DISCRETE SEMICONDUCTORS

Semiconductor Sensors

BOOK SC17 1991

Philips Components

PHILIPS

SEMICONDUCTOR SENSORS

SELECTION GUIDE

Semiconductor sensors

Selection guide

MAGNETIC FIELD SENSORS

TYPE	FIELD RANGE kA/m (note 1)	SUPPLY VOLTAGE V	T_{amb} °C	SENSITIVITY mV/V kA/m	BRIDGE RESISTANCE kΩ	PAGE
KMZ10A	−0.5 to +0.5	5	−40 to 150	16	1.2	53
KMZ10A1	−0.05 to +0.05	5	−40 to 150	22 (note 2)	1.3	57
KMZ10B	−2.0 to +2.0	5	−40 to 150	4	1.7	61
KMZ10C	−7.5 to +7.5	5	−40 to 150	1.5	1.4	65

Notes

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

PRESSURE SENSORS

TYPE	PRESSURE RANGE bar (note 1)	SUPPLY VOLTAGE V	T_{amb} °C	SENSITIVITY (T_{amb} = 25°C) mV/Vbar	BRIDGE RESISTANCE kΩ	INTEGRATED TEMPERATURE COMPENSATION	PAGE
KP100A	0 to 2 (abs.)	7.5	−40 to 125	13	1.8	Y	71
KP100A1	0 to 2 (abs.)	5	−40 to 125	13	1.8	Y	75
KP101A	0 to 1.2 (abs.)	5	−40 to 125	21	1.6	Y	79
KP130AE	0.2 to 2 (abs.)	5	−40 to 120	450	N/A note 2	Y	83
KP131AE	0.1 to 1.12 (abs.)	5	−40 to 120	800	N/A note 2	Y	89
KPZ20G	−1 to 2 (rel.)	7.5	−40 to 125	10.5	2.0	N	95
KPZ21G	−1 to 10 (rel.)	7.5	−40 to 125	3.5	2.0	N	99
KPZ21GE	−1 to 10 (rel.)	6.1	−40 to 120	500	N/A note 2	Y	103

Notes

1. 1 bar corresponds to 100 kPa and to 14.5 PSI.
2. Integrated signal processing; R_L = 5 kΩ min.

TEMPERATURE SENSORS

TYPE	TEMPERATURE RANGE °C	RESISTANCE R at T_{amb}		SENSOR ACCURACY at T_{amb}		SENSOR CURRENT mA	PAGE
		Ω	°C	°C	°C		
KTY81-110	–55 to 150	990 to 1010	25	±1.3	25	1	113
KTY81-120 (note 1)	–55 to 150	980 to 1020	25	±2.5	25	1	113
KTY81-121	–55 to 150	980 to 1000	25	±1.3	25	1	113
KTY81-122	–55 to 150	1000 to 1020	25	±1.3	25	1	113
KTY81-150 (note 2)	–55 to 150	950 to 1050	25	±6.3	25	1	113
KTY81-151	–55 to 150	950 to 1000	25	±3.2	25	1	113
KTY81-152	–55 to 150	1000 to 1050	25	±3.2	25	1	113
KTY81-210	–55 to 150	1980 to 2020	25	±1.3	25	1	117
KTY81-220 (note 1)	–55 to 150	1960 to 2040	25	±2.5	25	1	117
KTY81-221	–55 to 150	1960 to 2000	25	±1.3	25	1	117
KTY81-222	–55 to 150	2000 to 2040	25	±1.3	25	1	117
KTY81-250 (note 2)	–55 to 150	1900 to 2100	25	±6.3	25	1	117
KTY81-251	–55 to 150	1900 to 2000	25	±3.2	25	1	117
KTY81-252	–55 to 150	2000 to 2100	25	±3.2	25	1	117
KTY83-110	–55 to 175	990 to 1010	25	±1.3	25	1	121
KTY83-120 (note 1)	–55 to 175	980 to 1020	25	±2.6	25	1	121
KTY83-121	–55 to 175	980 to 1000	25	±1.3	25	1	121
KTY83-122	–55 to 175	1000 to 1020	25	±1.3	25	1	121
KTY83-150 (note 2)	–55 to 175	950 to 1050	25	±6.6	25	1	121
KTY83-151	–55 to 175	950 to 1000	25	±3.3	25	1	121
KTY83-152	–55 to 175	1000 to 1050	25	±3.3	25	1	121
KTY84-130	0 to 300	970 to 1030	25	±4.8	100	2	125
KTY84-150 (note 2)	0 to 300	950 to 1050	25	±8.0	100	2	125
KTY84-151	0 to 300	950 to 1000	25	±4.0	100	2	125
KTY84-152	0 to 300	1000 to 1050	25	±4.0	100	2	125
KTY85-110	–40 to 125	990 to 1010	25	±1.3	25	1	129
KTY85-120 (note 1)	–40 to 125	980 to 1020	25	±2.6	25	1	129
KTY85-121	–40 to 125	980 to 1000	25	±1.3	25	1	129
KTY85-122	–40 to 125	1000 to 1020	25	±1.3	25	1	129
KTY85-150 (note 2)	–40 to 125	950 to 1050	25	±6.6	25	1	129
KTY85-151	–40 to 125	950 to 1000	25	±3.3	25	1	129
KTY85-152	–40 to 125	1000 to 1050	25	±3.3	25	1	129
KTY86-205	–40 to 150	1990 to 2010	25	±0.7	25	0.1	135
KTY87-205	–40 to 125	1990 to 2010 3327 to 3361	25 100	±0.7 ±0.8	25 100	0.1 -	141 141

Notes

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

PROXIMITY DETECTORS

TYPE	SWITCHING DISTANCE mm	SUPPLY VOLTAGE V	MAX. OUTPUT CURRENT mA	AT V_B V	T_{amb} °C	PAGE
OM286;M OM287;M	1 to 5 1 to 5	4.5 to 30 –4.5 to –30	250 250	24 –24	–40 to 85 –40 to 85	149 149
OM386B OM387B	1 to 5 1 to 5	10 to 30 –10 to –30	250 250	10 to 30 –10 to –30	–40 to 85 –40 to 85	155 155
OM386M OM387M	1 to 5 1 to 5	10 to 30 –10 to –30	250 250	10 to 30 –10 to –30	–40 to 85 –40 to 85	161 161
OM388B OM389B	2 to 5 2 to 5	10 to 30 –10 to –30	250 250	10 to 30 –10 to –30	–40 to 85 –40 to 85	167 167
OM390 OM391	2 to 5 2 to 5	10 to 30 –10 to –30	250 250	10 to 30 –10 to –30	–40 to 85 –40 to 85	173 173
OM2860 OM2870		4.7 to 30 –4.7 to –30	250 250	24 –24	–40 to 85 –40 to 85	179 179

TYPE NUMBER SURVEY

Semiconductor sensors

Type number survey

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

Semiconductor sensors

Type number survey

		Page
KTY85-152	Temperature sensor, −40 to +125 °C	129
KTY86-205	Temperature sensor, −40 to +150 °C	135
KTY87-205	Temperature sensor, −40 to +125 °C	141
OM286;M	Proximity detector, 250 mA	149
OM287;M	Same as OM276;M but with reverse polarity	149
OM386B	Proximity detector, 250 mA	155
OM387B	Same as OM386B but with reverse polarity	155
OM386;M	Proximity detector, 250 mA	161
OM387;M	Same as OM386;M but with reverse polarity	161
OM388B	Proximity detector, 250 mA	167
OM389B	Same as OM388B but with reverse polarity	167
OM390	Proximity detector, 250 mA	173
OM391	Same as OM390 but with reverse polarity	173
OM2860	Proximity detector, 250 mA	179
OM2870	Same as OM2860 but with reverse polarity	179

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.

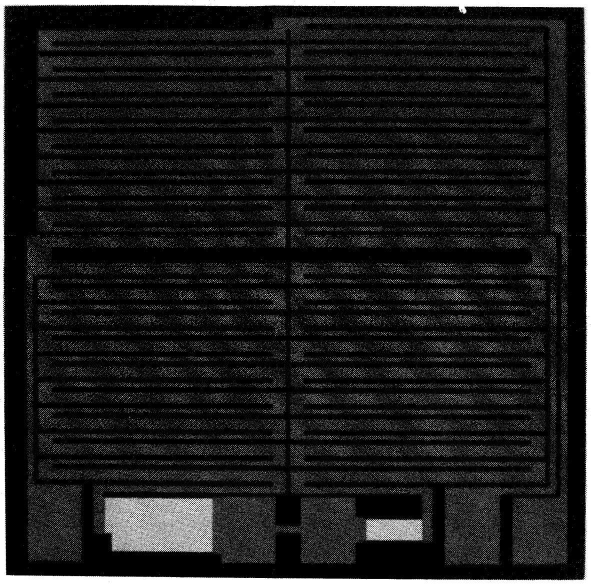
KMZ10 MAGNETIC FIELD SENSORS

	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)

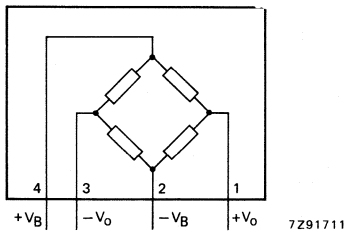
KMZ10 OPERATING PRINCIPLES

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.



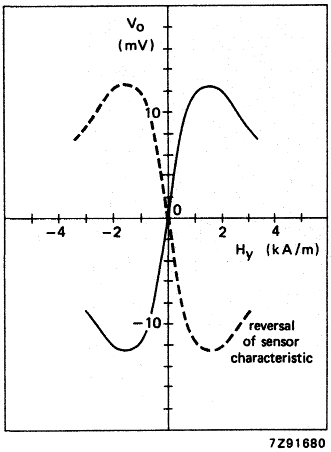
(a)



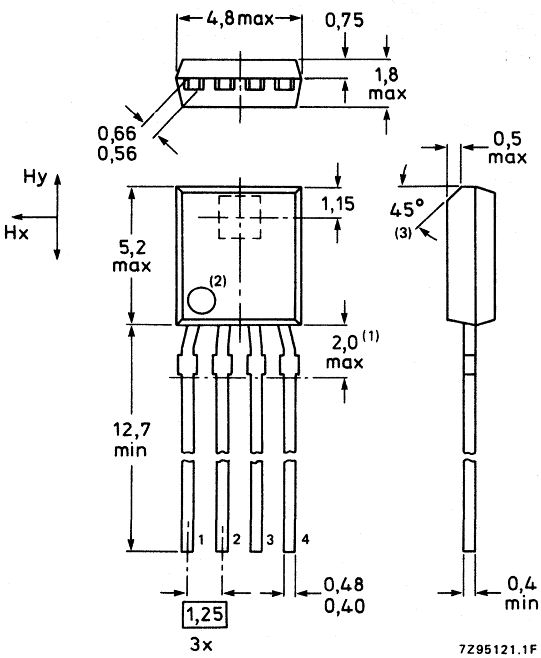
(b)

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)



(b)

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

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.

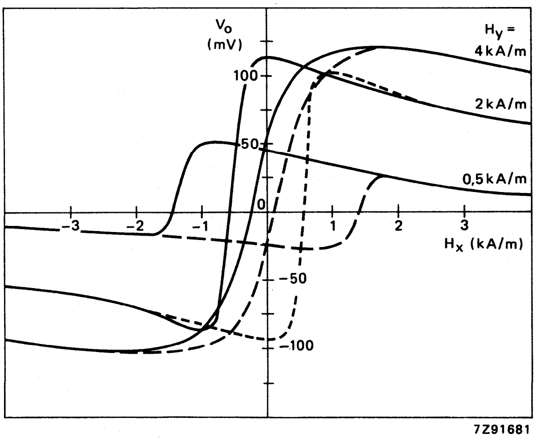


Fig.3 Sensor output V_o versus H_x for several values of H_y. The curves illustrate several things: first, that the sensor exhibits hysteresis, second, that the flipping is not instantaneous, and third, that sensitivity falls with increasing H_x

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

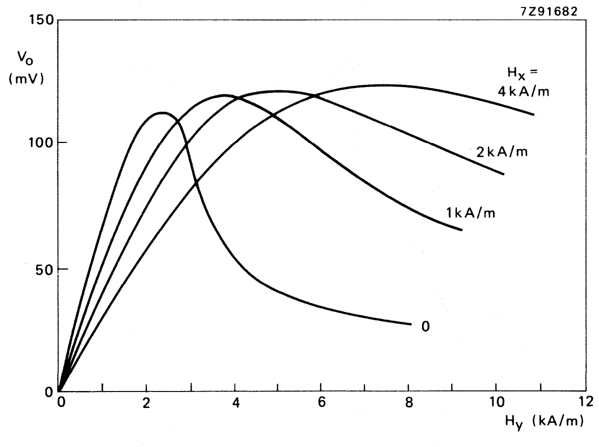


Fig.4 Output V_O versus H_Y for several values of H_X. This illustrates, even better than Fig.3, the fall in sensitivity (i.e. initial gradient) with increasing H_X

- 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.

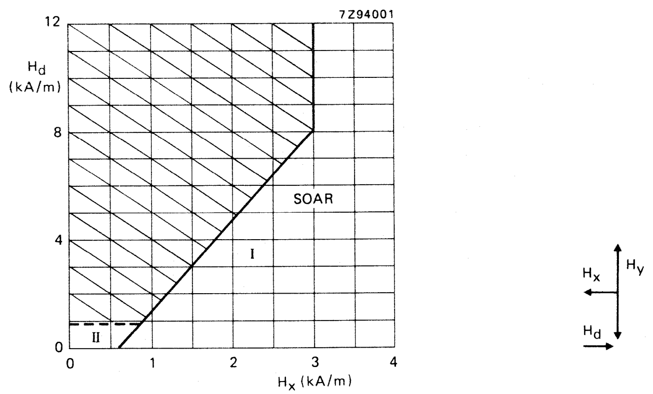


Fig.5 SOAR of a KMZ10B sensor as a function of auxiliary field H_x and of disturbing field H_d opposing H_x (area I). The SOAR can be extended slightly (area II) for values of $H_y < 1$ kA/m

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.

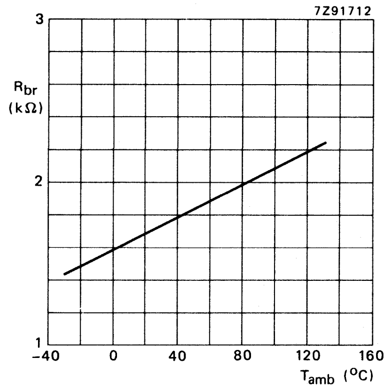


Fig.6 Bridge resistance as a function of temperature

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.

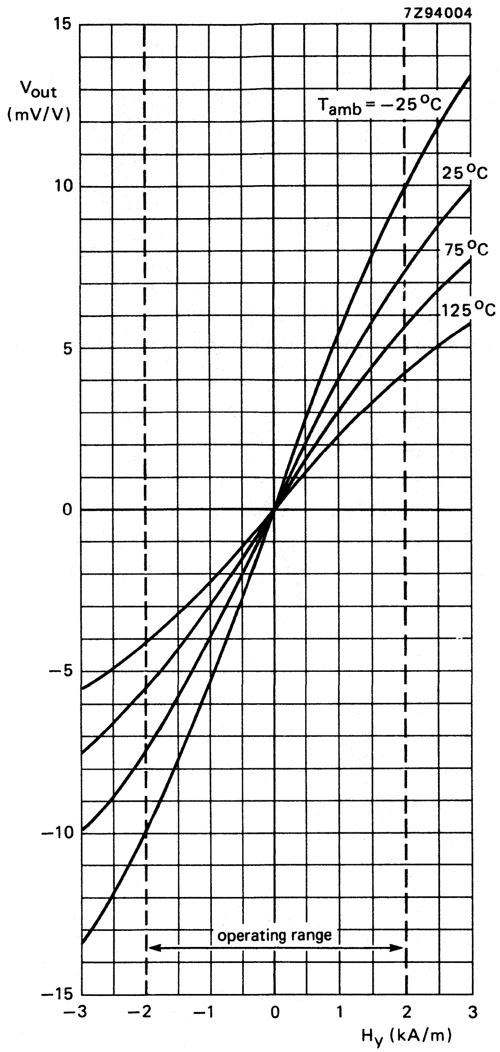


Fig.7 Output voltage V_o (as a fraction of the supply voltage) versus transverse field H_y for several temperatures. The figure illustrates that sensitivity falls with increasing temperature

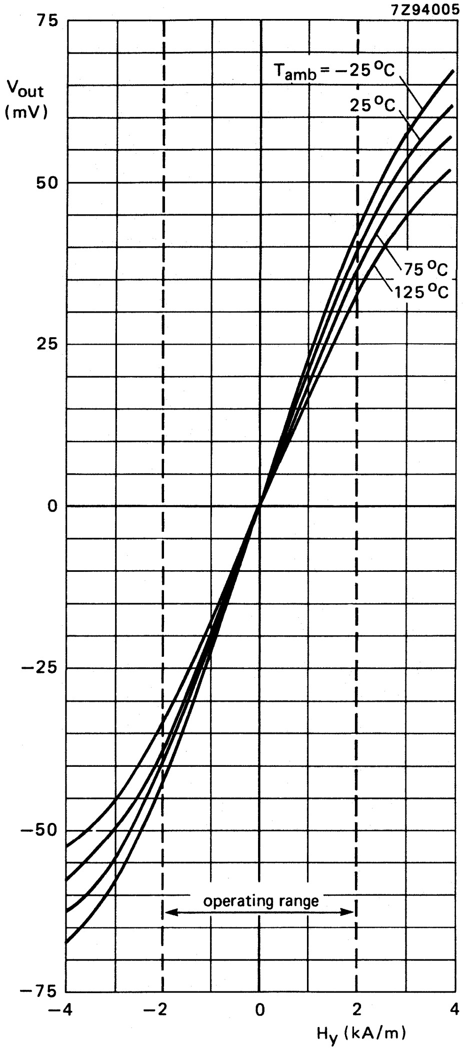


Fig.8 Output voltage V_O versus transverse field H_Y for several temperatures, with the sensor powered by a constant-current supply. The reduction in temperature dependence of sensitivity is a result of the increase of bridge resistance with temperature, which increases the bridge voltage to partially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

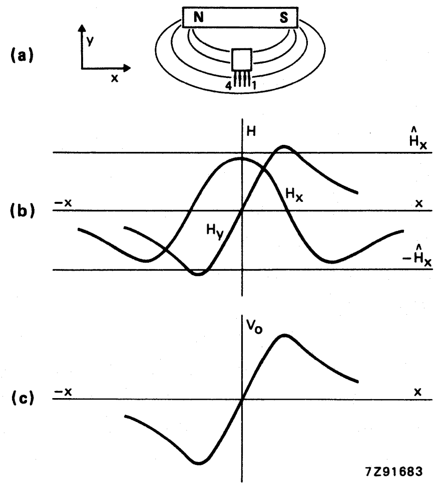


Fig.9 Sensor output in the field of a permanent magnet as a function of its displacement x parallel to the magnetic axis. The magnet provides both the auxiliary and transverse fields. In the example shown, the auxiliary field is always less than the field $\hat{H}_x$ that will cause flipping. Note the 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

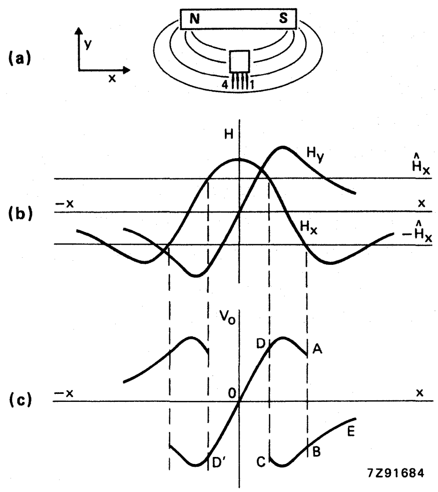


Fig.10 Sensor output in the setup of Fig.9, but in which the auxiliary field sometimes exceeds H_x

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.

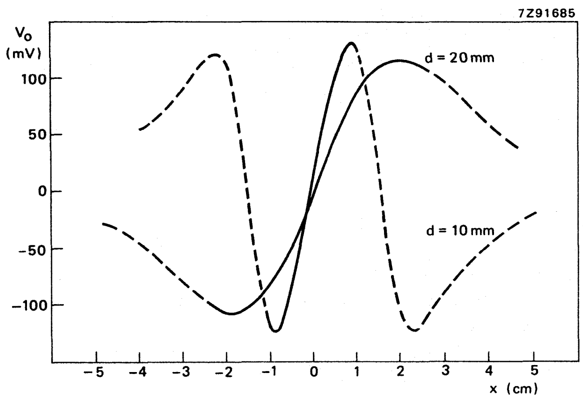
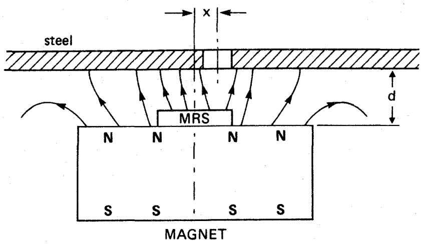


Fig.11 Measured sensor output at distances d of 10mm and 20mm from a permanent magnet as functions of displacement x parallel to the magnetic axis

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.



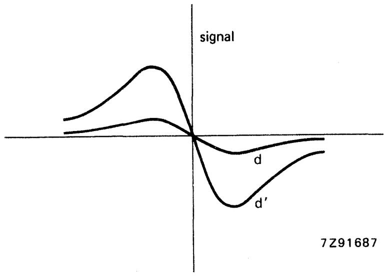


Fig.12 One-point measurement with the KMZ10.

(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.

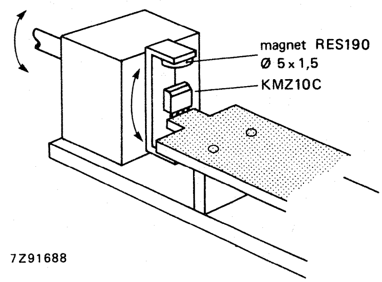


Fig.13 Angular measurement with the KMZ10

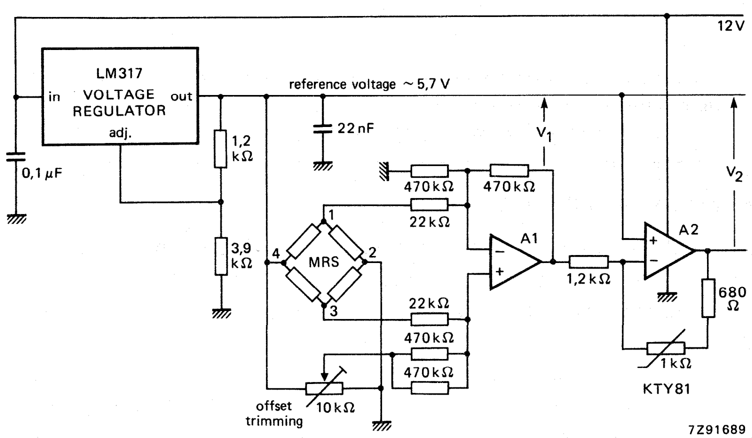


Fig.14 Circuit for measuring sensor output in the setup of Fig.13

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.

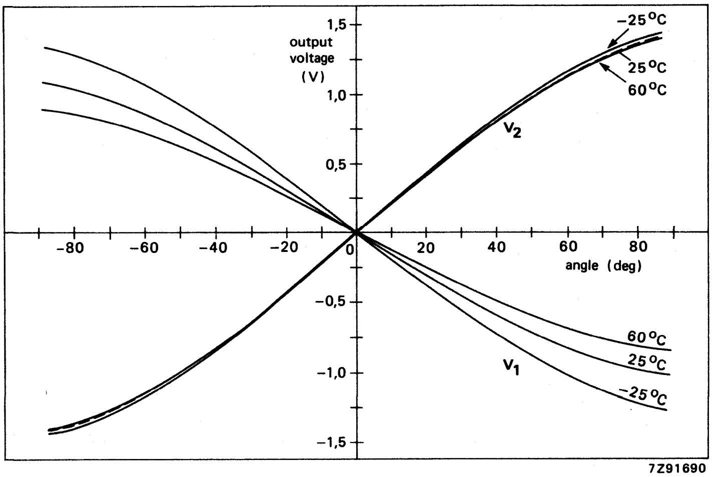


Fig.15 Effect of temperature compensation in the circuit of Fig.14. The figure compares the uncompensated output V_1 of opamp A_1 with the compensated output V_2 of opamp A_2

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.

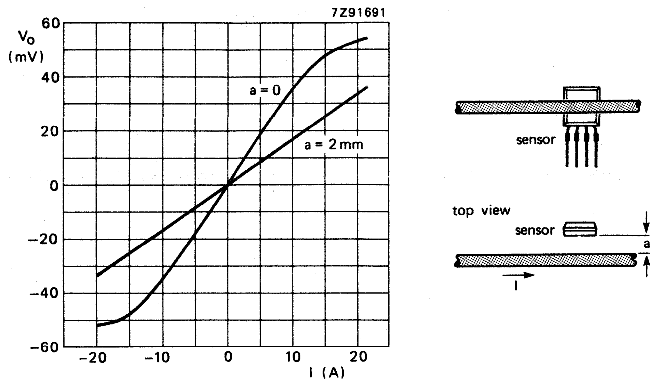


Fig.16 Simple setup for measuring current with a KMZ10 sensor. The sensor simply measures the magnetic field generated by a current-carrying wire

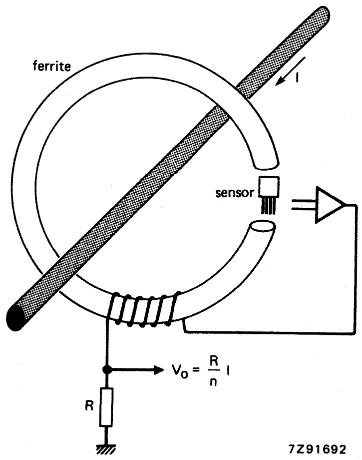


Fig.17 Current measurement with the KMZ10 sensor. In this setup a current-carrying wire is wrapped around a ferrite core, with the sensor located in the air gap between its ends

INTRODUCTION TO TEMPERATURE SENSORS

1. QUICK REFERENCE DATA

FAMILY TYPE	R_{25} (Ω)	AVAILABLE TOLERANCE GROUPS (ΔR)	OPERATING TEMPERATURE RANGE	PACKAGE
KTY81-1	1000	± 1% up to ± 5%	–55 to +150 °C	SOD70
KTY81-2	2000	± 1% up to ± 5%	–55 to +150 °C	SOD70
KTY83-1	1000	± 1% up to ± 5%	–55 to +175 °C	DO-34
KTY84-1	1000 (R_{100})	± 3% up to ± 5%	0 to +300 °C	DO-34
KTY85-1	1000	± 1% up to ± 5%	–40 to +125 °C	SOD80
KTY86-2	2000	± 0.5%	–40 to +150 °C	SOD103
KTY87-2	2000 (R_{25}) 3344 (R_{100})	± 0.5% ± 0.5%	–40 to +125 °C	SOD103

2. GENERAL

With their high accuracy and reliability, the KTY81/83/84/85/86 and 87 silicon temperature sensors in spreading resistance technology 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 (KTY81-1, KTY83, KTY85) or 2000 Ω (KTY81-2, KTY86, KTY87).
The nominal resistance of KTY84 is also 1000 Ω, but specified at 100 °C.

3. RESISTANCE TEMPERATURE CHARACTERISTICS

3.1 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 except for KTY87. The tolerance on resistance quoted in our data sheets is given by the resistance spread ΔR measured at 25 °C.

Because of spread in the slope of the resistance characteristics, ΔR will increase each side of the 25 °C point to produce the butterfly curve shown in Fig.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. We also provide this in the data sheets as a graph showing ΔT as a function of T.
For the high temperature sensor KTY84, we specify the resistance spread at 100 °C.
The resistance of the KTY87 is specified with a close tolerance at 25 °C and 100 °C. This specification at two temperatures provides an essential improvement of measurement accuracy in this temperature range.

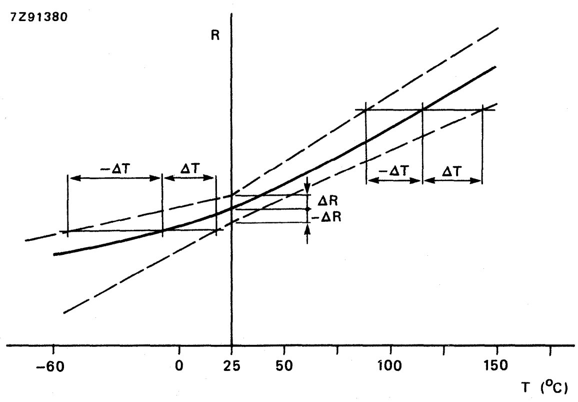


Fig.1 Butterfly curve.

3.2 Polarity of current

KTY83, KTY84, KTY85, KTY86 and KTY87 sensors are marked with a coloured band to indicate polarity. The published characteristics of the sensors will only be obtained if the current polarity is correct. In cases where the current polarity is incorrect, the curve R = f (Ta) differs in the upper temperature range significantly from the published form, and light, especially infrared, influences this to a greater or lesser degree.

3.3 Linearization

The resistance/temperature characteristics of the silicon 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.

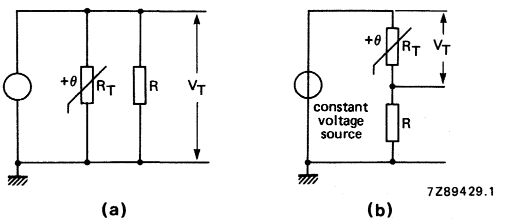


Fig.2 Linearization of sensor characteristics;
(a) with a resistor R shunted across the sensor
(b) with a resistor R in series with the sensor and system powered by a constant-voltage source.

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

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

i.e.

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

so

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

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

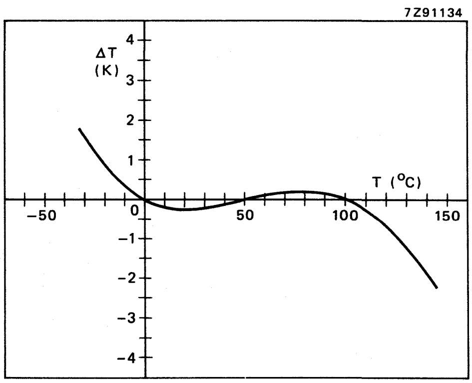


Fig.3 Temperature error ΔT to be expected from a nominal KTY81. sensor linearized over the temperature range 0 to 100 °C (linearizing resistance 2870 Ω).

Note

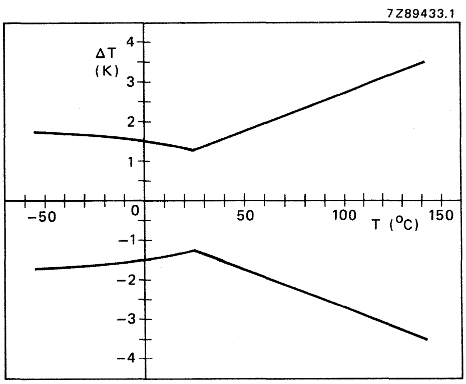
Because the KTY84 is chiefly intended for use at higher temperatures, say above 100 °C, its almost linear characteristics at these temperatures often renders linearization unnecessary.

3.3.1 Effect of tolerances on linearized sensor characteristics

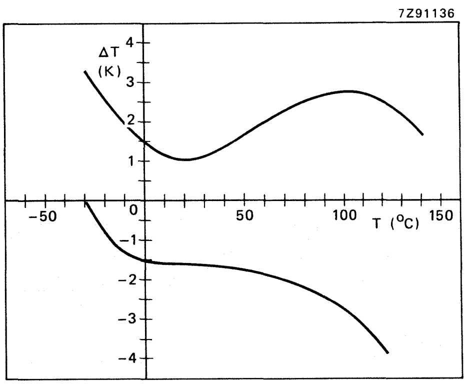
In practical applications with an arbitrary sensor, the total uncertainty in the sensor reading will be a combination of spread due to manufacturing tolerances and linearization errors.

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,

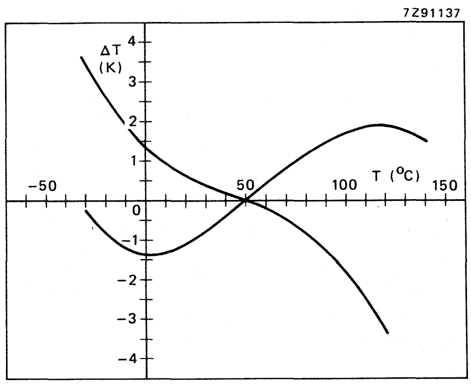


(a)

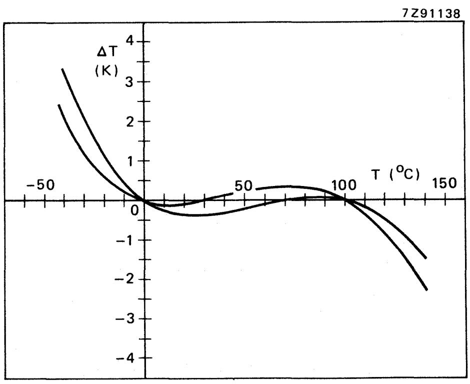


(b)

Fig.4 (a) absolute error ΔT expected of a silicon temperature sensor
(b) combined effect of manufacturing tolerances and linearization errors for the KTY81 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.

4. TYPICAL APPLICATION CIRCUIT

Figure 6 shows a typical and versatile measuring circuit for silicon temperature sensors. This example is designed for the KTY81-110 and a temperature range from 0 °C to 100 °C.

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

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

The measurement accuracy obtained by this two point calibration is shown in Fig.5(b). If the application can tolerate a temperature deviation of ± 2 K at the temperature extremes, (see Fig.5(a)) costs can be reduced by replacing P2 with a 1.8 kΩ fixed resistor and adjusting V_O at one temperature (the middle of the range, for example) using P1.

All resistors metal film, tolerance ± 1%

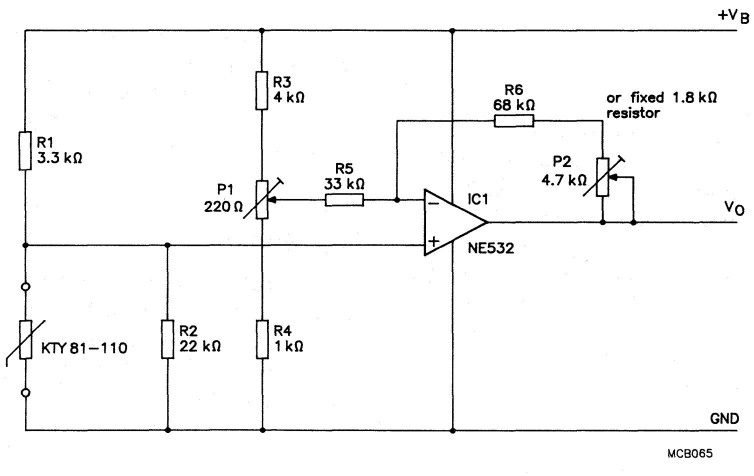


Fig.6 Temperature measuring circuit using KTY81-110 sensor; temperature range 0 - 100 °C; $V_O = V_B$ (0.2 - 0.6). For V_B = 5.0 V : V_O = 1 - 3 V.

