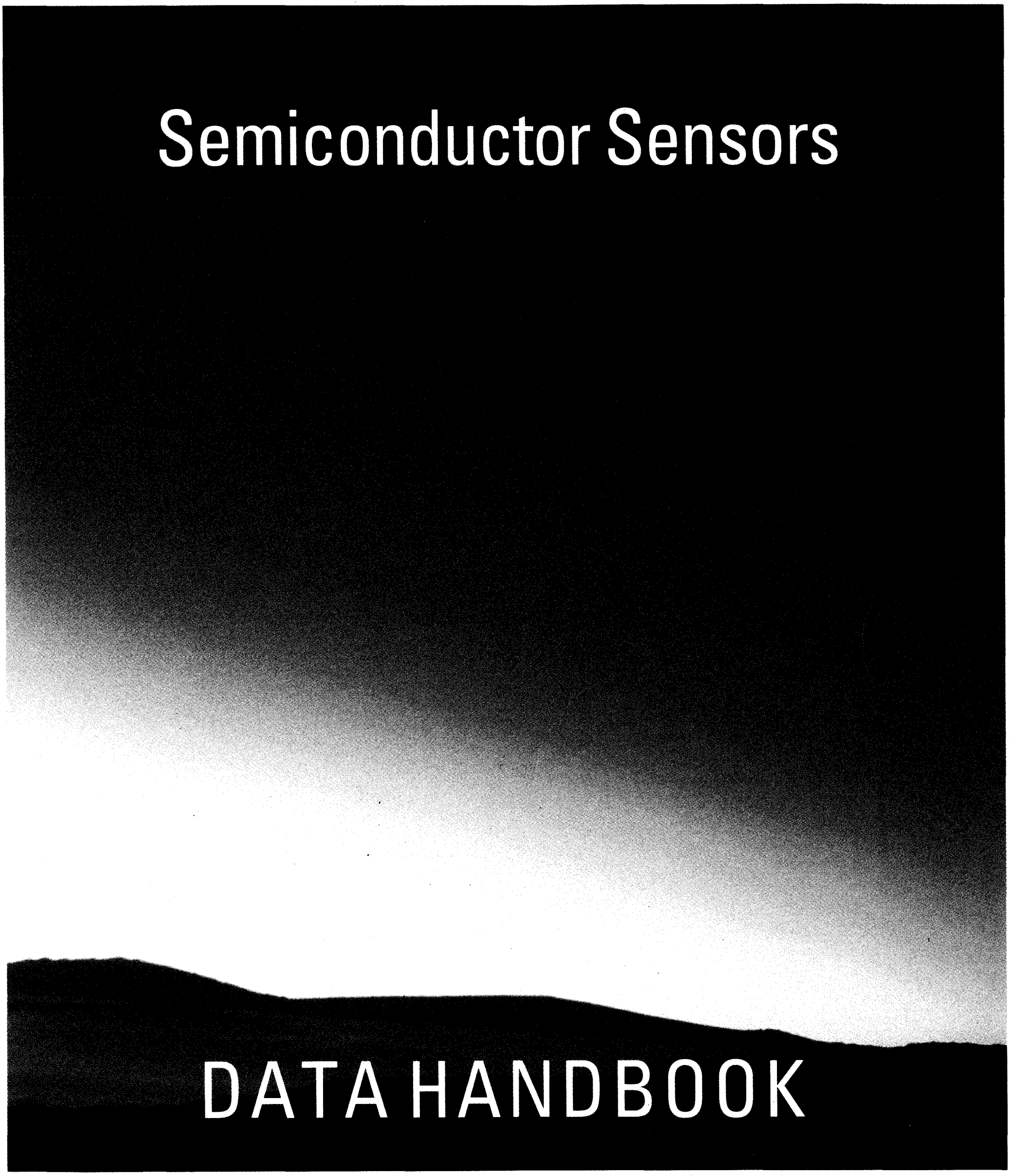
Semiconductor Sensors



DATA HANDBOOK

BOOK SC17 1993

Philips Semiconductors

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Semiconductor sensors

Contents

DEFINITIONS

Data sheet status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of this specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

SELECTION GUIDE

MAGNETIC FIELD SENSORS

TYPE	FIELD RANGE (kA/m) (note 1)	SUPPLY VOLTAGE (V)	T_{amb} (°C)	SENSITIVITY $(\frac{mV/V}{kA/m})$	BRIDGE RESISTANCE (kΩ)	PAGE
KM110B/1	−2.0 to 2.0 kA/m	5	−40 to 150	1.7	2.1	32
KMZ10A	−0.5 to +0.5	5	−40 to 150	16	1.2	36
KMZ10A1	−0.05 to +0.05 (note 2)	5	−40 to 150	22 (note 2)	1.3	39
KMZ10B	−2.0 to +2.0	5	−40 to 150	4	2.1	44
KMZ10C	−7.5 to +7.5	5	−40 to 150	1.5	1.4	48

Notes

1. In air, 1 kA/m corresponds to approximately 12.5 G or 1.25 mT.
2. With switched Hx.

SENSOR HYBRID MODULES

Sensors for rotational speed measurement and reference-mark detection

TYPE	SENSING DISTANCE (mm) (note 1)	SENSING FREQUENCY (Hz)	MOUNTING DIRECTION RELATIVE TO GEAR WHEEL	DETERMINATION OF ROTATIONAL DIRECTION	PAGE
KM110BH/11	2.5	0 to 3000	tangential	N	70
KM110BH/12	3.5	1 to 3000	tangential	N	70
KM110BH/13	2.5	0 to 3000	radial	N	74
KM110BH/14	3.5	1 to 3000	radial	N	74
KM110BH/31	3.0	2 to 50 000	radial	Y	78

Note

1. Gear wheel: pitch diameter = 44 mm; width = 16 mm; module 2; material: steel (1.0715).

Sensor modules for angle measurement

TYPE	ANGLE RANGE (deg)	OUTPUT VOLTAGE (note 1) (V)	SUPPLY VOLTAGE (V)	T_{amb} (°C)	PAGE
KM110BH/2130	30	0.5 to 4.5; linear	5	−40 to 125	84
KM110BH/2190	90	0.5 to 4.5; sinusoidal	5	−40 to 125	84

Note

1. Sensor signal is generated by a magnetic field H = 100 kA/m. For example: rare earth magnet 11.2 x 5.5 x 8.0 mm, distance 2.5 mm from KMZ chip.

TEMPERATURE SENSORS

TYPE	TEMPERATURE RANGE (°C)	RESISTANCE R (Ω)	RESISTANCE at T_{amb} (°C)	SENSOR ACCURACY at T_{amb} (°C)	SENSOR ACCURACY at T_{amb} (°C)	SENSOR CURRENT (mA)	PAGE
KTY81-110	−55 to 150	990 to 1010	25	±1.3	25	1	106
KTY81-120 (note 1)	−55 to 150	980 to 1020	25	±2.5	25	1	106
KTY81-121	−55 to 150	980 to 1000	25	±1.3	25	1	106
KTY81-122	−55 to 150	1000 to 1020	25	±1.3	25	1	106
KTY81-150 (note 2)	−55 to 150	950 to 1050	25	±6.3	25	1	106
KTY81-151	−55 to 150	950 to 1000	25	±3.2	25	1	106
KTY81-152	−55 to 150	1000 to 1050	25	±3.2	25	1	106
KTY81-210	−55 to 150	1980 to 2020	25	±1.3	25	1	110
KTY81-220 (note 1)	−55 to 150	1960 to 2040	25	±2.5	25	1	110
KTY81-221	−55 to 150	1960 to 2000	25	±1.3	25	1	110
KTY81-222	−55 to 150	2000 to 2040	25	±1.3	25	1	110
KTY81-250 (note 2)	−55 to 150	1900 to 2100	25	±6.3	25	1	110
KTY81-251	−55 to 150	1900 to 2000	25	±3.2	25	1	110
KTY81-252	−55 to 150	2000 to 2100	25	±3.2	25	1	110
KTY82-110	−55 to 150	990 to 1010	25	±1.3	25	1	114
KTY82-120 (note 1)	−55 to 150	980 to 1020	25	±2.5	25	1	114
KTY82-121	−55 to 150	980 to 1000	25	±1.3	25	1	114
KTY82-122	−55 to 150	1000 to 1020	25	±1.3	25	1	114
KTY82-150 (note 2)	−55 to 150	950 to 1050	25	±6.3	25	1	114
KTY82-151	−55 to 150	950 to 1000	25	±3.2	25	1	114
KTY82-152	−55 to 150	1000 to 1050	25	±3.2	25	1	114
KTY82-210	−55 to 150	1980 to 2020	25	±1.3	25	1	121
KTY82-220 (note 1)	−55 to 150	1960 to 2040	25	±2.5	25	1	121
KTY82-221	−55 to 150	1960 to 2000	25	±1.3	25	1	121
KTY82-222	−55 to 150	2000 to 2040	25	±1.3	25	1	121
KTY82-250 (note 2)	−55 to 150	1900 to 2100	25	±6.3	25	1	121
KTY82-251	−55 to 150	1900 to 2000	25	±3.2	25	1	121
KTY82-252	−55 to 150	2000 to 2100	25	±3.2	25	1	121
KTY83-110	−55 to 175	990 to 1010	25	±1.3	25	1	128

TEMPERATURE SENSORS *(Continued)*

TYPE	TEMPERATURE RANGE (°C)	RESISTANCE R (Ω)	RESISTANCE at T_{amb} (°C)	SENSOR ACCURACY at T_{amb} (°C)	SENSOR ACCURACY at T_{amb} (°C)	SENSOR CURRENT (mA)	PAGE
KTY83-120 (note 1)	–55 to 175	980 to 1020	25	±2.6	25	1	128
KTY83-121	–55 to 175	980 to 1000	25	±1.3	25	1	128
KTY83-122	–55 to 175	1000 to 1020	25	±1.3	25	1	128
KTY83-150 (note 2)	–55 to 175	950 to 1050	25	±6.6	25	1	128
KTY83-151	–55 to 175	950 to 1000	25	±3.3	25	1	128
KTY83-152	–55 to 175	1000 to 1050	25	±3.3	25	1	128
KTY84-130	–40 to 300	970 to 1030	100	±4.8	100	2	132
KTY84-150 (note 2)	–40 to 300	950 to 1050	100	±8.0	100	2	132
KTY84-151	–40 to 300	950 to 1000	100	±4.0	100	2	132
KTY84-152	–40 to 300	1000 to 1050	25	±4.0	100	2	132
KTY85-110	–40 to 125	990 to 1010	25	±1.3	25	1	137
KTY85-120 (note 1)	–40 to 125	980 to 1020	25	±2.6	25	1	137
KTY85-121	–40 to 125	980 to 1000	25	±1.3	25	1	137
KTY85-122	–40 to 125	1000 to 1020	25	±1.3	25	1	137
KTY85-150 (note 2)	–40 to 125	950 to 1050	25	±6.6	25	1	137
KTY85-151	–40 to 125	950 to 1000	25	±3.3	25	1	137
KTY85-152	–40 to 125	1000 to 1050	25	±3.3	25	1	137
KTY86-205	–40 to 150	1990 to 2010	25	±0.7	25	0.1	142
KTY87-205	–40 to 125	1990 to 2010 3327 to 3361	25 100	±0.7 ±0.8	25 100	0.1 0.1	147

Notes

1. Contains the groups –21 and –22, which are marked accordingly.
2. Contains the groups –51 and –52, which are marked accordingly.

PROXIMITY DETECTORS

T_{amb} = −40 to 85 °C.

TYPE	SWITCHING DISTANCE (mm)	SUPPLY VOLTAGE (V)	MAXIMUM OUTPUT CURRENT (mA)	at V_B (V)	PAGE
OM386B OM387B	1 to 5 1 to 5	10 to 30 −10 to −30	250 250	10 to 30 −10 to −30	155
OM386M OM387M	1 to 5 1 to 5	10 to 30 −10 to −30	250 250	10 to 30 −10 to −30	161
OM388B OM389B	2 to 5 2 to 5	10 to 30 −10 to −30	250 250	10 to 30 −10 to −30	167
OM390 OM391	2 to 5 2 to 5	10 to 30 −10 to −30	250 250	10 to 30 −10 to −30	173
OM2860 OM2870	0.8 to 5 0.8 to 5	4.7 to 30 −4.7 to −30	250 250	24 −24	179

TYPE NUMBER SURVEY

In this survey we give an alphanumeric list of all devices contained in this book.

TYPE	DESCRIPTION	PAGE
KM110B/1	Magnetic field sensor with magnet, −2.0 to +2.0 kA/m	32
KM110BH/11	contactless rotational speed sensor, 0 to 3000 Hz	70
KM110BH/12	contactless rotational speed sensor, 1 to 3000 Hz	70
KM110BH/13	contactless rotational speed sensor, 0 to 3000 Hz	74
KM110BH/14	contactless rotational speed sensor, 1 to 3000 Hz	74
KM110BH/31	contactless direction-sensitive rotational speed sensor, 2 to 50 000 Hz	78
KM110BH/2130	contactless angle sensor, −15 to +15 deg	84
KM110BH/2190	contactless angle sensor, −45 to +45 deg	84
KMZ10A	Magnetic field sensor, −0.5 to +0.5 kA/m	36
KMZ10A1	Magnetic field sensor, −0.05 to +0.05 kA/m	39
KMZ10B	Magnetic field sensor, −2.0 to +2.0 kA/m	44
KMZ10C	Magnetic field sensor, −7.5 to +7.5 kA/m	48
KTY81-110	Temperature sensor, −55 to +150 °C	106
KTY81-120	Temperature sensor, −55 to +150 °C	106
KTY81-121	Temperature sensor, −55 to +150 °C	106
KTY81-122	Temperature sensor, −55 to +150 °C	106
KTY81-150	Temperature sensor, −55 to +150 °C	106
KTY81-151	Temperature sensor, −55 to +150 °C	106
KTY81-152	Temperature sensor, −55 to +150 °C	106
KTY81-210	Temperature sensor, −55 to +150 °C	110
KTY81-220	Temperature sensor, −55 to +150 °C	110
KTY81-221	Temperature sensor, −55 to +150 °C	110
KTY81-222	Temperature sensor, −55 to +150 °C	110
KTY81-250	Temperature sensor, −55 to +150 °C	110
KTY81-251	Temperature sensor, −55 to +150 °C	110
KTY81-252	Temperature sensor, −55 to +150 °C	110
KTY82-110	Temperature sensor, −55 to +150 °C	114
KTY82-120	Temperature sensor, −55 to +150 °C	114
KTY82-121	Temperature sensor, −55 to +150 °C	114
KTY82-122	Temperature sensor, −55 to +150 °C	114
KTY82-150	Temperature sensor, −55 to +150 °C	114
KTY82-151	Temperature sensor, −55 to +150 °C	114
KTY82-152	Temperature sensor, −55 to +150 °C	114
KTY82-210	Temperature sensor, −55 to +150 °C	121
KTY82-220	Temperature sensor, −55 to +150 °C	121
KTY82-221	Temperature sensor, −55 to +150 °C	121
KTY82-222	Temperature sensor, −55 to +150 °C	121
KTY82-250	Temperature sensor, −55 to +150 °C	121

TYPE	DESCRIPTION	PAGE
KTY82-251	Temperature sensor, –55 to +150 °C	121
KTY82-252	Temperature sensor, –55 to +150 °C	121
KTY83-110	Temperature sensor, –55 to +175 °C	128
KTY83-120	Temperature sensor, –55 to +175 °C	128
KTY83-121	Temperature sensor, –55 to +175 °C	128
KTY83-122	Temperature sensor, –55 to +175 °C	128
KTY83-150	Temperature sensor, –55 to +175 °C	128
KTY83-151	Temperature sensor, –55 to +175 °C	128
KTY83-152	Temperature sensor, –55 to +175 °C	128
KTY84-130	Temperature sensor, –40 to 300 °C	132
KTY84-150	Temperature sensor, –40 to 300 °C	132
KTY84-151	Temperature sensor, –40 to 300 °C	132
KTY84-152	Temperature sensor, –40 to 300 °C	132
KTY85-110	Temperature sensor, –40 to +125 °C	137
KTY85-120	Temperature sensor, –40 to +125 °C	137
KTY85-121	Temperature sensor, –40 to +125 °C	137
KTY85-122	Temperature sensor, –40 to +125 °C	137
KTY85-150	Temperature sensor, –40 to +125 °C	137
KTY85-151	Temperature sensor, –40 to +125 °C	137
KTY85-152	Temperature sensor, –40 to +125 °C	137
KTY86-205	Temperature sensor, –40 to +150 °C	142
KTY87-205	Temperature sensor, –40 to +125 °C	147
OM386B	Proximity detector, 250 mA	155
OM386M	As OM386B, but with reverse polarity	161
OM387B	As OM386B, but with reverse polarity	155
OM387M	As OM387B, but with reverse polarity	161
OM388B	Proximity detector, 250 mA	167
OM389B	As OM388B, but with reverse polarity	167
OM390	Proximity detector, 250 mA	173
OM391	As OM390, but with reverse polarity	173
OM2860	Proximity detector, 250 mA	179
OM2870	As OM2860, but with reverse polarity	179

INTRODUCTION TO MAGNETIC FIELD SENSORS

INTRODUCTION

The KMZ10 range of magnetic field sensors are highly sensitive and provide an excellent means of measuring both linear and angular displacement. This is because a quite small movement of actuating components in machinery (metal rods, cogs, cams, etc.) can create measurable changes in a magnetic field.

Examples where this property can be put to good effect can be found in instrumentation and control equipment, which often requires position sensors capable of detecting displacements in the region of tenths of a millimeter, and in electronic ignition systems, which must be able to determine the angular position of an internal combustion engine with great accuracy.

If the KMZ10 is to be used to maximum advantage, however, it is important to have a clear understanding of its operating principles and characteristics, and of how its behaviour may be affected by external influences and by its magnetic history.

OPERATING PRINCIPLES

The KMZ10 makes use of the *magnetoresistive effect*, the well-known property of a current-carrying magnetic material to change its resistivity in the presence of an external magnetic field. This change is brought about by rotation of the magnetization relative to the direction of the current.

For example, in the case of permalloy (a ferromagnetic alloy containing 20% iron and 80% nickel), a 90 ° rotation of the magnetization (due to the application of a magnetic field normal to the direction of the current) will produce a change in resistivity of between 2 and 3%.

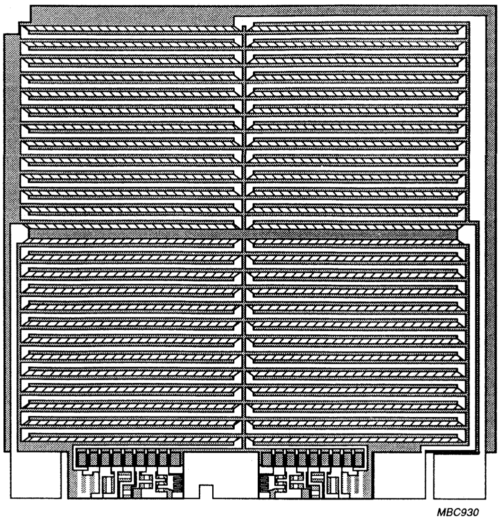
In the KMZ10, four permalloy strips are arranged in a meander pattern on a silicon substrate (Fig.1), and connected to form the four arms of a Wheatstone bridge (Fig.2). The degree of bridge imbalance is then used to indicate the magnetic field strength, or more precisely the variation in magnetic field in the plane of the permalloy strips normal to the direction of the current. The outline of the KMZ10 is shown in Fig.3.

THE KMZ10 RANGE OF MAGNETIC FIELD SENSORS

PARAMETER	KMZ10A	KMZ10A1 (note 1)	KMZ10B	KMZ10C	UNITS
H_{max} (typ.)	±0.5	±0.05	±2.0	±7.5	kA/m
open circuit sensitivity	16	22	4.0	1.5	(mV/V)/(kA/m)

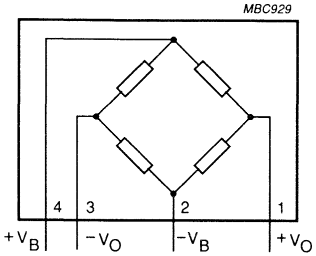
Note

1. With switched auxiliary field (H_x).



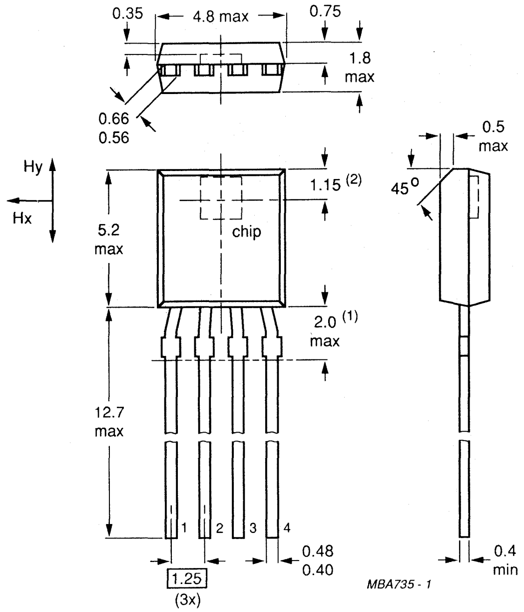
The chip incorporates special resistors that are trimmed during manufacture to give zero offset at 25 °C.

Fig.1 KMZ10 chip structure.



V_B = supply voltage.
V_O = output voltage.

Fig.2 KMZ10 bridge configuration.



Drawing shows pinning and magnetic field direction for normal operation.

Fig.3 KMZ10 outline.

Pinning for KMZ sensor

PIN	DESCRIPTION
1	output voltage (+)
2	supply voltage (–V_B)
3	output voltage (–)
4	supply voltage (+V_B)

CHARACTERISTIC BEHAVIOUR

During manufacture, a strong magnetic field is applied parallel to the strip axis. This field imparts a preferred magnetization direction to the permalloy strips. Therefore, even in the absence of an external magnetic field, the magnetization will always tend to align with the strips.

The internal magnetization of the sensor strips, therefore, has two stable positions, so that if for any reason the sensor should come under the influence of a powerful magnetic field opposing the internal aligning field, the magnetization may flip from one position to the other, and the strips become magnetized in the opposite direction (from, for example, the "+x" to the "−x" direction). As demonstrated in Fig.4, this can lead to drastic changes in sensor characteristics.

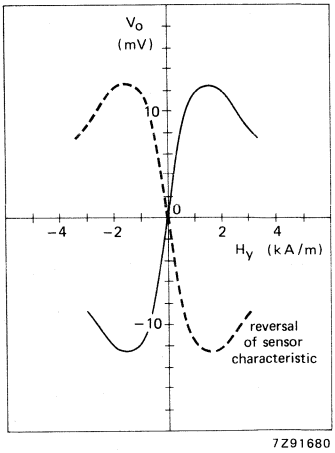
The field (e.g. "H_{-x}") needed to flip the sensor magnetization, and hence the characteristic, depends on the magnitude of the transverse field "H_y": the greater the field "H_y", the smaller the field "H_{-x}". This is perfectly reasonable, since the greater the field "H_y", the closer the magnetization's rotation approaches 90 °, and hence the easier it will be to flip it into a corresponding stable position in the "−x" direction.

Looking at the curve in Fig.5, where $H_y = 0.5$ kA/m: for such a low transverse field, the sensor characteristic is stable for all positive values of H_x, and a reverse field of approximately 1 kA/m is required before flipping occurs. At $H_y = 4$ kA/m however, the sensor will flip even at positive values of H_x (at approximately 1 kA/m).

Figure 5 also illustrates that the flipping itself is not instantaneous; this is because not all the permalloy strips flip at the same rate. The hysteresis effect exhibited by the sensor is also shown by Fig.5. Finally, Figs 5 and 6 show that the sensitivity of the sensor falls with increasing H_x. Again, this is perfectly reasonable, since the moment imposed on the magnetization by H_x directly opposes that imposed by H_y, thereby reducing the degree of bridge imbalance and hence the output signal for a given value of H_y.

The following general recommendations for operating the KMZ10 can be applied:

- To ensure stable operation, avoid operating the sensor in an environment where it is likely to be subjected to negative external fields (H_{-x}). Preferably, apply a positive auxiliary field (H_x) of sufficient magnitude to prevent any likelihood of flipping within the intended operating range (i.e. the range of H_y)

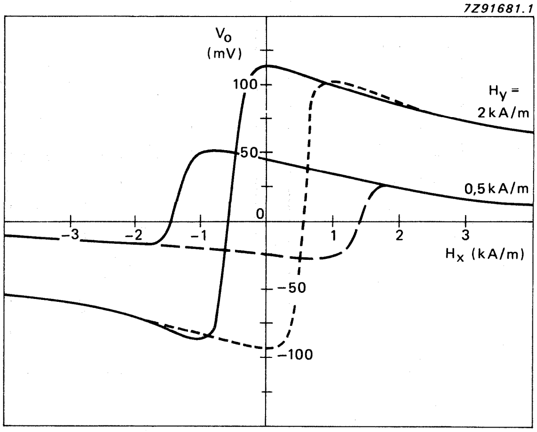


The unbroken line shows the characteristics of a 'normal' sensor (with the magnetization oriented in the "+x" direction), and the broken line shows the characteristic of a 'flipped' sensor (with the magnetization oriented in the "−x" direction).

Fig.4 Sensor characteristic.

- Use the minimum auxiliary field that will ensure stable operation. Remember, the larger the auxiliary field, the lower the sensitivity. For the KMZ10B sensor, a minimum auxiliary field of approximately 1 kA/m is recommended
- Finally, before using the sensor for the first time, apply a positive auxiliary field of at least 3 kA/m; this will effectively erase the sensor's history and will ensure that no residual hysteresis remains (see Fig.5). To *guarantee* stable operation, the sensor should in fact be operated in an auxiliary field of 3 kA/m (the value recommended in the data sheets).

These recommendations (particularly the first one) define a kind of safe operating area (SOAR) for the sensors. This can be seen from Fig.7, which is an example (for the KMZ10B sensor) of the SOAR graphs to be found in our data sheets. The graph shows the SOAR of a KMZ10B as a function of auxiliary field H_x and of disturbing field H_d opposing H_x.



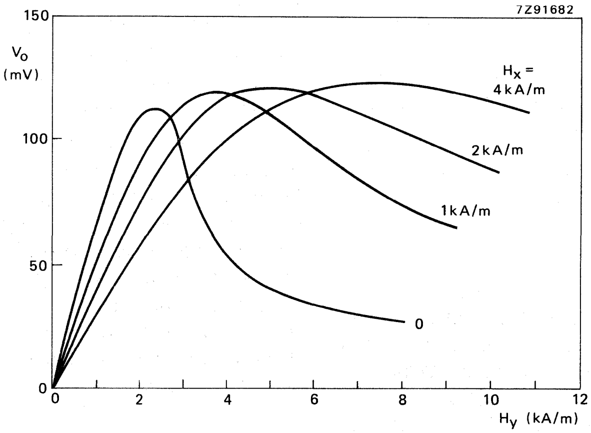
The curves illustrate three characteristics:

(1) The sensor exhibits hysteresis.

(2) The flipping is not instantaneous

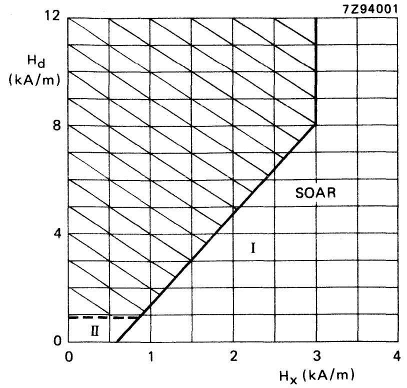
(3) Sensitivity falls with increasing H_x.

Fig.5 Sensor output (V_O) as a function of auxiliary field (H_x) for several values of transverse field (H_y).



The curves illustrate, more clearly than in Fig.5, the fall in sensitivity (i.e. initial gradient) with increasing H_x.

Fig.6 Output (V_O) as a function of transverse field (H_y) for several values of auxiliary field (H_x).



The SOAR can be extended slightly (area II) for values of H_y < 1 kA/m.

Fig.7 SOAR of a KMZ10B sensor as a function of auxiliary field H_x and disturbing field H_d opposing H_x (area I).

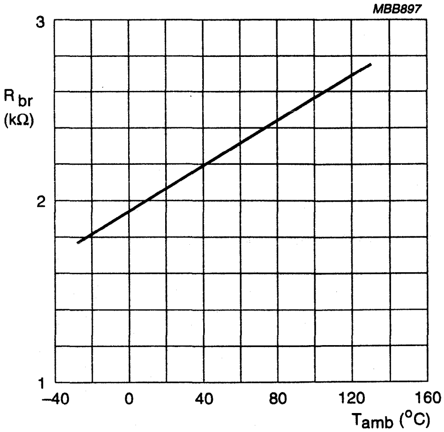


Fig.8 Bridge resistance of a KMZ10B sensor as a function of temperature.

The greater the auxiliary field, the greater the disturbing field that can be tolerated before flipping occurs. For auxiliary fields above 3 kA/m, the SOAR graph shows that the sensor is completely stable, regardless of the magnitude of the disturbing field. It can also be seen from this graph that the SOAR can be extended for low values of H_y. In this figure (for the KMZ10B sensor), the extension for H_y < 1 kA/m is shown.

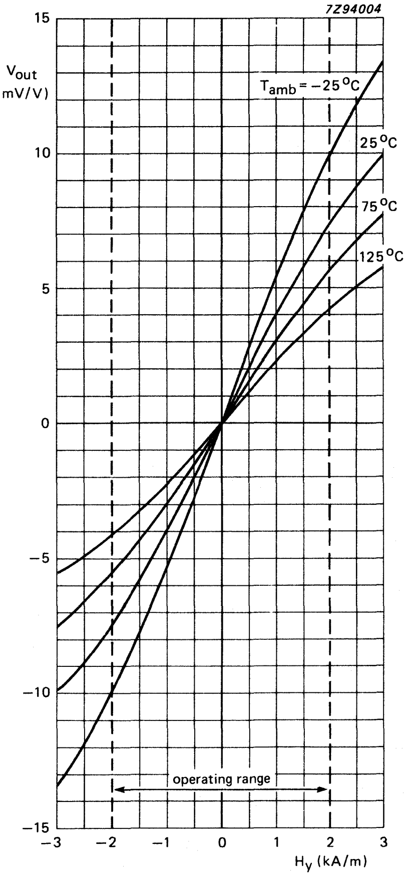
Samples of the KMZ10B sensor with an auxiliary magnet can be supplied upon request.

Effect of temperature on behaviour

Figure 8 shows that the bridge resistance increases linearly with temperature. This variation comes of course from the fact that the bridge resistors themselves (i.e. the permalloy strips) vary with temperature. As explained later, this variation can be put to good effect when operating with a constant current supply. Figure 8 shows only the variation for a typical KMZ10B sensor. The data sheets show also the spread in this variation due to manufacturing tolerances, and this should be taken into account when incorporating the sensor in practical circuits.

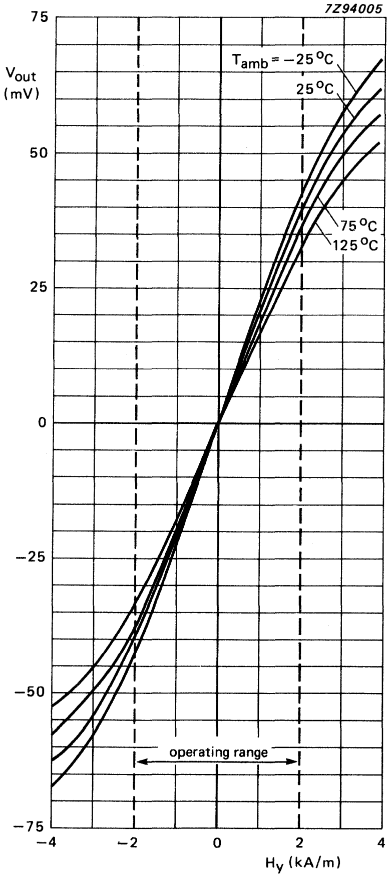
In addition to the bridge resistance, the sensitivity also varies with temperature. This can be seen from Fig.9, which plots output voltage against transverse field H_y for various temperatures. The figure shows that sensitivity falls with increasing temperature. The reason for this is quite complicated, and is connected with the energy-band structure of the permalloy strips.

Figure 10 is similar to Fig.9, but with the sensor powered by a constant current supply. The figure shows that with this constant current supply, the temperature dependence of sensitivity is significantly reduced. This is a direct result of the increase in bridge resistance with temperature (Fig.7), which partly compensates the fall in sensitivity by increasing the voltage across the bridge and hence the output voltage. The figure adequately demonstrates therefore the advantages of operating with constant current.



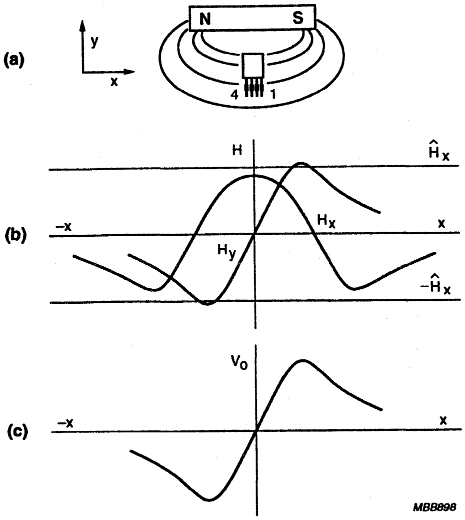
The figure illustrates that sensitivity falls with increasing temperature.

Fig.9 Output voltage (V_O) (as a fraction of the supply voltage) of a KMZ10B sensor as a function of transverse field (H_y) for several temperatures.



The reduction in temperature dependence of sensitivity is a result of the increase in bridge resistance with temperature, which increases the bridge voltage, to partly compensate the fall in sensitivity.

Fig.10 Output voltage (V_O) of a KMZ10B sensor as a function of transverse field (H_y) for several temperatures.



The magnet provides both the auxiliary and transverse fields. In the example shown, the auxiliary field is always less than the field $\hat{H}_x$ that will cause flipping. Note the pinning arrangement, which indicates that the sensor is viewed from the rear. Reversal of the sensor relative to the permanent magnet will reverse the characteristic.

Fig.11 Sensor output in the field of a permanent magnet as a function of its displacement x parallel to the magnetic axis.

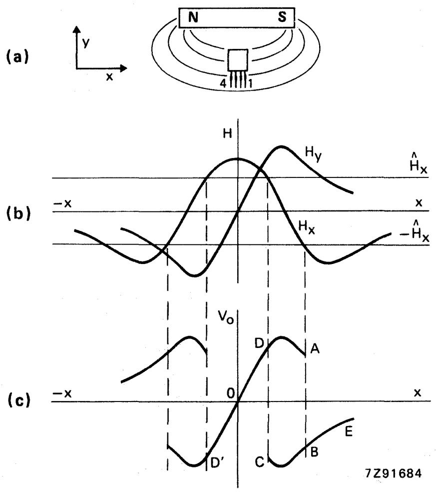
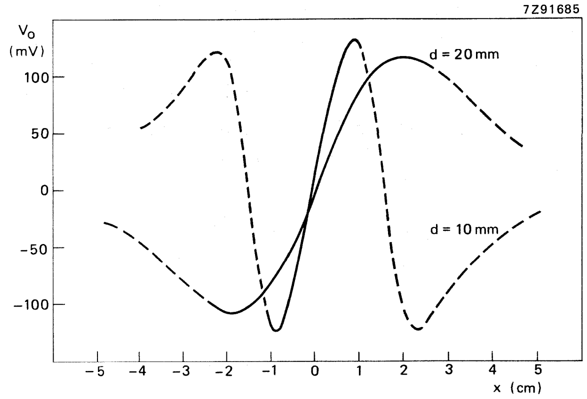


Fig.12 Sensor output in the set-up of Fig.11, but in which the auxiliary field sometimes exceeds $\hat{H}_x$.



Sensor at distances "d" of 10 mm and 20 mm from a permanent magnet.

Fig.13 Measured sensor output as a function of displacement "x" parallel to the magnetic axis.

USING THE KMZ10

Displacement measurement using permanent magnets

Figures 11 and 12 show one of the simplest arrangements for using a sensor/permanent magnet combination for measuring linear displacement, and illustrates some of the problems likely to be encountered if proper account is not taken of the effects previously described.

When the sensor is placed in the field of a permanent magnet, it is exposed to magnetic fields in both the x and y directions. If the magnet is oriented with its axis parallel to the sensor strips (i.e. in the x direction), as shown in Fig.11(a), H_x then provides the auxiliary field and the variation in H_y can be used as a measure of x displacement. Figure 11(b) shows how both H_x and H_y vary with x, and Fig.11(c) shows the corresponding output signal as a function of x.

In the example shown in Fig.11, H_x never exceeds $\pm\hat{H}_x$ (the field that can cause flipping of the sensor) and the sensor characteristic remains stable throughout the measuring range.

Consider the example shown in Fig.12. In this example, for certain values of x, H_x exceeds $\pm\hat{H}_x$ (Fig.12(b)). This could occur if, for example, the magnet were powerful or if the sensor should pass close to the magnet, and as Fig.12(c) shows, the effects on the output can be drastic.

Assuming the sensor is initially on the transverse axis of the magnet (i.e. x = 0). H_y will be zero and H_x will be at its maximum value (> $\hat{H}_x$). Therefore, the sensor will be oriented in the +x direction and the output voltage will vary as in Fig.11(a).

As the sensor moves in the +x direction, H_y (and hence V_O) increases, and H_x falls to zero and then increases negatively until it exceeds $-\hat{H}_x$. At this point, the sensor characteristic flips and the output voltage reverses, moving from A to B in Fig.12(c). Any further increase in x causes the sensor voltage to move along BE. However, if the sensor is moved in the opposite direction, H_x increases until it exceeds $+\hat{H}_x$ and V_O moves from B to C. At this point, the sensor characteristic flips again and V_O moves from C to D.

Under these conditions, the sensor characteristic will trace the hysteresis loop ABCD, and a similar loop in the –x direction. Figure 12(c) is in fact an idealized case and the reversals are never as abrupt as shown. It does however illustrate the effects that can occur if the sensor is placed close to a powerful magnet.

Under certain circumstances, particularly where there are likely to be temporary or fluctuating external fields, it may be advantageous to operate under these conditions, since over the region DD' the field of the permanent magnet will have a stabilizing effect upon the sensor (i.e. it will have to correct any flipping of the sensor due to transient magnetic fields). Note that reversal of the permanent magnet will give rise to the same sensor characteristic as shown in Figs 11(c) and 12(c) (i.e. with positive slope), since the sensor will then be forced to operate in its flipped state.

Figure 13 shows the sensor characteristic at distances of 10 mm and 20 mm from a permanent magnet, and amply illustrates the effects shown in Figs 11 and 12.

One-point measurement with the KMZ10

Figure 14(a) shows how a KMZ10 may be used to make position measurements of a metal object, for example a steel plate. The sensor is located between the plate and a permanent magnet oriented with its magnetic axis normal to the axis of the plate. A discontinuity in the plate's structure, such as a hole or region of non-magnetic material, will disturb the magnetic field and produce a variation in the output signal from the sensor.

This is shown in Fig.14(b), which gives the sensor output signal as a function of hole/sensor offset "x", for two values of magnet/plate spacing "d". The interesting feature of this figure is that the crossover point (i.e. the point where the hole and the sensor precisely coincide) is independent of "d". The obvious advantage of this set-up is that precise location of the sensor/magnet combination is unimportant for one-point measurements, so adjustment procedures in a practical device would be greatly simplified. Although not shown in Fig.14(b), the crossover point is also independent of the temperature. This is not surprising, since it is effectively a null measurement and could be a major advantage in practical applications.

Angular position measurement with the KMZ10

Figure 15 shows a practical set-up for measuring angular position, using a KMZ10C. The sensor itself is located in the magnetic field produced by two RES190 permanent magnets fixed to a rotatable frame. The output of the sensor will then be a measure of the rotation of the frame (Fig.17). Taking the zero position for measurement to be parallel to the "x" axis of the sensor (i.e. with the magnetic field in the H_x direction), the device can measure rotation up to approximately ±85 °. Beyond that, the sensor is in danger of flipping.

Figure 16 shows a circuit for measuring the sensor output in the set-up of Fig.15. The output signal of the sensor bridge is amplified by op-amps A1 and A2. A KTY81 silicon temperature sensor in the feedback loop of A2 varies the gain of the amplifier to provide temperature compensation for the output signal. Figure 17 shows the effectiveness of this temperature compensation by comparing the output V_2 of A2 with the direct output V_1 from op-amp A1 for a range of temperatures.

An alternative angular position measurement principle is discussed in the introductory section **Hybrid Sensor Modules**.

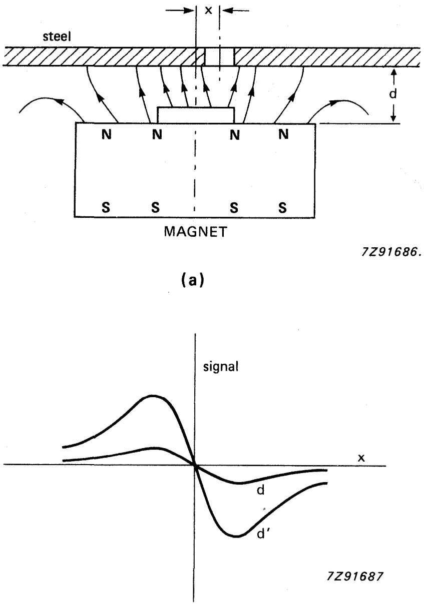
Current measurement with the KMZ10

Figures 18 and 19 show two ways in which the KMZ10B can be used to measure electric current. This could be useful, for example, in headlamp failure systems in automobiles or in clamp-on (non-contacting) meters, as used in the power industry.

Figure 18 is a fairly simple set-up, in which the sensor measures the magnetic field generated by the current-carrying wire. Figure 19 is a more sophisticated arrangement, in which the magnetic field generated by the current-carrying wire is compensated by a secondary circuit wrapped around a ferrite core. At the null-field point (detected by a KMZ10 sensor located in the air gap between the ends of the core) the magnitude of the current in the secondary circuit is a measure of the current in the main circuit. This arrangement provides a more accurate means of measuring current and lends itself more to precision applications. What is important to bear in mind in both these examples however is that they allow current measurement without any break in or interference with the circuit. In this way, they provide a distinct advantage over thermistor based systems.

Measuring weak magnetic fields with the KMZ10A1 - magnetic compass

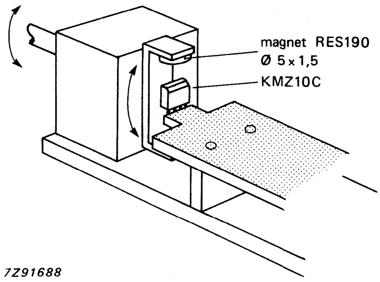
For the measurement of weak magnetic fields (e.g. the earth's field), it is often advantageous to omit the auxiliary magnet, in order to exploit the sensor's



(a)

(b)

Fig.14 One-point measurement with the KMZ10.



