HIGH VACUUM GAUGE / CONTROLLER - analogue

Cat: LB4170-001 (240V.AC. 50/60 Hz)  Sensor: LB4171-001

DESCRIPTION:
IEC manufactures both analogue and digital electronic High Vacuum gauges and controllers. This instrument is an analogue model with a large meter indicating vacuum against dual scales. The instrument is sold either with or without the sensor.

Range#1: Atmospheric pressure to 0.01 millibar
Range#2: 0.1 millibar to 0.001 millibar.

Although the scale indicates up to atmospheric pressure, the first useful vacuum reading on the scale is about 50 millibar.

The instrument is complete with an internal ‘single pole double throw’ relay and terminal block connections to directly control an external circuit at any voltage up to 240V.AC and 5 amps. The point on the scale at which the relay operates is fully adjustable and the differential between the switching on and switching off of the relay is also fully adjustable.

LB4170-001 high vacuum gauge … analogue

Physical size: 170x165x110mm LxDxH  Weight: 0.75 kg

Image shows both gauge / controller LB4170-001 and analogue sensor LB4171-001
POWER: 240V.AC. 50/60Hz. Approx. 0.5 Amp.

FRONT PANEL CONTROLS:

- On/Off switch
- Range #1 / #2 switch
- High/Low switching points check switch.
- Multi-turn controls behind the panel for screwdriver adjustment through small holes in the panel to set the switching points by referring to the scale.


SENSOR FITTING: 12.7mm (0.5”) parallel tail x 25mm long.

SENSOR CALIBRATION: By two internal potentiometers accessible from the end of the sensor when the cap is removed. The sensor is connected to the gauge by a 700mm long cable which plugs into a socket in the rear of the gauge.

OPERATION DETAILS:

Connect the sensor plug to the rear of the gauge. Plug gauge into 240V.AC. power outlet and turn gauge power switch on. Note the power on LED illuminates. Select range#1. Select MID position of Pressure Low / High switch.

Without a vacuum present, the gauge should read ATM (atmospheric pressure) on the extreme right hand side of the meter. Apply a vacuum to the sensor and observe the gauge reading in millibar move from atmosphere (1000 millibar) down through 100, 50, 20, 10 and perhaps, if your vacuum source is good you might see 1 millibar or lower.

For accurate results, allow several minutes for the sensor and system to stabilise in temperature.

To observe the existing switching points that are set in the gauge, turn the switch to Low Pressure. The gauge needle should be steady at some point on the scale. Turn the switch to High Pressure and the gauge needle should be steady at a different point to the right of the first point. **ALWAYS leave the Low / High switch set in the MID position.**

RANGES: The IEC high vacuum gauge provides two user ranges:
Range#1: Atmospheric pressure (1000 mb) to 0.01 mb. #2: 0.1mb to 0.001mb.

Most commercial vacuums lie within the limits of Range#1. It is unusual to require range#2
SETTING VACUUM LEVELS & SWITCHING POINTS

The instrument is complete with an internal ‘single pole double throw’ relay and terminal block connections to directly control an external circuit at any voltage up to 240V.AC. and 5 amps. The point on the scale at which the relay operates is fully adjustable and the differential between the switching on and switching off of the relay is also fully adjustable.

If the vacuum level is poor (RH end of meter scale) a red light will be seen on the front panel. As the vacuum level improves (pointer moves towards LH end of scale) the light will be seen to go OFF. The point at which the light extinguishes is the point at which the controller operates the relay to switch the external control circuit.

If the vacuum level becomes poor again, the light will go ON and this is the instant when the controller switches the external control circuit to its previous state.

The difference between these two switching points is the differential and, since both the high vacuum and low vacuum switching points are adjustable, the differential is adjustable.

To set High vacuum switch point: (High Vacuum = Low pressure)

This is the point that the light extinguishes as the vacuum is improving.

Turn the knob on the gauge to 'Low' pressure and, through the front panel of the gauge with a very small jeweller's screwdriver, turn the left side multi-turn control until the gauge needle indicates the desired switching position.