5. MOUNTING AND HANDLING RECOMMENDATIONS

5.1 Mounting

5.1.1 KTY81

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

5.1.2 KTY83, KTY84, KTY86, KTY87

Excessive forces applied to a sensor may cause serious damage. To avoid this, the following recommendations are given:

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

5.2 Handling

5.2.1 ESD-SENSITIVITY

Electrostatic discharges above a certain energy can lead to irreversible changes of the sensor characteristic. In extreme cases, sensors can even be destroyed. In accordance with the test methods detailed in IEC 47 (CO)955, sensors can withstand test pulses between 500 V and 2000 V without remarkable changes in their characteristic. They are therefore classified as sensitive components with respect to ESD. During handling (testing, transporting, fitting) the common rules for handling of ESD sensitive components should be observed.

Practical test results show that KTY sensors will survive the IEC discharge test with a capacitance value of 100 pF, charged to 800 V and discharged via 1.5 kΩ. After 2 x 5 discharges (5 in each polarity) the drift in R_{25} is still negligible.
If necessary, the ESD sensitivity in the practical application can be further reduced by connecting a 10 nF capacitor in parallel to the sensor.

5.3 Soldering

5.3.1 KTY81

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

5.3.2 KTY83, KTY86, KTY87

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

5.3.3 KTY85

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

5.4 Welding

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

INTRODUCTION TO PRESSURE SENSORS

INTRODUCTION TO PRESSURE SENSORS

GENERAL

The trend towards integration in electronic control and measuring systems has created a growing demand for fast, accurate pressure sensors. In this field both the KP-family of monolithic pressure sensors and the KPZ-family of thin-film pressure sensors stand in a leading position. Not only are they both very fast and accurate, they are also highly compatible with the electronic system that they are intended to serve.

The KP100A and the KP101A are essentially aneroid gauges, in that they rely for their pressure signals on the movement of a diaphragm closing an evacuated chamber, but unlike conventional aneroid gauges the KP100A/101A have no need of mechanical or optical means to detect diaphragm movement. In the KP100A/101A movement is detected directly by a series of piezoresistive strain gauges implanted in the diaphragm in a Wheatstone bridge configuration.

The advantages of an all silicon device include highly stable characteristics, principally due to the well defined behaviour of silicon, plus high reliability and low cost. The wealth of experience in semiconductor manufacture is shown in its production.

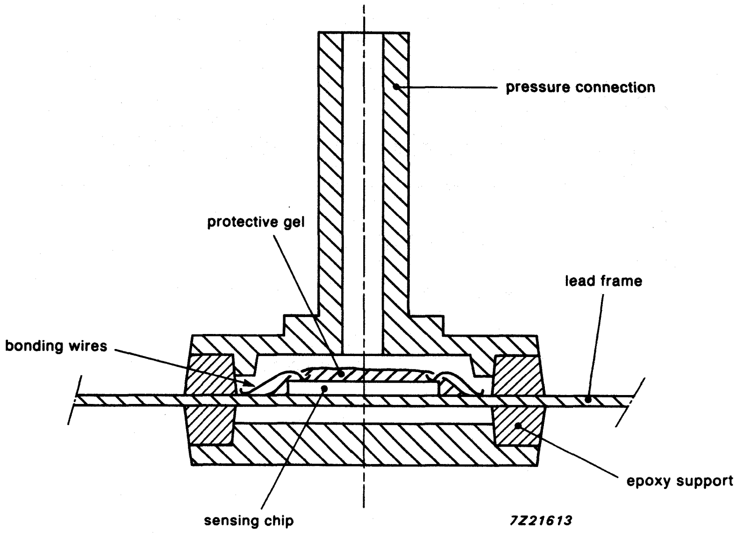


Fig. 1 KP100A/101A pressure sensor; cross section.

INTRODUCTION

The KPZ20G and KPZ21G are reference pressure sensors, which measure the applied pressure with reference to atmospheric pressure. The sensor consists of a thin metal membrane with condensed semiconducting thin-film strain gauges. In the KPZ-sensors the active system is separated from the pressure medium by the metallic membrane. The pressure medium acts on the reverse side of that membrane in contrast to the sensors of the KP-family, where pressure acts on the electrically active side of the crystal. The sensors of the KPZ-family can therefore be used for more dirty pressure media.

Both families of devices can be used in a wide range of applications; the KP-sensors for applications from simple pressure switches in domestic appliances, to altimeters and depth gauges, from domestic and professional barometers to automotive control systems. The KPZ-sensors can be used for detection of small differential pressures (i.e. burglar alarm systems), flow control, control of pneumatic systems and automotive systems (oil pressure, air brake systems, etc.). The KPZ-sensors may also be used for measurement of small mechanical forces acting on the reverse side of the metallic membrane.

Both families of sensors are also available with a new signal conditioning IC, which for many applications replaces much of the external control circuitry and provides linear output signal, temperature compensation and facilities for offset and sensitivity trimming.

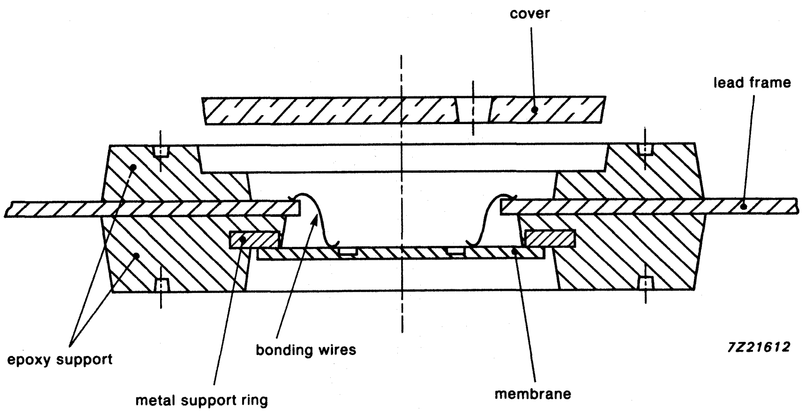


Fig. 2 KPZ20G/21G pressure sensors; cross section.

Piezoresistive strain gauges

In metals and semiconductors, both the mobility and concentration of carriers may change with strain. In semiconductors concentration changes come from a change in energy gap with strain. Depending on the type of doping, an increase in strain may produce either a fall or a rise in material resistivity; this is the piezoresistive effect.

The amount by which resistance changes with strain in given terms of the gauge factor, defined as the fractional change of resistance ($\Delta R/R$) per unit strain ($\Delta L/L$). For semiconductors, gauge factors between 50 and 100 are common, metals have gauge factors around 2.

Figure 3 shows as an example in plan and elevation, the major features of the KP100A. Essentially the KP100A consists of a Wheatstone bridge located in the centre of a rectangular silicon membrane ($1200 \times 2400\ \mu m^2$) closing an evacuated chamber.

Flexure of this membrane produced by external pressure, causes strain in the resistive elements of the bridge, and so (by virtue of the piezoresistive effect) imbalance of the bridge is then used as a measure of the external pressure.

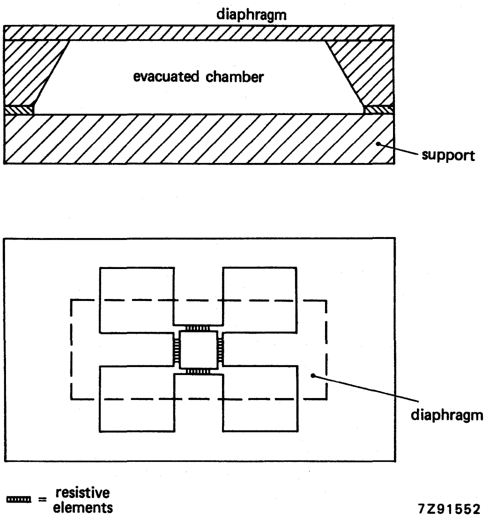


Fig. 3 KP100A in plan and elevation. The strain gauges are centrally located in a rectangular silicon membrane enclosing an evacuated chamber.

Note: The device relies for its action on the fact that the membrane is non-square, and hence that adjacent arms of the bridge experience different strains. If the membrane were square, all arms would experience exactly the same strain and no bridge imbalance would occur.

INTRODUCTION (continued)

Temperature compensation for monolithic pressure sensors

Figure 4 shows the basic bridge arrangement. The sensitivity of the bridge is around 13 mV/V bar at 25 °C (for the KP100A), but since the resistive elements are temperature sensitive, the sensitivity of the bridge itself varies with temperature by about 0.2 %/K. To compensate for this, and to allow its use for wide temperature ranges, the device incorporates integrated V_{BE}-multipliers, these increase the voltage across the bridge as the temperature rises, and so compensates the loss of sensitivity due to rise in temperature.

With a multiplier in circuit, sensitivity of the bridge falls to around 7.5 mV/V bar, but its temperature coefficient falls to an insignificant ± 0.02 %/K. The KP100A/101A has in fact five such integrated multipliers with different temperature characteristics, each optimized for a specific operating voltage.

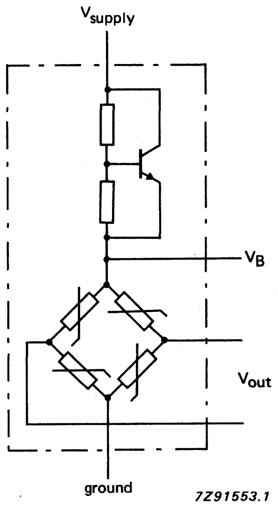


Fig. 4 Bridge configuration. The device incorporates integrated V_{BE}-multipliers that increase the voltage across the bridge as the temperature rises, and so compensate the loss in sensitivity due to rise in temperature.

The relationship between bridge output voltage and pressure, with supply voltage as the parameter, for the KP100A, is shown in Fig. 5 and Fig. 6. These figures illustrate two main points; firstly that the relationship is substantially linear and secondly how the V_{BE}-multiplier functions. In Fig. 5 the multiplier in circuit is optimized for a supply voltage of 4 V, and it is seen that variation in sensitivity over a 25 to 100 °C temperature range is very small, amounting to no more than about 1.5% over the whole temperature range. Figure 6 shows the same relationship using the multiplier optimized for a supply of 10 V.

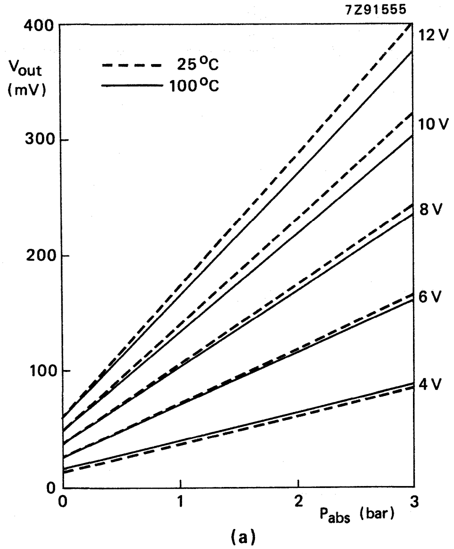


Fig. 5 Bridge output voltage as a function of pressure with supply voltage as a parameter and V_{BE}-multiplier in circuit. Supply voltage optimized at 4 V.

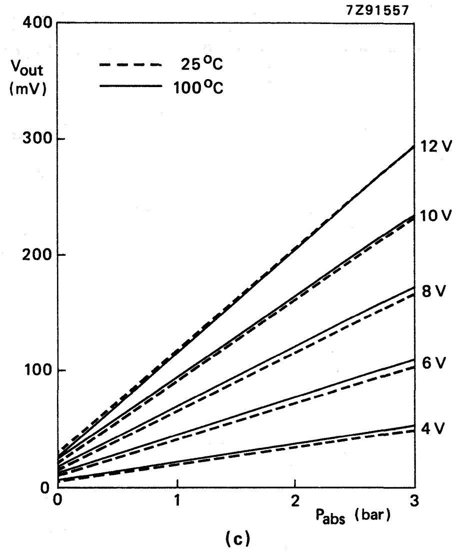


Fig. 6 Bridge output voltage as a function of pressure with supply voltage as a parameter and V_{BE}-multiplier in circuit. Supply voltage optimized at 10 V.

INTRODUCTION (continued)

Further illustration of benefits gained from temperature compensation are shown in Fig. 7. The output voltage is plotted against temperature with pressure as a parameter.

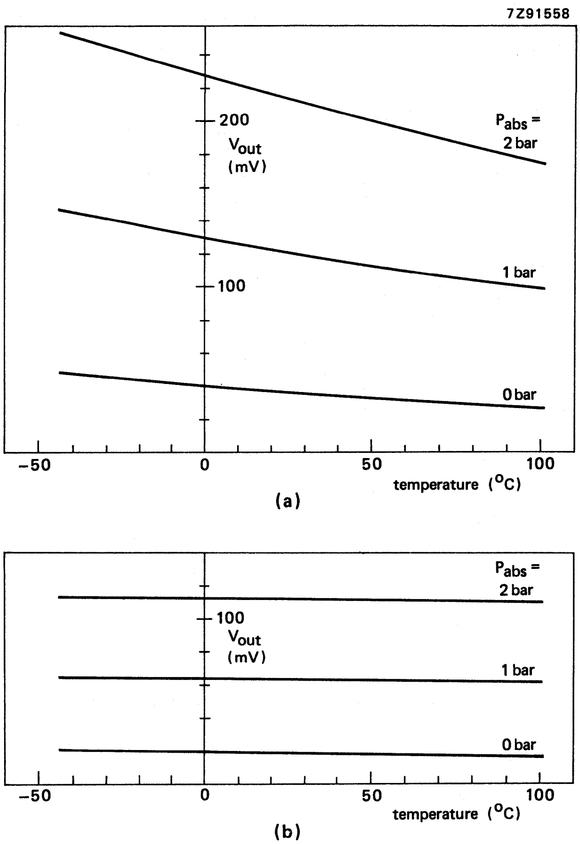


Fig. 7 Output voltage as a function of temperature with pressure as a parameter, (a) without compensation, and (b) with compensation.

The sensor KP100A is optimized for 7.5 V operation, the KP100A1 for 5 V operation. The 1 bar-sensor KP101A is optimized for 5 V operation.

Thin-film pressure sensors

A schematic drawing of the elastic element of the KPZ-sensor (9700 x 9700 μm^2) is shown in Fig. 8. The element consists of a stiff outer rim, a stiff central plunger and two (four in the KPZ21G) bending beams connecting rim and plunger. By application of pressure on the reverse side of the membrane the central plunger is displaced relatively to the fixed outer rim, and the bending beams are deformed. In the regions of maximum positive and negative strain (" ") the thin-film strain gauges are deposited. The strain gauges are connected, by means of a metallized layer, to a Wheatstone bridge circuit. Figure 8 shows the sensor before encapsulation.

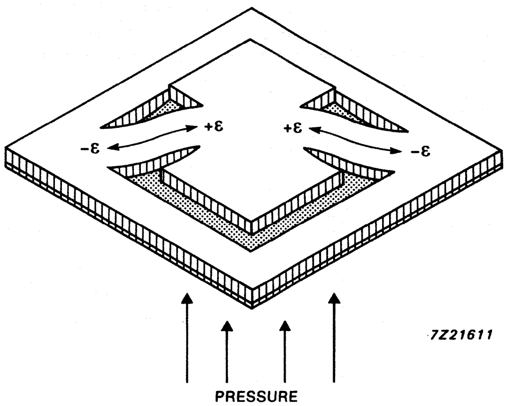


Fig. 8 Elastic element of the thin-film pressure sensor.

INTRODUCTION (continued)

Signal-conditioning IC for pressure sensors

The pressure sensors are also available with a dedicated signal-conditioning IC within the encapsulation. The IC requires an external power supply and provides the following functions:

— an output signal proportional to pressure, ranging from 10 to 90% of the supply voltage;
— temperature compensation;
— facility for offset and sensitivity trimming.

The IC can operate from a range of supply voltages from 4.75 V to 7 V (stabilized).

The circuit is based on a p-type silicon substrate with aluminium metallization. It incorporates low-ohmic WTi and high-ohmic CrSi thin-film resistors. All active areas of the circuit are protected by silicon dioxide glassover.

The functional layout of the IC, which incorporates a preamplifier stage, a current limiting stage and a feedback control line is shown in Fig. 9.

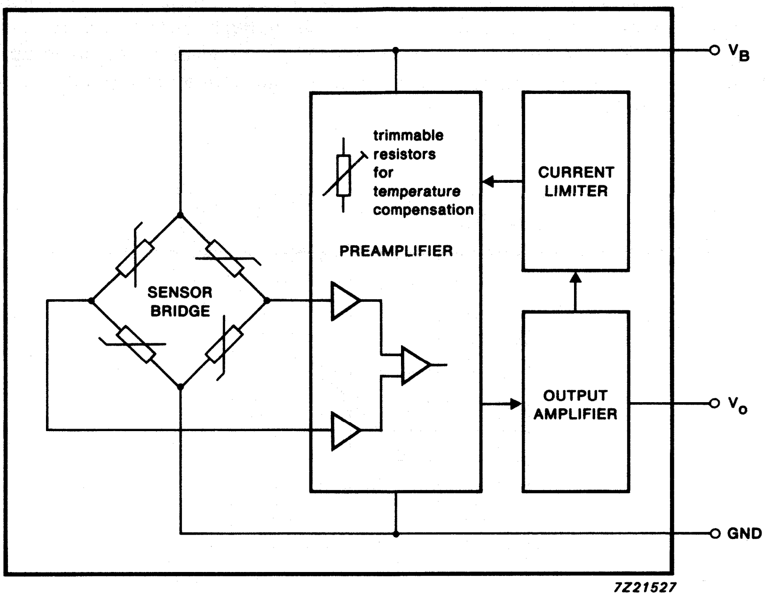


Fig. 9 Signal-conditioning IC.

The preamplifier stage, which incorporates a series of operational amplifiers and trimmable WTi and CrSi-sensors, amplifies the bridge signal by between 20 and 80. Moreover it compensates for the bridge's offset at low operating pressures, and for its temperature coefficients of offset and sensitivity.

The analogue output stage comprises 10 parallel-connected pnp transistors (one of which is utilized for current limiting), to provide an output signal of at least 90% of the supply voltage (for loads from 5 kΩ to infinity). The output stage has a low voltage drop (no more than about 0.5 V), so to prevent oscillation a capacitance of at least 0.1 μF with a series resistor of 60 Ω is connected externally across the output as shown in Fig. 10.

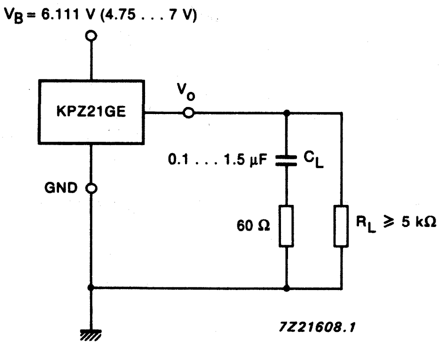


Fig. 10 Output circuit for the pressure sensor KPZ21GE.

The accuracy of the circuit depends on trimming. With very fine trimming a tolerance of about ± 2% can be realized.

INTRODUCTION (continued)

The sensor/IC combination of the KPZ21GE has an effective measuring range from + 1000 kPa relative pressure to below 0 kPa as shown in Fig. 11. The variation is linear down to the point where the residual output voltage of the IC becomes manifest; this residual output voltage is load dependent. As shown in Fig. 12 the linear relationship extends to −44 kPa and gives a residual voltage of 0.285 V for zero load (at V_{CC} = 6 mV). For R_L = 5 kΩ however, the linear relationship extends down to −87 kPa and gives a residual voltage of 0.07 V.

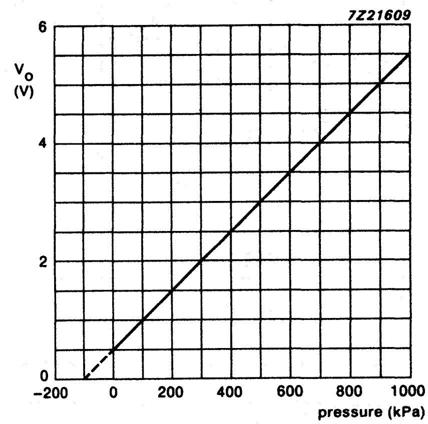


Fig. 11 Output voltage of the KPZ21GE sensor as a function of pressure, for a 6.111 V supply and 5 kΩ load.

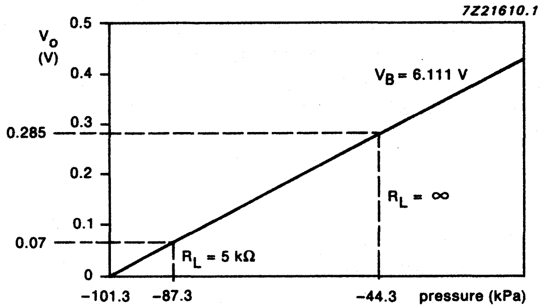


Fig. 12 KPZ21GE residual output voltage dependent on load resistance; supply voltage = 6.111 V.

Mounting of KPZ pressure sensors

The KPZ family of gauge pressure sensors is designed as a family of pressure sensing components. This implies that final mounting has to be done by the customer.

Normally the sensor element will be sealed by means of a O-ring which is located in the O-ring groove on the back of the sensor. Pressure tight fixation of the sensor must be achieved in such a way that forces introduced to the sensor should be kept to the absolute minimum. The forces must be applied to the envelope symmetrically. If the forces are too large or non-symmetrical, loading will shift the electrical characteristics of the sensor, especially the offset voltage, by a considerable amount, and may even destroy the plastic envelope. As it is very difficult to adjust out the small force readings it is recommended that the sensor is mounted in a jig, the principle of which is shown in Fig. 13.
In this way the forces are absorbed by the jig and not by the sensor.

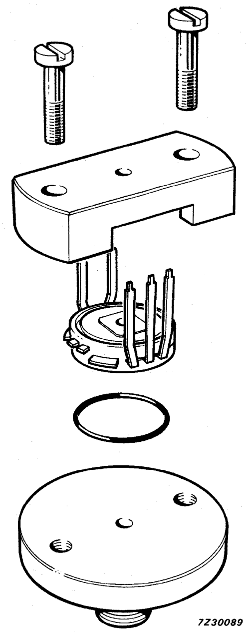


Fig. 13 Mounting jig principle.

INTRODUCTION (continued)

The sensor is centred in the mounting jig (Fig.14) with the upper metal ring (a), which is part of the crossbar (b) of the jig. This ring interlocks in the upper O-ring groove of the envelope (c). When screwing the jig to the base plate (d), the only permissible forces which may be introduced to the sensor are the reaction forces of the O-ring (e) in the lower O-ring groove, which is squeezed to the base plate. This will allow the mounting jig to be screwed tightly to the base plate with only small forces acting on the sensor. The amount of force will only vary with the small variations of mechanical dimensions of the sensor envelope and O-ring respectively and will not depend on the force used for fixing the mounting jig, thus unwanted shifts of sensor output voltage or destruction of the envelope can be avoided.

The critical dimension of the jig is the fixed distance between the bottom edge of the metal ring and the base plate. This distance must be chosen in such a way that the forces introduced to the envelope by squeezing of the O-ring are small, and that the compression of the O-ring is sufficient to guarantee a pressure tight seal at all permitted operating temperatures and pressures. The cross bar of the jig shall be made of material with a high rigidity (e.g. steel) to prevent flexing which may cause additional forces to act on the sensor.

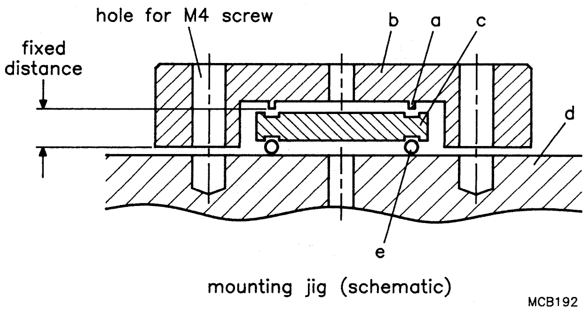


Fig.14 Mounting jig (schematic).

The mechanical data of a typical mounting jig is given in Fig.15. This jig is designed for use with an O-ring of 15.7 x 1.3 mm (Fig.16). A soft silicon material (shore hardness about 70) shall be used for the O-ring. Providing that these criteria are complied with, jig shifts of offset voltage caused by mounting are smaller than 0.5% of sull scale output voltage.

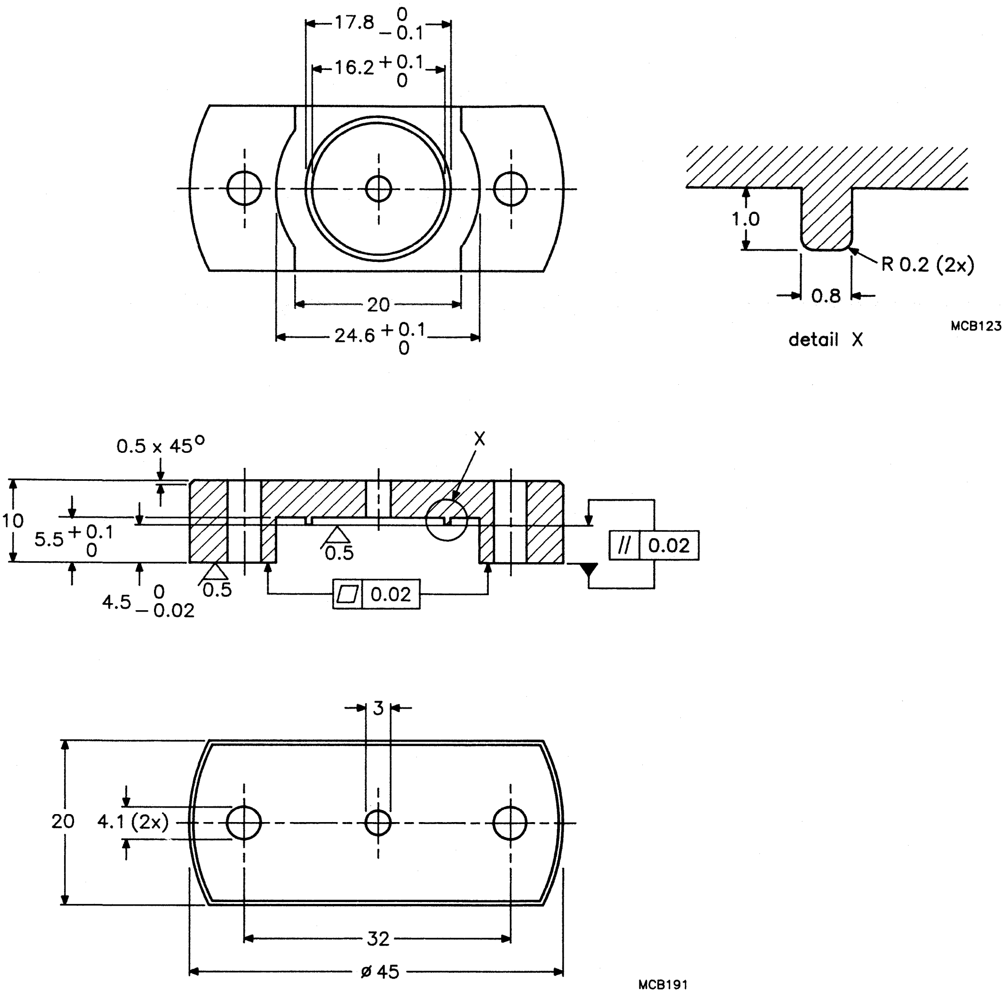


Fig.15 Mounting jig mechanical data.

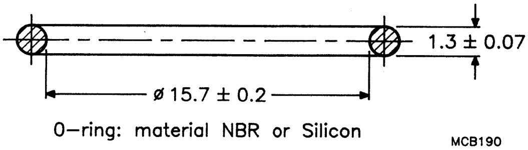


Fig.16 O-ring.

MAGNETIC FIELD SENSORS

MAGNETIC FIELD SENSOR

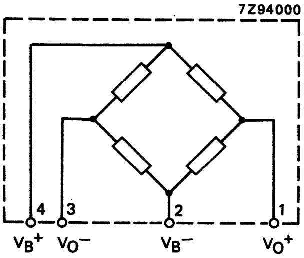
The KMZ10A is an extremely sensitive magnetic field sensor employing the magneto-resistive effect of thin film permalloy.
Its properties enable this sensor to be used in a wide range of applications for navigation, current and field measurement, revolution counters, angular or linear position measurement and proximity detectors, etc.

QUICK REFERENCE DATA

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

MECHANICAL AND ELECTRICAL DATA

Dimensions in mm



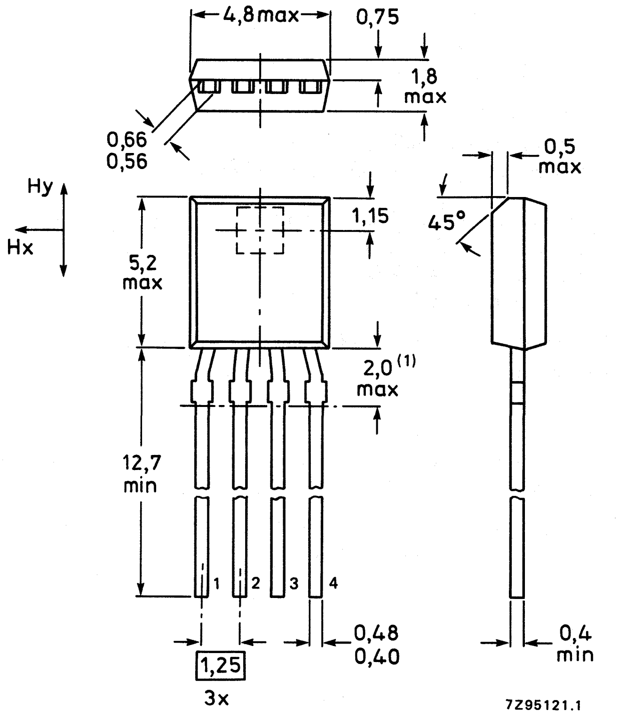


Fig. 1 SOT195.

(1) Terminal dimensions uncontrolled within this area.

RATINGS

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

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

THERMAL RESISTANCE

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

CHARACTERISTICS

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

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

Note

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

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

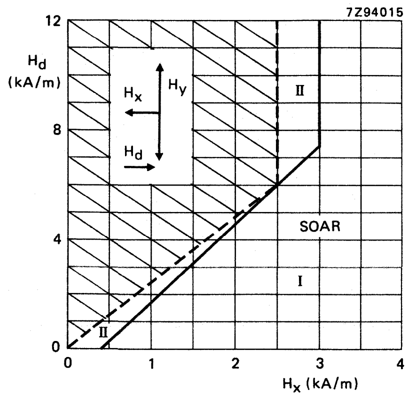


Fig. 2 Safe Operating Area (permissible disturbing field H_d as a component of auxiliary field H_x).

I Region of permissible operation.

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

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

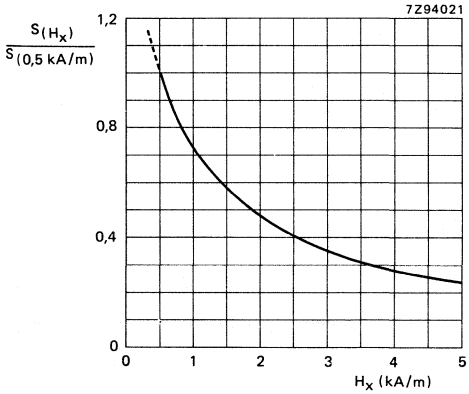


Fig. 3 Relative sensitivity (ratio of sensitivity at certain H_x and sensitivity at H_x = 0.5 kA/m.

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

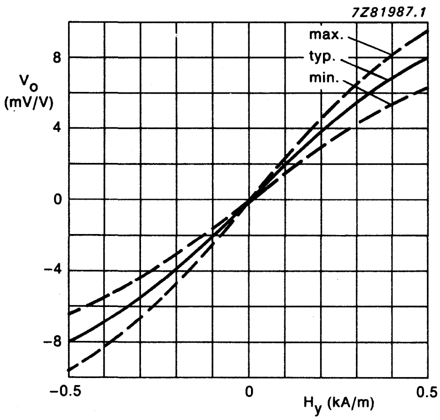


Fig. 4 Sensor output characteristic H_x = 0.5 kA/m T_{amb} = 25°C. Voff =0

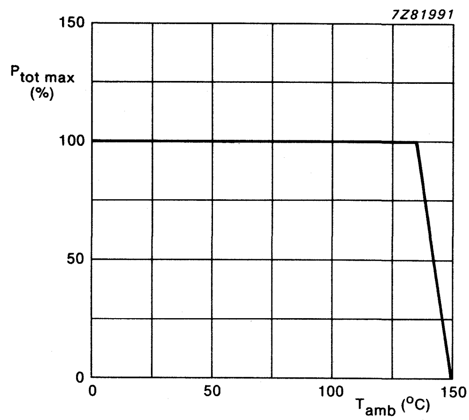


Fig. 5 Power derating curve.

MAGNETIC FIELD SENSOR

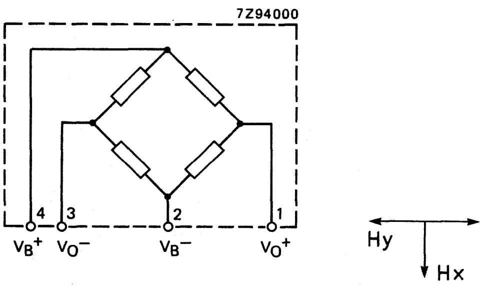
The KMZ10A1 is an extremely sensitive magnetic field sensor employing the magneto-resistive effect of thin film permalloy.
Its properties enable this sensor to be used in a wide range of applications for navigation, current and field measurement, etc. The special arrangement of the sensing chip allows the construction of coils for dynamic Hx along the length axis of the sensor.
The sensor can be operated at any frequency between DC and 1 MHz.

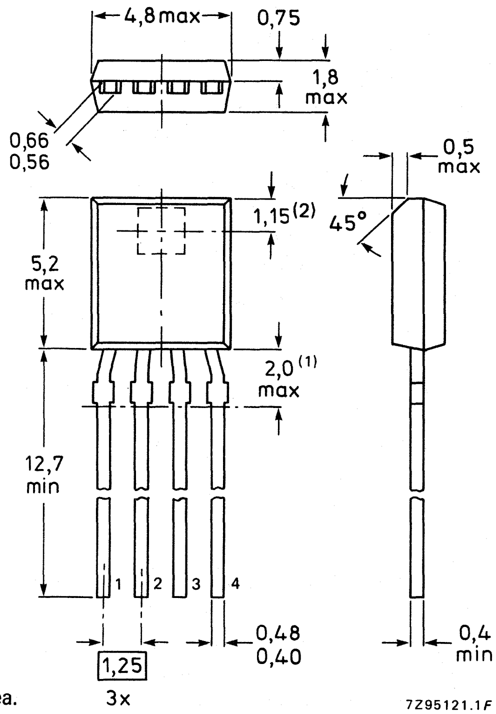
QUICK REFERENCE DATA

Operating voltage	V_B	=	5	V
Operating range	H_y	=	± 0.5	kA/m
Auxiliary field	H_x	=	0.5	kA/m
Sensitivity (with dynamic Hx)	S	=	22	$\frac{mV/V}{kA/m}$
Offset voltage	V_{off}	≤	± 1.5	mV/V
Bridge resistance	R_{bridge}	=	0.85 to 1.75	kΩ

MECHANICAL AND ELECTRICAL DATA

Dimensions in mm





(1) Terminal dimensions uncontrolled within this area.
(2) Position of sensor chip.

