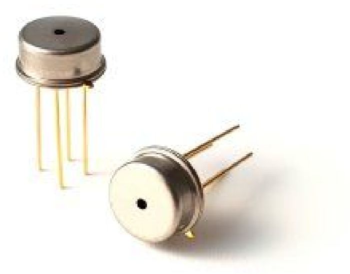
BostonElectronics

Vacuum Sensors
HVS Series



- Pirani measurement principle
- Very large pressure range 1000 mbar to 10-6 mbar
- Small form factor TO-39 or TO-8
- Robust metal housing
- High sensitivity

HEIMANN Sensor

www.boselec.com | boselec@boselec.com | shop.boselec.com | 617-566-3821

Vacuum Pressure Sensing

Besides thermopiles, Heimann Sensor also offers solutions for vacuum sensing for wide pressure ranges. These are MEMS type Pirani vacuum sensors.

Pirani Measurement Principle

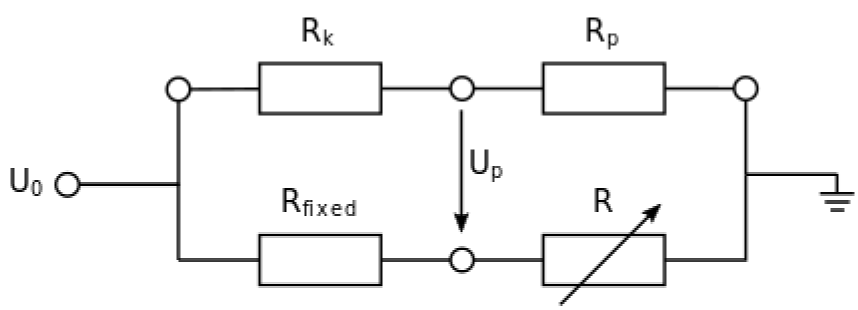
The measurement principle of a Pirani vacuum gauge is rather simple. A metal wire is heated by an electric current. If the wire is in a perfect vacuum, there is no gas and therefore no heat loss. In real conditions (not perfect vacuum) the surrounding gas will remove heat/energy from the wire. The amount of removed heat is related to the number of gas molecules and therefore to the pressure.

There are three possible operation modes for a Pirani vacuum gauge:

- Constant current
- Constant voltage
- Constant temperature

The most basic operation mode is constant current operation. In this case the sensor (which is basically a resistance) is supplied by a constant current. In this case the resistance which is related to the temperature of the sensor is measured and gives you the information about the pressure. In real application this mode is almost never used.

More common are the two other operation modes. In constant voltage mode (U0 = const.), the sensor is applied in a Wheatstone bridge configuration:

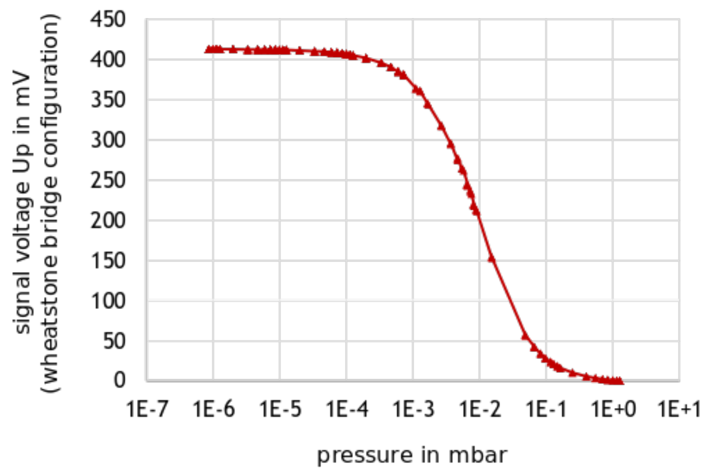


Rp is the pressure sensitive resistance and Rk is the compensation resistance which is placed also on the sensor chip. Rfixed and R are used to complete the Wheatstone bridge arrangement. For constant voltage mode the bride should be balanced (Up = 0V) at atmospheric pressure. This is done by tuning the potentiometer R. If the pressure is changing, Rp will change and therefore Up will change too. The constant voltage operation mode is recommended for high vacuum measurements and low power operation but requires a temperature stabilization or advanced calibration for accurate measurements.

