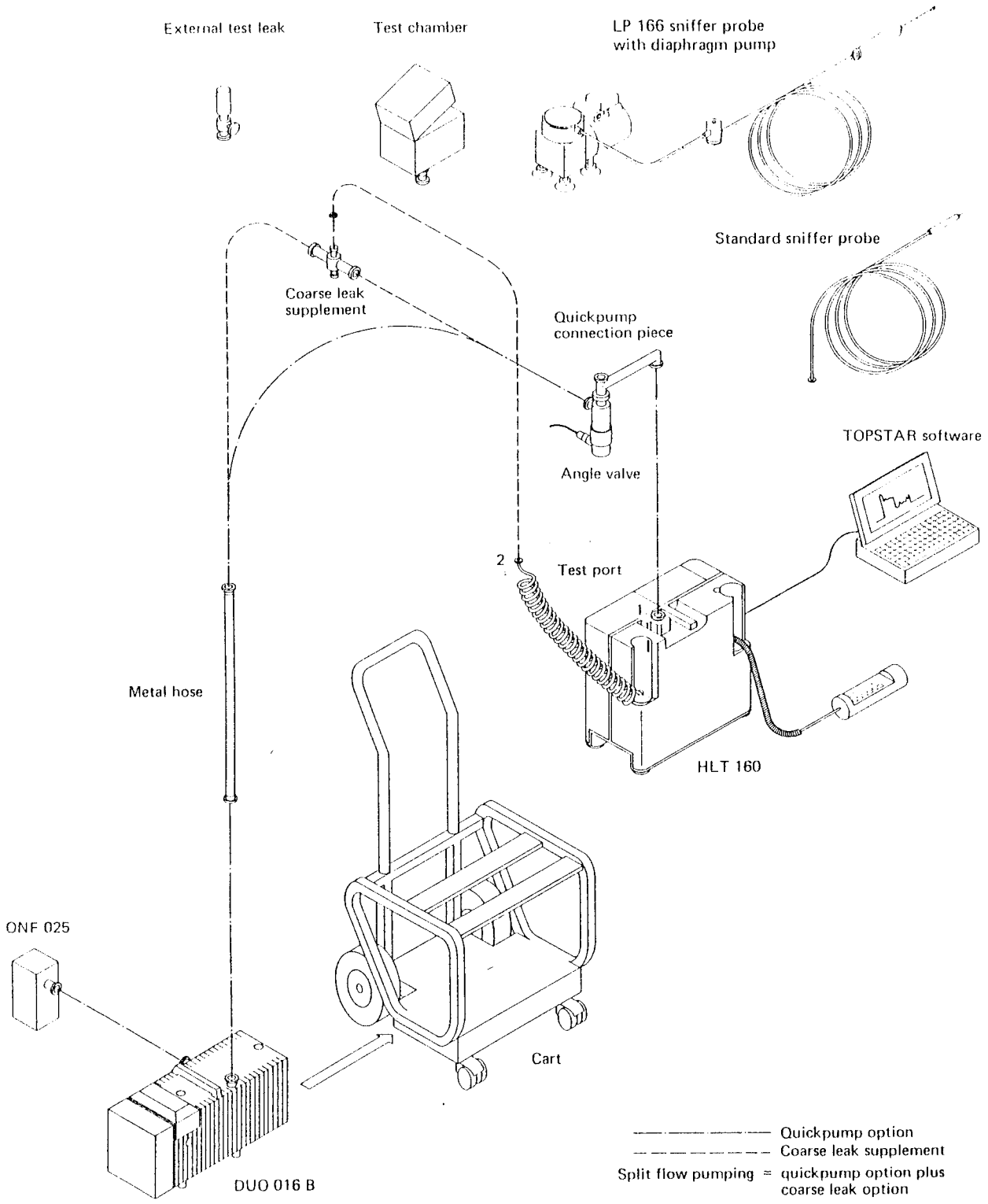


Fig. 15

5.1 Calibrated leak

Calibrated leaks are used to test the accuracy of the HLT and to calibrate its display. A calibrated leak consists of a container holding the tracer gas and a gas permeable plate.