Fig.1 SOT195.

RATINGS

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

Operating voltage	V_B	max.	9	V
Total power dissipation up to T_{amb} = 132 °C	P_{tot}	max.	100	mW
Storage temperature range	T_{stg}		−65 to + 150	°C
Operating bridge temperature range	T_{bridge}		−40 to + 150	°C

THERMAL RESISTANCE

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

CHARACTERISTICS

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

Bridge supply voltage	V_B	=	5	V
Operating range (1)	H_y	=	± 0.5	kA/m
Open circuit sensitivity (1) (2)	S	=	11 to 17	$\frac{mV/V}{kA/m}$
Temperature coefficient of output voltage				
V_B = constant; T_j = −25 to + 125 °C	TCV_o	typ.	−0.4	%/K
I_B = constant; T_j = −25 to + 125 °C	VCV_o	typ.	−0.15	%/K
Bridge resistance	R_{br}		0.85 to 1.75	kΩ
Temperature coefficient of bridge resistance at T_j = −25 to + 125 °C	TCR_{br}	typ.	0.25	%/K
Offset voltage	V_{off}	max.	± 1.5	mV/V
Temperature coefficient of offset voltage at T_{bridge} = −25 to + 125 °C	TCV_{off}	max.	± 6	$\frac{\mu V/V}{K}$
Linearity deviation of output voltage at				
H_y = 0 to ± 0.25 kAm^{-1}	FL	max.	0.8	% FS
H_y = 0 to ± 0.4 kAm^{-1}	FL	max.	2.5	% FS
H_y = 0 to ± 0.5 kAm^{-1}	FL	max.	4.0	% FS
Hysteresis of output voltage	FH	max.	0.5	% FS
Operating frequency	f_{max}	=	1	MHz

Characteristics with H_x = 0 (dynamic H_x)
(T_{amb} = 25 °C; V_{CC} = 5 V)

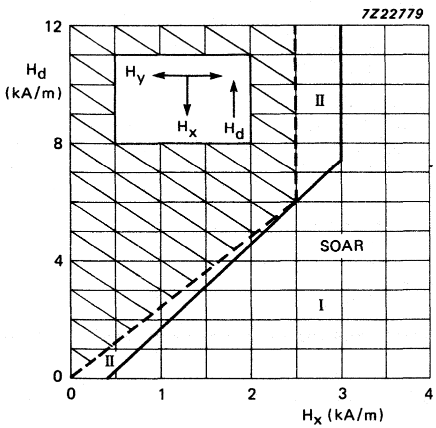
Operating range (1)	H_y	=	± 0.05	kA/m
Sensitivity (slope between H_y = 0 and H_y = 40 A/m)	S	=	14 to 27	$\frac{mV/V}{kA/m}$

Note

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

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

(2) Sensitivity measured as $\Delta V_O/\Delta H_y$ with H_y = 0.4 kA/m.



I Region of permissible operation.

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

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

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

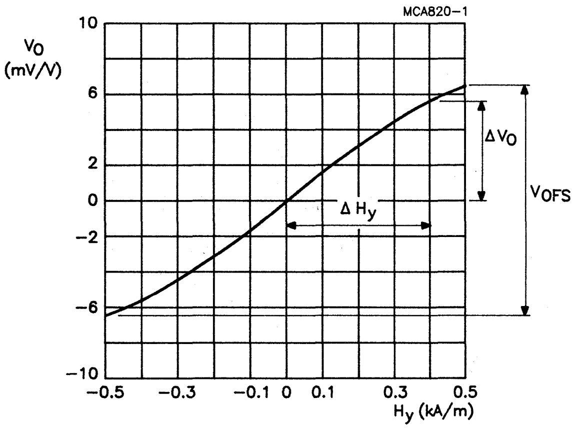


Fig. 3 Sensor output characteristic $H_x = 0.5$ kA/m; $T_{amb} = 25$ °C; $V_{off} = 0$; $S = \Delta V_O / \Delta H_y$.

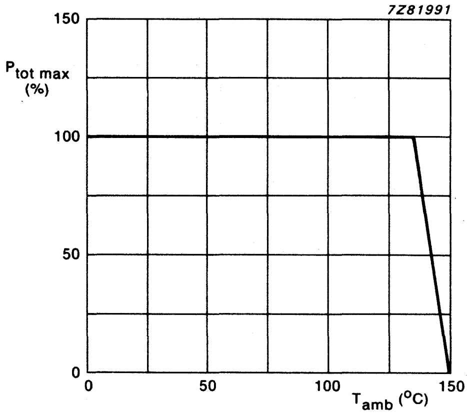
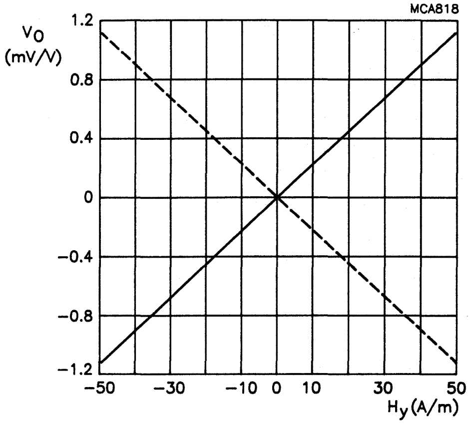


Fig. 4 Power derating curve.



——— Sensor reset with H_x = 3 kA/m
– – – – – Sensor reset with H_x = – 3 kA/m

Fig.5 Output characteristic with H_x = 0 kA/m.

MAGNETIC FIELD SENSOR

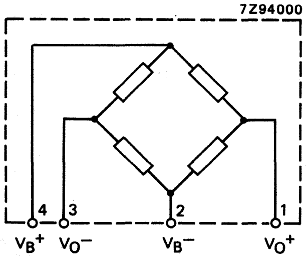
The KMZ10B is a sensitive magnetic field sensor employing the magneto-resistive effect of thin film permalloy.
Its properties enable this sensor to be used in a wide range of applications for current and field measurement, revolution counters, angular or linear position measurement and proximity detectors, etc.

QUICK REFERENCE DATA

Operating voltage	V_B	=	5	V
Operating range	H_y	=	± 2.0	kA/m
Auxiliary field	H_x	=	3	kA/m
Sensitivity	S	=	4	$\frac{mV/V}{kA/m}$
Offset voltage	V_{off}	⩽	± 1.5	mV/V
Bridge resistance	R_{bridge}	=	1.2 to 2.2	kΩ

MECHANICAL AND ELECTRICAL DATA

Dimensions in mm



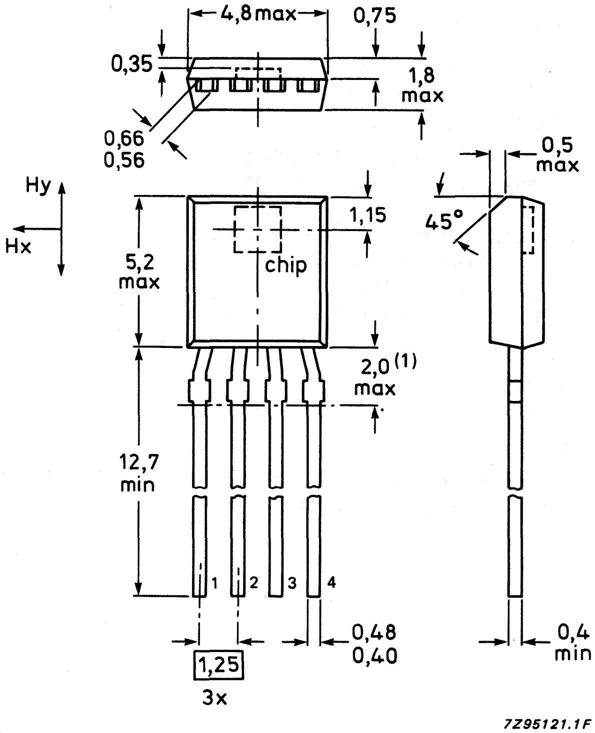


Fig. 1 SOT195.

(1) Terminal dimensions uncontrolled within this area.

RATINGS

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

Operating voltage	V_B	max.	12 V
Total power dissipation up to T_{amb} = 130 °C	P_{tot}	max.	120 mW
Storage temperature range	T_{stg}		–65 to + 150 °C
Operating bridge temperature range	T_{bridge}		–40 to + 150 °C

THERMAL RESISTANCE

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

CHARACTERISTICS

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

Operating voltage	V_B	=	5 V
Operating range of magnetic field	H_y	=	± 2.0 kA/m
Open circuit sensitivity	S	=	3.2 to 4.8 $\frac{mV/V}{kA/m}$
Temperature coefficient of output voltage			
V_B = constant; T_j = –25 to + 125 °C	TCV_o	typ.	–0.4 %/K
I_B = constant; T_j = –25 to + 125 °C	TCV_o	typ.	–0.10 %/K
Bridge resistance	R_{br}		1.2 to 2.2 kΩ
Temperature coefficient of bridge resistance at T_{bridge} = –25 to + 125 °C	TCR_{br}	typ.	0.30 %/K
Offset voltage	V_{off}	⩽	± 1.5 mV/V
Temperature coefficient of offset voltage at T_j = –25 to + 125 °C	TCV_{off}	⩽	± 3 $\frac{\mu V/V}{K}$
Linearity deviation of output voltage at			
H_y = 0 to ± 1 KAm^{-1}	FL	<	± 0.5 %FS
H_y = 0 to ± 1.6 KAm^{-1}	FL	<	± 1.7 %FS
H_y = 0 to ± 2 KAm^{-1}	FL	<	± 2.0 %FS
Hysteresis of output voltage	V_{oH}	<	0.5 %FS
Operating frequency	f_{max}	=	1 MHz

Note

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

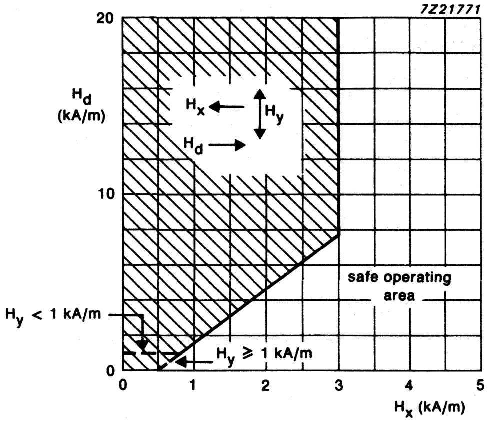


Fig. 2 Safe Operating Area (permissible disturbing field H_d as a component of auxiliary field H_x).
I Region of permissible operation.
II Permissible extension if $H_y < 1$ kA/m.
Note: In applications with $H_x < 3$ kA/m, the sensor has to be reset after leaving the SOAR, by an auxiliary field of $H_x = 3$ kA/m.

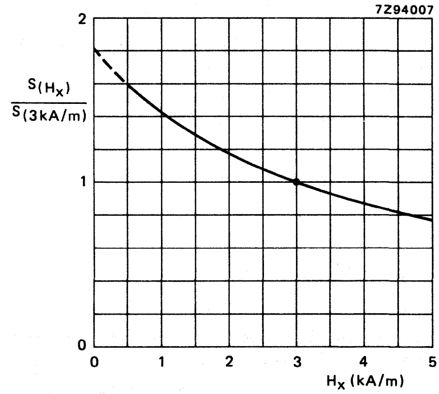


Fig. 3 Relative sensitivity (ratio of sensitivity at certain H_x and sensitivity at $H_x = 3$ kA/m.
Note: In applications with $H_x \leq 3$ kA/m the sensor has to be reset by an auxiliary field of $H_x = 3$ kA/m before using.

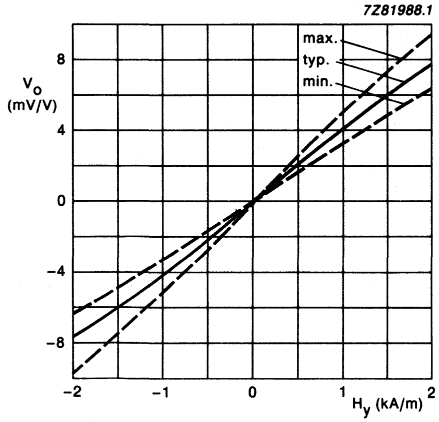


Fig. 4 Sensor output characteristic V_B = constant; $T_{amb} = 25\ ^oC$; $H_x = 3$ kA/m; $V_{off} = 0$.

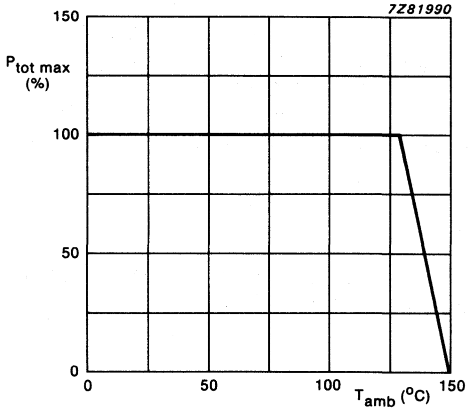


Fig. 5 Power derating curve.

MAGNETIC FIELD SENSOR

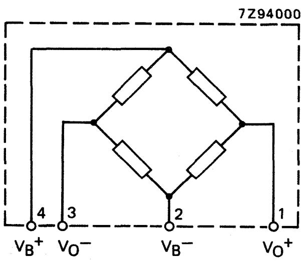
The KMZ10C is a magnetic field sensor employing the magneto-resistive effect of thin film permalloy. Its properties enable this sensor to be used in a wide range of applications for current and field measurement, revolution counters, angular or linear position measurement and proximity detectors, etc.

QUICK REFERENCE DATA

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

MECHANICAL AND ELECTRICAL DATA

Dimensions in mm



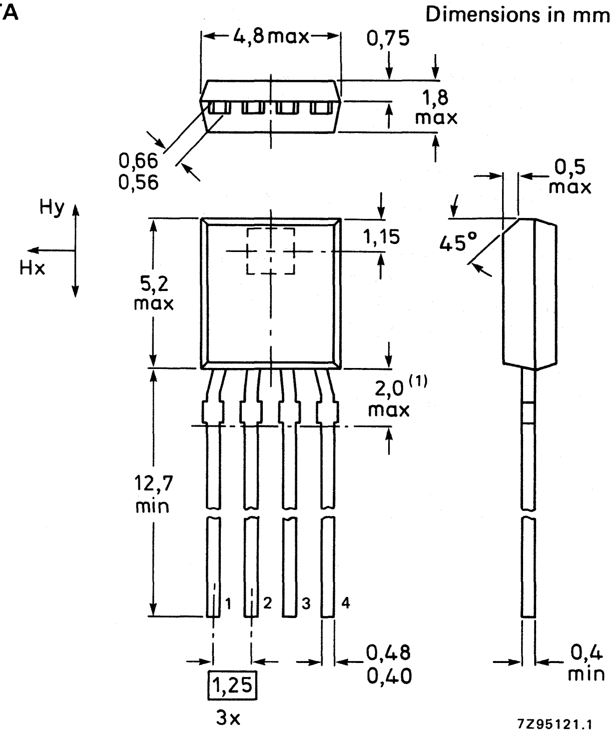


Fig. 1 SOT 195.

(1) Terminal dimensions uncontrolled within this area.

RATINGS

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

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

THERMAL RESISTANCE

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

CHARACTERISTICS

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

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

Note

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

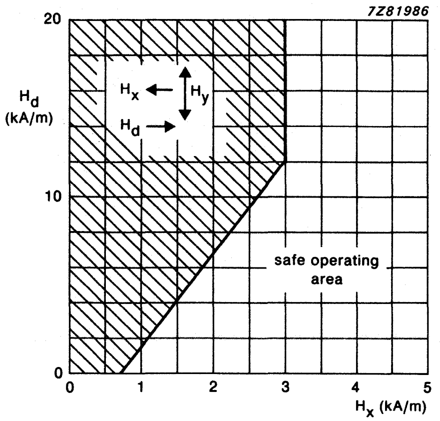


Fig. 2 Safe Operating Area (permissible disturbing field H_d as a component of auxiliary field H_x).
Note: In application with H_x < 3 kA/m, the sensor has to be reset after leaving the SOAR, by an auxiliary field of H_x = 3 kA/m.

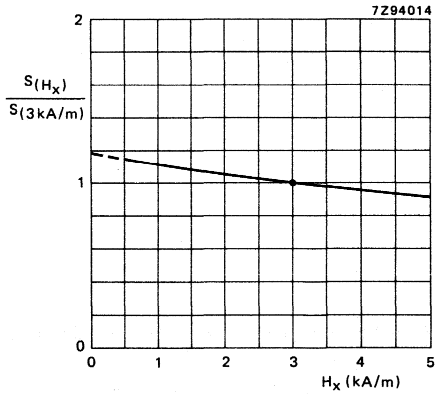


Fig. 3 Relative sensitivity (ratio of sensitivity at certain H_x and sensitivity at H_x = 3 kA/m.
Note: In application with H_x ⩽ 3 kA/m the sensor has to be reset by an auxiliary field of H_x = 3 kA/m before using.

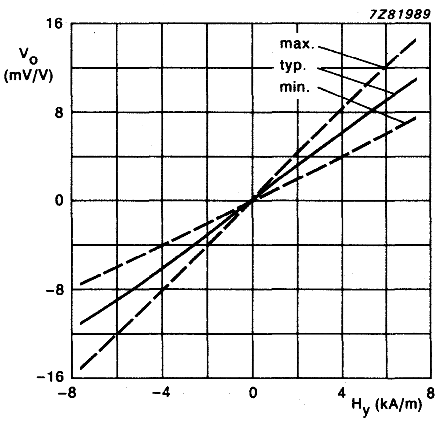


Fig. 4 Sensor output characteristic
H_x = 3 kA/m T_{amb} = 25 °C Voff =0.

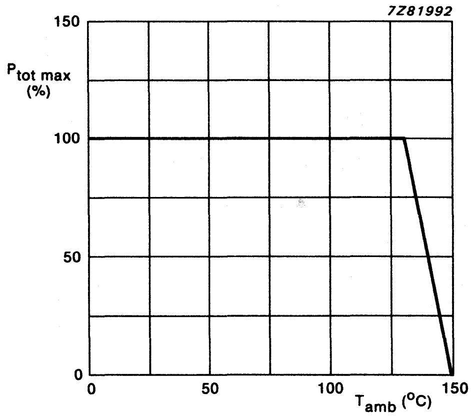


Fig. 5 Power derating curve.

PRESSURE SENSORS

MONOLITHIC PRESSURE SENSOR

The KP100A is designed for measurement of absolute pressures from 0 to 200 kPa.
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

Operating pressure range	P	0 to 200	kPa
Operating voltage	V_t, V_e	7.5	V
Operating ambient temperature range	T_{amb}	−40 to + 125	°C

MECHANICAL DATA

Dimensions in mm

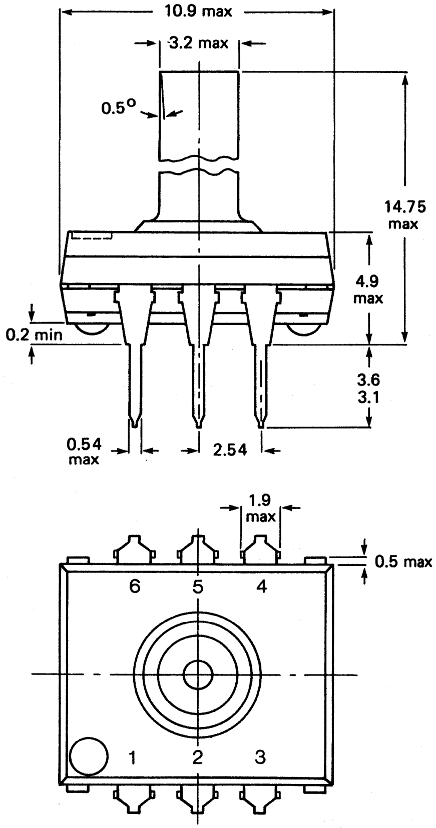


Fig. 1 SOT177.

The pressure transducer is suitable for use with non-ionic and non-corrosive media. The silicon diaphragm is covered with Si_3N_4 for protection.

The pressure port is defined for using flexible tubes with 3 mm internal diameter.

The SOT117 envelope is designed for soldering on a PCB.

RATINGS

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

Operating voltage	V_t, V_e	max.	12	V
Pressure (absolute)	P_{max}	max.	400	kPa
Burst pressure (absolute)	P_b	⩾	600	kPa
Operating ambient temperature range	T_{amb}		−40 to + 125	°C
Storage temperature range	T_{stg}		−65 to + 150	°C
Lead soldering temperature at $t_{sld} < 10$ s	T_{sld}	max.	260	°C

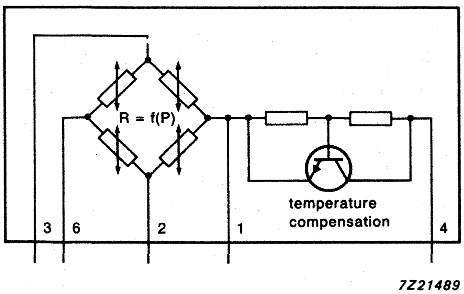
CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Operating pressure range	P		0 to 200	kPa
Bridge resistance (see Fig. 2)	R_{br}		1800 ± 400	Ω
Linearity (2)	FL	=	± 0.5	%FS
Pressure hysteresis (3)		=	0.1	%FS
For V_t = 7.5 V (operation without temperature compensation)				
Offset voltage (1)	V_{off}	⩽	± 37.5	mV
Sensitivity (1)	S		0.68 to 1.27	$\frac{mV}{kPa}$
Temperature coefficient of offset voltage	TCV_{off}	=	± 0.05	%FS/K
Temperature coefficient of sensitivity	TCS	=	−0.22	%/K
For V_e = 7.5 V (operation with temperature compensation)				
Offset voltage	V_{off}	⩽	± 25.0	mV
Sensitivity	S	=	0.30 to 0.90	$\frac{mV}{kPa}$
Temperature coefficient of sensitivity	TCS	=	± 0.06	%/K
Temperature coefficient of offset voltage	TCV_{off}	=	± 0.06	%FS/K
Temperature coefficient of compensation circuit	TCV_{comp}	=	−12	mV/K
For T_{amb} = −10 to 85 °C: temperature hysteresis (4)	TH	=	0.5	%FS

Notes

1. Transducer output voltage is ratiometric to operating voltage.
2. Deviation from Best Straight Line (BSL) in pressure range.
3. Deviation of output voltage at same pressure point by increasing or decreasing pressure.
4. Measurement cycle from −10 °C to +85 °C = 30 min. and from +85 to −10 °C = 30 min.



Pin connections:

1	V_t	Bridge operating voltage
2	V_{p+}	Positive output voltage
3	V_{p-}	Negative output voltage
4	V_e	Excitation voltage
5	n.c.	Not connected
6	V_g	Ground

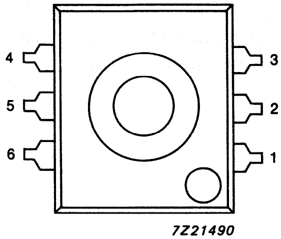


Fig. 2 Schematic diagram.

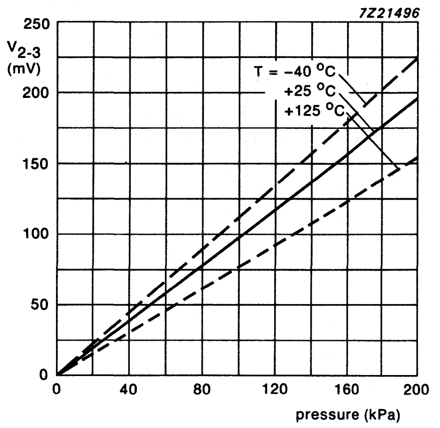


Fig. 3 Operation without temperature compensating circuit.

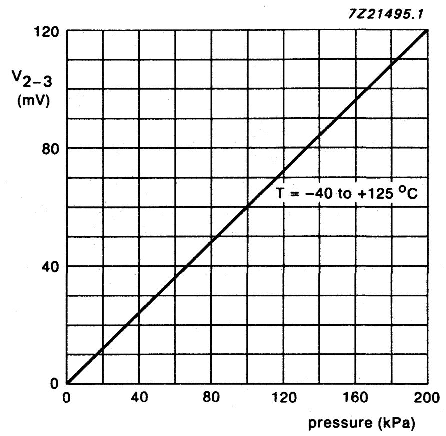


Fig. 4 Operation with temperature compensating circuit.

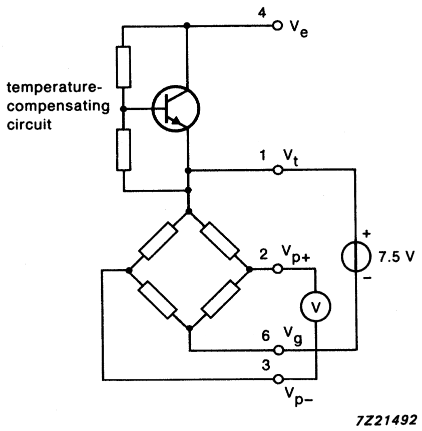


Fig. 5 Schematic without temperature compensation.

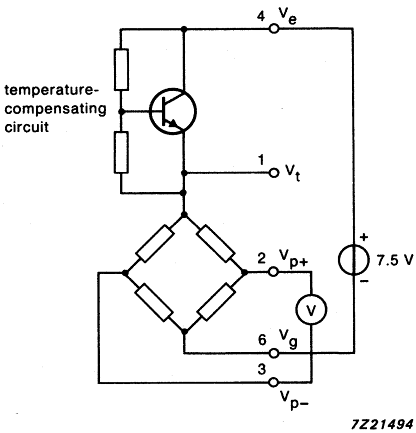


Fig. 6 Schematic with temperature compensation.

MONOLITHIC PRESSURE SENSOR

The KP100A1 is designed for measurement of absolute pressures from 0 to 200 kPa.
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

Operating pressure range	P	0 to 200 kPa
Operating voltage	V_t, V_e	5.0 V
Operating temperature range	T_{amb}	−40 to + 125 °C

MECHANICAL DATA

Dimensions in mm

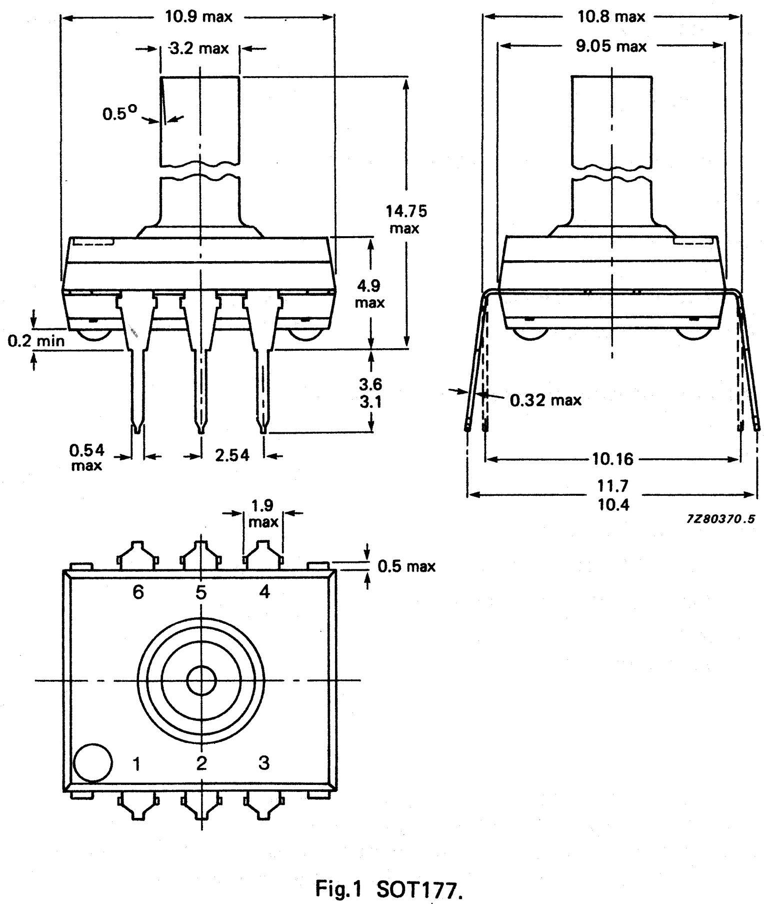


Fig.1 SOT177.

The pressure transducer is suitable for use with non-ionic and non-corrosive media. The silicon diaphragm is covered with Si_3N_4 for protection.

The pressure port is defined for using flexible tubes with 3 mm internal diameter.

The SOT117 envelope is designed for soldering on a PCB.

RATINGS

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

Operating voltage	V_t, V_e	max.	12	V
Pressure (absolute)	P_{max}	max.	400	kPa
Burst pressure (absolute)	P_b	⩾	600	kPa
Operating temperature range	T_{amb}		−40 to + 125	°C
Storage temperature range	T_{stg}		−65 to + 150	°C
Lead soldering temperature at $t_{sld} < 10$ s	T_{sld}	max.	260	°C

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Operating pressure range	P		0 to 200	kPa
Bridge resistance (see Fig. 2)	R_{br}		1800 ± 400	Ω
Linearity (note 2)	FL	=	± 0.5	%FS
Pressure hysteresis (note 3)	PH	=	0.1	%FS

For V_t = 5.0 V (operation without temperature compensation):

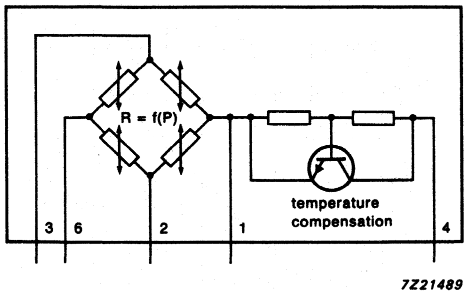
Offset voltage (note 1)	V_{off}	⩽	± 25.0	mV
Sensitivity (note 1)	S		0.45 to 0.85	$\frac{mV}{kPa}$
Temperature coefficient of offset voltage	TCV_{off}	=	± 0.05	%FS/K
Temperature coefficient of sensitvity	TCS	=	−0.22	%/K

For V_e = 5.0 V (operation with temperature compensation):

Offset voltage	V_{off}	⩽	± 15.0	mV
Sensitivity	S		0.20 to 0.60	$\frac{mV}{kPa}$
Temperature coefficient of sensitivity	TC	=	± 0.06	%/K
Temperature coefficient of offset voltage	TCV_{off}	=	± 0.06	%FS/K
Temperature coefficient of compensation circuit	TCV_{comp}	=	−12	mV/K
For T_{amb} = −10 to + 85 °C: temperature hysteresis (note 4)	TH	=	0.5	%FS

Notes

1. Transducer output voltage is ratiometric to operating voltage.
2. Deviation from Best Straight Line (BSL) in pressure range.
3. Deviation of output voltage at same pressure point by increasing or decreasing pressure.
4. Measurement cycle from −10 °C to + 85 °C = 30 min and from + 85 to −10 °C = 30 min



Pin connections:

1	V_t	Bridge operating voltage
2	V_{p+}	Positive output voltage
3	V_{p-}	Negative output voltage
4	V_e	Excitation voltage
5	n.c.	Not connected
6	V_g	Ground

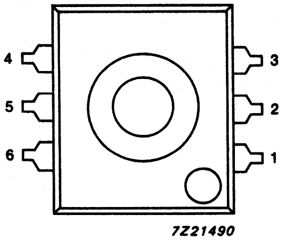


Fig. 2 Schematic diagram.

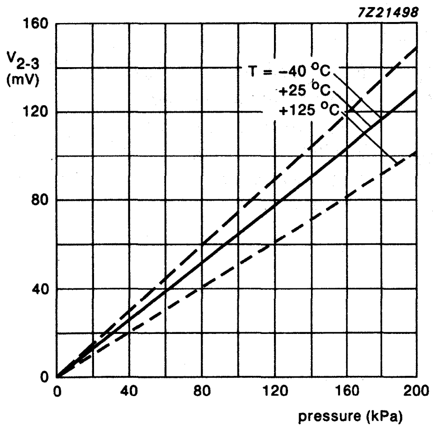


Fig. 3 Operation without temperature compensating circuit.

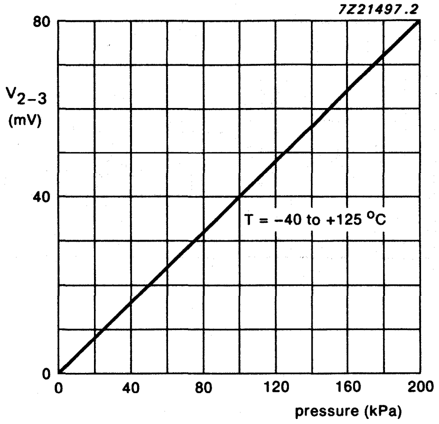


Fig. 4 Operation with temperature compensating circuit.

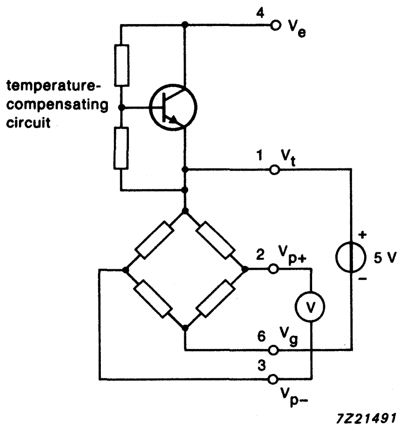


Fig. 5 Schematic without temperature compensation.

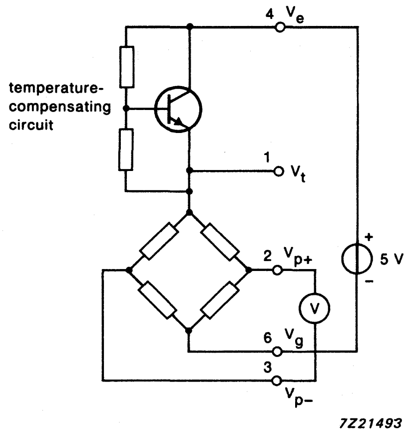


Fig. 6 Schematic with temperature compensation.

MONOLITHIC PRESSURE SENSOR

The KP100A is designed for measurement of absolute pressures from 0 up to 120 kPa.
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

Operating pressure range	P	0 to 120 kPa
Operating voltage	V_t, V_e	5.0 V
Operating ambient temperature range	T_{amb}	−40 to + 125 °C

MECHANICAL DATA

Dimensions in mm

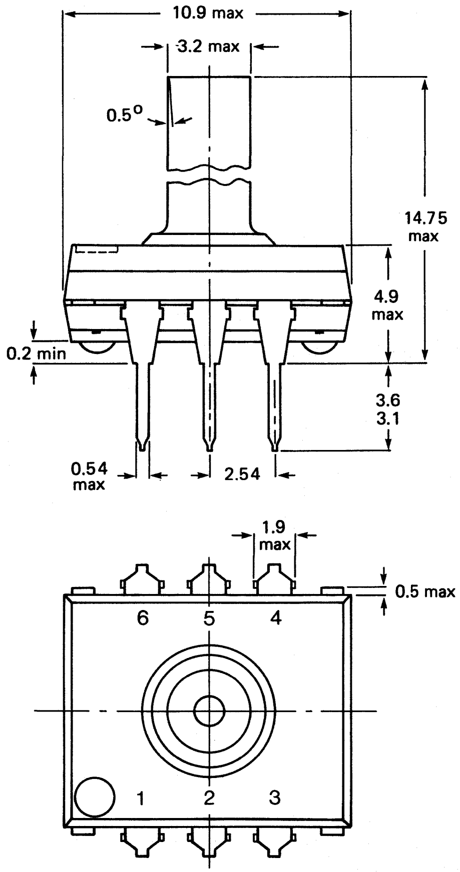


Fig. 1 SOT177.