(a)

Fig.15 Angular measurement with the KMZ10.

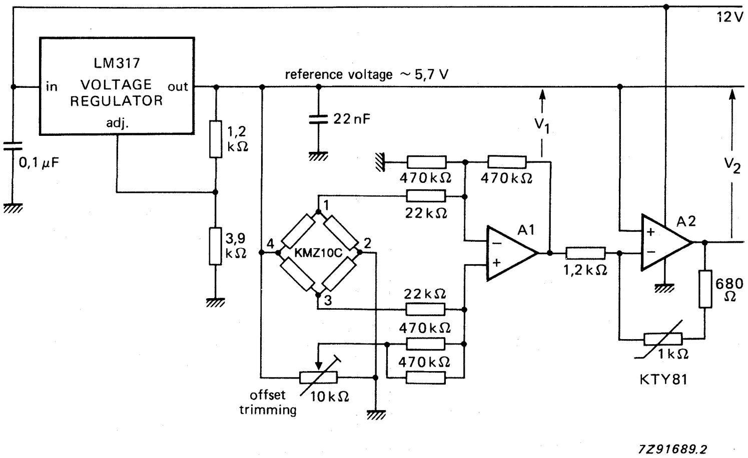


Fig.16 Circuit for measuring sensor output in the set-up of Fig.15.

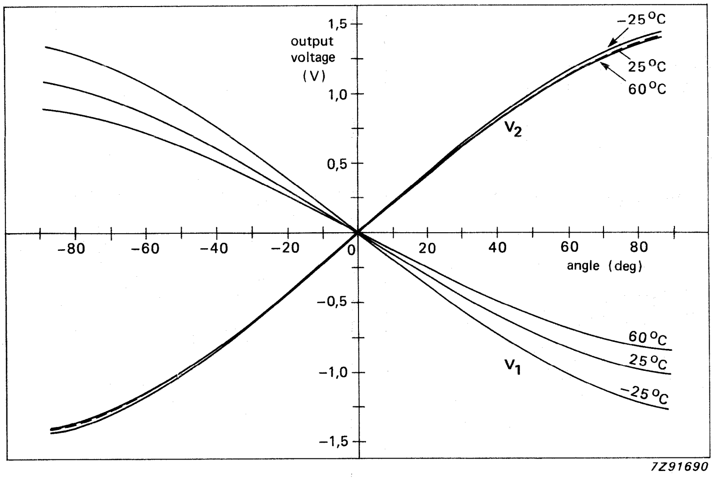
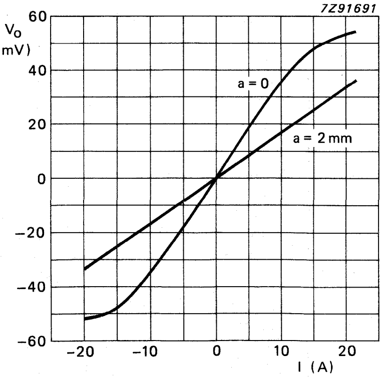
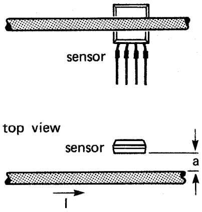


Fig.17 Effect of temperature compensation in the circuit of Fig.16.





The sensor measures the magnetic field generated by a current-carrying wire.

Fig.18 Simple set-up for measuring current with a KMZ10 sensor.

maximum sensitivity. The sensor's internal magnetization, however, is then in danger of being 'flipped' by stray magnetic fields.

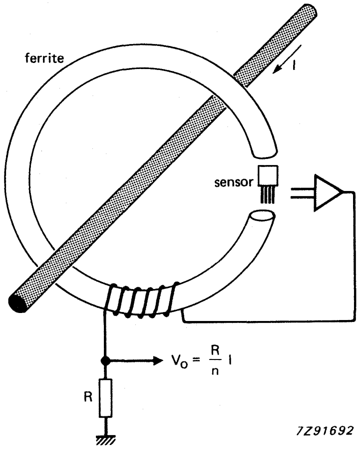
A further problem of measuring weak magnetic fields is that the measuring accuracy is limited by the drift of both the sensor and the amplifier offsets. Figure 20 shows a circuit that removes these problems by taking advantage of the 'flipping' characteristic of the KMZ10A1. The circuit contains a coil, (L1), the axial field of which is periodically reversed by successive positive and negative going pulses.

As a consequence, the internal magnetization of the KMZ10A1, which is located inside L1 (Fig.21a), is continuously flipped from its normal into its reverse polarity and back (Fig.21b). In this way, the influence of stray magnetic fields is removed. Moreover, as the polarity of the offset remains constant (Fig.21c), the offset itself can be eliminated by feeding the two output signals corresponding to the forward and reverse polarities of the sensor's internal magnetization, into an AC amplifier.

The output signal can then be rectified in a synchronous demodulation, which is controlled by the current pulse source. The resulting DC output voltage is proportional to the magnetic field to be measured.

As the KMZ10A1 has an internal magnetization that is parallel to the leads of the sensor, it is easy to mount the sensor inside the coil (L1) (sensor leads parallel to coil axis). The switching field applied by L1 should not be less than 3 kA/m. Since there is no auxiliary field in this arrangement, the sensitivity of the KMZ10A1 is approximately 22 mV/V/(kA/m) and fields up to 50 A/m can be measured without stability problems.

Figure 22 shows how a magnetic compass can be made, using two mutually perpendicular KMZ10A1 sensors. Again, the field inside the coil is periodically switched in order to obtain offset- and drift- independent sensor output signals. In addition, this compass does not need temperature correction, as the field direction depends on the ratio of the two output signals, not on their absolute values.



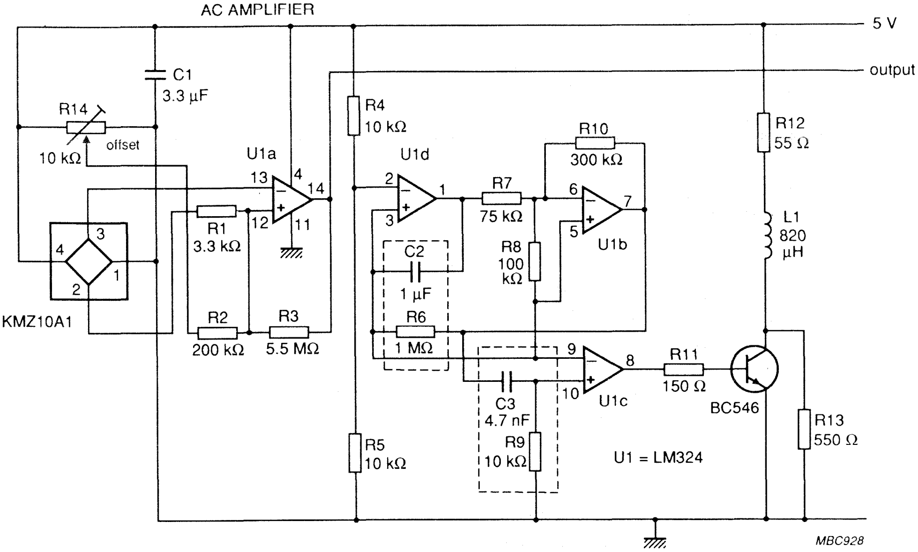
In this set-up, a current-carrying wire is wrapped around a ferrite core, with the sensor located in the air gap between its ends.

Fig.19 Current measurement with the KMZ10 sensor.

A suitable coil for this compass would be 100 turns of 0.35 mm copper wire wound on a Philips coil former (catalogue number 4322 021 30270), giving a resistance of 0.8 Ω, an inductance of 87 μH and an axial magnetic field of 8.3 (kA/m)/A.

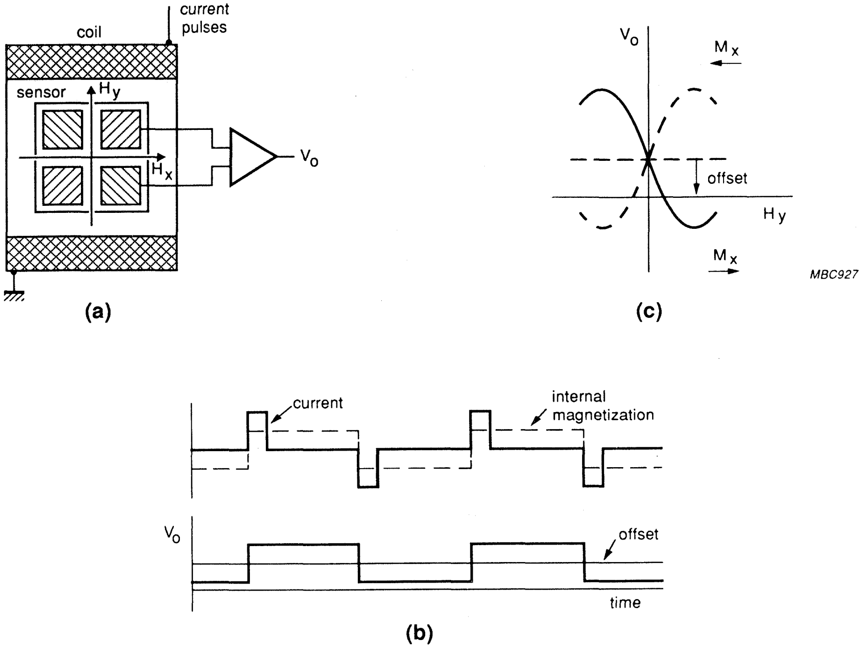
Other applications

Further examples of circuitry for KMZ10 sensors incorporating temperature compensation are discussed in the introductory section **Temperature Sensors**.



To remove the danger of flipping (sensor is used without an auxiliary magnet), the sensor's polarity is periodically flipped by the coil L1.

Fig.20 Circuit for measuring weak magnetic fields.

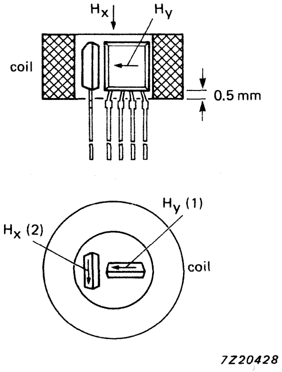


(a) Setup using a coil, the magnetic field of which is periodically reversed to flip the sensor's polarity and thus eliminate the effects of offset. Note that the sensor leads must be parallel to the coil axis.

(b) Pulse diagram.

(c) Sensor output characteristics.

Fig.21 Measuring weak magnetic fields with the KMZ10A1.



As in the previous example, the magnetic field is periodically reversed to produce an output that is independent of offset.

Fig.22 Magnetic compass using two mutually perpendicular KMZ10A1 sensors inside a coil.

DEVICE DATA - MAGNETIC FIELD SENSORS

Magnetic field sensor KM110B/1

DESCRIPTION

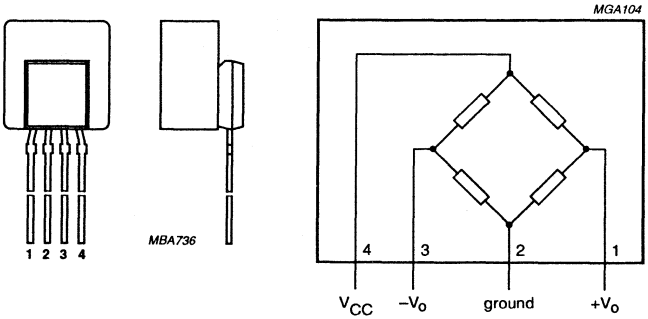
The KM110B/1 is a sensitive magnetic field sensor, employing the magneto-resistive effect of thin film permalloy.

The combination of a KMZ10B with a Ferroxdure 100 magnet and a special 30 ° magnetization enables the sensor to be used as a revolution sensor or proximity detector. The offset voltage of the KM110B/1 is magnetically trimmed during the magnetization process.

PINNING

PIN	DESCRIPTION
1	output voltage (+)
2	ground
3	output voltage (–)
4	supply voltage (V_{CC})

PIN CONFIGURATION



Marking: KMZ10B PHDxx.

Fig.1 Simplified outline and circuit configuration.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	DC supply voltage	–	5	–	V
V_{off}	offset voltage	–0.5	–	+0.5	mV/V
R_{bridge}	bridge resistance	1.6	2.1	2.6	kΩ
T_{bridge}	bridge operating temperature range	–40	–	150	°C

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	supply voltage		–	12	V
P_{tot}	total power dissipation	up to T_{amb} = 130 °C	–	120	mW
T_{stg}	storage temperature range		–40	150	°C
T_{bridge}	bridge operating temperature range	note 1	–40	150	°C
$T_{bridge\ peak}$	peak bridge operating temperature	max. 3 times ≤ 15 min during lifetime notes 1 and 2	–	190	°C
H_D	external disturbing field	note 3	–	32	kA/m

Notes

1. Maximum operating temperature of the thin film permalloy.
2. Maximum temperature gradient: 5 °C/min.
3. It is not permitted to press two sensors together **against** the magnetic forces, due to their own magnetic field (H ≥ 50 kA/m close to the magnetic poles).

THERMAL RESISTANCE

SYMBOL	PARAMETER	THERMAL RESISTANCE
$R_{th\ j\text{-}a}$	from junction to ambient in free air	180 K/W

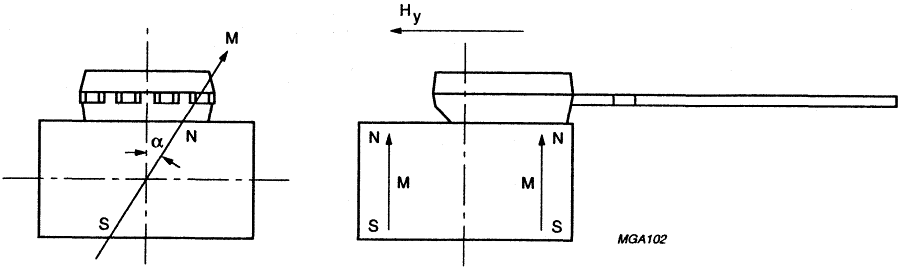
CHARACTERISTICS

T_{bridge} = 25 °C and V_{CC} = 5 V unless otherwise stated.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
R_{bridge}	bridge resistance		1.6	2.6	kΩ
V_{off}	offset voltage	notes 1 and 4	−0.5	+0.5	mV/V
S	sensitivity	notes 2 and 4	1.4	2.1	$\frac{mV/V}{kA/m}$
f	operating frequency	note 3	0	1	MHz
TCV_{off}	temperature coefficient of offset voltage	temperature range = −25 to 100 °C note 1	−5	+5	$\frac{\mu V/V}{K}$
TCR_{bridge}	temperature coefficient of bridge resistance	temperature range = −25 to 100 °C	–	0.4	%/K
TCS	temperature coefficient of sensitivity	temperature range = −25 to 100 °C	0.25	0.31	%/K

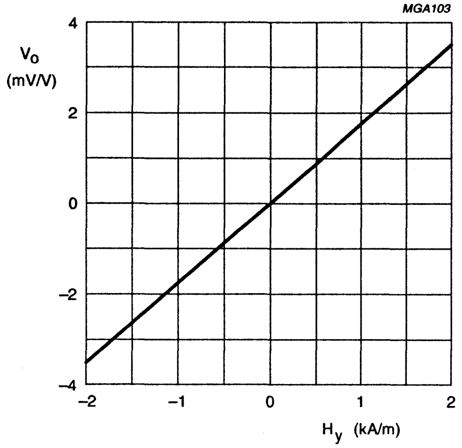
Notes

1. Measured in an environment without external magnetic fields and ferromagnetic materials.
2. $S = \{V_O(H_y = 1.6\ kA/m) - V_O(0\ kA/m)\} / \{1.6 \times V_{CC}\}$.
3. Only sensor bridge response. When sensing high speed rotation, the operating frequency may be reduced to eddy current effects.
4. The output voltage is ratiometric to the supply.



M = direction of magnetization.
N,S = magnetic poles.

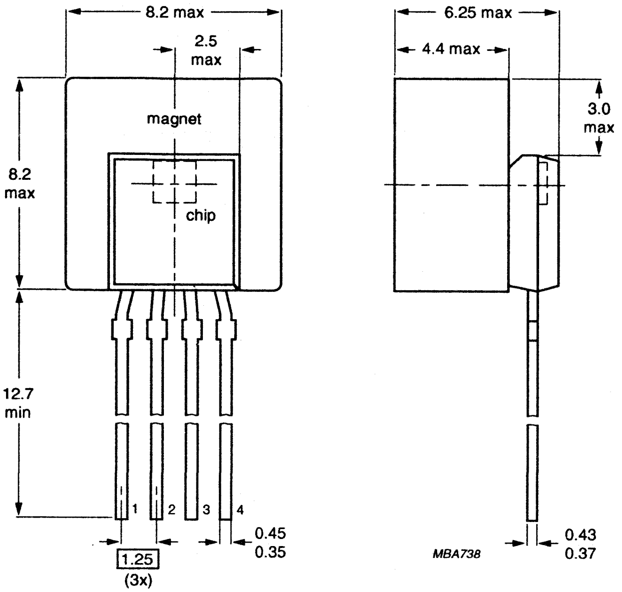
Fig.2 Principle of magnetization.



$V_{off} = 0$.

Fig.3 Sensor output characteristic.

PACKAGE OUTLINE



Dimensions in mm.

Fig.4 SOT195.

MAGNETIC FIELD SENSOR

The KMZ10A is an extremely sensitive magnetic field sensor employing the magneto-resistive effect of thin film permalloy.

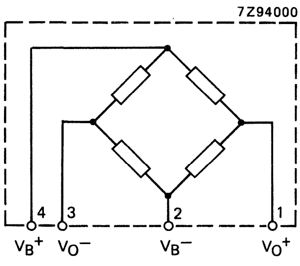
Its properties enable this sensor to be used in a wide range of applications for navigation, current and field measurement, revolution counters, angular or linear position measurement and proximity detectors, etc.

QUICK REFERENCE DATA

Operating voltage	V_B	=	5	V
Operating range	H_y	=	± 0.5	kA/m
Auxiliary field	H_x	=	0.5	kA/m
Sensitivity	S	=	16	$\frac{mV/V}{kA/m}$
Offset voltage	V_{off}	$\leqslant$	± 1.5	mV/V
Bridge resistance	R_{bridge}	=	0.8 to 1.6	kΩ

MECHANICAL AND ELECTRICAL DATA

Dimensions in mm



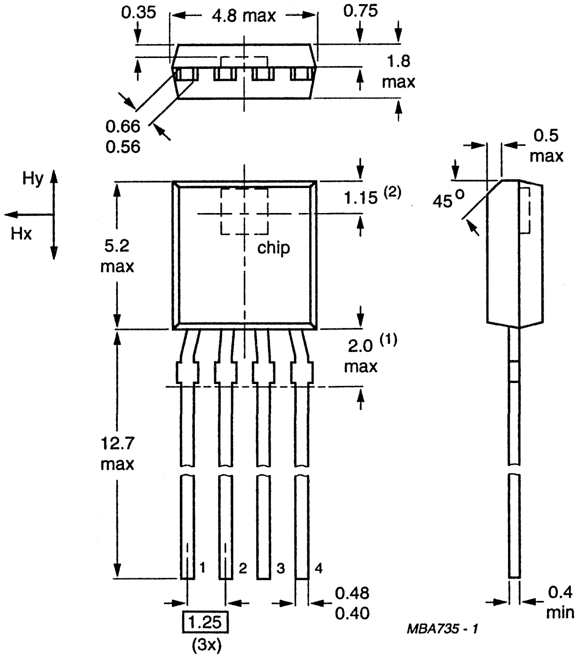


Fig. 1 SOT195.

(1) Terminal dimensions uncontrolled within this area.

(2) Position of sensor chip.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Operating voltage	V_B	max.	9	V
Total power dissipation up to T_{amb} = 134 °C	P_{tot}	max.	90	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Operating bridge temperature range	T_{bridge}		−40 to + 150	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\,j\text{-}a}$	=	180	K/W

CHARACTERISTICS

T_{amb} = 25 °C and H_x = 0.5 kA/m (1) unless otherwise specified

Bridge supply voltage	V_B	=	5	V
Operating range (1)	H_y	=	± 0.5	kA/m
Open circuit sensitivity (1)	S	=	13 to 19	$\frac{mV/V}{kA/m}$
Temperature coefficient of output voltage				
$V_B = 5$ V; $T_j = -25$ to + 125 °C	TCV_o	typ.	−0.4	%/K
$I_B = 3$ mA; $T_j = -25$ to + 125 °C	VCV_o	typ.	−0.15	%/K
Bridge resistance	R_{br}		0.8 to 1.6	kΩ
Temperature coefficient of bridge resistance at $T_j = -25$ to + 125 °C	TCR_{br}	typ.	0.25	%/K
Offset voltage	V_{off}	$\leqslant$	± 1.5	mV/V
Temperature coefficient of offset voltage at $T_{bridge} = -25$ to + 125 °C	TCV_{off}	$\leqslant$	± 6	$\frac{\mu V/V}{K}$
Linearity deviation of output voltage at				
$H_y = 0$ to ± 0.25 kAm^{-1}	FL	$<$	0.8	% FS
$H_y = 0$ to ± 0.4 kAm^{-1}	FL	$<$	2.5	% FS
$H_y = 0$ to ± 0.5 kAm^{-1}	FL	$<$	4.0	% FS
Hysteresis of output voltage		$<$	0.5	% FS
Operating frequency	f_{max}	=	1	MHz

Note

Before first operation or after operation outside the SOAR (Fig. 2) the sensor has to be reset by application of an auxiliary field H_x = 3 kA/m.

(1) No disturbing field (H_d) allowed; for stable operation under disturbing conditions see Fig. 2 (SOAR) and see Fig. 3 for decrease of sensitivity.

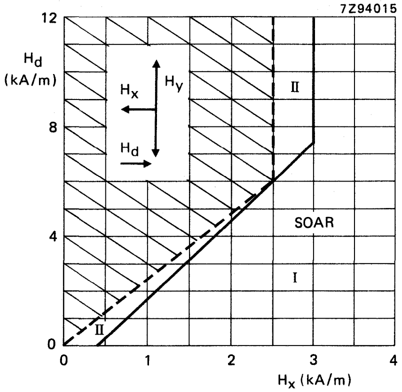


Fig. 2 Safe Operating Area (permissible disturbing field H_d as a component of auxiliary field H_x).

I Region of permissible operation.

II Permissible extension if $H_y < 0.15$ kA/m.

Note: In applications with $H_x < 3$ kA/m, the sensor has to be reset, after leaving the SOAR, by an auxiliary field of $H_x = 3$ kA/m.

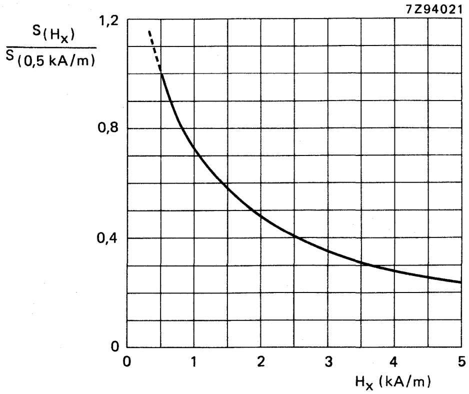


Fig. 3 Relative sensitivity (ratio of sensitivity at certain H_x and sensitivity at $H_x = 0.5$ kA/m.

Note: In applications with $H_x \leqslant 3$ kA/m the sensor has to be reset by an auxiliary field of $H_x = 3$ kA/m before using.

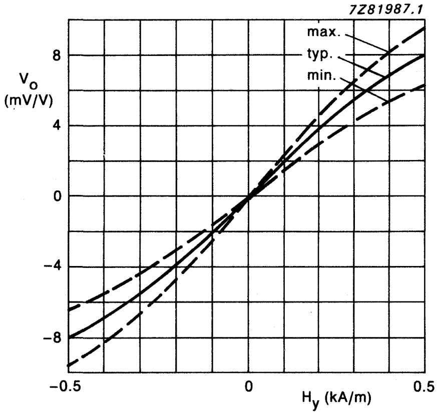


Fig. 4 Sensor output characteristic $H_x = 0.5$ kA/m $T_{amb} = 25^oC$. Voff =0

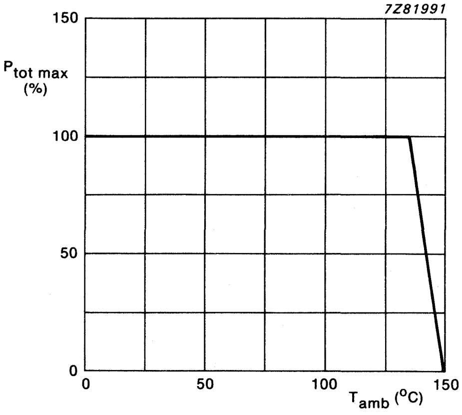


Fig. 5 Power derating curve.

Magnetic field sensor KMZ10A1

DESCRIPTION

The KMZ10A1 is an extremely sensitive magnetic field sensor, employing the magnetoresistive effect of thin film permalloy.

Its properties enable this sensor to be used in a wide range of applications, such as navigation, current and earth magnetic field measurement, etc. The special arrangement of the sensing chip allows the construction of coils for switching the auxiliary field (H_x) along the length axis of the sensor.

The sensor can be operated at any frequency between DC and 1 MHz.

PINNING

PIN	DESCRIPTION
1	output voltage (+)
2	supply voltage ($-V_B$)
3	output voltage (–)
4	supply voltage ($+V_B$)

PIN CONFIGURATION

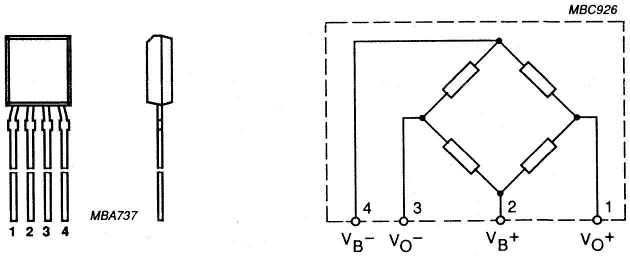


Fig.1 Simplified outline and circuit configuration.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_B	operating voltage	–	5	–	V
H_y	operating range	– 0.5	–	0.5	kA/m
H_x	auxiliary field	–	0.5	–	kA/m
S	sensitivity	–	14	–	$\frac{mV/V}{kA/m}$
S_s	sensitivity (with switched H_x)	–	22	–	$\frac{mV/V}{kA/m}$
V_{off}	offset voltage	–1.5	–	1.5	mV/V
R_{bridge}	bridge resistance	0.85	–	1.75	kΩ

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_B	operating voltage		–	9	V
P_{tot}	total power dissipation	up to T_{amb} = 132 °C	–	100	mW
T_{stg}	storage temperature range		–65	150	°C
T_{bridge}	bridge operating temperature range		–40	150	°C

THERMAL RESISTANCE

SYMBOL	PARAMETER	THERMAL RESISTANCE
$R_{th\ j\text{-}a}$	from junction to ambient	180 K/W

CHARACTERISTICS

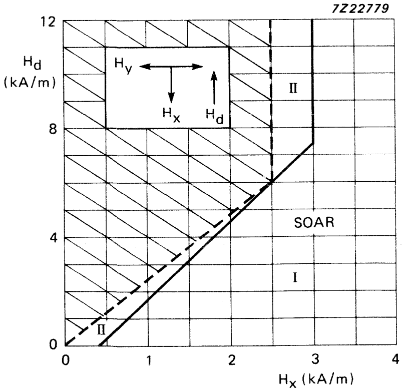
T_{amb} = 25 °C and H_x = 0.5 kA/m, unless otherwise specified; see note 1.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_B	bridge supply voltage		–	5	–	V
H_y	operating range (note 1)		– 0.5	–	0.5	kA/m
S	open circuit sensitivity	notes 1 and 2	11	–	17	$\frac{mV/V}{kA/m}$
TCV_O	temperature coefficient of output voltage at constant supply voltage	V_B = 5 V; T_j = –25 to 125 °C	–	– 0.4	–	%/K
VCV_O	temperature coefficient of output voltage at constant supply current	I_B = 3 mA; T_j = –25 to 125 °C	–	– 0.15	–	%/K
R_{bridge}	bridge resistance		0.85	–	1.75	kΩ
TCR_{bridge}	temperature coefficient of bridge resistance	resistance at T_j = –25 to 125 °C	–	0.25	–	%/K
V_{off}	offset voltage		–1.5	–	1.5	mV/V
TCV_{off}	temperature coefficient of offset voltage	at T_{bridge} = –25 to 125 °C	–6	–	6	$\frac{\mu V/V}{K}$
FL	linearity deviation of output voltage	H_y = 0 to ±0.25 kAm^{-1}	–	–	0.8	%FS
		H_y = 0 to ±0.4 kAm^{-1}	–	–	2.5	%FS
		H_y = 0 to ±0.5 kAm^{-1}	–	–	4.0	%FS
FH	hysteresis of output voltage		–	–	0.5	%FS
f	operating frequency		–	–	1	MHz
Characteristics with H_x = 0 (switched H_x, see note 3) (T_{amb} = 25 °C; V_B = 5 V)						
H_y	operating range (note 1)		– 0.05	–	0.05	kA/m
S_s	sensitivity (slope between H_y = 0 and H_y = 40 A/m)		14	–	27	$\frac{mV/V}{kA/m}$

Notes

Before first operation or after operation outside the SOAR (see Fig.2), the sensor must be reset by application of an auxiliary field H_x = 3 kA/m.

1. No disturbing field (H_d) allowed; for stable operation under disturbing conditions, see Fig.2 for SOAR and Fig.4 for decrease of sensitivity.
2. Sensitivity measured as $\Delta V_O/\Delta H_y$ between H_y = 0 and H_y = 0.4 kA/m.
3. See **APPLICATION INFORMATION.**

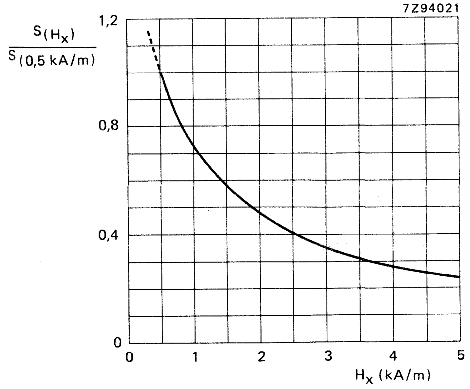


(I) Region of permissible operation.

(II)Permissible extension if $H_y < 0.05$ kA/m.

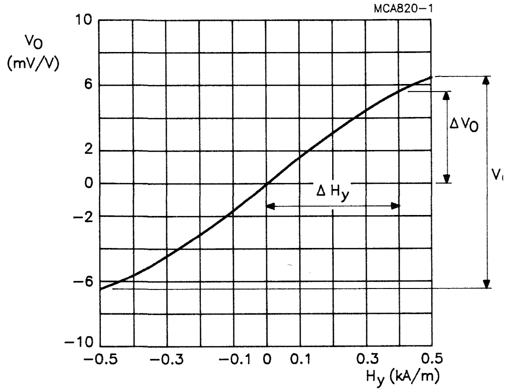
In applications with $H_x < 3$ kA/m, the sensor must be reset after leaving the SOAR by an auxiliary field of $H_x = 3$ kA/m.

Fig.2 Safe operating area (permissible disturbing field H_d as a component of auxiliary field H_x).



In applications with $H_x \leq 3$ kA/m, the sensor must be reset by an auxiliary field of $H_x = 3$ kA/m before use.

Fig.3 Relative sensitivity (ratio of sensitivity) at fixed H_x and sensitivity at $H_x = 0.5$ kA/m.



$H_x = 0.5$ kA/m; $T_{amb} = 25$ °C; $V_{off} = 0$; $S = \Delta V_O/\Delta H_y$.

Fig.4 Sensor output characteristic.

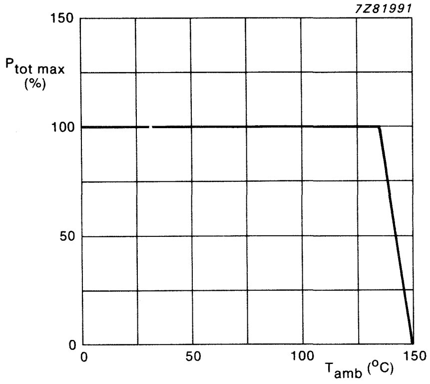
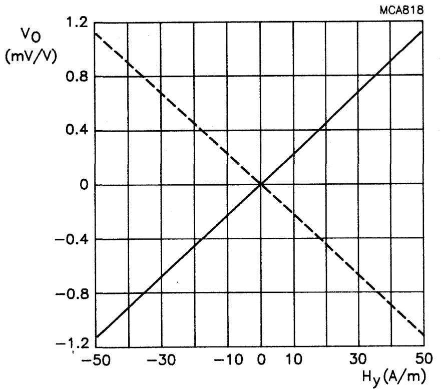


Fig.5 Power derating curve.



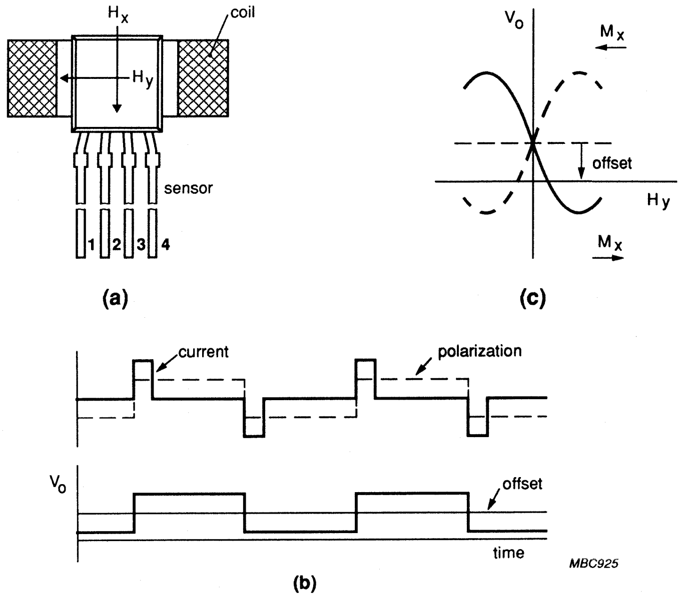
Solid line: sensor reset with H_x = 3 kA/m.
Dotted line: sensor reset with H_x = −3 kA/m.

Fig.6 Output characteristic with H_x = 0 (switched H_x).

APPLICATION INFORMATION

A problem of measuring weak magnetic fields is that precision is limited by drift in both the sensor and amplifier offset. In these instances, it is possible to take advantage of the 'flipping' characteristics of the KMZ10 series to generate an output that is independent of offset.

The sensor, located in a coil connected to a current pulse generator producing magnetic field pulses periodically reversed by alternate positive and negative current going pulses, is continually flipped from its normal to its reversed polarity and back again. The polarity of the offset, however, remains unchanged, so the offset itself can be eliminated by passing the output signal through a filter circuit.



(a)

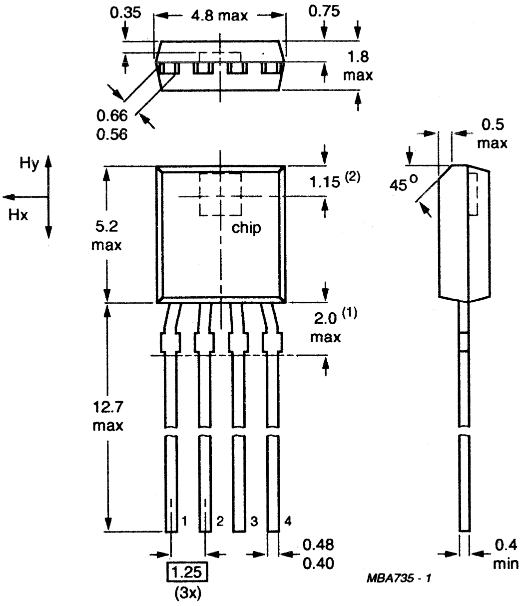
(c)

(b)

(a) Set- up.
(b) Pulse diagram.
(c) Sensor output characteristics.

Fig.7 Measuring weak magnetic fields with the KMZ10A1.

PACKAGE OUTLINE



Dimensions in mm.

(1) Terminal dimensions uncontrolled within this area.

(2) Position of sensor chip.

Fig.8 SOT195.

Magnetic field sensor KMZ10B

DESCRIPTION

The KMZ10B is a sensitive magnetic field sensor, employing the magneto-resistive effect of thin film permalloy.

Its properties enable this sensor to be used in a wide range of applications for current and field measurement, revolution counters, angular or linear position measurement, proximity detectors, etc.

PINNING

PIN	DESCRIPTION
1	output voltage (+)
2	supply voltage (–)
3	output voltage (–)
4	supply voltage (+)

PIN CONFIGURATION

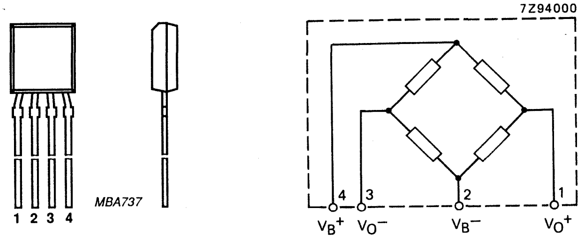


Fig.1 Simplified outline and circuit configuration.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_B	operating voltage	–	5	–	V
H_y	operating range	–2	–	2	kA/m
H_x	auxiliary field	–	3	–	kA/m
S	sensitivity	–	4	–	$\frac{mV/V}{kA/m}$
V_{off}	offset voltage	–1.5	–	+1.5	mV/V
R_{bridge}	bridge resistance	1.6	–	2.6	kΩ

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_B	operating voltage		–	12	V
P_{tot}	total power dissipation	up to T_{amb} = 130 °C	–	120	mW
T_{stg}	storage temperature range		–65	150	°C
T_{bridge}	bridge operating temperature range		–40	150	°C

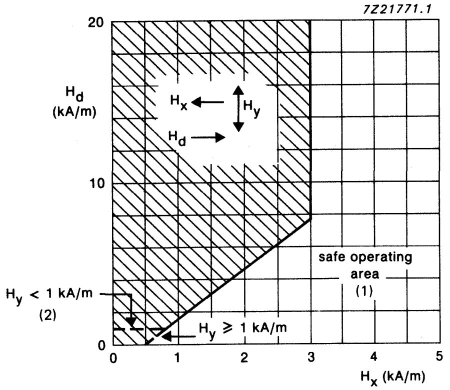
THERMAL RESISTANCE

SYMBOL	PARAMETER	VALUE	UNIT
$R_{th\ j\text{-}a}$	from junction to ambient	180	K/W

CHARACTERISTICS

T_{amb} = 25 °C and H_x = 3 kA/m. In applications with H_x < 3 kA/m, the sensor has to be reset before first operation of an auxiliary field H_x = 3 kA/m.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_B	operating voltage		–	5	–	V
H_y	operating range of magnetic field		–2	–	2	kA/m
S	sensitivity	open circuit	3.2	–	4.8	$\frac{mV/V}{kA/m}$
TCV_o	temperature coefficient of output voltage	V_B = 5 V; T_j = –25 to 125 °C	–	–0.4	–	%/K
		I_B = 3 mA; T_j = –25 to 125 °C	–	–0.1	–	%/K
R_{bridge}	bridge resistance		1.6	–	2.6	kΩ
TCR_{bridge}	temperature coefficient of bridge resistance	T_{bridge} = –25 to 125 °C	–	0.3	–	%/K
V_{off}	offset voltage		–1.5	–	+1.5	mV/V
TCV_{off}	temperature coefficient of offset voltage	T_j = –25 to 125 °C	–3	–	+3	$\frac{\mu V/V}{K}$
FL	linearity deviation of output voltage	H_y = 0 to ±1 KAm^{-1}	–	–	±0.5	%FS
		H_y = 0 to ±1.6 KAm^{-1}	–	–	±1.7	%FS
		H_y = 0 to ±2 KAm^{-1}	–	–	±2	%FS
V_{oH}	hysteresis of output voltage		–	–	0.5	%FS
f	operating frequency		0	–	1	MHz

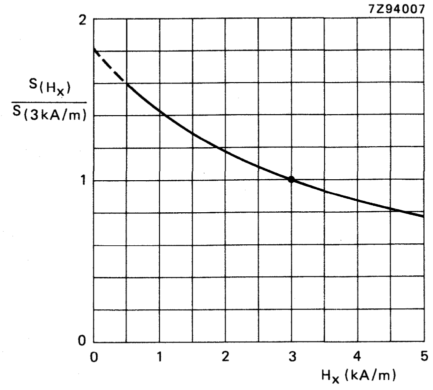


In applications with H_x < 3 kA/m, the sensor has to be reset after leaving the SOAR, by an auxiliary field of H_x = 3 kA/m.

(1) Region of permissible operation.

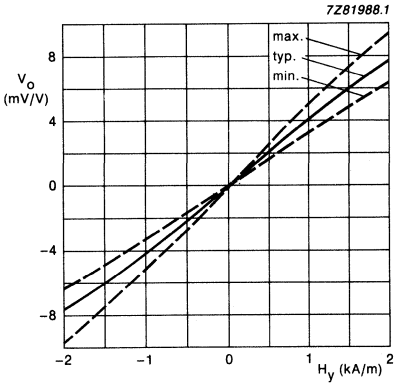
(2) Permissible extension if H_y < 1 kA/m.

Fig.2 Safe operating area (permissible disturbing field H_d as a component of auxiliary field H_x).



In applications with $H_x \leq 3$ kA/m, the sensor has to be reset by an auxiliary field of H_x = 3 kA/m before use.

Fig.3 Relative sensitivity (ratio of sensitivity at certain H_x and sensitivity at H_x = 3 kA/m).



V_B = constant; T_{amb} = 25 °C; H_x = 3 kA/m; V_{off} = 0.

Fig.4 Sensor output characteristic.

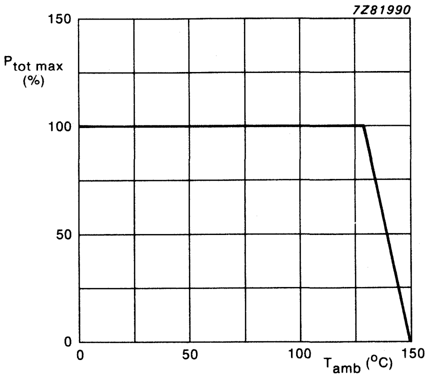
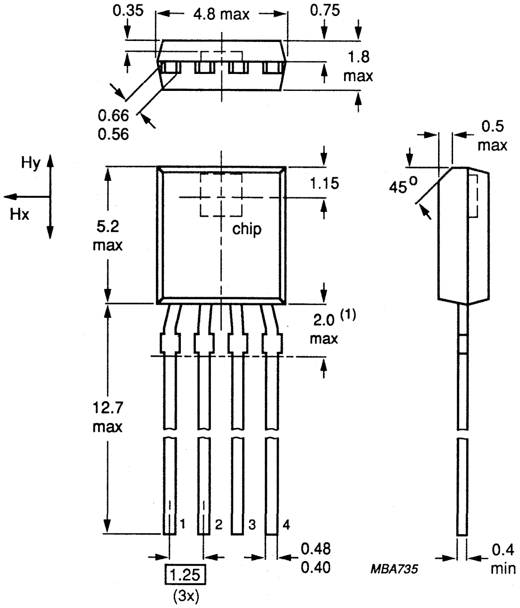


Fig.5 Power derating curve.