There are two ways the HLT can be calibrated:

- Using a calibrated leak on test port 1
- Using the internal calibrated leak

Typical data for a helium calibrated leak are:

(Note the individual specifications on the nameplate)

He leak rate:	1×10^{-7} mbar l/s (= 1×10^{-7} atm cm³/s)
Loss per year:	2%
Calibration temperature:	20 °C
Temperature coefficient:	3% pro °C
Accuracy:	±10%
Connection flange:	DN 25 KF

Installing the calibrated leak

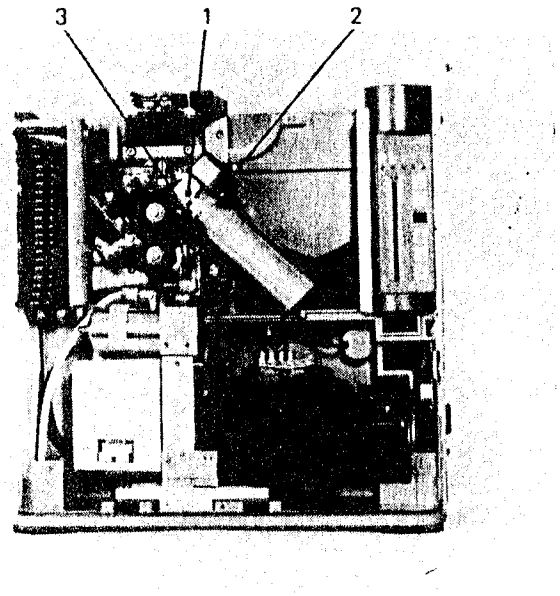


Fig. 16 Installing the calibrated leak

1. Remove the flange and screw on the calibrated leak
2. Plug in the valve
3. Attach the temperature sensor to the calibrated leak with a piece of foam rubber (heat insulation) and a clamp

NOTE:
All HLT units are equipped with an internal calibrated leak. The calibrated leak value is marked on the calibrated leak and on the cover of the operation mode selection unit.

5.2 Standard sniffer probe

The standard sniffer probe is used to detect leaks on containers filled with a tracer gas (see the short operating instructions 4.5.3 and 6.7.4).

The sniffer probe has a built-in filter (metal frit) to protect the capillary from clogging with dirt particles. This frit F can be removed from the probe for cleaning when the testing head is unscrewed.

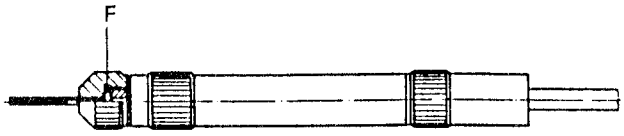


Fig. 17 Standard sniffer probe

5.3 LP 166 sniffer probe with diaphragm pump

Like the standard sniffer probe, the sniffer probe with diaphragm pump is used to detect leaks on containers filled with a tracer gas.

The advantage of this unit is that the response time is much shorter and that sampling lines with a length of up to 40 m can be used. The operating procedures and principles are described in the LP 166 user's guide.

5.4 Split flow pump set and quickpump set

The evacuation time required for the HLT to reach operational readiness when large-volume objects are being tested can be considerably shortened with the use of the split flow pump set (refer to section 5 of the Short operating instructions). The split flow pump set increases the upper detection limit of the HLT to approx. 4 mbar l/s.

The amount of oil mist expelled from the additional rotary vane pump depends on the pressures at which it is operated. If the pump is operated in a closed area, we recommend attaching an oil mist filter (ONF 025) to the exhaust port. For attaching the oil mist filter horizontally, remove the exhaust port from standard pumps, turn it by 180° and reattach it (see Fig. 15).

5.4.1 Split flow pump set

a) Mount the DUO 016 B rotary vane vacuum pump in the cart

b) Attach the ONF 025 oil mist filter (option) to the rotary vane pump

c) From the mounting kit:

- Mount the connection piece to test port 1
- Mount the EVA 025 M angle valve
- Install the double T reducer between the metal hose and the angle valve
- Insert the capillary into the double T reducer
- Connect test port 2 to the double T reducer
- Connect the DUO 016 B rotary vane vacuum pump to the metal hose

d) Establish the electrical connections:

- Connect the angle valve to the relay connector 4
- Connect the power cables of the rotary vane vacuum pump and the angle valve to the mains

5.4.2 Quickpump set

The evacuation time required for the HLT to reach operational readiness when large-volume objects are being tested can be considerably shortened with the use of the split flow pump set (refer to Section 5 of the operating instructions). With the quickpump set also large leak rates can be measured.