The pressure transducer is suitable for use with non-ionic and non-corrosive media. The silicon diaphragm is covered with Si_3N_4 for protection.

The pressure port is defined for using flexible tubes with 3 mm internal diameter.

The SOT177 envelope is designed for soldering on a PCB.

RATINGS

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

Operating voltage	V_t, V_e	max.	12	V
Pressure (absolute)	P_{max}	max.	250	kPa
Burst pressure (absolute)	P_b	$\geqslant$	600	kPa
Operating ambient temperature range	T_{amb}		−40 to +125	°C
Storage temperature range	T_{stg}		−65 to +150	°C
Lead soldering temperature at $t_{sld} < 10$ s	T_{sld}	max.	260	°C

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Operating pressure range	P		0 to 120	kPa
Bridge resistance (see Fig. 2)	R_{br}		1600 ± 500	Ω
Linearity (note 1)	FL		± 0.5	%FS
Pressure hysteresis (note 2)	PH	=	0.1	%FS

For V_t = 5.0 V (operation without temperature compensation)

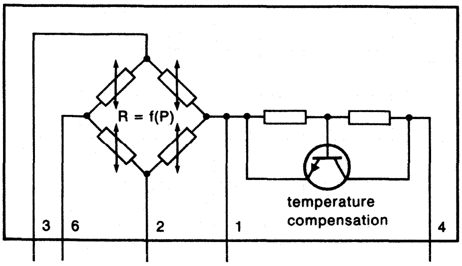
Offset voltage (note 3)	V_{off}	$\leqslant$	± 25.0	mV
Sensitivity (note 3)	S		0.70 to 1.40	$\frac{mV}{kPa}$
Temperature coefficient of offset voltage	TCV_{off}	=	± 0.05	%FS/K
Temperature coefficient of sensitivity	TCS	=	−0.22	%/K

For V_e = 5.0 V (operation with temperature compensation)

Offset voltage	V_{off}	$\leqslant$	± 15.0	mV
Sensitivity	S	=	0.25 to 0.75	$\frac{mV}{kPa}$
Temperature coefficient of sensitivity	TCS	=	± 0.06	%/K
Temperature coefficient of offset voltage	TCV_{off}	=	± 0.06	%FS/K
Temperature coefficient of compensation circuit	TCV_{comp}	=	−12	mV/K
For T_{amb} = −10 to +85 °C: temperature hysteresis (note 4)	TH	=	0.5	%FS

Notes to the characteristics

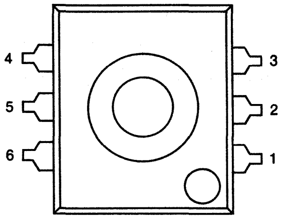
1. Deviation from Best Straight Line (BSL) in pressure range.
2. Deviation of output voltage at same pressure point by increasing or decreasing pressure.
3. Transducer output voltage is ratiometric to operating voltage.
4. Measurement cycle from −10 °C to +85 °C = 30 min. and from +85 °C to −10 °C = 30 min.



7Z21489

Pin connections:

1	V_t	Bridge operating voltage
2	V_{p+}	Positive output voltage
3	V_{p-}	Negative output voltage
4	V_e	Excitation voltage
5	n.c.	Not connected
6	V_g	Ground



7Z21490

Fig. 2 Schematic diagram.

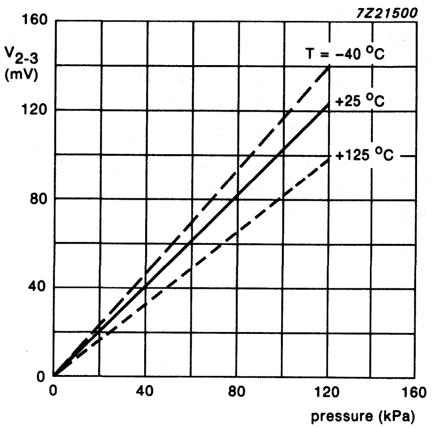


Fig. 3 Operation without temperature compensating circuit.

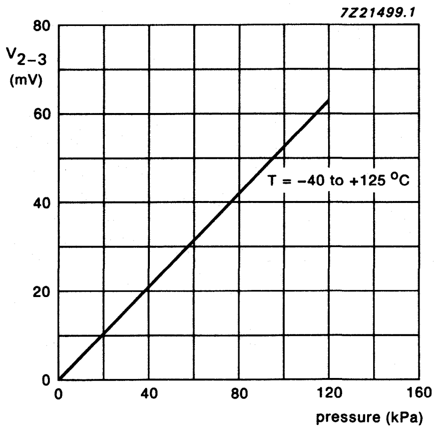


Fig. 4 Operation with temperature compensating circuit.

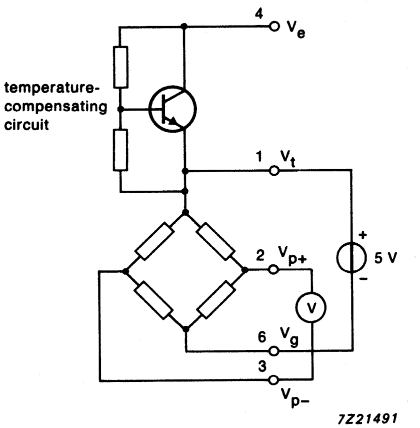


Fig. 5 Schematic without temperature compensation.

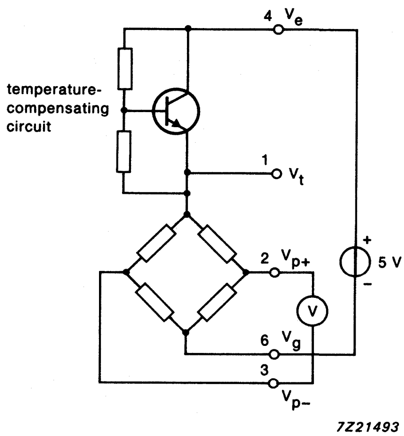


Fig. 6 Schematic with temperature compensation.

MONOLITHIC PRESSURE SENSOR

The KP130AE is designed for measurement of absolute pressures from 20 to 200 kPa. The sensor contains a monolithic silicon vacuum cell incorporating diffused strain gauge resistors and an IC amplifier which is calibrated for compensation of offset and sensitivity and of their temperature coefficients.
The housing is a plastic moulded 6-pin DIL SOT177 package with a rigid capillary tube for the pressure connection.

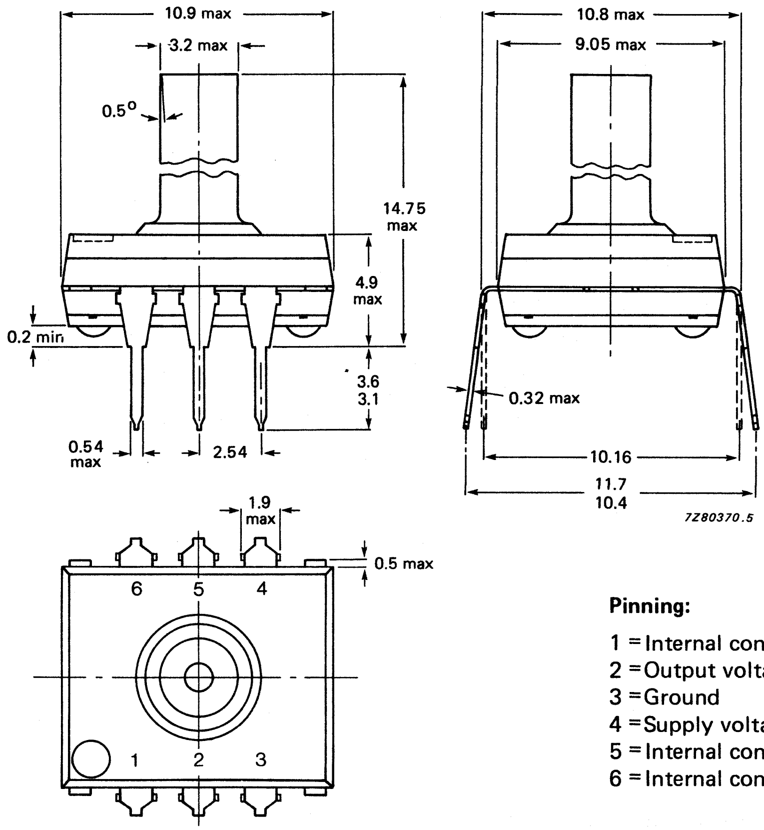
QUICK REFERENCE DATA

Operating pressure range	P_{abs}		20 to 200	kPa
Supply voltage range	V_B		4.75 to 7.0	V
Output voltage (for V_B = 5 V)				
P = 20 kPa	V_O	=	0.450	V
P = 200 kPa	V_O	=	4.500	V
Operating ambient temperature range	T_{amb}		−40 to + 120	^oC

MECHANICAL DATA

Dimensions in mm

Fig.1 SOT177.



Pinning:

1 = Internal connection
2 = Output voltage V_O
3 = Ground
4 = Supply voltage V_B
5 = Internal connection
6 = Internal connection

RATINGS

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

Supply voltage	V_B	max.	8	V
Storage temperature range	T_{stg}		−65 to 150	°C
Operating ambient temperature range	T_{amb}		−40 to 120	°C
Lead soldering temperature ($t < 10$ s)	T_{sld}	max.	260	°C
Operating pressure	P_{abs}	max.	350	kPa
Destructive pressure ($t < 10$ min)	P_b	min.	500	kPa
Load resistance	R_L	min.	5	kΩ
Load capacitance (note 1)	C_L		0.1 to 1.5	μF

Note

1. With a series resistor of 60 ± 10 Ω.

CHARACTERISTICS

T_{amb} = 25 °C unless otherwise specified

Operating pressure range	P_{abs}		20 to 200	kPa
Supply voltage	V_B	=	5.0	V
Supply current (at no load)	I_{CC}	max.	8	mA
Short load current limitation	I_{SC}		1.5 to 7.0	mA
Output voltage				
P = 20 kPa (notes 1 and 2)	V_O	=	0.450	V
P = 200 kPa (notes 1 and 2)	V_O	=	4.500	V
Sensitivity (nominal) (notes 1 and 2)	s	=	22.5	mV/kP
Pressure hysteresis and linearity combined (note 3)		max.	±0.9	%FS
Sensor response time for full scale pressure step (ideal pressure pulse, C_L = 0.1 μF, output voltage within the error band)	t_r	max.	10	ms
Overload behaviour (max. additional error within the nominal pressure range after 1 min at +350 kPa)		max.	±0.5	%FS
Effective leak area (note 4)	A_{eff}	max.	10^{-7}	cm²

DEVELOPMENT DATA

Notes

1. Ratiometric to supply voltage.
2. Nominal values, see error band (Fig.7).
3. Maximum deviation to Best Straight Line (BSL) in the nominal pressure range.
4. Effective leak area;

Calculated by $\frac{1.58\ (10^{-3})\ V}{t\sqrt{3.325\ T}}\ \ln \frac{P_o}{P_t}$

with V = Volume (cm³); t = time; T = absolute temperature (K);
P_o = start pressure; P_t = pressure after time t (kPa).

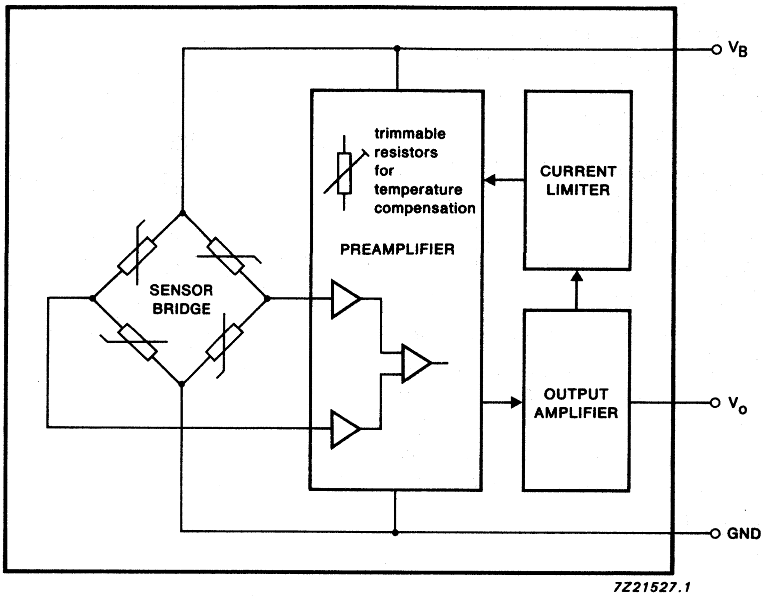


Fig.2 Circuit diagram.

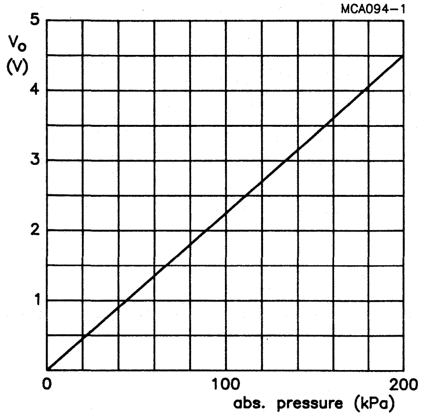


Fig.3 Nominal output characteristic KP130AE. Output voltages as a function of pressure; V_B = 5 V.

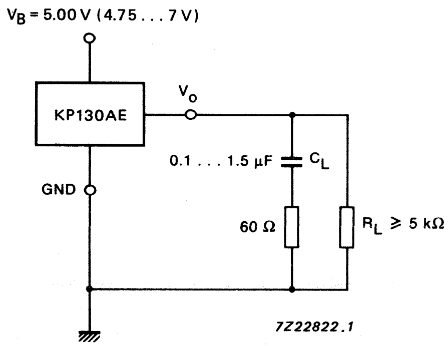


Fig.4 Recommended output circuit: R_s = 60 Ω ± 10 Ω; C_L = 0.1 to 1.5 μF; R_L ⩾ 5 kΩ.

DEVELOPMENT DATA

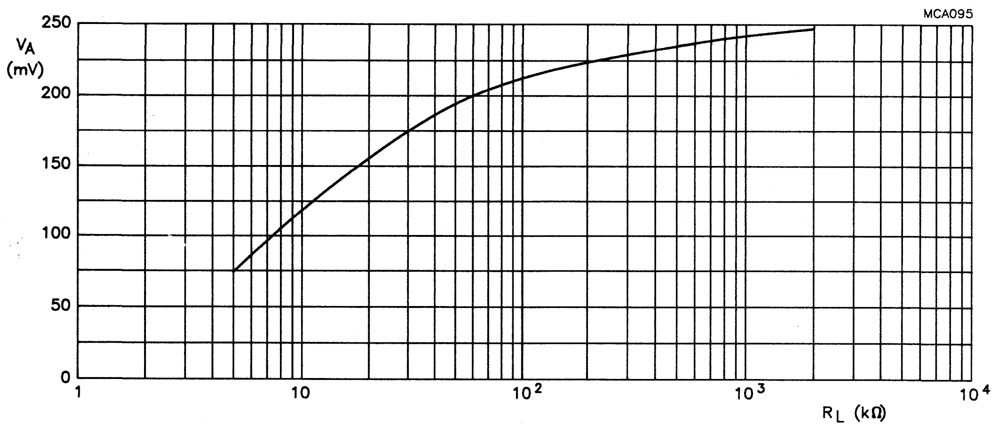


Fig.5 Residual voltage. Minimum output voltage as a function of load resistance; V_B = 5 V.

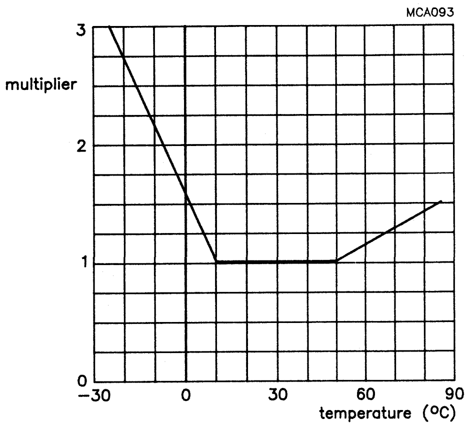


Fig.6 KP130AE error band modification. Multiplier as a function of temperature.

break points:

−25 °C : 3
10 °C : 1
50 °C : 1
85 °C : 1.5

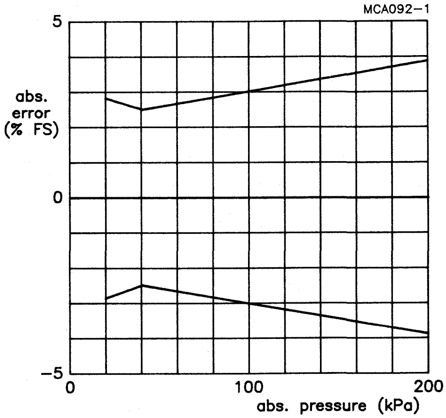


Fig.7 KP130AE error band. Absolute error (%FS) as a function of pressure (kPa). (temperature range 10 - 50 °C).

break points:

p = 20 kPa ± 2.75 %FS
p = 40 kPa ± 2.50 %FS
p = 160 kPa ± 3.50 %FS
p = 200 kPa ± 3.80 %FS

Philips Components

Data sheet	
status	Preliminary specification
date of issue	August 1990

KP131AE
Monolithic pressure transducer

APPLICATIONS

The KP131AE is designed for the measurement of absolute gas or air pressures from 10 up to 112.5 kPa which corresponds to 0.1 up to 1.12 bars. The pressure connection is designed for flexible tubing with a 3mm internal diameter.

DESCRIPTION

The KP131AE is a monolithic absolute pressure transducer in a plastic SOT177 envelope. The sensor includes an amplifier IC which is calibrated for compensation of offset, sensitivity tolerances and temperature coefficients.
The pressure sensor is suitable for use with non-ionic and non corrosive media. The active parts are coated with silicone gel for protection.

QUICK REFERENCE DATA

T_{amb} = 25 °C unless otherwise specified

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
P_{abs}	operating pressure range		10	-	112.5	kPa
V_{CC}	supply voltage		-	5.00	-	V
V_o	output voltage	P = 10 kPa P = 112.5 kPa	- -	0.400 4.500	- -	V V
T_{amb}	operating ambient temperature range		−40	-	+120	°C

ORDERING AND PACKAGE INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
KP131AE	6	DIL	plastic	SOT177

MECHANICAL DATA

Dimensions in mm

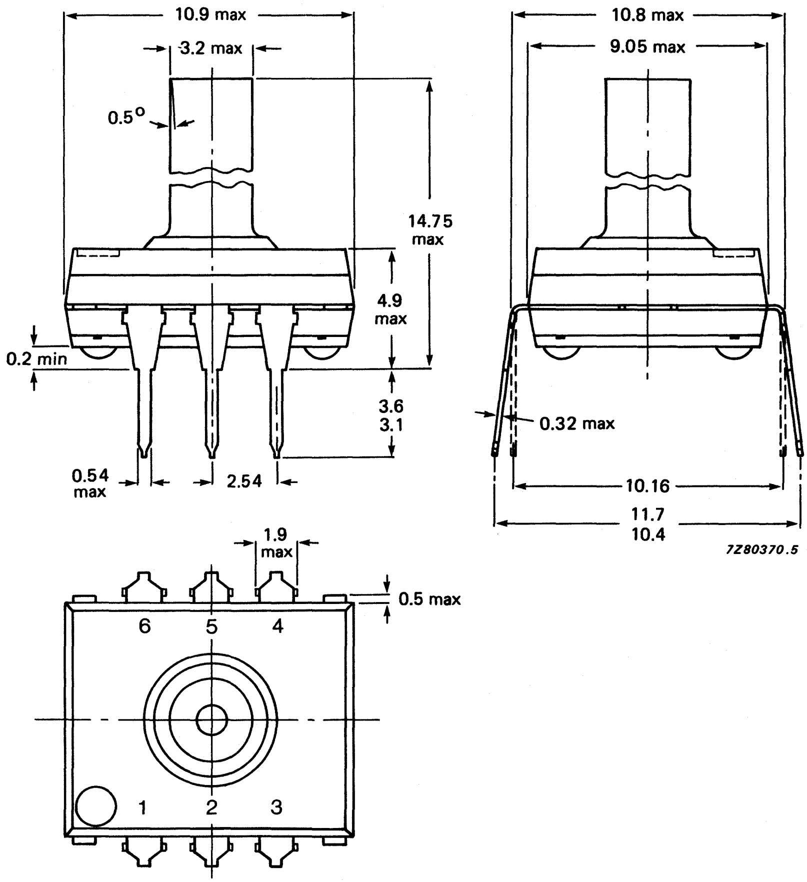


Fig.1 SOT177.

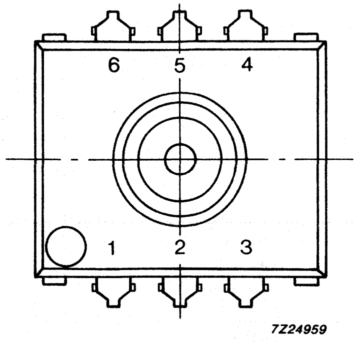


Fig.2 Pin configuration.

PINNING

SYMBOL	PIN	DESCRIPTION
–	1,5,6	connected internally
V_o	2	output voltage
GND	3	ground
V_{CC}	4	supply voltage

LIMITING VALUES

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{CC}	supply voltage		-	-	8	V
T_{stg}	storage temperature range		–65	-	+150	°C
T_{amb}	operating ambient temperature range		–40	-	+120	°C
P_{abs}	operating pressure		-	-	250	kPa
P_b	destructive pressure	t<10 minutes	500	-	-	kPa
A	envelope leakage	note 1	-	-	10^{-7}	cm^2
R_L	load resistance		5	-	-	kΩ
C_L	load capacitance range	with a series resistor of 60 ± 10 Ω	0.1	-	1.5	µF
T_{sld}	lead soldering temperature	t<10 s	-	-	260	°C

Note to the limiting values

1. Effective leak area calculated by:

$$A = \frac{1.58\,(10^{-3})\,V}{t\sqrt{3.325\,T}} \ln\left(\frac{P_o}{P_t}\right)$$

V = volume (cm^3); t = measurement time (s); T = absolute temp. (K);
p_o = pressure at start; p_t = pressure after time t.

CHARACTERISTICS

V_{CC} = 5.00 V; T_{amb} = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
P_{abs}	operating pressure range		10	-	112.5	kPa
V_{CC}	supply voltage range		4.75	-	7.0	V
I_{CC}	supply current	no load	-	-	8	mA
I_{SC}	short circuit load current limitation		1.5	-	7.0	mA
V_o	output voltage	p = 10 kPa note 1	-	0.400	-	V
		p = 112.5 kPa note 1	-	4.500	-	V
S	sensitivity	note 1	-	40	-	mV/kPa
	pressure hysteresis and linearity	note 2	-	-	± 0.9	%FS
t_R	pressure response time for full scale pressure step	ideal pressure pulse; C_L = 0.1 μF; output voltage within the pressure band	-	-	10	ms
	overload behaviour	maximum additional error within the nominal pressure range after 1 minute at +250 kPa	-	-	± 0.5	%FS

Notes to the characteristics

1. Ratiometric to supply voltage. Nominal values, for error see error band (Fig.5).
2. Maximum deviation to BSL in the nominal pressure range.

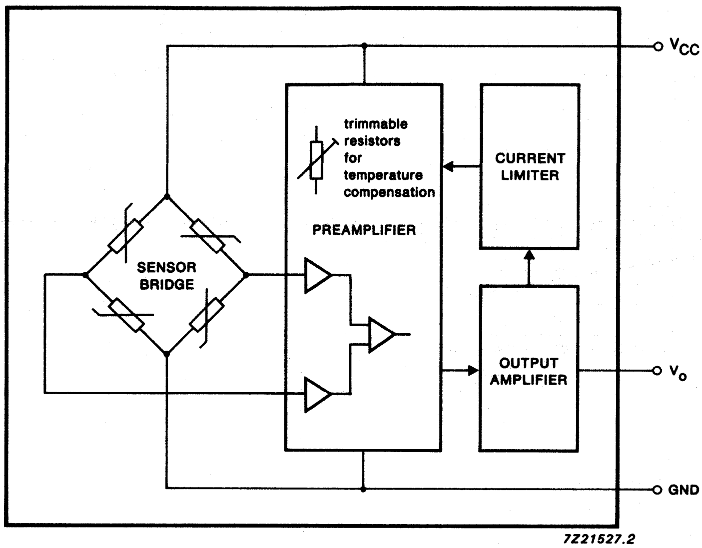


Fig.3 Block diagram.

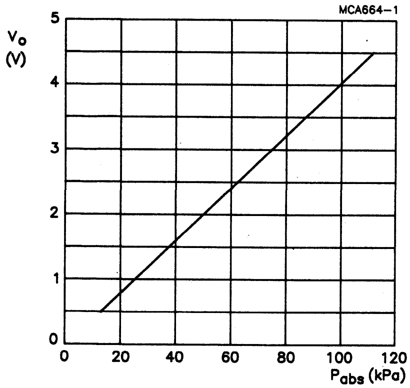


Fig.4 Output characteristic; $V_{CC} = 5.00$ V.

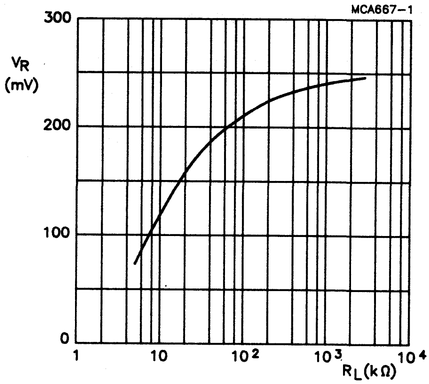
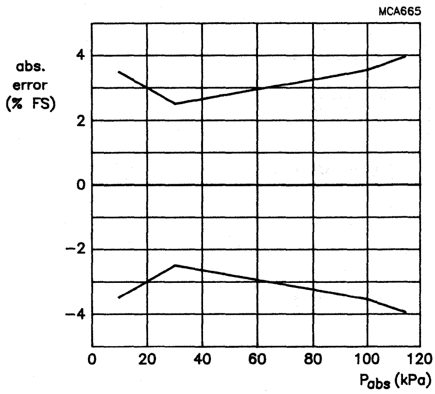


Fig.5 Residual voltage: minimum output voltage as a function of load resistance; $V_{CC} = 5.00$ V.

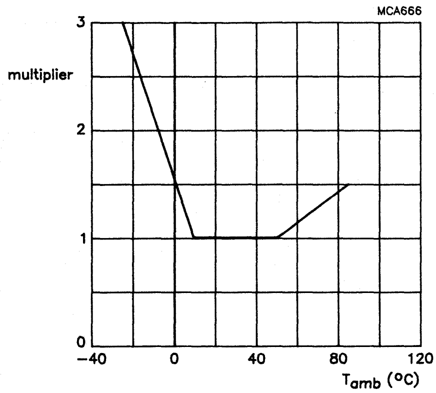
Monolithic pressure transducer KP131AE



break points

p = 10. kPa : ± 3.5 %FS
p = 30. kPa : ± 2.5 %FS
p = 100. kPa : ± 3.5 %FS
p = 112.5 kPa : ± 4.0 %FS

Fig.6 Error band; maximum error as a function of applied pressure; temperature range 10-50 °C.



break points

T = −25 °C : 3
T = 10 °C : 1
T = 50 °C : 1
T = 85 °C : 1.5

Fig.7 Error band modification as a function of temperature.

APPLICATION INFORMATION

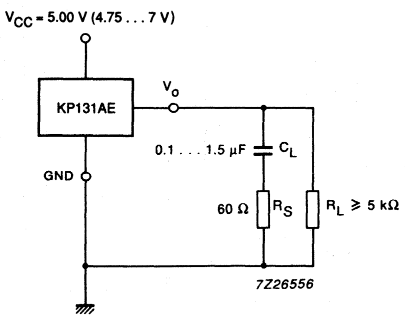


Fig.8 Recommended output circuit; $R_s = 60 \pm 10\ \Omega$; $C_L = 0.1\ \mu F$ to $1.5\ \mu F$; $R_L \geq 5\ k\Omega$.

Philips Components

Data sheet	
status	Product specification
date of issue	August 1990

KPZ20G

Thin-film pressure sensor

APPLICATION

Measurement of relative pressures from –1 up to 2 bar and for a wide range of gases or fluids.

DESCRIPTION

The KPZ20G is designed for the measurement of relative pressures from –1 up to 2 bar and for a wide range of gases or fluids. The sensor employs thin-film semi-conductor strain gauges deposited on a copper alloy 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 copper alloy, HC10 envelope plastic, epoxy glue and assembly parts, may be used. For the sensor reference side, only non-conductive and non-corrosive media are allowed.

An application note describing a suitable sensor mounting is available on request.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
P	pressure range	–100	-	200	kPa
V_B	supply voltage	-	7.5	-	V
T_{amb}	operating ambient temperature range	– 40	-	+ 125	°C

ORDERING AND PACKAGE INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
KPZ20G	6	DIL	plastic	SOT198

Thin-film pressure sensor KPZ20G

MECHANICAL DATA

Dimensions in mm

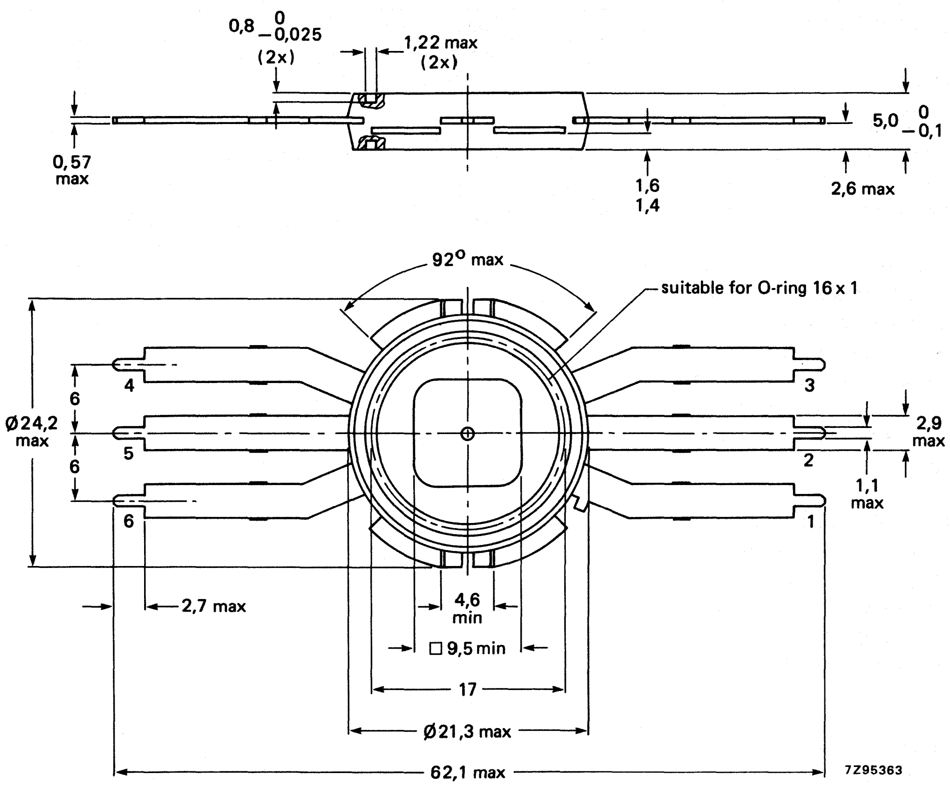


Fig.1 SOT198.

Thin-film pressure sensor KPZ20G

PINNING

SYMBOL	PIN	DESCRIPTION
V_B	1, 4	supply voltage
V_P	2, 5	output voltage

pins 3 and 6: not connected

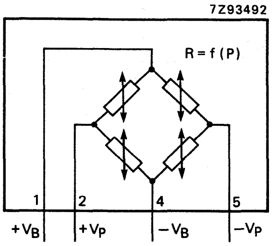


Fig.2 Schematic diagram.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_B	supply voltage		-	16	V
P_{max}	maximum pressure		-	500	kPa
P_b	destructive pressure	t < 10 min	1000	-	kPa
T_{amb}	operating ambient temperature range		−40	+125	°C
T_{stg}	storage temperature range		−65	+150	°C
T_{sld}	soldering temperature	t < 10 s	-	260	°C

CHARACTERISTICS

V_B = 7.5 V; T_{amb} = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
P	pressure range		−100	-	200	kPa
S	sensitivity	note 1	0.07	-	0.14	mV/VkPa
R_{br}	bridge resistance		1.0	2.0	3.0	kΩ
V_{off}	offset voltage	note 1	-	-	±5.0	mV/V
F_L	linearity	note 2	-	±0.5	-	%FS
PH	pressure hysteresis	note 3	-	0.2	-	%FS
f_d	diaphragm natural frequency		5	-	-	kHz
TC_s	temperature coefficient of sensitivity	T_{amb} between −40 and + 85 °C	-	−0.15	-	%/K
TC_{off}	temperature coefficient of offset voltage	T_{amb} between −40 and + 85 °C	-	±0.05	-	%FS/K

Notes to the characteristics

1. Transducer output voltage is ratiometric to operating voltage.
2. Deviation from Best Straight Line (BSL) in pressure range.
3. Deviation of output voltage at same pressure point by increasing or decreasing pressure.

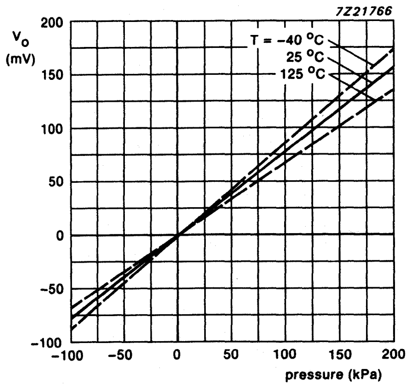


Fig.3 Nominal output characteristic KPZ20G. Output voltage as a function of pressure at V_B = 7.5 V.

Philips Components

Data sheet	
status	Product specification
date of issue	August 1990

KPZ21G

Thin-film pressure sensor

APPLICATION

Measurement of relative pressures between –100 and 1000 kPa and for a wide range of gases or fluids.

DESCRIPTION

The KPZ21G is designed for the measurement of relative pressures between –100 and 1000 kPa and for wide range of gases or fluids. The sensor employs thin-film semiconductor strain gauges deposited on a copper alloy isolating diaphragm. Sealing is achieved 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 copper alloy, HC10 envelope plastic, epoxy glue and assembly parts, may be used on the pressure transducer pressure side. For the sensor reference side, only non-corrosive media are permitted.

