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Sensors

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Electronic components and materials

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Sensors

SENSORS

NOTE: for optoelectronic sensors see Handbook Devices for optoelectronics.

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* To be issued shortly.

Magnetic field sensors

type	field range kA/m	supply voltage V	T_{amb} °C	sensitivity $\frac{mV/V}{kA/m}$	bridge resistance kΩ*	page
KMZ10A	−0,5 to + 0,5	5	−40 to 150	14	1,7 ± 0,5	29
KMZ10B	−2,0 to + 2,0	5	−40 to 150	4	1,7 ± 0,5	33
KMZ10C	−7,5 to + 7,5	5	−40 to 150	1,5	1,4 ± 0,4	37

Pressure sensors

type	pressure range bar	supply voltage V	T_{amb} °C	sensitivity (T_{amb} = 25 °C) mV/Vbar	bridge resistance Ω*	page
KP100A	+ 1 to 2	7,5	−40 to 105	13	1800	43
KP101A	0 to 1,2	5	−40 to 125	50	1600	47
KPZ20G	−1 to 2	7,5	−40 to 125	10,5 ± 3,5	2000	51
KPZ21G	−1 to 10	7,5	−40 to 125	3,5 ± 3,5	2000	55

Temperature sensors

type	temperature range °C	resistance R . . at T_{amb} and I (R25 or R100) Ω	°C	mA	continuous sensor current mA*	page
KTY81-110	−55 to 150	1000 ± 1%	25	1	10	61
-120	−55 to 150	1000 ± 2%	25	1	10	61
KTY81-210	−55 to 150	2000 ± 1%	25	0,5	10	65
-220	−55 to 150	2000 ± 2%	25	0,5	10	65
KTY83-110	−55 to 175	1000 ± 1%	25	1	10	69
-120	−55 to 175	1000 ± 2%	25	1	10	69
KTY84-130	0 to 300	1000 ± 3%	100	2	10	73
-150	0 to 300	1000 ± 5%	100	2	10	73

Proximity detectors

type	switching distance mm	supply voltage V	max. output current mA	at V_B V	T_{amb} °C	page
OM286; M	1 to 5	4,5 to 30	250	24	−40 to 85	79
OM287; M	1 to 5	−4,5 to −30	250	−24	−40 to 85	79
OM386B	1 to 5	10 to 30	250	10 to 30	−40 to 85	85
OM387B	1 to 5	−10 to −30	250	−10 to −30	−40 to 85	85
OM386M	1 to 5	10 to 30	200	10 to 30	−40 to 85	91
OM387M	1 to 5	−10 to −30	200	−10 to −30	−40 to 85	91
OM388B	2 to 5	10 to 30	250	10 to 30	−40 to 85	97
OM389B	2 to 5	−10 to −30	250	−10 to −30	−40 to 85	97

Note: For optoelectronic sensors see Handbook Devices for optoelectronics.

* At T_{amb} = 25 °C.

Note: For optoelectronic sensors see Handbook Devices for optoelectronics.

INTRODUCTION TO MAGNETIC FIELD SENSORS

MAGNETIC FIELD SENSORS

The KMZ10 is a highly-sensitive magnetic-field sensor and provides an excellent means of measuring both linear and angular displacement. This is because even quite small movement of actuating components in machinery (metal rods, cogs, cams etc.) can create measurable changes in magnetic field. Examples where this property is 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 millimetre, 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's 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.

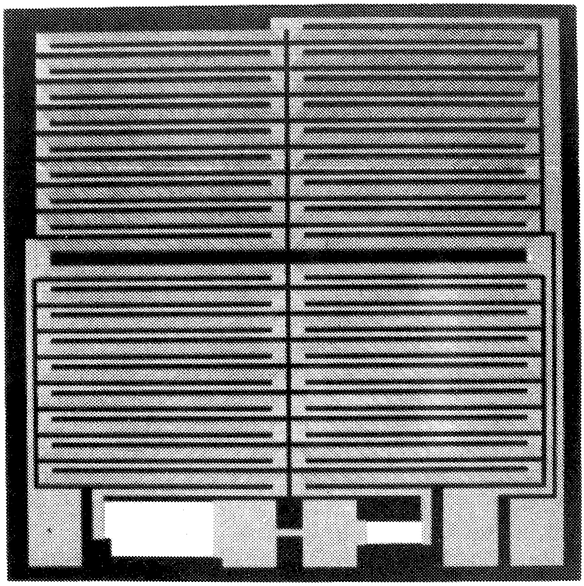
KMZ10 MAGNETIC FIELD SENSORS

	KMZ10A	KMZ10B	KMZ10C	units
H_{max} (typ)	500	2000	7,500	A/m
open-circuit sensitivity	12,0	5,0	1,1	(mV/V)/(kA/M)

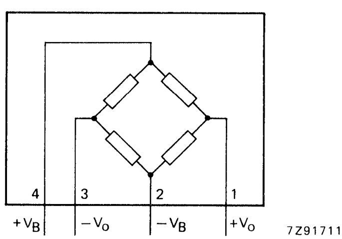
KMZ10 OPERATING PRINCIPLES

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 current direction. In the case of permalloy for example (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 current direction) will produce a 2 to 3% change in resistivity.

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. 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 current.



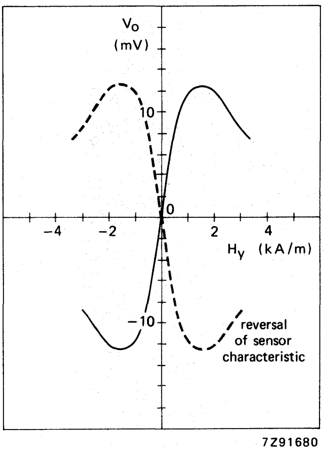
(a)



(b)

Fig.1 (a) The KMZ10 chip is made up of four permalloy strips arranged in a meander pattern and connected to form the four arms of a Wheatstone bridge. The chip incorporates special resistors that are trimmed during manufacture to give zero offset at 25 °C.

(b) Bridge configuration of the KMZ10. V_B – supply voltage, V_O – output voltage

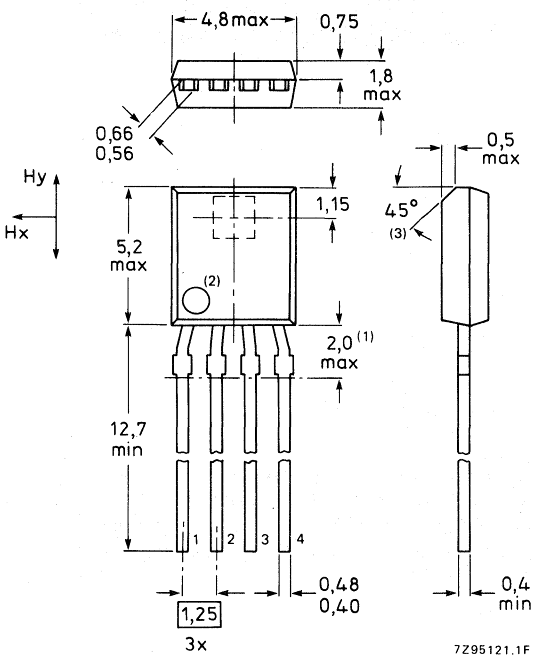


(a)

Fig.2

(a) Sensor characteristic. 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.

(b) Dimensional drawing of the KMZ10 showing pinning and magnetic field direction for normal operation



(b)

KMZ10 CHARACTERISTIC BEHAVIOUR

During manufacture, a strong magnetic field is applied parallel to the strip axis. This imparts a preferred magnetization direction to the permalloy strips. So 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 say the +x to the −x direction). As Fig.2 shows, this can lead to drastic changes in sensor characteristics.

In Fig.2 the unbroken line shows the characteristics of a normal sensor (i.e. with the sensor magnetization oriented in the +x direction), and the broken line shows the characteristics of a 'flipped' sensor.

The field, $\hat{H}_{-x}$ say, 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 $\hat{H}_{-x}$. This is quite reasonable when you think of it, 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.

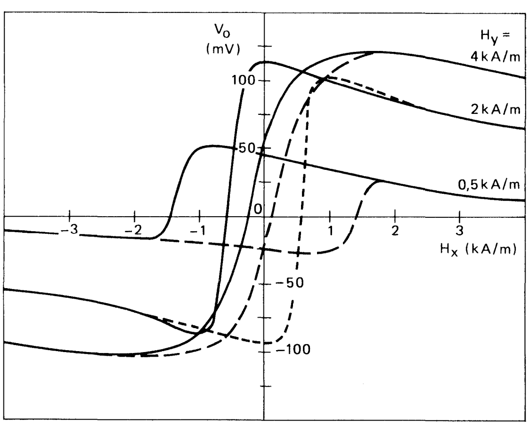


Fig.3 Sensor output V_o versus H_x for several values of H_y. The curves illustrate several things: first, that the sensor exhibits hysteresis, second, that the flipping is not instantaneous, and third, that sensitivity falls with increasing H_x

This is illustrated in Fig.3, which shows sensor output signal V_o versus H_x for several values of H_y.

Take the curve for $H_y = 0{,}5\,kA/m$. For such a low transverse field, the sensor characteristic is stable for all positive values of H_x, and a reverse field of around 1 kA/m is required before flipping occurs. At $H_y = 4\,kA/m$, on the other hand, the sensor will flip at even positive values of H_x (at around 1 kA/m).

Figure 3 also illustrates that the flipping itself is not instantaneous; this is because not all the permalloy strips flip at the same rate. Also in Fig.3 you can see the hysteresis effect exhibited by the sensor. Finally, Fig.3 and Fig.4 show that the sensitivity of the sensor falls with increasing H_x. This again is 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.

From the foregoing discussions we arrive at the following general recommendations for operating the KMZ10:

- to assure stable operation, avoid operating the sensor in an environment where it's 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 operating range (i.e. the range of H_y) you intend to use the sensor

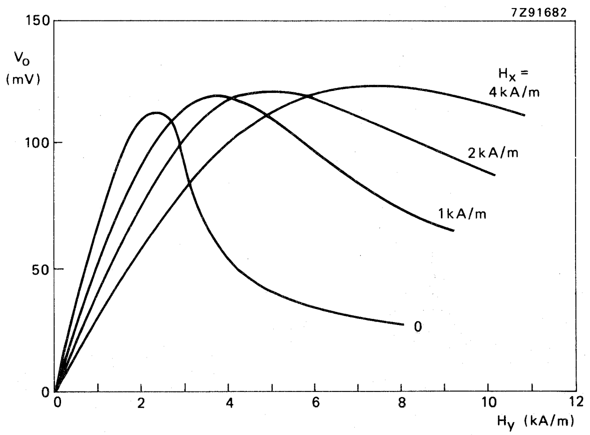


Fig.4 Output V_o versus H_y for several values of H_x. This illustrates, even better than Fig.3, the fall in sensitivity (i.e. initial gradient) with increasing H_x

- use the minimum auxiliary field that will assure stable operation. Remember, the larger the auxiliary field, the lower the sensitivity. For the KMZ10B sensor, we recommend a minimum auxiliary field of around 1 kA/m
- and 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.3). Note: to *guarantee* stable operation, you should, in fact, operate the sensor in an auxiliary field of 3 kA/m (the value we recommend in our data sheets).

These recommendations (particularly the first one) define a kind of SOAR for the sensors. This can be seen from Fig.5, which is an example (for the KMZ10B sensor) of the SOAR graphs you'll find in our data sheets. The graph shows the SOAR of a KMZ10 as a function of auxiliary field H_x and of disturbing field H_d opposing H_x. 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. You can also see from Fig.5 that the SOAR can be extended for low values of H_y. In this graph (for the KMZ10B sensor) we've shown the extension in SOAR for $H_y < 1$ kA/m.

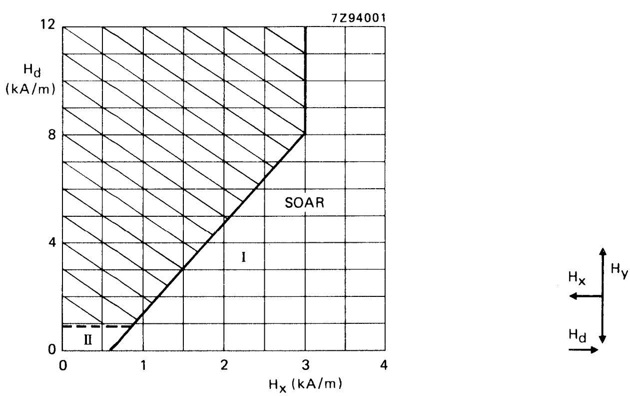


Fig.5 SOAR of a KMZ10B sensor as a function of auxiliary field H_x and of disturbing field H_d opposing H_x (area I). The SOAR can be extended slightly (area II) for values of $H_y < 1$ kA/m

Effect of temperature on behaviour

Figure 6 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, and as we see below, it can be put to good effect when operating with a constant-current supply. Figure 6 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 into practical circuits.

Not just the bridge resistance but the sensitivity too varies with temperature. This can be seen from Fig.7 which plots output voltage against transverse field H_y for various temperatures. The figures shows that sensitivity falls with increasing temperature. The reason for this is rather complicated and is connected with the energy-band structure of the permalloy strips.

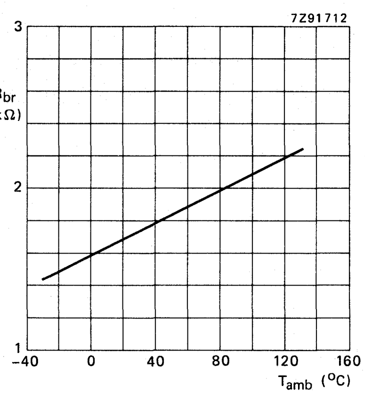


Fig.6 Bridge resistance as a function of temperature

Figure 8 is similar to Fig.7 but with the sensor powered by a constant-current supply. The figure shows that with a constant current supply, the temperature dependence of sensitivity is significantly reduced. This is a direct result of the increase of bridge resistance with temperature (Fig.5) which partially compensates the fall in sensitivity by increasing the voltage across the bridge and hence the output voltage. The figure, therefore, adequately demonstrates the advantages of operating with constant current.

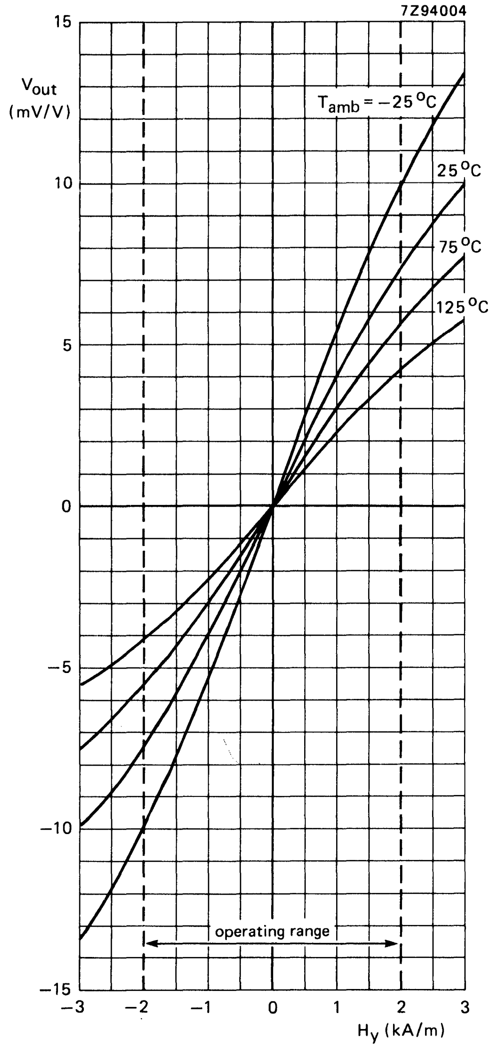


Fig.7 Output voltage V_o (as a fraction of the supply voltage) versus transverse field H_y for several temperatures. The figure illustrates that sensitivity falls with increasing temperature

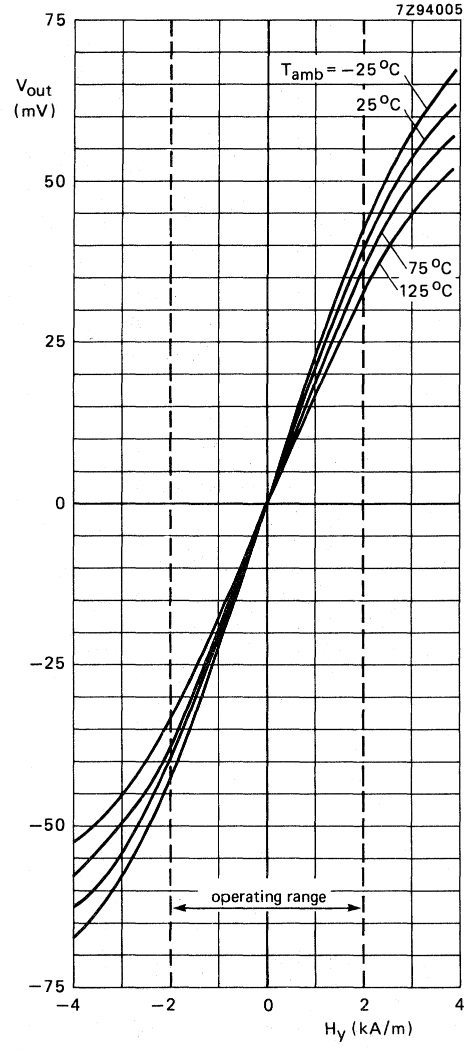


Fig.8 Output voltage V_O versus transverse field H_y for several temperatures, with the sensor powered by a constant-current supply. The reduction in temperature dependence of sensitivity is a result of the increase of bridge resistance with temperature, which increases the bridge voltage to partially compensate the fall in sensitivity

USING THE KMZ10

Displacement measurement using permanent magnets

Figures 9 and 10 show probably one of the simplest arrangements for using a sensor/permanent-magnet combination to measure linear displacement, and exposes some of the problems likely to be encountered if proper account is not taken of the effects described above.