The amount of oil mist expelled from the additional rotary vane pump depends on the pressures at which it is operated. If the pump is being operated in a closed area, we recommend attaching an oil mist filter (ONF 025) to the exhaust port. For mounting the oil mist filter horizontally, remove the exhaust port from the rotary vane vacuum pump, turn it by 180° and reattach it (see Fig. 15).

a) Mount the DUO 016 B rotary vane vacuum pump in the cart

b) Attach the ONF 025 oil mist filter (option) to the rotary vane vacuum pump

c) From the mounting kit:

- Install the connection piece on test port 1
- Install the EVA 025 M angle valve
- Connect the angle valve to the metal hose
- Connect the metal hose to the rotary vane vacuum pump

d) Establish the electrical connections

- Connect the angle valve to the relay connector 4
- Connect the power cables of the rotary vane vacuum pump and the angle valve to the mains.

5.5 Cart

A cart is available on which the split flow pump set and the HLT can be mounted. Inflatable tires are used for the two main wheels to protect the HLT from mechanical shock when it is moved. The tire pressure should be approx. 1.5 atm (max. 2.5 atm).

5.6 Extension cable for the remote control

An 8 m extension cable is available for the remote control unit for a total cable length of 16 m when it is attached to the standard cable (longer cables on request).

The extension cable must be connected between the HLT and the standard cable. To connect the extension cable, remove the front cover panel and the cable guide, unscrew the connector and insert the extension cable.

6. Spare parts

Order spare parts according to the spare parts list in the Appendix.

When ordering be sure to state the **model** and the **serial number** of your unit as given on the nameplate.

Ordering example

1 pc filament
Ordering number BN 845 866 -T
as per spare parts list BG 800 387 E/19, item 1
for HLT 160, serial number ....

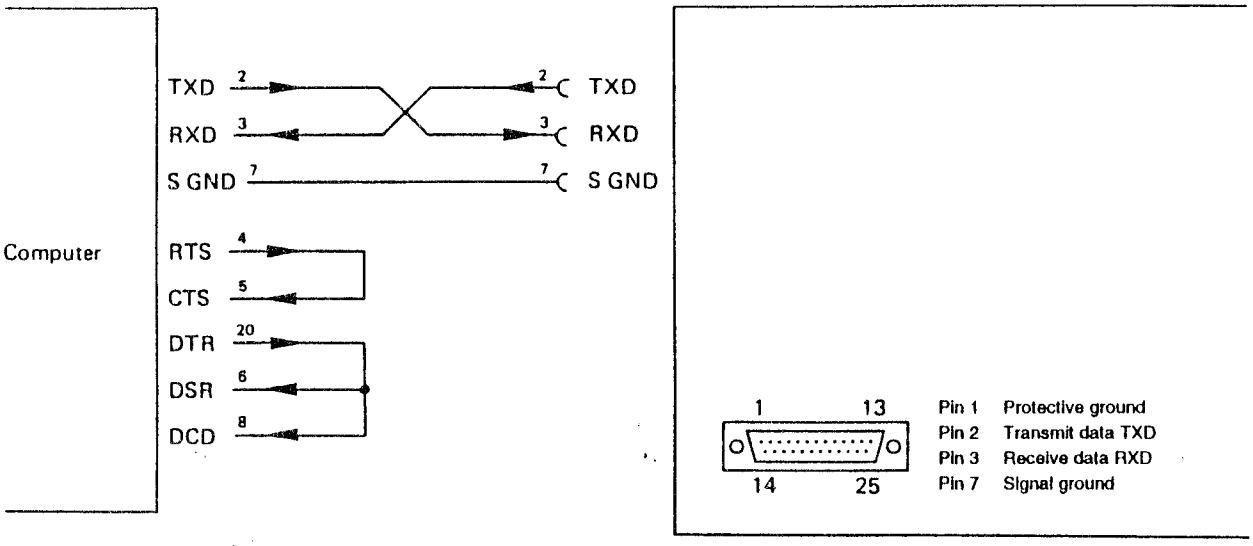
Appendix

A: Description of the RS-232-C computer interface

This serial interface allows communication between the HLT and a computer.