An application note describing a suitable sensor mounting is available on request.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
P	pressure range	–100	-	1000	kPa
V_B	supply voltage	-	7.5	-	V
T_{amb}	operating ambient temperature range	– 40	-	+125	°C

ORDERING AND PACKAGE INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
KPZ21G	6	DIL	plastic	SOT198

MECHANICAL DATA

Dimensions in mm

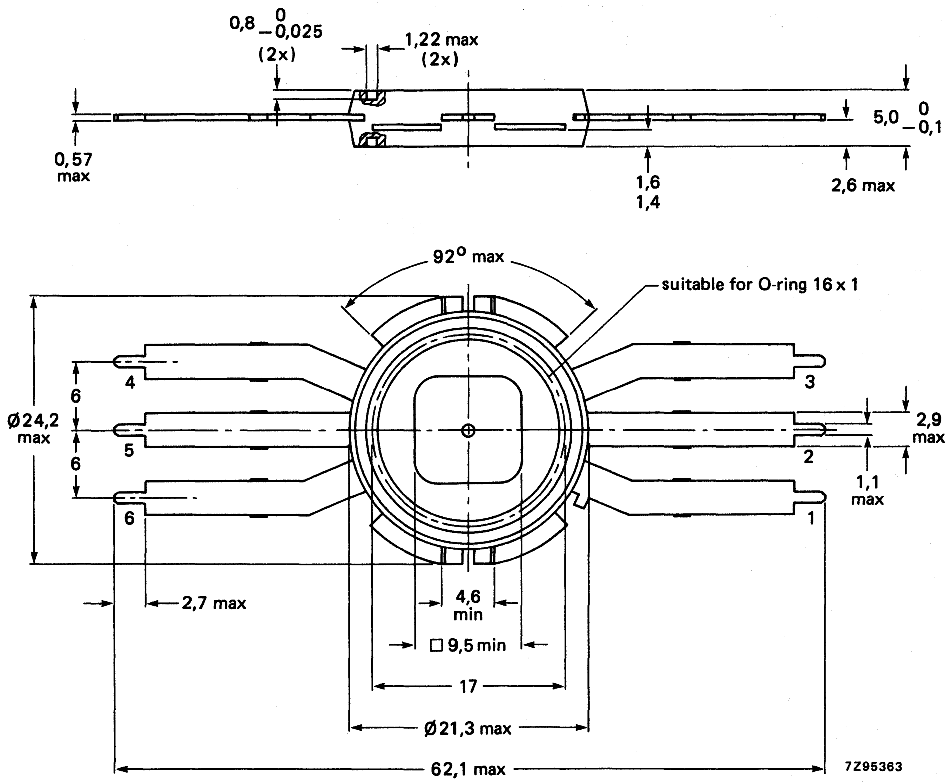


Fig.1 SOT 198.

Thin-film pressure sensor — KPZ21G

PINNING

SYMBOL	PIN	DESCRIPTION
V_B	1, 4	supply voltage
V_P	2, 5	output voltage

pins 3 and 6: not connected

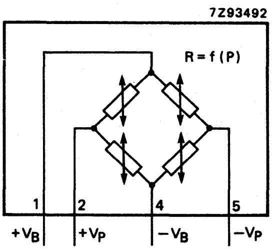


Fig.2 Schematic diagram.

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_B	supply voltage		-	16	V
P_{max}	maximum pressure		-	2000	kPa
P_b	destructive pressure	$t < 10$ min	3000	-	kPa
T_{amb}	operating ambient temperature range		−40	+125	°C
T_{stg}	storage temperature range		−65	+100	°C
T_{sld}	soldering temperature	$t < 10$ s	-	260	°C

CHARACTERISTICS

V_B = 7.5 V; T_{amb} = 25 °C, unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
P	pressure range		−100	-	1000	kPa
S	sensitivity	note 1	0.025	-	0.045	mV/VkPa
R_{br}	bridge resistance		-	2.0 ± 1.0	-	kΩ
V_{off}	offset voltage	note 1	-	-	±5.0	mV/V
F_L	linearity	note 2	-	±0.3	-	%FS
PH	pressure hysteresis	note 3	-	0.2	-	%FS
f_d	diaphragm natural frequency		5	-	-	kHz
TC_s	temperature coefficient of sensitivity	T_{amb} between −40 and + 85 °C	-	−0.15	-	%/K
TC_{off}	temperature coefficient of offset voltage	T_{amb} between −40 and + 85 °C	-	±0.05	-	%FS/K

Notes to the characteristics

1. Transducer output voltage is ratiometric to operating voltage.
2. Deviation from Best Straight Line (BSL) in pressure range.
3. Deviation of output voltage at same pressure point by increasing or decreasing pressure.

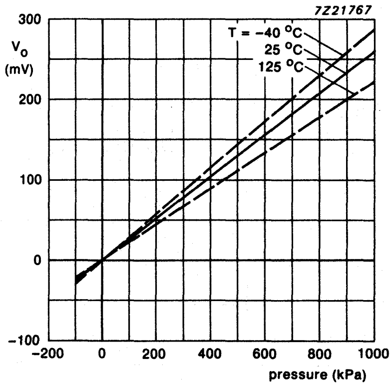


Fig.3 Nominal output characteristic KPZ21G. Output voltage as a function of pressure at V_B = 7.5 V.

Philips Components

Data sheet	
status	Preliminary specification
date of issue	August 1990

KPZ21GE

Thin-film pressure sensor

APPLICATION

Measurement of relative pressures between −100 and 1000 kPa (−1 to 10 Bar), temperature compensated and with high accuracy.

DESCRIPTION

The KPZ21GE is designed for the measurement of relative pressures between −100 and 1000 kPa and is provided with an internal amplifier IC which is laser trimmed for temperature effects, offset and sensitivity tolerances. The sensor is mounted in a SOT198D4 plastic envelope.

The sensor employs thin-film semi-conductor strain gauges deposited on a copper alloy isolating diaphragm. Sealing is achieved 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 copper alloy, HC10 envelope plastic, epoxy glue and assembly parts, may be used on the pressure transducer pressure side. For the sensor reference side, only dry gases are permitted. The thin film bridge resistors and the amplifier IC are covered with silicon gel for protection.

An application note describing a suitable sensor mounting is available on request.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
P	pressure range	−100	–	1000	kPa
V_{CC}	supply voltage	–	6.111	–	V
T_{amb}	operating ambient temperature range	− 40	–	+120	°C

ORDERING AND PACKAGE INFORMATION

EXTENDED TYPE NUMBER	PACKAGE			
	PINS	PIN POSITION	MATERIAL	CODE
KPZ21GE	6	DIL	plastic	SOT198D4

Thin-film pressure sensor KPZ21GE

MECHANICAL DATA

Dimensions in mm

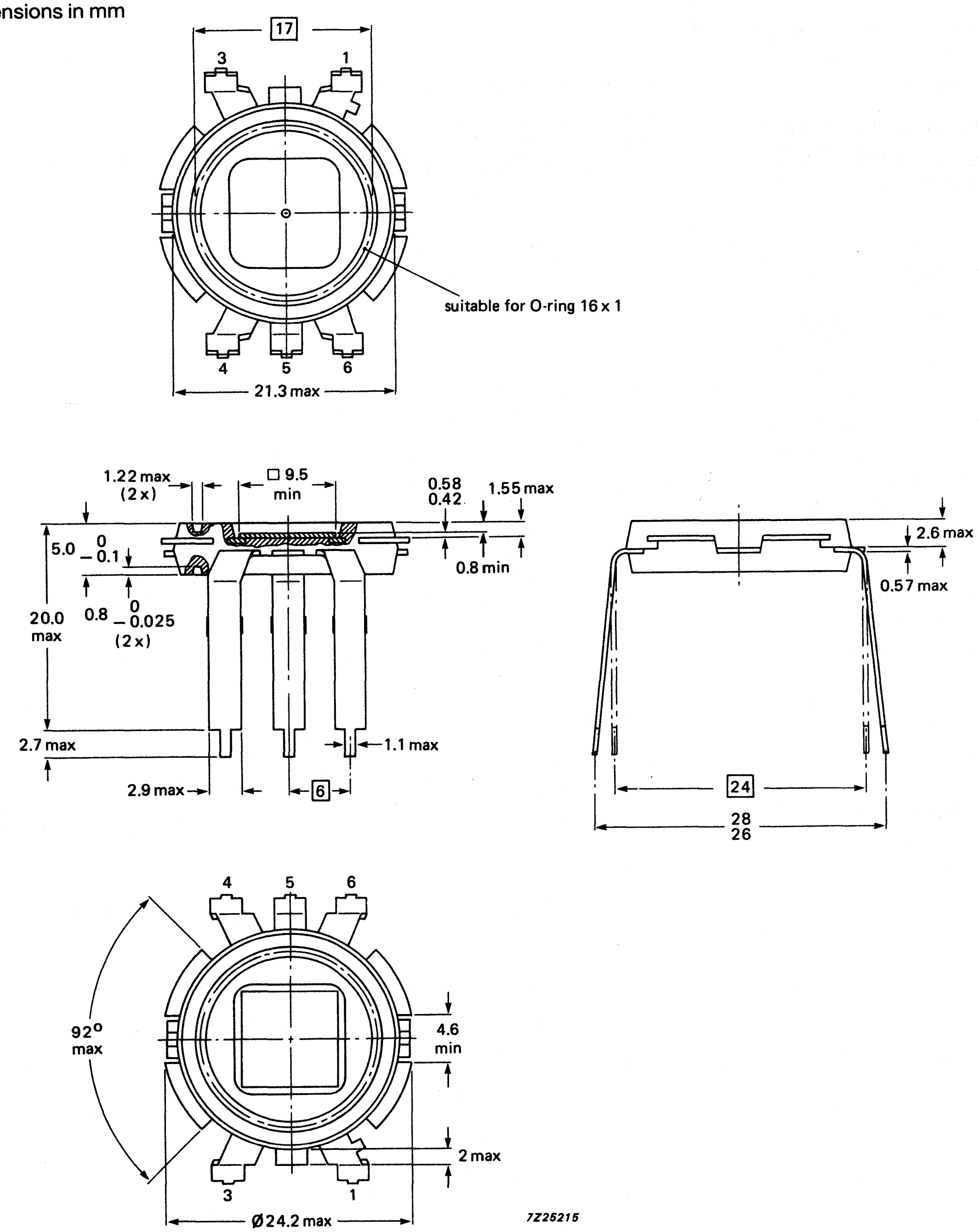


Fig.1 SOT 198D4.

Thin-film pressure sensor KPZ21GE

PINNING

SYMBOL	PIN	DESCRIPTION
V_{CC}	1	supply voltage (+)
	2	internally connected
Ground	3	supply voltage (-)
	4	internally connected
	5	internally connected
V_o	6	output voltage

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{CC}	supply voltage		–	–	8.0	V
P_{max}	maximum pressure		–	–	2000	kPa
P_b	destructive pressure	t < 10 min	3000	–	–	kPa
T_{amb}	operating ambient temperature range		–40	–	+120	°C
T_{stg}	storage temperature range		–65	–	+150	°C
T_{sld}	soldering temperature	t < 10 s	–	–	260	°C

CHARACTERISTICS

V_{CC} = 6.111 V; T_{amb} = 25 °C unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V_{CC}	supply voltage		4.75	–	7.5	V
I_{CC}	supply current	with no load	–	–	8	mA
P	operating pressure range	note 1	–100	–	1000	kPa
S	sensitivity	notes 2 and 5	–	5.00	–	mV/VkPa
V_{off}	offset voltage	notes 2 and 5	–	0.500	–	V
F/PH	linearity and pressure hysteresis combined	note 3	–	–	±1.0	%FS
I_{sc}	short circuit output current limitation		–	–	7.0	mA
C_L	load capacitor	with a series resistor of 60 ± 10 Ω	0.1	–	1.5	µF
R_L	load resistor		5	–	–	kΩ
f_d	diaphragm natural frequency		5	–	–	kHz
t_r	sensor response time for full scale pressure step	note 4	–	–	10	ms
A_{eff}	effective leakage area		–	–	10^{-7}	cm^2

Notes to the characteristics

1. See residual voltage diagram (Fig.5) for negative pressure values.
2. Transducer output voltage is ratiometric to operating voltage.
3. Deviation from Best Straight Line (BSL) in pressure range.
4. For C_L = 0.1 µF.
5. Combined error (pressure and temperature) see error band specification.
6. Calculated by $\frac{1.58\,(10^{-3})\,V}{t\sqrt{3.325\,T}}\ \ln\left(\frac{P0}{P_t}\right)$

   with V = Volume (cm^3); t = time(s); T = abs.temperature (K); P_O = start pressure (kPa); P_t = pressure after time t (kPa).

Thin-film pressure sensor KPZ21GE

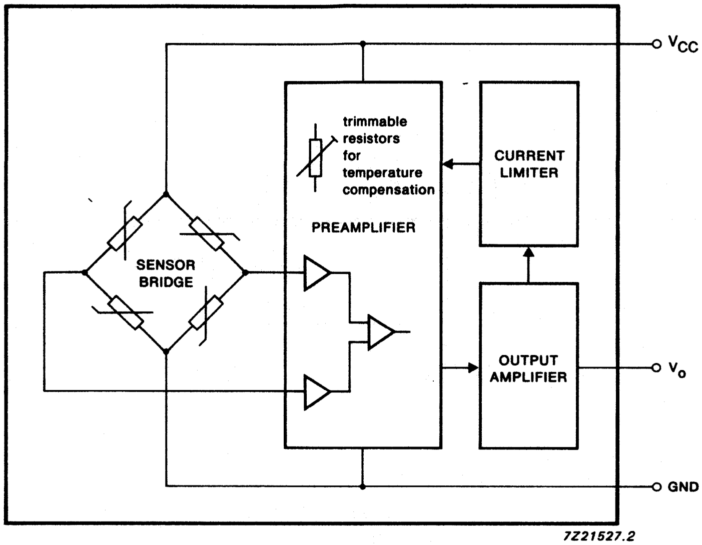


Fig.2 Circuit diagram.

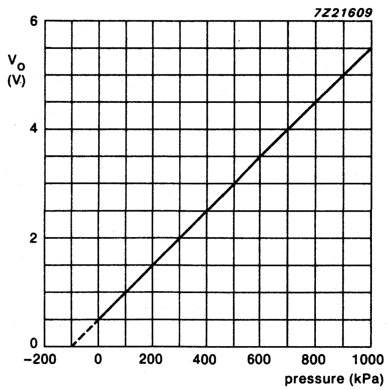


Fig.3 Nominal output characteristic KPZ21GE. Output voltage as a function of pressure; V_{CC} = 6.111 V.

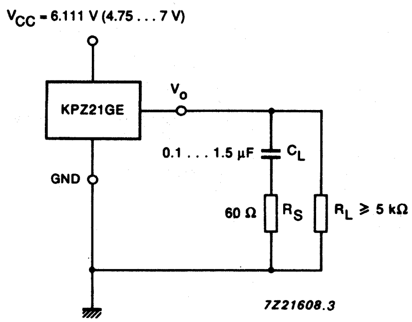


Fig.4 Recommended output circuit;
$R_s = 60\ \Omega \pm 10\ \Omega$;
$C_L = 0.1$ to $1.5\ \mu F$;
$R_L \geq 5\ k\Omega$.

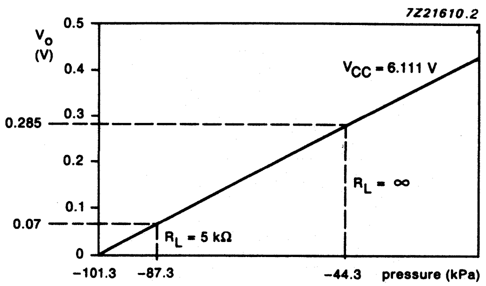
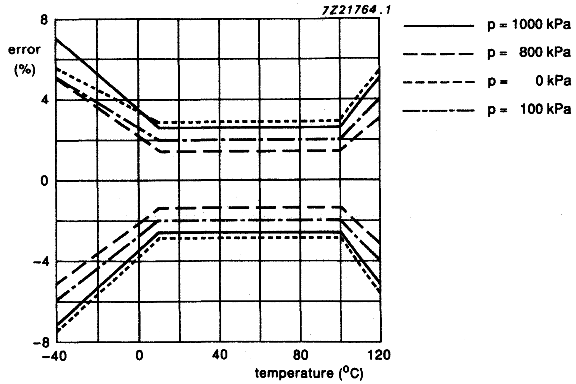


Fig.5 Residual voltage. Minimum output voltage as a function of load resistance; $V_B = 6.111$ V,

Thin-film pressure sensor KPZ21GE



Break points (%FS):

	−40 °C	10 °C ... 100 °C	120 °C
p = −100 kPa	+/−7	+/−2.5	+/−5
p = 0 kPa	+/−5	+/−1.5	+/−3
p = 800 kPa	+ 5/−5.9	+/−2.0	+/−4
p = 1000 kPa	+ 5.4/−7.3	+/−2.7	+/−5.4

Fig.6 KPZ21GE Error band. Error (%FS) as a function of temperature.

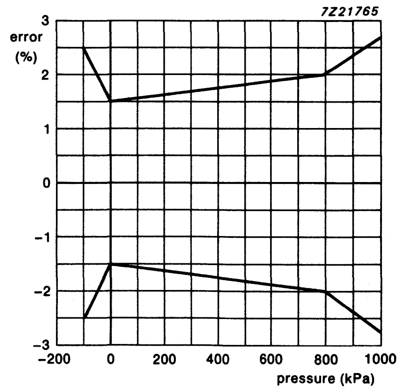


Fig.7 KPZ21GE error band. Error (%FS) as a function of pressure (kPa). (Temperature range 10 – 100 °C)

TEMPERATURE SENSORS

SILICON TEMPERATURE SENSORS

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

QUICK REFERENCE DATA

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

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

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

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

MECHANICAL DATA

Dimensions in mm

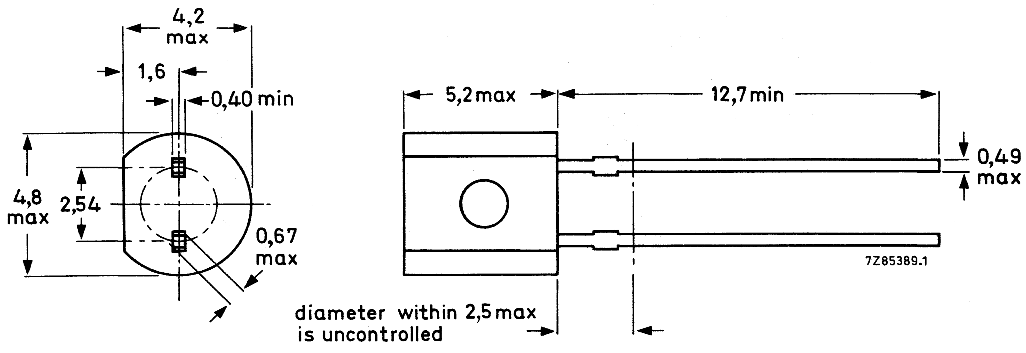


Fig. 1 SOD-70.

RATINGS

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

Continuous sensor current in free air

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

CHARACTERISTICS

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

Resistance				
I_C = 1 mA	KTY81-110	R_{25}	990 - 1010 Ω	
	KTY81-120	R_{25}	980 - 1020 Ω	
	KTY81-121	R_{25}	980 - 1000 Ω	
	KTY81-122	R_{25}	1000 - 1020 Ω	
	KTY81-150	R_{25}	950 - 1050 Ω	
	KTY81-151	R_{25}	950 - 1000 Ω	
	KTY81-152	R_{25}	1000 - 1050 Ω	
Temperature coefficient		typ.		0.79 %/K
Resistance ratio		R100/R25	1.696 ± 0.020	
		R–55/R25	0.490 ± 0.010	
Thermal time constant*				
in still air		typ.		30 s
in still liquid**		typ.		5.0 s
in flowing liquid**		typ.		3.0 s
Measuring temperature range				–55 to +150 °C

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

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

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

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

** Inert liquid FC43 of 3M company.

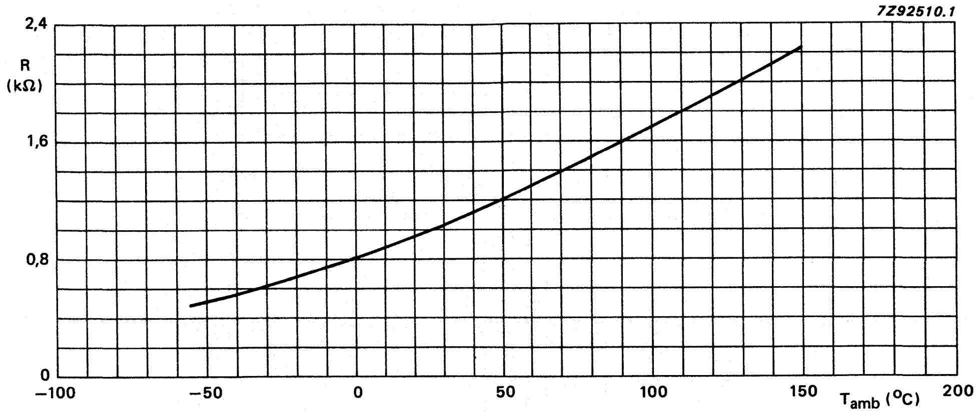


Fig. 2 Average resistance value of sensor at I_C = 1 mA as a function of temperature.

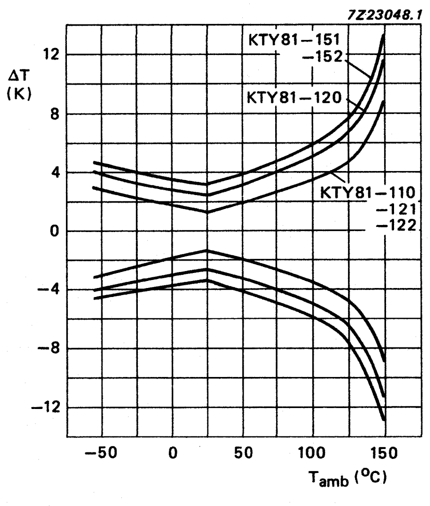


Fig. 3 Maximum expected temperature error ΔT.

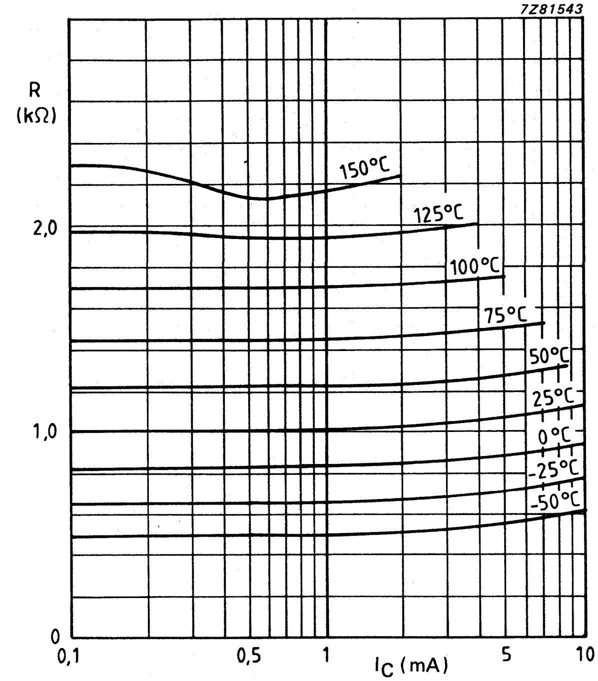


Fig. 4 Sensor resistance as a function of operating current (see Note).

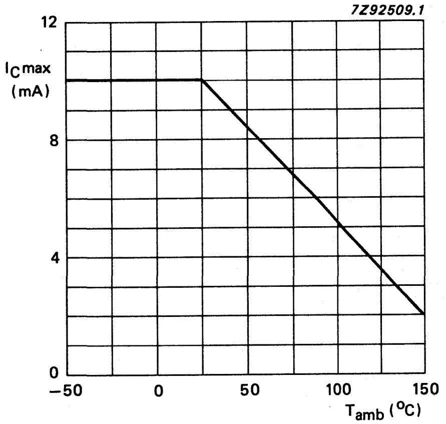


Fig. 5 Maximum operating current for safe operation.

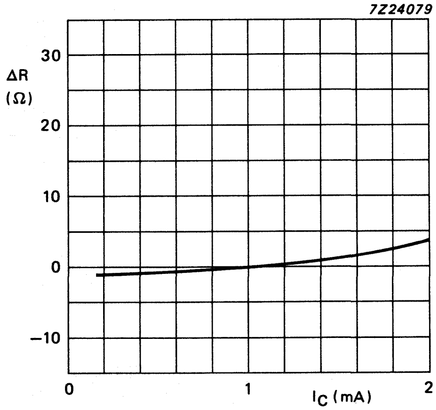


Fig. 6 Resistance deviation as a function of measuring current in still liquid; T_{amb} = 25 °C.

Note

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

SILICON TEMPERATURE SENSORS

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

QUICK REFERENCE DATA

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

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

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

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

MECHANICAL DATA

Dimensions in mm

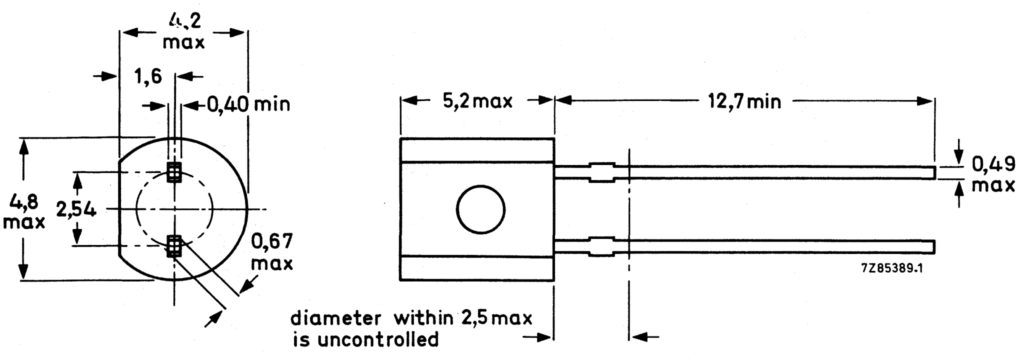


Fig. 1 SOD-70.

RATINGS

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

Continuous sensor current in free air

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

CHARACTERISTICS

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

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

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

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

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

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

** Inert liquid FC43 of 3M company.

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

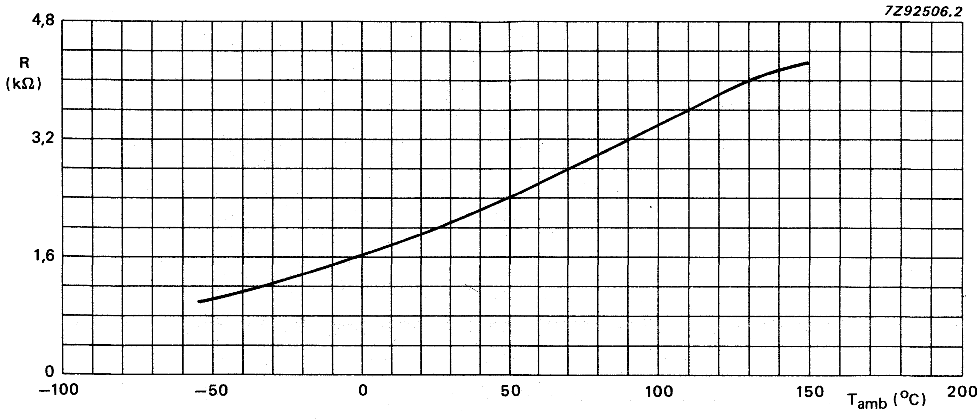


Fig. 2 Average resistance value of sensor at I_C = 1 mA as a function of temperature.

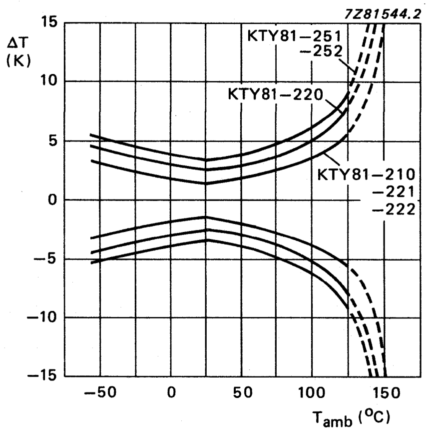


Fig. 3 Maximum expected temperature error ΔT.

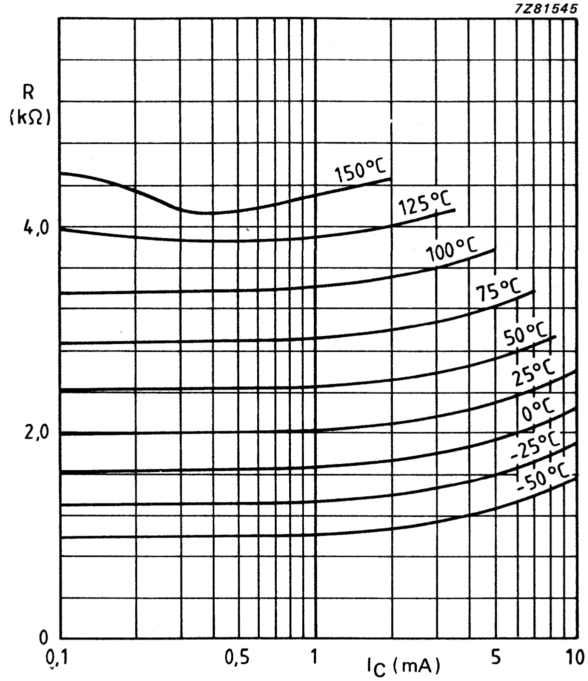


Fig. 4 Sensor resistance as a function of operating current (see Note).

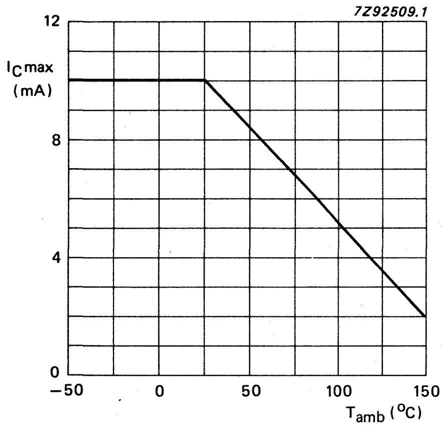


Fig. 5 Maximum operating current for safe operation.

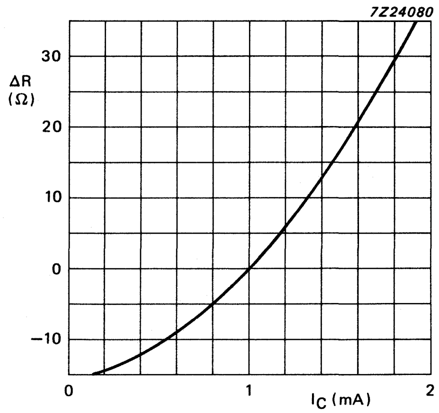


Fig. 6 Resistance deviation as a function of measuring current in still liquid; T_{amb} = 25 °C.

Note

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

SILICON TEMPERATURE SENSORS

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

QUICK REFERENCE DATA

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

Type		Type tape (identification colour)
KTY83-110	R_{25} = 990 - 1010 Ω;	yellow
KTY83-120	R_{25} = 980 - 1020 Ω;	white or green
KTY83-121	R_{25} = 980 - 1000 Ω;	white
KTY83-122	R_{25} = 1000 - 1020 Ω;	green
KTY83-150	R_{25} = 950 - 1050 Ω;	black or blue
KTY83-151	R_{25} = 950 - 1000 Ω;	black
KTY83-152	R_{25} = 1000 - 1050 Ω;	blue

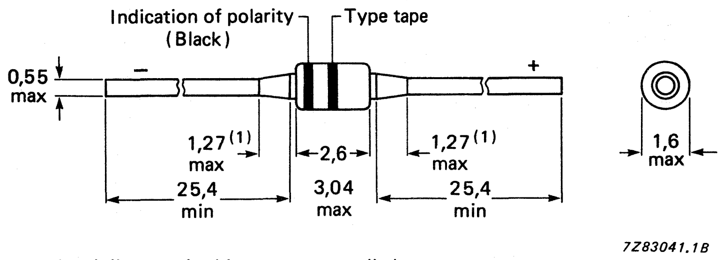
KTY83-120 is composed of groups −121 and −122 and is correspondingly designated.

KTY83-150 is composed of groups −151 and −152 and is correspondingly designated.

Operating ambient temperature range T_{amb} −55 to +175 °C

MECHANICAL DATA

Dimensions in mm



(1) Lead diameter in this zone uncontrolled

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

Note

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

RATINGS

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

Continuous sensor current in free air

T_{amb} = 25 °C	I_C	max.	10 mA
T_{amb} = 175 °C	I_C	max.	2.0 mA

CHARACTERISTICS

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

Resistance

I_C = 1 mA

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

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

T_{amb} °C	Resistance Ω
−55	500
−50	525
−40	577
−30	632
−20	691
−10	754
0	820
10	889
20	962
25	1000
30	1039
40	1118
50	1202
60	1288

T_{amb} °C	Resistance Ω
70	1379
80	1472
90	1569
100	1670
110	1774
120	1882
125	1937
130	1993
140	2107
150	2225
160	2346
170	2471
175	2535

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

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

** Inert liquid FC43 of 3M company.

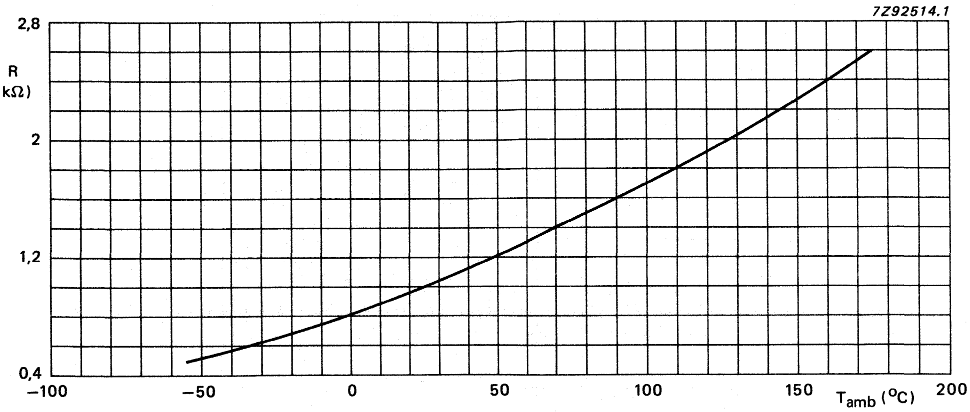


Fig. 2 Average resistance value of sensor at I_C = 1 mA as a function of temperature.

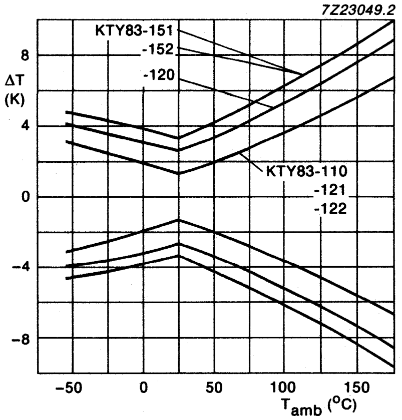


Fig. 3 Maximum expected temperature error ΔT.