When the sensor is placed in the field of a permanent magnet, it's 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.9(a), H_x then provides the auxiliary field and the variation in H_y can be used as a measure of x displacement. Figure 9(b) shows how both H_x and H_y vary with x, and Fig.9(c) shows the corresponding output signal as a function of x.

In the example shown in Fig.9, H_x never exceeds $\pm\hat{H}_x$ (the field that can cause flipping of the sensor) and the sensor characteristic remains stable and well-behaved throughout the measuring range.

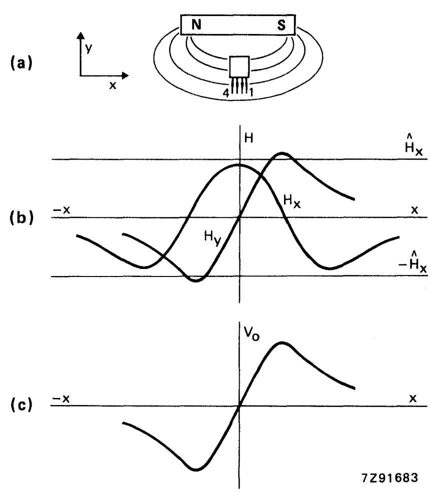


Fig.9 Sensor output in the field of a permanent magnet as a function of its displacement x parallel to the magnetic axis. The magnet provides both the auxiliary and transverse fields. In the example shown, the auxiliary field is always less than the field $\hat{H}_x$ that will cause flipping. Note the pinning arrangement in this figure, which indicates that the sensor is viewed from the rear. Reversal of the sensor relative to the permanent will reverse the characteristic

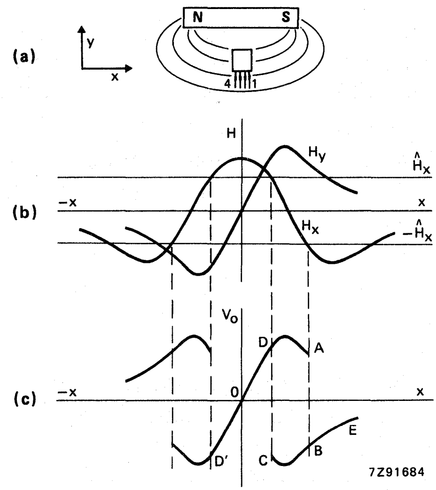


Fig.10 Sensor output in the setup of Fig.9, but in which the auxiliary field sometimes exceeds H_x

Consider now the example shown in Fig.10. Here for certain values of x, H_x exceeds $\pm\hat{H}_x$, (Fig.10(b)). This could happen if, for example, the magnet were powerful or if the sensor should pass close to the magnet, and as Fig.10(c) shows, the effects on the output signal can be drastic.

Suppose the sensor is initially on the transverse axis of the magnet ($x = 0$ say). H_y will be zero and H_x will be at its maximum value ($>\hat{H}_x$). So the sensor will be oriented in the +x direction and the output voltage will vary as in Fig.9(a). As the sensor moves in the +x direction H_y and hence V_o increases, and H_x falls to zero and then increase 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.10(c). Further increase of x causes the sensor voltage to move along BE. If the sensor is moved in the opposite direction, however, H_x increases until it exceeds $+\hat{H}_x$ and V_o moves from B to C. At this point the sensor characteristic again flips and V_o moves from C to D.

Under these conditions, then, the sensor characteristic will trace the hysteresis loop ABCD, and a similar loop in the −x direction. Figure 10(c) is, in fact, an idealized case and the reversals are never as abrupt as shown in this figure. It does, however, illustrate the effects that can occur if the sensor is placed close to a powerful permanent magnet. Note that under certain circumstances, particularly where there are likely to be temporary of 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 on the sensor (i.e. it will tend to correct any flipping of the sensor due to transient magnetic fields). Note also that reversal of the permanent magnet will give rise to the same sensor characteristic as shown in Figs.9(c) and 10(c) (i.e. with positive slope) since the sensor will then be forced to operate in its flipped state.

Figure 11 shows the sensor characteristic at distances of 10 mm and 20 mm from a permanent magnet, and amply illustrates the effects show in Figs.9 and 10.

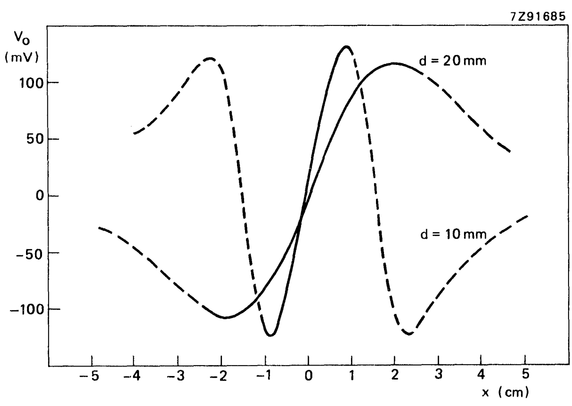


Fig.11 Measured sensor output at distances d of 10 mm and 20 mm from a permanent magnet as functions of displacement x parallel to the magnetic axis

One-point position measurement with the KZM10

Figure 12(a) shows how a KMZ10B may be used to make position measurements of a metal object, a steel plate for instance. 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.

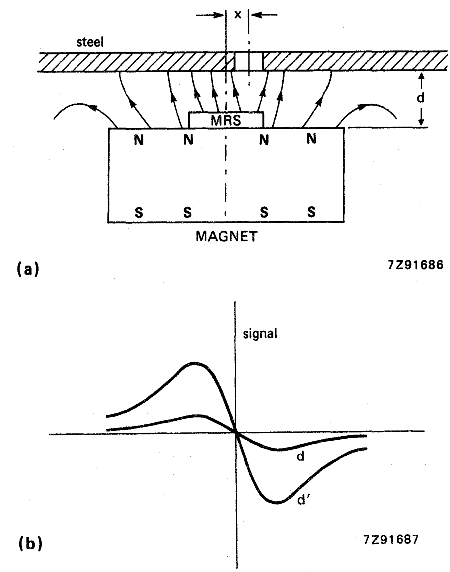


Fig.12 One-point measurement with the KMZ10.
(a) The sensor is located between a metal plate and a permanent magnet oriented with its magnetic axis normal to the axis of the plate. A discontinuity in the plate's structure, such as a hole or region of non-magnetic material, will disturb the magnetic field and produce a variation in the output signal from the sensor.
(b) Output signal versus hole/sensor offset x for two values of magnet/plate spacing d. The figure shows that the crossover point, is independent of d, which greatly simplifies adjustment procedures

This is shown in Fig.12(b) which gives the sensor output signal versus hole/sensor offset x, for two values of magnet/plate spacing d. The interesting point of this figure is that the crossover point, i.e. the point where the hole and sensor precisely coincide, is independent of d. The obvious advantage of this setup is that precise location of the sensor/magnet combination is unimportant for one-point position measurements, so adjustment procedures in a practical device would be greatly simplified. Although not shown in Fig.12(b), the crossover point is also independent of temperature. This is not surprising since it is effectively a null measurement, and it could be a major advantage in practical applications.

Angular position measurement with the KMZ10

Figure 13 shows a practical setup 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 rotable frame. The output of the sensor will then be a measure of the rotation of the frame (Fig.15). 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), then the device can measure rotation up to around ±85°. Beyond that and the sensor is in danger of flipping.

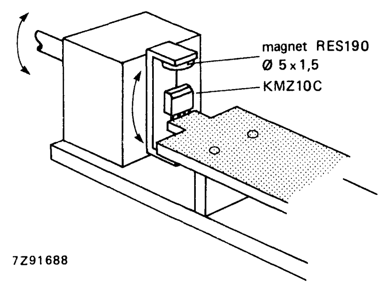


Fig.13 Angular measurement with the KMZ10

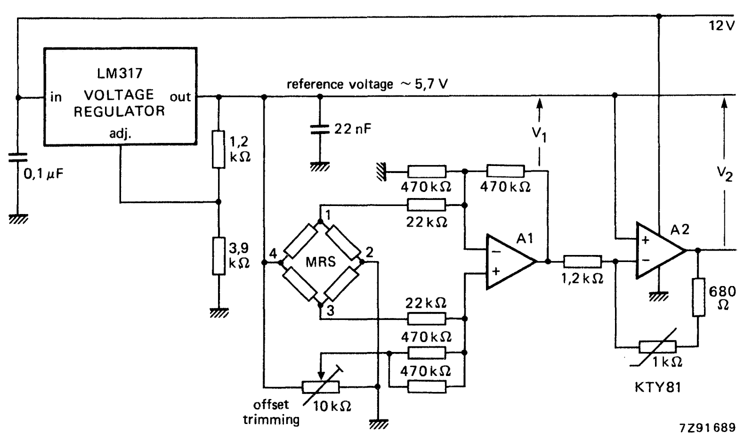


Fig.14 Circuit for measuring sensor output in the setup of Fig.13

Figure 14 shows a circuit for measuring the sensor output in the setup of Fig.13. The output signal of the sensor bridge is amplified by opamps A_1 and A_2. A KTY81 silicon temperature sensor in the feedback loop of A_2 varies the gain of the amp to provide temperature compensation for the output signal. Fig.15 shows the effectiveness of this temperature compensation by comparing the output V_2 of A_2 with the direct output V_1 from opamp A_1 for a range of temperatures.

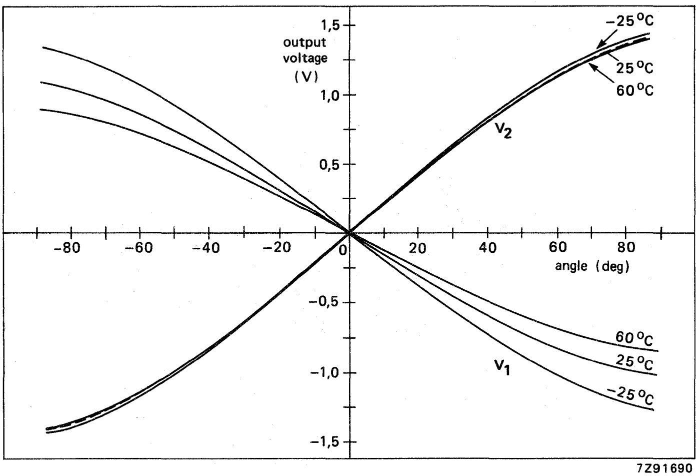


Fig.15 Effect of temperature compensation in the circuit of Fig.14. The figure compares the uncompensated output V_1 of opamp A_1 with the compensated output V_2 of opamp A_2

Current measurement with the KMZ10

Finally Figs.16 and 17 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.

Fig.16 is a rather simple setup in which the sensor measures the magnetic field generated by the current-carrying wire. Fig.17 is a more sophisticated arrangement in which the current-carrying wire is wrapped around a ferrite core, with the sensor located in the air gap between its ends. This arrangement provides a more accurate means of measuring current and lends itself more to precision applications. What's 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 – and thereby they provide a distinct advantage over thermistor-based systems.

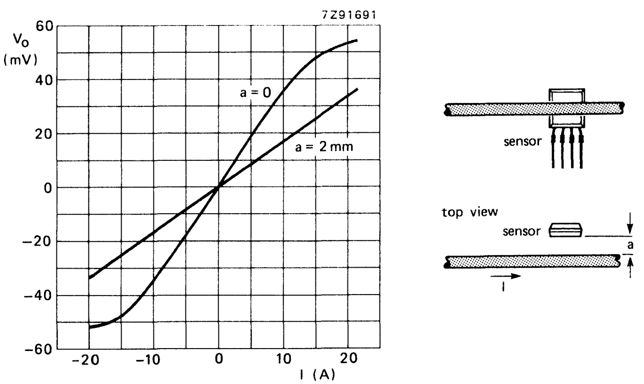


Fig.16 Simple setup for measuring current with a KMZ10 sensor. The sensor simply measures the magnetic field generated by a current-carrying wire

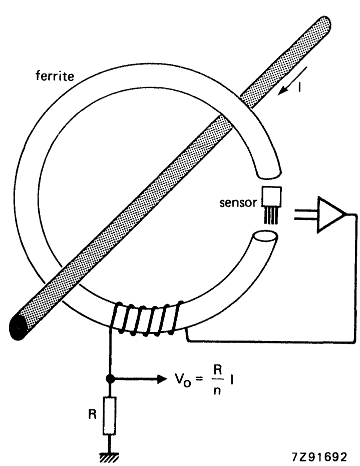


Fig.17 Current measurement with the KMZ10 sensor. In this setup a current-carrying wire is wrapped around a ferrite core, with the sensor located in the air gap between its ends

INTRODUCTION TO TEMPERATURE SENSORS

SILICON TEMPERATURE SENSORS

General

With their high accuracy and reliability, the KTY81/83/84 silicon temperature sensors provide an attractive alternative to more conventional sensors using NTC or PTC thermistors.

They use n-type silicon with a doping level between 10^{14} and $10^{15}/cm^3$, providing a nominal resistance of about 1000 Ω. Note, however, that variants of the KTY81 series exist, the KTY81-210 and KTY81-220, with a nominal resistance of 2000 Ω.

QUICK REFERENCE DATA

KTY81-110	R_{25} = 1000 Ω ± 1%	SOD-70 encapsulation
KTY81-120	R_{25} = 1000 Ω ± 2%	
KTY81-210	R_{25} = 2000 Ω ± 1%	
KTY81-220	R_{25} = 2000 Ω ± 2%	
KTY83-110	R_{25} = 1000 Ω ± 1%	DO-34 encapsulation
KTY83-120	R_{25} = 1000 Ω ± 2%	
KTY84-130	R_{100} = 1000 Ω ± 3%	DO-34 encapsulation
KTY84-150	R_{100} = 1000 Ω ± 5%	

Resistance-temperature characteristics — manufacturing tolerances

Silicon temperature sensors are normally produced to quite fine tolerances: ΔR between ± 1% and ± 2% (see quick reference data). Figure 1 illustrates how these tolerances are specified for the KTY81 and KTY83 sensors. 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-temperature characteristic, ΔR will increase each side of the 25 °C point to produce the butterfly curve shown in Fig. 1. 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}.

The user, however, is usually more interested in the temperature spread ± ΔT (standard deviation). So we also provide this in the data sheets as a graph of ΔT versus T.

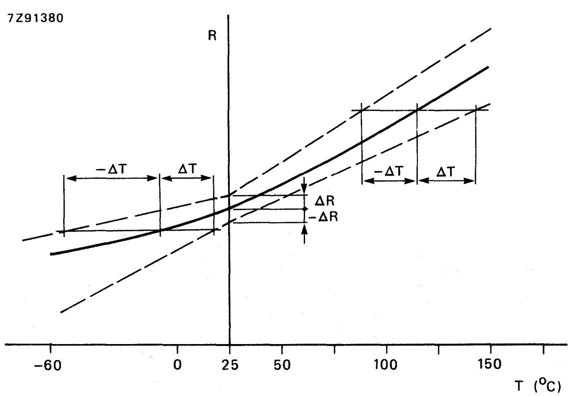


Fig.1 Resistance and temperature tolerances of the KTY81 and KTY83 sensors (exaggerated for clarity).

For the high-temperature KTY84, we specify the resistance spread at 100 °C. This is, however, an extrapolation from the measured spread at 25 °C.

Resistance-temperature characteristics – linearization

The resistance-temperature characteristics of the KTY81 and KTY83 temperature sensors are non linear, and in some applications, e.g. control systems requiring high accuracy, linearization becomes necessary.

A simple way to do this is to shunt the sensor (resistance R_T) with a fixed resistor R (Fig. 2). 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.

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 that gives zero temperature error at three equidistant points T_a, T_b and T_c say.

Consider the parallel arrangement. If the resistance of the sensor at the three points is R_a, R_b and R_c, and the corresponding resistance of the parallel arrangement R_{pa}, R_{pb} and R_{pc}, 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

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

The same resistor turns out to be suitable for the series arrangement as well.

As an example, Fig. 3 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.

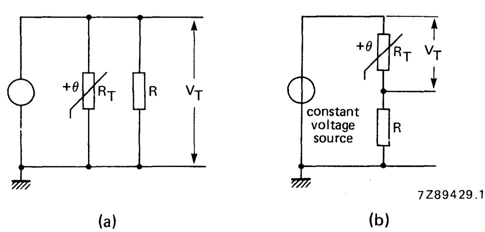


Fig.2 Linearization of sensor characteristics

a) with a resistor R shunted across the sensor

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

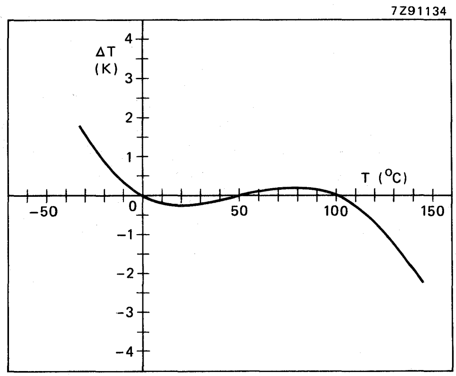


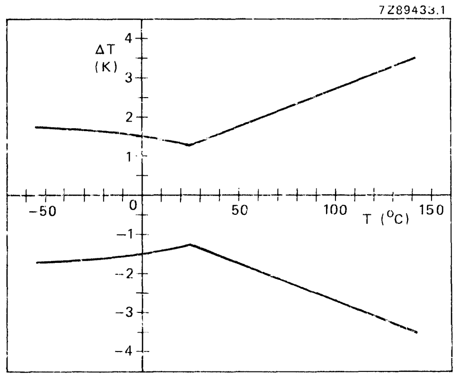
Fig.3 Temperature error ΔT to be expected from a nominal KTY83 sensor linearized over the temperature range 0 to 100 °C (linearizing resistance 2870 Ω).