A1: Installation

Interface cable



A2: Initializing the Interface

- Baud rate
- Parity

} Selection in "Service overlay: RS-232-C"

A3: Data transmission

Data traffic is bi-directional i.e. data and commands can be transmitted in either direction.

Only the TXD (transmitted data) and the RXD (received data) lines are used.

For technical data refer to Section A5.

Definitions

The following abbreviations and symbols are used:

Symbol	Meaning		Character set
HOST	Computer or terminal		
[...]	Optional elements		
ASCII	American Standard Code for Information Interchange		
<ETX>	END OF TEXT	Interface reset	ASCII - 3
<CR>	CARRIAGE RETURN		ASCII - 13
<LF>	LINE FEED		ASCII - 10
<ENQ>	ENQUIRY	Request for data transmission	ASCII - 5
<ACK>	ACKNOWLEDGE	Positive acknowledgement	ASCII - 6
<NAK>	NEGATIVE ACKNOWLEDGE	Negative acknowledgement	ASCII - 21

Control

The HOST must wait for the response message (<ACK>, <NAK>) after each ASCII string has been sent.

The HOST input buffer must have a capacity of at least 32 bytes.

A4: Communication protocol

Input format

The messages are transmitted to the HLT in the form of mnemonics and parameters as ASCII strings. With the exception of the transmission control messages <ENQ>, <ACK>, <NAK>, the mnemonics consist of three ASCII characters.

Spaces are ignored.

Entries are terminated with <CR>, <LF> or <CR> <LF> (end of message) after which the HLT begins the evaluation.

The tables in A5 applies to mnemonics and parameters. The maximum amount of places, the data format and the permissible value range are given there.

Input protocol

HOST → HLT	Explanation
Mnemonics and parameter →	Receives message
<CR> [<LF>] →	with "End of message"
← <ACK> <CR> <LF>	Positive acknowledgement of a message received

Output format

The HLT transmits the measured data or parameters in the form of ASCII strings to the HOST computer on request. <ENQ> must be transmitted as a request to send an ASCII string.

NOTE:
Please note that the confirmation sequence <CR> <LF> or <CR> <LF> must be awaited before an <ENQ> is transmitted. Since the control characters are transmitted in 20 ms intervals, a waiting time of ≥60 ms is required.

Repeated transmission of <ENQ> allows further ASCII strings to be read out.

An <ENQ> without a valid request is acknowledged with the ERROR word.

Single position exponents for [x.xEsxx] are transmitted as follows: e.g. 1.3 E–5

Output protocol

HOST → HLT	Explanation
Mnemonics →	Receives message
<CR> [<LF>] →	with "End of message"
← <ACK> <CR> <LF>	Positive acknowledgement of a message received
<ENQ> →	Request for data transmission
← Measured values or parameters	Transmits data with
← <CR> <LF>	"End of message"
<ENQ> →	Request for data transmission
← Measured values or parameters	Transmits data with
← <CR> <LF>	"End of message"

Input errors

Incoming strings are tested. In the event of an error, the message is acknowledged negatively with <NAK>. The corresponding flag is set in the ERROR word.

Errors can be decoded when the "ERROR word" is entered.

Error detection protocol

HOST	HLT	Explanation
Mnemonics [and parameter] <CR> [<LF>]	⟶	Receives message with "End of message"
	⟵ <ACK> <CR> <LF>	Positive acknowledgement of a message received
***** Transmission or programming error *****		
	⟵ <NAK> <CR> <LF>	Negative acknowledgement of a message received

A5: RS 232 commands

In the following, "transmit" and "receive" are referenced to the HOST.