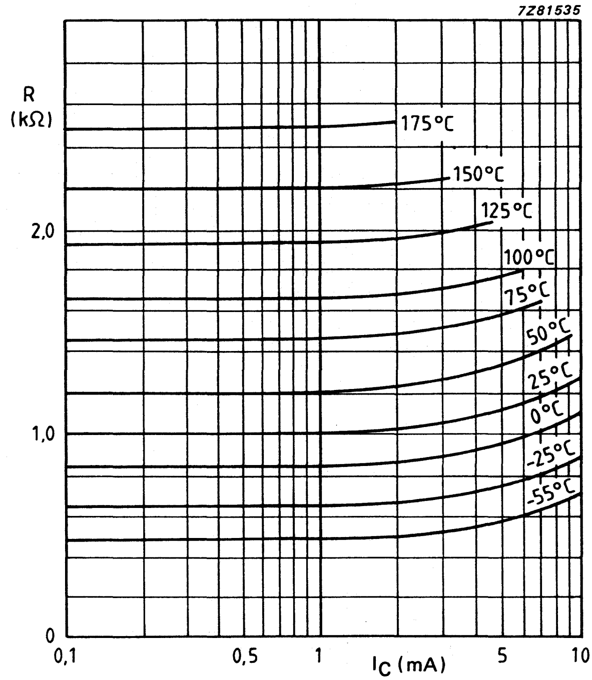


Fig. 4 Sensor resistance as a function of operating current.

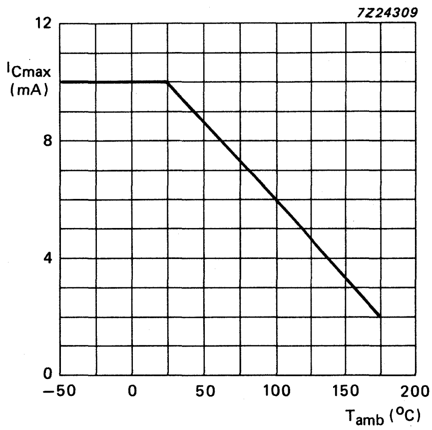


Fig. 5 Maximum operating current for safe operation.

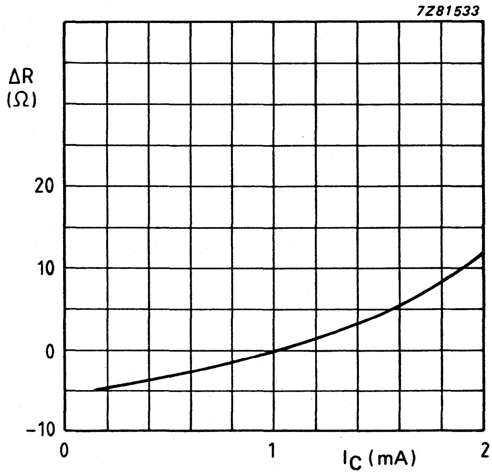


Fig. 6 Resistance deviation as a function of measuring current in still liquid; T_{amb} = 25 °C.

SILICON TEMPERATURE SENSORS

These sensors have a positive temperature coefficient of resistance and are for use in measurement and control over a temperature range of 0 to + 300 °C.

QUICK REFERENCE DATA

Resistance at T_{amb} = 100 °C — Type tape (identification colour)

I_C = 2 mA

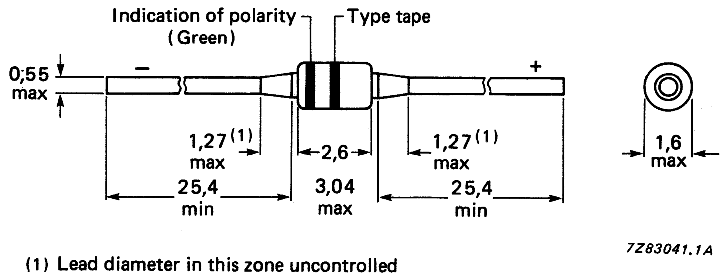
KTY84-130	R100 = 970 - 1030 Ω;	yellow
KTY84-150	R100 = 950 - 1050 Ω;	black or blue
KTY84-151	R100 = 950 - 1000 Ω;	black
KTY84-152	R100 = 1000 - 1050 Ω;	blue

KTY84-150 is composed of groups —151 and —152, and is correspondingly designated.

Measuring temperature range — 0 to +300 °C

MECHANICAL DATA

Dimensions in mm



(1) Lead diameter in this zone uncontrolled

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

Notes

1. The sensor has to be operated with the lower potential at the marked connection.
2. Leads of the sensor are covered with a nickel layer. Hard soldering or welding is recommended.

RATINGS

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

Continuous sensor current in free air			
T_{amb} = 25 °C see note 1	I_C	max.	10 mA
T_{amb} = 300 °C	I_C	max.	2.0 mA

CHARACTERISTICS

(Based on the measurements in liquid at I_C = 2 mA;
T_{amb} = 100 °C unless otherwise specified)

KTY84-130	R100 =	970 - 1030 Ω
KTY84-150	R100 =	950 - 1050 Ω
KTY84-151	R100 =	950 - 1000 Ω
KTY84-152	R100 =	1000 - 1050 Ω

Temperature coefficient	typ.	0.62 %/K
Resistance ratio	R250/R100	2.195 ± 0.055
	R 25/R100	0.598 ± 0.008
Thermal time constant*		
in still air	typ.	20 s
in still liquid**	typ.	1.0 s
in flowing liquid**	typ.	0.5 s
Measuring temperature range		0 to +300 °C
Storage temperature		−55 to +300 °C

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

** Inert liquid FC43 of 3M company.

Note

1. For temperatures > 200 °C a sensor current of I_C = 2 mA must be used.

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

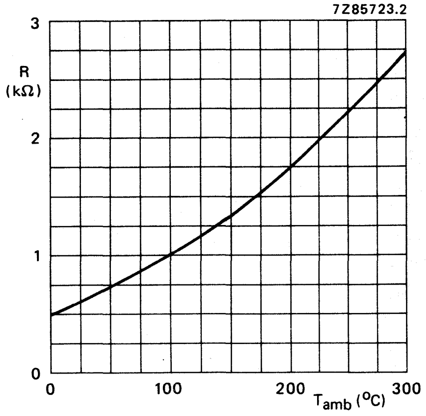


Fig. 2 Resistance value of sensor at I_C = 2 mA as a function of ambient temperature.

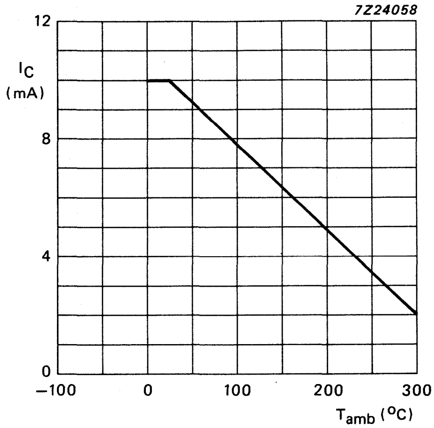


Fig. 3 Maximum operating current for safe operation.

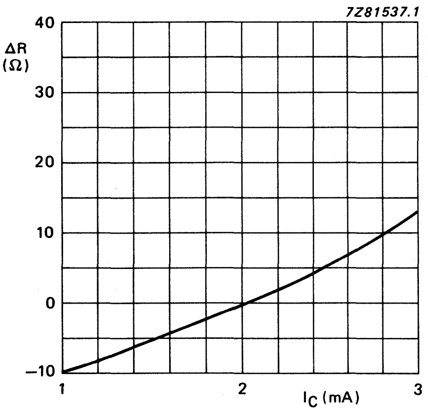


Fig. 4 Deviation of sensor resistance R as a function of operating current I_C in still liquid; T_{amb} = 100 °C.

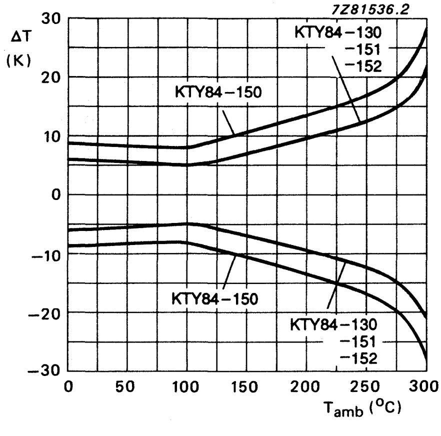


Fig. 5 Maximum expected temperature error Δ T.

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 — Type tape (identification colour)

I_C = 1 mA

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

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

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

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

MECHANICAL DATA

Dimensions in mm

Indication of polarity and type tape

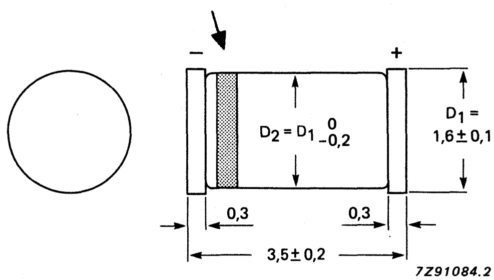


Fig. 1 SOD-80.

Note

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

RATINGS

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

Continuous sensor current in free air

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

CHARACTERISTICS

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

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

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

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

** Inert liquid FC43 of 3M company.

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

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

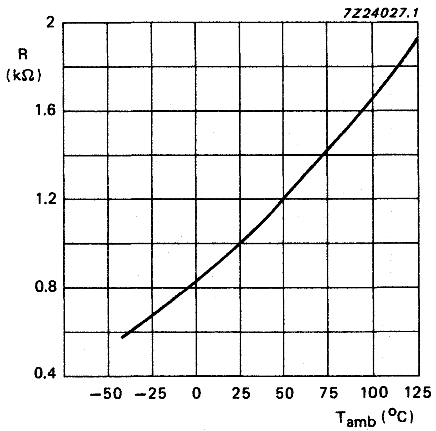


Fig. 2 Average resistance value of sensor at I_C = 1 mA as a function of ambient temperature.

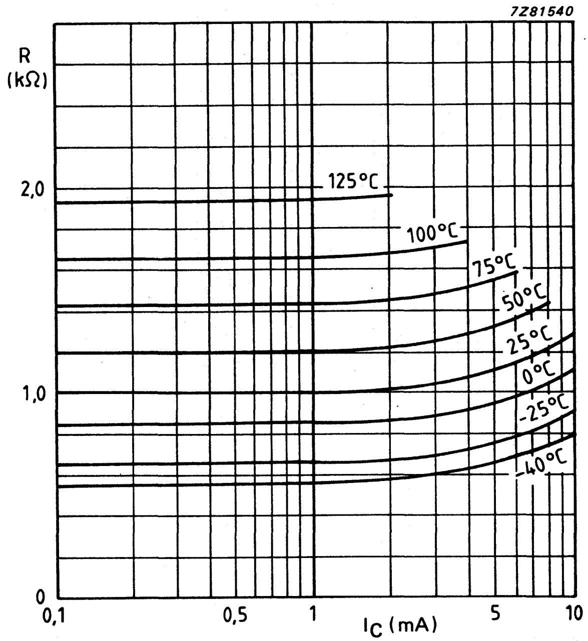


Fig. 3 Sensor resistance as a function of operating current.

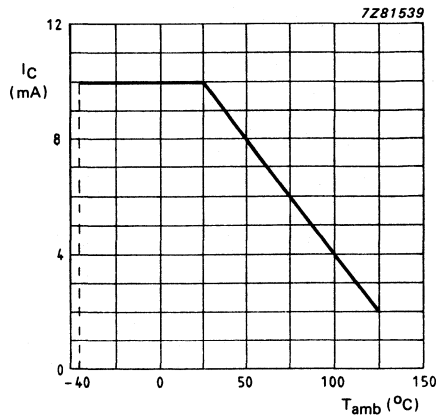


Fig. 4 Maximum operating current for safe operation.

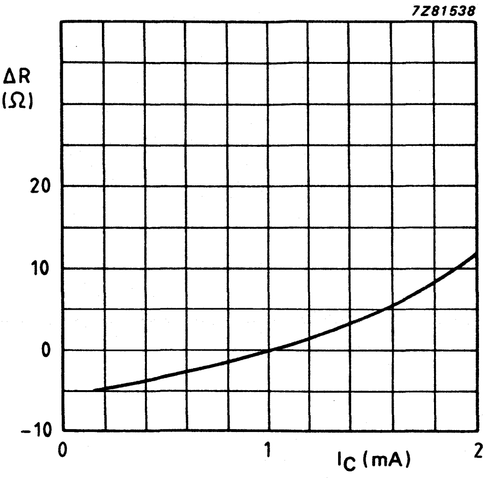


Fig. 5 Deviation of sensor resistance R as a function of operating current I_C in still liquid; T_{amb} = 25 °C.

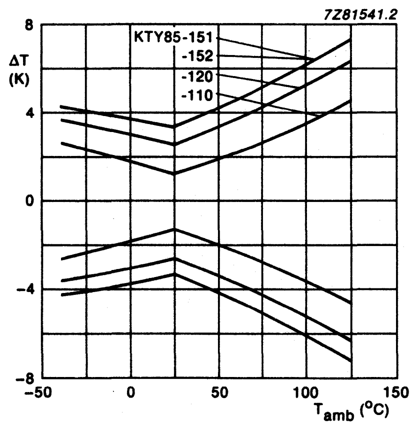


Fig. 6 Maximum expected temperature error ΔT.

SILICON TEMPERATURE SENSORS

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

QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

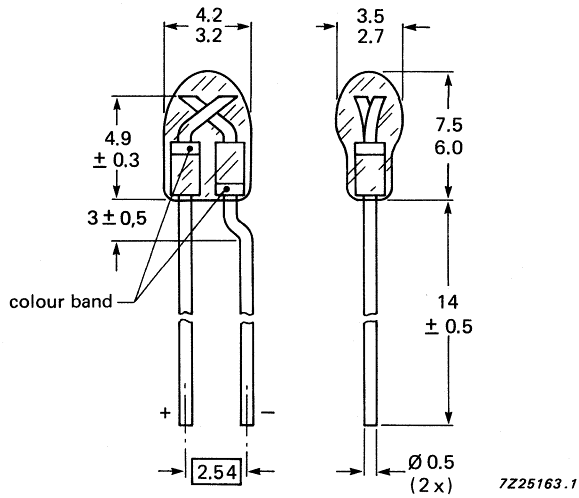


Fig.1 SOD103; colour band is white.

Note

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

RATINGS

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

Continuous sensor current in free air

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

CHARACTERISTICS

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

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

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

** Inert liquid FC43 of 3M company.

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

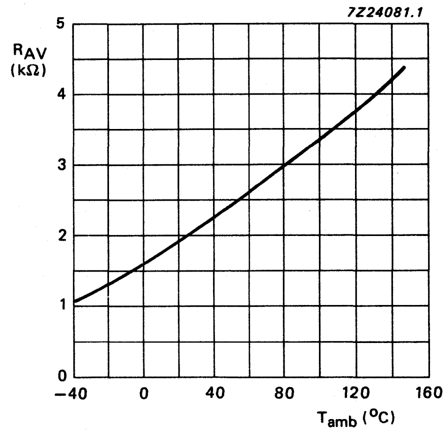


Fig. 2 Average resistance value of sensor at I_C = 0.1 mA as a function of ambient temperature.

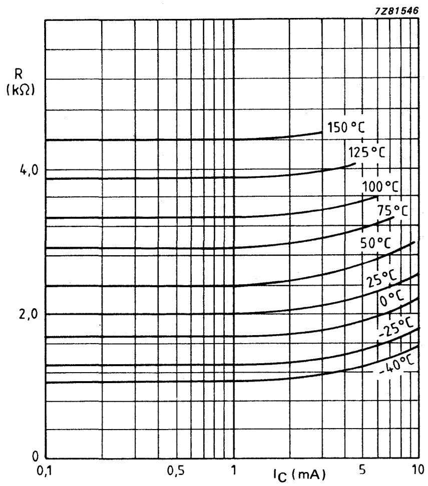


Fig. 3 Sensor resistance as a function of operating current.

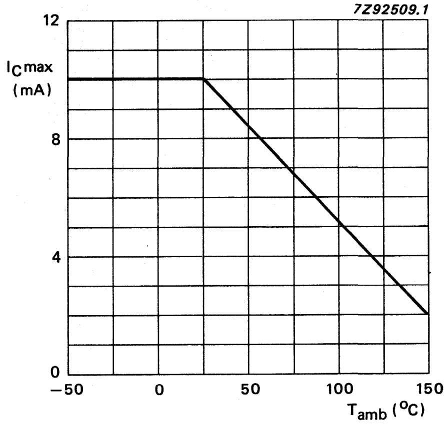


Fig. 4 Maximum operating current for safe operation.

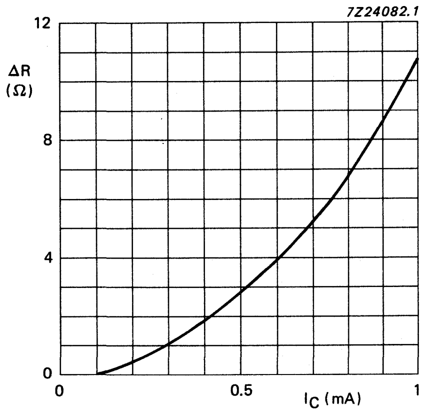


Fig. 5 Deviation of sensor resistance R as a function of operating current I_C in still liquid; T_{amb} = 25 °C.

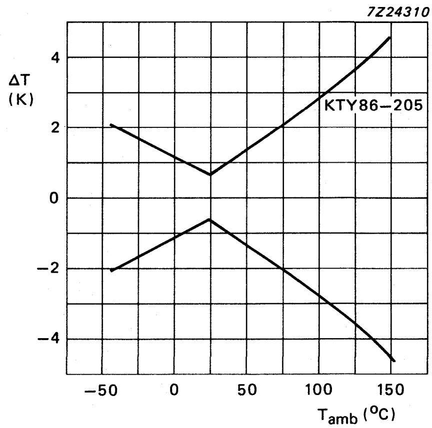


Fig. 6 Maximum expected temperature error ΔT.

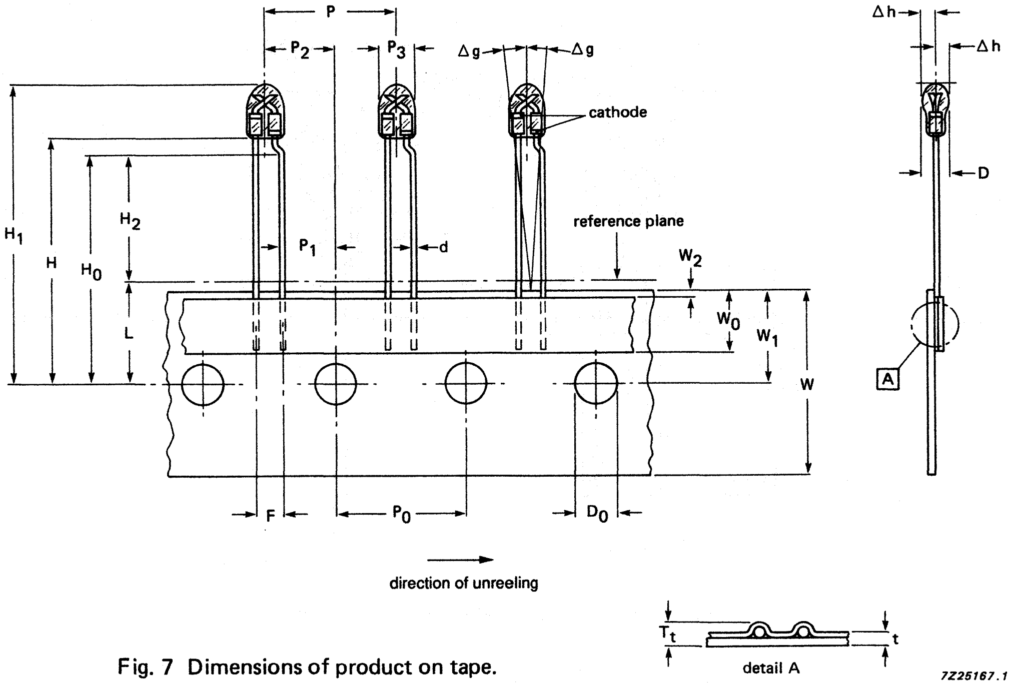


Fig. 7 Dimensions of product on tape.

Table 1 Dimensions of product on tape

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

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

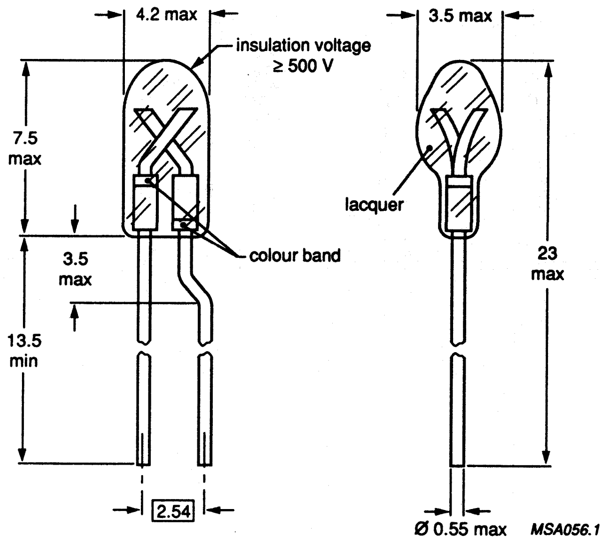


Fig.8 Dimensions of product cut out of tape.

SILICON TEMPERATURE SENSORS

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

QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

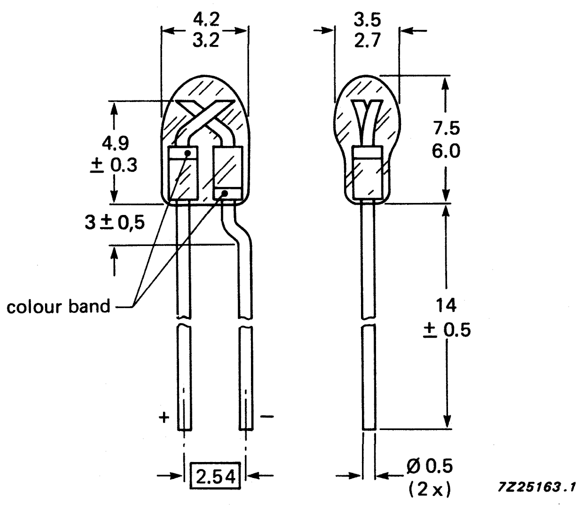


Fig.1 SOD103; colour band is green.

Notes

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

RATINGS

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

Continuous sensor current in free air

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

CHARACTERISTICS

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

Resistance	R25	=	2000 ± 10	Ω
T_{amb} = 100 °C	R100	=	3344 ± 17	Ω
Temperature coefficient	at −40 °C	=	0.93	%/K
	at 25 °C	=	0.75	%/K
	at 100 °C	=	0.61	%/K
Resistance ratio	R100/R25	=	1.672 ± 0.020	
	R−40/R25	=	0.577 ± 0.008	
Thermal time constant*				
in still air		typ.	30	s
in still liquid**		typ.	2.2	s
in flowing liquid**		typ.	1.7	s
Operating temperature range			−40 to + 125	°C

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

** Inert liquid FC43 of 3M company.

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

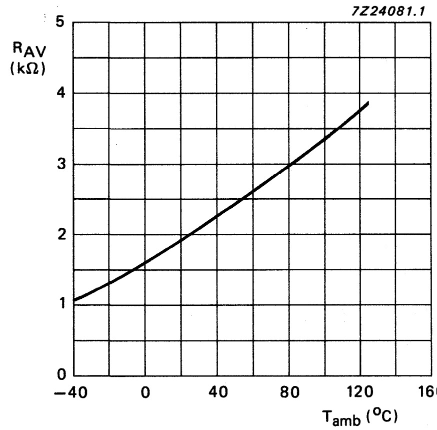


Fig. 2 Average resistance value of sensor at I_C = 0.1 mA as a function of ambient temperature.

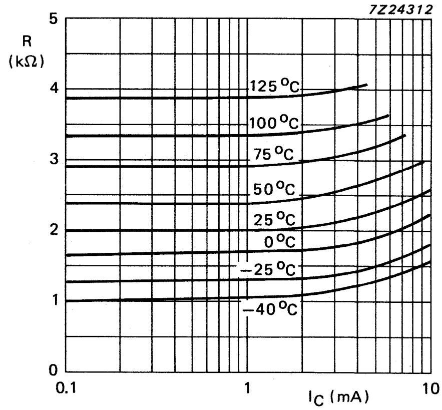


Fig. 3 Sensor resistance as a function of operating current.

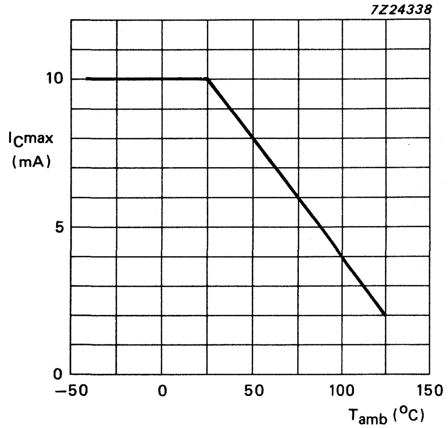


Fig. 4 Maximum operating current for safe operation.

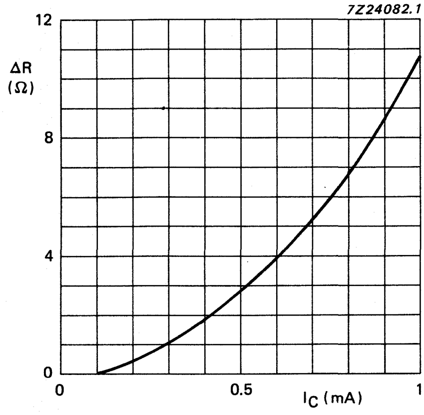


Fig. 5 Deviation of sensor resistance R versus operating current I_C in still liquid.

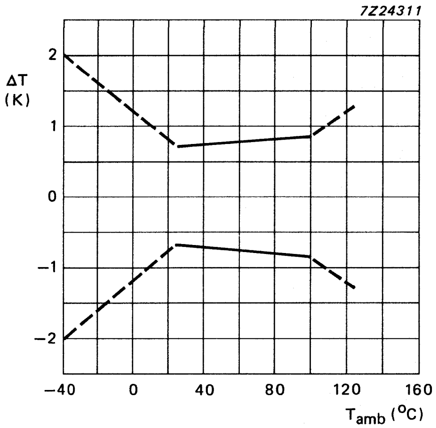


Fig. 6 Maximum temperature error ΔT.

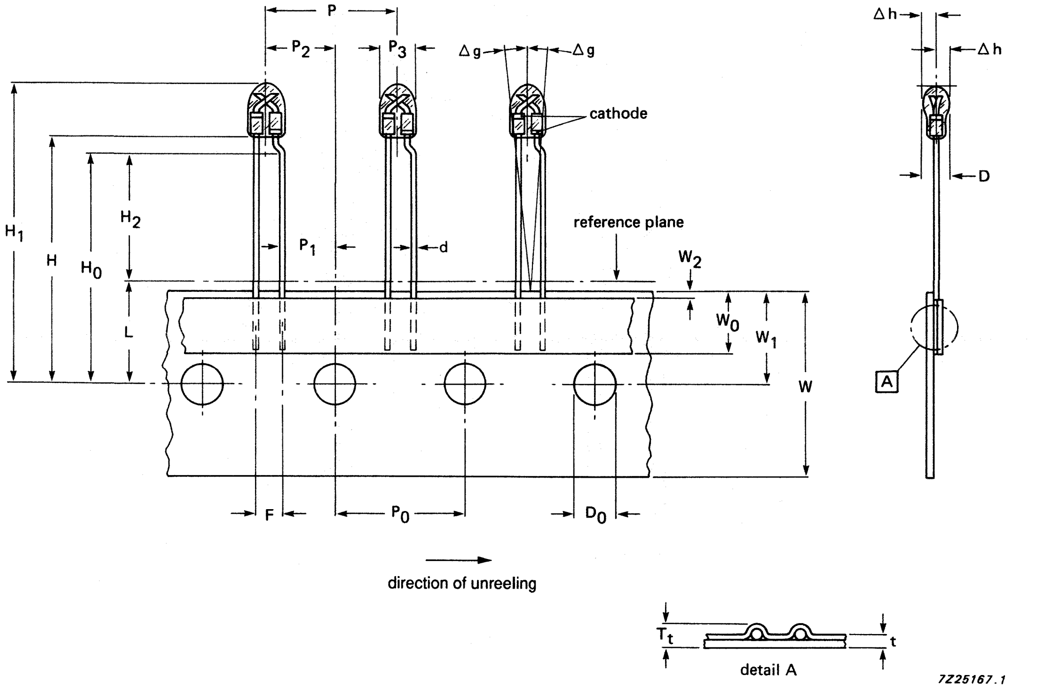


Table 1 Dimensions of product on tape

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

Fig. 7 Dimensions of product on tape.

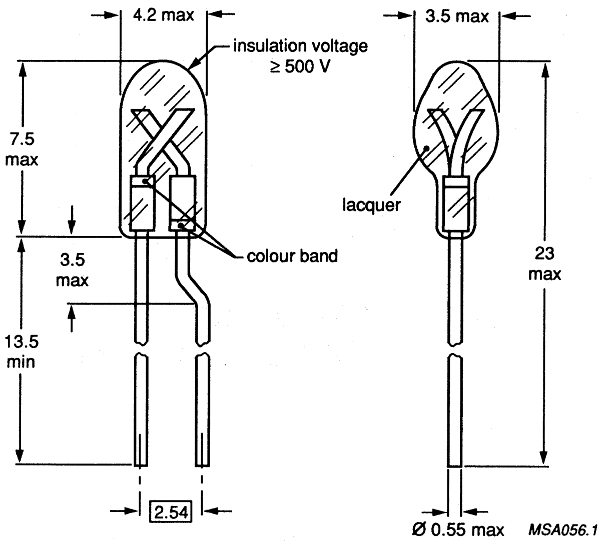


Fig.8 Dimensions of product cut out of tape.

HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

Hybrid integrated circuits

Type number survey

Hybrid integrated circuits for inductive proximity detectors

Stud type	OM type	L x W mm (max)	V_S V	I_o mA	false polarity protection	short circuit/ overload protection	R_x		LED connection
							discrete	integrated	
M5	2860 2870	21.5 x 3	4.7 - 30	250	supply with spikes protect.	transient protection	yes	no	no
M8	286	32.5 x 5	4.5 - 30 (note 1)	50 - 250	supply	no	yes	no	no
M8	286M 287M	22.6 x 5 (note 2)	4.5 - 30	50 - 250	supply	no	yes	no	no
	386B 387B (note 3)	43.6 x 5	10 - 30	250	supply/ load	yes	yes	yes	yes
	386M 387M (note 3)	22.5 x 5 (note 2)	10 - 30	250	supply/ load	yes	yes	yes	yes
M12	388B 389B (note 3)	26.5 x 5	10 - 30	250	supply/ load	yes	yes	yes	yes
M12	390 (note 3)	14.2 x 14.2	10 - 30	250	supply/ load	yes	yes	yes	yes

Notes

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

HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

Hybrid integrated circuits intended for inductive proximity detectors in tubular construction, especially the M8 hollow stud. The 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	°C
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

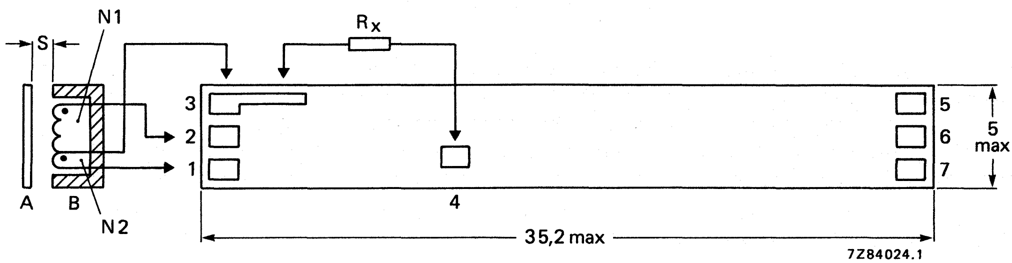


Fig. 1a OM286/OM287.

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

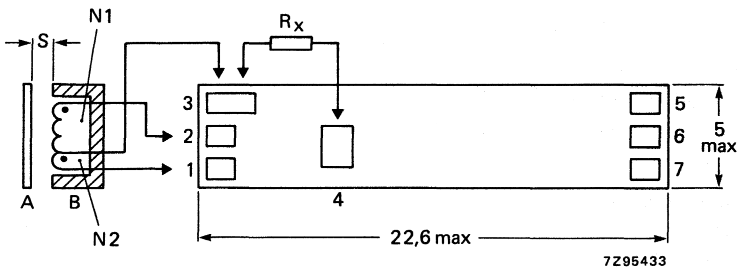


Fig. 1b OM286M/OM287M.

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.

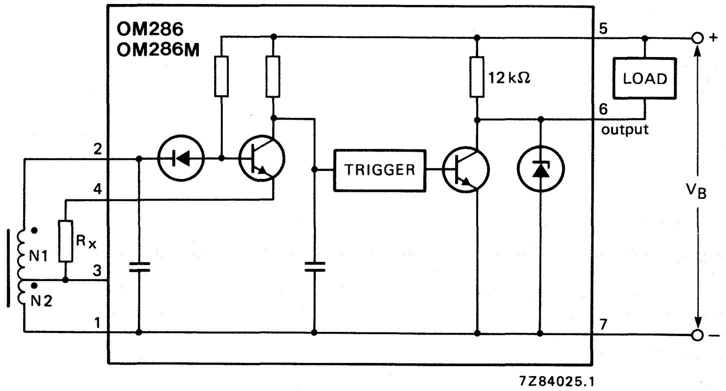


Fig. 2 Circuit diagram of OM286 and OM286M.

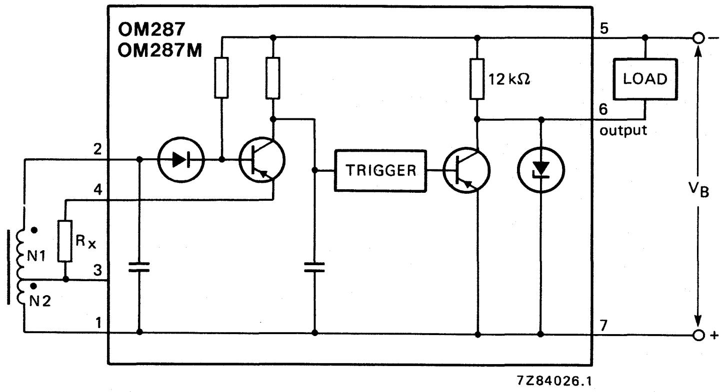


Fig. 3 Circuit diagram of OM287 and OM287M.

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"	I_B	typ.	9,0	mA
output stage "OFF"	I_B	typ.	7,7	mA
Voltage drop				
I_o = 250 mA	V_d	max.	1	V
I_o = 10 mA	V_d	max.	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.