Note: because the KTY84 is chiefly intended for use at higher temperatures, say above 100 °C, its almost linear characteristic at these temperatures often renders linearization unnecessary.

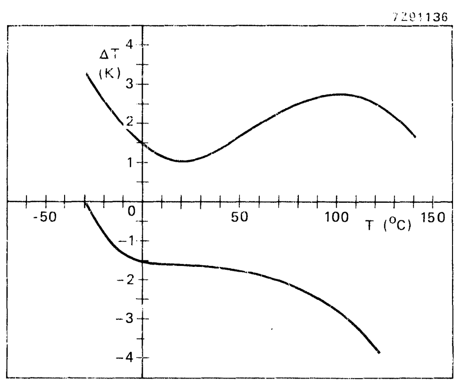
Effect of tolerances on linearized sensor characteristics

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.4 shows the combined effect 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 amps, control circuitry etc.) can reduce this error significantly. Figure 5a shows the temperature error of the system with (linear) output circuitry calibrated at 50 °C, and Fig.5b shows the error of the same system calibrated at 0 and 100 °C.



(a)

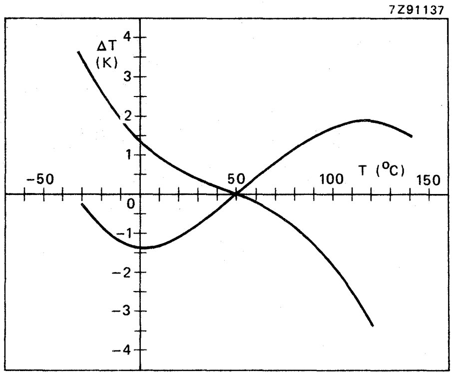


(b)

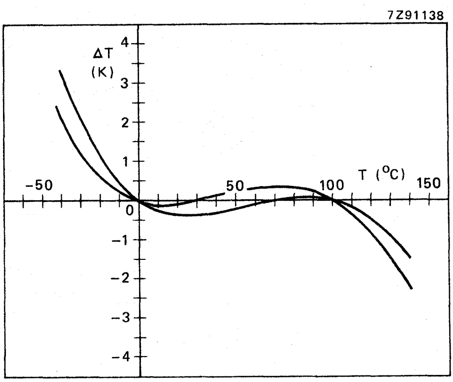
Fig. 4

a) absolute error ΔT expected of a silicon temperature sensor.

b) combined effect of manufacturing-tolerances and linearization errors for the KTY83 sensor.



(a)



(b)

Fig.5

a) temperature error of system with linear output circuitry calibrated at 50 °C

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

MAGNETIC FIELD SENSORS

MAGNETIC FIELD SENSOR

The KMZ10A 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.

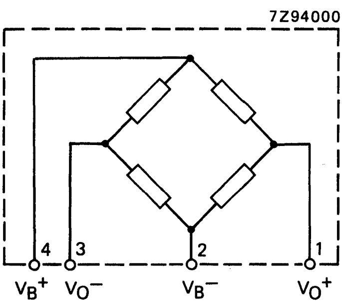
QUICK REFERENCE DATA

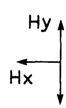
Bridge supply voltage	V_B	typ.	5	V
Magnetic field range	H_y	=	± 0,5	kA/m
Auxiliary field	H_x	=	0,5	kA/m
Sensitivity	s	typ.	14	$\frac{mV/V}{kA/m}$
Operating temperature	T_{op}	−40 to	+ 150	°C

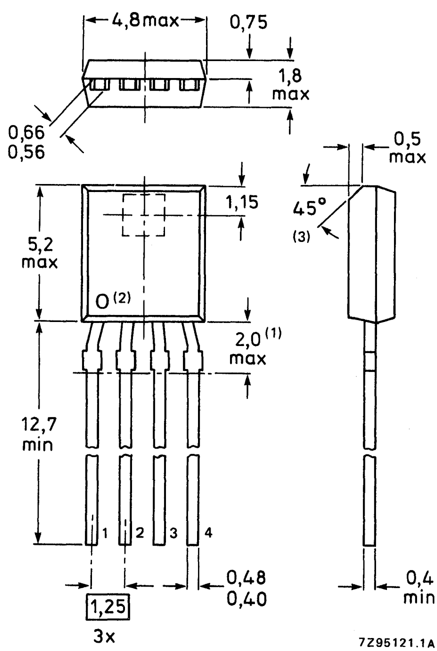
MECHANICAL AND ELECTRICAL DATA

Dimensions in mm

Fig. 1 VO-52B.







V_B = supply voltage
V_O = output voltage

(1) Terminal dimensions uncontrolled within this area
(2) Until October 1985
(3) Starting October 1985.

RATINGS

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

Bridge supply voltage	V_B	max.	9 V
Total power dissipation up to T_{amb} = 130 °C	P_{tot}	max.	90 mW
Storage temperature	T_{stg}	−65 to + 150	°C
Operating temperature	T_{op}	−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	typ.	5	V
Magnetic field range (1)	H_y		−0,5 to + 0,5	kA/m
Open circuit sensitivity (1)	s		14 ± 3	$\frac{mV/V}{kA/m}$
Temperature coefficient of sensitivity				
V_B = constant; T_j = −25 to + 125 °C	α_s	typ.	−0,4	%/K
I_B = constant; T_j = −25 to + 125 °C	α_s	typ.	−0,15	%/K
Bridge resistance	R_{br}		1,7 ± 0,5	kΩ
Temperature coefficient of bridge resistance at T_j = −25 to + 125 °C	α_{Rbr}	typ.	+ 0,3	%/K
Off-set voltage				
with offset trimming (2)	V_{off}		−1,5 to + 1,5	mV/V
without offset trimming	V_{off}		−20 to + 20	mV/V
Temperature coefficient of offset voltage at T_j = −25 to + 125 °C	α_{Voff}		−6 to + 6	$\frac{\mu V/V}{K}$
Linearity deviation of output voltage at				
H_y = 0 to 50%		⩽	0,8	% (3)
H_y = 0 to 80%		⩽	2,5	% (3)
H_y = 0 to 100%		⩽	4,0	% (3)
Hysteresis of output voltage		⩽	0,5	% (3)
Operating frequency	f	max.	1	MHz

Note: Before first operation or if to be operated 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. 8 for decrease of sensitivity.
(2) Offset trimming to be introduced approx. end 1985.
(3) Full scale.

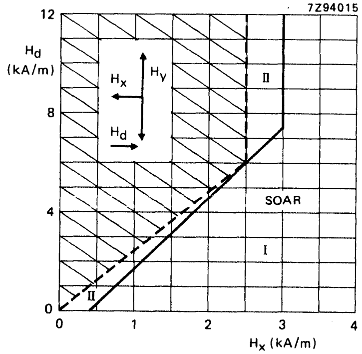


Fig. 2 Safe Operating ARea (possible disturbing field H_d versus auxiliary field H_x)

I Region of permissible operation

II Permissible extension if $H_y < 0,15$ kA/m.

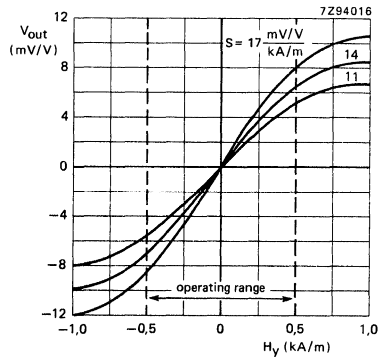


Fig. 3 V_B = constant; H_x = 0,5 kA/m; T_{amb} = 25 °C.

DEVELOPMENT DATA

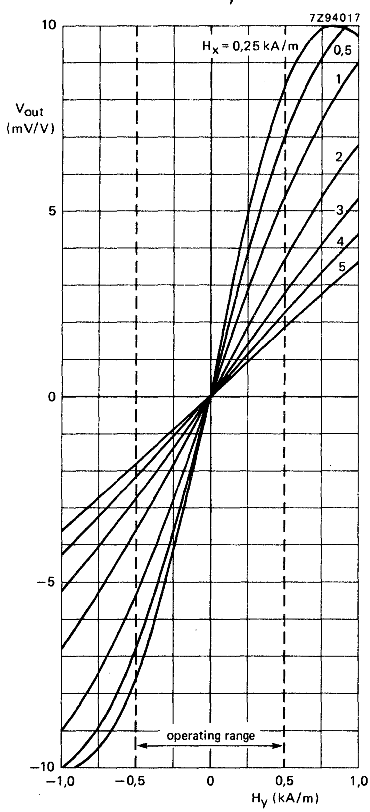


Fig. 4 V_B = constant; T_{amb} = 25 °C.

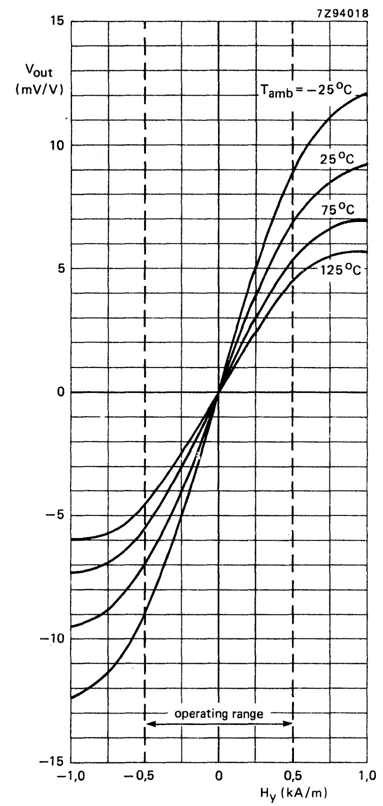


Fig. 5 V_B = constant; H_x = 0,5 kA/m.

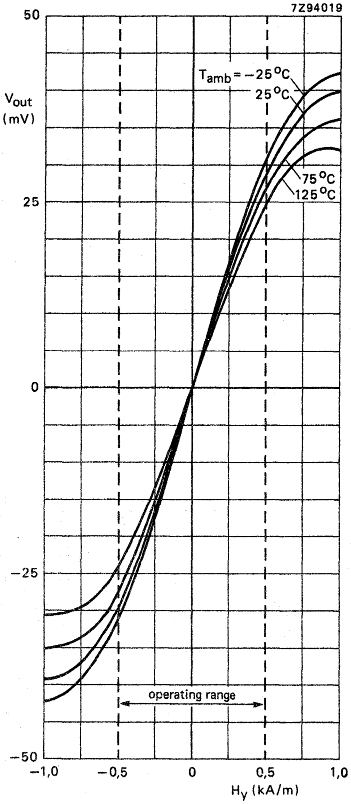


Fig. 6 I_B = constant = 3 mA; H_x = 0,5 kA/m.

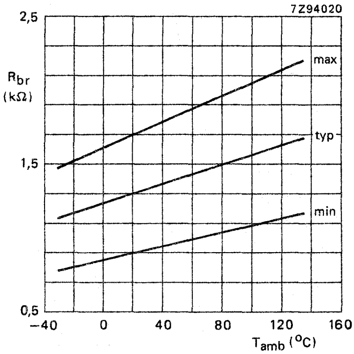


Fig. 7 Bridge resistance.

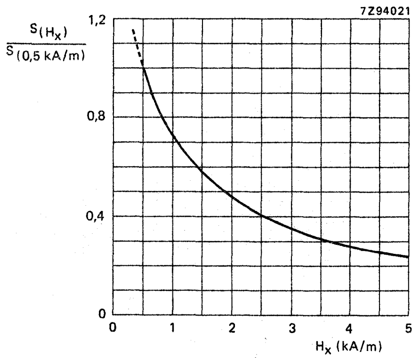


Fig. 8 Relative sensitivity (ratio of sensitivity at certain H_x and sensitivity at H_x = 0,5 kA/m.

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MAGNETIC FIELD SENSOR

The KMZ10B 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.

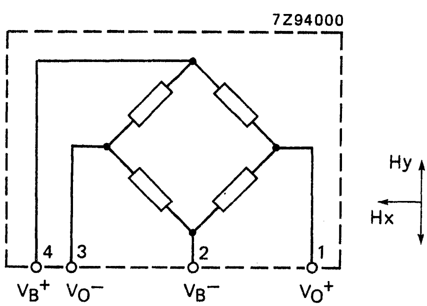
QUICK REFERENCE DATA

Bridge supply voltage	V_B	typ.	5	V
Magnetic field range	H_y	=	± 2,0	kA/m
Auxiliary field	H_x	=	3	kA/m
Sensitivity	s	typ.	4	$\frac{mV/V}{kA/m}$
Operating temperature	T_{op}	−40 to	+ 150	°C

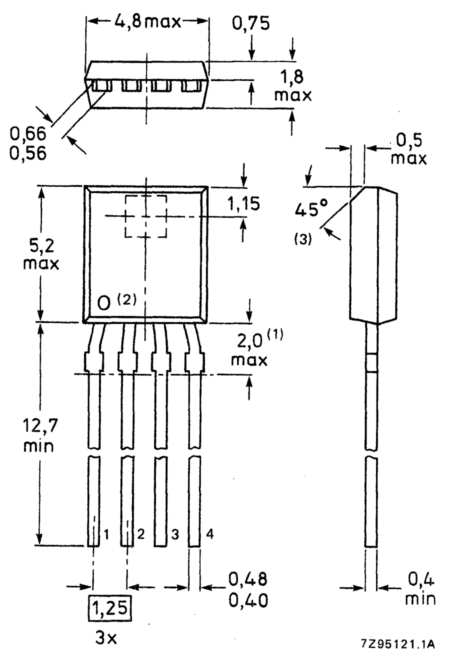
MECHANICAL AND ELECTRICAL DATA

Dimensions in mm

Fig. 1 VO-52B.



V_B = supply voltage
V_O = output voltage



(1) Terminal dimensions uncontrolled within this area
(2) Until October 1985.
(3) Starting October 1985.

RATINGS

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

Bridge supply voltage	V_B	max.	12	V
Total power dissipation up to T_{amb} = 130 °C	P_{tot}	max.	120	mW
Storage temperature	T_{stg}	–65 to	+ 150	°C
Operating temperature	T_{op}	–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 unless otherwise specified

Bridge supply voltage	V_B	typ.	5	V
Magnetic field range	H_y	–2,0 to	+ 2,0	kA/m
Open circuit sensitivity	s		4,0 ± 0,8	$\frac{mV/V}{kA/m}$
Temperature coefficient of sensitivity				
V_B = constant; T_j = –25 to + 125 °C	α_s	typ.	–0,4	%/K
I_B = constant; T_j = –25 to + 125 °C	α_s	typ.	–0,1	%/K
Bridge resistance	R_{br}		1,7 ± 0,5	kΩ
Temperature coefficient of bridge resistance at T_j = –25 to + 125 °C	α_{Rbr}	typ.	+ 0,3	%/K
Off-set voltage				
with offset trimming*	V_{off}	–1,5 to	+ 1,5	mV/V
without offset trimming	V_{off}	–20 to	+ 20	mV/V
Temperature coefficient of offset voltage at T_j = –25 to + 125 °C	α_{Voff}		–3 to + 3	$\frac{\mu V/V}{K}$
Linearity deviation of output voltage at				
H_y = 0 to 50%		⩽	0,5	% **
H_y = 0 to 80%		⩽	1,7	% **
H_y = 0 to 100%		⩽	2,0	% **
Hysteresis of output voltage		⩽	0,5	% **
Operating frequency	f	max.	1	MHz

Note: see KMZ10A.

* Offset trimming to be introduced approx. end 1985.
** Full scale.

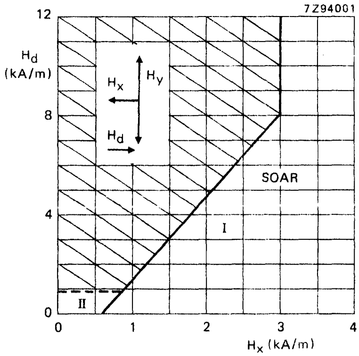


Fig. 2 Safe Operating ARea (possible disturbing field H_d versus auxiliary field H_x)

I Region of permissible operation
II Permissible extension if $H_y < 1$ kA/m.

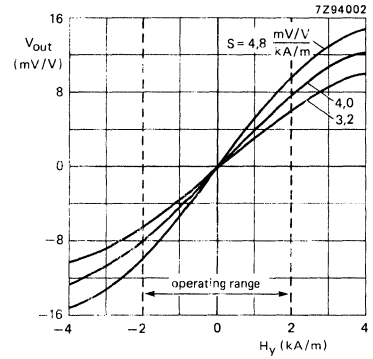


Fig. 3 V_B = constant;
H_x = 3 kA/m; T_{amb} = 25 °C.

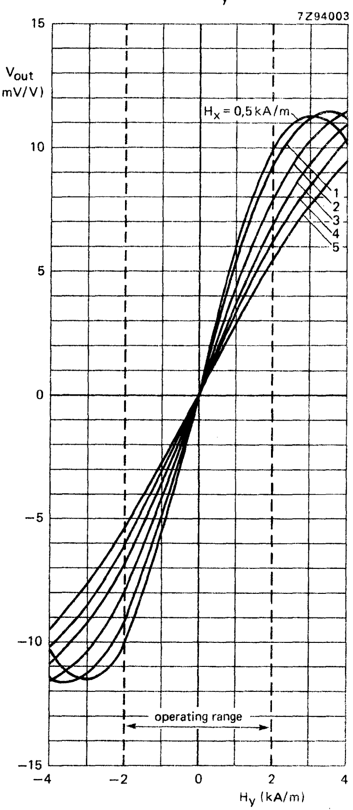


Fig. 4 V_B = constant; T_{amb} = 25 °C.