To set Low vacuum switch point: (Low Vacuum = High pressure)

This is the point that the light comes ON as the vacuum is becoming softer (poorer).

Turn knob to 'High' pressure and repeat above procedure using the right side control.

NOTES:

- Be very sure that the Low Pressure set point is definitely to the Left of the High Pressure set point. If these are reversed, the gauge switching cannot operate.
- Be sure to leave the High / Low selector knob in the centre position otherwise the vacuum gauge will not indicate vacuum level and will not control.
- If a vacuum controller or sensor is changed, it must be matched to its sensor by following the calibration instructions.
CALIBRATION OF VACUUM GAUGE / CONTROLLER:

1. Turn off vacuum gauge/controller. Check meter zero and adjust if necessary.

2. Connect the probe to be calibrated to the socket at the rear of the gauge housing. Remove the retaining screws from the end cap on the Sensor and remove the end cap from the Sensor. Rotate the Sensor body so that the two potentiometer controls are on the UPPER SIDE of the small circuit board.

3. The left hand control sets the High Vacuum reading end of the scale and the right hand control sets the Atmospheric reading end of the scale. Turn on the gauge and allow several minutes warm up time to stabilise temperature.

4. USING RANGE #1, adjust the Atmospheric control so that the gauge reads correctly at 'ATM' on the scale.

5. Apply a known vacuum to the Sensor and adjust the Vacuum control to read correctly on the scale. If range #1 is calibrated correctly, range #2 is automatically correct.

USEFUL HINT: In the absence of a known vacuum source, a normal two stage oil immersed vacuum pump, in good condition, can be used as an approximate 'known source'. If the Sensor is coupled directly on the outlet port of the pump without hoses and valves etc., the gauge should read to the extreme left point on the gauge when set on Range#1. When switched to Range #2, the reading should be between 0.01 and 0.001 mb.

Remember, using this method is only approximate since it depends on a two stage pump normally being able to achieve an ultimate vacuum of 0.001mb, but this method is close enough for normal commercial applications.

6. Remove vacuum source and recheck the 'ATM' end of the scale. Readjust if necessary, then recheck the high vacuum end again. Replace the end cap.
THE ANALOGUE OUTPUT:

Some models of this gauge have an analogue output signal as an option. This was provided by a 4 pin ‘DIN’ socket on the rear face of the instrument adjacent to the 5 pin ‘DIN’ sensor socket. Two different output ranges were provided to suit the application.

ANALOGUE OUTPUT VOLTAGES:  (from zero to atmospheric pressure)

The two output voltages provided are 0-5V and 0-600mV.

The output of zero = 0.001 millibar (very high vacuum) and the maximum = atmospheric.

• For driving PLC analogue input modules, the signal is 0-5V.DC.
• For input signal for a chart recorder, the signal is 0-600mV.

The voltage output follows the meter needle movement and the needle reading is approximately logarithmic. To obtain the actual value of the vacuum in millibars, a calculation must be performed on this voltage value using the PIRANI hot wire principle ‘characteristic curve’ formula. Contact the manufacturer for further details.

SENSOR CONTAMINATION:

If a sensor is filled with fluid and is obviously contaminated, its reading may vary from a true reading. To de-contaminate a sensor:

• Turn off vacuum pumps and remove sensor from its socket.
• Remove all naked flames and cigarettes.
• Pour a small amount of methylated spirits into the sensor.
• GENTLY rock the sensor back and forth to wash the filament.
• Repeat the exercise again with fresh spirits.
• Allow as much as possible to drain out, Gently shake.
• Refit sensor and allow 5 minutes of vacuum to dry out the residual vapour.

NOTE: The sensor's electrical plug SHOULD be removed from the vacuum gauge socket so that the sensor filament is not hot. Be careful, a hot sensor MIGHT ignite the spirits.