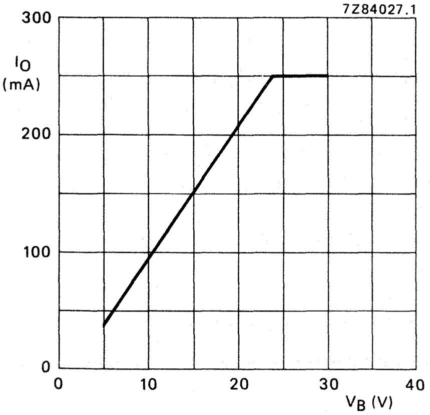


Fig. 4 Maximum allowable output current as a function of supply voltage; T_s = 25 °C.

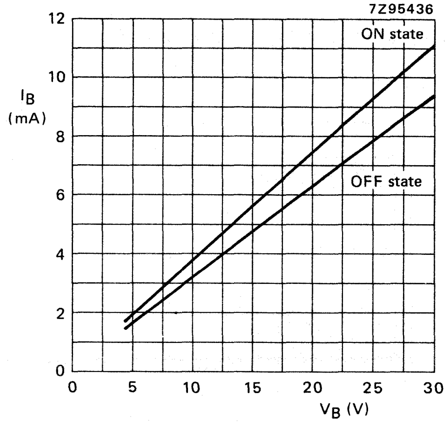


Fig. 5 Supply current as a function of supply voltage; T_s = 25 °C; typical values.

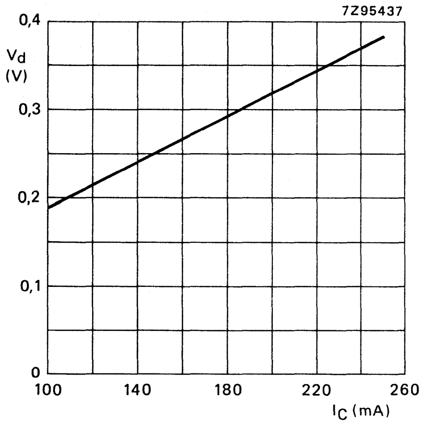


Fig. 6 Voltage drop as a function of output current; V_B = 24 V; T_s = 25 °C; typical values.

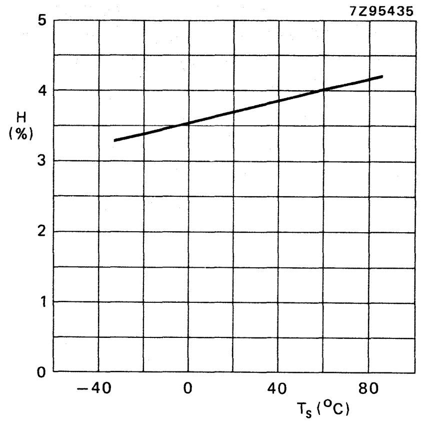
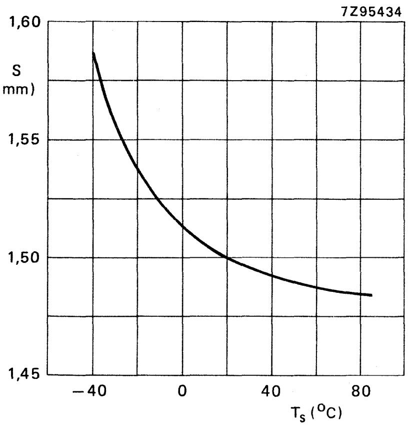


Fig. 7 Hysteresis as a function of substrate temperature; typical values.



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

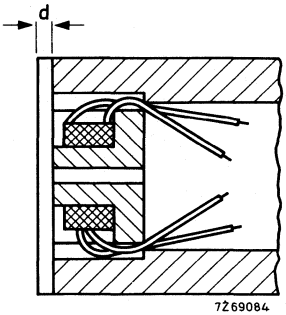


Fig. 9 Insertion of potcore in brass tube.

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	^oC
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

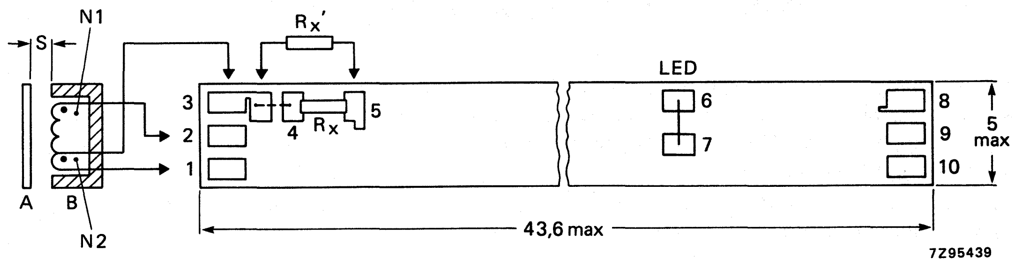
Dimensions in mm

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.

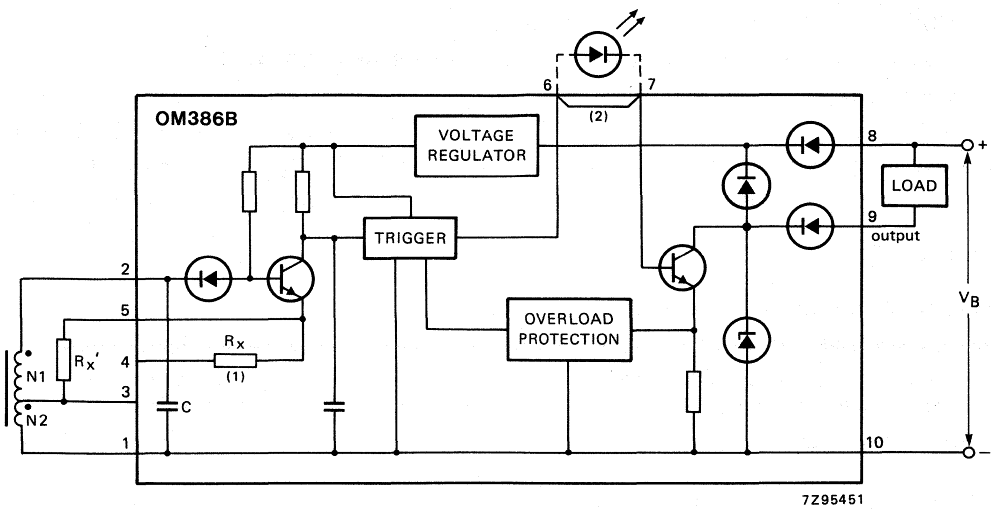


Fig. 2 Circuit diagram of OM386B.

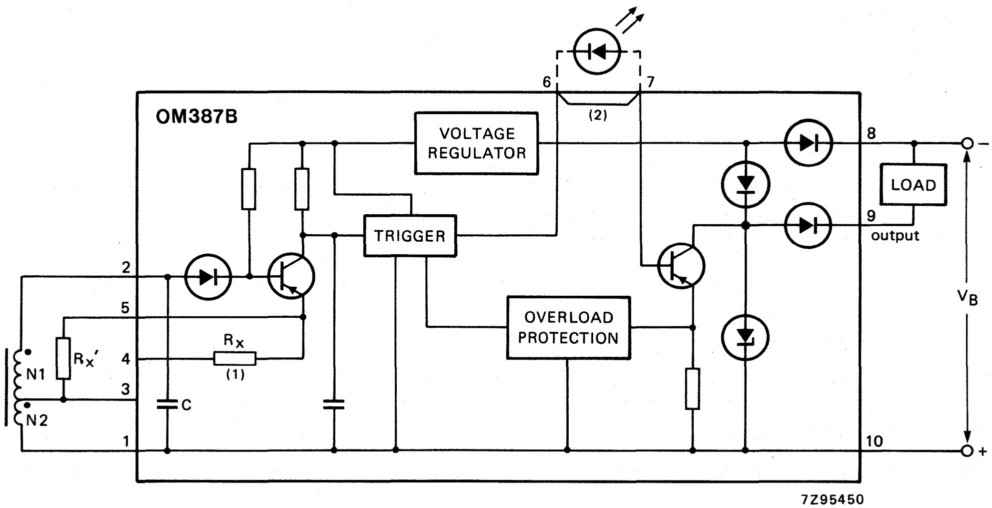


Fig. 3 Circuit diagram of OM387B.

(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.

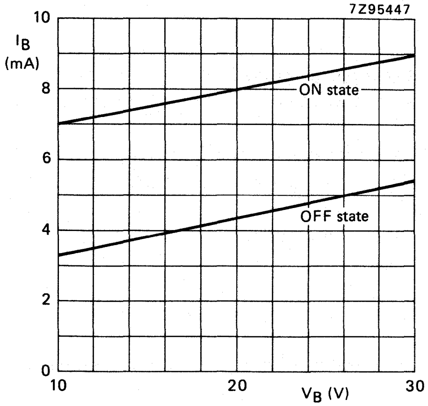


Fig. 4 Supply current as a function of supply voltage; T_s = 25 °C.

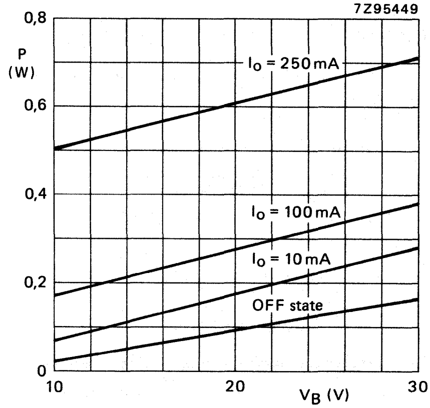


Fig. 5 Power dissipation as a function of supply voltage.

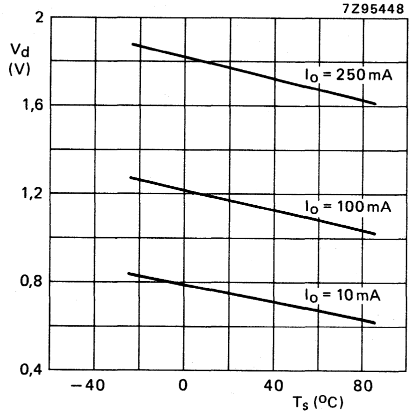


Fig. 6 Voltage drop as a function of substrate temperature.

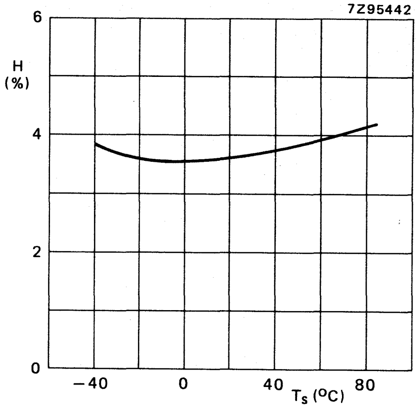
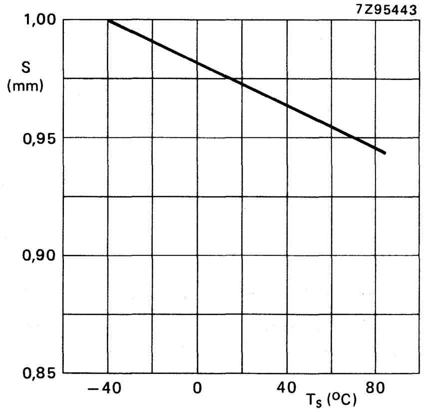


Fig. 7 Hysteresis as a function of substrate temperature.



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

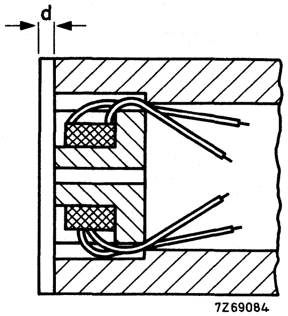


Fig. 9 Insertion of potcore in brass tube.

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

Potting recommendations

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

HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

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

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

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

Features:

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

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

QUICK REFERENCE DATA

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

MECHANICAL DATA

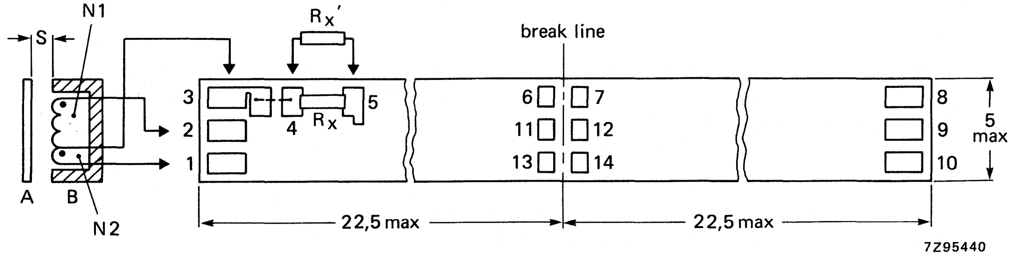
Dimensions in mm

Fig. 1 (see next page).

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

MECHANICAL DATA (outline and connections) Dimensions in mm

Fig. 1.



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

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

S is the operating distance.

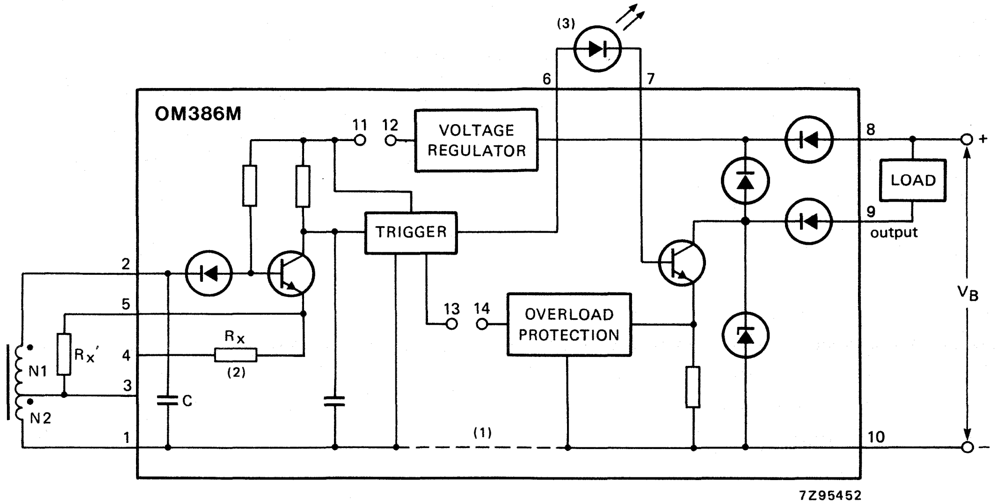


Fig. 2 Circuit diagram of OM386M.

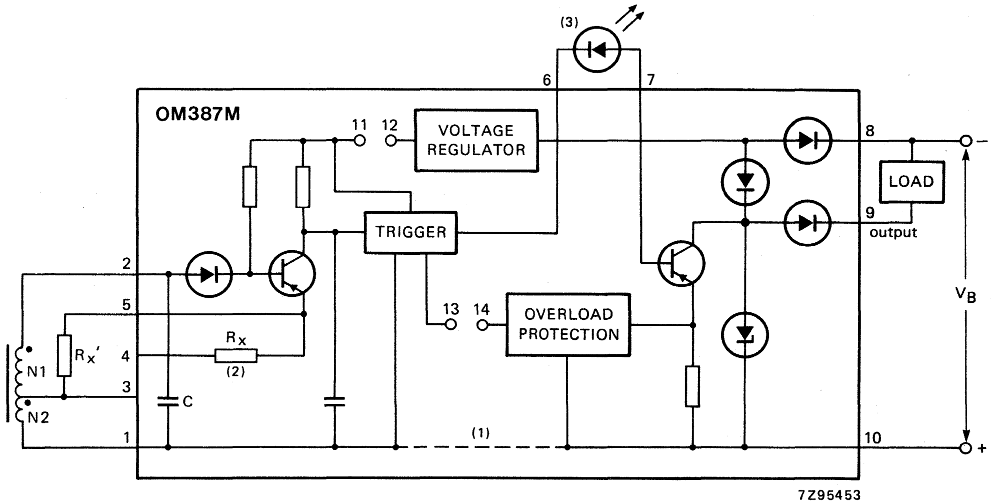


Fig. 3 Circuit diagram of OM387M.

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

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

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

RATINGS

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

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

CHARACTERISTICS

Conditions (unless otherwise specified)

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

Performances

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

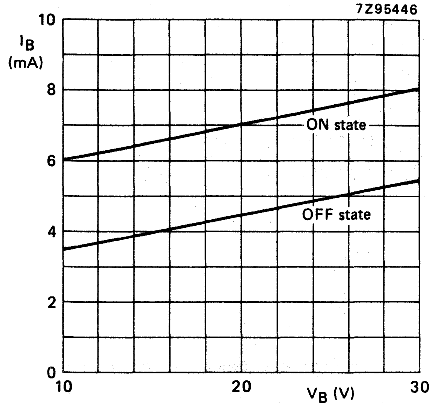


Fig. 4 Supply current as a function of supply voltage; $T_S = 25\,^{\circ}C$.

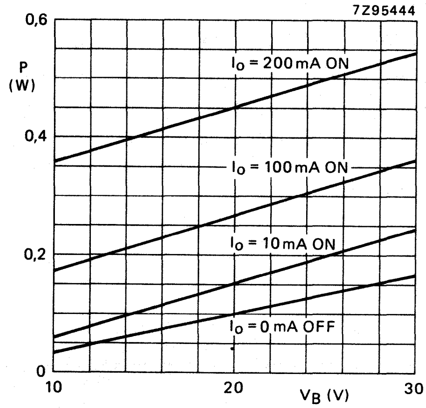


Fig. 5 Power dissipation as a function of supply voltage.

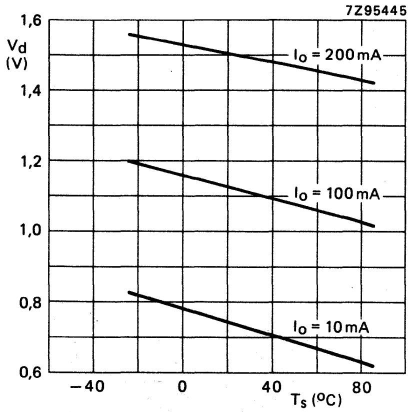


Fig. 6 Voltage drop as a function of substrate temperature.

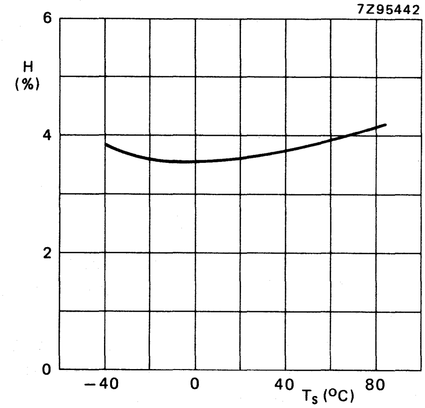
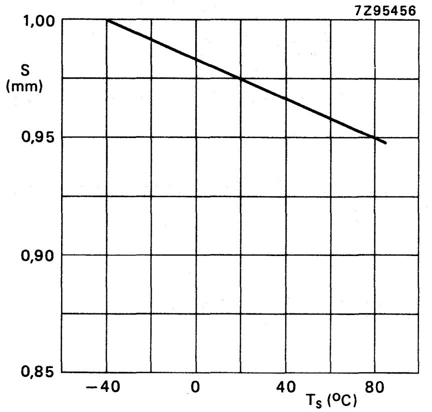


Fig. 7 Hysteresis as a function of substrate temperature.



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

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.

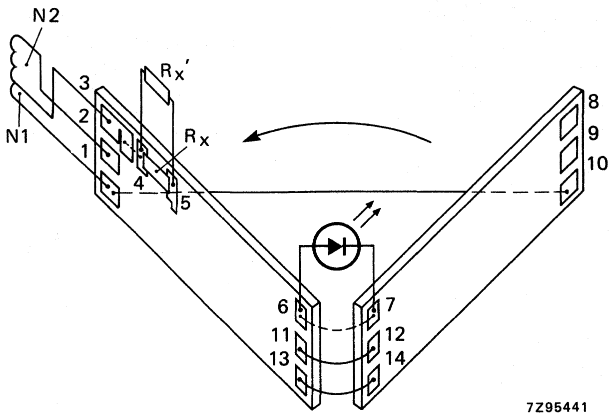


Fig. 9 If no LED is used, connect point 6 to point 7;
connect points 11 and 12, point 13 to 14 and point 1 to point 10.

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.

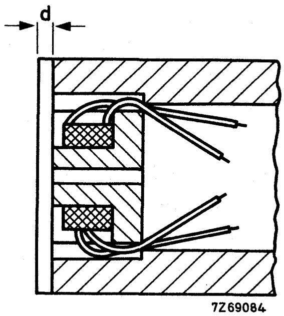


Fig. 10 Insertion of potcore in brass tube.

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 ^oC).

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

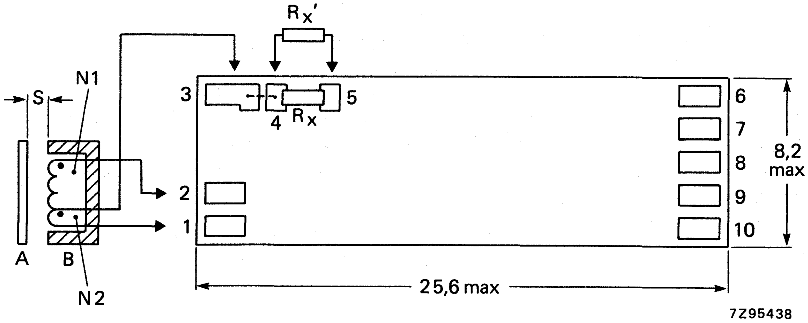
Dimensions in mm

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.

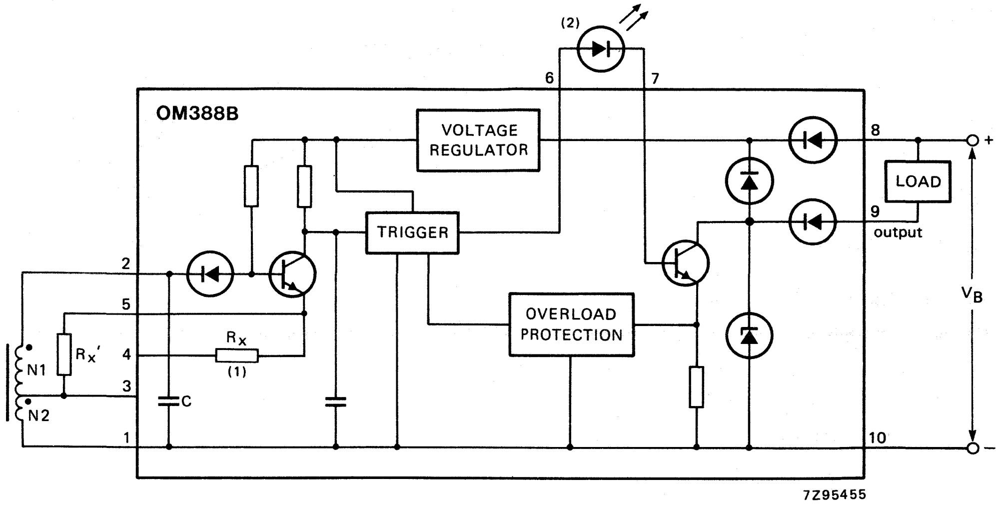


Fig. 2 Circuit diagram of OM388B.

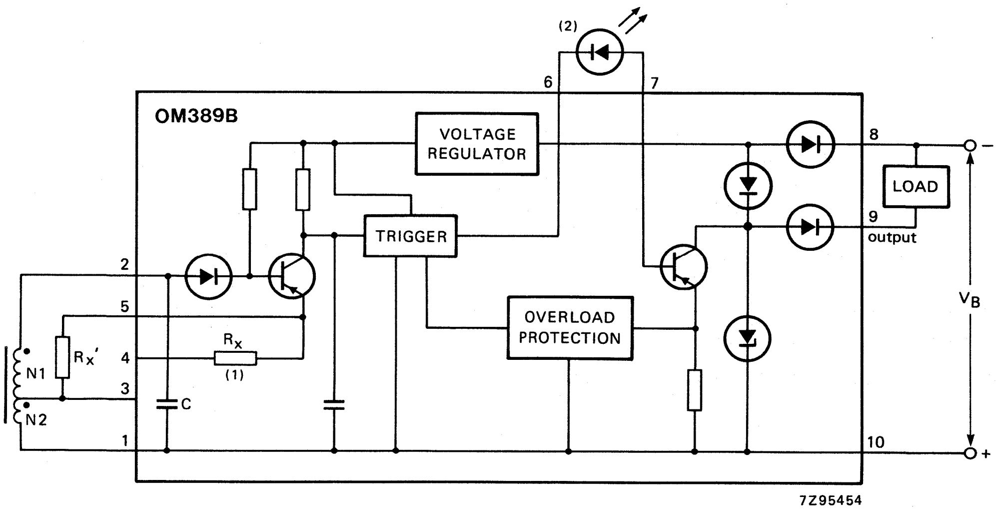


Fig. 3 Circuit diagram of OM389B.

(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" output stage "OFF"	I_B	 typ. typ.	 8,4 mA 4,8 mA
Voltage drop I_O = 250 mA I_O = 10 mA	V_d	 max. max.	 1,9 V 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.

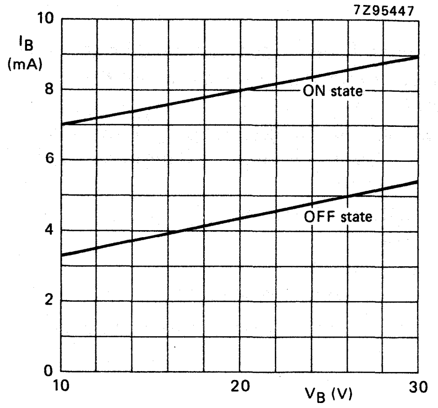


Fig. 4 Supply current as a function of supply voltage; $T_s = 25\ ^oC$.

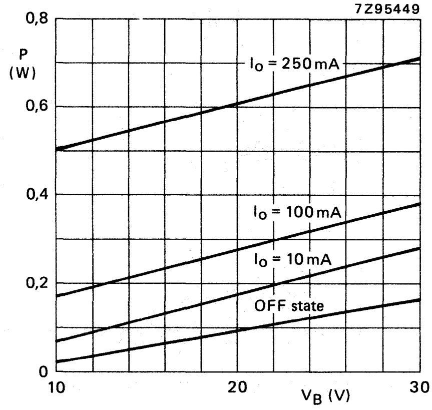


Fig. 5 Power dissipation as a function of supply voltage.

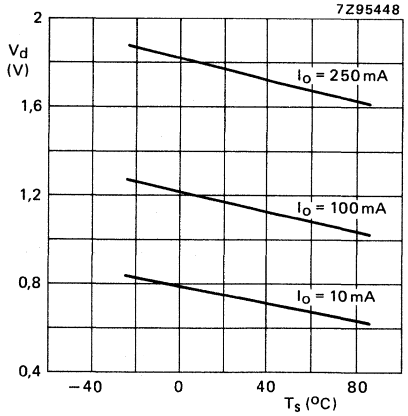


Fig. 6 Voltage drop as a function of substrate temperature.

MOUNTING RECOMMENDATIONS

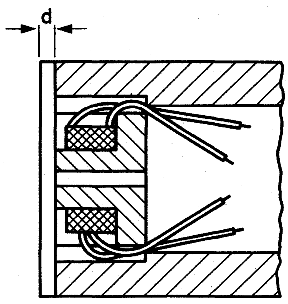


Fig. 7 Insertion of potcore in brass tube.

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.

HYBRID INTEGRATED CIRCUITS FOR INDUCTIVE PROXIMITY DETECTORS

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

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

Features:

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

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

QUICK REFERENCE DATA

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

MECHANICAL DATA

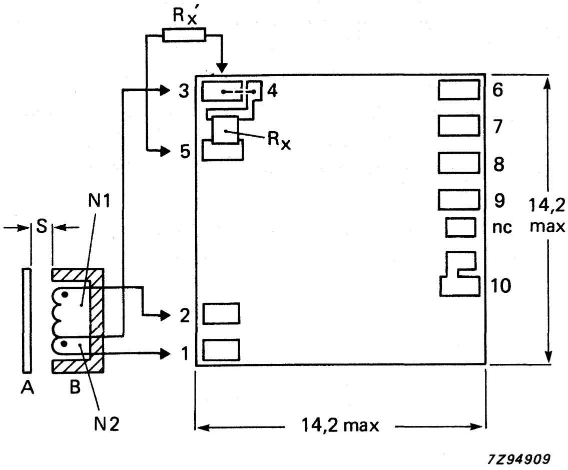
Dimensions in mm

Fig. 1 (see next page).

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

MECHANICAL DATA (outline and connections). Dimensions in mm

Fig. 1.



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

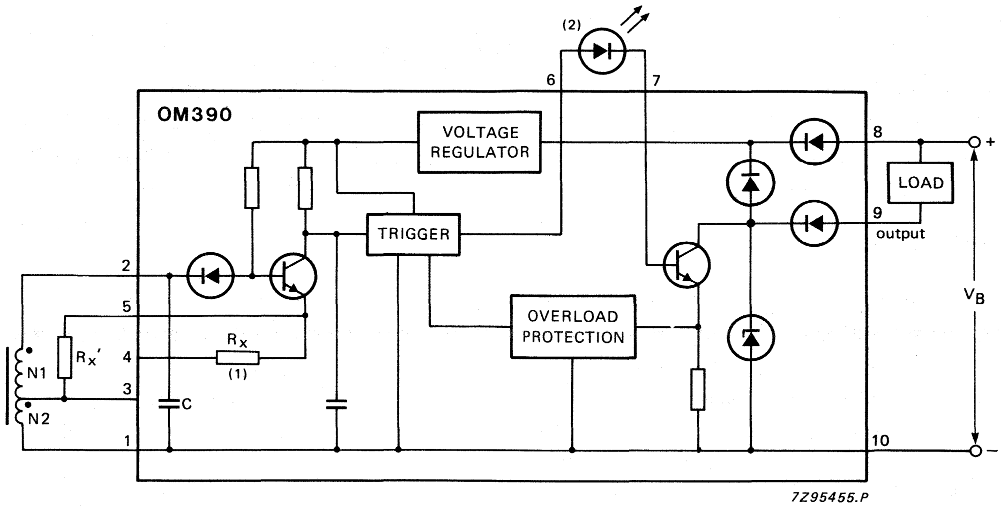


Fig. 2 Circuit diagram of OM390.

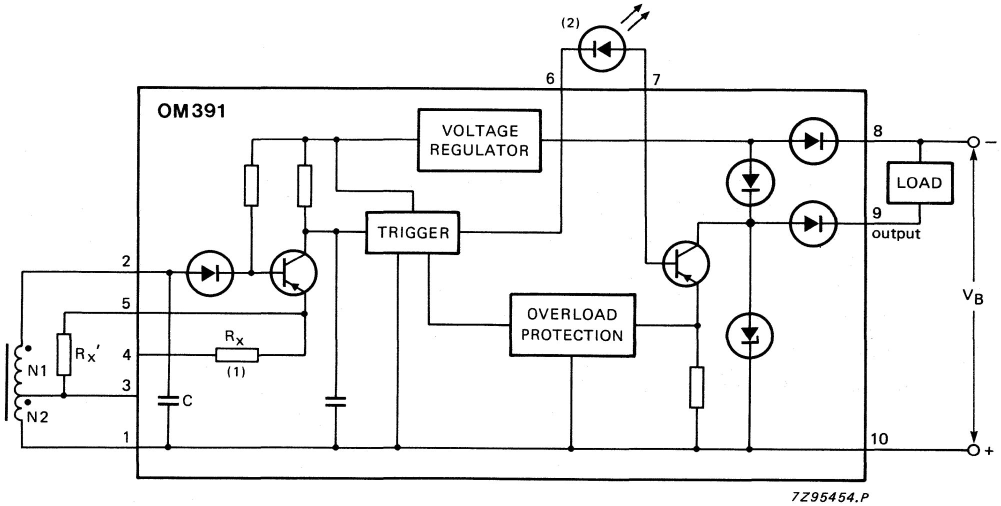


Fig. 3 Circuit diagram of OM391.

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

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

RATINGS

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

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

CHARACTERISTICS

Conditions (unless otherwise specified)

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

Performances

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

Operating (switching) distance*

type	oscillator coil number of turns N1	N2	average operating distance S in mm at R_X (Ω) 200	250	300	recommended potcore	oscillator frequency kHz
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.

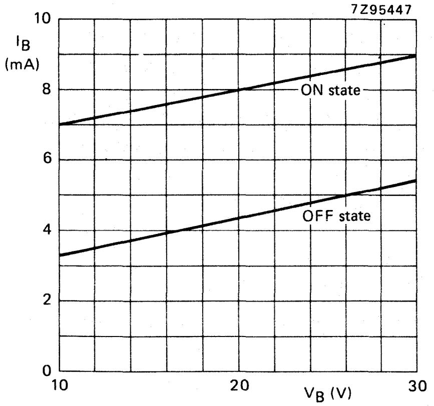


Fig. 4 Supply current as a function of supply voltage; $T_s = 25\ ^oC$.

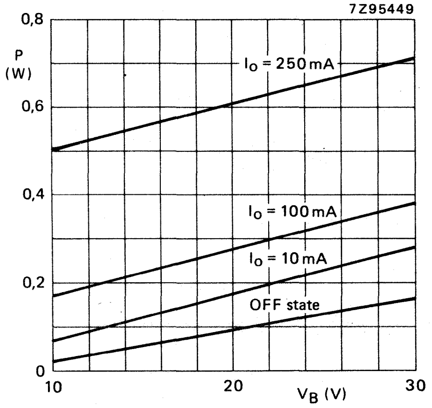


Fig. 5 Power dissipation as a function of supply voltage.

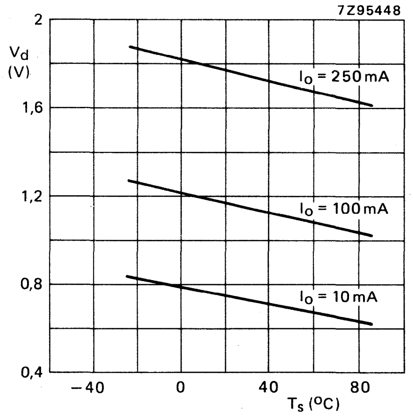


Fig. 6 Voltage drop as a function of substrate temperature.

MOUNTING RECOMMENDATIONS

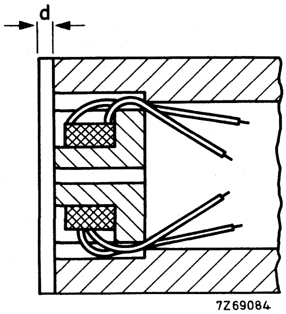


Fig. 7 Insertion of potcore in brass tube.

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.

Philips Components

Data sheet	
status	Product Specification
date of issue	August 1990

OM2860/OM2870

Hybrid integrated circuits for inductive proximity detectors

FEATURES

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

DESCRIPTION

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

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

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

QUICK REFERENCE DATA

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

MECHANICAL DATA

Dimensions in mm

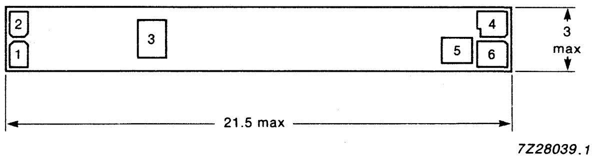


Fig.1 Outline and connections.