The constant temperature mode, also called constant resistance mode, is commonly used, because it can reduce unwanted signal drift caused by changing ambient temperature. This is best suited for rough and fine vacuum conditions. In this case an operational amplifier is used to control the resistance ratio of Rk and Rp and therefore keeps them at a constant temperature difference.

Pirani Gauge Characteristic Curve

The picture below shows a typical characteristic curve of a Pirani type vacuum gauge in the Wheatstone bridge configuration (constant voltage mode). It shows the signal voltage Up vs. the pressure in mbar. As you can see the sensor can go down to 10-6 mbar, but the slope of the curve is very low. This means sensitivity is also very low in this range. In the range from 10-1 to 10-3 mbar the sensor has a steep slope and therefore its highest sensitivity.

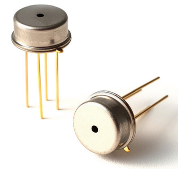


The above curve shows the sensitivity of a relatively large chip (HVS 03k) with 4x4 mm² chip size. You can combine this with a second, smaller chip with 1x1 mm² which has its peak sensitivity in higher pressure regimes. This combination of two chips allows to sense the whole pressure range from atmospheric pressure down to 10 -6 mbar.

Pirani Sensors – Features and Benefits

- HVS Series
- Pirani measurement principle
- Very large pressure range 1000 mbar to 10-6 mbar
- Small form factor TO-39 or TO-8
- Robust metal housing
- High sensitivity

HEIMANN Sensor
HEIMANN SENSOR GMBH



Boston Electronics

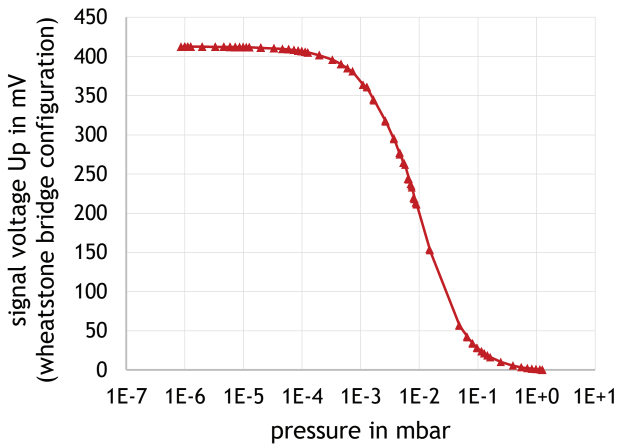
HVS Series – TO-39

MEMS Type Pirani Vacuum Sensors

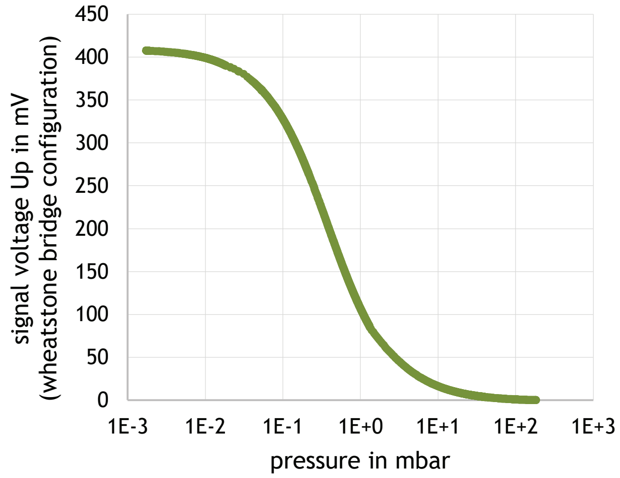
The HVS Series is the vacuum sensing series of Heimann. These miniature Pirani-type vacuum sensors allow measurements in a pressure range starting from 1000 to 10^{-3} mbar (HVS 04) and 10 down to 10^{-5} mbar (HVS 03k). These sensors are built in small and robust TO-39 metal housing.

Common operation modes for this sensor type comprise either constant voltage or constant temperature mode. Regarding the constant temperature mode, we suggest a circuit for a constant resistance ratio (see next page).