Error message

Transmit: ERR <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: xxxx <CR> <LF>

- Incorrect syntax
- Invalid parameter
- NO Hardware
- FATAL ERROR

A5.1: Operating mode selection unit commands

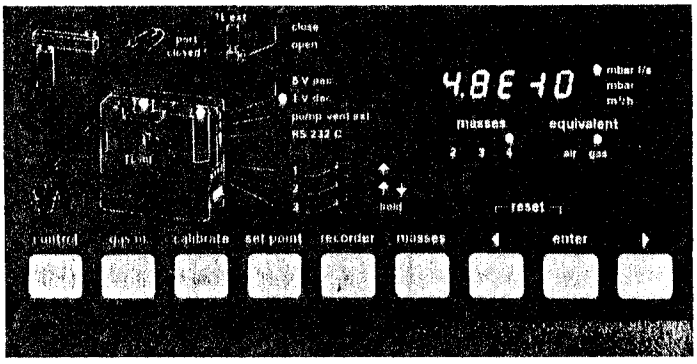


Fig. 18

Leak rate

Transmit: LEC <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x,y.yyE-yy <CR> <LF>

- Leak rate value in mbar l/s
- Pump status: 0 = Pump leak rate
  1 = Pump Pirani
  2 = Overrange
  3 = Error

Pump / Vent

Transmit: PVS [,x] <CR> [<LF>]

- 0 = Vent
  1 = Pump

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x <CR> <LF>

└──────→ 0 = Vent
1 = Pump
2 = Not ready

control (Short operating instructions, section 4.11)

Transmit: CON [,x] <CR> [<LF>]

- 1 = Local
- 2 = Pump/Vent ext.
- 3 = Remote RS 232

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x <CR> <LF>

- 1 = Local
- 2 = Pump/Vent ext.
- 3 = Remote RS 232

gas in (Short operating instructions, section 4.5)

Transmit: GIN [,x,yyyy] <CR> [<LF>]

- Volume flow range in m^3/h (if x = 1)
- 1 = Coarse leak
  2 = Standard sniffer
  3 = Standard
  4 = Split flow
  5 = Quickpump
  6 = Fast sniffer

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x,yyyy <CR> [<LF>]

- Volume flow rate in m^3/h (if x = 1)
- Sensitivity (if x = 1)
  1 = Coarse leak
  2 = Standard sniffer
  3 = Standard
  4 = Split flow
  5 = Quickpump
  6 = Fast sniffer

  } 0 = coarse; 1 = low; 2 = medium

calibrate (Short operating instructions, section 4.7)

Transmit: cal [,x,y] <CR> [<LF>]

- Calibration run: 0 = Stop (reset)
  1 = Start
- Cal. leak select.: 0 = Internal
  1 = External

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x,y <CR> <LF>

- Execution status: 0 = Off
  1 = Run calibrate
  2 = Run calibrate CU measuring (background)
  3 = Run calibrate CTU measuring (background and calibrated leak)
- Error messages: 0 = No error
  1 = Calibrated leak out of range
  2 = Background (CU) out of range
  3 = Calibration factor (CF) out of range
  4 = Calibration time exceeded (timeout)

Since the leak detector cannot initiate any transmission request when it needs an acknowledgement within a calibration procedure, the calibration status must be continually polled.

For calibrating with an external calibrated leak, the leak rate must first be specified (refer to section 4.7 of the Short operating instructions).

Calibrate - acknowledgement

Transmit: CAQ [,x] <CR> [<LF>]
└ Acknowledgement number according to the calibration sequence status

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x <CR> <LF>
└ Calibr. sequence status: 0 = Run (no acknowledgement)
1 = Wait for 'ext. open' acknowledgement
2 = Wait for 'ext. closed' acknowledgement
3 = Wait for 'CF o.k.' or error acknowledgement
4 = Wait for 'port closed' acknowledgement (internal calibrated leak)

The calibration sequence status is polled with the CAQ command. If the response is >0 the leak detector waits for an acknowledgement.

This acknowledgement is given by transmitting the CAQ command and the corresponding acknowledgement number. (If the calibration sequence status = 3, the CAL inquiry provides information on whether the calibration operation was successful or whether an error exists).

Calibrated leak rate external

Transmit: TLE [,y.yE-yy] <CR> [<LF>]
└ Calibrated leak value in mbar l/s

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: y.yE-yy <CR> <LF>

Calibration factor

Transmit: CAF <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x.xx <CR> <LF>

The calibration factor can be read out at any time.