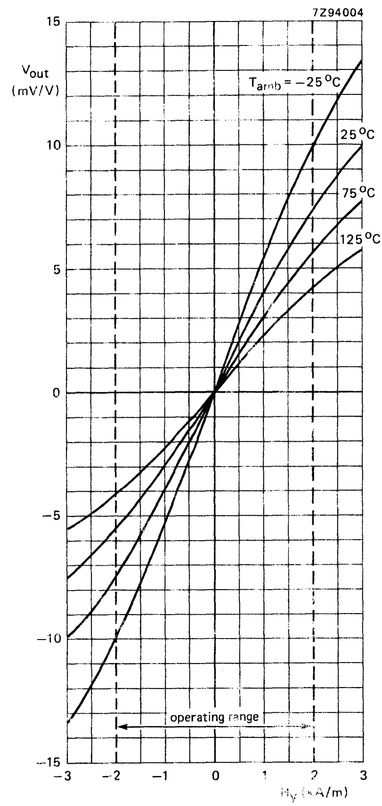


Fig. 5 V_B = constant; H_x = 3 kA/m.

DEVELOPMENT DATA

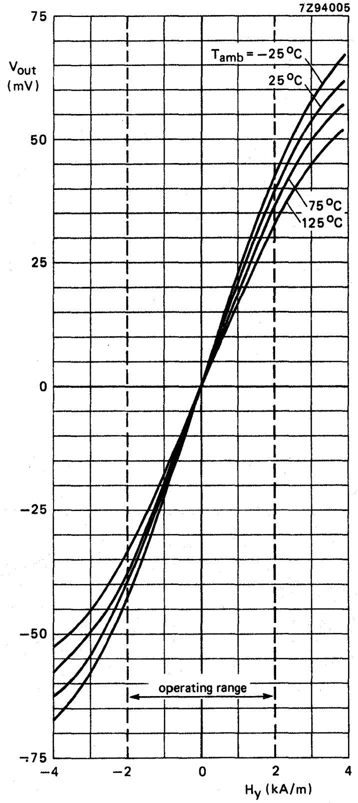


Fig. 6 I_B = constant = 3 mA; H_x = 3 kA/m.

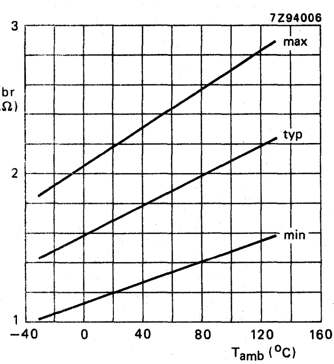


Fig. 7 Bridge resistance.

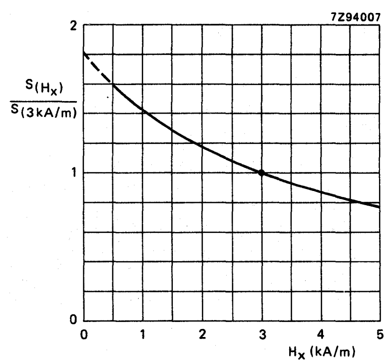


Fig. 8 Relative sensitivity (ratio of sensitivity at certain H_x and sensitivity at H = 3 kA/m).

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.

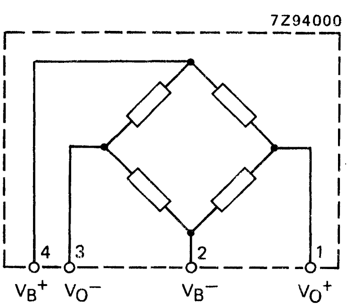
QUICK REFERENCE DATA

Bridge supply voltage	V_B	typ.	5	V
Magnetic field range	H_y	=	± 7,5	kA/m
Auxiliary field	H_x	=	3	kA/m
Sensitivity	s	typ.	1,5	$\frac{mV/V}{kA/m}$
Operating temperature	T_{op}	−40 to	+ 150	°C

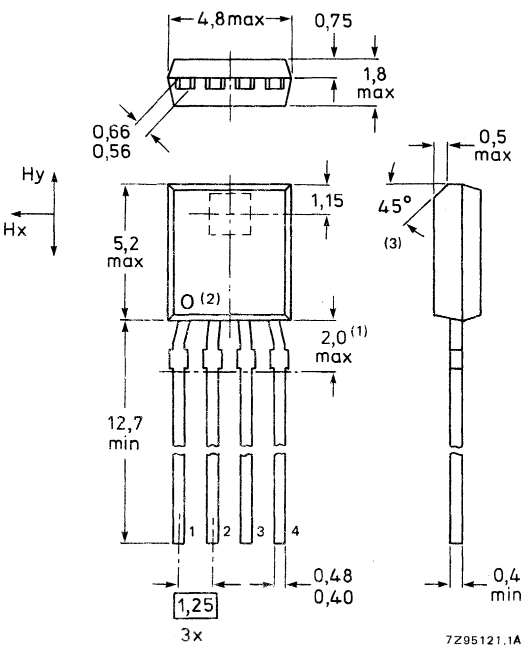
MECHANICAL AND ELECTRICAL DATA

Dimensions in mm

Fig. 1 VO-52B.



V_B = supply voltage
V_O = output voltage



(1) Terminal dimensions uncontrolled within this area
(2) Until October 1985
(3) Starting October 1985.

RATINGS

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

Brdige supply voltage	V_B	max.	10 V
Total power dissipation up to T_{amb} = 130 °C	P_{tot}	max.	100 mW
Storage temperature	T_{stg}	−65 to + 150	°C
Operating temperature	T_{op}	−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 unless otherwise specified

Bridge supply voltage	V_B	typ.	5 V
Magnetic field range	H_y	−7,5 to + 7,5	kA/m
Open circuit sensitivity	s	1,5 ± 0,5	$\frac{mV/V}{kA/m}$
Temperature coefficient of sensitivity			
V_B = constant; T_j = −25 to + 125 °C	α_s	typ.	−0,5 %/K
I_B = constant; T_j = −25 to + 125 °C	α_s	typ.	−0,15 %/K
Bridge resistance	R_{br}	1,4 ± 0,4	kΩ
Temperature coefficient of bridge resistance at T_j = −25 to + 125 °C	α_{Rbr}	typ.	+ 0,35 %/K
Off-set voltage			
with offset trimming*	V_{off}	−1,5 to + 1,5	mV/V
without offset trimming	V_{off}	−20 to + 20	mV/V
Temperature coefficient of offset voltage at T_j = −25 to + 125 °C	α_{Voff}	−2 to + 2	$\frac{\mu V/V}{K}$
Linearity deviation of output voltage at			
H_y = 0 to 50%		≤	0,8 % **
H_y = 0 to 80%		≤	2,4 % **
H_y = 0 to 100%		≤	2,7 % **
Hysteresis of output voltage		≤	0,5 % **
Operating frequency	f	max.	1 MHz

Note: see KMZ10A.

* Offset trimming to be introduced appprox. end 1985.
** Full scale.

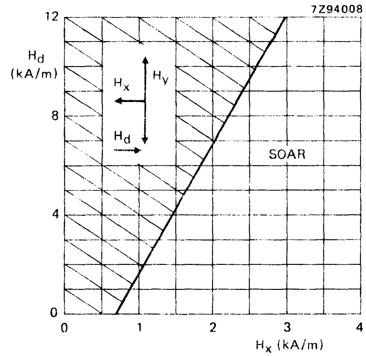


Fig. 2 Safe Operating ARea (possible disturbing field H_d versus auxiliary field H_x).

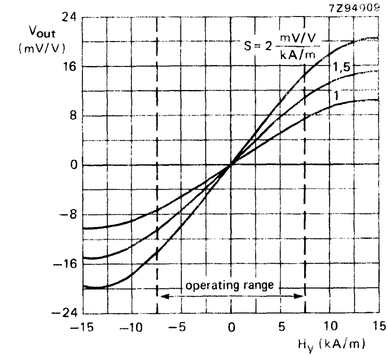


Fig. 3 V_B = constant; H_x = 3 kA/m; T_{amb} = 25 °C.

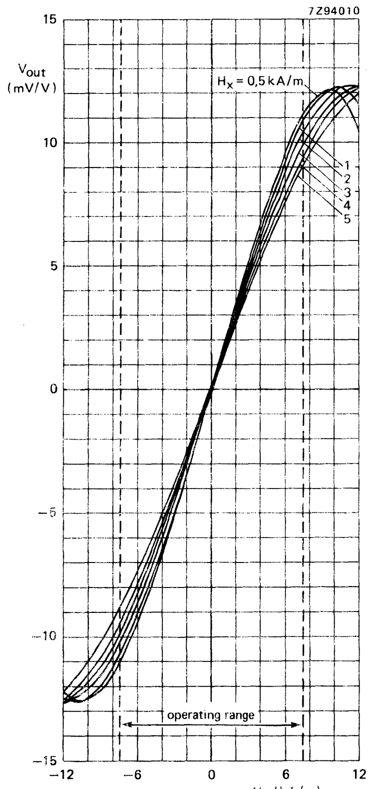


Fig. 4 V_B = constant; T_{amb} = 25 °C.

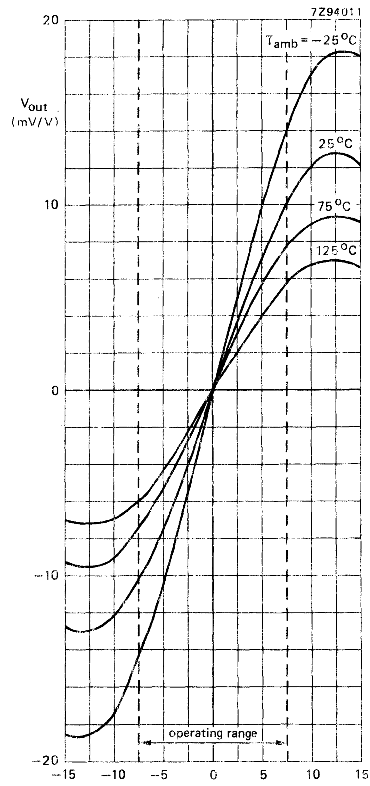


Fig. 5 V_B = constant; H_x = 3 kA/m.

DEVELOPMENT DATA

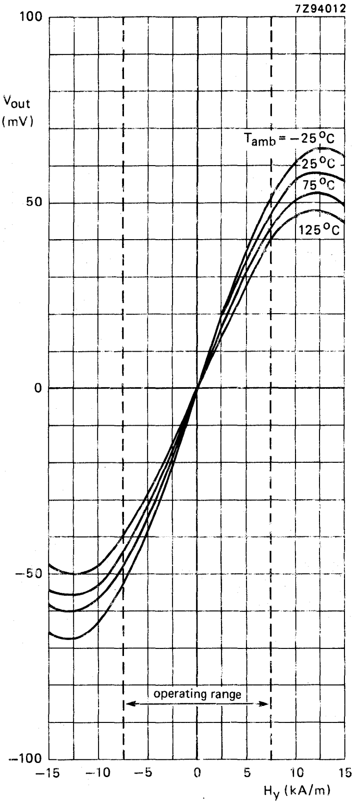


Fig. 6 I_B = constant = 3 mA; H_x = 3 kA/m.

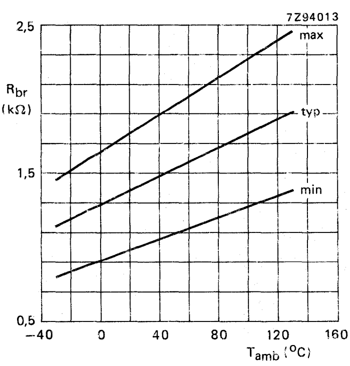


Fig. 7 Bridge resistance.

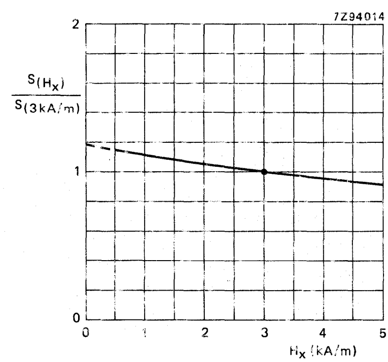


Fig. 8 Relative sensitivity (ratio of sensitivity at certain H_x and sensitivity at H = 3 kA/m.

PRESSURE SENSORS

MONOLITHIC PRESSURE SENSOR

The KP100A is designed to measure absolute pressure up to 2 bar. The device includes temperature compensation.

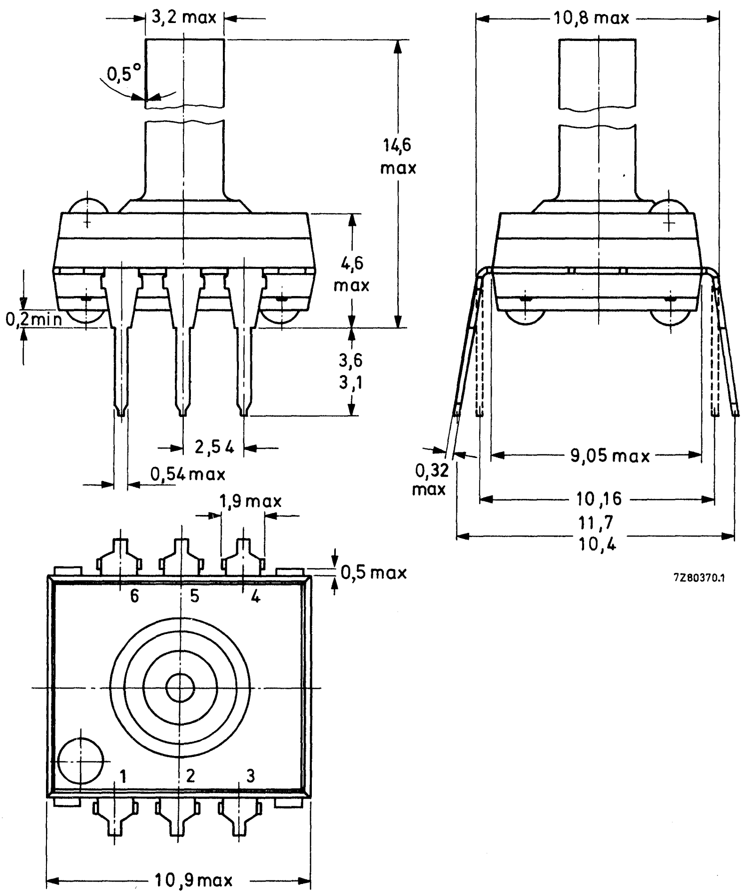
QUICK REFERENCE DATA

Pressure range	P_{typ}		0 to 2 bar
Supply voltage	V_B	typ.	7,5 V
Operating ambient temperature	T_{amb}		−40 to + 105 °C

MECHANICAL DATA

Dimensions in mm

Fig. 1.



RATINGS

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

Supply voltage	V_B	max.	12	V
Maximum pressure	P_{max}	max.	2 x P_{typ} or 4	bar
Destructive pressure	P_{des}	min.	7	bar
Operating ambient temperature	T_{amb}		−40 to + 105	°C
Lead soldering temperature at $t_{sld} < 10$ s	T_{sld}	max.	260	°C*

CHARACTERISTICS

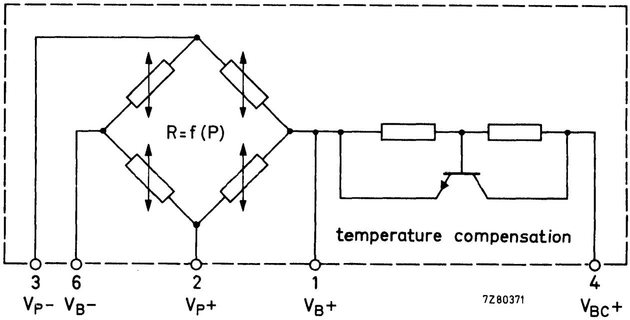
Supply voltage	V_B	typ.	7,5	V
Pressure range	P_{typ}		0 to + 2	bar
Sensitivity T_{amb} = 25 °C	s	typ.	13	mV/Vbar
Temperature coefficient of sensitivity with temperature compensation T_{amb} between −40 and + 85 °C	$\alpha_{s\,comp}$	typ.	± 0,02	%/K
Temperature coefficient of sensitivity T_{amb} between −40 and + 85 °C	α_s	typ.	−0,2	%/K
Bridge resistance (see Fig. 2) T_{amb} = 25 °C	R_{br}	typ.	1800	Ω
Offset voltage T_{amb} = 25 °C	V_{off}	typ.	± 5	mV/V
Temperature coefficient of offset voltage T_{amb} between −40 and + 85 °C	α_{off}	typ.	± 0,04	%/K
Non-linearity, hysteresis and repeatability P_{typ} between 0 and 2 bar		max.	1	%

APPLICATION NOTE

This pressure sensor is primarily intended for barometric measurements. It is advisable to apply non-aggressive and isolating pressure media only.

For application in dirty environments and with aggressive pressure media the KPZ10 pressure sensor series are advised.

* Solderability may be affected by high temperature storage over longer periods.



V_B+ = pos. supply voltage
V_B- = neg. supply voltage
$V_{BC}+$ = pos. supply voltage for temp. compensation
V_P+ = pos. output voltage
V_P- = neg. output voltage

Fig. 2 Schematic diagram.

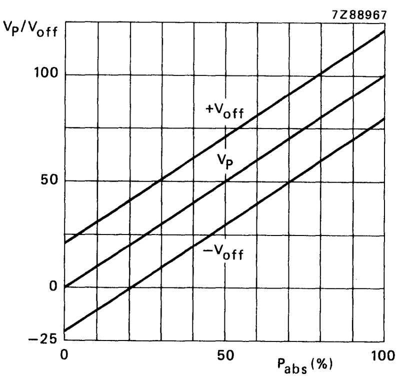


Fig. 3 V_B = constant; T_{amb} = constant.