HVS 03k Characteristics

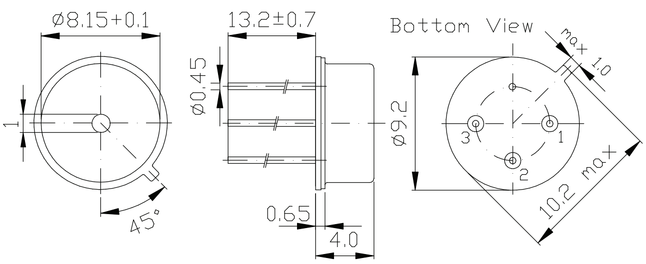


HVS 04 Characteristics

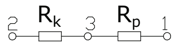


Dimensions and PIN-Configuration

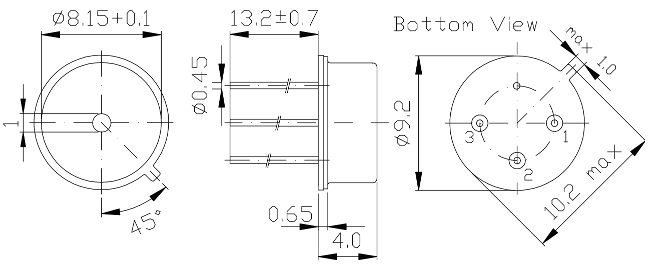
HVS 03k



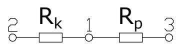
Configuration 03k:



HVS 04



Configuration 04:



Characteristics

	HVS 03k	HVS 04 (single)	Unit
Housing	TO-39	TO-39	
Chip size	4.0^2	1.0^2	mm^2
Max. signal voltage U_p	400	410	mV
Resistance sensor chip R_p	9	1	kOhm
On chip reference resistor R_K	9	1	kOhm
Supply voltage U_0 a)	3.2	2	V
Operating temperature	-20 … 120		°C
Storage temperature	-40 … 120		°C

a) Bridge circuit

Ordering Information

HVS	Heimann Vacuum Sensor	**E.g.:**	**HVS 03k**
03k, 04	Chip type and package type (TO-8 / TO-39)		**HVS 04 (Single)**

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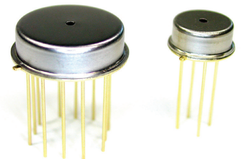


Vacuum Sensors

HVS Series - TO-8

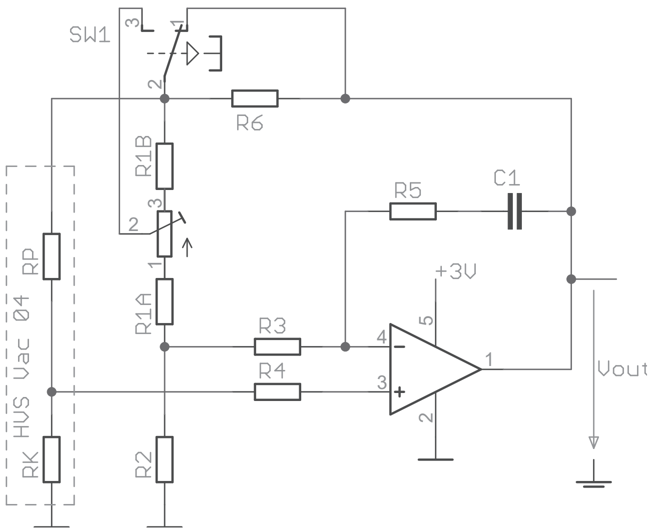
MEMS Type Pirani Vacuum Sensors

The HVS Series is the vacuum sensing series of Heimann. These miniature Pirani-type vacuum sensors allow measurements in a pressure range starting from 1000 to 10^{-3} mbar (HVS 04) and 10 down to 10^{-5} mbar (HVS 03k). These sensors are built in small and robust TO-8 metal housings.

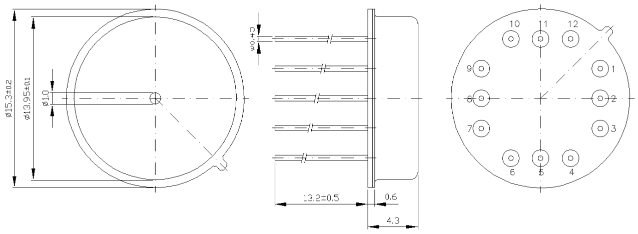
Combining the HVS 03k and HVS 04 type chip in one TO-8 housing results in a dual-chip model with an extended pressure measurement range.