In a calibration operation the newly calculated value is specified when the acknowledgement 'CF o.k.' (calibration status = 3) is reached.

Calibrate sniffer as of version D

Transmit: CAS [,x] <CR> [<LF>]
└ 0 = stop (reset)
1 = start
2 = acknowledge background

Receive: x,y.yEsyy <CR> <LF>
└ Background in mbar l/s
└ 0 = off
1 = run calibrate
2 = await acknowledgement

set point (switching thresholds for the relay outputs) (Short operating instructions, section 4.9)

Transmit: SPn [,x,y.yE-yy] <CR> [<LF>]

- Threshold value
- Operating mode: 0 = off
  1 = offset - setpoint ⊗ ↑
  2 = offset - setpoint hold ⊗ ↑ hold
  3 = absolute - setpoint ⊗ ↑ ↓
  4 = absolute - setpoint hold ⊗ ↑ ↓ hold
  5 = ready
- 1 = Switching threshold No. 1
  2 = Switching threshold No. 2
  3 = Switching threshold No. 3

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x,y.yE-yy <CR> <LF>

- Threshold value
- Operating mode: 0 = off
  1 = offset - setpoint ⊗ ↑
  2 = offset - setpoint hold ⊗ ↑ hold
  3 = absolute - setpoint ⊗ ↑ ↓
  4 = absolute - setpoint hold ⊗ ↑ ↓ hold
  5 = ready

Switching threshold status (Short operating instructions, section 4.9)

Transmit: SPS <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x,x,x,x <CR> <LF>

- 0 = V9 off / sniffer probe clogged
  1 = V9 on / sniffer probe OK
- Switching threshold No. 1: 0 = off
  1 = on
- Switching threshold No. 2: 0 = off
  1 = on
- Switching threshold No. 3: 0 = off
  1 = on

recorder (Short operating instructions, section 4.10)

Transmit: REC [,x] <CR> [<LF>]

- 1 = 1 V / decade
  5 = 5 V / decade

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x <CR> <LF>

- 1 = 1 V / decade
  5 = 5 V / decade

masses (Short operating instructions, section 4.5.6)

Transmit: MAS [,x,y] <CR> [<LF>]

- Equivalent: 0 = Air, 1 = Gas
- Mass: 2 = H_2, 3 = ^3He, 4 = ^4He

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x,y <CR> <LF>

- Equivalent: 0 = Air, 1 = Gas
- Mass: 2 = H_2, 3 = ^3He, 4 = ^4He

A5.2: Service mode commands

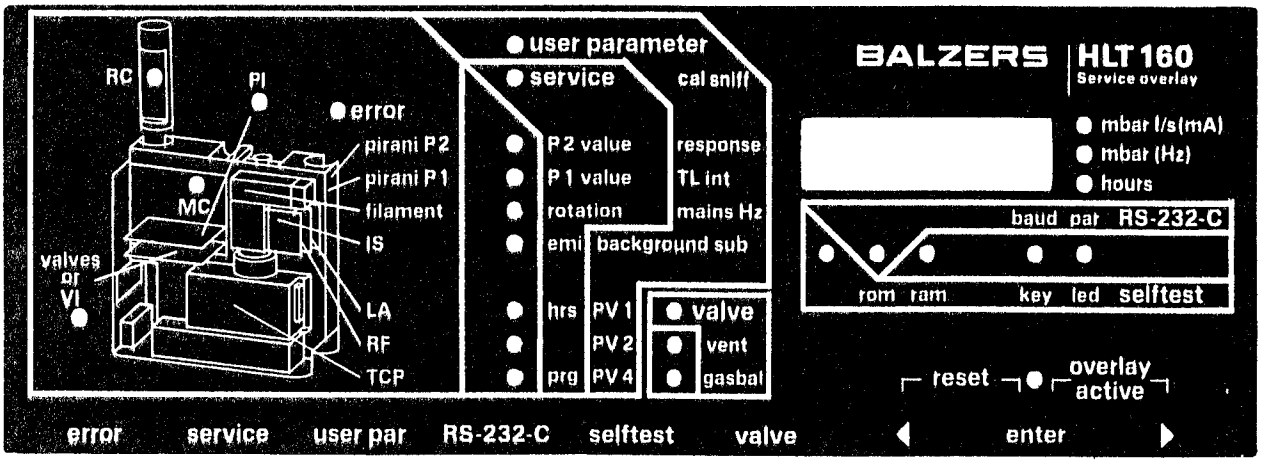


Fig. 19

Error parameters

reset (HLT error messages) (see 2.1)