PACKAGE OUTLINE



Dimensions in mm.

(1) Terminal dimensions uncontrolled within this area.

Fig.6 SOT195.

MAGNETIC FIELD SENSOR

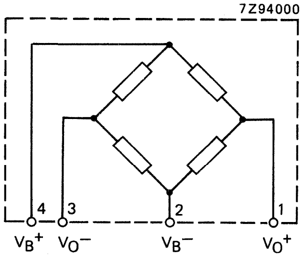
The KMZ10C is a magnetic field sensor employing the magneto-resistive effect of thin film permalloy. Its properties enable this sensor to be used in a wide range of applications for current and field measurement, revolution counters, angular or linear position measurement and proximity detectors, etc.

QUICK REFERENCE DATA

Operating voltage	V_B	=	5	V
Operating range	H_y	=	± 7.5	kA/m
Auxiliary field	H_x	=	3.0	kA/m
Sensitivity	S	=	1.5	$\frac{mV/V}{kA/m}$
Offset voltage	V_{off}	⩽	± 1.5	mV/V
Bridge resistance	R_{bridge}	=	1.0 to 1.8	kΩ

MECHANICAL AND ELECTRICAL DATA

Dimensions in mm



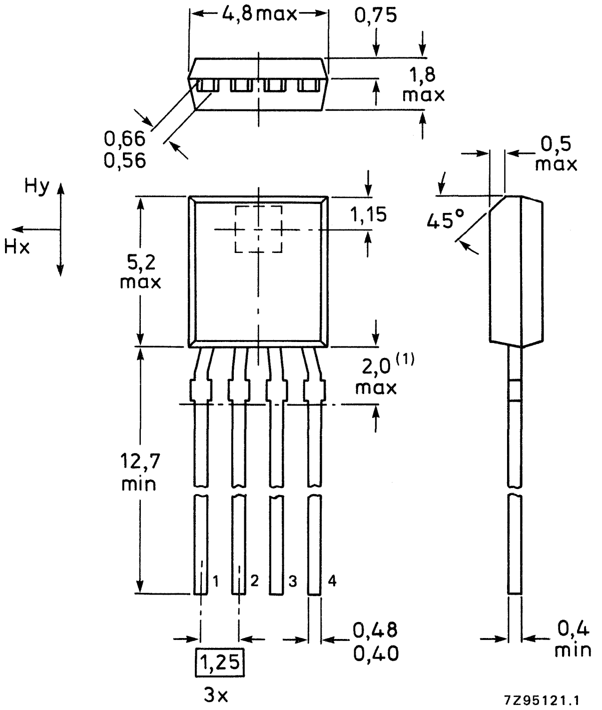


Fig. 1 SOT 195.

(1) Terminal dimensions uncontrolled within this area.

RATINGS

Limiting values in accordance with the Absolute Maximum System(IEC 134)

Operating voltage	V_B	max.	10	V
Total power dissipation up to T_{amb} = 132 °C	P_{tot}	max.	100	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Operating bridge temperature range	T_{bridge}		−40 to + 150	°C

THERMAL RESISTANCE

From junction to ambient	$R_{th\,j\text{-}a}$	=	180	K/W

CHARACTERISTICS

T_{amb} = 25 °C and H_x = 3 kA/m(1) unless otherwise specified

Operating voltage	V_B	=	5	V
Operating range of magnetic field	H_y	=	± 7.5	kA/m
Open circuit sensitivity	S		1 to 2	$\frac{\text{mV/V}}{\text{kA/m}}$
Temperature coefficient of output voltage				
V_B = 5 V; T_j = −25 to + 125 °C	TCV_o	typ.	−0.5	%/K
I_B = 3 mA; T_j = −25 to + 125 °C	VCV_o	typ.	−0.15	%/K
Bridge resistance	R_{br}		1.0 to 1.8	kΩ
Temperature coefficient of bridge resistance at T_j = −25 to + 125 °C	TCR_{br}	typ.	0.35	%/K
Offset voltage	V_{off}	$\leqslant$	± 1.5	mV/V
Temperature coefficient of offset voltage at T_{bridge} = −25 to + 125 °C	TCV_{off}	$\leqslant$	± 2	$\frac{\mu\text{V/V}}{\text{K}}$
Linearity deviation of output voltage at				
H_y = 0 to ± 3.75 kAm^{-1}	FL	$<$	± 0.8	%= FS
H_y = 0 to ± 6.0 kAm^{-1}	FL	$<$	± 2.4	%= FS
H_y = 0 to ± 7.5 kAm^{-1}	FL	$<$	± 2.7	%= FS
Hysteresis of output voltage	VoH	$<$	0.5	%= FS
Operating frequency	f_{max}	=	1	MHz

Note

1. In applications with $H_x < 3$ kA/m the sensor has to be reset before first operation by application of an auxiliary field H_x =3 kA/m.

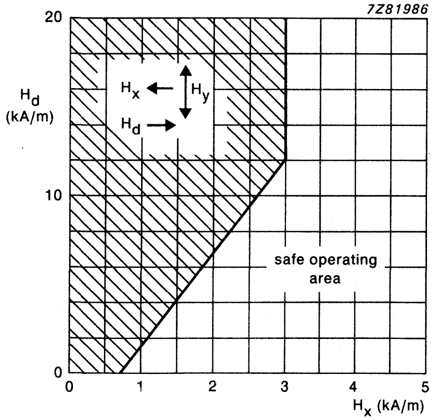


Fig. 2 Safe Operating Area (permissible disturbing field H_d as a component of auxiliary field H_x).
Note: In application with H_x < 3 kA/m, the sensor has to be reset after leaving the SOAR, by an auxiliary field of H_x = 3 kA/m.

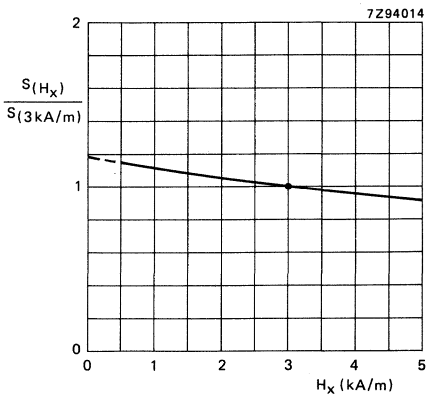


Fig. 3 Relative sensitivity (ratio of sensitivity at certain H_x and sensitivity at H_x = 3 kA/m.
Note: In application with H_x ⩽ 3 kA/m the sensor has to be reset by an auxiliary field of H_x = 3 kA/m before using.

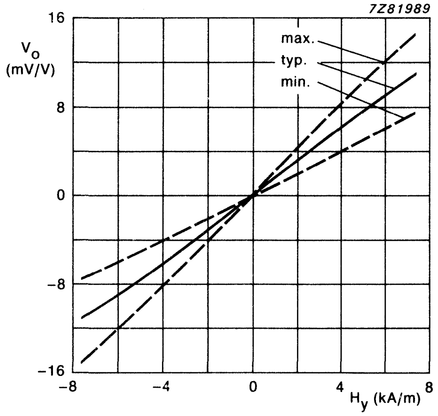


Fig. 4 Sensor output characteristic H_x = 3 kA/m T_{amb} = 25 °C Voff =0.

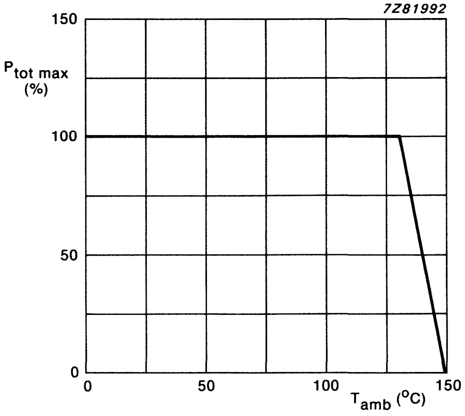


Fig. 5 Power derating curve.

INTRODUCTION TO SENSOR HYBRID MODULES

GENERAL

The KMZ10 series of magnetoresistive sensors are successfully used in a wide range of applications, due to their excellent characteristics:

- high sensitivity
- wide operating frequency range (0 Hz (DC) to > 1 MHz)
- wide operating temperature range (–40 to +150 °C; 190 °C peak)
- linear characteristics
- long life
- insensitivity to mechanical stress.

In order to assist the designer in applying KMZ10 sensors, Philips Semiconductors has developed a number of modules in hybrid thick-film technology, containing a KMZ10B sensor in addition to signal conditioning circuitry. These modules offer many important advantages:

- contactless measurement, making them wear-free with a long life and high reliability
- hybrid technology, providing a wide operating temperature range (–40 to +125 °C), and making fast redesigns possible (e.g. customization)
- ready for use: all modules are laser-trimmed, so no further adjustment or trimming is required
- shorter systems-development times.

The modules are offered as standard products. However, they may also serve as a starting point for the development of customized products.

In this section, the following three series of modules are described:

- KM110BH/1 series, for contactless rotational speed measurement
- KM110BH/21 series, for contactless angle measurement
- KM110BH/31 module, for contactless measurement of rotational speed and direction.

KM110BH/1 MODULE SERIES FOR MAGNETORESISTIVE SENSING OF ROTATION AND REFERENCE MARK DETECTION

The KM110BH/1 module series provides a simple and cost-effective method of measuring rotational speed very accurately. The output of the module is a noise-free digital signal. The modules can operate:

- quasi-statically (0 Hz frequency)
- at large distances from the objects to be measured
- from –40 to +125 °C (190 °C peak)
- without external magnets.

Magnetic sensing

For low-cost rotation sensing and reference mark detection under difficult environmental conditions, magnetic contactless detection, based on the influence of ferrous components (e.g. iron), is very useful.

In the automotive industry, for example, inductive (variable reluctance) sensors are often used because of their ruggedness and large output signals. They have, however, two disadvantages:

- output signals become very small when detecting slow movements
- high frequency vibrations can generate large noise signals in the output.

Magnetic field sensors (such as the KMZ10B magnetoresistive sensor), which measure field variations statically, overcome these disadvantages. In addition, their ruggedness and high sensitivity make them ideal for use in low-cost active rotational sensing equipment, such as the sensor modules described here.

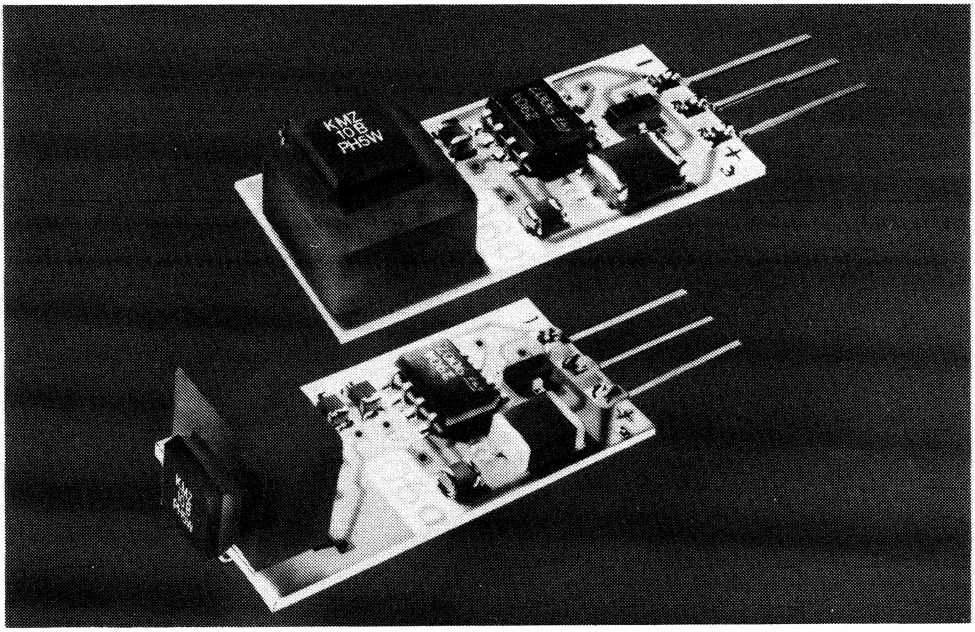


Fig.1 The KM110BH/1 series.

Sensor module

The module is based on thick-film technology using a ceramic substrate. Two versions are available, with circuitry optimized for specific application areas:

- a quasi-static module for slow movement sensing (i.e. speed measurements down to zero)
- a module with a high-pass filter for use at larger measuring distances and speeds above zero.

The position of the sensor can also be selected, as the module is supplied with the sensor either radially or tangentially arranged. Figure 2 shows both mechanical arrangements, set to measure the rotation of a toothed wheel. The data for this set-up and the type range are given in Table 1. Table 2 gives the key specifications of the module.

The circuit and sensor position options enable the module to be used in many applications, e.g:

- incremental measurement can be performed easily and at low cost
- the module can be used as the first stage when customizing speed sensing equipment.

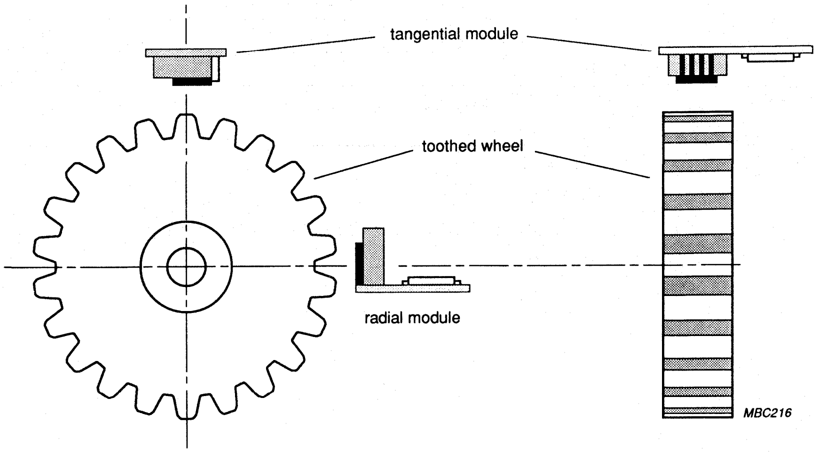


Fig.2 Radial and tangential versions of the module, arranged for rotation measurement of a toothed wheel.

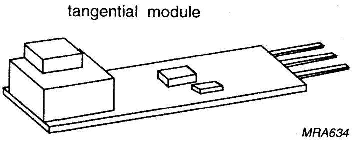


Fig.3 Tangential module (KM110BH/11 & /12).

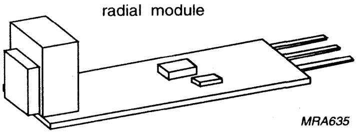


Fig.4 Radial module (KM110BH/13 & /14).

Table 1 Philips' magnetoresistive sensor modules

	See Fig.3		**See Fig.4**	
PARAMETER	**KM110BH/11 (without filter)**	**KM110BH/12 (with filter)**	**KM110BH/13 (without filter)**	**KM110BH/14 (with filter)**
Frequency range for a toothed wheel (Hz)	0 to 3000	1 to 3000	0 to 3000	1 to 3000
Maximum distance to wheel (mm)	2.5	3.5	2.5	3.5

Table 2 Sensor module specifications

CHARACTERISTIC	SPECIFICATION
Supply voltage	5 V (4 to 10 V; maximum ripple for filter version is 50 mV)
Output signal (relative)	0 to 5 V; digital
Operating temperature range	–40 to +125 °C (150 °C max.; 500 hours)
Measuring distance	0 to 2.5 mm without filter 0 to 3.5 mm with filter (measured using steel toothed-wheel: diameter 48 mm, width 16 mm, 22 teeth)
Frequency range	0 to 3 kHz without filter 1 Hz to 3 kHz with filter
Mounting	the sensor's axis of symmetry corresponds to that of the module's magnet; this axis should also correspond to the equivalent axis of the toothed wheel, to operate at the specified measuring distance

Module circuit

Figure 5 shows the sensor module circuit. The circuit amplifies the sensor signal (IC1) and then digitizes it using a comparator (IC2) to provide the digital output signal (V_O). For good switching performance (especially at low frequencies) and to suppress small noise signals, the comparator has a built-in switching hysteresis. The hysteresis has a defined temperature drift, to compensate the temperature dependent sensor signal.

In the module for quasi-static operation, the bridge connectors BR1 and BR2 are open. In the version that uses the filter, these connectors are closed.

The recommended supply is 5 V, but values in the range of approximately 4 to 10 V are also possible. If the filter versions of the modules are used (KM110BH/12 or /14), the ripple on the supply voltage should not exceed 50 mV; this prevents unwanted switching of the comparator. The output can withstand short circuiting to the two supply levels. Normally, the external load should be ≥ 100 kΩ, but with an additional external pull-up resistor, a lower value may be used. The values of internal resistors R18 and R19 are 10 kΩ and 100 Ω respectively. Since a protection diode is not provided on the substrate, care should be taken to ensure the correct supply polarity.

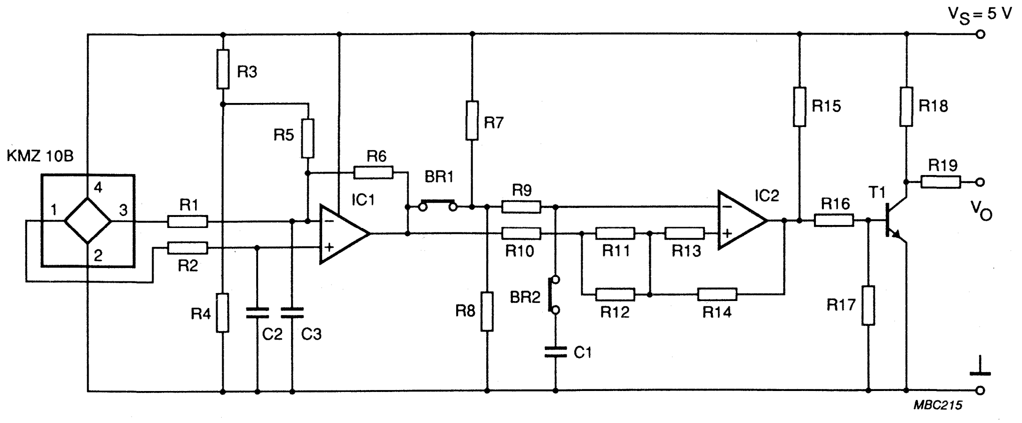


Fig.5 Sensor module circuit.

Mounting

The module's magnetoresistive sensor operates as a magnetic Wheatstone bridge, measuring non-symmetrical magnetic conditions such as metal teeth or pins in front of the sensor. Figure 2 shows how the module should be mounted for measuring the rotation of a ferrous pulse wheel. The sensor position is important, since sensing is not symmetrical around the modules's symmetrical axis.

When mounting the module, there are two factors, shown in Fig.6, that may affect the performance of the module:

- the angle (γ) between the symmetry axes of the sensor module and the wheel
- the vertical shift (y) relative to the optimum sensor position.

These two factors must be minimized, especially when using the modules without filter (types KM110BH/11 and /13). Recommended tolerances for normal conditions are: $\gamma < 1$ degree, $y < 0.5$ mm.

The sensor's symmetry axis corresponds to that of the module's magnet (the crystal is not mounted in the centre of the sensor encapsulation).

Module encapsulation

When designing a module encapsulation, the following considerations should be borne in mind:

- the encapsulation material must be non-magnetic
- to operate the module at large distances from the object to be measured, the part of the encapsulation directly in front of the sensor element should be as thin as possible
- there are no components near the sides of the module; 0.8 mm of substrate edges is available, to allow the module to be securely mounted into grooves (see Figs 7 and 8).

Temperature range

The front of the module (sensor and magnet) can withstand temperatures up to 190 °C, providing the duration is limited to a few hours over the lifetime of the module. The integrated circuit, however, should not operate in environments above 125 °C.

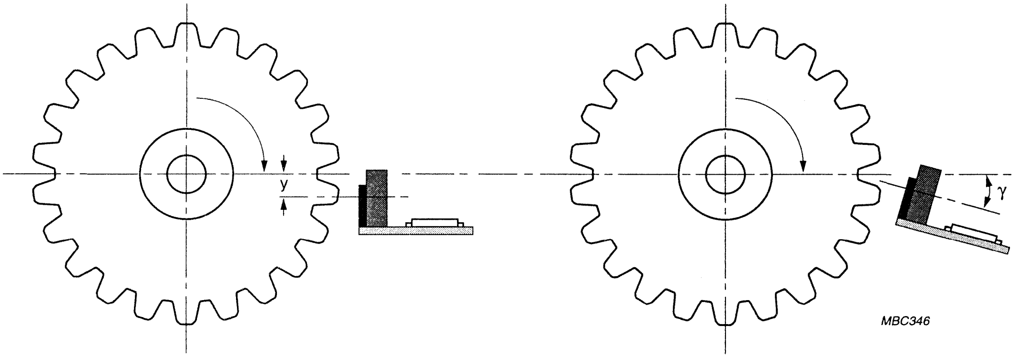
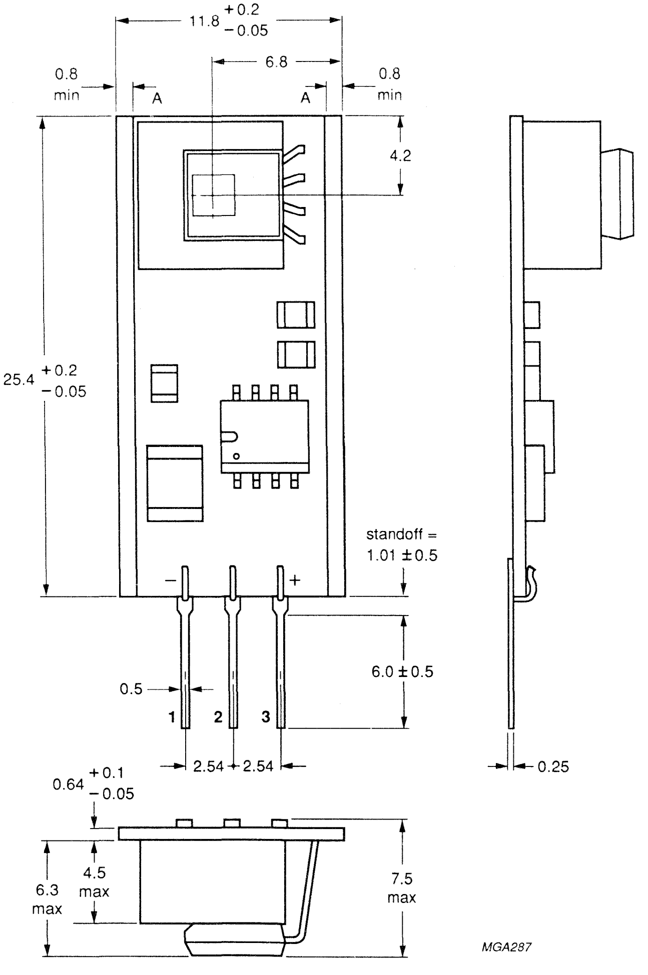
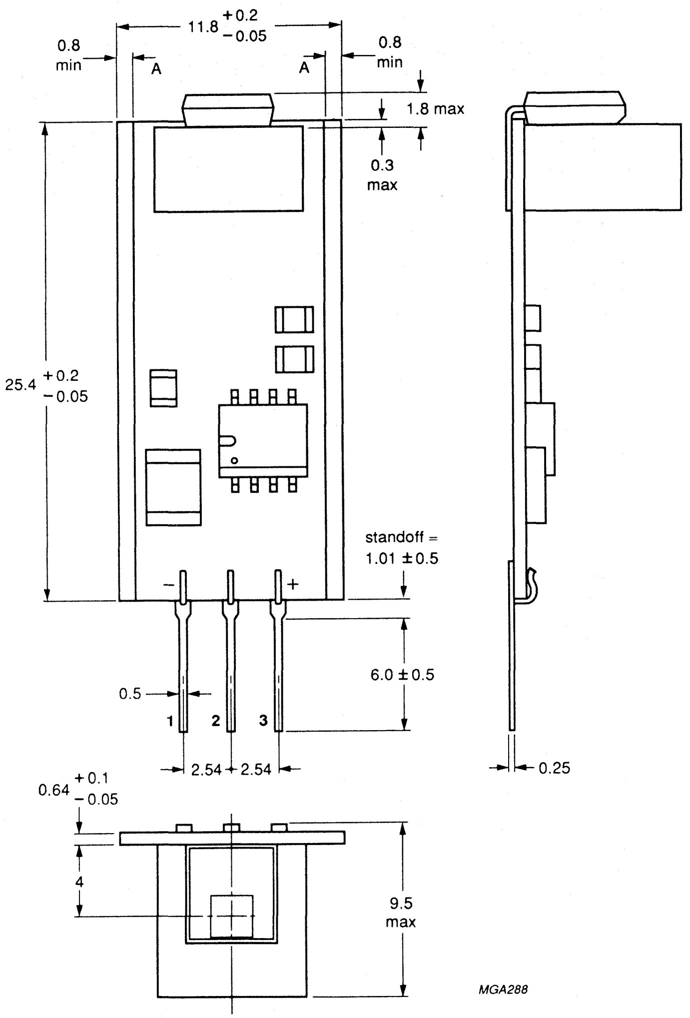


Fig.6 Sensor position tolerances.



Dimensions in mm.

Fig.7 Module dimensions, KM110BH/11 & /12.



Dimensions in mm.

Fig.8 Module dimensions, KM110BH/13 & /14.

Performance

The maximum measuring distance depends upon the structure of the wheel and, for modules without filter, also on the accuracy of mounting. If wheel structures differ greatly from the example shown, the range can be found by measurement.

With high rotational speeds, eddy current signals are generated that reduce the performance of the modules without filter.

KM110BH/21 MAGNETORESISTIVE SENSOR MODULES FOR ANGLE MEASUREMENT

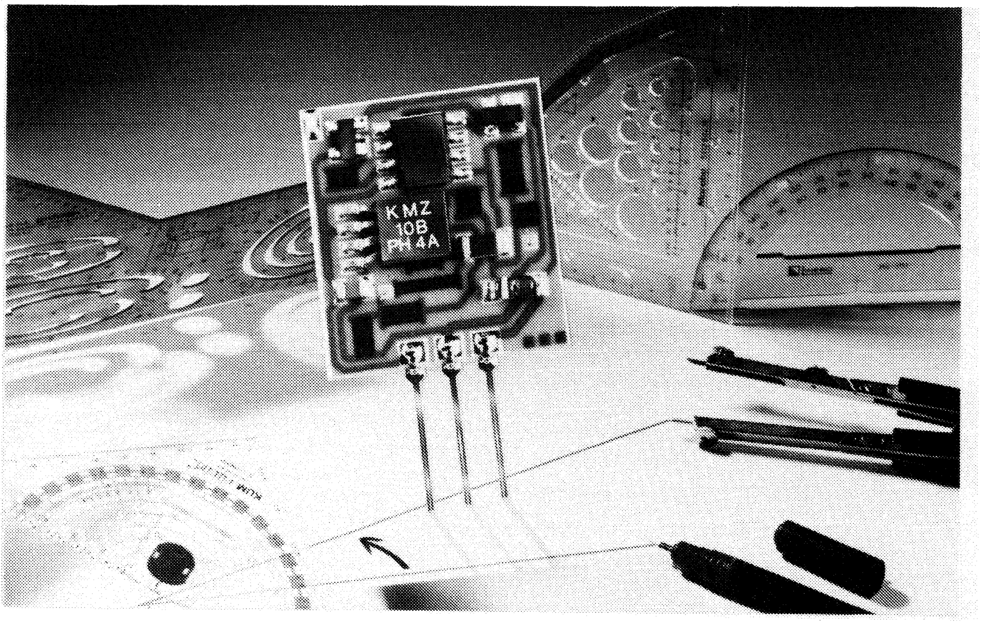


Fig.9 KM110BH/21 sensor module.

The KM110BH/21 module series is designed to meet the strong demand for contactless angle measurement systems. In the automotive field alone, there are many potential applications, such as electronic control of accelerator pedal, chassis position, steering angle and throttle position.

These ready-to-use, active modules enable easy and cost-effective contactless angle measurement, since the only external component required is a magnet.

Each KM110BH/21 module comprises a KMZ10B magnetoresistive sensor and a thick-film hybrid circuit. The modules are delivered with the sensitivity, offset and zero point ready trimmed, and contain integrated temperature compensation, which virtually eliminates the influence of the temperature sensitivity of the external magnet.

The circuit and the magnetic parameters have been chosen so that the modules can be used:

- directly, in a wide range of applications (without further trimming or any adjustments)
- as the basis for, or the development of, customized modules.

Sample kits containing a KM110BH/21 module and a magnet are available.

Angle measurement with magnetoresistive sensors

With the KMZ10 magnetoresistive sensor, two different techniques are available for angle measurement. The first, used in most magnetic field sensor angle measurement equipment, entails measuring the *field strength* of a rotating magnet as a function of the angle. With this technique, the field used is within the normal sensitivity range of the KMZ10, and angles of approximately ±90 degrees can be measured.

However, since the magnet's properties influence the sensor output, the measurement equipment must be calibrated after assembly. Only with a very well-defined magnetic system would a pre-calibrated circuit be possible. Defining such a system is both expensive and difficult, due to the tolerances caused by the thermal sensitivity of the magnet.

The second technique, used in our KM110BH/21 modules, requires strong magnetic fields (≥ 80 kA/m). The KMZ10 operates in 'saturation mode', detecting only the *field direction.* In the limiting case of infinite field strength, the field strength and its drift with temperature have no influence on the sensor.

Therefore, using this technique reduces measurement - system tolerances and allows pre-trimming of the sensors; the only requirement is that field directions during trimming correspond with field directions after assembly. The typical angle measurement range is from –45 to +45 degrees, and the sensor output signal is sinusoidal. Because of this, a linear signal can be obtained in the central part of the output characteristic.

In practice, it is not necessary to use very strong and possibly expensive magnets for the sensor to operate in saturation mode. Even with readily available magnets (or field strengths), the influence of tolerances or temperature drift is minimal. As field strengths decrease, the peak output signal remains more or less constant and the angle range increases from ±45 degrees to a maximum of approximately ±90 degrees at very low magnetic fields.

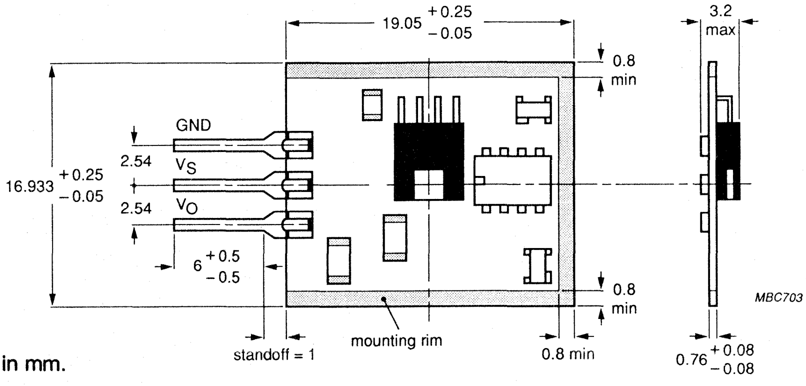
The KM110BH/21 module series

Figure 10 shows the construction of a KM110BH/21 module. Currently, there are two types in the range: the KM110BH/2130 and the KM110BH/2190. They are trimmed differently, but both are based on the same circuit (Fig.11). The KM110BH/2130 is trimmed to a higher amplification and measures angles between –15 and +15 degrees, generating a linear output signal (non-linearity is only approximately 1%).

The KM110BH/2190 measures the angle range from approximately –45 to +45 degrees, with a sinusoidal output. Figure 12 shows the output signals (V_O) of the two modules as a function of measured angle (α).

The modules are trimmed with an applied magnetic field of approximately 100 kA/m, generated by a rare earth magnet, for which the temperature compensation has been optimized. This has been effected in such a way that the specified angle range corresponds to an output ranging from 0.5 to 4.5 V. For an angle $\alpha = 0$ (see Fig.12), the output voltage is 2.5 V.

At different field strengths, slight changes in angle range and temperature drift must be taken into account (see the section entitled **Magnets**). Once the modified measurement conditions have been determined (e.g. in a customized module), the trimming procedure must be adapted accordingly.



Dimensions in mm.

Fig.10 Construction of a KM110BH/21 module.

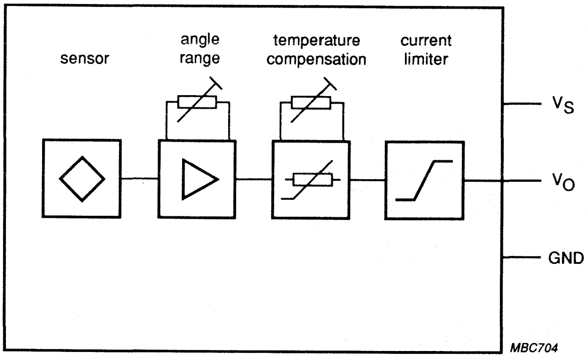


Fig.11 Block diagram of a module circuit.

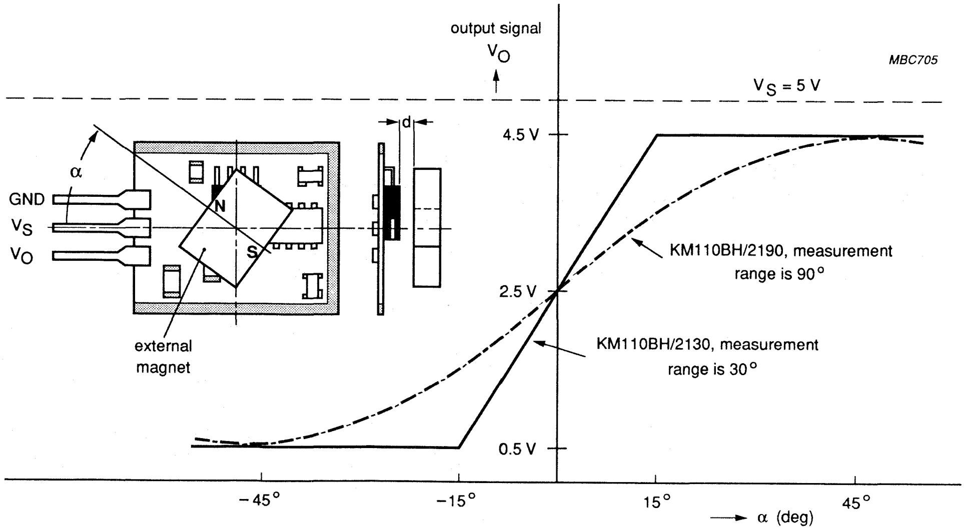


Fig.12 Output characteristics of the KM110BH/2130 and KM110BH/2190 modules.

Further data on the KM110BH/21 module can be found in Table 3 and in the data sheet.

Table 3 Characteristics of the KM110BH/21 modules

SYMBOL	PARAMETER	KM110BH/2130	KM110BH/2190	UNIT
α	angle range (field H = 100 kA/m)	30 (−15 to +15, linear)	90 (−45 to +45, sinusoidal)	deg
V_{CC}	supply voltage	5 ±0.5	5 ±0.5	V
I_{CC}	supply current	typ. 9	typ. 9	mA
V_O	output voltage (V_S = 5 V)	0.5 to 4.5	0.5 to 4.5	V
R_L	load resistance	≥10	≥10	kΩ
	maximum angular speed	10	30	deg/ms
	temperature range	−40 to +125	−40 to +125	°C
d	measuring distance (H = 100 kA/m)	see Table 4		
	dimensions (excluding pins)	16.93 x 19.05		mm^2
	zero-point accuracy (α = 0 degree relative to substrate edge)	typ. 0.2	typ. 0.2	deg
	thermal drift at α = 0 degree and −40 < T < 85 °C	typ. 0.3	typ. 0.3	°C
	T = 125 °C	typ. 0.5	typ. 0.5	°C
	thermal drift at α = 15 degrees and −40 < T < 85 °C	typ. 0.4	typ. 0.4	°C
	T = 125 °C	typ. 0.9	typ. 0.9	°C

Magnets

From a technical viewpoint, the most suitable operating magnet is a large and strong one; all tolerances are then negligible. However, cost and space must also be considered. The optimum size, therefore, largely depends on individual requirements. In Table 4 six different commercially available magnets are given, all of which are suitable for angle measurement applications. For each magnet the dimensions, temperature range, the recommended measuring distance (d) and the corresponding angle range is given.

The anisotropic magnet materials described have tolerances of magnetization direction affecting the angle measurement. Deviations of 1 to 2 degrees are possible. This should be taken into account if no mechanical $\alpha = 0$ calibration is possible.

Isotropic magnets generate weaker fields, e.g. ferrites generate approximately 30 kA/m, but optimum alignment of magnetization is possible using well-defined magnetization equipment.

The symmetry axis of the module and the rotation axis of the magnet should be identical. If one of the axes is shifted, the measuring system neglects this tolerance because of the parallel field lines of the magnet. Measurements with magnets 11.2 x 8 mm^2 faced to the sensor allow for eccentric tolerances of up to approximately 0.5 mm for the case of an accepted V_O tolerance of 1% (offset, angle range). For smaller magnets, this axis tolerance should be reduced proportionally.

Table 4 Magnets for angle sensor hybrids

MAGNETS			HYBRID ANGLE SENSORS			
MATERIAL	DIMENSIONS (note 1) (mm)	TEMP. RANGE (°C)	DISTANCE d (note 2) (mm)	ANGLE RANGE CORRESPONDING TO V_O = 0.5 to 4.5 V		TEMP. RANGE (°C)
				/2130	/2190	
NdFeB (note 3)	11.2 x 5.5 x 8	−55 to +110	2.5	30	93	−40 to +125
NdFeB (note 3)	6 x 3 x 5		0.8			
SmCo	11.2 x 5.5 x 8	−55 to +125	2.0	30	93	
SmCo	6 x 3 x 5		0.6			
FXD 330	10 x 7 x 8	−55 to +125	0.5	30.5	94.5	
FXD 330	7 x 5 x 4		0.2	30	93	

Notes

1. The magnetization is always parallel to the latter dimension given.
2. Between magnet and KMZ sensor front as shown in Fig.14.
3. Special care must be taken to avoid exposure of NdFeB magnets to moisture or vapour.

THE KM110BH/31 MODULE FOR MAGNETORESISTIVE SENSING OF ROTATIONAL SPEED AND DIRECTION

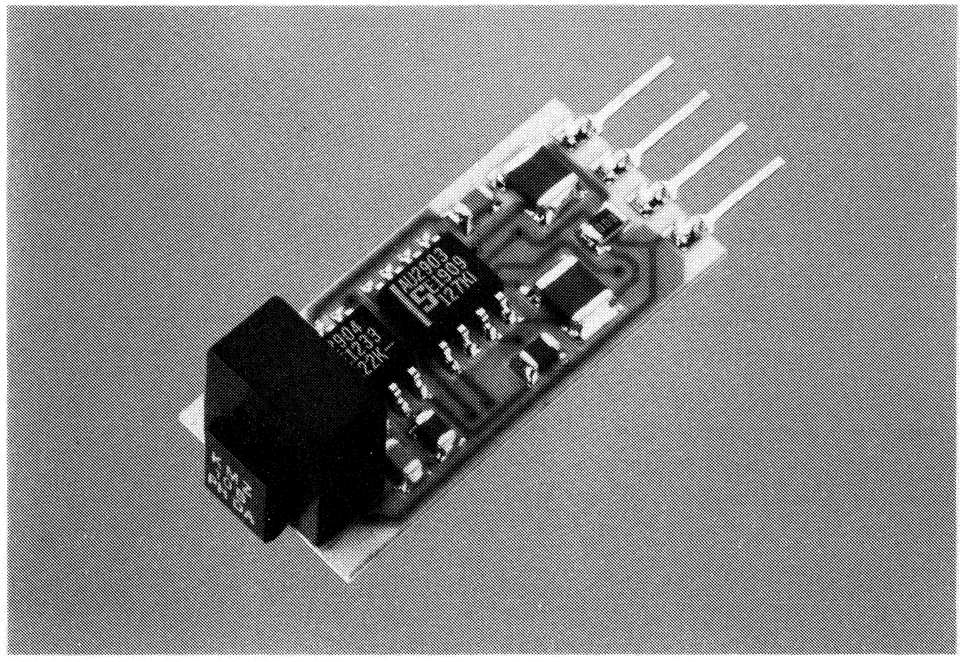


Fig.13 KM110BH/31 module.

With the introduction of the KM110BH/31, Philips Semiconductors has broadened its wide range of ready-to-use, active sensor modules. Based around the KMZ10B magnetoresistive sensor, the KM110BH/31 extends the successful KM110BH/1 range for contactless rotation-speed sensing. In addition, this module uses a new circuit which enables it to indicate *rotational direction*, as well as accurately measure rotation speeds. The KM110BH/31 can operate:

- from 2 Hz to 20 kHz
- at a large distance from the object to be measured
- from -40 to +125 °C (150 °C peak)
- without external magnets
- with a wide range of toothed wheels.

Direction indication with magnetoresistive sensors

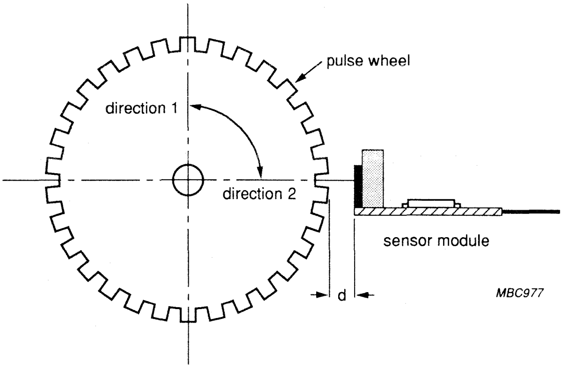


Fig.14 Optimum operating position.

Until recently, two magnetic field sensors were needed to indicate the rotational direction of a toothed wheel. The technique required placing the sensors a specific distance apart, around the wheel, to ensure that the two sensor output signals were optimally phase-shifted by 90 degrees. The distance, of course, varied with the 'Module'(1) of the specific toothed wheel used. However, with filters to suppress offset signals, it was possible to vary the distance between the sensors and thus use different wheels.

The single-sensor technique used in the KM110BH/31 is based on separate signal-processing for the sensor's two half-bridge signals. As the bridge geometry is fixed within the sensor chip, there is an optimum wheel Module (of 0.8 mm; see Fig.20) for the KM110BH/31. Nevertheless, it operates successfully using toothed wheels with a wide range of pitches. Although the stability of the two half bridges is reduced with non-optimal pitches, filtering compensates for this and allows the KM110BH/31 to operate at long distances from the wheel. Without filtering, the circuit could indicate zero speed, and be capable of incremental counting, but the operating range would be limited.

Mounting

The sensor operates like a magnetic Wheatstone bridge measuring non-symmetric magnetic conditions such as when teeth or pins move in front of the sensor. The KM110BH/31 can sense this movement in two possible directions (shown in Fig.14), so the mounting position is very important for accurate measurements. Two types of mounting error affect the KM110BH/31's performance:

- allowing an angle between the sensor's symmetry axis (the centre line in Fig.14) and that of the toothed wheel
- vertically shifting the sensor away from the optimum position shown in Fig.14.