Constant Temperature Readout Circuit

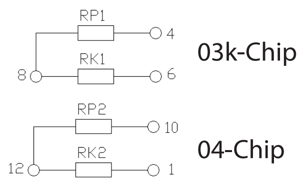
The constant resistance readout is commonly used as it can reduce - however not eliminate - unwanted signal drift caused by changing ambient temperature. It is best suited for rough and fine vacuum regimes. The op-amp is part of a control loop which keeps R_p and R_k at a certain temperature difference.



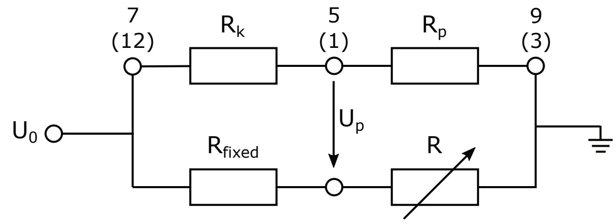
Dimensions and PIN-Configuration



Configuration:



Wheatstone Bridge Configuration



One possible readout is the wheatstone bridge arrangement. The output voltage U_p should be balanced (Up = 0 V) at atmospheric pressure (1013 mbar) by using the potentiometer R. The resistance R_p is changing with pressure p and therefore U_p is changing as well.

The wheatstone bridge is recommended for high vacuum measurements and low power operation, but requires an advanced calibration.

Characteristics

	HVS 03k +HVS 04 (dual)	Unit
Housing	TO-8	
Chip size	$4.0^2 + 1.0^2$	mm²
Signal voltage U_P	180 + 410	mV
Resistance sensor chip R_p	9 + 1	kOhm
On chip reference resistor R_K	9 + 1	kOhm
Supply voltage U_0 a)	2	V
Operating temperature	-20 ... 120	°C
Storage temperature	-40 ... 120	°C

a) Bridge circuit

Ordering Information

HVS	Heimann Vacuum Sensor	**E.g.: HVS 03k + HVS 04 (Dual)**
03k, 04	Chip type and package type (TO-8 / TO-39)	

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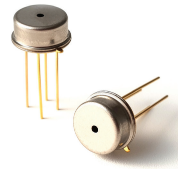


Constant resistance ratio circuit

The vacuum sensor has two resistive elements inside, one on a thin membrane, the other on the sensor's bulk material. The following circuit supplies voltages to the sensor in a way that the RP (membrane element) is a few degrees warmer than the RK (bulk element).

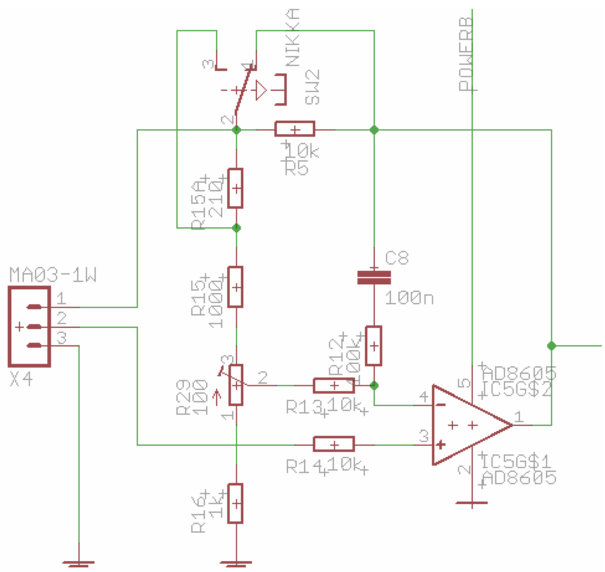
In operation, the more molecules in contact with the membrane, due to higher atmospheric pressure, cool the membrane due to convection the higher the voltage required to keep the temperature difference between the two elements.

The op-amp is part of a control loop which keeps the RP, membrane resistor, at a certain temperature difference with the RK.

The switch (SW2) is shown in the operating position.

When the switch is in the other position the power on the sensor element is very limited due to R5 and R15A being shorted. This corresponds to the resistance change due to the heating of the sensor element. Use this position to find the offset point of the circuit.

The sensor is connected at X4, RP is between 1 and 2, RK is between 2 and 3.



In steady state operation the upper branch has 1,260 Ω, the lower one 10,500 Ω (middle position of R29). The sensor must follow and creates , in a controlled loop, the same resistance ratio. When the membrane is cooled with increasing amounts of gas more electrical power is required to keep the same resistance ratio. Therefore, the output voltage of the op-amp is related to the atmospheric pressure.

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