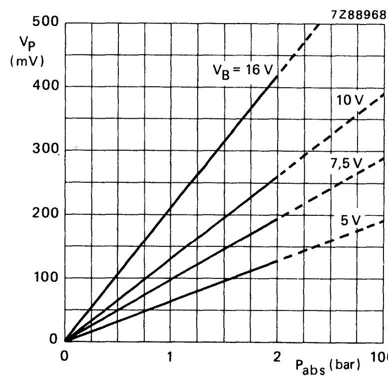


Fig. 4 V_{off} = 0; T_{amb} = 25 °C; without temperature compensation.

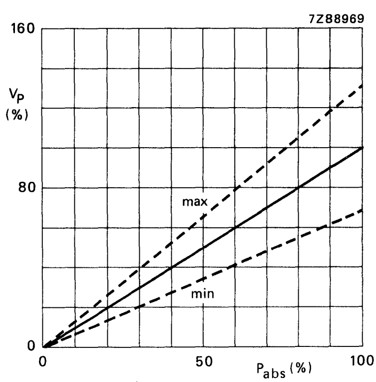


Fig. 5 V_B = constant; V_{off} = 0; T_{amb} = constant.

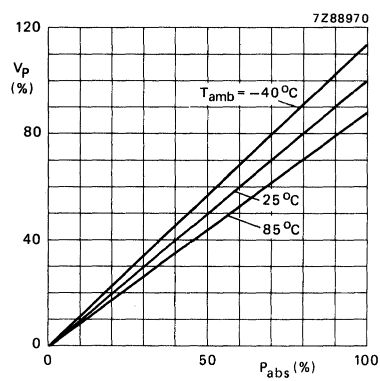


Fig. 6 V_B = constant; V_{off} = 0; without temperature compensation.

MONOLITHIC PRESSURE SENSOR

The KP101A is designed for measurement of atmospheric pressures up to 1,2 bars. The sensor comprises a monolithic silicon vacuum cell incorporating diffused strain gauge resistors and integral sensitivity temperature compensation.

The housing is a plastic moulded 6-pin DIL package with a rigid capillary tube for the pressure connection.

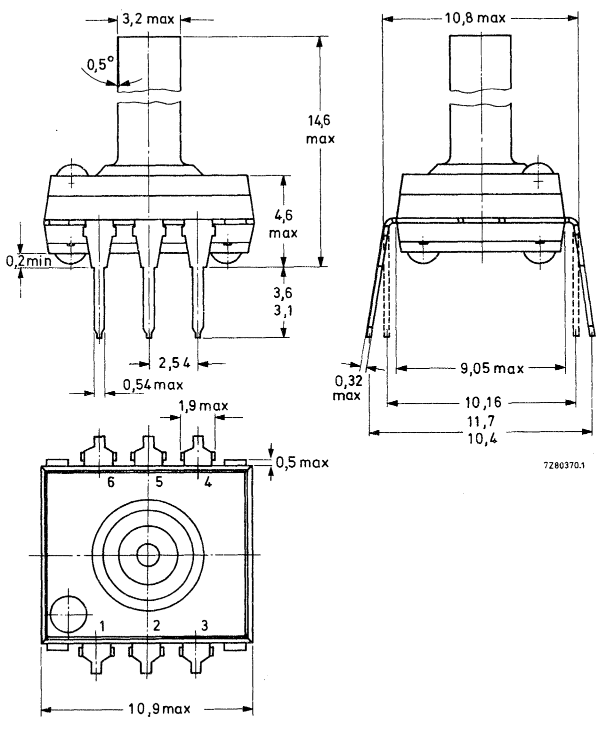
QUICK REFERENCE DATA

Absolute pressure range	P		0 to 1,2	bar
Supply voltage	V_B	typ.	5	V
Operating ambient temperature	T_{amb}		−40 to + 125	°C

MECHANICAL DATA

Dimensions in mm

Fig. 1.



RATINGS

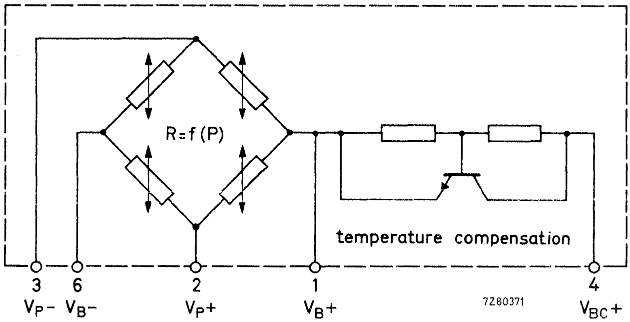
Limiting values in accordance with the Absolute Maximum System (IEC 134)

Supply voltage	V_B	max.	12	V
Maximum pressure (absolute)	P_{max}	max.	2,5	bar
Destructive pressure (absolute)	P_{des}	min.	6	bar
Operating ambient temperature	T_{amb}		−40 to + 125	°C
Lead soldering temperature at $t_{sld} < 10$ s	T_{sld}	max.	260	°C

CHARACTERISTICS

Absolute pressure range	P		0 to 1,2	bar
Bridge resistance (see Fig. 2) T_{amb} = 25 °C	R_{br}		1600 ± 500	Ω
Without temperature compensation				
Supply voltage (terminals 1 and 6)	V_B	typ.	5	V
Sensitivity at T_{amb} = 25 °C	s	typ.	100 (70 to 140)	mV/bar
Temperature coefficient of sensitivity T_{amb} between −40 and + 85 °C	α_s	typ.	−0,22	%/K
Offset voltage T_{amb} = 25 °C	V_{off}		−25 to + 25	mV
Temperature coefficient of offset voltage T_{amb} between −40 and + 85 °C	αV_{off}	typ.	± 0,04	%/K
Non-linearity, hysteresis and repeatability between 0 and 1,2 bar		⩽	0,6	%
Hysteresis with temperature*		⩽	0,5	%
With temperature compensation				
Supply voltage (terminals 4 and 6)	V_B	typ.	5	V
Sensitivity at T_{amb} = 25 °C	s_{comp}	typ.	50 (25 to 75)	mV/bar
Temperature coefficient of sensitivity T_{amb} between −40 and + 85 °C	αs_{comp}	typ.	± 0,03	%/K
Offset voltage T_{amb} = 25 °C	$V_{off\,comp}$	typ.	± 15	mV
Temperature coefficient of offset voltage T_{amb} between −40 and + 85 °C	$\alpha V_{off\,comp}$	typ.	± 0,06	%/K
Non-linearity, hysteresis and repeatability between 0 and 1,2 bar		⩽	0,6	%

* Measured with a linear temperature cycle from −10 °C to + 85 °C with a periodic time of not less than 30 minutes.



V_B+ = pos. supply voltage
V_B- = neg. supply voltage
$V_{BC}+$ = pos. supply voltage for temp. compensation
V_P+ = pos. output voltage
V_P- = neg. output voltage

Fig. 2 Schematic diagram.

DEVELOPMENT DATA

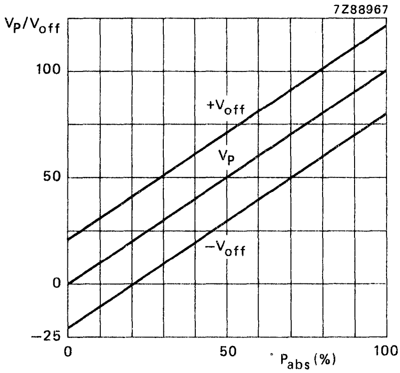


Fig. 3 V_B = constant; T_{amb} = constant.

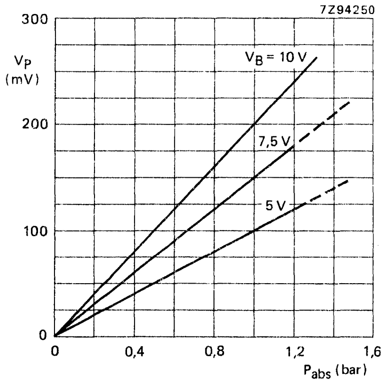


Fig. 4 V_{off} = 0; T_{amb} = 25 °C; without temperature compensation.

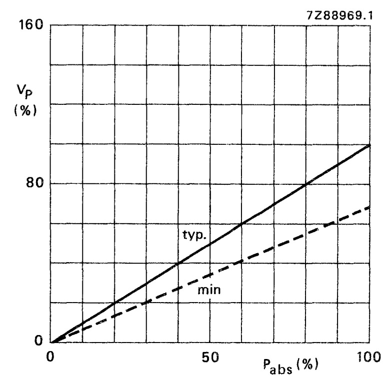


Fig. 5 V_B = constant; V_{off} = 0; T_{amb} = constant.

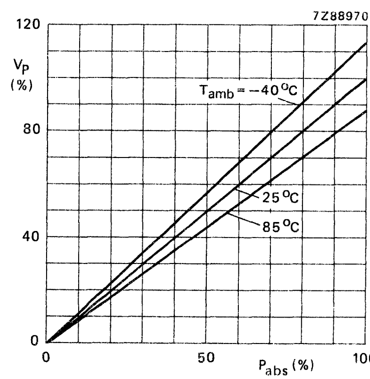


Fig. 6 V_B = constant; offset omitted; without temperature compensation.

THIN-FILM PRESSURE SENSOR

The KPZ20G is designed for measurement of relative pressures up to 2 bar and for a wide range of gasses or fluids. The sensor employs thin-film semiconductor strain gauges deposited on a beryllium copper isolating diaphragm. Sealing is obtained by pressure contact using an O-ring in a groove provided in the transfer-moulded body and electrical connections are made via silver-plated lead-outs to form a dual-in-line configuration.

All pressure media, which do not attack CuBe, epoxy novolack plastic, epoxy glue and assembly parts, may be used.

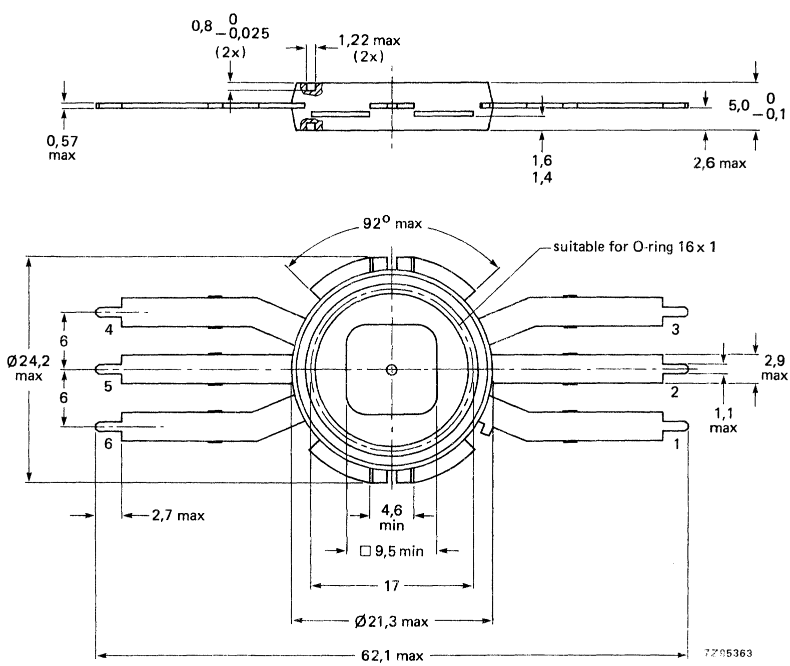
QUICK REFERENCE DATA

Pressure range	P		−1 to 2 bar
Supply voltage	V_B	typ.	7,5 V
Operating ambient temperature	T_{amb}		−40 to + 125 °C

MECHANICAL DATA

Dimensions in mm

Fig. 1.



RATINGS

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

Supply voltage	V_B	max.	16	V
Maximum pressure	P_{max}	max.	5	bar
Destructive pressure	P_{des}	min.	10	bar
Operating ambient temperature	T_{amb}		−40 to + 125	°C
Storage temperature	T_{stg}	max.	140	°C
Lead soldering temperature at $t_{sld} < 10$ s	T_{sld}	max.	260	°C*

CHARACTERISTICS

Supply voltage	V_B	typ.	7,5	V
Pressure range	P_{typ}		−1 to + 2	bar
Sensitivity T_{amb} = 25 °C	s		10,5 ± 3,5	mV/Vbar
Temperature coefficient of sensitivity T_{amb} between −40 and + 85 °C	α_s	typ.	−0,15	%/K
Bridge resistance T_{amb} = 25 °C	R_{br}	typ.	2000	Ω
Offset voltage T_{amb} = 25 °C	V_{off}	max.	± 5	mV/V
Temperature coefficient of offset voltage T_{amb} between −40 and + 85 °C	α_{off}	max.	± 0,05	%/K
Non-linearity and hysteresis at T_{amb} = 25 °C P_{typ} between −1 and 2 bar		max.	± 0,7	%

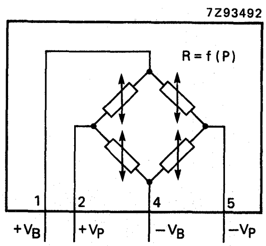


Fig. 2 Schematic diagram.
V_B = supply voltage
V_P = output voltage

* Solderability may be affected by high temperature storage over longer periods.

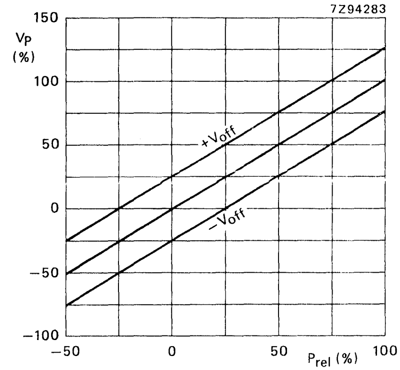


Fig. 3 V_B = constant; T_{amb} = constant.

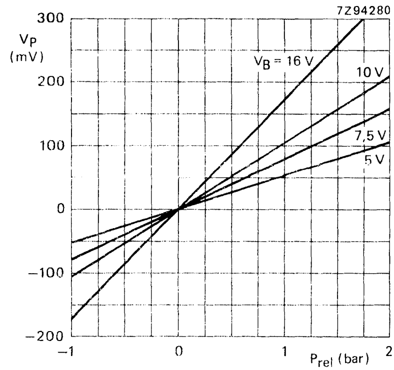


Fig. 4 V_{off} = 0; T_{amb} = 25 °C.

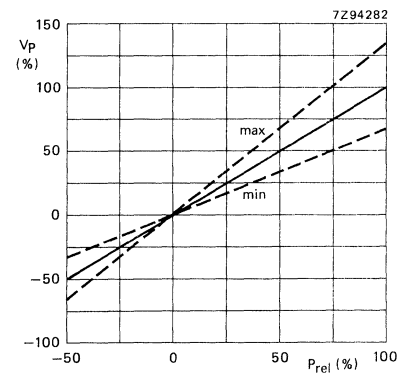


Fig. 5 V_B = constant; V_{off} = 0; T_{amb} = constant.

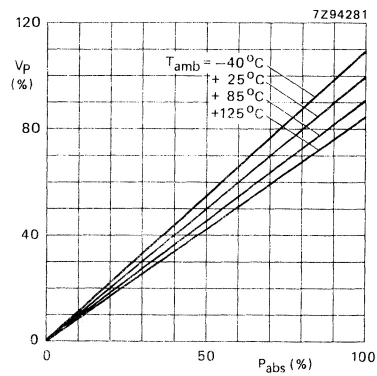


Fig. 6 V_B = constant; offset omitted.

THIN-FILM PRESSURE SENSOR

The KPZ21G is designed for measurement of relative pressures up to 10 bar and for a wide range of gases or fluids. The sensor employs thin-film semiconductor strain gauges deposited on a beryllium copper isolating diaphragm. Sealing is obtained by pressure contact using an O-ring in a groove provided in the transfer-moulded body and electrical connections are made via silverplated leads-outs to form a dual-in-line configuration.

All pressure media, which do not attack CuBe, epoxy novolack plastic, epoxy glue and assembly parts, may be used.

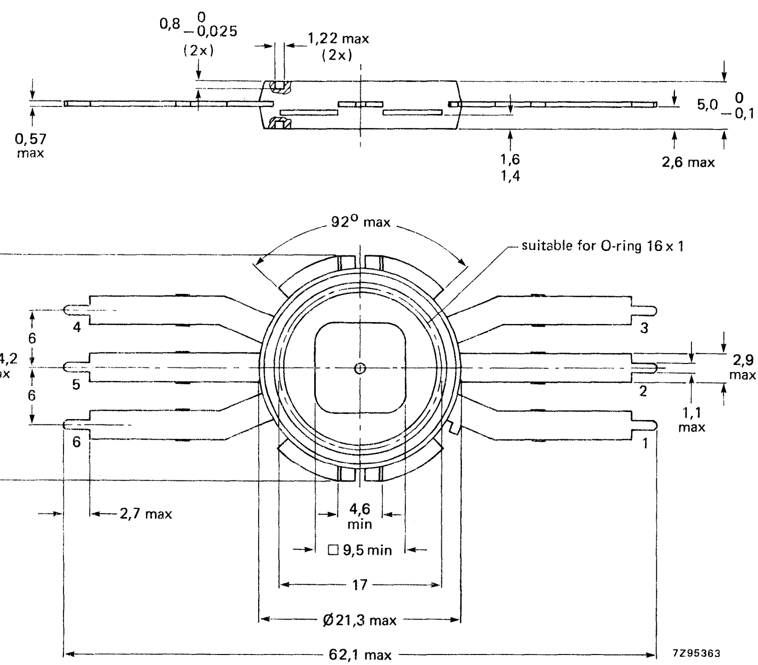
QUICK REFERENCE DATA

Pressure range	P		−1 to 10	bar
Supply voltage	V_B	typ.	7,5	V
Operating ambient temperature	T_{amb}		−40 to + 125	°C

MECHANICAL DATA

Dimensions in mm

Fig. 1.