The sensor's symmetry axis corresponds with that of the built-in magnet: the chip is not mounted in the centre of the sensor encapsulation.

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(1) The Module of a toothed wheel = pitch diameter (in mm)/the number of teeth (the distance between teeth = π x Module).

Circuit

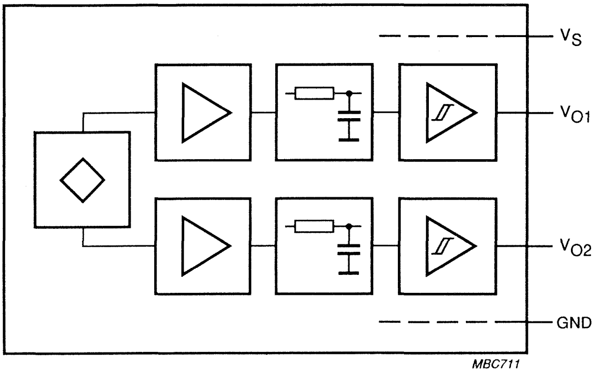


Fig.15 Block diagram of module circuit.

Figure 15 shows a block diagram of the circuit with separate signal processing for each half of the bridge. The digital output signals (V_{O1} and V_{O2}) are connected directly to the output pins. The circuit design enables evaluation of the output signals by a microcomputer. Figures 16 and 17 show how both output signals vary with rotational direction. If desired, the two output signals may be connected to a flip-flop, for a direct indication of rotation direction (Fig.18).

Since a protection diode is not included in the KM110BH/31, care should be taken to ensure the correct supply polarity ($+V_S$). The recommended supply is 5 V, but operation is possible with supplies from 4 to 10 V. The supply ripple should not exceed 40 mV to prevent unwanted switching of the comparator.

Either output pin can withstand short-circuiting to the supply lead (V_S). Normally the external load should be ≥100 kΩ, but with an additional external pull-up resistor, this value can be reduced. The output resistance is 100 Ω when the signal is LOW and 10 kΩ when HIGH.

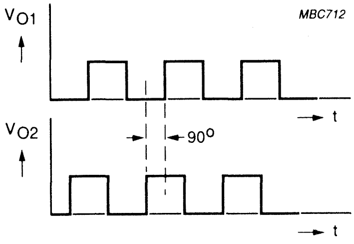


Fig.16 Output signals (direction 1).

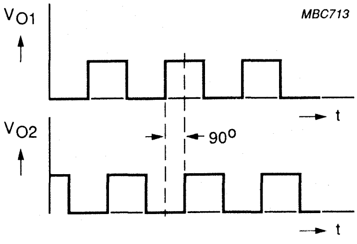


Fig.17 Output signals (direction 2).

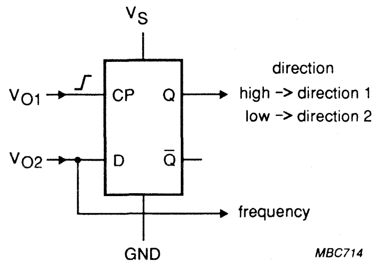


Fig.18 Interface for direction indication (D-type flip-flop, such as HEF4013 or 74LS74).

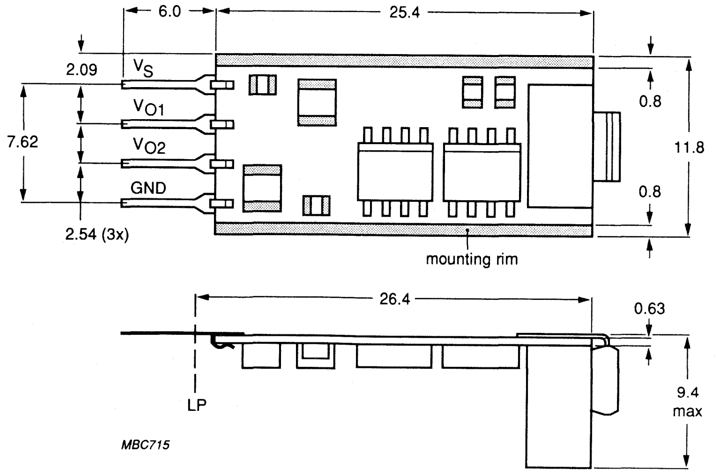
Encapsulation

In designing an encapsulation, please bear in mind:

- the encapsulation material should be non-magnetic
- to operate the KM110BH/31 at large distances from the wheel, the part of the encapsulation directly in front of the sensor should be as thin as possible
- 0.8 mm of the circuit-board edge is available to allow a secure mounting into grooves (see Fig.19).

Temperature range

The front of the KM110BH/31 (sensor and magnet) can withstand temperatures up to 150 °C provided the duration is limited to a few hours over the module's lifetime. The integrated circuits, however, should not operate in environments above 125 °C.



Dimensions in mm.

Fig.19 Construction of the KM110BH/31 module.

Performance

The measuring distance range depends on the structure of the toothed wheel and also on the accuracy of mounting. The latter may influence the output signal form and cause an effective phase shift if the measuring distance is very small.

If different wheel Modules are used from the range given in Fig.20, the measuring distance range has to be found by measurement.

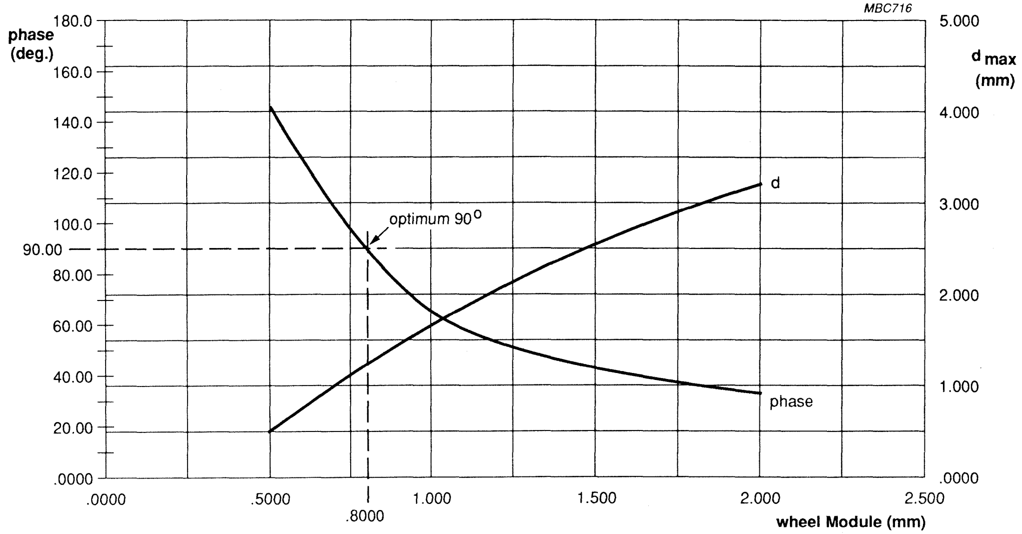


Fig.20 Effect of different toothed wheel structures on the KM110BH/31.

Table 5 Sensor module specifications

CHARACTERISTIC	SPECIFICATION
Supply voltage (V_S)	5 V (4 to 10 V; maximum ripple is 40 mV)
Output signals (V_{O1}, V_{O2})	0 to 5 V; digital; peak is relative to V_S
Operating temperature range	–40 to 125 °C (150 °C max.; 500 hours)
Measuring distance (d)	see Fig.20
Frequency range	2 Hz to 20 kHz
Output resistance	100 Ω (LOW), 10 kΩ (HIGH)
Minimum external load	100 kΩ (lower with external pull-up resistor)

DEVICE DATA - SENSOR HYBRID MODULES

Revolution sensors KM110BH/11; KM110BH/12

DESCRIPTION

Sensor modules used for the detection of rotation and markings. The module is a combination of a magnetoresistive sensor, a permanent magnet and a signal conditioning circuit in hybrid technology. The module delivers a ratiometric digital output signal with short-circuit protection.

The KM110BH/11 is the DC coupled version, which allows revolution sensing beginning at 0 Hz. The AC coupled KM110BH/12 starts at 1 Hz for increased sensing distance.

PINNING

PIN	DESCRIPTION
1	ground
2	V_{OUT}
3	V_{CC}

PIN CONFIGURATION

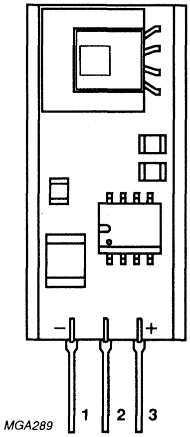


Fig.1 Simplified outline.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	DC supply voltage	–	5	–	V
V_{OL}	output signal LOW	–	–	0.4	V
V_{OH}	output signal HIGH	4.3	–	–	V
d	sensing distance	–	–	3.5	mm
f	operating frequency range	0	–	3000	Hz
T_{op}	operating temperature range	–40	–	125	°C

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	supply voltage		4	10	V
V_{ripple}	ripple voltage supply	KM110BH/12 only	–	50	mV
I	supply current		–	14	mA
T_{stg}	storage temperature range		–40	125	°C
T_{op}	operating temperature range	note 1	–40	125	°C
$T_{op\ sens}$	peak temperature	note 2	–	190	°C
	output short-circuit duration to ground	permanent (note 3)			

Notes

1. The operating temperature range of the module can be extended up to +150 °C for a limited time. This will be monitored by environmental quality tests up to 500 hours of operation at +150 °C under characteristic conditions.
2. This value applies to the sensor only, for a period not exceeding 1 hour.
3. If pin 3 is shorted to either pin 1 or pin 2, current may flow permanently, without damage to the device.

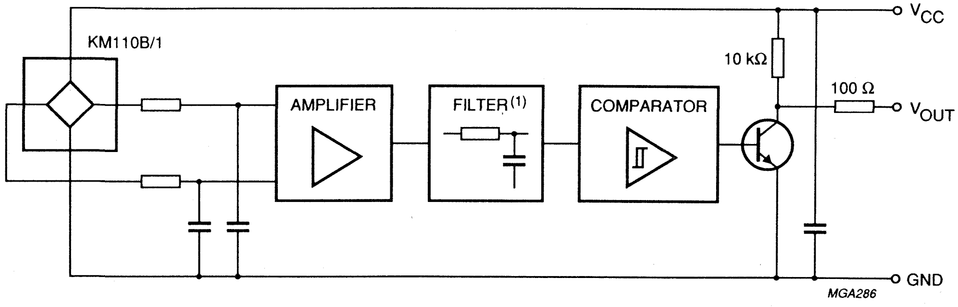
CHARACTERISTICS

T_{amb} = 25 °C; f = 100 Hz; V_{CC} = 5 V unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{OL}	output signal LOW		–	0.4	V
V_{OH}	output signal HIGH		4.3	–	V
t_r	output signal rise time	$C_L \leq 50$ pF	–	10	µs
t_f	output signal fall time	$C_L \leq 50$ pF	–	10	µs
f	operating frequency range	for both directions of rotation			
	KM110BH/11 (note 1)		0	3000	Hz
	KM110BH/12		1	3000	Hz
R_L	load resistance	note 2	100	–	kΩ
d	sensing distance	note 3 see Fig.3			
	KM110BH/11		–	2.5	mm
	KM110BH/12		–	3.5	mm
y	linear position error	see Fig.4	–	0.5	mm
θ	angle error	see Fig.4	–	1	deg

Notes

1. High rotation speeds of wheels reduce the range of the KMB110H/11, due to eddy currents. This causes a reduction in sensing distance.
2. $R_L \leq 100$ kΩ possible with external pull-up resistor.
3. Gear wheel: pitch diameter = 44 mm; width = 16 mm; module 2; material 1.0715. See also section: 'Gear wheel dimensions'.



(1) KM110BH/12 only.

Fig.2 Circuit diagram.

Gear wheel dimensions

The gear wheel dimensions are specified in accordance with the German DIN standard, where:

d = pitch diameter (mm); z = number of teeth; m = module m = d/z (mm); t = pitch = π x m (mm).

Mounting conditions

Refer to Fig.3. The module senses ferrous indicators like wheels in one direction only (no rotational symmetry). The symmetrical axis of the sensor corresponds to the axis of the ferrite magnet. The crystal is not mounted in the centre of the housing.

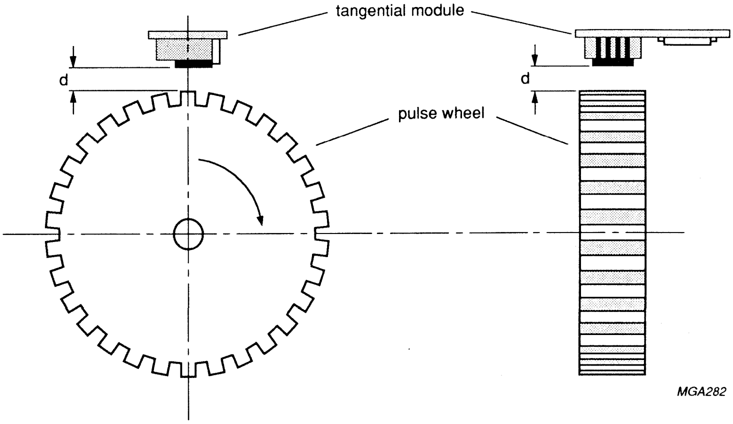


Fig.3 Optimal sensor position.

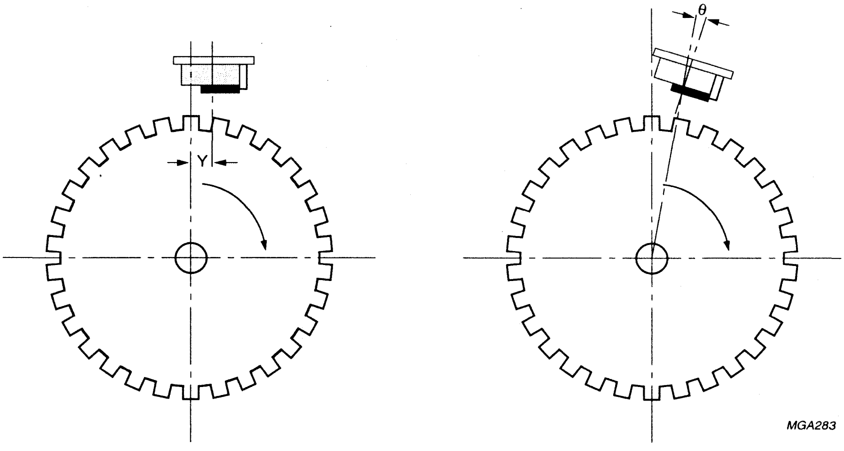
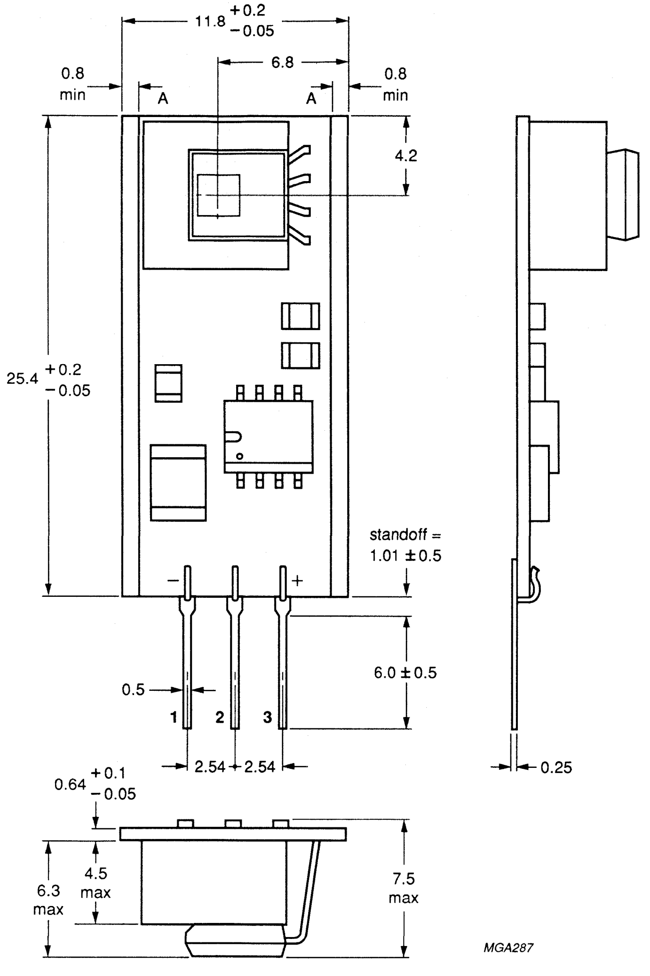


Fig.4 Sensor position with tolerances.

PACKAGE OUTLINE



Dimensions in mm.

Area 'A' free of SMD devices.

Fig.5 KM110BH/11; KM110BH/12.

Revolution sensors KM110BH/13; KM110BH/14

DESCRIPTION

Sensor modules used for the detection of rotation and markings. The module is a combination of a magnetoresistive sensor, a permanent magnet and a signal conditioning circuit in hybrid technology. The module delivers a ratiometric digital output signal with short-circuit protection.

The KM110BH/13 is the DC coupled version, which allows revolution sensing beginning at 0 Hz. The AC coupled KM110BH/14 starts at 1 Hz for increased sensing distance.

PINNING

PIN	DESCRIPTION
1	ground
2	V_{OUT}
3	V_{CC}

PIN CONFIGURATION

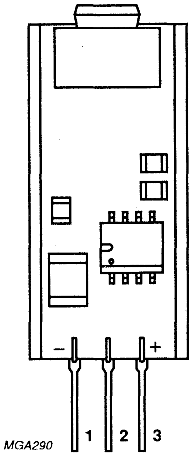


Fig.1 Simplified outline.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	DC supply voltage	–	5	–	V
V_{OL}	output signal LOW	–	–	0.4	V
V_{OH}	output signal HIGH	4.3	–	–	V
d	sensing distance	–	–	3.5	mm
f	operating frequency range	0	–	3000	Hz
T_{op}	operating temperature range	–40	–	125	°C

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	supply voltage		4	10	V
V_{ripple}	ripple voltage supply	KM110BH/14 only	–	50	mV
I	supply current		–	14	mA
T_{stg}	storage temperature range		–40	125	°C
T_{op}	operating temperature range	note 1	–40	125	°C
$T_{op\ sens}$	peak temperature	note 2	–	190	°C
	output short-circuit duration to ground	permanent (see note 3)			

Notes

1. The operating temperature range of the module can be extended up to +150 °C for a limited time. This will be monitored by environmental quality tests up to 500 hours of operation at +150 °C under characteristic conditions.
2. This value applies to the sensor only, for a period not exceeding 1 hour.
3. If pin 3 is shorted to either pin 1 or pin 2, current may flow permanently, without damage to the device.

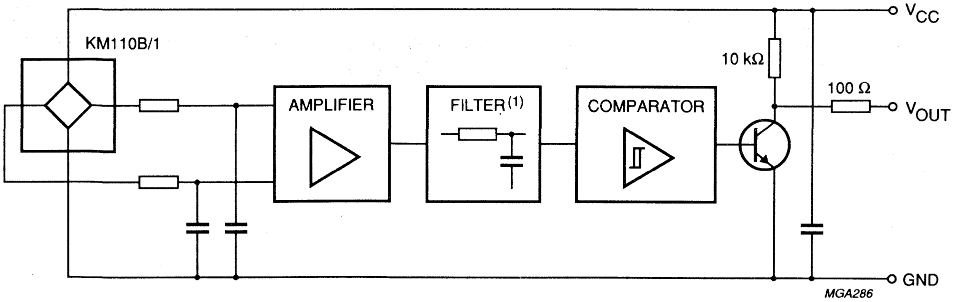
CHARACTERISTICS

T_{amb} = 25 °C; f = 100 Hz; V_{CC} = 5 V unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{OL}	output signal LOW		–	0.4	V
V_{OH}	output signal HIGH		4.3	–	V
t_r	output signal rise time	$C_L \leq 50$ pF	–	10	µs
t_f	output signal fall time	$C_L \leq 50$ pF	–	10	µs
f	operating frequency range	for both directions of rotation			
	KM110BH/13 (note 1)		0	3000	Hz
	KM110BH/14		1	3000	Hz
R_L	load resistance	note 2	100	–	kΩ
d	sensing distance	note 3			
	KM110BH/13	see Fig.3	–	2.5	mm
	KM110BH/14		–	3.5	mm
y	linear position error	see Fig.4	–	0.5	mm
θ	angle error	see Fig.4	–	1	deg

Notes

1. High rotation speeds of wheels reduce the range of the KMB110H/11, due to eddy currents. This causes a reduction in sensing distance.
2. $R_L \leq 100$ kΩ possible with external pull-up resistor.
3. Gear wheel: pitch diameter = 44 mm; width = 16 mm; module 2; material 1.0715. See also section: 'Gear wheel dimensions'.



(1) KM110BH/14 only.

Fig.2 Circuit diagram.

Gear wheel dimensions

The gear wheel dimensions are specified in accordance with the German DIN standard, where:

d = pitch diameter (mm); z = number of teeth; m = module m = d/z (mm); t = pitch = π x m (mm).

Mounting conditions

Refer to Fig.3. The module senses ferrous indicators like wheels in one direction only (no rotational symmetry). The symmetrical axis of the sensor corresponds to the axis of the ferrite magnet. The crystal is not mounted in the centre of the housing.

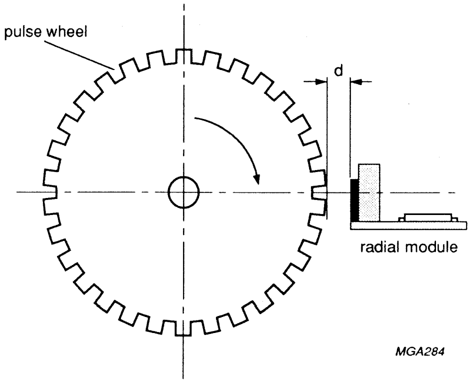


Fig.3 Optimal sensor position.

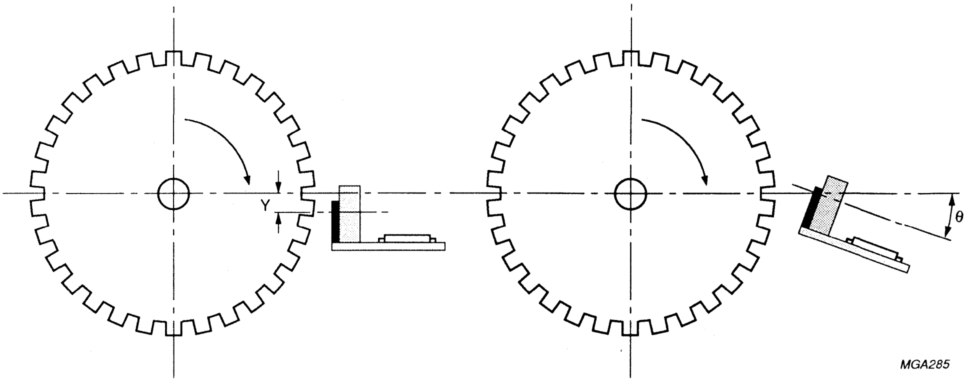
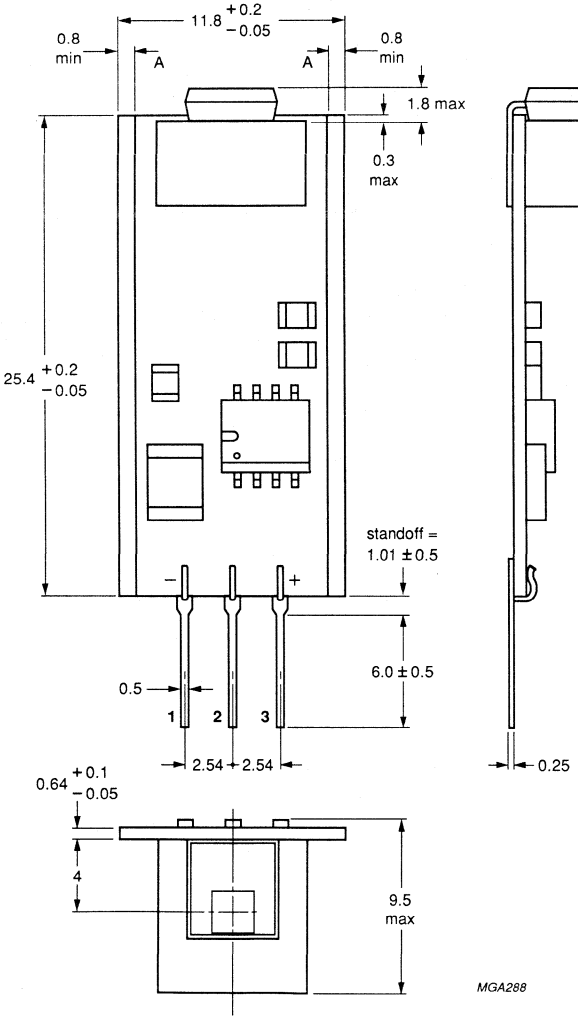


Fig.4 Sensor position with tolerances.

PACKAGE OUTLINE



Dimensions in mm.
Area 'A' free of SMD devices.

Fig.5 KM110BH/13; KM110BH/14.

Rotational speed sensor with direction recognition

KM110BH/31

DESCRIPTION

Sensor module for the detection of rotational speed and its direction. The module consists of the magnetoresistive sensor KMZ10B, a permanent magnet and a signal conditioning circuit in hybrid technology. The module delivers a digital output signal with short-circuit protection.

PINNING

PIN	DESCRIPTION
1	V_{CC}
2	V_{O1}
3	V_{O2}
4	ground

PIN CONFIGURATION

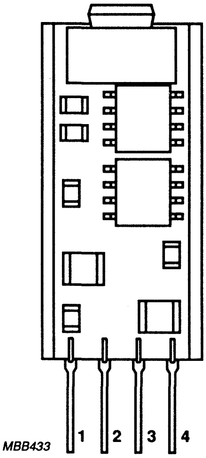


Fig.1 Simplified outline.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	DC supply voltage	–	5	–	V
V_{O1L}, V_{O2L}	output signal LOW	–	–	0.4	V
V_{O1H}, V_{O2H}	output signal HIGH	4.3	–	–	V
d	sensing distance	–	–	3	mm
f	operating frequency range	2	–	50000	Hz
T_{op}	operating temperature range	–40	–	125	°C

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	supply voltage		4	10	V
V_{ripple}	ripple voltage supply		–	40	mV
I_{CC}	supply current		–	14	mA
T_{stg}	storage temperature range		–40	125	°C
T_{op}	operating temperature range	note 1	–40	125	°C
$T_{op\ sens}$	peak temperature	sensor only	–	150	°C
	output short-circuit duration to ground	continuous			

Note

1. The operating temperature range of the module can be extended up to +150 °C for a limited time. This will be monitored by environmental quality tests up to 500 hours of operation at +150 °C under characteristic conditions.

CHARACTERISTICS

T_{amb} = 25 °C; f = 100 Hz; V_{CC} = 5 V unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{O1L}, V_{O2L}	output signal LOW	note 1	–	0.4	V
V_{O1H}, V_{O2H}	output signal HIGH	note 2	4.3	–	V
t_r	output signal rise time	$C_L \leq 50$ pF	–	10	µs
t_f	output signal fall time	$C_L \leq 50$ pF	–	10	µs
f	operating frequency range	for both directions of rotation	2	50 000	Hz
R_L	load resistance	note 3	100	–	kΩ
d	sensing distance	note 4 see Fig.3		3	mm
y	linear position error	see Fig.4	–	0.5	mm
θ	angle error	see Fig.4	–	1	deg

Notes

1. Refer to Figs 2, 5 and 6. The KM110BH/31 sensor is based on separated signal conditioning for two half-bridge signals. As the average distance between the two bridge-halves is fixed by the magnetoresistive sensor dimensions, the optimum structure pitch of a gear wheel should be 2.8 mm. Figures 5 and 6 show the dependence of both output signals on the direction of movement.
2. V_{O1H} and V_{O2H} are relative to V_{CC}.
3. $R_L \leq 100$ kΩ possible with external pull-up resistor.

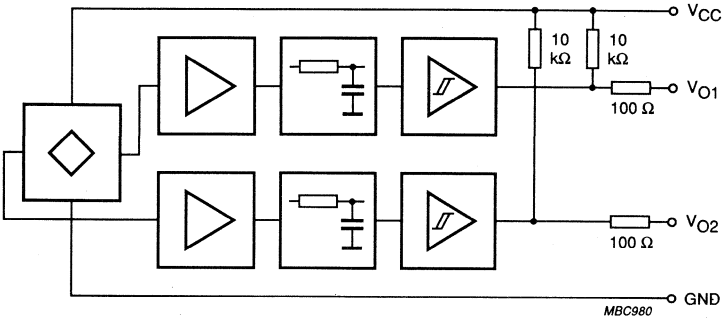


Fig.2 Circuit diagram.

Gear wheel dimensions

The gear wheel dimensions are specified in accordance with the German DIN 780 standard, where:

d = pitch diameter (mm); z = number of teeth; m = module m = d/z (mm); t = pitch = π x m (mm).

Mounting conditions

Refer to Fig.3 for the correct mounting position. The module senses ferrous indicators like wheels in one plane only (no rotational symmetry). The measuring axis of the sensor corresponds to the symmetry axis of the ferrite magnet - the crystal is not mounted in the centre of the housing.

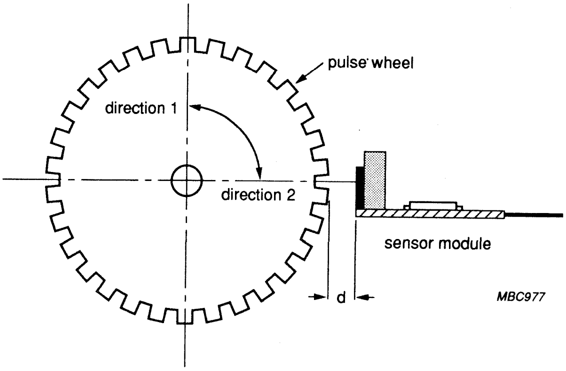


Fig.3 Optimal sensor position.

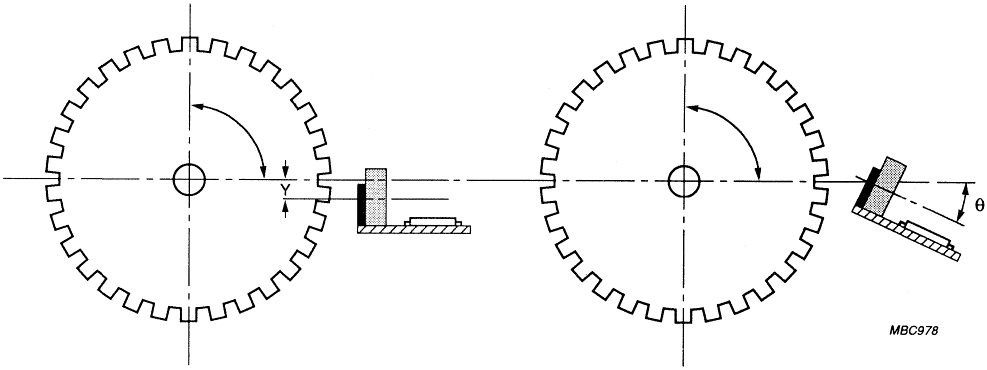


Fig.4 Sensor position with tolerances.

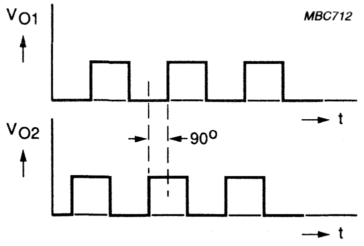


Fig.5 Output signals with gear wheel rotation in direction 1.

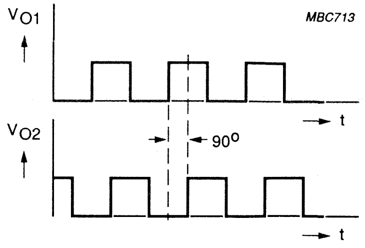


Fig.6 Output signals with gear wheel rotation in direction 2.

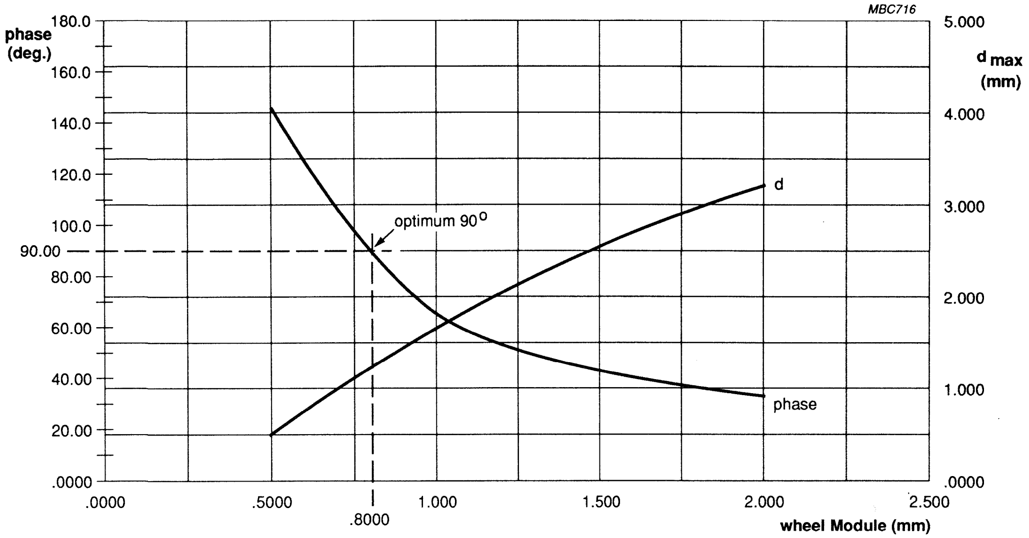


Fig.7 Phase and distance relationship for different gear wheel modules.

APPLICATION INFORMATION

Direction recognition can be achieved with a microprocessor or with a simple flip-flop circuit, see Fig.8.

In life-support systems, the behaviour of electronic components throughout their working life can be unpredictable. The use of these devices in support systems can only be permitted when there is no danger to life caused by devices failing unexpectedly.

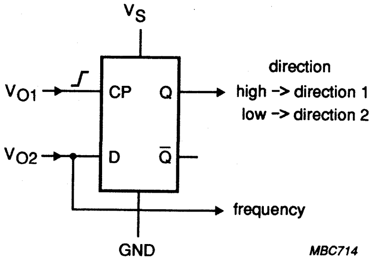
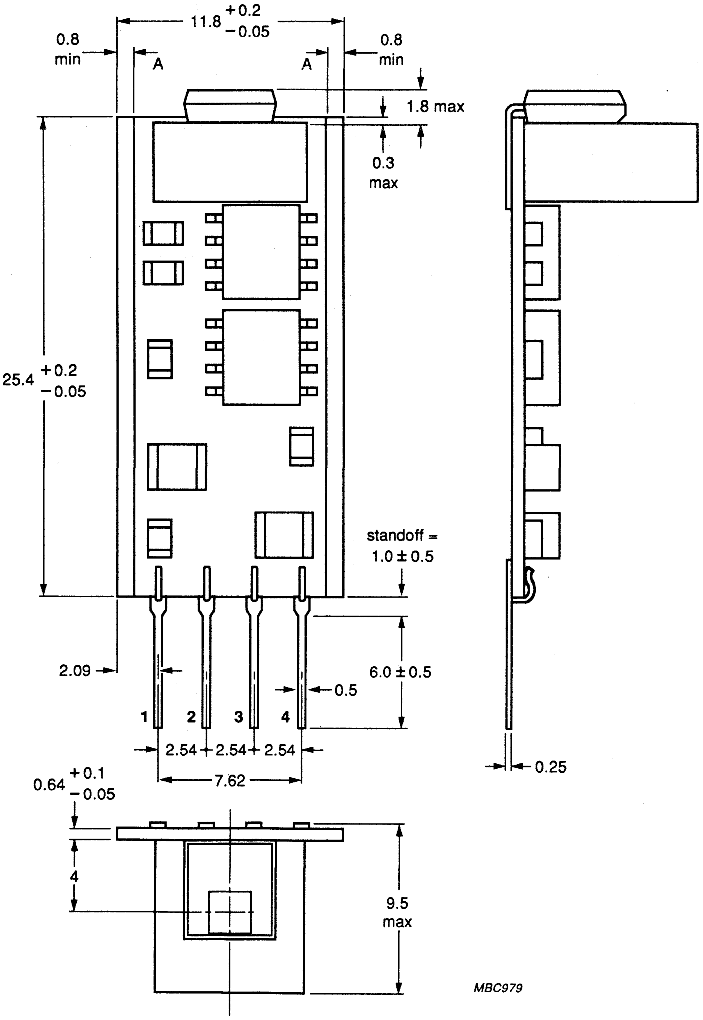


Fig.8 Interface for direction rotation.

PACKAGE OUTLINE



Dimensions in mm.

Area 'A' free of SMD devices.

Fig.9 KM110BH/31.

Angle sensor hybrid KM110BH/2130; KM110BH/2190

DESCRIPTION

Sensor module for contactless measurement of angular displacements of strong magnetic fields. The module is a ready-trimmed (sensitivity and zero point) combination of the magnetoresistive sensor KMZ10B and a signal conditioning circuit in hybrid technology. The KM110BH/2130 delivers a linear output signal that is proportional to the direction of the magnetic field. The KM110BH/2190 delivers a sinusoidal signal.

PINNING

PIN	DESCRIPTION
1	ground
2	V_{CC}
3	V_O

PIN CONFIGURATION

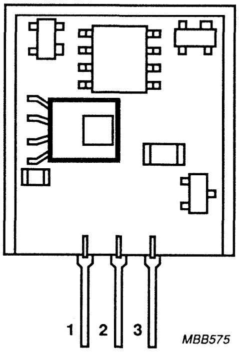


Fig.1 Simplified outline.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	DC supply voltage	–	5	–	V
V_O	output voltage range	0.5	–	4.5	V
α	angle range				
	KM110BH/2130	–15	–	15	deg
	KM110BH/2190	–45	–	45	deg
T_{op}	operating temperature range	–40	–	125	°C

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_{CC}	supply voltage	4.5	5.5	V
I_{CC}	supply current	–	20	mA
T_{stg}	storage temperature range	–40	125	°C
T_{op}	operating temperature range	–40	125	°C
	output short-circuit duration	permanent (see note 1)		

Note

1. If pin 3 is shorted to either pin 1 or pin 2, current may flow permanently, without damage to the device.

CHARACTERISTICS

T_{amb} = 25 °C; V_{CC} = 5 V and a homogeneous magnetic field H_{ext} = 100 kA/m in the sensitive layer of the KMZ sensor unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
α	angle range (note 1)					
	KM110BH/2130		−15	–	15	deg
	KM110BH/2190	note 2	−45	–	45	deg
V_O	output voltage range					
	KM110BH/2130	linear, see Fig.4	0.5	–	4.5	V
	KM110BH/2190	sinusoidal, see Fig.5	0.5	–	4.5	V
V_{zero}	zero point voltage	α = 0 deg	–	2.5	–	V
V_{off}	zero point offset voltage					
	KM110BH/2130		–	±45	–	mV
	KM110BH/2190		–	±35	–	mV
S	sensitivity (note 3)	α = 0 deg				
	KM110BH/2130		–	139	–	mV/deg
	KM110BH/2190		–	70	–	mV/deg
FL	deviation of linearity (note 4)					
	KM110BH/2130		–	–	±1	%/FS
	KM110BH/2190		–	–	–	%/FS
SP_{max}	maximum angular speed					
	KM110BH/2130		–	10	–	deg/ms
	KM110BH/2190		–	30	–	deg/ms
R_L	load resistance		–	10	–	kΩ
Temperature coefficients (−40 to +85 °C)						
TCV_{zero}	temperature coefficient of zero point voltage					
	KM110BH/2130		–	0.6	–	mV/K
	KM110BH/2190		–	0.3	–	mV/K
TCS	temperature coefficient of sensitivity		–	±200	–	ppm/K

Notes

1. Refer to Fig.3. The magnetic field can be achieved using the first magnet listed in Table 1. Other magnets, along with their required distances from the front of the KMZ sensor, are given in this table.
2. Valid for $H_{ext} = \infty$. The real field strength of 100 kA/m gives a slightly higher operating angle range of ±46.5 deg.
3. The sensitivity will change slightly with +0.33% per 10% magnetic field increase if H_{ext} deviates from 100 kA/m.
4. Deviation from best straight line in angle range.

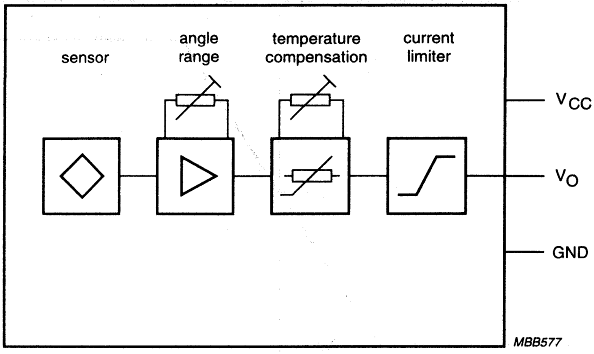


Fig.2 Circuit diagram.

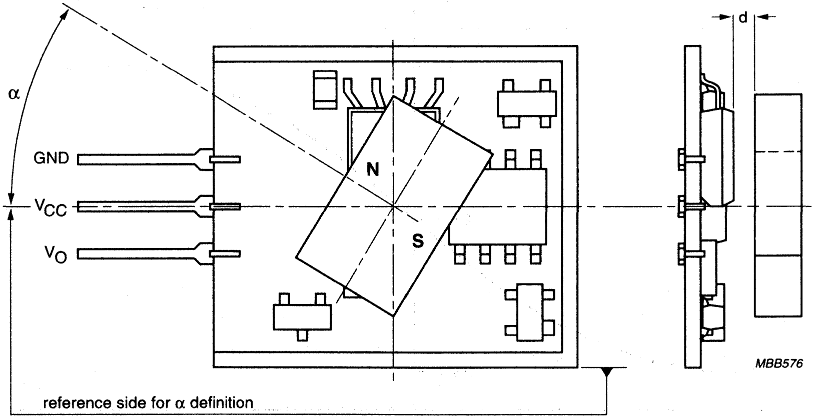


Fig.3 Optimum magnet position relative to the sensor module.