Transmit: RES [,y] <CR> [<LF>]

- -1 = Rest HLT

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: xx,y <CR> <LF>

- 1 = Reset HLT
- Error: 16 = No error
  0 = NOVRAM lost
  1 = RAC error
  5 = Gas inrush
  6 = Watchdog error
  7 = VP error
  8 = IS defective
  9 = TCP defective
  10 = Pirani 2 defective
  11 = Pirani 1 defective
  12 = Filament defective
  13 = RF defective
  14 = ROM defective
  15 = RAM defective

Service parameter <service> (see 2.2)

Pirani 1 (see 2.2.2)

Transmit: PI1 [,y] <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x,y.yE-yy <CR> <LF>

- Pressure in mbar
- Status: 0 = No error
  1 = Pirani defective

Pirani 2 (see 2.2.1)

Transmit: PI2 [,y] <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x,y.yE-yy <CR> <LF>

- Pressure in mbar
- Status: 0 = No error
  1 = Pirani defective

Turbo speed (see 2.2.3)

Transmit: TUR <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x.yyyy <CR> <LF>

- Turbo speed in Hz
- Status: 0 = TCP error
  1 = TCP o.k.

Emission current (see 2.2.4)

Transmit: EMI <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x,y.yyy <CR> <LF>

- Emission current in mA
- Status: 0 = ON, high
  1 = ON, low
  2 = OFF
  3 = IS defective
  4 = Filament defective

Operating hours (see 2.2.5)

Transmit: HOR <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: xxxx.x <CR> <LF>

- Duty time in hours

Program version (see **2.2.6**)

Transmit: PNR <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: BGXXXXXX <CR> <LF>
└── Program number

Operating data <userpar> (see **2.3**)

Sniffer Multiplier (see **2.3.1**)

Transmit: SNM [,x.xEsxx] <CR> [<LF>]
└── Correction factor

Receive: x.xEsxx <CR> [<LF>]
└── Correction factor

Filter (see **2.3.2**)

Transmit: FIL [,x] <CR> [<LF>]
└── 0 = Fast
1 = Medium
2 = Slow

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: X <CR> <LF>
└── 0 = Fast
1 = Medium
2 = Slow

Internal calibrated leak rate (see **2.3.3**)

Transmit: TLI [,x,y.yE-yy] <CR> [<LF>]
└── Calibrated leak rate in mbar l/s
└── Internal calibrated leak: 0 = disabled
1 = enabled

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x,y.yE-yy,xxx <CR> <LF>
└── Calibrated leak temperature in °C
└── Calibrated leak rate in mbar l/s
└── Internal calibrated leak: 0 = disabled
1 = enabled

Background sub (see **2.3.5**)

Transmit: SUB [,x] <CR> [<LF>]
└── 0 = off
1 = on

Receive: x,y.yyEsyy <CR> <LF>
└── Background in mbar l/s
└── 0 = off
1 = on

User parameter PV1 (see **2.3.6.1**)

(Fixed parameter setting: 0.5 mbar)

Transmit: PV1 <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: y.yE-yy <CR> <LF>

User parameter PV2 (see **2.3.6.2**)

Transmit: PV2 [,y.yE-yy] <CR> [<LF>]
└── Value range 1.0 ... 9.9 10^{-5} mbar l/s

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: y.yE-yy <CR> <LF>

User parameter PV4 (see **2.3.6.3**)

Transmit: PV4 [,y.yE-yy] <CR> [<LF>]
└── Value range 3.0 ... 9.9 10^{-2} mbar

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: y.yE-yy <CR> <LF>

Vent and gas ballast valve control <valve>

Vent valve (see **2.6.1**)