RATINGS

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

Supply voltage	V_B	max.	16	V
Maximum pressure	P_{max}	max.	20	bar
Destructive pressure	P_{des}	min.	30	bar
Operating ambient temperature	T_{amb}	−40 to + 125		°C
Storage temperature	T_{stg}	max.	140	°C
Lead soldering temperature at $t_{sld} < 10$ s	T_{sld}	max.	260	°C*

CHARACTERISTICS

Supply voltage	V_B	typ.	7,5	V
Pressure range	P_{typ}		−1 to + 10	bar
Sensitivity T_{amb} = 25 °C	s		3,5 ± 1	mV/Vbar
Temperature coefficient of sensitivity T_{amb} between −40 and + 85 °C	α_s	typ.	−0,14	%/K
Bridge resistance T_{amb} = 25 °C	R_{br}	typ.	2000	Ω
Offset voltage T_{amb} = 25 °C	V_{off}	max.	± 5	mV/V
Temperature coefficient of offset voltage T_{amb} between −40 and + 85 °C	α_{off}	max.	± 0,05	%/K
Non-linearity and hysteresis P_{typ} between 0 and 10 bar		max.	± 0,7	%

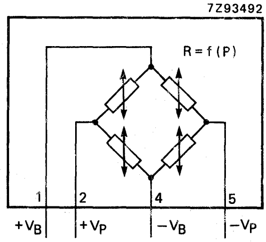


Fig. 2 Schematic diagram.

V_B = supply voltage
V_P = output voltage

* Solderability may be affected by high temperature storage over longer periods.

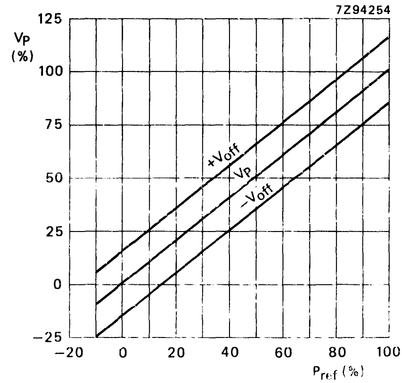


Fig. 3 V_B = constant; T_{amb} = constant.

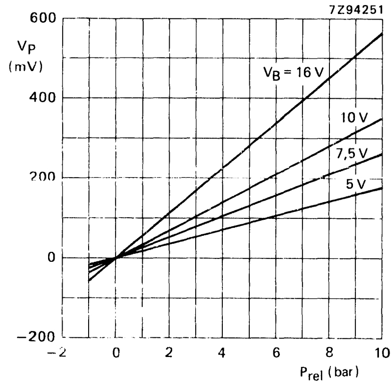


Fig. 4 $V_{off} = 0$; T_{amb} = 25 °C.

DEVELOPMENT DATA

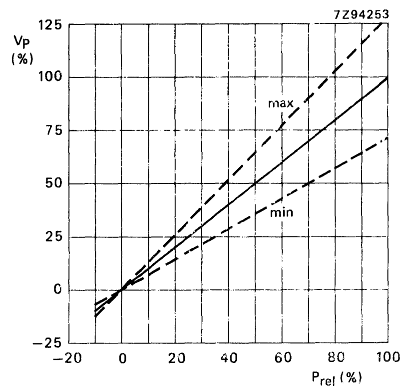


Fig. 5 V_B = constant; $V_{off} = 0$; T_{amb} = constant.

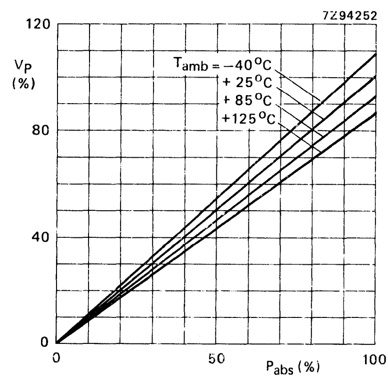


Fig. 6 V_B = constant; offset omitted.

TEMPERATURE SENSORS

SILICON TEMPERATURE SENSORS

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

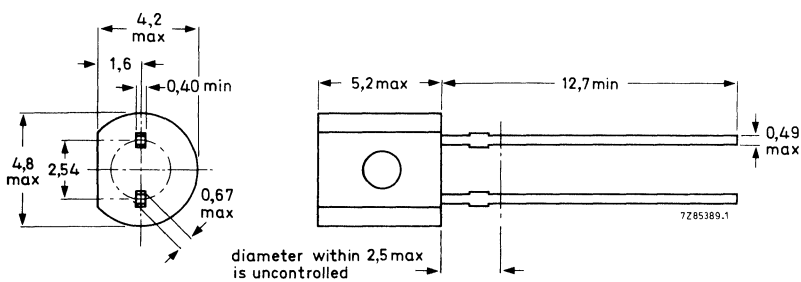
QUICK REFERENCE DATA

Resistance at T_{amb} = 25 °C			
I = 1 mA	KTY81-110	R_{25}	1000 Ω ± 1 %
	KTY81-120	R_{25}	1000 Ω ± 2 %
Measuring temperature range			−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_D	max.	10 mA
T_{amb} = 150 °C	I_D	max.	2 mA

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Resistance			
I = 1 mA, KTY81-110	R_{25}	typ.	1000 Ω
			990 to 1010 Ω
KTY81-120	R_{25}	typ.	1000 Ω
			980 to 1020 Ω
Temperature coefficient		typ.	0,75 %/K
R_{100}/R_{25}			1,69 ± 0,02
R_{-55}/R_{25}			0,49 ± 0,01
Thermal time constant*			
in still air		typ.	50 s
in still liquid**		typ.	5 s
in flowing liquid**		typ.	3 s
Measuring temperature range			−55 to + 150 °C

Ambient temperatures and correponding resistance values of sensor

T_{amb} °C	resistance Ω
−55	495
−50	514
−40	568
−30	625
−20	686
−10	750
0	817
10	887
20	961
25	1000
30	1039
40	1120

T_{amb} °C	resistance Ω
50	1205
60	1295
70	1390
80	1489
90	1591
100	1696
110	1804
120	1915
130	2017
140	2120
150	2225

* 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.

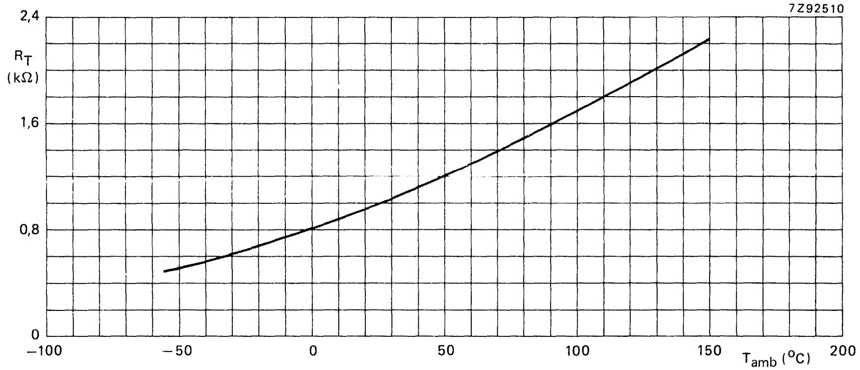


Fig. 2 Resistance value of sensor at I = 1 mA as a function of temperature.

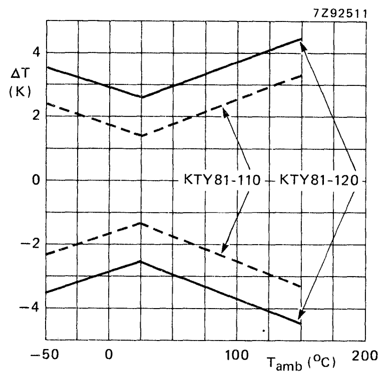


Fig. 3 Absolute error ΔT (standard deviation) expected from a KTY81-100 temperature sensor.

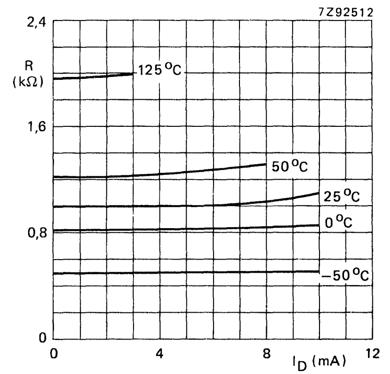


Fig. 4 Sensor resistance versus operating current.

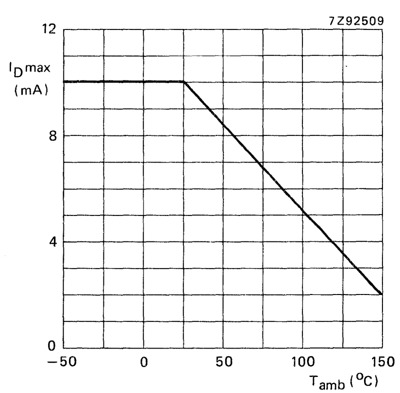


Fig. 5 Maximum operating current for safe operation.

SILICON TEMPERATURE SENSORS

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

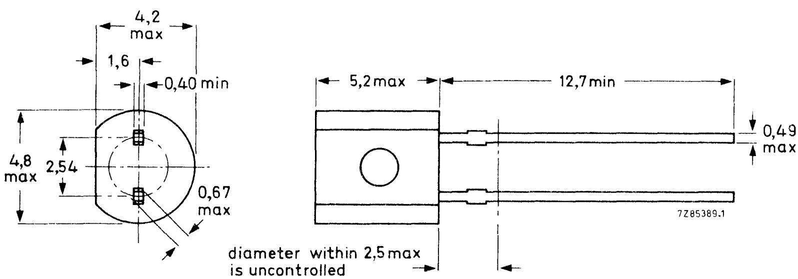
QUICK REFERENCE DATA

Resistance at T_{amb} = 25 °C I = 0,5 mA	KTY81-210	R_{25}	2000 Ω ± 1 %
	KTY81-220	R_{25}	2000 Ω ± 2 %
Measuring temperature range			−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_D	max.	10	mA
T_{amb} = 150 °C	I_D	max.	2	mA

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Resistance					
I = 0,5 mA	KTY81-210	R_{25}	typ.	2000	Ω
				1980 to 2020	Ω
	KTY81-220	R_{25}	typ.	2000	Ω
				1960 to 2040	Ω
Temperature coefficient			typ.	0,75	%/K
R_{100}/R_{25}				1,69 ± 0,02	
R_{-55}/R_{25}				0,49 ± 0,01	
Thermal time constant*					
in still air			typ.	50	s
in still liquid**			typ.	5	s
in flowing liquid**			typ.	3	s
Measuring temperature range				–55 to + 150	°C

Ambient temperatures and corresponding resistance values of sensor

T_{amb} °C	resistance Ω
–55	990
–50	1028
–40	1136
–30	1250
–20	1372
–10	1500
0	1634
10	1774
20	1922
25	2000
30	2078
40	2240

T_{amb} °C	resistance Ω
50	2410
60	2590
70	2780
80	2978
90	3182
100	3392
110	3593
120	3800
125	3904
130	4005
140	4180
150	4306

* 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.

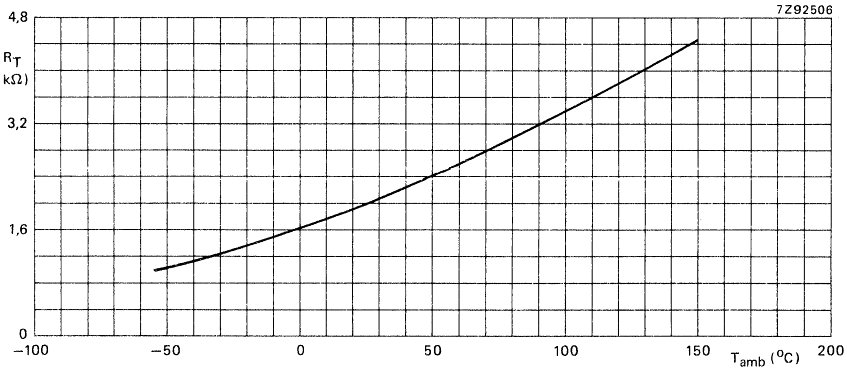


Fig. 2 Resistance value of sensor at I = 0,5 mA as a function of temperature.

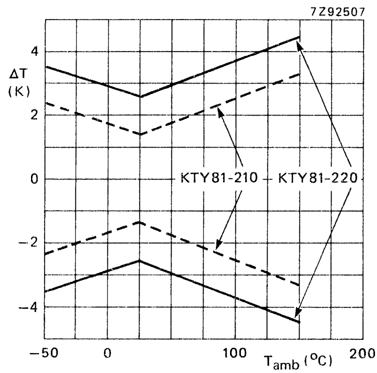


Fig. 3 Absolute error ΔT (standard deviation) expected from a KTY81-200 temperature sensor.

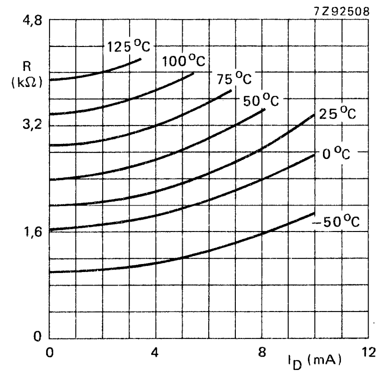


Fig. 4 Sensor resistance versus operating current.

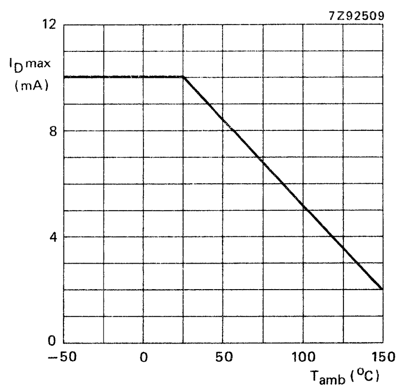


Fig. 5 Maximum operating current for safe operation.

SILICON TEMPERATURE SENSORS

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

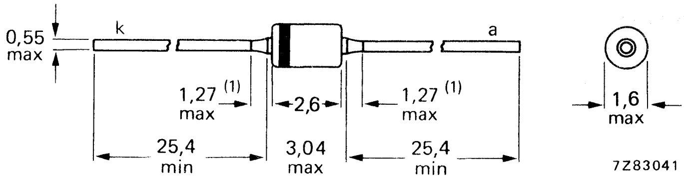
QUICK REFERENCE DATA

Resistance at T_{amb} = 25 °C I = 1 mA	KTY83-110	R_{25}	1000 Ω ± 1 %
	KTY83-120	R_{25}	1000 Ω ± 2 %
Measuring temperature range			−55 to + 175 °C

MECHANICAL DATA

Dimensions in mm

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



(1) Lead diameter in this zone uncontrolled.

RATINGS

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

Continuous sensor current in free air			
T_{amb} = 25 °C	I_D	max.	10 mA
T_{amb} = 175 °C	I_D	max.	2 mA

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Resistance				
I = 1 mA	KTY83-110	R_{25}	typ.	1000 Ω
				990 to 1010 Ω
	KTY83-120	R_{25}	typ.	1000 Ω
				980 to 1020 Ω
Temperature coefficient			typ.	0,75 %/K
R_{100}/R_{25}				1,68 ± 0,02
R_{-55}/R_{25}				0,49 ± 0,01
Thermal time constant*				
in still air			typ.	40 s
in still liquid**			typ.	1 s
in flowing liquid**			typ.	0,5 s
Measuring temperature range				−55 to +175 °C

Ambient temperatures and corresponding resistance values of sensor

T_{amb} °C	resistance Ω
−55	495
−50	520
−40	572
−30	627
−20	687
−10	750
0	817
10	887
20	961
25	1000
30	1039
40	1121

T_{amb} °C	resistance Ω
50	1206
60	1295
70	1387
80	1483
90	1583
100	1687
110	1794
120	1905
125	1962
130	2020
140	2138
150	2260

* 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.

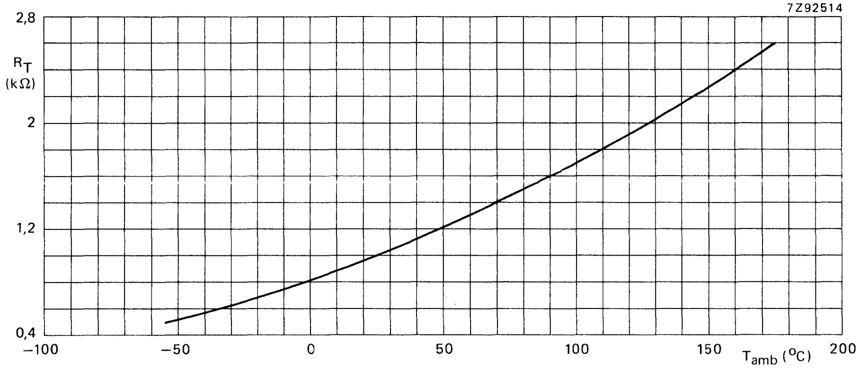


Fig. 2 Resistance value of sensor at I = 1 mA as a function of temperature.

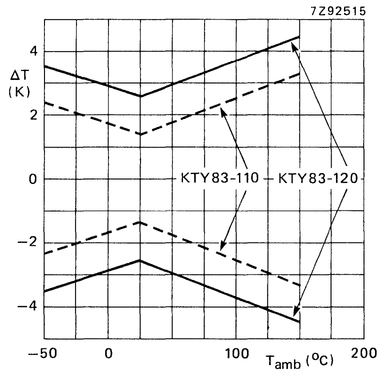


Fig. 3 Absolute error ΔT (standard deviation) expected from a KTY83-100 temperature sensor.