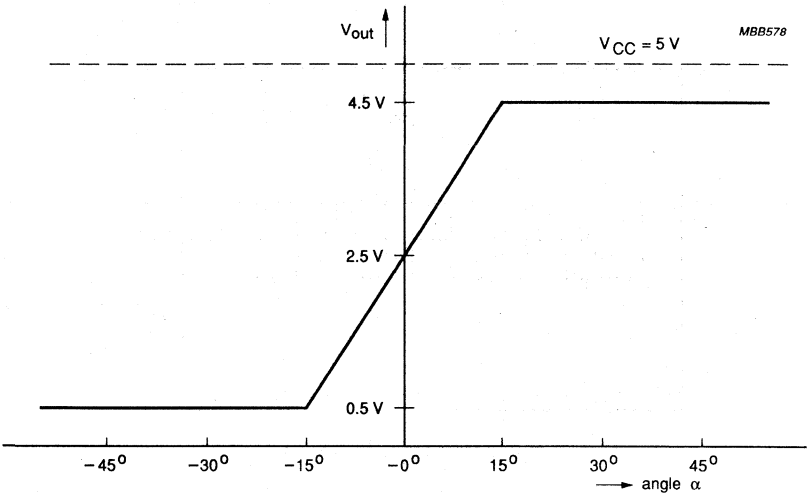


Fig.4 Output signal of KM110BH/2130.

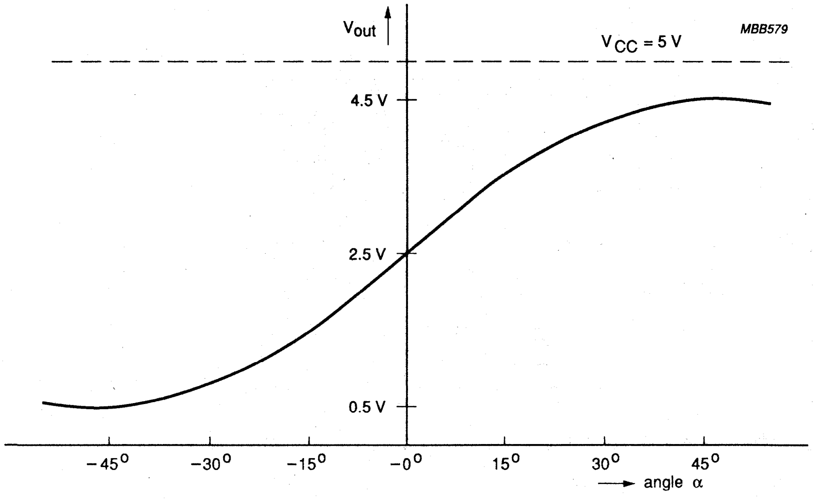


Fig.5 Output signal of KM110BH/2190.

Table 1 Magnets for angle sensor hybrids

MAGNETS			HYBRID ANGLE SENSORS			
MATERIAL	DIMENSIONS (note 1) (mm)	TEMP. RANGE (°C)	DISTANCE d (note 2) (mm)	ANGLE RANGE CORRESPONDING TO V_O = 0.5 to 4.5 V		TEMP. RANGE (°C)
				/2130	/2190	
NdFeB (note 3)	11.2 x 5.5 x 8	−55 to +110	2.5	30	93	−40 to +125
NdFeB (note 3)	6 x 3 x 5		0.8			
SmCo	11.2 x 5.5 x 8	−55 to +125	2.0	30	93	
SmCo	6 x 3 x 5		0.6			
FXD 330	10 x 7 x 8	−55 to +125	0.5	30.5	94.5	
FXD 330	7 x 5 x 4		0.2	30	93	

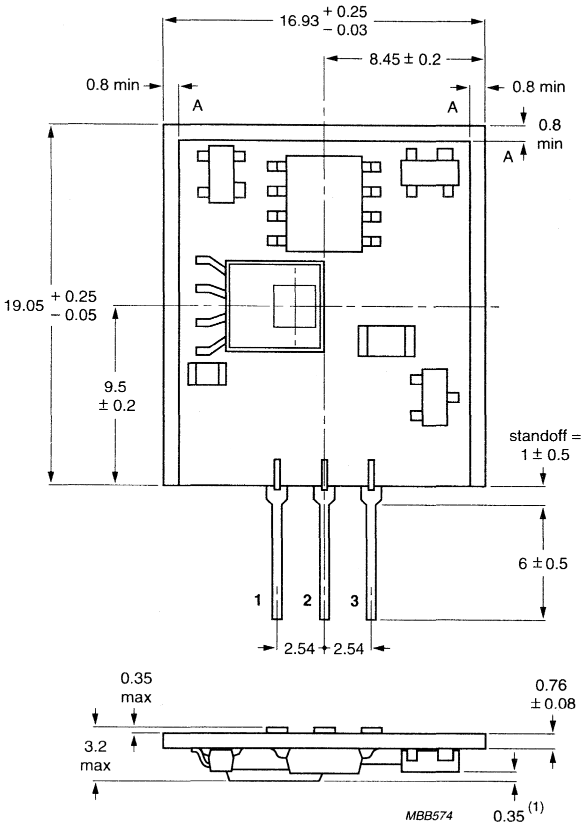
Notes

1. The magnetization is always parallel to the latter dimension given.
2. Between magnet and KMZ sensor front as shown in Fig.3.
3. Special care must be taken to avoid exposure of NdFeB magnets to moisture or vapour.

APPLICATION

In life-support systems, the behaviour of electronic components throughout their working life can be unpredictable. The use of these devices in support systems can only be permitted when there is no danger to life caused by devices failing unexpectedly.

PACKAGE OUTLINE



Dimensions in mm.

Area 'A' free of SMD devices.

(1) Sensitive layer below KMZ front.

Fig.6 KM110BH/2130; KM110BH/2190.

INTRODUCTION TO TEMPERATURE SENSORS

QUICK REFERENCE DATA

FAMILY TYPE	R_{25} (Ω)	AVAILABLE TOLERANCE GROUPS (ΔR)	OPERATING TEMPERATURE RANGE (°C)	PACKAGE
KTY81-1	1000	±1% up to ±5%	–55 to 150	SOD70
KTY81-2	2000	±1% up to ±5%	–55 to 150	SOD70
KTY82-1	1000	±1% up to ±5%	–55 to 150	SOT23
KTY82-2	2000	±1% up to ±5%	–55 to 150	SOT23
KTY83-1	1000	±1% up to ±5%	–55 to 175	DO-34
KTY84-1	1000 (R_{100})	±3% up to ±5%	–40 to 300	DO-34
KTY85-1	1000	±1% up to ±5%	–40 to 125	SOD80
KTY86-2	2000	±0.5%	–40 to 150	SOD103
KTY87-2	2000 (R_{25}) 3344 (R_{100})	±0.5% ±0.5%	–40 to 125	SOD103

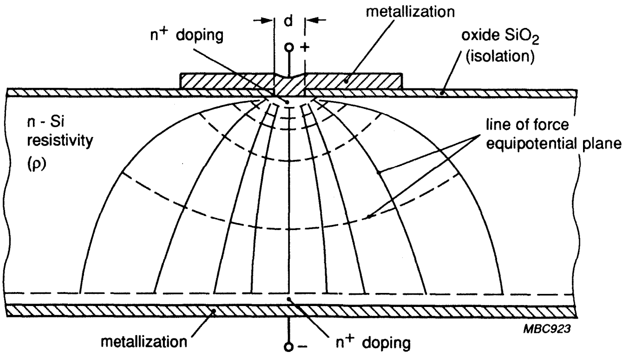
GENERAL

With their high accuracy and reliability, the KTY series of silicon temperature sensors in spreading resistance technology provide an attractive alternative to more conventional sensors using NTC or PTC thermistors. They have a positive temperature coefficient and a virtually linear temperature characteristic.

The sensors use n-type silicon with a doping level between 10^{14} and $10^{15}/cm^3$, providing a nominal resistance at 25 °C of about 1000 Ω (KTY81-1, KTY82-1, KTY83, KTY85) or 2000 Ω (KTY81-2, KTY82-2, KTY86, KTY87). The nominal resistance of the KTY84 is also 1000 Ω, but specified at 100 °C.

Construction of the sensor: spreading resistance principle

The construction of the basic sensor chip is shown in Fig.1. The approximate chip size is 500 x 500 x 240 μm. The upper plane of the chip is covered by an SiO_2 insulation layer, in which a metallized hole with a



The top plane is provided with a circular metal contact; the entire bottom plane is metallized.

Fig.1 Section through the crystal showing the spreading resistance principle and the electrode arrangement.

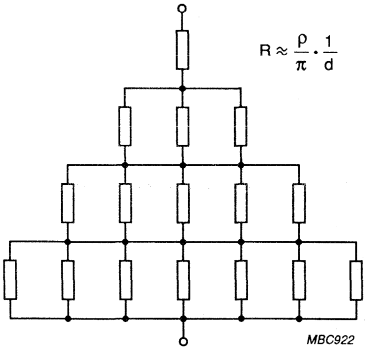


Fig.2 Equivalent circuit symbolically representing the spreading resistance principle shown in Fig.1.

diameter of approximately 20 µm has been cut out. The entire bottom plane is metallized.

This arrangement provides a conical current distribution through the crystal, hence the name 'spreading resistance' (see Fig.2). A major advantage of this arrangement is that the dependence of the sensor resistance on manufacturing tolerances is significantly reduced. An n^+ region, diffused into the crystal beneath the metallization reduces barrier-layer effects at the metal-semiconductor junctions.

Figure 3 shows a second arrangement, effectively consisting of two single sensors connected in series, but with opposite polarity. This twin-sensor arrangement has the advantage of providing a resistance that is independent of current direction, in contrast to the single-sensor arrangement of Fig.1, which, for larger currents and temperatures above 100 °C, gives a resistance that varies slightly with the current direction.

Normally, silicon temperature sensors have a temperature limit of approximately 150 °C, imposed by the intrinsic semiconductor properties of silicon. If, however, the single-sensor device is biased with its metal contact positive, the onset of intrinsic semiconductor behaviour is shifted to a higher temperature. This stems from the fact that a positive voltage on the gold contact severely depletes the hole concentration in the upper n^+ diffusion layer, and so effectively insulates holes spontaneously generated within the body of the crystal (due to its intrinsic nature) - preventing them from contributing to the total current, and hence from affecting the resistance.

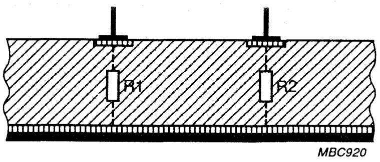


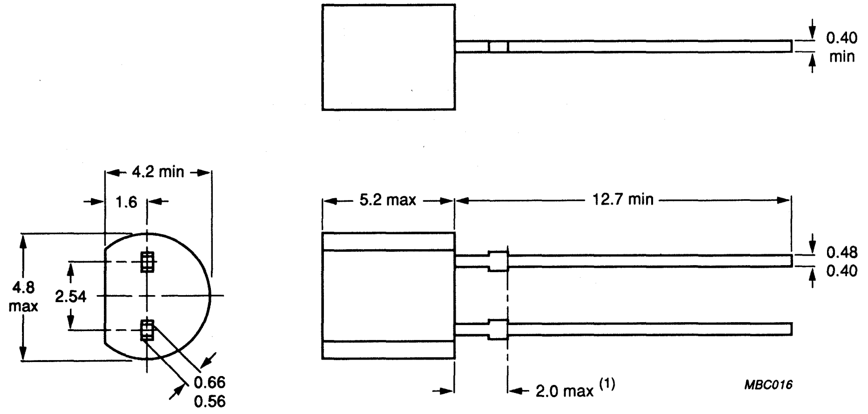
Fig.3 Setup consisting of two single sensors connected in series, but with opposite polarity.

The twin-sensor arrangement shown in Fig.3 has been applied in the KTY81 and KTY82 series. These sensors, in SOD70 (KTY81) and SOT23 (KTY82) encapsulations (Figs 4 and 5), are therefore polarity independent.

The KTY83/84/85 series use the more basic single-sensor arrangement. The simplicity of this arrangement allows the sensors to be produced in the compact DO-34 (KTY83/84) and SOD80 (KTY85) packages (Figs 6 and 7, respectively).

In addition to simplicity, the single-sensor device has another important advantage: the potential for operation at temperatures up to 300 °C. The KTY84 makes use of this property, being specifically designed for operation at temperatures up to 300 °C.

The KTY86/87 temperature sensors consist of two KTY83 sensors in series, the resistance of the latter having been matched, in order to reduce tolerances. For the KTY86, the KTY83 sensors are matched at 25 °C; for the KTY87, at 25 and 100 °C (see 'Quick Reference Data'). The outline of the KTY86/87 sensors is given in Fig.8.



(1) Terminal dimensions within this zone are uncontrolled to allow for flow of plastic and terminal irregularities.

Fig.4 KTY81 outline (SOD70).

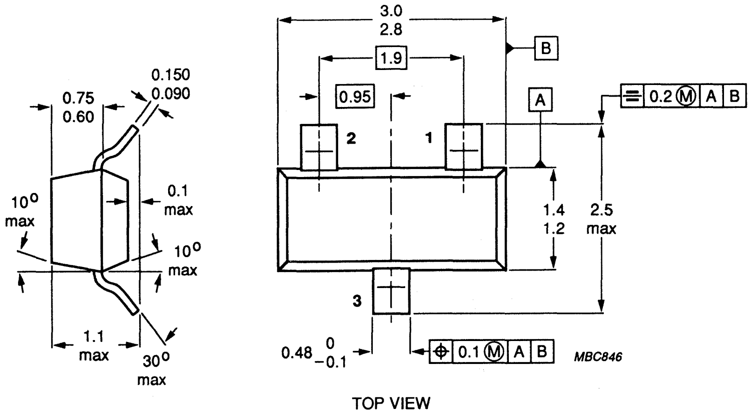


Fig.5 KTY82 outline (SOT23).

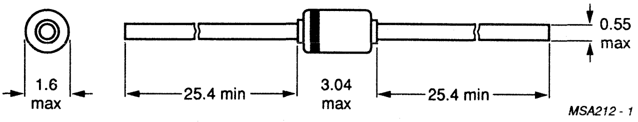


Fig.6 KTY83/84 outline (SOD68).

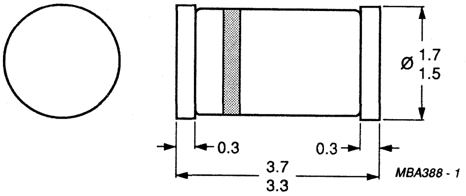


Fig.7 KTY85 outline (SOD80).

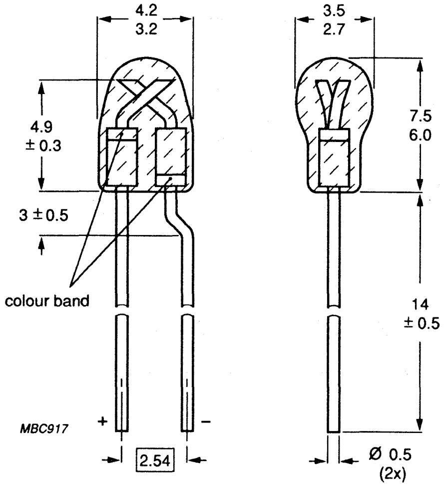


Fig.8 KTY86/87 outline (SOD103).

TEMPERATURE DEPENDENCE

For the KTY83/85/86/87 series of temperature sensors, the mathematical expression for the sensor resistance R(T) as a function of temperature is given by:

$$R(T) = R_{ref}\,[1 + A\,(T - T_{ref}) + B\,(T - T_{ref})^2\,]$$

where:

$R(T)$ = resistance at temperature T

R_{ref} = the nominal resistance at the reference temperature (T_{ref})

T_{ref} = reference temperature (100 °C for the KTY84, 25 °C for all other types)

A, B = type-dependent coefficients.

For the KTY81/82/84 series, the slope of the characteristic curve decreases slightly in the upper temperature range above a certain temperature T_I (point of inflection). Therefore, an additional term in the foregoing equation becomes necessary:

$$R(T) = R_{ref}\,[1 + A\,(T - T_{ref}) + B\,(T - T_{ref})^2 - C\,(T - T_I)^D\,]$$

where:

T_I = temperature above which the slope of the characteristic curve starts to decrease (point of inflection)

C, D = type-dependent coefficients

C = 0 for $T < T_I$.

For the types previously mentioned, the type-dependent constants A, B, C and D, as well as T_I, are given in Table 1.

For high-precision applications, e.g. microprocessor-based control systems, the above expressions and the values in Table 1 can be used to generate a calibration table to store in a ROM for look-up and linear interpolation.

If a microprocessor is not used, the slight deviation from linearity can easily be compensated using a parallel resistor (if a constant current source is used) or a series resistor (if a constant voltage source is used). This is discussed in the section entitled 'Linearization'.

Table 1

SENSOR TYPE	A (1/K)	B (1/K²)	C (1/K^D) (note 1)	D (–)	T_I (°C)
KTY81-1	7.874×10^{-3}	1.874×10^{-5}	3.42×10^{-8}	3.7	100
KTY81-2	7.874×10^{-3}	1.874×10^{-5}	1.096×10^{-6}	3.0	100
KTY82-1	7.874×10^{-3}	1.874×10^{-5}	3.42×10^{-8}	3.7	100
KTY82-2	7.874×10^{-3}	1.874×10^{-5}	1.096×10^{-6}	3.0	100
KTY83	7.635×10^{-3}	1.731×10^{-5}	–	–	–
KTY84	6.229×10^{-3}	1.159×10^{-5}	3.14×10^{-8}	3.6	250
KTY85	7.635×10^{-3}	1.731×10^{-5}	–	–	–
KTY86/87	7.646×10^{-3}	1.752×10^{-5}	–	–	–

Note

1. For $T < T_I$: C = 0.

RESISTANCE/TEMPERATURE CHARACTERISTICS

Manufacturing tolerances

Silicon temperature sensors are normally produced to quite fine tolerances: ΔR between ±0.5% and ±2% (see 'Quick Reference Data'). Figure 9 illustrates how these tolerances are specified, except for the KTY87. The tolerance on resistance quoted in our data sheets is given by the resistance spread (ΔR) measured at 25 °C.

Because of spread in the slope of the resistance characteristics, ΔR will increase each side of the 25 °C point, to produce the butterfly curve shown in Fig.9. To give an indication of this spread in slope, we also quote the ratio of resistance at two other temperatures (−55 °C and 100 °C) to the nominal resistance at 25 °C, i.e. R_{-55}/R_{25} and R_{100}/R_{25}; for the KTY84, we quote R_{25}/R_{100} and R_{250}/R_{100}.

The user, however, is usually more interested in the maximum expected temperature error (±ΔT). We also provide this in the data sheets, as a graph showing ΔT as a function of T. For the high temperature sensor KTY84, we specify the resistance spread at 100 °C.

The resistance of the KTY87 is specified with a close tolerance at 25 °C and 100 °C. This specification at two temperatures provides an essential improvement of measurement accuracy in this temperature range.

Polarity of current

KTY83, 84, 85, 86 and 87 sensors are marked with a coloured band to indicate polarity. The published characteristics of the sensors will only be obtained if the current polarity is correct. In cases where the current polarity is incorrect, the curve $R = f(T_{amb})$ differs in the upper temperature range significantly from the published form and light (especially infrared) influences this to a greater or lesser degree.

Linearization

The resistance/temperature characteristics of the silicon temperature sensors are nearly linear, but in some applications further linearization becomes necessary, e.g. control systems requiring high accuracy.

A simple way to do this is to shunt the sensor (resistance R_T) with a fixed resistor (R) (see Fig.10). The resistance $RR_T/(R + R_T)$ of the parallel combination then effectively becomes a linear function of temperature, and the output voltage (V_T) of the linearizing circuit can be used to regulate the control system.

If the circuit is powered by a constant-voltage source, a resistor can be connected in series with the sensor. The voltages across the sensor and across the resistor will then again be approximately linear functions of temperature.

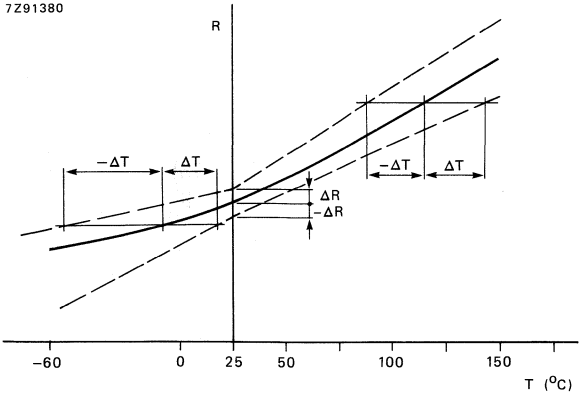
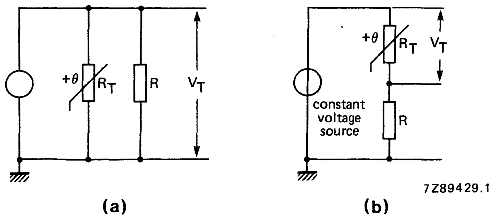


Fig.9 Butterfly curve.



(a) With a resistor (R) shunted across the sensor.

(b) With a resistor (R) in series with the sensor and system powered by a constant-voltage source.

Fig.10 Linearization of sensor characteristics.

The value of the series or parallel resistor depends on the required operating temperature range of the sensor. A method for finding this resistance is described here, giving zero temperature error at three equidistant points T_a, T_b and T_c.

Consider the parallel arrangement. If the resistance of the sensor at the three points is R_a, R_b and R_c, the requirement for linearity at the three points is:

$$R_{pa} - R_{pb} = R_{pb} - R_{pc}$$

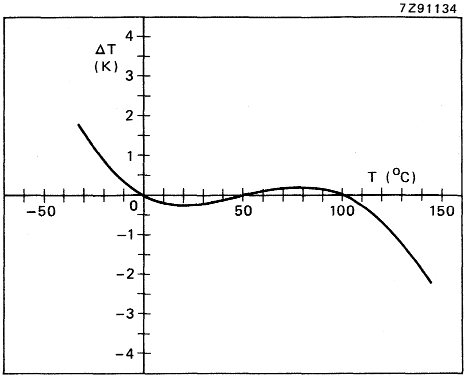
i.e.

$$\frac{RR_a}{R+R_a} - \frac{RR_b}{R+R_b} = \frac{RR_b}{R+R_b} - \frac{RR_c}{R+R_c}$$

so

$$R = \frac{R_b(R_a + R_c) - 2R_aR_c}{R_a + R_c - 2R_b}$$

The same resistor will also be suitable for the series arrangement.



Sensor linearized over the temperature range 0 to 100 °C (linearizing resistance 2870 Ω).

Fig.11 Linearization error (ΔT) to be expected from a nominal KTY81.

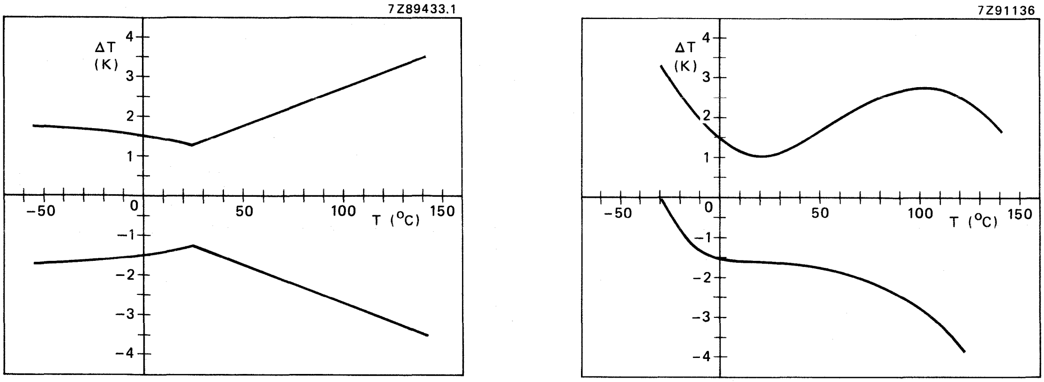
As an example, Fig.11 shows the deviation from linearity to be expected from a nominal KTY81 sensor linearized over the temperature range 0 to 100 °C, with a linearizing resistance of 2870 Ω.

EFFECT OF TOLERANCES ON LINEARIZED SENSOR CHARACTERISTICS

In practical applications with an arbitrary sensor, the total uncertainty in the sensor reading will be a combination of spread due to manufacturing tolerances and linearization errors.

As an example, Fig.12(b) shows the combined effects of manufacturing tolerances and linearization errors for the KTY81 sensor linearized over the temperature range 0 to 100 °C. Calibration of the subsequent circuitry (op-amp, control circuitry, etc.) can reduce this error significantly.

Figure 13(a) shows the temperature error of the system with (linear) output circuitry calibrated at 50 °C, and Fig.13(b) shows the error of the same system calibrated at 0 and 100 °C.



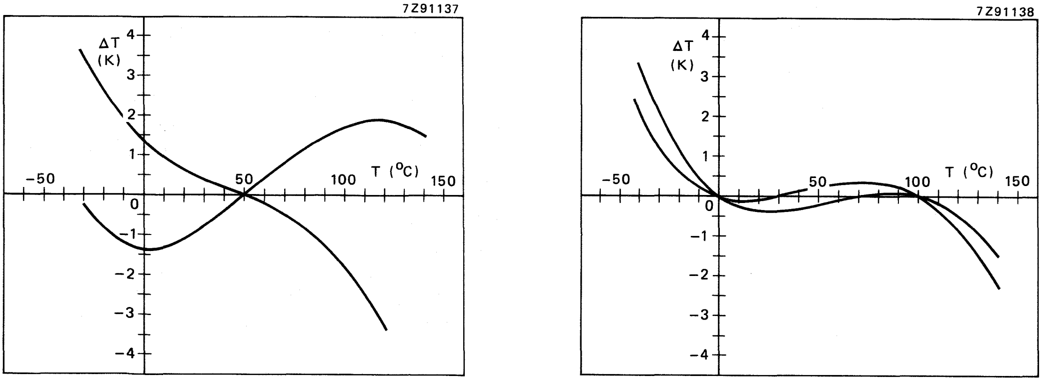
(a)

(b)

(a) Maximum temperature error (ΔT) due to manufacturing tolerances expected of a KTY81-1 sensor.

(b) Combined effects of manufacturing tolerances and linearization errors for the KTY81 sensor.

Fig.12 Maximum expected temperature error for an uncalibrated KTY81-1 sensor.



(a)

(b)

(a) Maximum expected temperature error of a KTY81-1 sensor plus linearization resistor calibrated at 50 °C.

(b) Error of the same system calibrated at 0 and 100 °C.

Fig.13 Maximum expected temperature error for a calibrated KTY81-1 sensor.

TEMPERATURE COMPENSATION

In many applications, it is necessary to compensate for the temperature dependence of electronic circuitry. For example, the sensitivity of many magnetic field sensors has a linear drift with temperature. To compensate for this drift, a temperature sensor with linear characteristics is required. The temperature sensors of the KTY series are well suited for this purpose and can be used for compensation of both positive and negative drift.

In many cases, as with the magnetoresistive sensor KMZ10B, the temperature drift is negative. For this sensor, two circuits, which include temperature compensation, are described below. The formulae given can be used to adapt the circuits to other conditions.

Figure 14 shows a simple setup using a single op-amp (NE5230D). The circuit provides the following facilities:

- compensation of the average (sensor to sensor) sensitivity drift with temperature via a negative feedback loop incorporating a KTY82-110 silicon temperature sensor
- offset adjustment by means of potentiometers R1 and R2
- gain adjustment by means of potentiometer R7.

The circuit does not compensate for the spread in sensitivity drift and offset drift. In addition, the sensor draws a relatively high current, so that self-heating effects may slightly influence the temperature compensation.

To compensate for the negative sensor drift, the amplification stage is given an equal but positive temperature coefficient by means of the KTY82-120.

The temperature coefficient of amplification (TC_A) is given by:

$$TC_A = \frac{R_8(T) \times TC_{KTY}}{R_8(T) + R_9/2} \quad \text{with } R_9 = R_{10}$$

where, for the KTY82-120, one has:

$TC_{KTY} = 0.79 \times 10^{-2}/K$.

For completeness, the formula for the amplification A is given:

$$A = \frac{R_7}{R_4}\left(1 + \frac{2\,R_8(T)}{R_9}\right) \quad \text{with } R_9 = R_{10}.$$

From the above formulae, it is clear that changing R_9 to obtain the desired TC_A results in a change of amplification. In both equations, the impedance of the sensor has been ignored.

Figure 15 shows a more elaborate circuit, embodying the functions of the simple circuit shown in Fig.14. The circuit compensates for the sensor's temperature coefficient of sensitivity and provides for the adjustment of gain (P2) and offset voltage (P1) of the sensor. It provides no compensation for the relatively small temperature variation of the offset voltage.

Compared with the circuit of Fig.14, however, it allows the use of higher supply voltages and hence can generate higher output voltages.

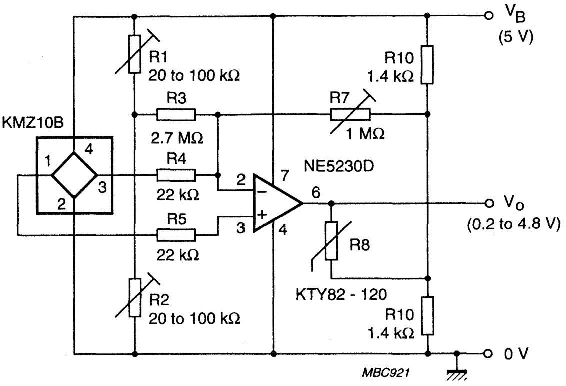
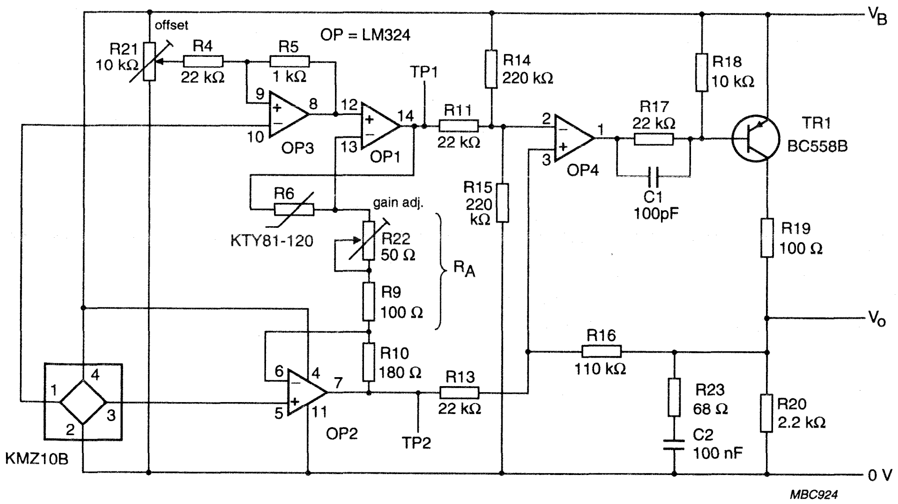


Fig.14 Simple circuitry for the KMZ10B incorporating temperature compensation.



The circuit provides for adjustment of gain, offset voltage and temperature coefficient of sensor sensitivity.

Fig.15 KMZ10 drive circuitry with a quadruple op-amp.

The circuit can be divided into two stages: a differential amplifier stage that produces a symmetrical output signal derived from the magnetoresistive sensor, and an output stage that also provides a reference to ground for the amplification stage.

To compensate the negative sensor drift, the amplification is again given an equal but positive temperature coefficient by means of a KTY81-120 silicon temperature sensor in the feedback loop of the differential amplifier. The temperature coefficient of amplification TC_A (equal and opposite to the magnetoresistive sensor's temperature coefficient of sensitivity) is given by:

$$TC_A = \frac{R_6(T)\ TC_{KTY}}{R_A + R_6(T) + R_{10}}$$

and the amplification A is:

$$A = 1 + \frac{R_6(T) + R_{10}}{R_A}.$$

In the first equation, $TC_{KTY} = 0.79 \times 10^{-2}$/K for a KTY81-120 at T = 25 °C. For a given gain A, the resistances R_A and R_{10} can be calculated from:

$$R_{10} = R_6(T)\left\{\frac{TC_{KTY}}{TC_A}\left(1 - \frac{1}{A}\right) - 1\right\}$$

$$R_A = \frac{R_6(T) + R_{10}}{A-1}.$$

In Fig.15, the output stage has a maximum gain of 5 and gives an output voltage of half the supply voltage V_B for zero differential output voltage of the amplification stage (between test points TP1 and TP2). Output voltage will vary from zero to slightly less than V_B.

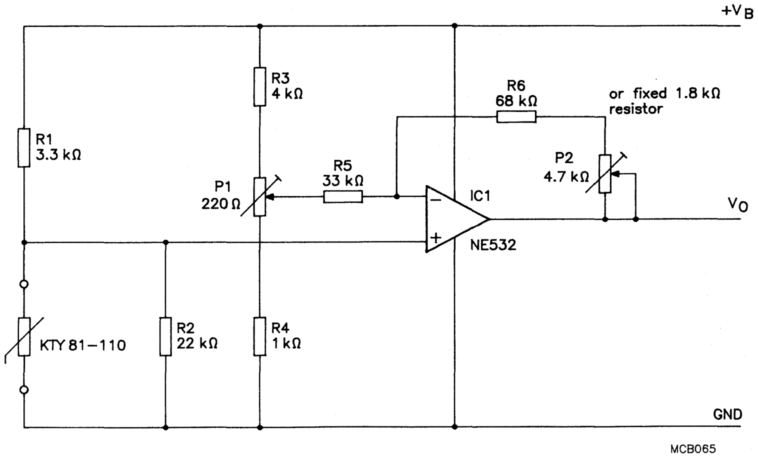
TYPICAL APPLICATION CIRCUIT

Figure 16 shows a typical and versatile temperature measuring circuit using silicon temperature sensors. This example is designed for the KTY81-110 (or the KTY82-110) and a temperature range from 0 to 100 °C.

With resistors R1 and R2, the sensor forms one arm of a bridge, the other arm being formed by resistor R3, potentiometer P1 and resistor R4. The values of R1 and R2 are chosen to supply the sensor with the proper current of approximately 1 mA, and to linearize the sensor characteristic over the temperature range of interest: in this case, between 0 and 100 °C. Over this temperature range, the output voltage V_O will vary linearly between 0.2 V_B and 0.6 V_B, i.e. between 1 V and 3 V for a 5 V supply.

To calibrate the circuit, adjust P1 to set V_O to 1 V, with the sensor at 0 °C. Then, at a temperature of 100 °C, adjust P2 to set V_O to the corresponding output voltage, in this example 3 V. With this circuit, adjustment of P2 has no effect on the zero adjustment.

The measurement accuracy obtained by this two-point calibration is shown in Fig.13(b). If the application can tolerate a temperature deviation of ±2 K at the temperature extremes, (see Fig.13(a)) costs can be reduced by replacing P2 with a 1.8 kΩ fixed resistor and adjusting V_O at one temperature (the middle of the range, for example), using P1.



In the above circuit, a KTY82-110 sensor would be equally suitable.

Temperature range 0 to 100 °C; $V_O = 0.2\ V_B$ to $0.6\ V_B$.

For $V_B = 5$ V: $V_O = 1$ to 3 V.

All resistors metal film, tolerance ±1%.

Fig.16 Temperature measuring circuit using a KTY81-110 sensor.

MOUNTING AND HANDLING RECOMMENDATIONS

Mounting

KTY81

When potting techniques for KTY81 sensors are used for assembling, care has to be taken to ensure that mechanical stress and temperature development during curing of epoxy resin do not overstress the devices.

KTY83, 84, 86 AND 87

Excessive forces applied to a sensor may cause serious damage. To avoid this, the following recommendations should be adhered to:

- no perpendicular forces must be applied to the body
- during bending, the leads must be supported
- bending close to the body must be done very carefully
- axial forces to the body can influence the accuracy of the sensor and should be avoided.

Handling

ELECTROSTATIC DISCHARGE (ESD) SENSITIVITY

Electrostatic discharges above a certain energy can lead to irreversible changes of the sensor characteristic. In extreme cases, sensors can even be destroyed. In accordance with the test methods described in IEC 47 (CO)955, temperature sensors are classified as sensitive components with respect to ESD. During handling (testing, transporting, fitting), the common rules for handling of ESD sensitive components should be observed.

If necessary, the ESD sensitivity in the practical application can be further reduced by connecting a 10 nF capacitor in parallel to the sensor.

Soldering

KTY81

The common rules for soldering components in TO-92 packages should be observed.

KTY83, 86 AND 87

Avoid any force on the body or leads during, or just after, soldering. Do not correct the position of an already soldered sensor by pushing, pulling or twisting the body. Prevent fast cooling after soldering. For hand soldering, where mounting is not on a printed circuit board, the soldering temperature should be < 300 °C, the soldering time < 3 s and the distance between body and soldering point > 1.5 mm. For hand soldering, dip, wave or other bath soldering, mounted on a printed circuit board, the soldering temperature should be < 300 °C, the soldering time < 5 s and the distance between body and soldering point > 1.5 mm.

KTY85

The common rules for surface mounted devices in SOD80 packages should be observed. Hand soldering is not recommended, because there is a great risk of damaging the glass body or the inner construction by uncontrolled temperature and time.

Welding

The KTY84 sensors are manufactured with nickel plated leads suitable for welding. The distance between the body and the welding point should be > 0.5 mm. Care should be taken to ensure that welding current never passes through the sensor.

DEVICE DATA - TEMPERATURE SENSORS

SILICON TEMPERATURE SENSORS

These sensors have a positive temperature coefficient of resistance and are for use in measurement and control.

QUICK REFERENCE DATA

Resistance at T_{amb} = 25 °C
I_C = 1 mA

KTY81-110	R_{25}	990 - 1010 Ω
KTY81-120	R_{25}	980 - 1020 Ω
KTY81-121	R_{25}	980 - 1000 Ω
KTY81-122	R_{25}	1000 - 1020 Ω
KTY81-150	R_{25}	950 - 1050 Ω
KTY81-151	R_{25}	950 - 1000 Ω
KTY81-152	R_{25}	1000 - 1050 Ω

KTY81-120 is composed of groups −121 and −122 and is correspondingly designated.

KTY81-150 is composed of groups −151 and −152 and is correspondingly designated.

Operating ambient temperature range T_{amb} −55 to +150 °C

MECHANICAL DATA

Dimensions in mm

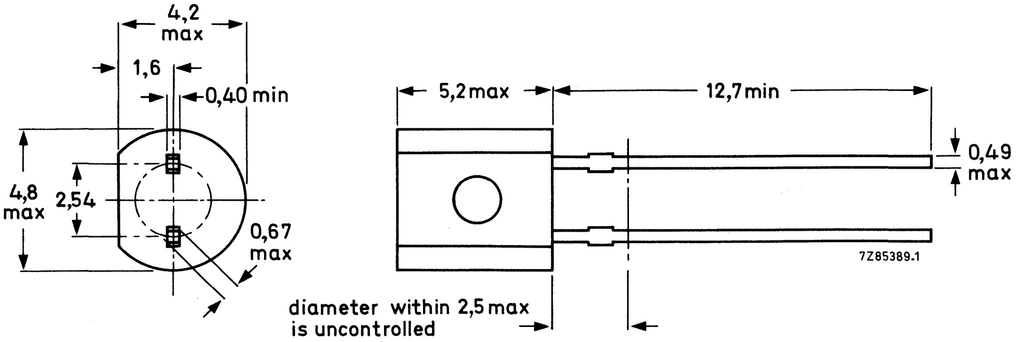


Fig. 1 SOD-70.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous sensor current in free air

T_{amb} = 25 °C	I_C	max.	10 mA
T_{amb} = 150 °C	I_C	max.	2.0 mA

CHARACTERISTICS

(Based on the measurements in liquid at T_{amb} = 25 °C unless otherwise specified).

Resistance

I_C = 1 mA	KTY81-110	R_{25}	990 - 1010 Ω
	KTY81-120	R_{25}	980 - 1020 Ω
	KTY81-121	R_{25}	980 - 1000 Ω
	KTY81-122	R_{25}	1000 - 1020 Ω
	KTY81-150	R_{25}	950 - 1050 Ω
	KTY81-151	R_{25}	950 - 1000 Ω
	KTY81-152	R_{25}	1000 - 1050 Ω

Temperature coefficient	typ.	0.79 %/K
Resistance ratio	R100/R25	1.696 ± 0.020
	R−55/R25	0.490 ± 0.010
Thermal time constant*		
in still air	typ.	30 s
in still liquid**	typ.	5.0 s
in flowing liquid**	typ.	3.0 s
Measuring temperature range		−55 to +150 °C

T_{amb} °C	Resistance Ω
−55	490
−50	515
−40	567
−30	624
−20	684
−10	747
0	815
10	886
20	961
25	1000
30	1040
40	1122

T_{amb} °C	Resistance Ω
50	1209
60	1299
70	1392
80	1490
90	1591
100	1696
110	1805
120	1915
130	2023
140	2124
150	2211

Ambient temperature and corresponding average resistance values of sensor (I_C = 1 mA).

* The thermal time constant is the time the sensor needs to reach 63.2% of the total temperature difference. For instance, the time needed to reach a temperature of 72.4 °C, when a sensor with an initial temperature of 25 °C is put into an ambient with a temperature of 100 °C.

** Inert liquid FC43 of 3M company.

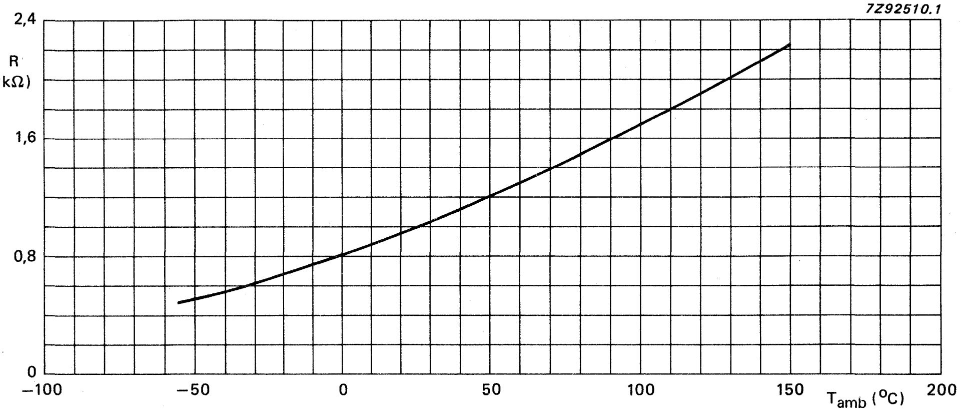


Fig. 2 Average resistance value of sensor at I_C = 1 mA as a function of temperature.

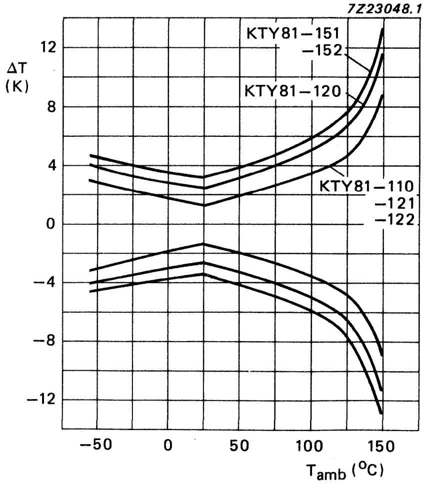


Fig. 3 Maximum expected temperature error ΔT.