Transmit: FVT [,x] <CR> [<LF>]
└── 0 = Auto
1 = Closed

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x <CR> <LF>
└── 0 = Auto
1 = Closed

Gas ballast valve: (see **2.6.2**)

Transmit: GVT [,x,yy.yy] <CR> [<LF>] or GVT [,x,y.yEvyy] <CR> [<LF>]
└── Threshold in mbar l/s (if x = 3)
└── Opening time in hours (if x = 1)
└── 0 = Auto
1 = Open
2 = Closed
3 = Setpt

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: x.yy.yy <CR> <LF> or x,y.yEyy <CR> <LF>
└── Threshold in mbar l/s (if x = 3)
└── Opening time in hours (if x = 1)
└── Operating mode: 0 = Auto
1 = Open
2 = Closed
3 = Setpt

A5.3: Other commands

Valve status (see 2.6)

Transmit: VST <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: xxxxxxxx <CR> <LF>

0 ... 255

↓

Binary representation

↓

Bit0 - V1	:	0 = closed 1 = open
Bit1 - V2	:	0 = closed 1 = open
Bit 2 - V3	:	0 = closed 1 = open
Bit 3 - V4	:	0 = closed 1 = open
Bit 4 - V5	:	0 = closed 1 = open
Bit 5 - V6	:	0 = closed 1 = open
Bit 6 - V7	:	0 = closed 1 = open
Bit 7 - V8	:	0 = closed 1 = open

A/D converter (only for test purposes)

Transmit: ADC <CR> [<LF>]

Receive: <ACK> <CR> <LF> or <NAK> <CR> <LF>
Transmit: <ENQ>

Receive: xxxx,xxxx,xxxx,xxxx,xxxx,xxxx <CR> <LF>

- Pirani 1
- Pirani 2
- Emission
- Electrometer
- Turbo speed
- Roughing pump speed

A6: Programming example

BASIC program for operating the HLT RS-232 interface

```
10  REM ************************************************************************
11  REM  DUPHLT.BAS Data transmission protocol HLT  May 12, 1993 BEB
12  REM
13  REM  Creation Date : May 12, 1993
14  REM  Author        : B. Berger,  Dept. KEE
15  REM  Version       : V1.0
16  REM  Modification  :
17  REM  Contents      :
18  REM ************************************************************************
19  REM
20  OPEN "COM2":9600,N,8,,CS,DS,CD" FOR RANDOM AS #1
21  REM Opens COM2: with 9600 bps, no parity and 8 Data bits.
22  REM CTS,DSR and CD are not checked.
23  REM
30  ACK$ = CHR$(6): ENQ$ = CHR$(5): LF$ = CHR$(10) = CHR$(13)
100 LINE INPUT "Mnemonics? ";m$
101 REM Read the messages from the keyboard which could contain
102 REM commas (,) or other separating characters.
103 IF m$ = "END" THEN GOTO 300
110 PRINT #1,m$ * CR$ + LF$; : REM transmit the message to the HLT 160
120 LINE INPUT #1,a$: REM waits for acknowledgement of the message
130 IF INSTR(a$,ACK$) THEN PRINT "Acknowledge"; ELSE GOTO 200 : REM if
acknowledgement is positive.
140 PRINT #1,ENQ$; : REM Request for data transmission.
150 LINE INPUT #1,mp$ : REM Read the measured value or parameter from the HLT 160
160 PRINT "    "+RIGHT$(mp$,(LEN(mp$)-INSTR(mp$,LF$))) : REM Display of the
measured value or parameter.
190 GOTO 100
200 PRINT "    Negative Acknowledge"; : REM if acknowledgment is negative
210 PRINT #1,ENQ$ : REM Request for transmission of the error word.
220 INPUT #1,e: REM read the error word from the HLT 160
230 IF e>999 THEN PRINT "   FATAL ERROR"; : E = E-1000
240 IF e>99  THEN PRINT "   NO HARDWARE"; : E = E-100
250 IF e>9   THEN PRINT "   PARAMETER ERROR"; : E = E-10
260 IF e     THEN PRINT "   SYNTAX ERROR";
270 PRINT
280 GOTO 100
300 END
```

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