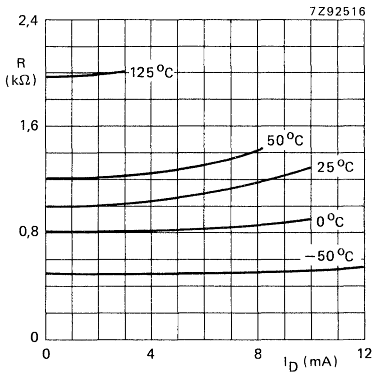


Fig. 4 Series resistance versus operating current.

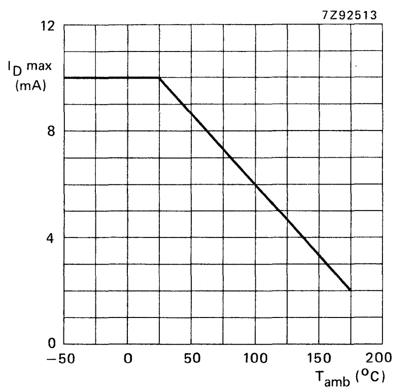


Fig. 5 Maximum operating current for safe operation.

SILICON TEMPERATURE SENSORS

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

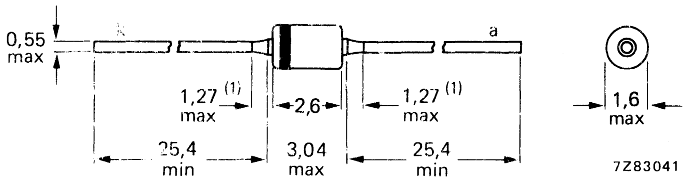
QUICK REFERENCE DATA

Resistance at T_{amb} = 100 °C I = 2 mA	KTY84-130	R_{100}	1000 Ω ± 3 %
	KTY84-150	R_{100}	1000 Ω ± 5 %
Measuring temperature range			0 to + 300 °C

MECHANICAL DATA

Dimensions in mm

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



(1) Lead diameter in this zone uncontrolled.

The sensor has to be operated in the forward biased condition.

RATINGS

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

Continuous sensor current in free air				
T_{amb} = 25 °C	I_D	max;	10	mA
T_{amb} = 300 °C	I_D	max.	4	mA

CHARACTERISTICS

Resistance					
I = 2 mA; T_{amb} = 100 °C 1)	KTY84-130	R_{100}	typ.	1000	Ω
				970 to 1030	Ω
	KTY84-150	R_{100}	typ.	1000	Ω
				950 to 1050	Ω
Temperature coefficient			typ.	0,60	%/K
R_{250}/R_{100}				2,185 ± 0,04	
R_{25}/R_{100}				0,592 ± 0,01	
Thermal time constant 2)					
in still air			typ.	40	s
in still liquid 3)			typ.	1	s
in flowing liquid 3)			typ.	0,5	s
Measuring temperature range				0 to + 300	°C
Storage temperature				−55 to + 300	°C

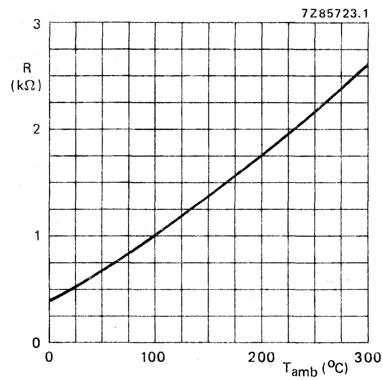


Fig. 2 Resistance value of sensor at I = 2 mA as a function of ambient temperature.

1) For operation over 200 °C a current I ⩾ 2 mA is prescribed.
2) 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.
3) Inert liquid FC43 of 3M.

RESISTANCE VALUES for KTY84

Degree C	Resistance (Ω)
0	486
10	528
20	572
30	618
40	666
50	716
60	769
70	823
80	880
90	939
100	1000
110	1063
120	1128
130	1195
140	1264
150	1336
160	1409
170	1485
180	1563
190	1643
200	1725
210	1809
220	1896
230	1984
240	2076
250	2170
260	2263
270	2359
280	2458
290	2559
300	2662

HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

OM-	L x W mm (max.)	V_S V	I_o mA	false polarity protection	short-circuit/ overload prot.	R_X discr.	R_X integr.
286	35,2 x 5	4,5 – 30	50 – 250*	supply	no	yes	no
287	35,2 x 5	4,5 – 30	50 – 250*	supply	no	yes	no
286M	22,6 x 5	4,5 – 30	50 – 250*	supply	no	yes	no
287M	22,6 x 5	4,5 – 30	50 – 250*	supply	no	yes	no
386B	43,6 x 5	10 – 30	250	supply/load	yes	yes	yes
387B	43,6 x 5	10 – 30	250	supply/load	yes	yes	yes
386M	22,5 x 5**	10 – 30	200	supply/load	yes	yes	yes
387M	22,5 x 5**	10 – 30	200	supply/load	yes	yes	yes
388B	25,6 x 8,2	10 – 30	250	supply/load	yes	yes	yes
389B	25,6 x 8,2	10 – 30	250	supply/load	yes	yes	yes

* Depending upon supply voltage (for odd-numbered types: reverse polarity).

** After assembling.

NOTE: 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 OM286 and OM286M are for positive supply voltage and the OM287 and OM287M are for negative supply voltage. The circuit consists of an oscillator, a rectifier stage, a Schmitt trigger and an output stage. 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.

The output transistor is protected against transients from the inductive load by a voltage regulator diode. The circuit is protected against false polarity connection of the supply voltage.

The devices OM286/OM287 are thick-film circuits and the OM287M/OM287M are thin-film circuits deposited on ceramic substrates. They may be potted, together with the oscillator coil and a resistor (R_X), in a non-magnetic tube.

QUICK REFERENCE DATA

D.C. supply voltage range	V_B		4,5 to 30	V
Output current at V_B = 24 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	^oC
Substrate length of OM286 and OM287	L		35,0 ±0,2	mm
Substrate length of OM286M and OM287M	L		22,4 ±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. 1a and 1b (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 Dimensions in mm

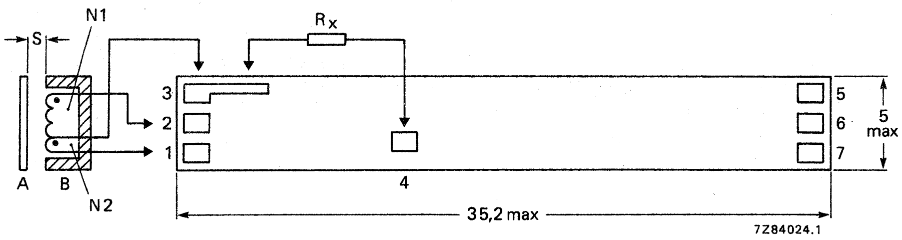


Fig. 1a OM286/OM287.

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

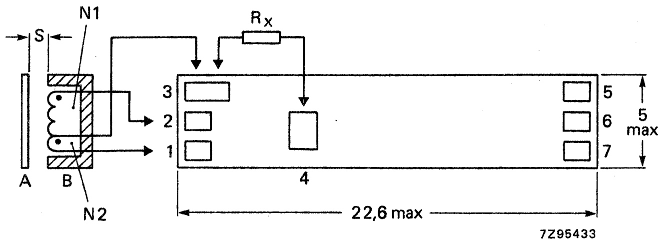


Fig. 1b OM286M/OM287M.

Mechanical outline and connections: note that the supply polarities to points 5 and 7 are given for the OM286 and OM286M; for the OM287 and OM287M the polarities are point 5: $-V_B$, and point 7: $+V_B$.

S is the operating distance.

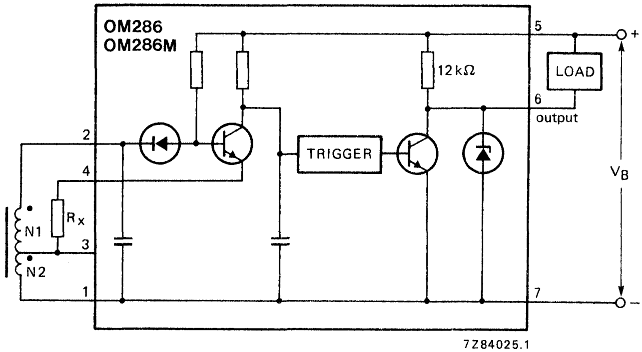


Fig. 2 Circuit diagram of OM286 and OM286M.

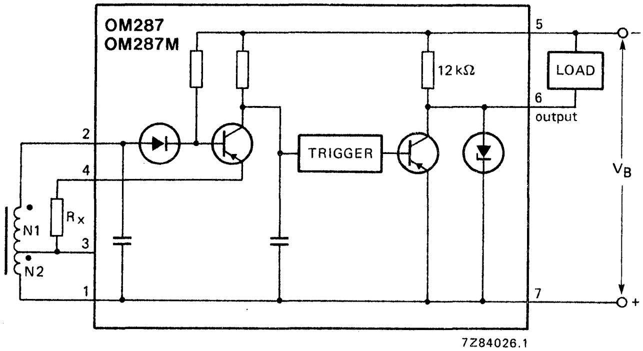


Fig. 3 Circuit diagram of OM287 and OM287M.

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" output stage "OFF"	I_B	typ. typ.	9,0 mA 7,7 mA
Voltage drop I_o = 250 mA I_o = 10 mA	V_d	max. max.	1 V 0,25 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. Influence of supply voltage: −1 μm/V for V_B = 15 to 30 V.

Temperature coefficient of S:
M8 : 0,2 %/K
M12: 0,17 %/K
M18: 0,1 %/K

** Grade 3B7/3H1.

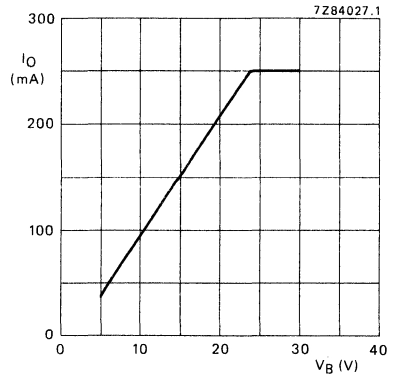


Fig. 4 Maximum allowable output current as a function of supply voltage; T_s = 25 °C.

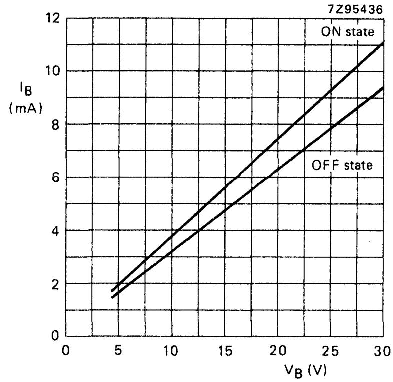


Fig. 5 Supply current as a function of supply voltage; T_s = 25 °C; typical values.

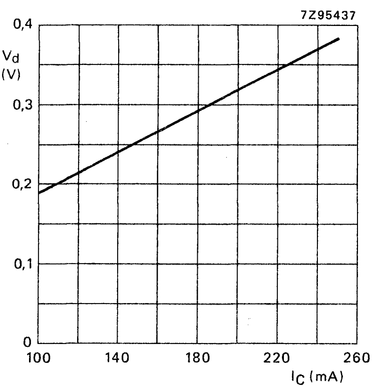


Fig. 6 Voltage drop as a function of output current; V_B = 24 V; T_s = 25 °C; typical values.

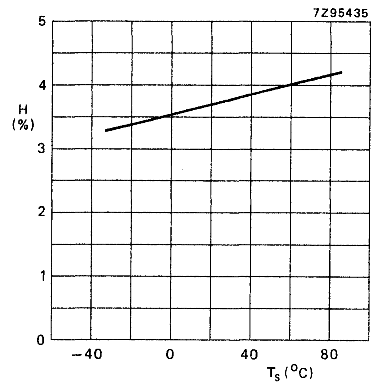
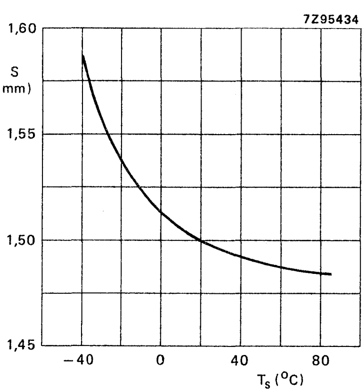


Fig. 7 Hysteresis as a function of substrate temperature; typical values.



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

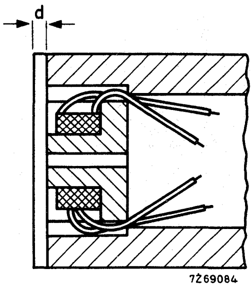


Fig. 9 Insertion of potcore in brass tube.

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 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

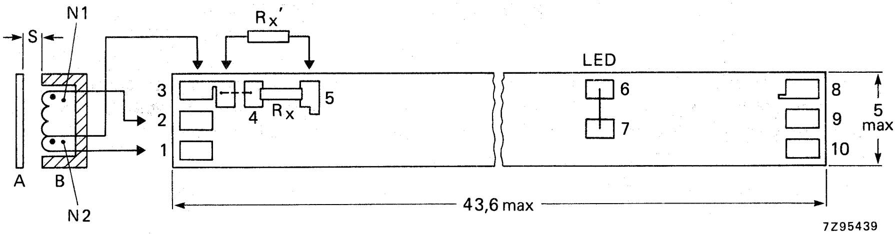
Dimensions in mm

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.

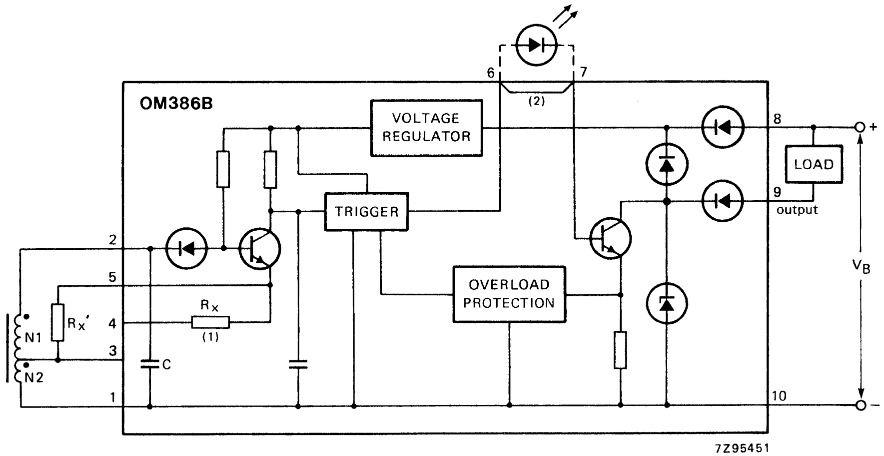


Fig. 2 Circuit diagram of OM386B.

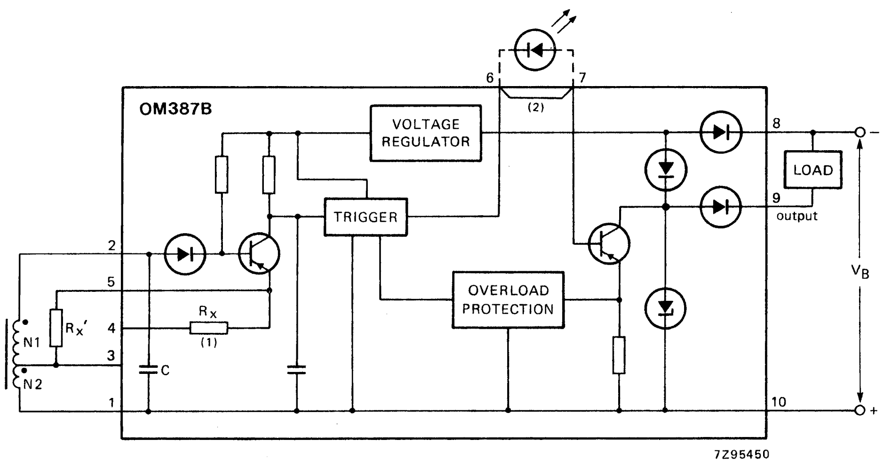


Fig. 3 Circuit diagram of OM387B.

(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"	I_B	typ.	4,8 mA
Voltage drop			
I_o = 250 mA	V_d	max.	1,9 V
I_o = 10 mA	V_d	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.

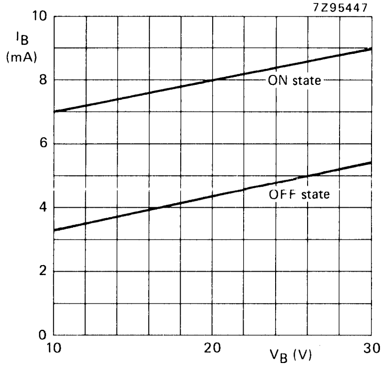


Fig. 4 Supply current as a function of supply voltage; T_S = 25 °C.

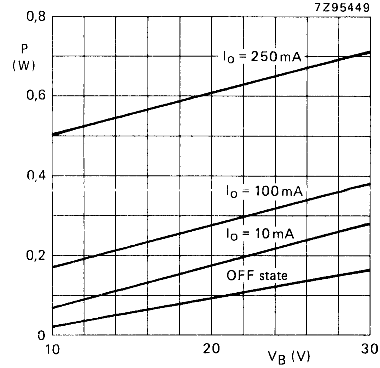


Fig. 5 Power dissipation as a function of supply voltage.