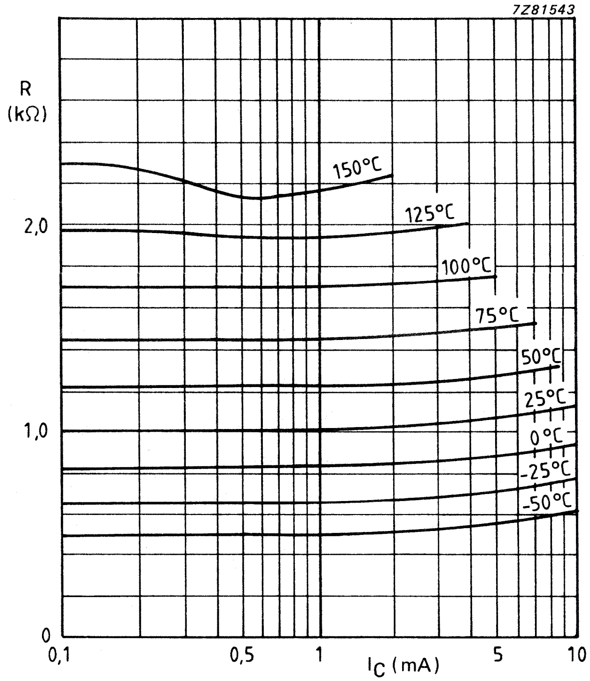


Fig. 4 Sensor resistance as a function of operating current (see Note).

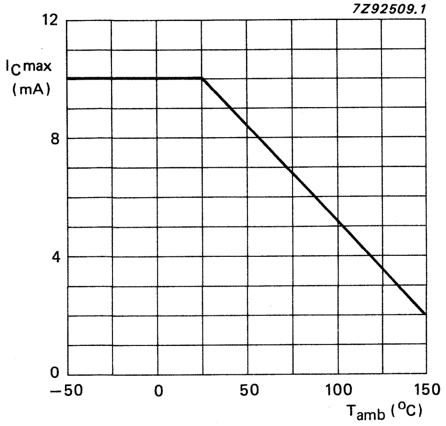


Fig. 5 Maximum operating current for safe operation.

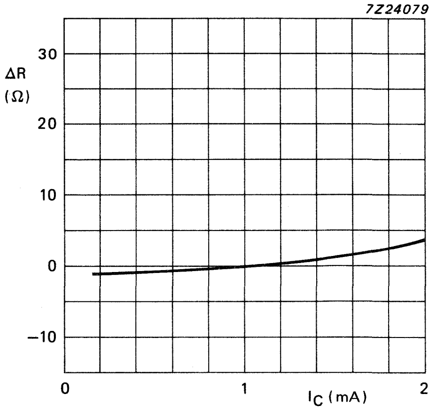


Fig. 6 Resistance deviation as a function of measuring current in still liquid; T_{amb} = 25 °C.

Note

To minimize temperature error, an operating current of I_C = 1 mA is recommended for temperatures above 100 °C.

SILICON TEMPERATURE SENSORS

These sensors have a positive temperature coefficient of resistance and are for use in measurement and control systems.

QUICK REFERENCE DATA

Resistance at T_{amb} = 25 °C I_C = 1 mA	KTY81-210	R_{25}	1980 - 2020 Ω
	KTY81-220	R_{25}	1960 - 2040 Ω
	KTY81-221	R_{25}	1960 - 2000 Ω
	KTY81-222	R_{25}	2000 - 2040 Ω
	KTY81-250	R_{25}	1900 - 2100 Ω
	KTY81-251	R_{25}	1900 - 2000 Ω
	KTY81-252	R_{25}	2000 - 2100 Ω

KTY81-220 is composed of groups –221 and –222 and is correspondingly designated.

KTY81-250 is composed of groups –251 and –252 and is correspondingly designated.

Operating ambient temperature range T_{amb} –55 to +150 °C

MECHANICAL DATA

Dimensions in mm

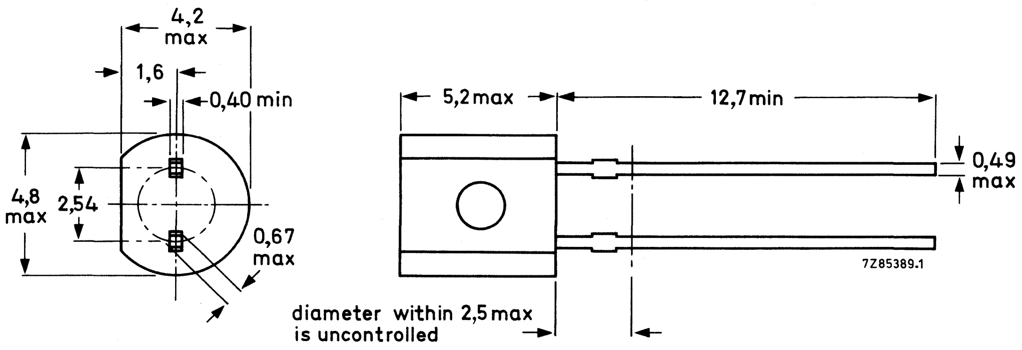


Fig. 1 SOD-70.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous sensor current in free air			
T_{amb} = 25 °C	I_C	max.	10 mA
T_{amb} = 150 °C	I_C	max.	2.0 mA

CHARACTERISTICS

(Based on the measurements in liquid at T_{amb} = 25 °C unless otherwise specified).

Resistance				
I_C = 1 mA	KTY81-210	R_{25}	1980 - 2020 Ω	
	KTY81-220	R_{25}	1960 - 2040 Ω	
	KTY81-221	R_{25}	1960 - 2000 Ω	
	KTY81-222	R_{25}	2000 - 2040 Ω	
	KTY81-250	R_{25}	1900 - 2100 Ω	
	KTY81-251	R_{25}	1900 - 2000 Ω	
	KTY81-252	R_{25}	2000 - 2100 Ω	
Temperature coefficient			typ.	0.79 %/K
Resistance ratio		R100/R25		1.696 ± 0.020
		R−55/R25		0.490 ± 0.010
Thermal time constant*				
in still air			typ.	30 s
in still liquid**			typ.	5 s
in flowing liquid			typ.	3 s
Measuring temperature range ***				−55 to +150 °C

T_{amb} °C	Resistance Ω
−55	980
−50	1030
−40	1135
−30	1247
−20	1367
−10	1495
0	1630
10	1772
20	1922
25	2000
30	2080
40	2245

T_{amb} °C	Resistance Ω
50	2417
60	2597
70	2785
80	2980
90	3182
100	3392
110	3607
120	3817
125	3915
130	4008
140	4166
150	4280

Ambient temperatures and corresponding resistance values of sensor (IC = 1 mA).

* The thermal time constant is the time the sensor needs to reach 63.2% of the total temperature difference. For instance, the time needed to reach a temperature of 72.4 °C, when a sensor with an initial temperature of 25 °C is put into an ambient with a temperature of 100 °C.

** Inert liquid FC43 of 3M company.

*** Restricted accuracy in the temperature range 125 °C to 150 °C.

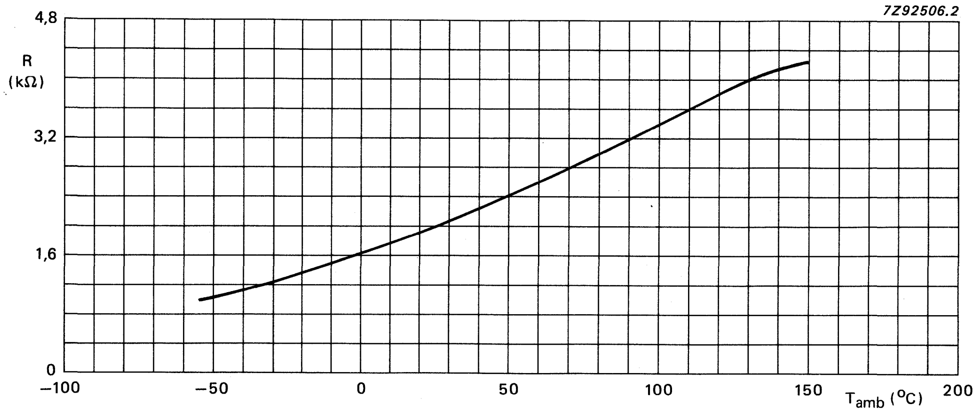


Fig. 2 Average resistance value of sensor at I_C = 1 mA as a function of temperature.

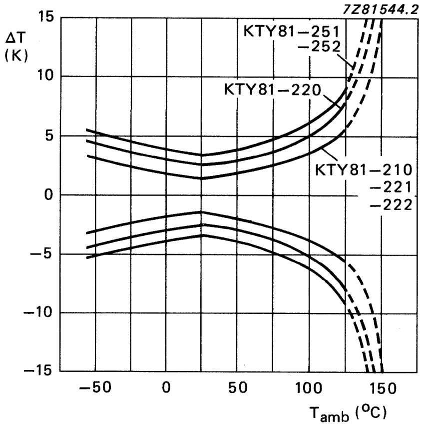


Fig. 3 Maximum expected temperature error ΔT.

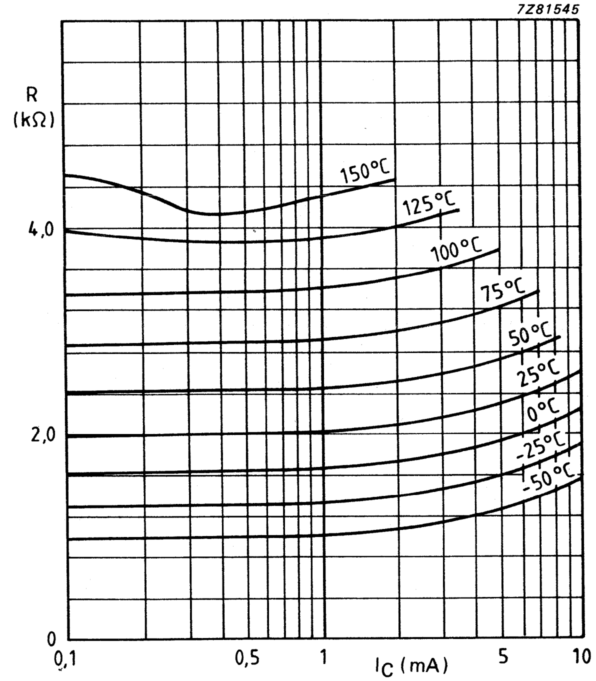


Fig. 4 Sensor resistance as a function of operating current (see Note).

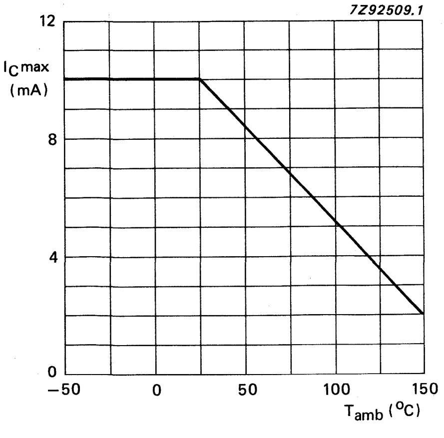


Fig. 5 Maximum operating current for safe operation.

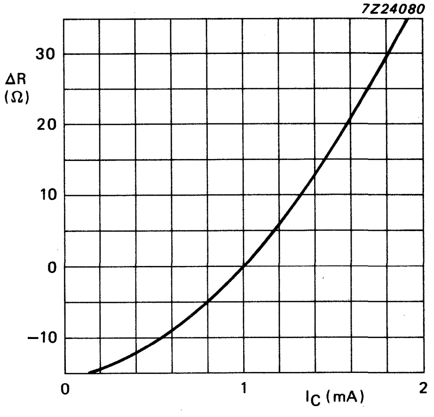


Fig. 6 Resistance deviation as a function of measuring current in still liquid; T_{amb} = 25 °C.

Note

To keep the temperature error low, an operating current of I_C = 1 mA is recommended for temperatures above 100 °C.

Silicon temperature sensors | KTY82-1 series

DESCRIPTION

These temperature sensors have a positive temperature coefficient of resistance and are for use in measurement and control systems.

PINNING

PIN	DESCRIPTION
1	electrical contact
2	electrical contact
3	substrate (must remain potential free)

Marking codes:

KTY82-110: 110.
KTY82-120: 120.
KTY82-121: 121.
KTY82-122: 122.
KTY82-150: 150.
KTY82-151: 151.
KTY82-152: 152.

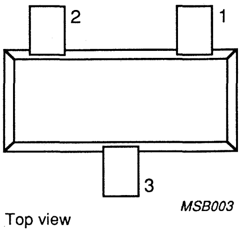


Fig.1 Simplified outline.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
R_{25}	sensor resistance	T_{amb} = 25 °C; I_{cont} = 1 mA			
	KTY82-110		990	1010	Ω
	KTY82-120		980	1020	Ω
	KTY82-121		980	1000	Ω
	KTY82-122		1000	1020	Ω
	KTY82-150		950	1050	Ω
	KTY82-151		950	1000	Ω
	KTY82-152		1000	1050	Ω
T_{amb}	ambient operating temperature range		−55	150	°C

Note

Tolerances of 0.5% or other special selections available on request.

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
I_{cont}	continuous sensor current	in free air; T_{amb} = 25 °C	–	10	mA
		in free air; T_{amb} = 150 °C	–	2	mA
T_{amb}	ambient operating temperature range		–55	150	°C

CHARACTERISTICS

T_{amb} = 25 °C, in liquid, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
R_{25}	sensor resistance	T_{amb} = 25 °C; I_{cont} = 1 mA				
	KTY82-110		990	–	1010	Ω
	KTY82-120		980	–	1020	Ω
	KTY82-121		980	–	1000	Ω
	KTY82-122		1000	–	1020	Ω
	KTY82-150		950	–	1050	Ω
	KTY82-151		950	–	1000	Ω
	KTY82-152		1000	–	1050	Ω
TC	temperature coefficient		–	0.79	–	%/K
R_{100}/R_{25}	resistance ratio	at T_{amb} = 100 °C and 25 °C	1.676	1.696	1.716	
R_{-55}/R_{25}	resistance ratio	at T_{amb} = –55 °C and 25 °C	0.480	0.490	0.500	
τ	thermal time constant (note 1)	in still air	–	7	–	s
		in still liquid (note 2)	–	1	–	s
		in flowing liquid	–	0.5	–	s
	rated temperature range		–55	–	150	°C

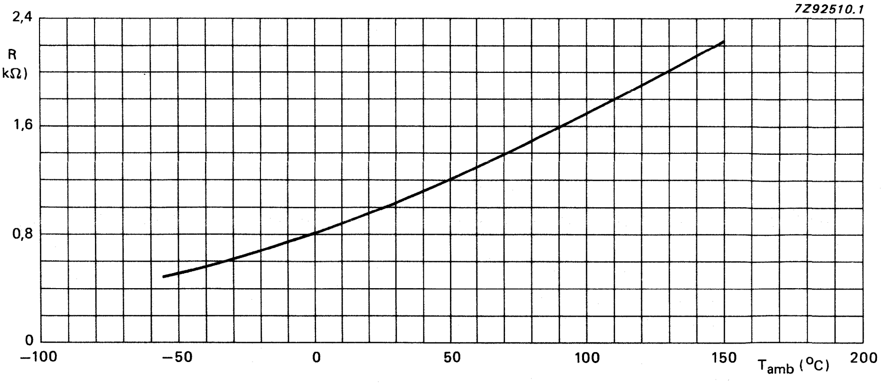
Notes

1. The thermal time constant is the time the sensor needs to reach 63.2% of the total temperature difference. For example, the time needed to reach a temperature of 72.4 °C, when a sensor with an initial temperature of 25 °C is put into an ambient with a temperature of 100 °C.
2. Inert liquid FC43 by 3M.

AMBIENT TEMPERATURES AND CORRESPONDING RESISTANCE OF SENSOR

I_{cont} = 1 mA.

AMBIENT TEMPERATURE (°C)	RESISTANCE (Ω)
−55	490
−50	515
−40	567
−30	624
−20	684
−10	747
0	815
10	886
20	961
25	1000
30	1040
40	1122
50	1209
60	1299
70	1392
80	1490
90	1591
100	1696
110	1805
120	1915
125	1969
130	2023
140	2124
150	2211



I_{cont} = 1 mA.

Fig.2 Average resistance value of sensor as a function of ambient temperature.

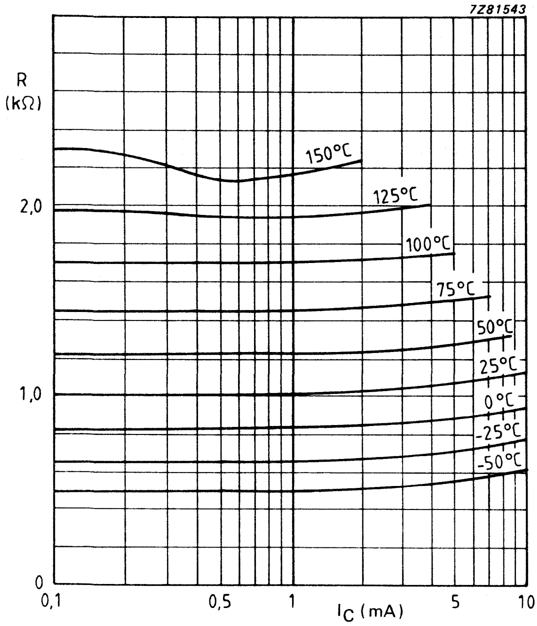


Fig.3 Sensor resistance as a function of operating current.

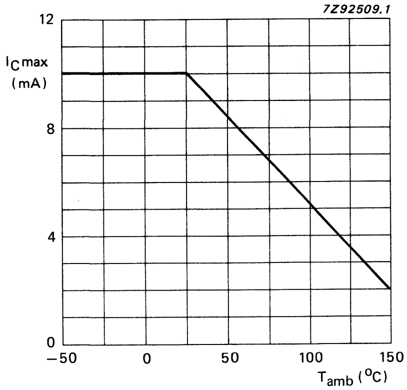
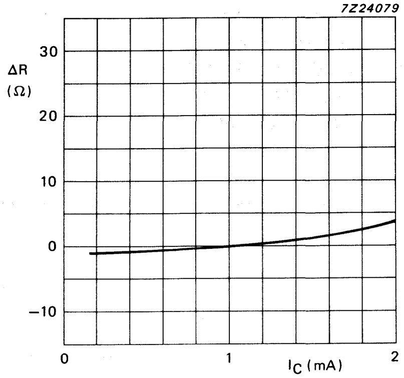


Fig.4 Maximum operating current for safe operation.



T_{amb} = 25 °C.

Fig.5 Deviation of sensor resistance as a function of operating current in still liquid.

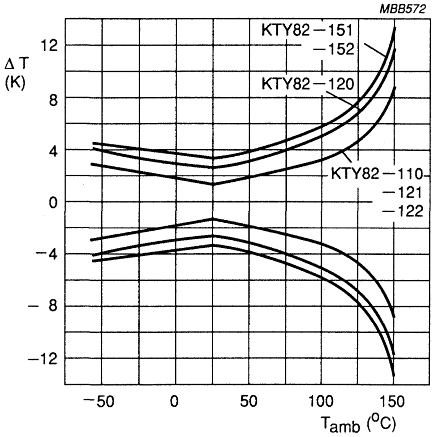


Fig.6 Maximum expected temperature error (ΔT).

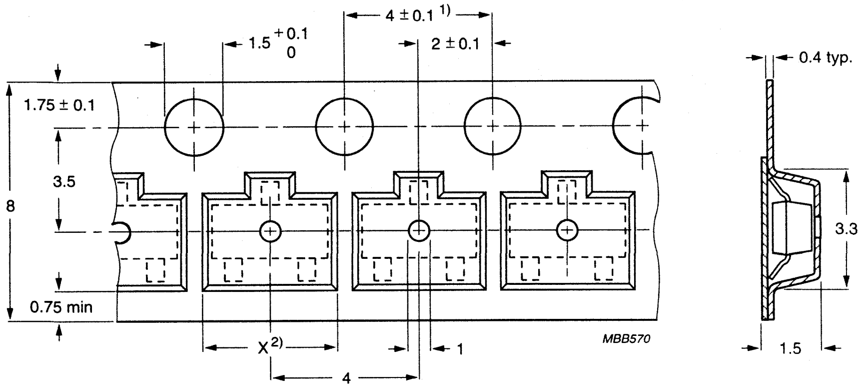
Note

To keep the temperature error low, an operating current of I_{cont} = 1 mA is recommended for temperatures above 100 °C.

PACKING DIMENSIONS

Tape specification

Sensors in SOT23 encapsulation are delivered in reel packing for automatic placement on hybrid circuits and printed circuit boards. The devices are placed with the mounting side downwards in compartments.



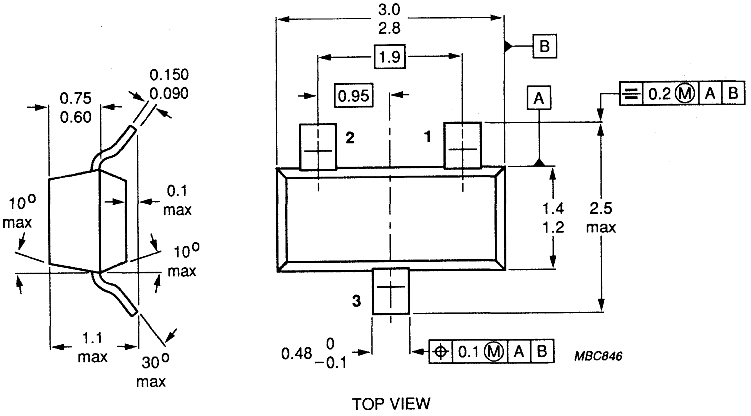
Dimensions in mm.

1) Tolerance over any 10 pitches: ±0.2 mm.

X = component length + 0.2 mm.

Fig.7 Configuration of bandolier.

PACKAGE OUTLINE



Dimensions in mm.

Weight: 0.01 g.

Fig.8 SOT23.

Silicon temperature sensors KTY82-2 series

DESCRIPTION

These temperature sensors have a positive temperature coefficient of resistance and are for use in measurement and control systems.

PINNING

PIN	DESCRIPTION
1	electrical contact
2	electrical contact
3	substrate (must remain potential free)

Marking codes:

KTY82-210: 210.
KTY82-220: 220.
KTY82-221: 221.
KTY82-222: 222.
KTY82-250: 250.
KTY82-251: 251.
KTY82-252: 252.

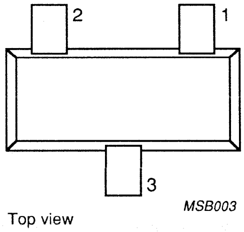


Fig.1 Simplified outline.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
R_{25}	sensor resistance	T_{amb} = 25 °C; I_{cont} = 1 mA			
	KTY82-210		1980	2020	Ω
	KTY82-220		1960	2040	Ω
	KTY82-221		1960	2000	Ω
	KTY82-222		2000	2040	Ω
	KTY82-250		1900	2100	Ω
	KTY82-251		1900	2000	Ω
	KTY82-252		2000	2100	Ω
T_{amb}	ambient operating temperature range		–55	150	°C

Note

Tolerances of 0.5% or other special selections available on request.

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
I_{cont}	continuous sensor current	in free air; T_{amb} = 25 °C	–	10	mA
		in free air; T_{amb} = 150 °C	–	2	mA
T_{amb}	ambient operating temperature range		–55	150	°C

CHARACTERISTICS

T_{amb} = 25 °C, in liquid, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
R_{25}	sensor resistance	T_{amb} = 25 °C; I_{cont} = 1 mA				
	KTY82-210		1980	–	2020	Ω
	KTY82-220		1960	–	2040	Ω
	KTY82-221		1960	–	2000	Ω
	KTY82-222		2000	–	2040	Ω
	KTY82-250		1900	–	2100	Ω
	KTY82-251		1900	–	2000	Ω
	KTY82-252		2000	–	2100	Ω
TC	temperature coefficient		–	0.79	–	%/K
R_{100}/R_{25}	resistance ratio	at T_{amb} = 100 °C and 25 °C	1.676	1.696	1.716	
R_{-55}/R_{25}	resistance ratio	at T_{amb} = –55 °C and 25 °C	0.480	0.490	0.500	
τ	thermal time constant (note 1)	in still air	–	7	–	s
		in still liquid (note 2)	–	1	–	s
		in flowing liquid	–	0.5	–	s
	rated temperature range (note 3)		–55	–	150	°C

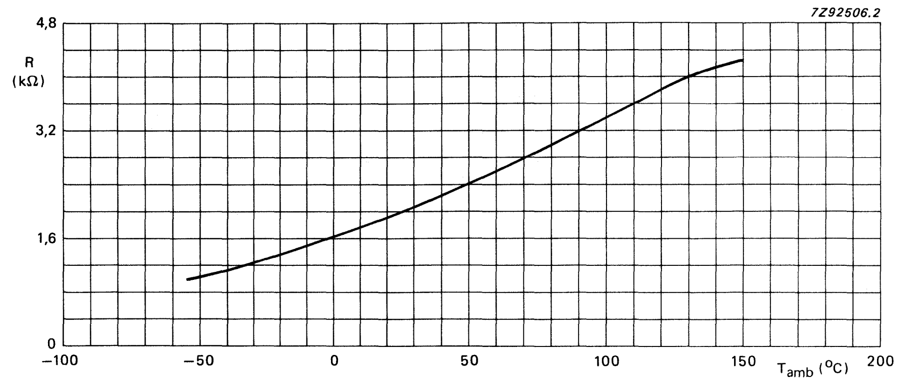
Notes

1. The thermal time constant is the time the sensor needs to reach 63.2% of the total temperature difference. For example, the time needed to reach a temperature of 72.4 °C, when a sensor with an initial temperature of 25 °C is put into an ambient with a temperature of 100 °C.
2. Inert liquid FC43 by 3M.
3. Restricted accuracy in the temperature range 125 to 150 °C.

AMBIENT TEMPERATURES AND CORRESPONDING RESISTANCE OF SENSOR

I_{cont} = 1 mA.

AMBIENT TEMPERATURE (°C)	RESISTANCE (Ω)
−55	980
−50	1030
−40	1135
−30	1247
−20	1367
−10	1495
0	1630
10	1772
20	1922
25	2000
30	2080
40	2245
50	2417
60	2597
70	2785
80	2980
90	3182
100	3392
110	3607
120	3817
125	3915
130	4008
140	4166
150	4280



I_{cont} = 1 mA.

Fig.2 Average resistance value of sensor as a function of ambient temperature.

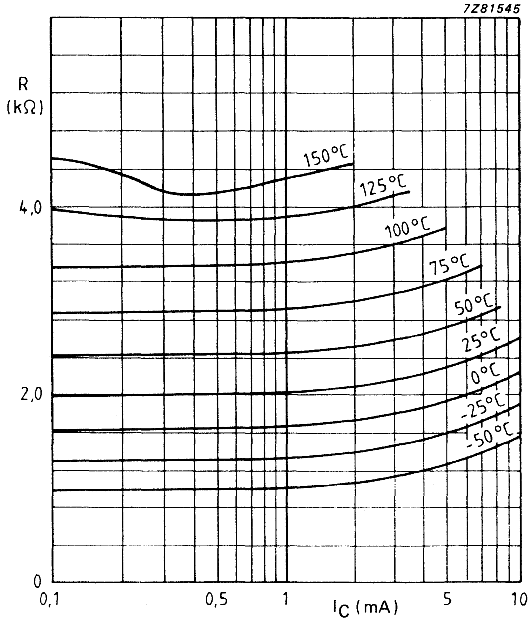


Fig.3 Sensor resistance as a function of operating current (ΔT).

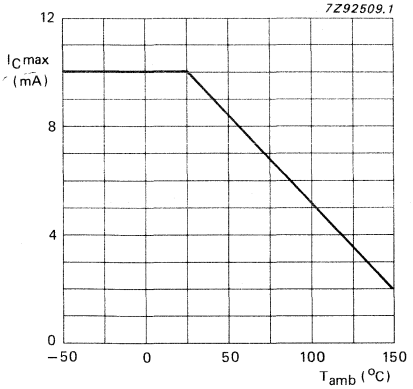
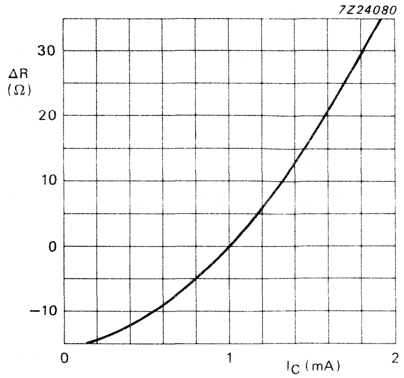


Fig.4 Maximum operating current for safe operation.



T_{amb} = 25 °C.

Fig.5 Deviation of sensor resistance as a function of operating current in still liquid.

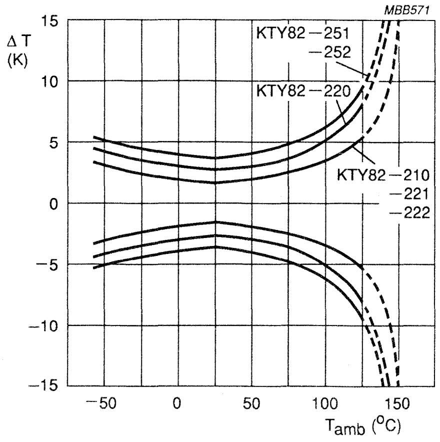


Fig.6 Maximum expected temperature error (ΔT).

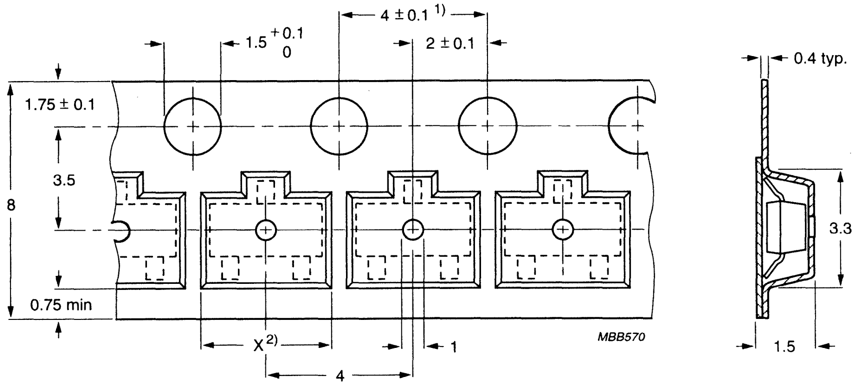
Note

To keep the temperature error low, an operating current of I_{cont} = 1 mA is recommended for temperatures above 100 °C.

PACKING DIMENSIONS

Tape specification

Sensors in SOT23 encapsulation are delivered in reel packing for automatic placement on hybrid circuits and printed circuit boards. The devices are placed with the mounting side downwards in compartments.



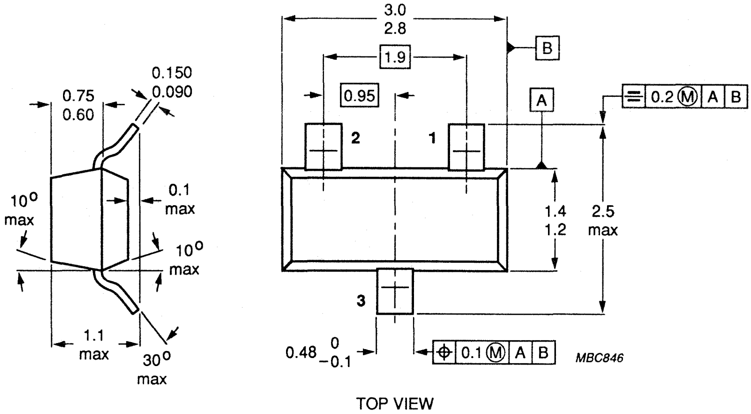
Dimensions in mm.

1) Tolerance over any 10 pitches: ±0.2 mm.

X = component length + 0.2 mm.

Fig.7 Configuration of bandolier.

PACKAGE OUTLINE



Dimensions in mm.
Weight: 0.01 g.

Fig.8 SOT23.

SILICON TEMPERATURE SENSORS

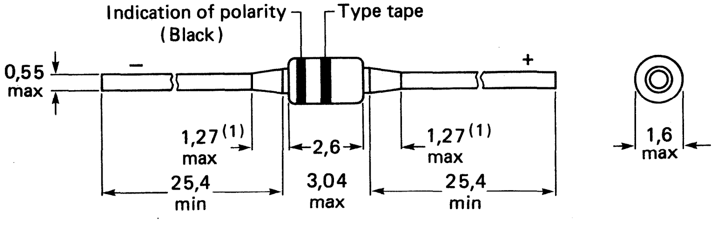
These sensors have a positive temperature coefficient of resistance and are for use in measurement and control.

QUICK REFERENCE DATA

		Type tape (identification colour)
Resistance at T_{amb} = 25 °C I_C = 1 mA	KTY83-110	R_{25} = 990 - 1010 Ω; yellow
	KTY83-120	R_{25} = 980 - 1020 Ω; white or green
	KTY83-121	R_{25} = 980 - 1000 Ω; white
	KTY83-122	R_{25} = 1000 - 1020 Ω; green
	KTY83-150	R_{25} = 950 - 1050 Ω; black or blue
	KTY83-151	R_{25} = 950 - 1000 Ω; black
	KTY83-152	R_{25} = 1000 - 1050 Ω; blue
	KTY83-120	is composed of groups −121 and −122 and is correspondingly designated.
	KTY83-150	is composed of groups −151 and −152 and is correspondingly designated.
Operating ambient temperature range T_{amb}		−55 to +175 °C

MECHANICAL DATA

Dimensions in mm



7Z83041.1B

(1) Lead diameter in this zone uncontrolled

Fig. 1 DO-34 (SOD-68).

Note

The sensor has to be operated with the lower potential at the marked connection (black type).

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous sensor current in free air			
T_{amb} = 25 °C	I_C	max.	10 mA
T_{amb} = 175 °C	I_C	max.	2.0 mA

CHARACTERISTICS

(Based on the measurements in liquid at T_{amb} = 25 °C unless otherwise specified)

Resistance		
I_C = 1 mA	KTY83-110	R_{25} = 990 - 1010 Ω
	KTY83-120	R_{25} = 980 - 1020 Ω
	KTY83-121	R_{25} = 980 - 1000 Ω
	KTY83-122	R_{25} = 1000 - 1020 Ω
	KTY83-150	R_{25} = 950 - 1050 Ω
	KTY83-151	R_{25} = 950 - 1000 Ω
	KTY83-152	R_{25} = 1000 - 1050 Ω

Temperature coefficient	typ.	0.76 %/K
Resistance ratio	R100/R25	1.67 ± 0.02
	R–55/R25	0.50 ± 0.01
Thermal time constant*		
in still air	typ.	20 s
in still liquid**	typ.	1.0 s
in flowing liquid**	typ.	0.5 s
Measuring temperature range		–55 to +175 °C

T_{amb} °C	Resistance Ω
–55	500
–50	525
–40	577
–30	632
–20	691
–10	754
0	820
10	889
20	962
25	1000
30	1039
40	1118
50	1202
60	1288
70	1379
80	1472
90	1569
100	1670
110	1774
120	1882
125	1937
130	1993
140	2107
150	2225
160	2346
170	2471
175	2535

Ambient temperatures and corresponding resistance values of sensor (I_C = 1 mA).

* The thermal time constant is the time the sensor needs to reach 63.2% of the total temperature difference. For instance, the time needed to reach a temperature of 72.4 °C, when a sensor with an initial temperature of 25 °C is put into an ambient with a temperature of 100 °C.

** Inert liquid FC43 of 3M company.

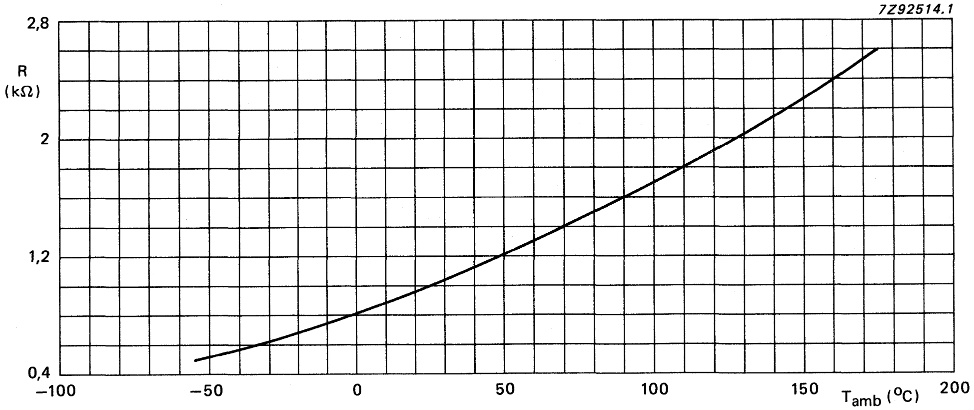


Fig. 2 Average resistance value of sensor at I_C = 1 mA as a function of temperature.

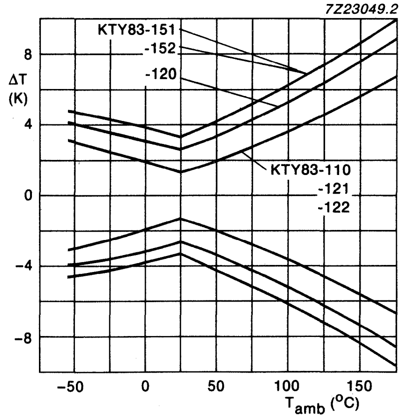


Fig. 3 Maximum expected temperature error ΔT.

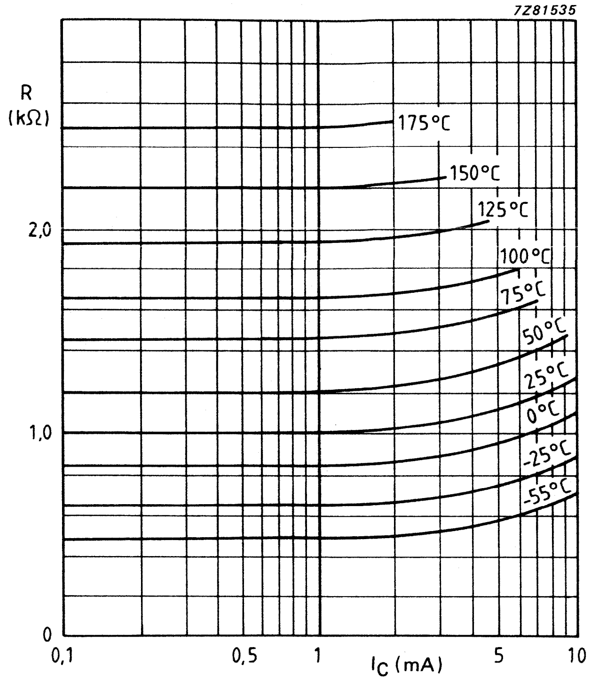


Fig. 4 Sensor resistance as a function of operating current.

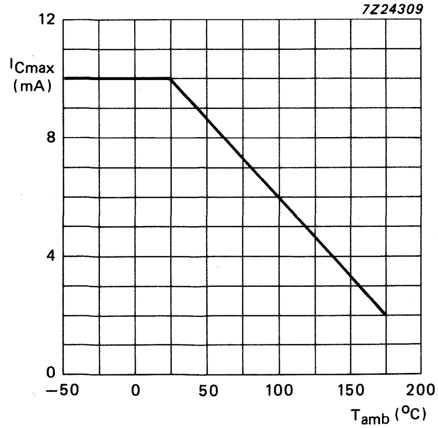


Fig. 5 Maximum operating current for safe operation.

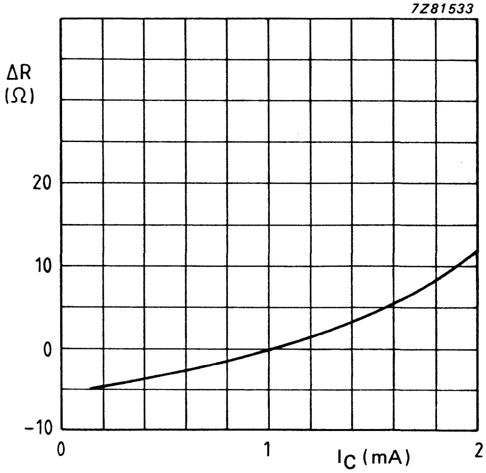


Fig. 6 Resistance deviation as a function of measuring current in still liquid; T_{amb} = 25 °C.

Silicon temperature sensors KTY84-130/150/151/152

DESCRIPTION

These temperature sensors have a positive temperature coefficient of resistance and are for use in measurement and control over a temperature range of –40 to +300 °C.

PACKAGE OUTLINE

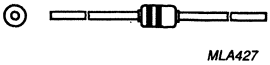


Fig.1 Simplified outline.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT	TYPE TAPE (IDENTIFICATION COLOUR)
R_{100}	resistance	T_{amb} = 100 °C; I_{cont} = 2 mA				
	KTY84-130		970	1030	Ω	yellow
	KTY84-150 (note 1)		950	1050	Ω	black or blue
	KTY84-151		950	1000	Ω	black
	KTY84-152		1000	1050	Ω	blue

Note

1. Type KTY84-150 is composed of groups –151 and –152, and is correspondingly designated.

LIMITING VALUES

In accordance with the Absolute Maximum System (IEC 134).

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
I_{cont}	continuous sensor current	in free air; T_{amb} = 25 °C; (note 1)	–	10	mA
		in free air; T_{amb} = 300 °C	–	2	mA
T_{amb}	operating temperature range		–40	300	°C
T_{stg}	storage temperature range		–55	300	°C

Note

1. For temperatures greater than 200 °C, a sensor current of I_{cont} = 2 mA must be used.

CHARACTERISTICS

T_{amb} = 100 °C, in liquid, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
R_{100}	resistance	I_{cont} = 2 mA				
	KTY84-130		970	–	1030	Ω
	KTY84-150		950	–	1050	Ω
	KTY84-151		950	–	1000	Ω
	KTY84-152		1000	–	1050	Ω
TC	temperature coefficient		–	0.62	–	%/K
R_{250}/R_{100}	resistance ratio		2.140	2.195	2.250	
R_{25}/R_{100}	resistance ratio		0.590	0.598	0.606	
τ	thermal time constant (note 1)	in still air	–	20	–	s
		in still liquid (note 2)	–	1	–	s
		in flowing liquid (note 2)	–	0.5	–	s

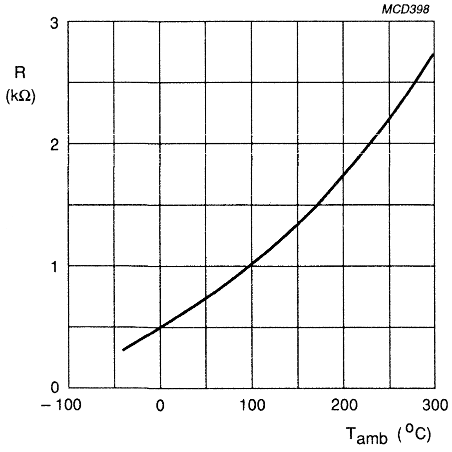
Notes

1. The thermal time constant is the time the sensor needs to reach 63.2% of the total temperature difference. For example, the time needed to reach a temperature of 72.4 °C, when a sensor with an initial temperature of 25 °C is put into an ambient with a temperature of 100 °C.
2. Inert liquid FC43 by 3M.