Designed and Manufactured in Australia
USEFUL INFORMATION

DISCUSSION OF THE VACUUM SCALE:

The units of vacuum can be very confusing: Over the years, the vacuum units have changed from imperial to metric and the way the scale is handled depends on whether you are talking 'Vacuum' or talking 'Pressure'. The terms Vacuum and Pressure are really the same but 'Vacuum' is a pressure lower than the atmospheric pressure which surrounds us all on Earth. Below is information on the various units and their meanings relating to pressures below atmospheric pressure.

Abbreviations:

- Atmospheric pressure: ATP
- Pounds per sq.inch: psi (old pressure unit)
- Torr (mm of mercury): Torr (old vacuum unit)
  
  This unit is sometimes called 'mmHg'. This is the height of a mercury column drawn up a tube by a vacuum. A 'perfect' vacuum supports a mercury (Hg) column of nominally 760mm height.

- Inches of mercury: "Hg (old vacuum unit)

  This is similar to the Torr, but in imperial terms, the mercury column is 30" high.

- Millitorr: mT (old vacuum unit)
- Kilopascals: kPa (modern pressure unit)
- Bar: b (modern pressure/vacuum unit)
- Millibar: mb (current vacuum unit)

One 'Atmospheric Pressure' is called 1x Bar

1x Bar equals 14.7psi, = 760Torr, = 30"Hg, = 100kPa or 1000mb.

1/1000th of 1Bar (1 mb) is unreadable in psi

1 millibar = 0.760Torr or 760mT

This is unreadable in ‘inches of Hg’ or in kPa

1/1,000,000 of 1Bar (0.001mb) is unreadable in psi or in kPa or in Torr.

0.001mb (called 1 micron) = 0.00076mT

This value of 1x micron (millionth of one Atmospheric Pressure) is the typical ULTIMATE vacuum achievable for a two stage oil immersed high vacuum pump. The vacuum must be read directly at the port of the pump without a rubber hose or any other material which could permit air molecules to enter the evacuated space. If vacuums much better than this are required, a different type of vacuum pump must be used.
MEASURING VACUUMS:

When dealing with positive pressures (pressures above atmospheric pressure), ATP is usually called zero and all pressures above this are positive readings. Readings below ATP are considered negative pressures. This convention is called 'gauge' reading. The confusion in this method is of course that ATP varies from day to day and hour to hour as the weather changes. It is also different in different places around the earth due to altitude and so on. Thus the zero reference shifts.

The converse to this is 'absolute' readings where zero is the complete absence of pressure. Thus a perfect vacuum, which is unattainable on earth, would be always called zero. It is a fixed reference because a pressure can NEVER be lower than zero absolute.

Units used for vacuum are usually applied forward from absolute zero. For example, 1000mb (1x Bar) is ATP and 1/1000th of one ATP is called 1mb (from absolute zero). It is not called -999mb. An exception to this is the old Inches of mercury unit which used zero for ATP and 30"Hg for a 'perfect' vacuum. This is very common on dial type gauges which are often scaled from 0-30"Hg as a vacuum range.

POINTS TO REMEMBER REGARDING EVACUATING A SYSTEM:

As a system becomes evacuated, any differences in pressure around the system become very small. Air will move from one place to another only if the pressure at one place is higher than another. It follows then that the movement of air from one place to another in a system being evacuated slows down greatly as the vacuum rises. If the path of the air flow is torturous with long pipes and small orifices, the migration of air becomes even slower.

The migration rate of the air depends on:

- The difference in pressures between the source and the load.
- The restriction in the path from the load to the vacuum source.

The final vacuum achieved in a given time depends on:

- The migration rate of the air (see above).
- The volume of the total system being evacuated.
- The capacity of the pump relative to the volume being evacuated. This is specially relevant in early pull-down when large volumes of air are involved. As the vacuum rises, the air volumes passing to the pump begin to approach zero.
- The condition of the system regarding materials 'gassing' vapours into the evacuated system whilst the air is being drawn out. Moisture will cause vapour problems as it boils away into vapour and softens the vacuum. VERY SMALL amounts of vapour or air will spoil high vacuums.

To achieve the fastest pull-down time for a system, it is important that the source of vacuum is kept as high as practicable during evacuation to provide the maximum differential between the vacuum source and the load (the system being evacuated).