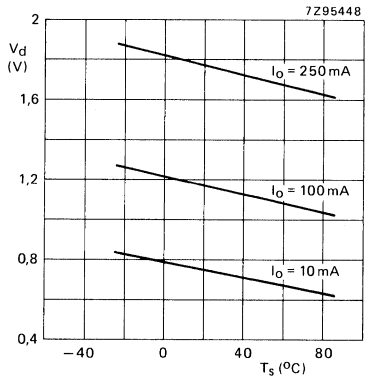


Fig. 6 Voltage drop as a function of substrate temperature.

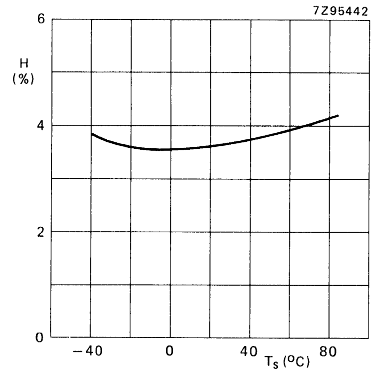
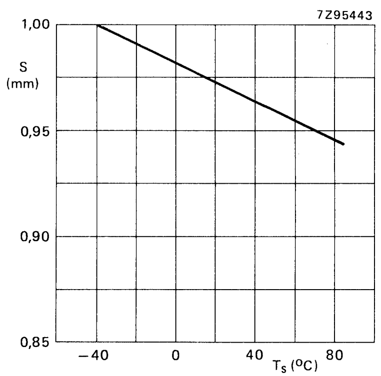


Fig. 7 Hysteresis as a function of substrate temperature.



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

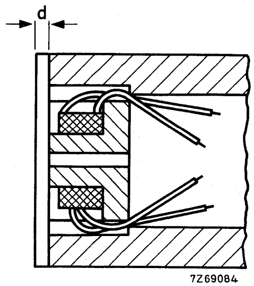


Fig. 9 Insertion of potcore in brass tube.

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 ^{o}C).

The substrate is preferably preheated to a temperature of 100 ^{o}C with a minimum of 80 ^{o}C and a maximum of 125 ^{o}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	^oC
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

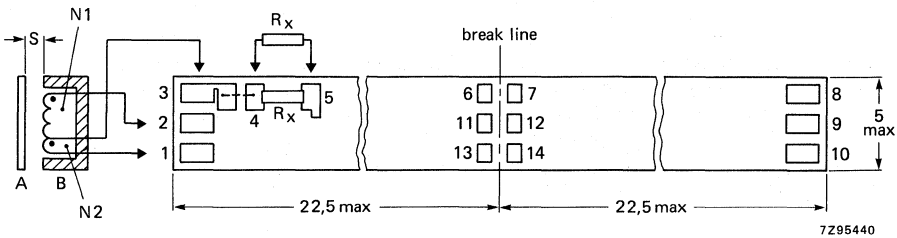
Fig. 1 (see next page).

* 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.

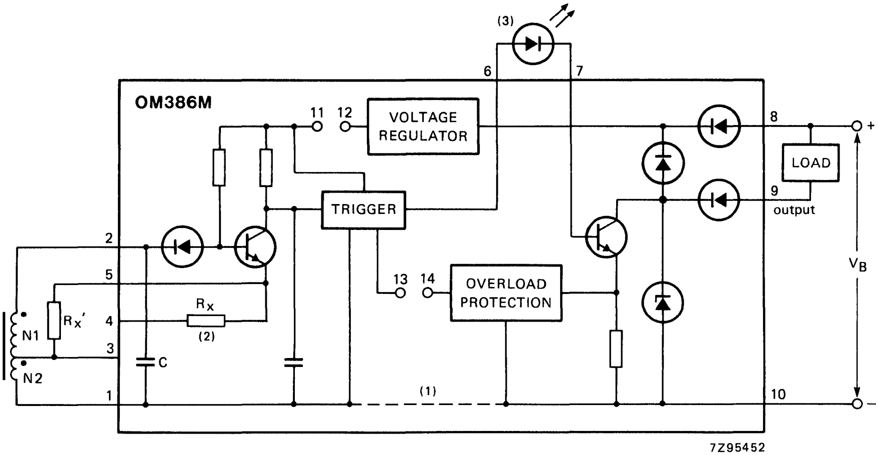


Fig. 2 Circuit diagram of OM386M.

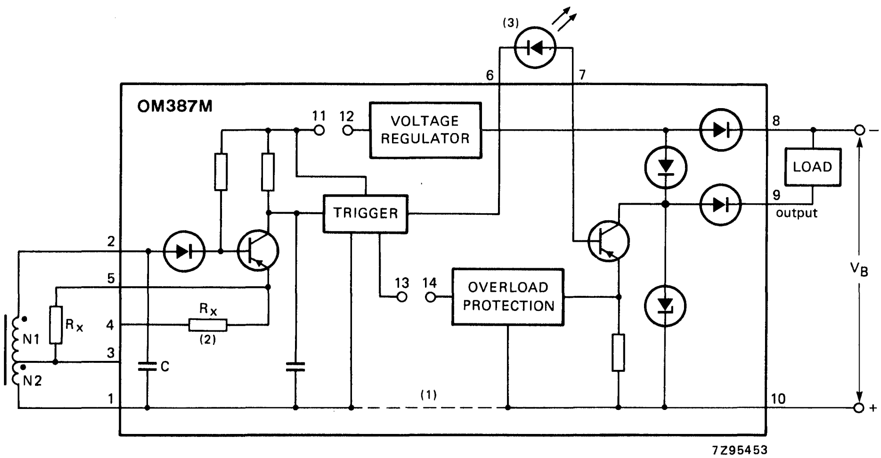


Fig. 3 Circuit diagram of OM387M.

(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"	I_B	typ.	4,8 mA
Voltage drop			
I_o = 200 mA	V_d	max.	1,9 V
I_o = 10 mA	V_d	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.

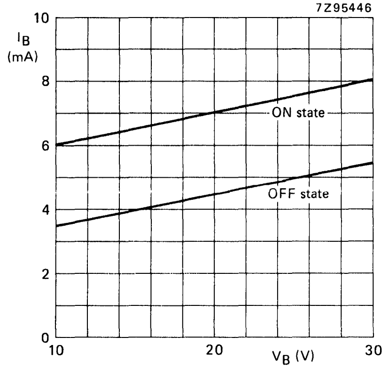


Fig. 4 Supply current as a function of supply voltage; T_S = 25 °C.

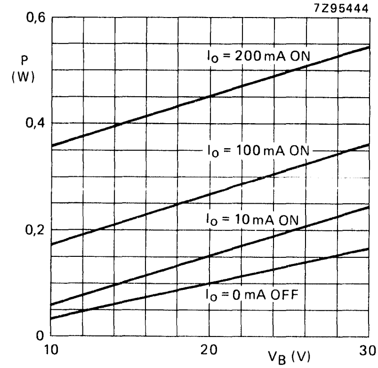


Fig. 5 Power dissipation as a function of supply voltage.

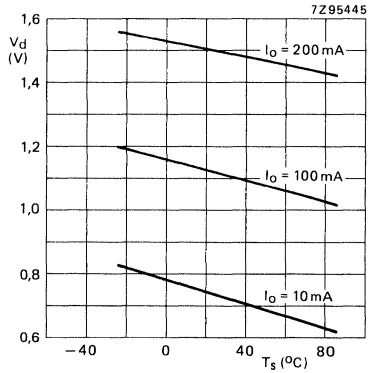


Fig. 6 Voltage drop as a function of substrate temperature.

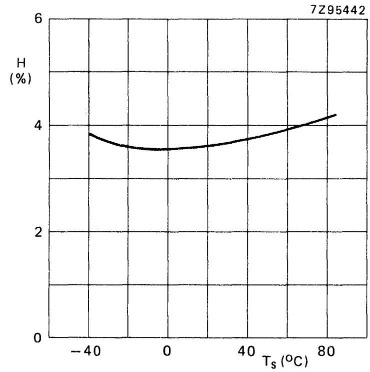
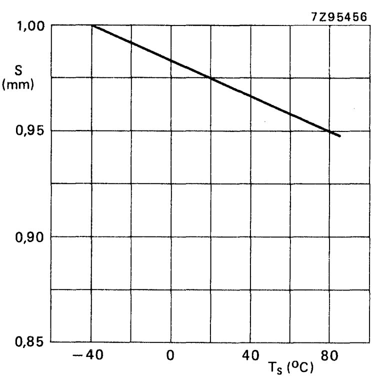


Fig. 7 Hysteresis as a function of substrate temperature.



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

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.

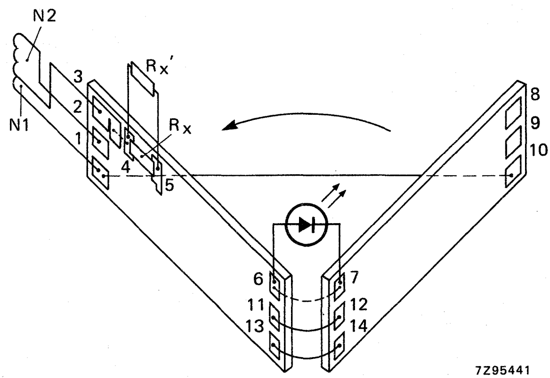


Fig. 9 If no LED is used, connect point 6 to point 7;
connect points 11 and 12, point 13 to 14 and point 1 to point 10.

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.

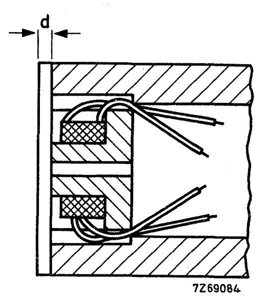


Fig. 10 Insertion of potcore in brass tube.

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

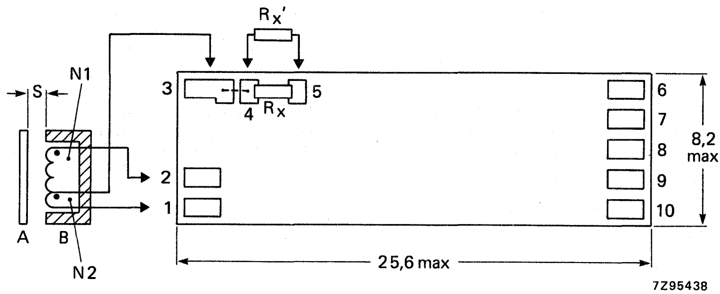
Dimensions in mm

Fig. 1 (see next page).

* 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.

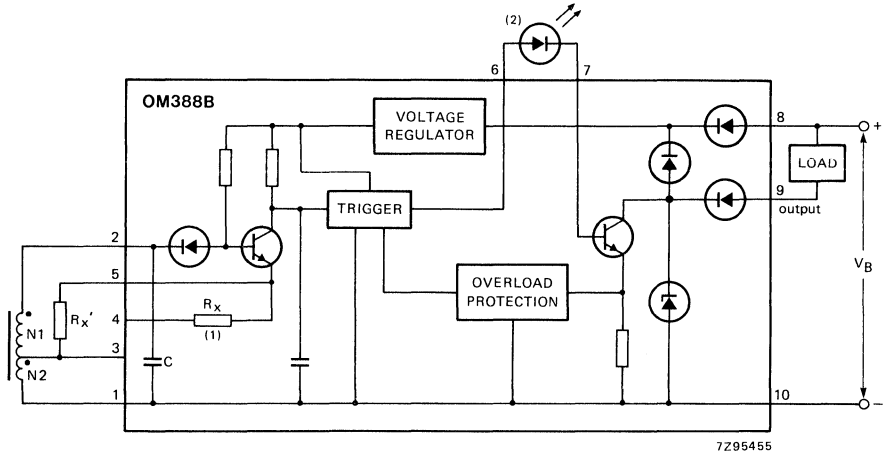


Fig. 2 Circuit diagram of OM388B.

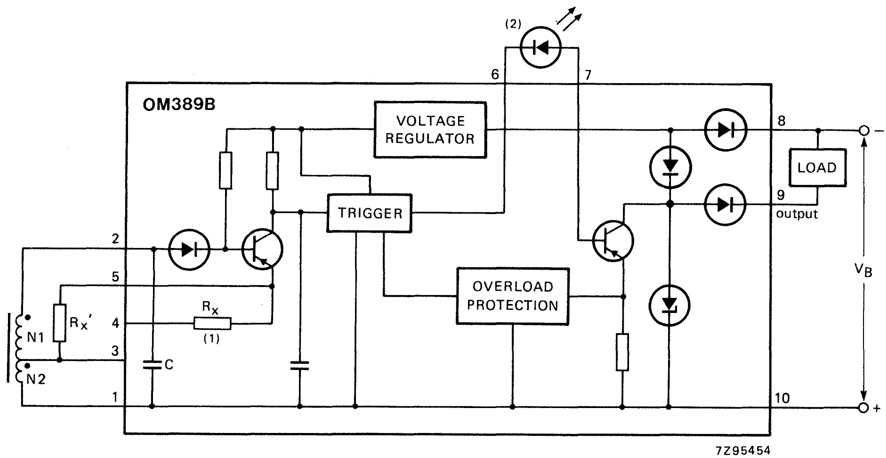


Fig. 3 Circuit diagram of OM389B.

(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"	I_B	typ.	4,8 mA
Voltage drop			
I_o = 250 mA	V_d	max.	1,9 V
I_o = 10 mA	V_d	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

* 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.

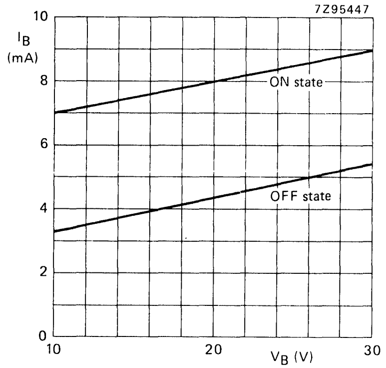


Fig. 4 Supply current as a function of supply voltage; $T_s = 25\ ^oC$.

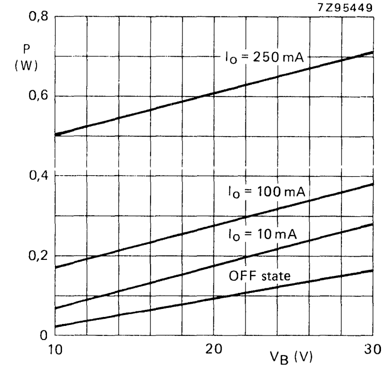


Fig. 5 Power dissipation as a function of supply voltage.

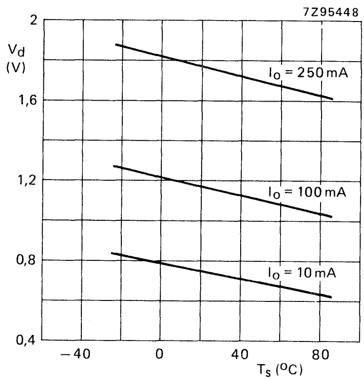


Fig. 6 Voltage drop as a function of substrate temperature.

MOUNTING RECOMMENDATIONS

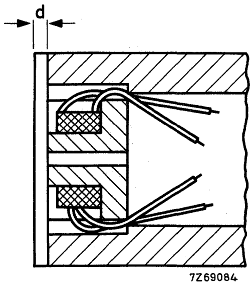


Fig. 7 Insertion of potcore in brass tube.

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.

INDEX OF TYPE NUMBERS

The inclusion of a type number in this publication does not necessarily imply its availability.

Mm = Microminiature semiconductors for hybrid circuits
SD = Small-signal diodes
Sp = Special diodes
T = Tuner diodes
Vrg = Voltage regulator diodes
Sm = Small-signal transistors

* = series
FET = Field-effect transistors
Mm = Microminiature semicondcutors for hybrid circuits
P = Low-frequency power transistors
Sm = Small-signal transistors

P = Low-frequency power transistors

P = Low-frequency power transistors

FET = Field-effect transistors
HVP = High-voltage power transistors
Mm = Microminiature semiconductors for hybrid circuits
P = Low-frequency power transistors
Sm = Small-signal transistors
WBT = Wideband hybrid IC transistors

* = series
FET = Field-effect transistors
Mm = Microminiature semiconductors for hybrid circuits
RFP = R.F. power transistors and modules
RT = Tripler
Sm = Small-signal transistors
ThM = Thyristor modules
WBM = Wideband hybrid IC modules
WBT = Wideband hybrid IC transistors

* = series
RFP = R.F. power transistors and modules
WBM = Wideband hybrid IC modules

FET = Field-effect transistors
Mm = Microminiature semiconductors for hybrid circuits
Sm = Small-signal transistors
PDT = Photodiodes or transistors
Th = Thyristors
RFP = R.F. power transistors and modules

* = series
PM = Power MOS transistors
SP = Low-frequency switching power transistors
Sm = Small-signal transistors
Th = Thyristors
Tri = Triacs

* = series
R = Rectifier diodes
PM = Power MOS transistors

* = series
D = Displays
LED = Light-emitting diodes
M = Microwave transistors
Mm = Microminiature semiconductors
Ph = Photoconductive devices
PhC = Photocouplers
R = Rectifier diodes
TS = Transient suppressor diodes
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes

* = series
FET = Field-effect transistors
LED = Light-emitting diodes
M = Microwave transistors
P = Low-frequency power transistors
St = Rectified stacks
WBM = Wideband hybrid IC modules

* = series
I = Infrared devices
M = Microwave transistors
P = Low-frequency power transistors
Ph = Photoconductive diodes
R = Rectifier diodes
Sm = Small-signal transistors
SP = Low-frequency switching power transistors
Vrf = Voltage reference diodes

A = Accessories
FET = Field-effect transistors
I = Infrared devices
Ph = Photoconductive devices
R = Rectified diodes
RFP = R.F. power transistors and modules
SD = Small-signal diodes
Sm = Small-signal transistors
Vrf = Voltage reference diodes
WBT = Wideband transistors

A = Accessories

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