AMBIENT TEMPERATURES AND CORRESPONDING RESISTANCE OF SENSOR

I_{cont} = 2 mA.

AMBIENT TEMPERATURE (°C)	RESISTANCE (Ω)
–40	355
–30	386
–20	419
–10	455
0	493
10	533
20	576
25	598
30	621
40	668
50	718
60	769
70	824
80	880
90	939
100	1000
110	1063
120	1129
130	1197
140	1268
150	1340
160	1415
170	1493
180	1572
190	1654
200	1739
210	1825
220	1914
230	2006
240	2099
250	2195
260	2293
270	2392
280	2490
290	2584
300	2668



I_{cont} = 2 mA.

Fig.2 Resistance value of sensor as a function of ambient temperature.

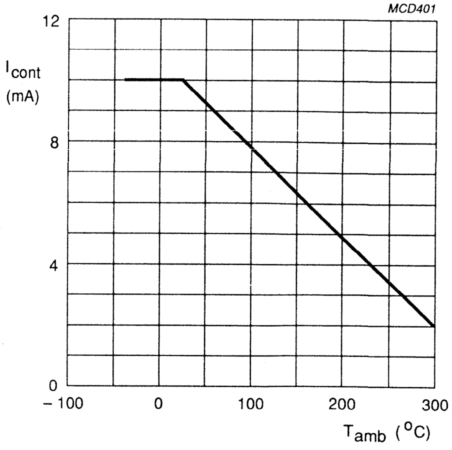
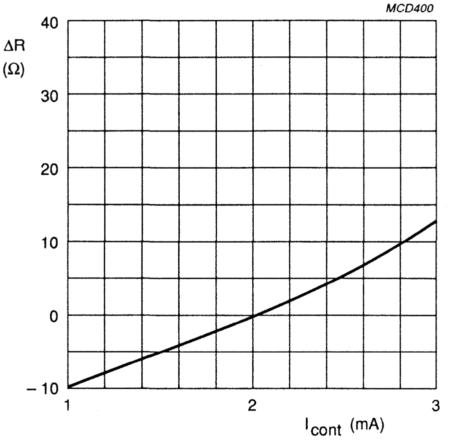


Fig.3 Maximum operating current for safe operation.



T_{amb} = 100 °C.

Fig.4 Deviation of sensor resistance as a function of operating current in still liquid.

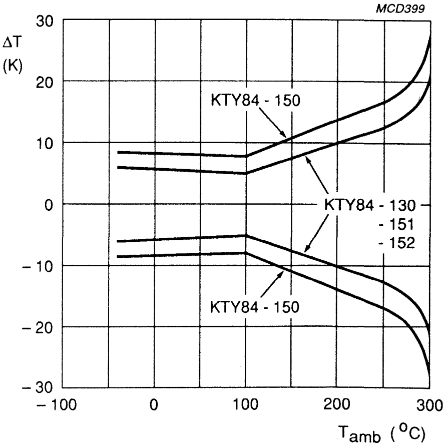
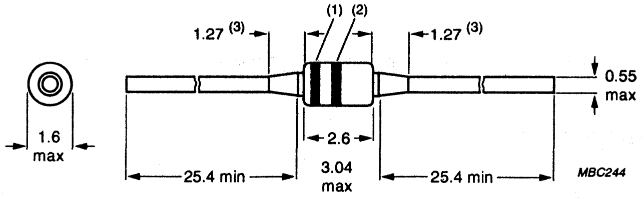


Fig.5 Maximum expected temperature error.



Dimensions in mm.

(1) Indication of polarity (green).

(2) Type tape.

(3) Lead diameter within this zone is not controlled.

Fig.6 SOD68 (DO-34).

SILICON TEMPERATURE SENSORS

These sensors have a positive temperature coefficient of resistance and are for use in measurement and control.

QUICK REFERENCE DATA

Resistance at T_{amb} = 25 °C

I_C = 1 mA

		Type tape (identification colour)
KTY85-110	R_{25} = 990 - 1010 Ω;	yellow
KTY85-120	R_{25} = 980 - 1020 Ω;	white or green
KTY85-121	R_{25} = 980 - 1000 Ω;	white
KTY85-122	R_{25} = 1000 - 1020 Ω;	green
KTY85-150	R_{25} = 950 - 1050 Ω;	black or blue
KTY85-151	R_{25} = 950 - 1000 Ω;	black
KTY85-152	R_{25} = 1000 - 1050 Ω;	blue

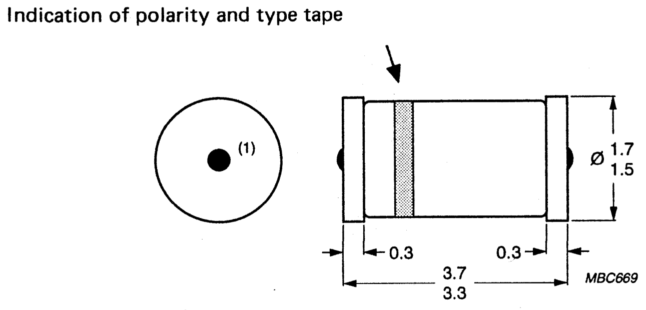
KTY85-120 is composed of groups −121 and −122, and is correspondingly designated.

KTY85-150 is composed of groups −151 and −152, and is correspondingly designated.

Operating ambient temperature range T_{amb} −40 to +125 °C

MECHANICAL DATA

Dimensions in mm



(1) Area not tinned; small elevations are possible.
Fig. 1 SOD-80.

Note

The sensor has to be operated with the lower potential at the marked connection.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous sensor current in free air

T_{amb} = 25 °C	I_C	max.	10	mA
T_{amb} = 125 °C	I_C	max.	2.0	mA

CHARACTERISTICS

(Based on the measurements in liquid at T_{amb} = 25 °C unless otherwise specified)

Resistance

I_C = 1 mA	KTY85-110	R_{25} = 990 - 1010 Ω
	KTY85-120	R_{25} = 980 - 1020 Ω
	KTY85-121	R_{25} = 980 - 1000 Ω
	KTY85-122	R_{25} = 1000 - 1020 Ω
	KTY85-150	R_{25} = 950 - 1050 Ω
	KTY85-151	R_{25} = 950 - 1000 Ω
	KTY85-152	R_{25} = 1000 - 1050 Ω

Temperature coefficient	typ.	0.76	%/K
Resistance ratio	R100/R25	1.670 ± 0.020	
	R−40/R25	0.577 ± 0.008	
Thermal time constant*			
in still air	typ.	20	s
in still liquid**	typ.	1.0	s
in flowing liquid**	typ.	0.5	s
Measuring temperature range		−40 to +125	°C

---

* The thermal time constant is the time the sensor needs to reach 63.2% of the total temperature difference. For instance, the time needed to reach a temperature of 72.4 °C, when a sensor with an initial temperature of 25 °C is put into an ambient with a temperature of 100 °C.

** Inert liquid FC43 of 3M company.

T_{amb} °C	Resistance Ω
−40	577
−30	632
−20	691
−10	754
0	820
10	889
20	962
25	1000
30	1039
40	1118
50	1202
60	1288
70	1379
80	1472
90	1569
100	1670
110	1774
120	1882
125	1937

Ambient temperatures and corresponding resistance values of sensor (I_C = 1mA).

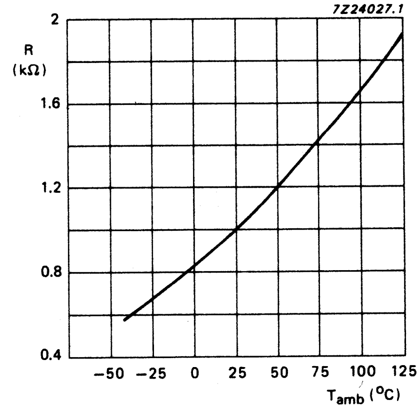


Fig. 2 Average resistance value of sensor at I_C = 1 mA as a function of ambient temperature.

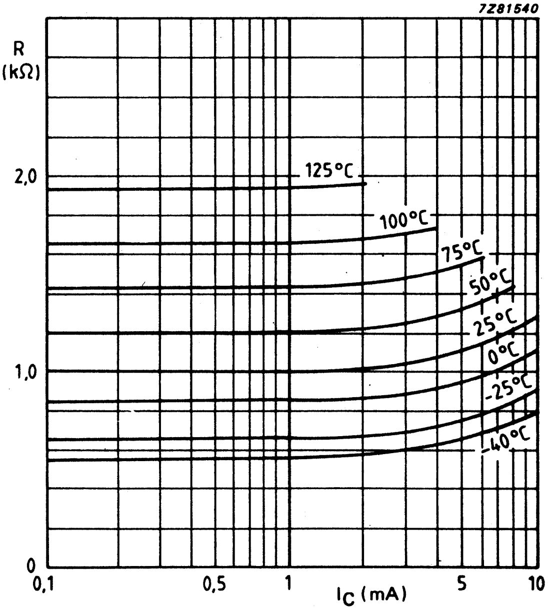


Fig. 3 Sensor resistance as a function of operating current.

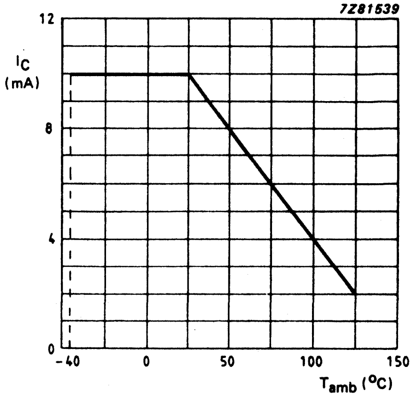


Fig. 4 Maximum operating current for safe operation.

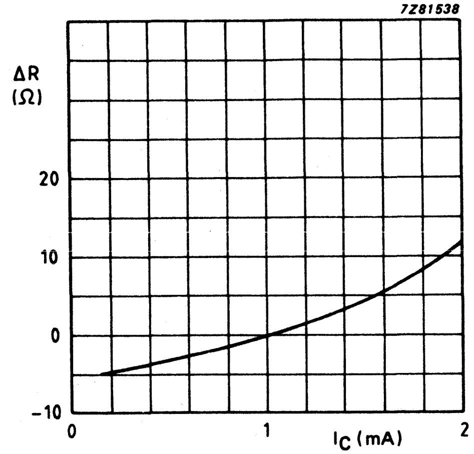


Fig. 5 Deviation of sensor resistance R as a function of operating current I_C in still liquid; T_{amb} = 25 °C.

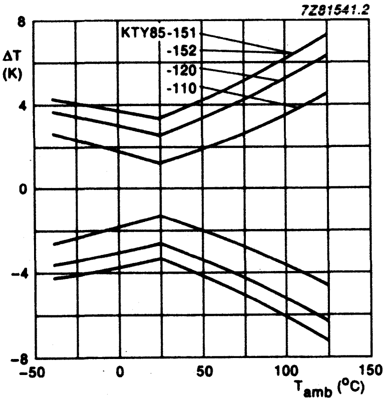


Fig. 6 Maximum expected temperature error ΔT.

SILICON TEMPERATURE SENSORS

These sensors are high accuracy temperature sensors with a positive temperature coefficient of resistance. Each sensor consists of a pair of 1000 Ω sensors in series and its main application fields are the measurement and control of temperature.

QUICK REFERENCE DATA

Resistance at T_{amb} = 25 °C I_C = 0.1 mA	KTY86-205	R_{25}	2000 ± 10 Ω
Operating ambient temperature range		T_{amb}	−40 to + 150 °C

MECHANICAL DATA

Dimensions in mm

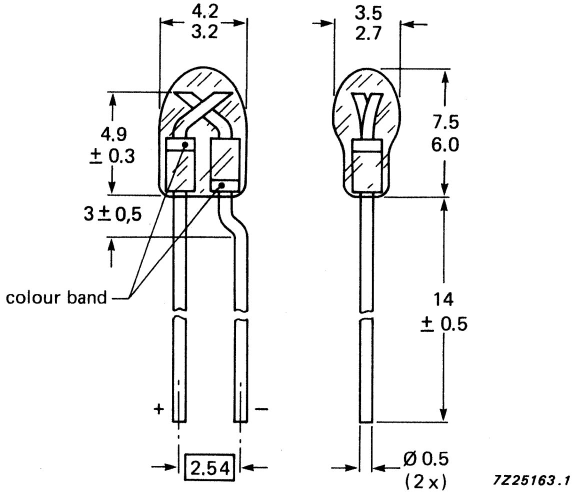


Fig.1 SOD103; colour band is white.

Note

The sensor has to be operated with the lower potential at the bent lead.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous sensor current in free air			
T_{amb} = 25 °C	I_C	max.	10 mA
T_{amb} = 150 °C	I_C	max.	2.0 mA

CHARACTERISTICS

(Based on the measurements in liquid at T_{amb} = 25 °C; I_C = 0.1 mA unless otherwise specified).

Resistance	KTY86-205	R_{25} =	2000 ± 10 Ω
Resistance ratio			
$R_{100\,°C}/R_{25\,°C}$			1.672 ± 0.020
$R_{-40\,°C}/R_{25\,°C}$			0.577 ± 0.008
Temperature coefficient		α_{-40}	0.93 %/K
		α_{25}	0.76 %/K
		α_{100}	0.61 %/K
Thermal time constant*			
in still air		typ.	30 s
in still liquid**		typ.	2.2 s
in flowing liquid**		typ.	1.7 s
Measuring temperature range			−40 to +150 °C

---

* The thermal time constant is the time the sensor needs to reach 63.2% of the total temperature difference, for instance, the time needed to reach a temperature of 72.4 °C, when a sensor with an initial temperature of 25 °C is put into an ambient with a temperature of 100 °C.

** Inert liquid FC43 of 3M company.

T_{amb} °C	Resistance Ω
–40	1154
–30	1265
–20	1383
–10	1508
0	1640
10	1779
20	1924
25	2000
30	2077
40	2237
50	2404
60	2578
70	2759
80	2947
90	3142
100	3344
110	3553
120	3769
130	3992
140	4222
150	4459

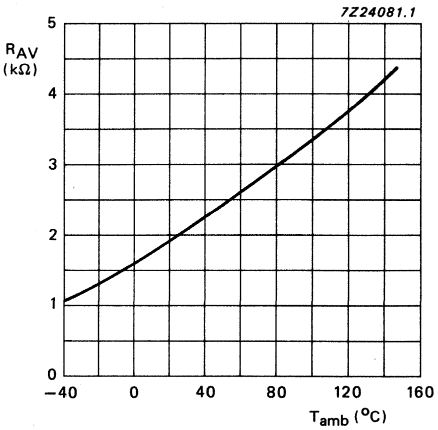


Fig. 2 Average resistance value of sensor at $I_C = 0.1$ mA as a function of ambient temperature.

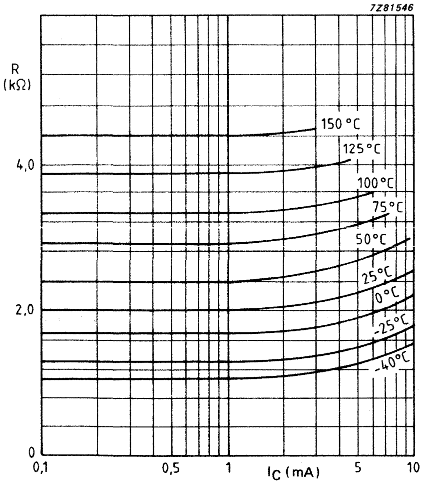


Fig. 3 Sensor resistance as a function of operating current.

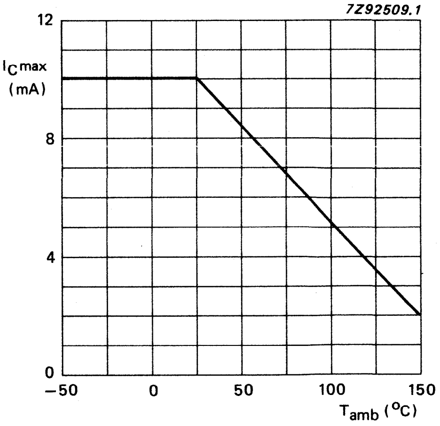


Fig. 4 Maximum operating current for safe operation.

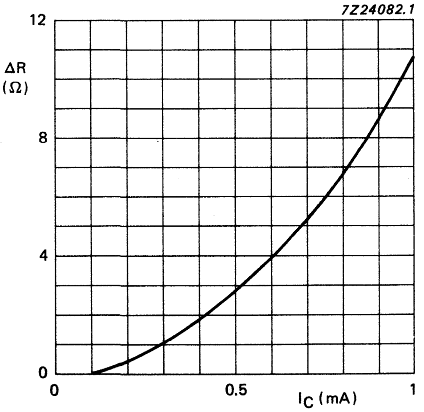


Fig. 5 Deviation of sensor resistance R as a function of operating current I_C in still liquid; T_{amb} = 25 °C.

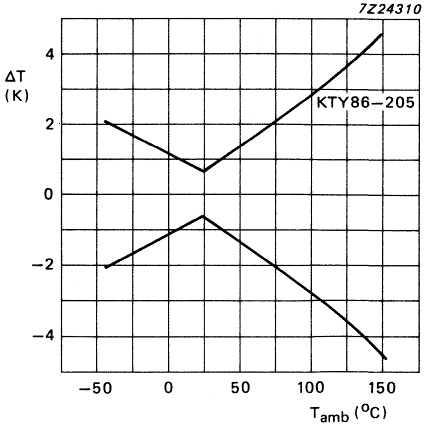


Fig. 6 Maximum expected temperature error ΔT.

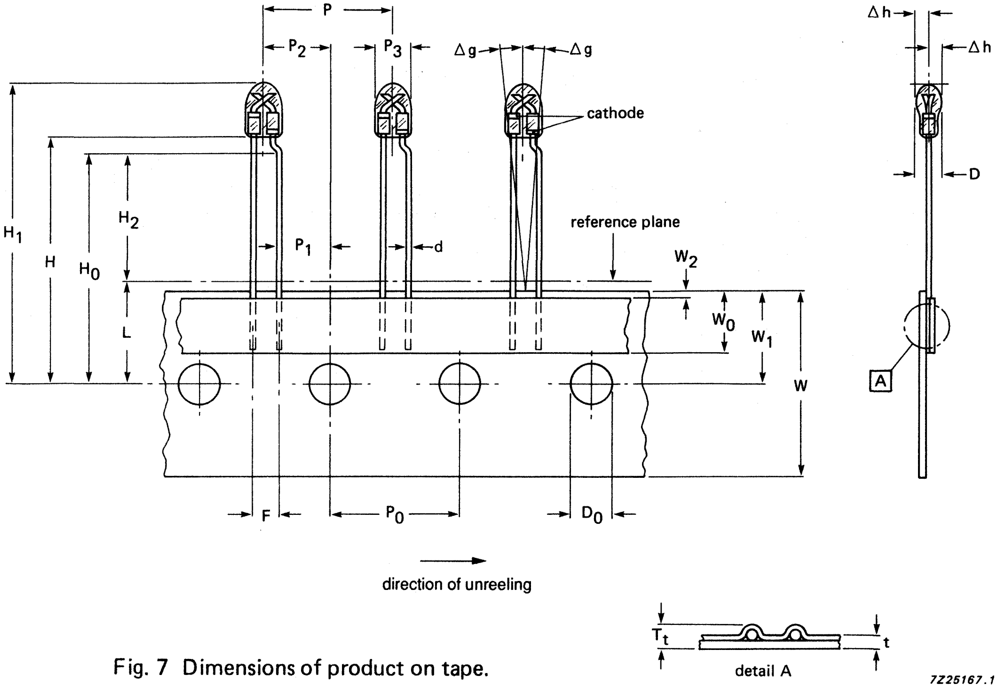


Fig. 7 Dimensions of product on tape.

Table 1 Dimensions of product on tape

symbol	dimensions
D	2.7 - 3.5
D_0	4.0 ± 0.2
d	0.48 - 0.55
F	2.54 + 0.4/−0.1
Δg	$0 + 5^{o}$
H	24.5 max.
H_0	22.0 max.
H_1	32.0 max.
H_2	12.0 max.
Δh	± 2.0
L	10.0 max.

symbol	dimensions
P	12.7 ± 1.0
P_0	12.7 ± 0.3
P_1	5.09 ± 0.7
P_2	5.95 ± 1.0
P_3	3.2 - 4.2
Tt	1.5 max.
t	0.7 ± 0.2
W	18.0 ± 1.0/−0.5
W_0	6.0 min.
W_1	9.0 ± 0.5
W_2	0 - 1.5

SILICON TEMPERATURE SENSORS

The KTY87 are high precision temperature sensors with a positive temperature coefficient of resistance for temperature measuring and temperature control. In the temperature range 10 °C to 110 °C the measuring accuracy is better than ± 1 °C.

QUICK REFERENCE DATA

Resistance at $I_C = 0.1$ mA	
$T_{amb} = 25$ °C	$R_{25} = 2000 \pm 10$ Ω
$T_{amb} = 100$ °C	$R100 = 3344 \pm 17$ Ω
Operating temperature range	−40 to + 125 °C

MECHANICAL DATA

Dimensions in mm

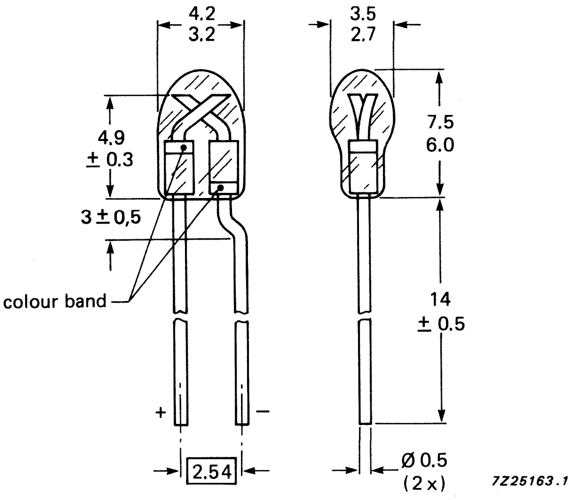


Fig.1 SOD103; colour band is green.

Notes

1. The sensor has to be operated with the lower potential at the bent lead.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

Continuous sensor current in free air

T_{amb} = 25 °C	I_C	max.	10 mA
T_{amb} = 125 °C	I_C	max.	2.0 mA

CHARACTERISTICS

(Based on the measurements in liquid at T_{amb} = 25 °C; I_C = 0.1 mA unless otherwise specified)

Resistance	R25	=	2000 ± 10 Ω
T_{amb} = 100 °C	R100	=	3344 ± 17 Ω
Temperature coefficient	at −40 °C	=	0.93 %/K
	at 25 °C	=	0.75 %/K
	at 100 °C	=	0.61 %/K
Resistance ratio	R−40/R25	=	0.577 ± 0.008
Thermal time constant*			
in still air		typ.	30 s
in still liquid**		typ.	2.2 s
in flowing liquid**		typ.	1.7 s
Operating temperature range			−40 to + 125 °C

---

* The thermal time constant is the time the sensor needs to reach 63.2% of the total temperature difference. For instance, the time needed to reach a temperature of 72.4 °C, when a sensor with an initial temperature of 25 °C is put into an ambient with a temperature of 100 °C.

** Inert liquid FC43 of 3M company.

T_{amb} °C	Resistance Ω
−40	1154
−30	1265
−20	1383
−10	1508
0	1640
10	1779
20	1924
25	2000
30	2077
40	2237
50	2404
60	2578
70	2759
80	2947
90	3142
100	3344
110	3553
120	3769
125	3880

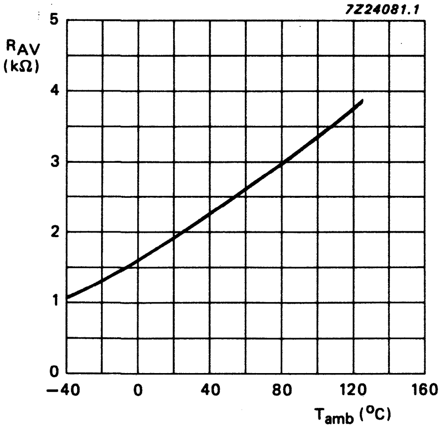


Fig. 2 Average resistance value of sensor at I_C = 0.1 mA as a function of ambient temperature.

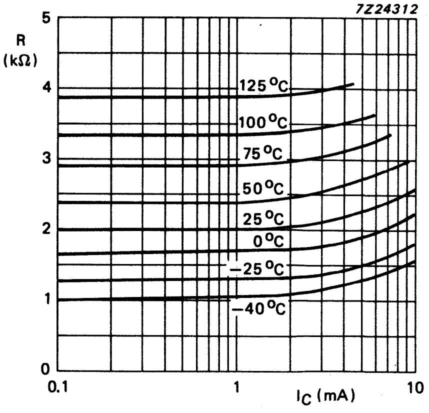


Fig. 3 Sensor resistance as a function of operating current.

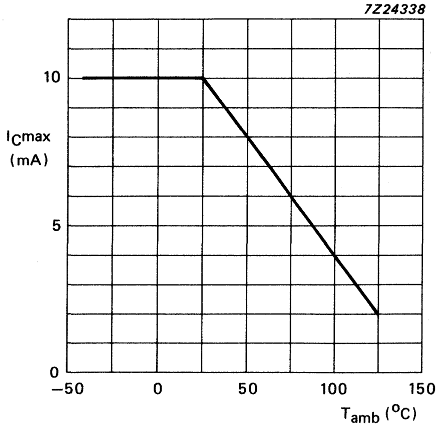


Fig. 4 Maximum operating current for safe operation.

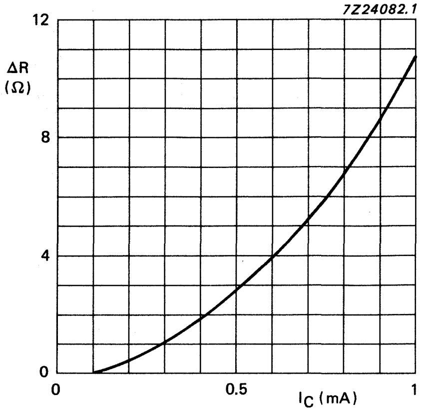


Fig. 5 Deviation of sensor resistance R versus operating current I_C in still liquid.

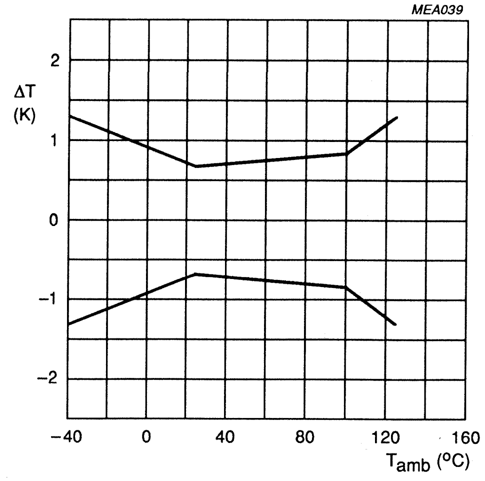


Fig. 6 Maximum temperature error ΔT.

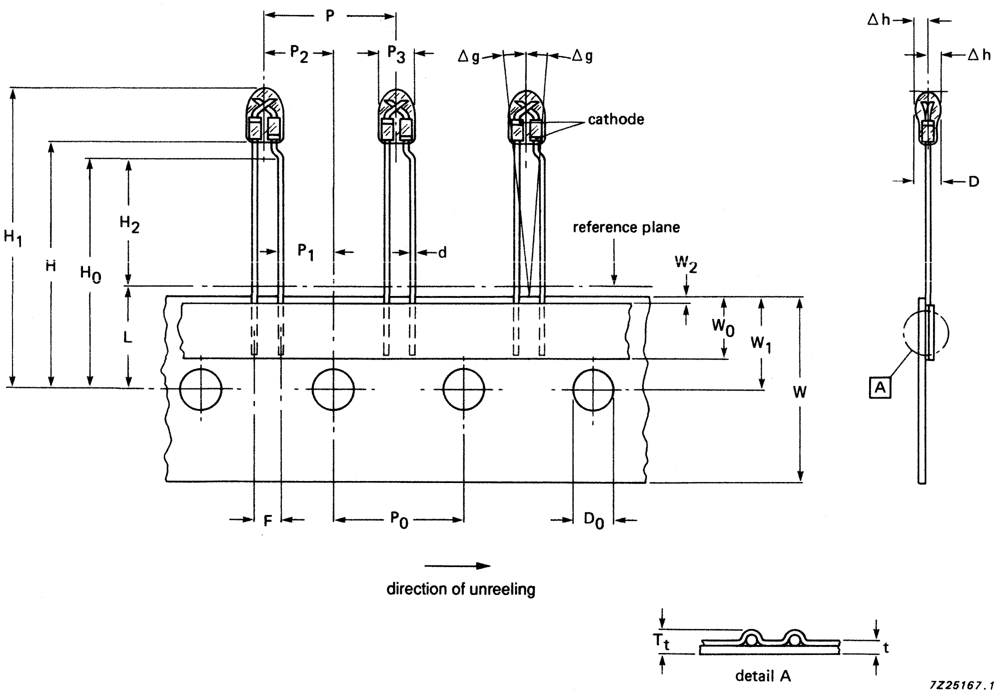


Table 1 Dimensions of product on tape

symbol	dimensions
D	2.7 – 3.5
D_0	4.0 ±0.2
d	0.48 – 0.55
F	2.54 +0.4/–0.1
Δg	0 +5°
H	24.5 max.
H_0	22.0 max.
H_1	32.0 max.
H_2	12.0 max.
Δh	±2.0
L	10.0 max
P	12.7 ±1.0
P_0	12.7 ±0.3
P_1	5.09 ±0.7
P_2	5.95 ±1.0
P_3	3.2 – 4.2
T_t	1.5 max
t	0.7 ±0.2
W	18.0 + 1.0/–0.5
W_0	6.0 min
W_1	9.0 ±0.5
W_2	0 – 1.5

Fig. 7 Dimensions of product on tape.

DEVICE DATA -
HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

Hybrid integrated circuits

Type number survey

Hybrid integrated circuits for inductive proximity detectors

Stud type	OM type	L x W mm (max)	V_S V	I_o mA	false polarity protection	short circuit/ overload protection	R_x		LED connection
							discrete	integrated	
M5	2860 2870	21.5 x 3	4.7 - 30	250	supply with spikes protect.	transient protection	yes	no	no
M8	386B 387B (note 3)	43.6 x 5	10 - 30	250	supply/ load	yes	yes	yes	yes
	386M 387M (note 3)	22.5 x 5 (note 2)	10 - 30	250	supply/ load	yes	yes	yes	yes
M12	388B 389B (note 3)	26.5 x 5	10 - 30	250	supply/ load	yes	yes	yes	yes
M12	390 (note 3)	14.2 x 14.2	10 - 30	250	supply/ load	yes	yes	yes	yes

Notes

1. Depending upon supply voltage
2. After assembly
3. The 300-series provide the possibility of directly connecting a LED for function control, without additional power dissipation.

HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

Hybrid integrated circuits intended for inductive proximity detectors in tubular construction, especially the M8 hollow stud. The OM386B is for positive supply voltage and the OM387B is for negative supply voltage. The circuit consists of a voltage regulator, an oscillator, a rectifier stage, a Schmitt trigger, an output stage and a protection circuit.

The circuit performs a make function: when actuated the current flows through the load, which can be e.g. the coil of an electromagnetic relay, a LED or a photocoupler.

Features:

- protection against short-circuit and overload
- protection of output transistor against transients by a voltage regulator diode
- protection against false polarity of the three connection leads
- choice between two methods to adjust the operating (switching) distance i.e. trimming a resistor integrated on the substrate or mounting a resistor
- possibility of connecting a LED for function control

The devices are thin-film circuits deposited on ceramic substrates. They may be potted, together with the oscillator coil, in a non-magnetic tube.

QUICK REFERENCE DATA

D.C. supply voltage range	V_B		10 to 30	V
Output current at V_B = 10 to 30 V	I_o	max.	250	mA
Operating (switching) distance (depends on R_x value and oscillator coil)	S		1 to 5	mm
Differential travel (hysteresis in switching distance)	H		3 to 10	%
Operating (switching) frequency	f	$<$	5	kHz
Operating substrate temperature range*	T_s		−40 to +85	°C
Substrate length	L		43,4 ±0,2	mm
Substrate width	W		4,8 ±0,2	mm
Height of circuit including substrate	h	max.	1,7	mm

MECHANICAL DATA

Dimensions in mm

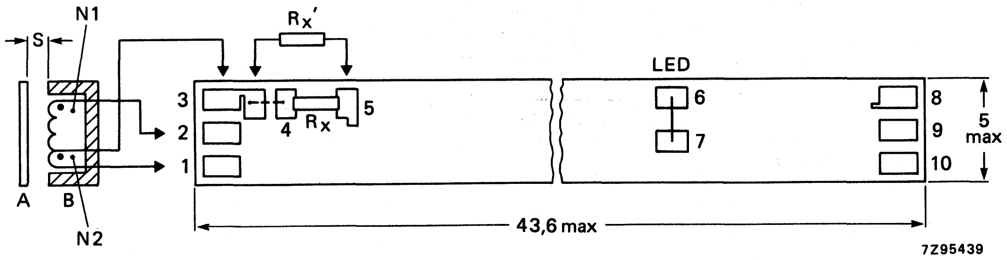
Fig. 1 (see next page).

---

* The tube, potting and connection materials are the main limiting factors for the operating temperature range of a completely assembled proximity detector.

MECHANICAL DATA (outline and connections) Dimensions in mm

Fig. 1.



A = metal actuator; B = open potcore or potcore half with coil.

Mechanical outline and connections: note that the supply polarities to points 8 and 10 are given for the OM386B; for the OM387B the polarities are point 8: $-V_B$, and point 10: $+V_B$.

S is the operating distance.

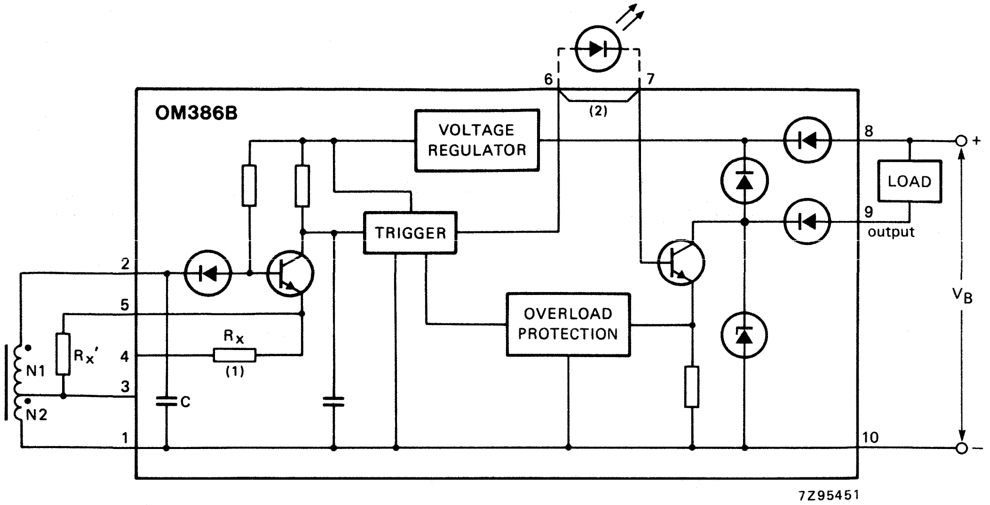


Fig. 2 Circuit diagram of OM386B.

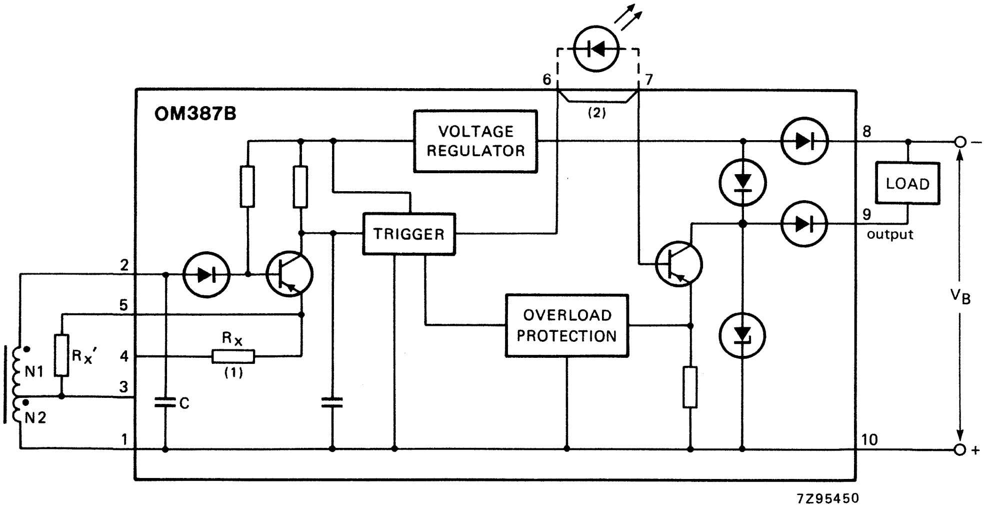


Fig. 3 Circuit diagram of OM387B.

(1) R_X is integrated on the substrate and suitable for trimming (laser or sandblasting). To use integrated resistance R_X it is necessary to connect point 3 to 4.

(2) If a LED is to be connected, the jumper between points 6 and 7 should be removed.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

D.C. supply voltage	V_B	max.	30	V
Output current	I_o	max.	250	mA
Storage temperature	T_{stg}		−40 to +125	°C
Operating substrate temperature	T_s		−40 to +85	°C

CHARACTERISTICS

Conditions (unless otherwise specified)

D.C. supply voltage	V_B	24	V
External resistor (R_X) and oscillator coil Device embedded in brass tube	see operating distance table below		
Substrate temperature	T_s	25	°C

Performances

Supply current				
output stage "ON"	I_B	typ.	8,4	mA
output stage "OFF"		typ.	4,8	mA
Voltage drop				
I_o = 250 mA	V_d	max.	1,9	V
I_o = 10 mA		max.	1,0	V

Operating (switching) distance*

type	oscillator coil number of turns		average operating distance S in mm at R_X (Ω)			recommended potcore	oscillator frequency kHz
	N1	N2	200	250	300		
M8	32	16	1	1,5	–	ϕ 5,8 mm (Neosid)	800
M12	40	10	2	3	–	P9 Philips**	600
M18	46	4	3	4	5	P14 Philips**	600

Differential travel (in % of S)	H		3 to 10	%
Operating frequency (according to EN 50010)	f	<	5	kHz

---

* The operating distance S depends on the oscillator coil, the material of the metal actuator and R_X. For measuring purposes a square steel sheet (St 37) with dimensions such that a circle with the diameter of the core can be inscribed, and 1 mm thickness can be used. R_X must not be chosen outside the range of 200 to 300 Ω.

** Grade 3B7/3H1.

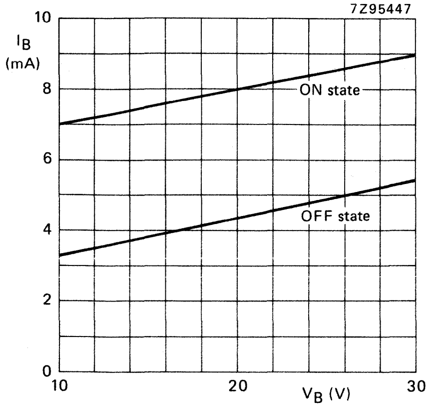


Fig. 4 Supply current as a function of supply voltage; T_S = 25 °C.

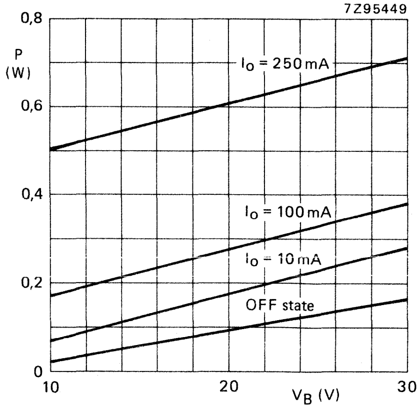


Fig. 5 Power dissipation as a function of supply voltage.

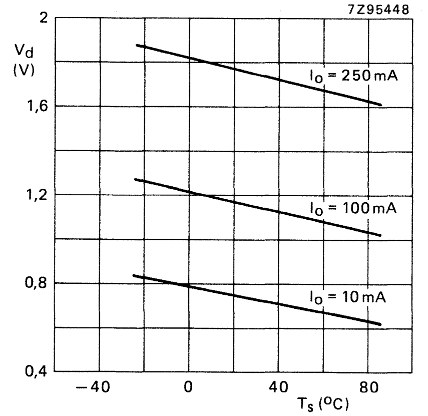


Fig. 6 Voltage drop as a function of substrate temperature.

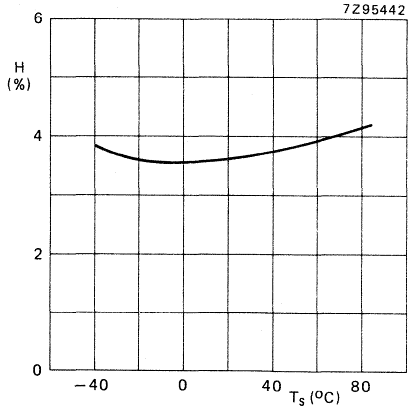
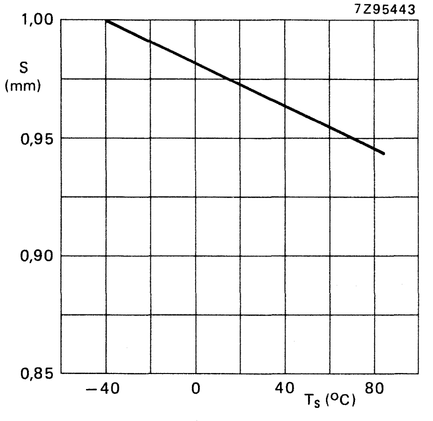


Fig. 7 Hysteresis as a function of substrate temperature.



Conditions relating to Figs 7 and 8:
potcore ϕ 5,8 mm Neosid
osc. coil N1 = 32, N2 = 16 turns
R_X = 200 Ω.

Fig. 8 Operating distance as a function of substrate temperature.

MOUNTING RECOMMENDATIONS

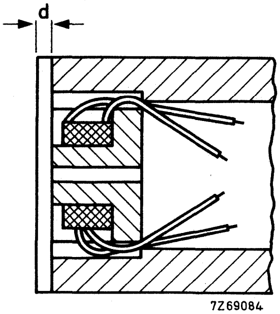


Fig. 9 Insertion of potcore in brass tube.

If a protective cap is incorporated, it should be as thin as possible, because its thickness d forms part of the operating distance S.
A brass stud wall should not extend beyond the potcore.
The exact value of S with its spread is determined by a number of variables, e.g.
- value of the adjustment resistor R_X
- the oscillator coil
- the metal of the actuator
- the material and shape of the housing.

Soldering recommendations

Use normal 60/40 solder; use a soldering iron with a fine point; soldering time as short as possible and it should not exceed 2,5 s per soldering point (T_{sld} = max. 250 °C).
The substrate is preferably preheated to a temperature of 100 °C with a minimum of 80 °C and a maximum of 125 °C.

Potting recommendations

First cover the hybrid IC with about 0,5 mm of silicone rubber, let it harden and with the parts inserted in the tube, fill up the tube with an epoxy.

HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

Hybrid integrated circuits intended for inductive proximity detectors in tubular construction, especially the M8 hollow stud. The OM386M is for positive supply voltage and the OM387M is for negative supply voltage. The circuit consists of a voltage regulator, an oscillator, a rectifier stage, a Schmitt trigger, an output stage and a protection circuit.

The circuit performs a make function: when actuated the current flows through the load, which can be e.g. the coil of an electromagnetic relay, a LED or a photocoupler.

Compared to the types OM386B/OM387B the substrate length is drastically reduced.

Features:

- extra-small dimensions
- protection against short-circuit and overload
- protection of output transistor against transients by a voltage regulator diode
- protection against false polarity of the three connection leads
- choice between two methods to adjust the operating (switching) distance i.e. trimming a resistor integrated on the substrate or mounting a resistor
- possibility of connecting a LED for function control

The devices are thin-film circuits deposited on ceramic substrates. They may be potted, together with the oscillator coil, in a non-magnetic tube.

QUICK REFERENCE DATA

D.C. supply voltage range	V_B		10 to 30	V
Output current at V_B = 10 to 30 V	I_o	max.	200	mA
Operating (switching) distance (depends on R_x value and oscillator coil)	S		1 to 5	mm
Differential travel (hysteresis in switching distance)	H		3 to 10	%
Operating (switching) frequency	f	$<$	5	kHz
Operating substrate temperature range*	T_s		−40 to +85	°C
Substrate length after assembly	L		22,3 ±0,2	mm
Substrate width	W		4,8 ±0,2	mm
Thickness of assembled hybrid (two parts glued together back to back)	h	max.	3,8	mm

MECHANICAL DATA

Dimensions in mm

Fig. 1 (see next page).

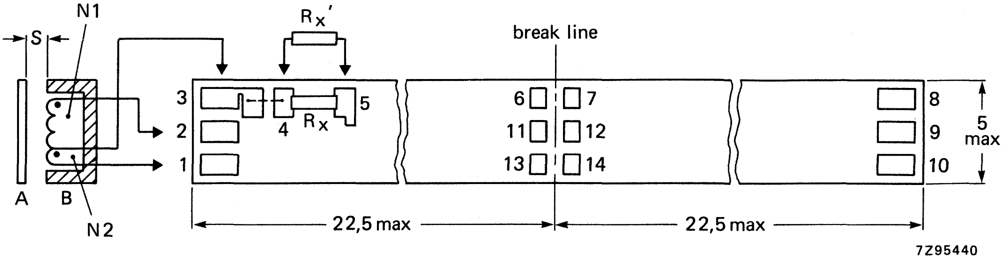
---

* The tube, potting and connection materials are the main limiting factors for the operating temperature range of a completely assembled proximity detector.

MECHANICAL DATA (outline and connections)

Dimensions in mm

Fig. 1.



A = metal actuator; B = open potcore or potcore half with coil.

Mechanical outline and connections: note that the supply polarities to points 8 and 10 are given for the OM386M; for the OM387M the polarities are point 8: $-V_B$, and point 10: $+V_B$.

S is the operating distance.

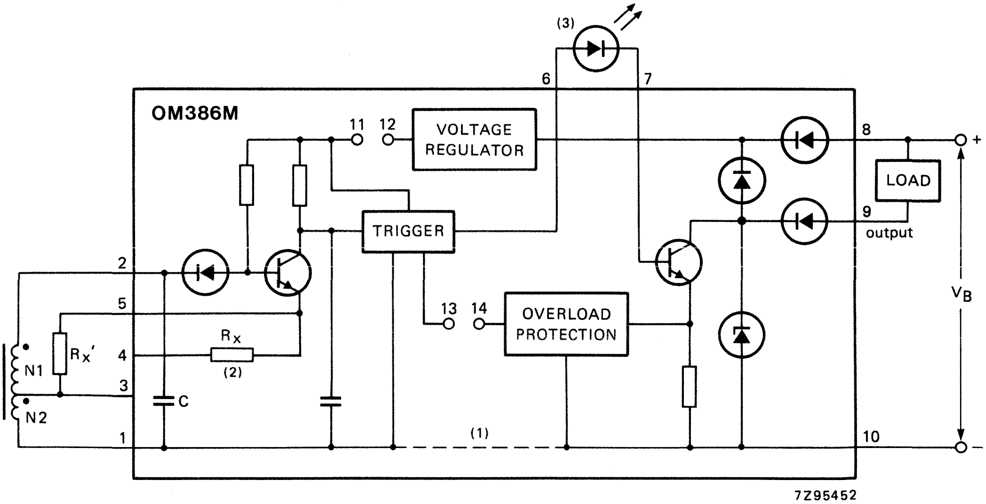


Fig. 2 Circuit diagram of OM386M.

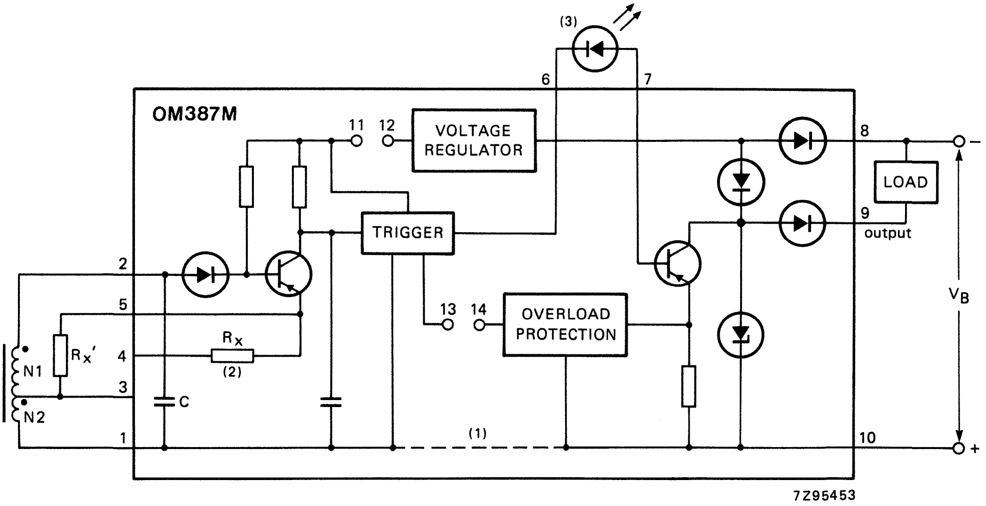


Fig. 3 Circuit diagram of OM387M.

(1) Connect point 1 to point 10 after assembling.

(2) R_X is integrated on the substrate and suitable for trimming (laser or sandblasting). To use integrated resistance R_X it is necessary to connect point 3 to 4.

(3) If no LED is used, connect point 6 to point 7.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

D.C. supply voltage	V_B	max.	30	V
Output current	I_o	max.	200	mA
Storage temperature	T_{stg}		−40 to +125	°C
Operating substrate temperature	T_s		−40 to +85	°C

CHARACTERISTICS

Conditions (unless otherwise specified)

D.C. supply voltage	V_B	24	V
External resistor (R_X) and oscillator coil Device embedded in brass tube	see operating distance table below		
Substrate temperature	T_s	25	°C

Performances

Supply current				
output stage "ON"	I_B	typ.	7,4	mA
output stage "OFF"		typ.	4,8	mA
Voltage drop				
I_o = 200 mA	V_d	max.	1,9	V
I_o = 10 mA		max.	1,0	V

Operating (switching) distance*

type	oscillator coil number of turns N1	N2	average operating distance S in mm at R_X (Ω) 200	250	300	recommended potcore	oscillator frequency kHz
M8	32	16	1	1,5	–	ϕ 5,8 mm (Neosid)	800
M12	40	10	2	3	–	P9 Philips**	600
M18	46	4	3	4	5	P14 Philips**	600

Differential travel (in % of S)	H		3 to 10	%
Operating frequency (according to EN 50010)	f	<	5	kHz

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* The operating distance S depends on the oscillator coil, the material of the metal actuator and R_X. For measuring purposes a square steel sheet (St. 37) with dimensions such that a circle with the diameter of the core can be inscribed, and 1 mm thickness can be used. R_X must not be chosen outside the range of 200 to 300 Ω.

** Grade 3B7/3H1.

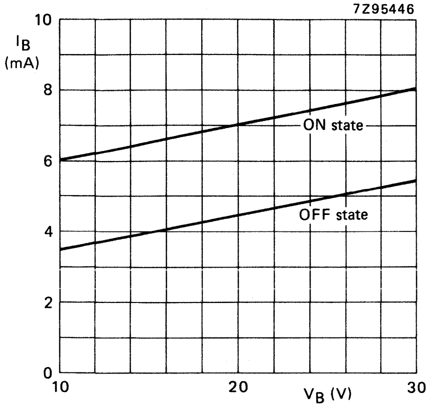


Fig. 4 Supply current as a function of supply voltage; T_s = 25 °C.

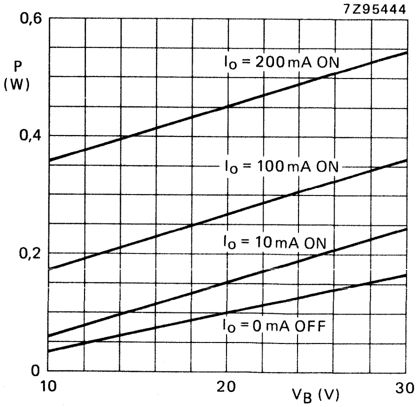


Fig. 5 Power dissipation as a function of supply voltage.

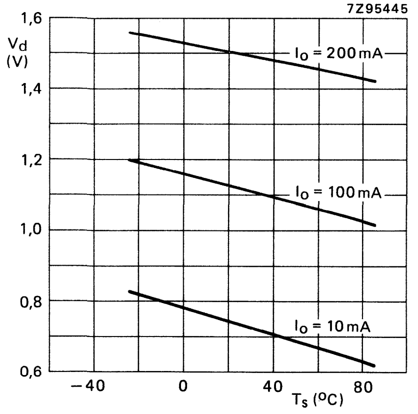


Fig. 6 Voltage drop as a function of substrate temperature.

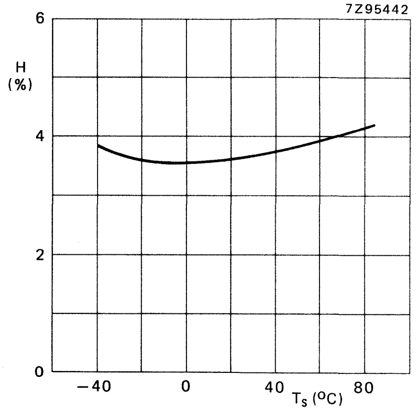
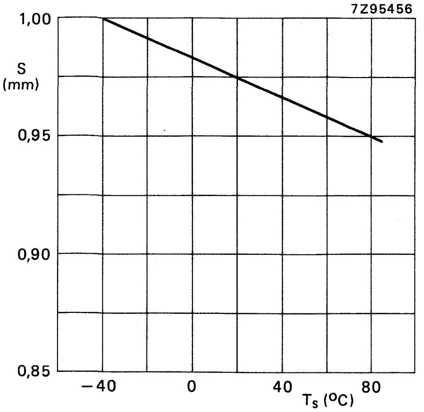


Fig. 7 Hysteresis as a function of substrate temperature.



Conditions relating to Figs 7 and 8:
potcore ϕ 5,8 mm Neosid
osc. coil N1 = 32, N2 = 16 turns
R_X = 200 Ω.

Fig. 8 Operating distance as a function of substrate temperature.

MOUNTING RECOMMENDATIONS

A. Assembling and connecting the two half substrates:

- Use the breakline to break the substrate in two pieces.
- Apply glue (e.g. epoxy Ablebond 293-1) to the blank sides of the two parts.
- After hardening of the glue connect the pads according to Fig. 9.

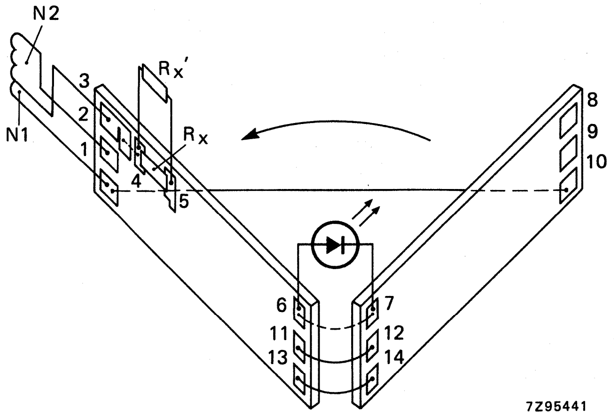


Fig. 9 If no LED is used, connect point 6 to point 7;
connect points 11 and 12, point 13 to 14 and point 1 to point 10.

B. If a protective cap is incorporated, it should be as thin as possible, because its thickness d forms part of the operating distance S.
A brass stud wall should not extend beyond the potcore.
The exact value of S with its spread is determined by a number of variables, e.g.

- value of the adjustment resistor R_x
- the oscillator coil
- the metal of the actuator
- the material and shape of the housing.

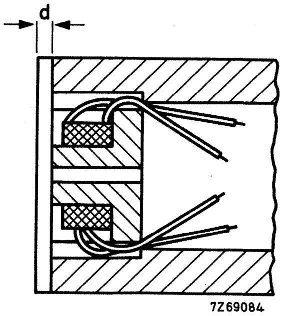


Fig. 10 Insertion of potcore in brass tube.

Soldering recommendations

Use normal 60/40 solder; use a soldering iron with a fine point; soldering time as short as possible and it should not exceed 2,5 s per soldering point (T_{sld} = max. 250 °C).

Potting recommendations

First cover the hybrid IC with about 0,5 mm of silicone rubber, let it harden and with the parts inserted in the tube, fill up the tube with an epoxy.

HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

Hybrid integrated circuits intended for inductive proximity detectors in tubular construction, especially the M12 hollow stud. The OM388B is for positive supply voltage and the OM389B is for negative supply voltage. The circuit consists of a voltage regulator, an oscillator, a rectifier stage, a Schmitt trigger, an output stage and a protection circuit.

The circuit performs a make function: when actuated the current flows through the load, which can be e.g. the coil of an electromagnetic relay, a LED or a photocoupler.

Features:

- protection against short-circuit and overload
- protection of output transistor against transients by a voltage regulator diode
- protection against false polarity of the three connection leads
- choice between two methods to adjust the operating (switching) distance i.e. trimming a resistor integrated on the substrate or mounting a resistor
- possibility of connecting a LED for function control

The devices are thin-film circuits deposited on ceramic substrates. They may be potted, together with the oscillator coil, in a non-magnetic tube.

QUICK REFERENCE DATA

D.C. supply voltage range	V_B		10 to 30	V
Output current at V_B = 10 to 30 V	I_o	max.	250	mA
Operating (switching) distance (depends on R_x value and oscillator coil)	S		2 to 5	mm
Differential travel (hysteresis in switching distance)	H		3 to 10	%
Operating (switching) frequency	f	$<$	5	kHz
Operating substrate temperature range*	T_s		−40 to +85	°C
Substrate length	L		25,4 ±0,2	mm
Substrate width	W		8,0 ±0,2	mm
Height of circuit including substrate	h	max.	1,7	mm

MECHANICAL DATA

Dimensions in mm

Fig. 1 (see next page).

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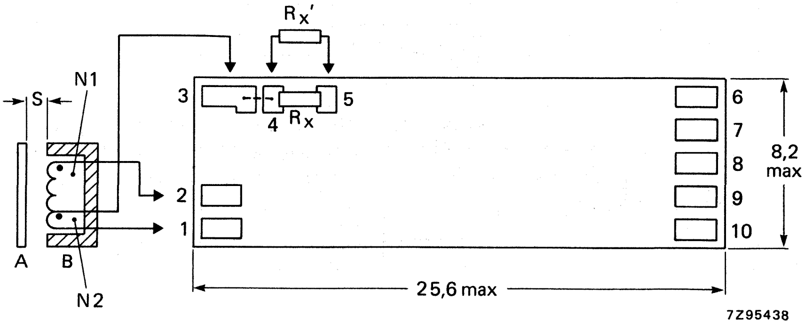
* The tube, potting and connection materials are the main limiting factors for the operating temperature range of a completely assembled proximity detector.

MECHANICAL DATA (outline and connections). Dimensions in mm

Fig. 1.



A = metal actuator; B = open potcore or potcore half with coil.

Mechanical outline and connections: note that the supply polarities to points 8 and 10 are given for the OM388B; for the OM389B the polarities are point 8: $-V_B$ and point 10: $+V_B$.

S is the operating distance.

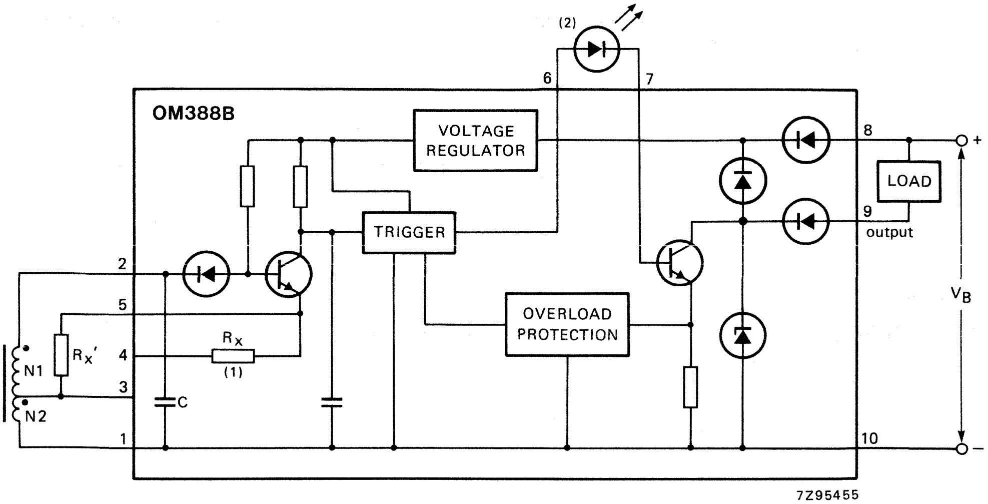


Fig. 2 Circuit diagram of OM388B.

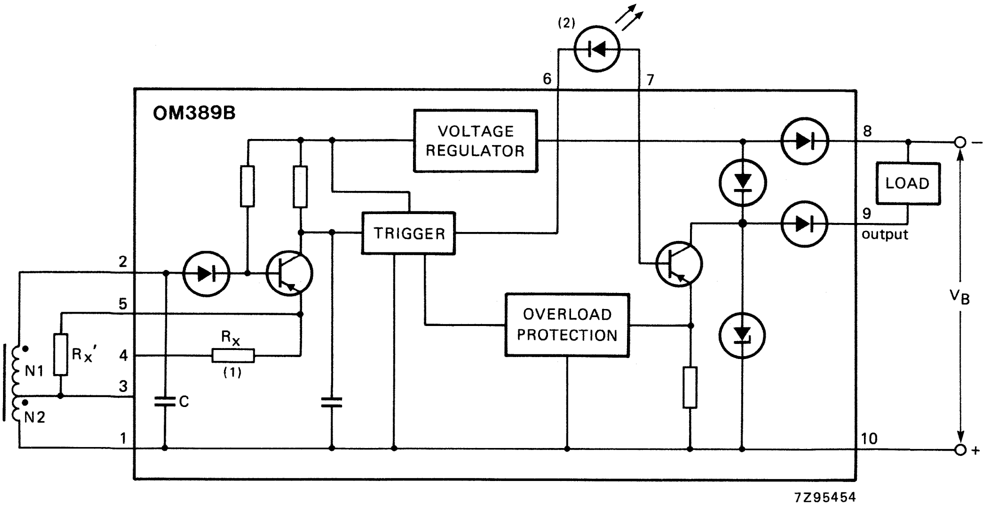


Fig. 3 Circuit diagram of OM389B.

(1) R_X is integrated on the substrate and suitable for trimming (laser or sandblasting). To use integrated resistance R_X it is necessary to connect point 3 to 4.

(2) If no LED is used, point 6 is to be connected to point 7.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

D.C. supply voltage	V_B	max.	30 V
Output current	I_o	max.	250 mA
Storage temperature	T_{stg}		−40 to +125 °C
Operating substrate temperature	T_s		−40 to +85 °C

CHARACTERISTICS

Conditions (unless otherwise specified)

D.C. supply voltage	V_B		24 V
External resistor (R_X) and oscillator coil Device embedded in brass tube	see operating distance table below		
Substrate temperature	T_s		25 °C

Performances

Supply current			
output stage "ON"	I_B	typ.	8,4 mA
output stage "OFF"		typ.	4,8 mA
Voltage drop			
I_o = 250 mA	V_d	max.	1,9 V
I_o = 10 mA		max.	1,0 V

Operating (switching) distance*

type	oscillator coil number of turns		average operating distance S in mm at R_X (Ω)			recommended potcore	oscillator frequency kHz
	N1	N2	200	250	300		
M12	40	10	2	3	–	P9 Philips**	600
M18	46	4	3	4	5	P14 Philips**	600

Differential travel (in % of S)	H		3 to 10 %
Operating frequency (according to EN 50010)	f	<	5 kHz

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* The operating distance S depends on the oscillator coil, the material of the metal actuator and R_X. For measuring purposes a square steel sheet (St 37) with dimensions such that a circle with the diameter of the core can be inscribed, and 1 mm thickness can be used. R_X must not be chosen outside the range of 200 to 300 Ω.

** Grade 3B7/3H1.

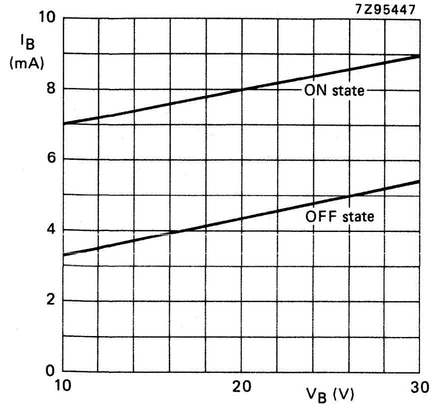

Fig. 4 Supply current as a function of supply voltage; $T_s = 25\ ^oC$.

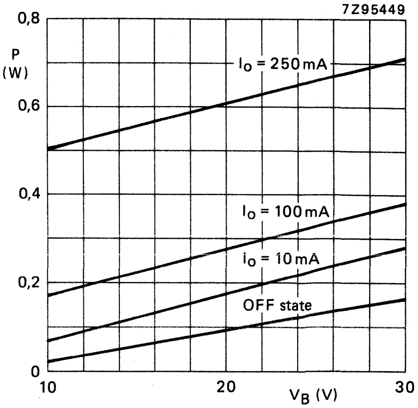

Fig. 5 Power dissipation as a function of supply voltage.

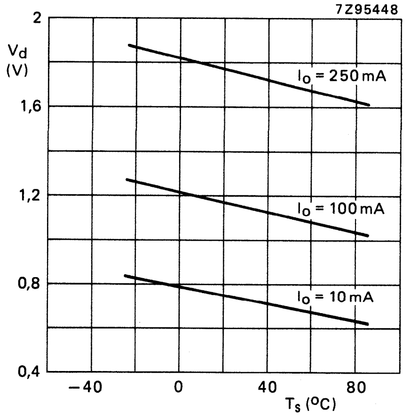

Fig. 6 Voltage drop as a function of substrate temperature.

MOUNTING RECOMMENDATIONS

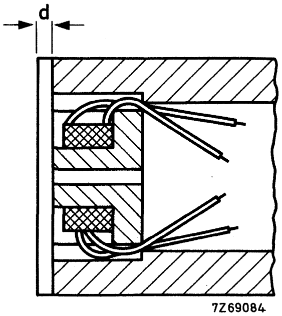

Fig. 7 Insertion of potcore in brass tube.

If a protective cap is incorporated, it should be as thin as possible, because its thickness d forms part of the operating distance S.

A brass stud wall should not extend beyond the potcore.

The exact value of S with its spread is determined by a number of variables, e.g.

- value of the adjustment resistor R_x
- the oscillator coil
- the metal of the actuator
- the material and shape of the housing.

Soldering recommendations

Use normal 60/40 solder; use a soldering iron with a fine point; soldering time as short as possible and it should not exceed 2,5 s per soldering point (T_{sld} = max. 250 °C).

The substrate is preferably preheated to a temperature of 100 °C with a minimum of 80 °C and a maximum of 125 °C.

Potting recommendations

First cover the hybrid IC with about 0,5 mm of silicone rubber, let it harden and with the parts inserted in the tube, fill up the tube with an epoxy.

HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

Hybrid integrated circuits intended for inductive proximity detectors in tubular construction, especially the M18 hollow stud. The OM390 is for positive supply voltage and the OM391 is for negative supply voltage. The circuit consists of a voltage regulator, an oscillator, a rectifier stage, a Schmitt trigger, an output stage and a protection circuit.

The circuit performs a make function: when actuated the current flows through the load, which can be e.g. the coil of an electromagnetic relay, a LED or a photocoupler.

Features:

- Protection against short-circuit and overload
- Protection of output transistor against transients by a voltage regulator diode
- Protection against false polarity of the three connection leads
- Choice between two methods to adjust the operating (switching) distance i.e. trimming a resistor integrated on the substrate or mounting a resistor
- Possibility of connecting a LED for function control

The devices are thin-film circuits deposited on ceramic substrates. They may be potted, together with the oscillator coil, in a non-magnetic tube.

QUICK REFERENCE DATA

D.C. supply voltage range	V_B		10 to 30	V
Output current at V_B = 10 to 30 V	I_o	max.	250	mA
Operating (switching) distance (depends on R_x value and oscillator coil)	S		2 to 5	mm
Differential travel (hysteresis in switching distance)	H		3 to 10	%
Operating (switching) frequency	f	$<$	5	kHz
Operating substrate temperature range*	T_s		−40 to +85	°C
Substrate length	L		14,0 ±0,2	mm
Substrate width	W		14,0 ±0,2	mm
Height of circuit including substrate	h	max.	1,7	mm

MECHANICAL DATA

Dimensions in mm

Fig. 1 (see next page).

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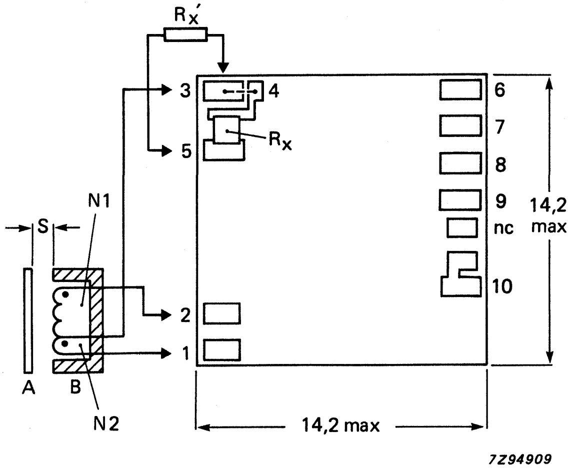
* The tube, potting and connection materials are the main limiting factors for the operating temperature range of a completely assembled proximity detector.

MECHANICAL DATA (outline and connections). Dimensions in mm

Fig. 1.



A = metal actuator; B = open potcore or potcore half with coil. S is the operating distance.

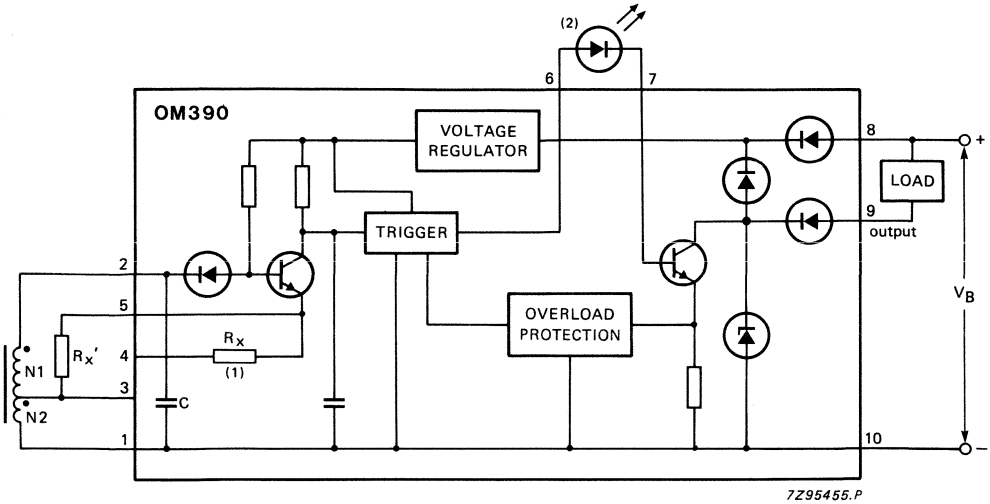


Fig. 2 Circuit diagram of OM390.

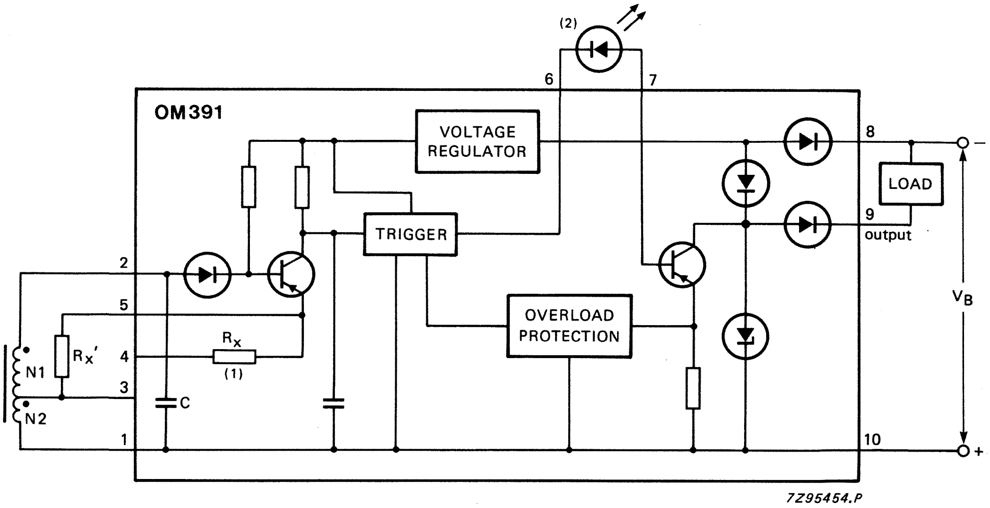


Fig. 3 Circuit diagram of OM391.

(1) R_x is integrated on the substrate and suitable for trimming (laser or sandblasting). To use integrated resistance R_x it is necessary to connect point 3 to 4.

(2) If no LED is used, point 6 is to be connected to point 7.

RATINGS

Limiting values in accordance with the Absolute Maximum System (IEC 134)

D.C. supply voltage	V_B	max.	30 V
Output current	I_o	max.	250 mA
Storage temperature	T_{stg}		−40 to +125 °C
Operating substrate temperature	T_s		−40 to +85 °C

CHARACTERISTICS

Conditions (unless otherwise specified)

D.C. supply voltage	V_B	24 V
External resistor (R_X) and oscillator coil Device embedded in brass tube	see operating distance table below	
Substrate temperature	T_s	25 °C

Performances

Supply current			
output stage "ON"	I_B	typ.	8,4 mA
output stage "OFF"		typ.	4,8 mA
Voltage drop			
I_o = 250 mA	V_d	max.	1,9 V
I_o = 10 mA		max.	1,0 V

Operating (switching) distance*

type	oscillator coil number of turns		average operating distance S in mm at R_X (Ω)			recommended potcore	oscillator frequency kHz
	N1	N2	200	250	300		
M18	46	4	3	4	5	P14 Philips**	600

Differential travel (in % of S)	H		3 to 10 %
Operating frequency (according to EN 50010)	f	<	5 kHz

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* The operating distance S depends on the oscillator coil, the material of the metal actuator and R_X. For measuring purposes a square steel sheet (St 37) with dimensions such that a circle with the diameter of the core can be inscribed, and 1 mm thickness can be used. R_X must not be chosen outside the range of 200 to 300 Ω.

** Grade 3B7/3H1.

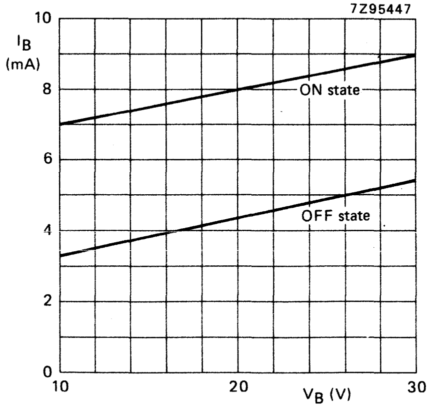

Fig. 4 Supply current as a function of supply voltage; $T_s = 25$ °C.

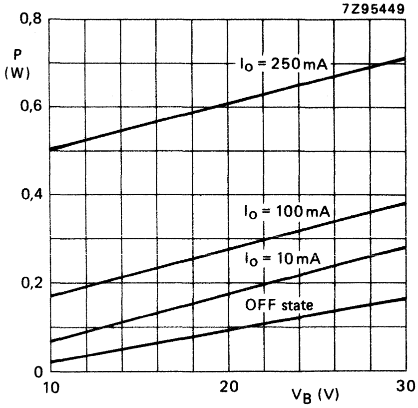

Fig. 5 Power dissipation as a function of supply voltage.

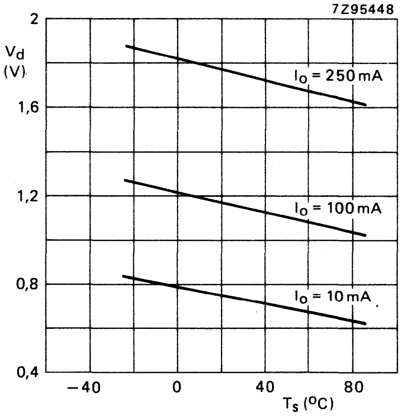

Fig. 6 Voltage drop as a function of substrate temperature.

MOUNTING RECOMMENDATIONS

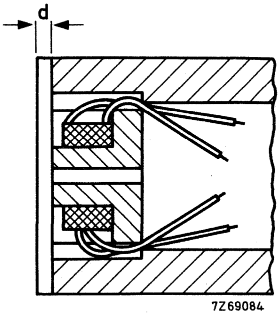

Fig. 7 Insertion of potcore in brass tube.

If a protective cap is incorporated, it should be as thin as possible, because its thickness d forms part of the operating distance S.
A brass stud wall should not extend beyond the potcore.
The exact value of S with its spread is determined by a number of variables, e.g.
- value of the adjustment resistor R_x
- the oscillator coil
- the metal of the actuator
- the material and shape of the housing.

Soldering recommendations

Use normal 60/40 solder; use a soldering iron with a fine point; soldering time as short as possible and it should not exceed 2,5 s per soldering point (T_{sld} = max. 250 °C).
The substrate is preferably preheated to a temperature of 100 °C with a minimum of 80 °C and a maximum of 125 °C.

Potting recommendations

First cover the hybrid IC with about 0,5 mm of silicone rubber, let it harden and with the parts inserted in the tube, fill up the tube with an epoxy.

Data sheet	
status	Product Specification
date of issue	August 1990

OM2860/OM2870

Hybrid integrated circuits for inductive proximity detectors

FEATURES

- Extra small dimensions.
- Wide range of supply voltage.
- High output current.
- Well proven oscillator stage using discrete transistors.
- RC filter on the supply lines.
- Output transistor protected against transients from the inductive load by a voltage regulator diode.
- Circuit protected against false polarity connection of the supply voltage.

DESCRIPTION

Hybrid integrated circuits intended for inductive proximity detectors in tubular construction, especially the M5 hollow stud.

The OM2860 is for positive supply voltage and the OM2870 is for negative supply voltage. The circuit consists of an oscillator, a rectifier stage, a Schmitt trigger, an output stage and a supply filter.

The circuit performs a make function: when actuated, the current flows through the load, which can be for example, the coil of an electromagnetic relay, a LED or an optocoupler.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_B	DC supply voltage		4.7	30	V
I_o	output current	$V_B = 24$ V	-	250	mA
$f_{switch\text{-}max.}$	operating frequency		-	5	kHz
T_s	substrate operating temperature range		−40	+85	°C

MECHANICAL DATA

Dimensions in mm

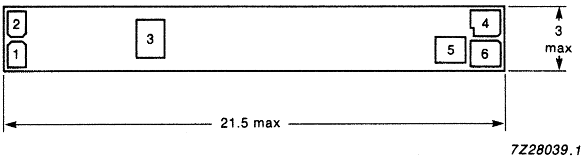

Fig.1 Outline and connections.

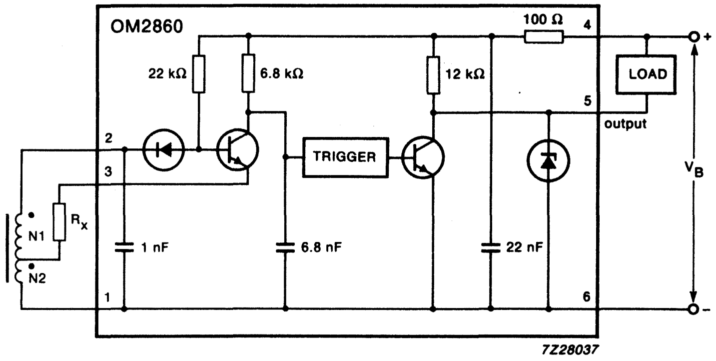

Fig.2 Circuit diagram of OM2860.

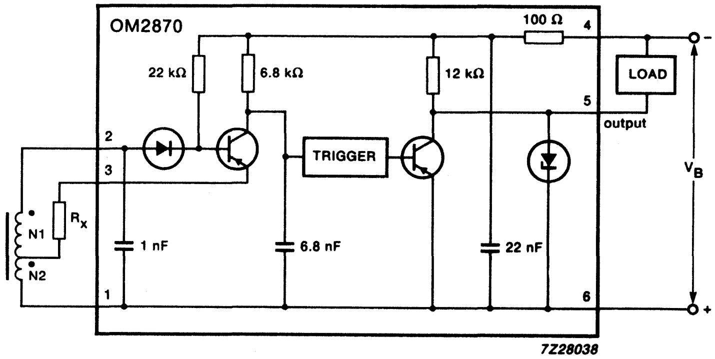

Fig.3 Circuit diagram of OM2870.

LIMITING VALUES

Limiting values in accordance with the Absolute Maximum System (IEC 134)

SYMBOL	PARAMETER	MIN.	MAX.	UNIT
V_B	DC supply voltage	-	30	V
I_o	output current	-	250	mA
T_{stg}	storage temperature range	−40	+125	°C
T_s	substrate operating temperature range	−40	+85	°C

CHARACTERISTICS

V_B = 24 V(DC); T_s = 25°C; unless otherwise specified.

SYMBOL	PARAMETERS	CONDITIONS	TYP.	MAX.	UNIT
I_B	supply current	output stage "ON" output stage "OFF"	9.0 7.7	- -	mA mA
V_d	voltage drop	I_o = 250 mA I_o = 10 mA	- -	1 0.25	V V

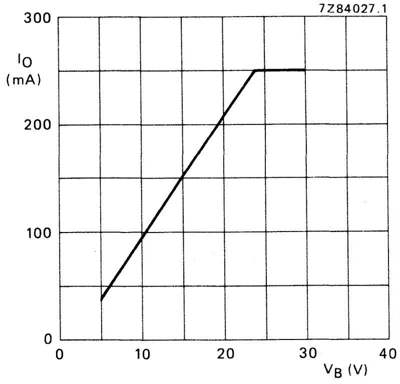

Fig.4 Maximum allowable output current as a function of supply voltage; T_s = 25°C.

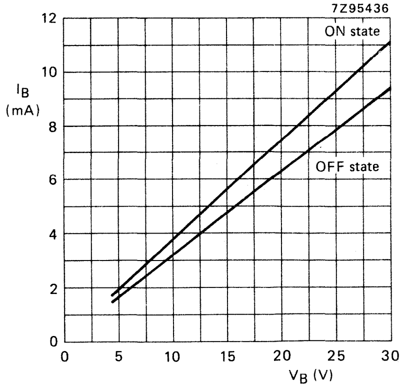

Fig.5 Supply current as a function of supply voltage; T_s = 25°C; typical values.

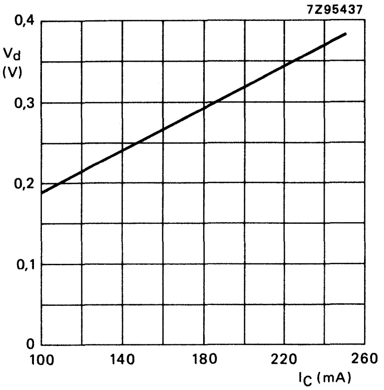

Fig.6 Voltage drop as a function of collector current; V_B = 24 V; T_s = 25°C; typical values.

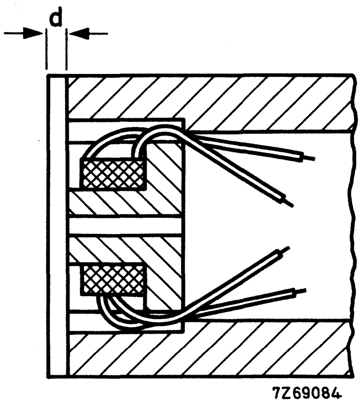

Fig.7 Insertion of potcore in brass tube.

MOUNTING RECOMMENDATIONS

If a protective cap is incorporated, it should be as thin as possible, because its thickness "d" forms part of the operating distance "S".
A brass stud wall should not extend beyond the potcore.
The exact value of "S" with its spread is determined by a number of variables, e.g.

- value of the adjustment resistor R_X
- the oscillator coil
- the metal of the actuator
- the material and shape of the housing.

SOLDERING RECOMMENDATIONS

- use normal 60/40 solder
- use a soldering iron with a fine point
- soldering time should be kept to a minimum, not exceeding 2.5 s per soldering point (T_{sld} = max. 250°C).
- the substrate should preferably be preheated to a temperature of 100°C with a minimum of 80°C and a maximum of 125°C.

DATA HANDBOOK SYSTEM

Data handbook system

INTRODUCTION

Our data handbook system comprises more than 65 books with subjects including electronic components, subassemblies and magnetic products. The handbooks are classified into seven series:

INTEGRATED CIRCUITS;
DISCRETE SEMICONDUCTORS;
DISPLAY COMPONENTS;
PASSIVE COMPONENTS;
PROFESSIONAL COMPONENTS;
MAGNETIC PRODUCTS;
LIQUID CRYSTAL DISPLAYS.

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Data handbook system

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