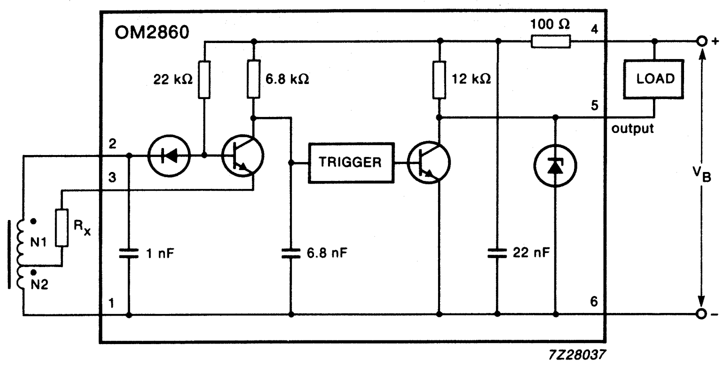


Fig.2 Circuit diagram of OM2860.

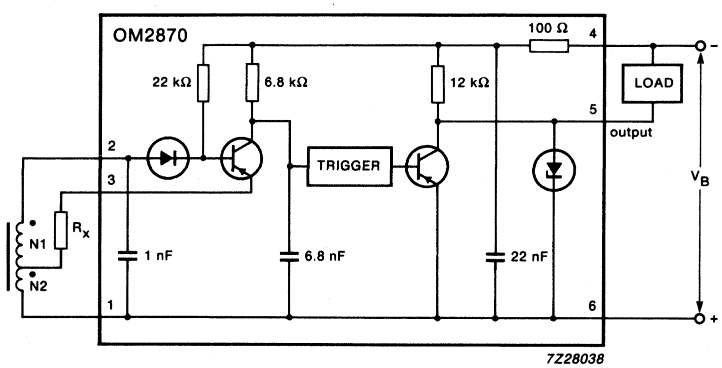


Fig.3 Circuit diagram of OM2870.

Hybrid integrated circuits for inductive proximity detectors

OM2860/OM2870

LIMITING VALUES

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

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

CHARACTERISTICS

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

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

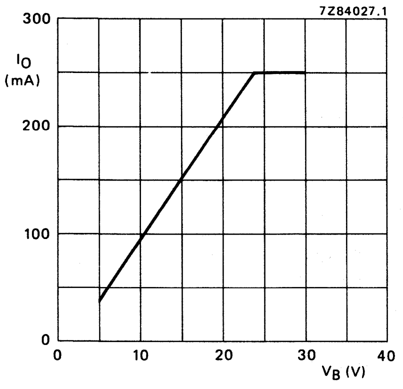


Fig.4 Maximum allowable output current as a function of supply voltage; T_s = 25°C.

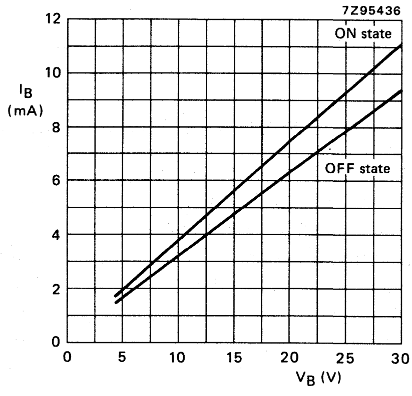


Fig.5 Supply current as a function of supply voltage; T_s = 25°C; typical values.

Hybrid integrated circuits for inductive proximity detectors

OM2860/OM2870

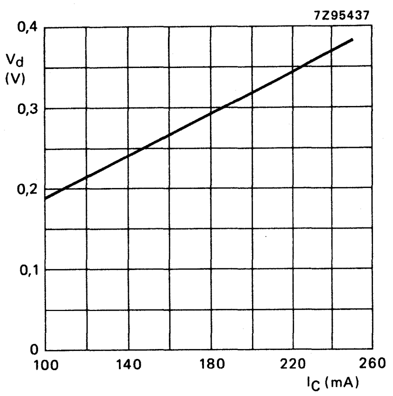


Fig.6 Voltage drop as a function of collector current; V_B = 24 V; T_s = 25°C; typical values.

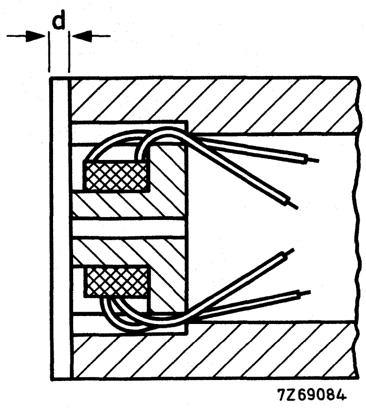


Fig.7 Insertion of potcore in brass tube.

MOUNTING RECOMMENDATIONS

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

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

SOLDERING RECOMMENDATIONS

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

INDEX

INDEX OF TYPE NUMBERS

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

Key to handbook sections

A = Accessories
FET = Field-effect transistors
I = Infrared devices
LED = Light-emitting diodes
LCD = Liquid crystal displays
Mm = Surface-mounted devices
M = Microwave transistors
P = Low-frequency power transistors and modules
PDT = Photodiodes or transistors
Ph = Photoconductive devices
PhC = Photocouplers
PM = Power MOS transistors
R = Rectifier diodes
RFP = RF power transistors and modules
RT = Triplers
Sen = Semiconductor sensors
SD = Small-signal diodes
Sm = Small-signal transistors
Sp = Special diodes
SP = Low-frequency switching power diodes
St = Rectifier stacks
T = Tuner diodes
Th = Thyristors
Tri = Triacs
TS = Transient suppressor diodes
Vrf = Voltage reference diodes
Vrg = Voltage regulator diodes
WBT = Wideband hybrid IC transistors
WBM = Wideband hybrid IC modules

* series.

Type no.	book	section	Type no.	book	section	Type no.	book	section
BB405B	SC01	T	BC557	SC04	Sm	BCP69	SC10	Mm
BB417	SC01	T	BC558	SC04	Sm	BCV26	SC10	Mm
BB804	SC01/10	T/Mm	BC559	SC04	Sm	BCV27	SC10	Mm
BB809	SC01	T	BC560	SC04	Sm	BCV28	SC10	Mm
BB909A	SC01	T	BC635	SC04	Sm	BCV29	SC10	Mm
BB909B	SC01	T	BC636	SC04	Sm	BCV46	SC10	Mm
BB910	SC01	T	BC637	SC04	Sm	BCV47	SC10	Mm
BB911	SC01	T	BC638	SC04	Sm	BCV48	SC10	Mm
BBY31	SC01/10	T/Mm	BC639	SC04	Sm	BCV49	SC10	Mm
BBY39	SC01	T	BC640	SC04	Sm	BCV61	SC10	Mm
BBY40	SC01/10	T/Mm	BC807	SC10	Mm	BCV62	SC10	Mm
BBY42	SC01	T	BC808	SC10	Mm	BCV63	SC10	Mm
BBY62	SC01	T	BC817	SC10	Mm	BCV64	SC10	Mm
BC107	SC04	Sm	BC818	SC10	Mm	BCV65	SC10	Mm
BC108	SC04	Sm	BC846	SC10	Mm	BCV71	SC10	Mm
BC109	SC04	Sm	BC847	SC10	Mm	BCV71R	SC10	Mm
BC140	SC04	Sm	BC848	SC10	Mm	BCV72	SC10	Mm
BC141	SC04	Sm	BC849	SC10	Mm	BCV72R	SC10	Mm
BC160	SC04	Sm	BC850	SC10	Mm	BCW29	SC10	Mm
BC161	SC04	Sm	BC856	SC10	Mm	BCW29R	SC10	Mm
BC177	SC04	Sm	BC857	SC10	Mm	BCW30	SC10	Mm
BC178	SC04	Sm	BC858	SC10	Mm	BCW30R	SC10	Mm
BC179	SC04	Sm	BC859	SC10	Mm	BCW31	SC10	Mm
BC264A	SC07	FET	BC860	SC10	Mm	BCW31R	SC10	Mm
BC264B	SC07	FET	BC868	SC10	Mm	BCW32	SC10	Mm
BC246C	SC07	FET	BC869	SC10	Mm	BCW32R	SC10	Mm
BC264D	SC07	FET	BCF29	SC10	Mm	BCW33	SC10	Mm
BC327	SC04	Sm	BCF29R	SC10	Mm	BCW33R	SC10	Mm
BC327A	SC04	Sm	BCF30	SC10	Mm	BCW60*	SC10	Mm
BC328	SC04	Sm	BCF30R	SC10	Mm	BCW61*	SC10	Mm
BC337	SC04	Sm	BCF32	SC10	Mm	BCW69	SC10	Mm
BC337A	SC04	Sm	BCF32R	SC10	Mm	BCW69R	SC10	Mm
BC338	SC04	Sm	BCF33	SC10	Mm	BCW70	SC10	Mm
BC368	SC04	Sm	BCF33R	SC10	Mm	BCW70R	SC10	Mm
BC369	SC04	Sm	BCF70	SC10	Mm	BCW71	SC10	Mm
BC375	SC04	Sm	BCF70R	SC10	Mm	BCW71R	SC10	Mm
BC376	SC04	Sm	BCF81	SC10	Mm	BCW72	SC10	Mm
BC516	SC04	Sm	BCF81R	SC10	Mm	BCW72R	SC10	Mm
BC517	SC04	Sm	BCP51	SC10	Mm	BCW81	SC10	Mm
BC546	SC04	Sm	BCP52	SC10	Mm	BCW81R	SC10	Mm
BC547	SC04	Sm	BCP53	SC10	Mm	BCW89	SC10	Mm
BC548	SC04	Sm	BCP54	SC10	Mm	BCW89R	SC10	Mm
BC549	SC04	Sm	BCP55	SC10	Mm	BCX17	SC10	Mm
BC550	SC04	Sm	BCP56	SC10	Mm	BCX17R	SC10	Mm
BC556	SC04	Sm	BCP68	SC10	Mm	BCX18	SC10	Mm

Type no.	book	section	Type no.	book	section	Type no.	book	section
BCX18R	SC10	Mm	BD204F	SC05	P	BD337	SC05	P
BCX19	SC10	Mm	BD226	SC05	P	BD338	SC05	P
BCX19R	SC10	Mm	BD227	SC05	P	BD433	SC05	P
BCX20	SC10	Mm	BD228	SC05	P	BD434	SC05	P
BCX20R	SC10	Mm	BD229	SC05	P	BD435	SC05	P
BCX51	SC10	Mm	BD230	SC05	P	BD436	SC05	P
BCX52	SC10	Mm	BD231	SC05	P	BD437	SC05	P
BCX53	SC10	Mm	BD233	SC05	P	BD438	SC05	P
BCX54	SC10	Mm	BD234	SC05	P	BD643	SC05	P
BCX55	SC10	Mm	BD235	SC05	P	BD643F	SC05	P
BCX56	SC10	Mm	BD236	SC05	P	BD644	SC05	P
BCX58	SC04	Sm	BD237	SC05	P	BD644F	SC05	P
BCX59	SC04	Sm	BD238	SC05	P	BD645	SC05	P
BCX70*	SC10	Mm	BD239	SC05	P	BD645F	SC05	P
BCX71*	SC10	Mm	BD239A	SC05	P	BD646	SC05	P
BCX78	SC04	Sm	BD239B	SC05	P	BD646F	SC05	P
BCX79	SC04	Sm	BD239C	SC05	P	BD647	SC05	P
BCY56	SC04	Sm	BD240	SC05	P	BD647F	SC05	P
BCY57	SC04	Sm	BD240A	SC05	P	BD648	SC05	P
BCY58	SC04	Sm	BD240B	SC05	P	BD648F	SC05	P
BCY59	SC04	Sm	BD240C	SC05	P	BD649	SC05	P
BCY65	SC04	Sm	BD241	SC05	P	BD649F	SC05	P
BCY70	SC04	Sm	BD241A	SC05	P	BD650	SC05	P
BCY71	SC04	Sm	BD241B	SC05	P	BD650F	SC05	P
BCY72	SC04	Sm	BD241C	SC05	P	BD651	SC05	P
BCY78	SC04	Sm	BD242	SC05	P	BD651F	SC05	P
BCY79	SC04	Sm	BD242A	SC05	P	BD652	SC05	P
BCY87	SC04	Sm	BD242B	SC05	P	BD652F	SC05	P
BCY88	SC04	Sm	BD242C	SC05	P	BD675	SC05	P
BCY89	SC04	Sm	BD243	SC05	P	BD676	SC05	P
BD131	SC05	P	BD243A	SC05	P	BD677	SC05	P
BD132	SC05	P	BD243B	SC05	P	BD678	SC05	P
BD135	SC05	P	BD243C	SC05	P	BD679	SC05	P
BD136	SC05	P	BD244	SC05	P	BD680	SC05	P
BD137	SC05	P	BD244A	SC05	P	BD681	SC05	P
BD138	SC05	P	BD244B	SC05	P	BD682	SC05	P
BD139	SC05	P	BD244C	SC05	P	BD683	SC05	P
BD140	SC05	P	BD329	SC05	P	BD684	SC05	P
BD201	SC05	P	BD330	SC05	P	BD719	SC05	P
BD201F	SC05	P	BD331	SC05	P	BD720	SC05	P
BD202	SC05	P	BD332	SC05	P	BD721	SC05	P
BD202F	SC05	P	BD333	SC05	P	BD722	SC05	P
BD203	SC05	P	BD334	SC05	P	BD723	SC05	P
BD203F	SC05	P	BD335	SC05	P	BD724	SC05	P
BD204	SC05	P	BD336	SC05	P	BD725	SC05	P

Type no.	book	section	Type no.	book	section	Type no.	book	section
BD726	SC05	P	BD949	SC05	P	BDT32AF	SC05	P
BD825	SC05	P	BD949F	SC05	P	BDT32B	SC05	P
BD826	SC05	P	BD950	SC05	P	BDT32BF	SC05	P
BD827	SC05	P	BD950F	SC05	P	BDT32C	SC05	P
BD828	SC05	P	BD951	SC05	P	BDT32CF	SC05	P
BD829	SC05	P	BD951F	SC05	P	BDT32D	SC05	P
BD830	SC05	P	BD952	SC05	P	BDT32DF	SC05	P
BD839	SC05	P	BD952F	SC05	P	BDT41A	SC05	P
BD840	SC05	P	BD953	SC05	P	BDT41AF	SC05	P
BD841	SC05	P	BD953F	SC05	P	BDT41B	SC05	P
BD842	SC05	P	BD954	SC05	P	BDT41BF	SC05	P
BD843	SC05	P	BD954F	SC05	P	BDT41C	SC05	P
BD844	SC05	P	BD955	SC05	P	BDT41CF	SC05	P
BD933	SC05	P	BD955F	SC05	P	BDT42	SC05	P
BD933F	SC05	P	BD956	SC05	P	BDT42F	SC05	P
BD934	SC05	P	BD956F	SC05	P	BDT42A	SC05	P
BD934F	SC05	P	BDT29	SC05	P	BDT42AF	SC05	P
BD935	SC05	P	BDT29F	SC05	P	BDT42B	SC05	P
BD935F	SC05	P	BDT29A	SC05	P	BDT42BF	SC05	P
BD936	SC05	P	BDT29AF	SC05	P	BDT42C	SC05	P
BD936F	SC05	P	BDT29B	SC05	P	BDT42CF	SC05	P
BD937	SC05	P	BDT29BF	SC05	P	BDT60	SC05	P
BD937F	SC05	P	BDT29C	SC05	P	BDT60F	SC05	P
BD938	SC05	P	BDT29CF	SC05	P	BDT60A	SC05	P
BD938F	SC05	P	BDT30	SC05	P	BDT60AF	SC05	P
BD939	SC05	P	BDT30F	SC05	P	BDT60B	SC05	P
BD939F	SC05	P	BDT30A	SC05	P	BDT60BF	SC05	P
BD940	SC05	P	BDT30AF	SC05	P	BDT60C	SC05	P
BD940F	SC05	P	BDT30B	SC05	P	BDT60CF	SC05	P
BD941	SC05	P	BDT30BF	SC05	P	BDT61	SC05	P
BD941F	SC05	P	BDT30C	SC05	P	BDT61F	SC05	P
BD942	SC05	P	BDT30CF	SC05	P	BDT61A	SC05	P
BD942F	SC05	P	BDT31	SC05	P	BDT61AF	SC05	P
BD943	SC05	P	BDT31F	SC05	P	BDT61B	SC05	P
BD943F	SC05	P	BDT31A	SC05	P	BDT61BF	SC05	P
BD944	SC05	P	BDT31AF	SC05	P	BDT61C	SC05	P
BD944F	SC05	P	BDT31B	SC05	P	BDT61CF	SC05	P
BD945	SC05	P	BDT31BF	SC05	P	BDT62	SC05	P
BD945F	SC05	P	BDT31C	SC05	P	BDT62F	SC05	P
BD946	SC05	P	BDT31CF	SC05	P	BDT62A	SC05	P
BD946F	SC05	P	BDT31D	SC05	P	BDT62AF	SC05	P
BD947	SC05	P	BDT31DF	SC05	P	BDT62B	SC05	P
BD947F	SC05	P	BDT32	SC05	P	BDT62BF	SC05	P
BD948	SC05	P	BDT32F	SC05	P	BDT62C	SC05	P
BD948F	SC05	P	BDT32A	SC05	P	BDT62CF	SC05	P

Type no.	book	section	Type no.	book	section	Type no.	book	section
BDT63	SC05	P	BDT93F	SC05	P	BDX63C	SC05	P
BDT63F	SC05	P	BDT94	SC05	P	BDX64	SC05	P
BDT63A	SC05	P	BDT94F	SC05	P	BDX64A	SC05	P
BDT63AF	SC05	P	BDT95	SC05	P	BDX64B	SC05	P
BDT63B	SC05	P	BDT95F	SC05	P	BDX64C	SC05	P
BDT63BF	SC05	P	BDT96	SC05	P	BDX65	SC05	P
BDT63C	SC05	P	BDT96F	SC05	P	BDX65A	SC05	P
BDT63CF	SC05	P	BDV64	SC05	P	BDX65B	SC05	P
BDT64	SC05	P	BDV64A	SC05	P	BDX65C	SC05	P
BDT64F	SC05	P	BDV64B	SC05	P	BDX66	SC05	P
BDT64A	SC05	P	BDV64C	SC05	P	BDX66A	SC05	P
BDT64AF	SC05	P	BDV65	SC05	P	BDX66B	SC05	P
BDT64B	SC05	P	BDV65A	SC05	P	BDX66C	SC05	P
BDT64BF	SC05	P	BDV65B	SC05	P	BDX67	SC05	P
BDT64C	SC05	P	BDV65C	SC05	P	BDX67A	SC05	P
BDT64CF	SC05	P	BDV66A	SC05	P	BDX67B	SC05	P
BDT65	SC05	P	BDV66B	SC05	P	BDX67C	SC05	P
BDT65F	SC05	P	BDV66C	SC05	P	BDX68	SC05	P
BDT65A	SC05	P	BDV66D	SC05	P	BDX68A	SC05	P
BDT65AF	SC05	P	BDV67A	SC05	P	BDX68B	SC05	P
BDT65B	SC05	P	BDV67B	SC05	P	BDX68C	SC05	P
BDT65BF	SC05	P	BDV67C	SC05	P	BDX69	SC05	P
BDT65C	SC05	P	BDV67D	SC05	P	BDX69A	SC05	P
BDT65CF	SC05	P	BDV91	SC05	P	BDX69B	SC05	P
BDT81	SC05	P	BDV92	SC05	P	BDX69C	SC05	P
BDT81F	SC05	P	BDV93	SC05	P	BDX77	SC05	P
BDT82	SC05	P	BDV94	SC05	P	BDX77F	SC05	P
BDT82F	SC05	P	BDV95	SC05	P	BDX78	SC05	P
BDT83	SC05	P	BDV96	SC05	P	BDX78F	SC05	P
BDT83F	SC05	P	BDX35	SC05	P	BDX91	SC05	P
BDT84	SC05	P	BDX36	SC05	P	BDX92	SC05	P
BDT84F	SC05	P	BDX37	SC05	P	BDX93	SC05	P
BDT85	SC05	P	BDX42	SC05	P	BDX94	SC05	P
BDT85F	SC05	P	BDX43	SC05	P	BDX95	SC05	P
BDT86	SC05	P	BDX44	SC05	P	BDX96	SC05	P
BDT86F	SC05	P	BDX45	SC05	P	BDY90	SC05	P
BDT87	SC05	P	BDX46	SC05	P	BDY91	SC05	P
BDT87F	SC05	P	BDX47	SC05	P	BDY92	SC05	P
BDT88	SC05	P	BDX62	SC05	P	BF198	SC04	Sm
BDT88F	SC05	P	BDX62A	SC05	P	BF199	SC04	Sm
BDT91	SC05	P	BDX62B	SC05	P	BF240	SC04	Sm
BDT91F	SC05	P	BDX62C	SC05	P	BF241	SC04	Sm
BDT92	SC05	P	BDX63	SC05	P	BF245A	SC07	FET
BDT92F	SC05	P	BDX63A	SC05	P	BF245B	SC07	FET
BDT93	SC05	P	BDX63B	SC05	P	BF245C	SC07	FET

Type no.	book	section	Type no.	book	section	Type no.	book	section
BF247A	SC07	FET	BF820	SC10	Mm	BFG97	SC14/10	WBT/Mm
BF247B	SC07	FET	BF821	SC10	Mm	BFG135	SC14/10	WBT/Mm
BF247C	SC07	FET	BF822	SC10	Mm	BFG195	SC14	WBT
BF256A	SC07	FET	BF823	SC10	Mm	BFG198	SC14/10	WBT/Mm
BF256B	SC07	FET	BF824	SC10	Mm	BFP90A	SC14	WBT
BF256C	SC07	FET	BF840	SC10	Mm	BFP91A	SC14	WBT
BF324	SC04	Sm	BF841	SC10	Mm	BFP96	SC14	WBT
BF370	SC04	Sm	BF926	SC04	Sm	BFQ10	SC07	FET
BF410A	SC07	FET	BF936	SC04	Sm	BFQ11	SC07	FET
BF410B	SC07	FET	BF939	SC04	Sm	BFQ12	SC07	FET
BF410C	SC07	FET	BF960	SC07	FET	BFQ13	SC07	FET
BF410D	SC07	FET	BF964S	SC07	FET	BFQ14	SC07	FET
BF420	SC04	Sm	BF965	SC07	FET	BFQ15	SC07	FET
BF421	SC04	Sm	BF966S	SC07	FET	BFQ16	SC07	FET
BF422	SC04	Sm	BF967	SC04	Sm	BFQ17	SC14/10	WBT/Mm
BF423	SC04	Sm	BF970	SC04	Sm	BFQ18A	SC14/10	WBT/Mm
BF450	SC04	Sm	BF970A	SC04	Sm	BFQ19	SC14/10	WBT/Mm
BF451	SC04	Sm	BF979	SC04	Sm	BFQ22S	SC14	WBT
BF483	SC04	Sm	BF980	SC07	FET	BFQ23	SC14	WBT
BF485	SC04	Sm	BF980A	SC07	FET	BFQ23C	SC14	WBT
BF487	SC04	Sm	BF981	SC07	FET	BFQ24	SC14	WBT
BF494	SC04	Sm	BF982	SC07	FET	BFQ32	SC14	WBT
BF495	SC04	Sm	BF989	SC07/10	FET/Mm	BFQ32C	SC14	WBT
BF496	SC04	Sm	BF990A	SC07/10	FET/Mm	BFQ32M	SC14	WBT
BF510	SC07/10	FET/Mm	BF990AR	SC07/10	FET/Mm	BFQ32S	SC14	WBT
BF511	SC07/10	FET/Mm	BF991	SC07/10	FET/Mm	BFQ33	SC14	WBT
BF512	SC07/10	FET/Mm	BF992	SC07/10	FET/Mm	BFQ33C	SC14	WBT
BF513	SC07/10	FET/Mm	BF992R	SC07/10	FET/Mm	BFQ34	SC14	WBT
BF550	SC10	Mm	BF994S	SC07/10	FET/Mm	BFQ34T	SC14	WBT
BF550R	SC10	Mm	BF994SR	SC07/10	FET/Mm	BFQ42	SC08	RFP
BF569	SC10	Mm	BF996S	SC07/10	FET/Mm	BFQ43	SC08	RFP
BF570	SC10	Mm	BF996SR	SC07/10	FET/Mm	BFQ43S	SC08	RFP
BF579	SC10	Mm	BF997	SC07/10	FET/Mm	BFQ51	SC14	WBT
BF620	SC10	Mm	BFG23	SC14	WBT	BFQ51C	SC14	WBT
BF621	SC10	Mm	BFG32	SC14	WBT	BFQ52	SC14	WBT
BF622	SC10	Mm	BFG34	SC14	WBT	BFQ53	SC14	WBT
BF623	SC10	Mm	BFG35	SC14/10	WBT/Mm	BFQ63	SC14	WBT
BF660	SC10	Mm	BFG51	SC14	WBT	BFQ65	SC14	WBT
BF660R	SC10	Mm	BFG65	SC14	WBT	BFQ66	SC14	WBT
BF689K	SC14	WBT	BFG67	SC14/10	WBT/Mm	BFQ67	SC14/10	WBT/Mm
BF720	SC10	Mm	BFG90A	SC14	WBT	BFQ68	SC14	WBT
BF721	SC10	Mm	BFG91A	SC14	WBT	BFQ136	SC14	WBT
BF722	SC10	Mm	BFG92A	SC14	WBT	BFR29	SC07	FET
BF723	SC10	Mm	BFG93A	SC14	WBT	BFR30	SC07/10	FET/Mm
BF763	SC14	WBT	BFG96	SC14	WBT	BFR31	SC07/10	FET/Mm

Type no.	book	section	Type no.	book	section	Type no.	book	section
BFR49	SC14	WBT	BFW30	SC14	WBT	BGY49B	SC09	RFP
BFR53	SC14/10	WBT/Mm	BFW61	SC07	FET	BGY50	SC14	WBM
BFR54	SC04	Sm	BFW92	SC14	WBT	BGY51	SC14	WBM
BFR64	SC14	WBT	BFW92A	SC14	WBT	BGY52	SC14	WBM
BFR65	SC14	WBT	BFW93	SC14	WBT	BGY53	SC14	WBM
BFR84	SC07	FET	BFX34	SC04	Sm	BGY54	SC14	WBM
BFR90	SC14	WBT	BFX89	SC14	WBT	BGY55	SC14	WBM
BFR90A	SC14	WBT	BFY50	SC04	Sm	BGY56	SC14	WBM
BFR91	SC14	WBT	BFY51	SC04	Sm	BGY57	SC14	WBM
BFR91A	SC14	WBT	BFY52	SC04	Sm	BGY58	SC14	WBM
BFR92	SC14/10	WBT/Mm	BFY55	SC04	Sm	BGY58A	SC14	WBM
BFR92A	SC14/10	WBT/Mm	BFY90	SC14	WBT	BGY59	SC14	WBM
BFR93	SC14/10	WBT/Mm	BG2000	SC01	RT	BGY60	SC14	WBM
BFR93A	SC14/10	WBT/Mm	BG2097	SC01	RT	BGY61	SC14	WBM
BFR94	SC14	WBT	BGD102	SC14	WBM	BGY65	SC14	WBM
BFR95	SC14	WBT	BGD102E	SC14	WBM	BGY67	SC14	WBM
BFR96	SC14	WBT	BGD104	SC14	WBM	BGY67A	SC14	WBM
BFR96S	SC14	WBT	BGD104E	SC14	WBM	BGY70	SC14	WBM
BFR101A	SC07/10	FET/Mm	BGD502	SC14	WBM	BGY71	SC14	WBM
BFR101B	SC07/10	FET/Mm	BGD504	SC14	WBM	BGY74	SC14	WBM
BFS17	SC14/10	WBT	BGX885	SC14	WBM	BGY75	SC14	WBM
BFS17A	SC14	WBT	BGY22	SC09	RFP	BGY78	SC14	WBM
BFS18	SC10	Mm	BGY22A	SC09	RFP	BGY84	SC14	WBM
BFS18R	SC10	Mm	BGY23	SC09	RFP	BGY84A	SC14	WBM
BFS19	SC10	Mm	BGY23A	SC09	RFP	BGY85	SC14	WBM
BFS19R	SC10	Mm	BGY32	SC09	RFP	BGY85A	SC14	WBM
BFS20	SC10	Mm	BGY33	SC09	RFP	BGY86	SC14	WBM
BFS20R	SC10	Mm	BGY35	SC09	RFP	BGY87	SC14	WBM
BFS21	SC07	FET	BGY36	SC09	RFP	BGY88	SC14	WBM
BFS21A	SC07	FET	BGY40A	SC09	RFP	BGY90A	SC09	RFP
BFS22A	SC08	RFP	BGY40B	SC09	RFP	BGY90B	SC09	RFP
BFS23A	SC08	RFP	BGY41A	SC09	RFP	BGY91A	SC09	RFP
BFT24	SC14	WBT	BGY41B	SC09	RFP	BGY91B	SC09	RFP
BFT25	SC14/10	WBT/Mm	BGY43	SC09	RFP	BGY93A	SC09	RFP
BFT44	SC04	Sm	BGY45A	SC09	RFP	BGY93B	SC09	RFP
BFT45	SC04	Sm	BGY45B	SC09	RFP	BGY93C	SC09	RFP
BFT46	SC07/10	FET/Mm	BGY45C	SC09	RFP	BGY94A	SC09	RFP
BFT92	SC14/10	WBT/Mm	BGY46A	SC09	RFP	BGY94B	SC09	RFP
BFT93	SC14/10	WBT/Mm	BGY46B	SC09	RFP	BGY94C	SC09	RFP
BFW10	SC07	FET	BGY47A	SC09	RFP	BGY95A	SC09	RFP
BFW11	SC07	FET	BGY47F	SC09	RFP	BGY95B	SC09	RFP
BFW12	SC07	FET	BGY48A	SC09	RFP	BGY96A	SC09	RFP
BFW13	SC07	FET	BGY48B	SC09	RFP	BGY96B	SC09	RFP
BFW16A	SC14	WBT	BGY48C	SC09	RFP	BGY110A	SC09	RFP
BFW17A	SC14	WBT	BGY49A	SC09	RFP	BGY110B	SC09	RFP

Type no.	book	section	Type no.	book	section	Type no.	book	section
BGY584A	SC14	WBM	BLV25	SC08	RFP	BLW89	SC08	RFP
BGY585A	SC14	WBM	BLV30	SC08	RFP	BLW90	SC08	RFP
BGY586	SC14	WBM	BLV30/12	SC08	RFP	BLW91	SC08	RFP
BGY587	SC14	WBM	BLV31	SC08	RFP	BLW95	SC08	RFP
BLF145	SC08	RFP/FET	BLV32F	SC08	RFP	BLW96	SC08	RFP
BLF147	SC08	RFP/FET	BLV33	SC08	RFP	BLW97	SC08	RFP
BLF175	SC08	RFP/FET	BLV33F	SC08	RFP	BLW98	SC08	RFP
BLF177	SC08	RFP/FET	BLV36	SC08	RFP	BLW99	SC08	RFP
BLF221	SC08	RFP/FET	BLV37	SC08	RFP	BLX13	SC08	RFP
BLF241	SC08	RFP/FET	BLV38	SC08	RFP	BLX13C	SC08	RFP
BLF242	SC08	RFP/FET	BLV45/12	SC08	RFP	BLX14	SC08	RFP
BLF244	SC08	RFP/FET	BLV57	SC08	RFP	BLX15	SC08	RFP
BLF245	SC08	RFP/FET	BLV59	SC08	RFP	BLX39	SC08	RFP
BLF246	SC08	RFP/FET	BLV75/12	SC08	RFP	BLX65	SC08	RFP
BLF278	SC08	RFP/FET	BLV80/28	SC08	RFP	BLX65E	SC08	RFP
BLF368	SC08	RFP/FET	BLV90	SC08	RFP	BLX65ES	SC08	RFP
BLF378	SC08	RFP/FET	BLV90/SL	SC08	RFP	BLX67	SC08	RFP
BLF521	SC08	RFP/FET	BLV91	SC08	RFP	BLX68	SC08	RFP
BLF522	SC08	RFP/FET	BLV91/SL	SC08	RFP	BLX69A	SC08	RFP
BLF543	SC08	RFP/FET	BLV92	SC08	RFP	BLX91A	SC08	RFP
BLF544	SC08	RFP/FET	BLV93	SC08	RFP	BLX91CB	SC08	RFP
BLF545	SC08	RFP/FET	BLV94	SC08	RFP	BLX92A	SC08	RFP
BLF547	SC08	RFP/FET	BLV95	SC08	RFP	BLX93A	SC08	RFP
BLF548	SC08	RFP/FET	BLV97	SC08	RFP	BLX94A	SC08	RFP
BLT90/SL	SC08	RFP	BLV98	SC08	RFP	BLX94C	SC08	RFP
BLT91/SL	SC08	RFP	BLV99	SC08	RFP	BLX95	SC08	RFP
BLT92/SL	SC08	RFP	BLW29	SC08	RFP	BLX96	SC08	RFP
BLT93/SL	SC08	RFP	BLW31	SC08	RFP	BLX97	SC08	RFP
BLU20/12	SC08	RFP	BLW32	SC08	RFP	BLX98	SC08	RFP
BLU30/12	SC08	RFP	BLW33	SC08	RFP	BLY87A	SC08	RFP
BLU30/28	SC08	RFP	BLW34	SC08	RFP	BLY87C	SC08	RFP
BLU45/12	SC08	RFP	BLW50F	SC08	RFP	BLY88A	SC08	RFP
BLU50	SC08	RFP	BLW60	SC08	RFP	BLY88C	SC08	RFP
BLU51	SC08	RFP	BLW60C	SC08	RFP	BLY89A	SC08	RFP
BLU52	SC08	RFP	BLW76	SC08	RFP	BLY89C	SC08	RFP
BLU53	SC08	RFP	BLW77	SC08	RFP	BLY90	SC08	RFP
BLU60/12	SC08	RFP	BLW78	SC08	RFP	BLY91A	SC08	RFP
BLU60/28	SC08	RFP	BLW79	SC08	RFP	BLY91C	SC08	RFP
BLU97	SC08	RFP	BLW80	SC08	RFP	BLY92A	SC08	RFP
BLU98	SC08	RFP	BLW81	SC08	RFP	BLY92C	SC08	RFP
BLU99	SC08	RFP	BLW83	SC08	RFP	BLY93A	SC08	RFP
BLV10	SC08	RFP	BLW84	SC08	RFP	BLY93C	SC08	RFP
BLV11	SC08	RFP	BLW85	SC08	RFP	BLY94	SC08	RFP
BLV20	SC08	RFP	BLW86	SC08	RFP	BR100/03	SC03	Th
BLV21	SC08	RFP	BLW87	SC08	RFP	BR101	SC04	Sm

Type no.	book	section	Type no.	book	section	Type no.	book	section
BR210*	SC02	R	BSP51	SC10	Mm	BSR62	SC04	Sm
BR211*	SC02	R	BSP52	SC10	Mm	BSR111	SC07/10	FET/Mm
BR213*	SC02	R	BSP60	SC10	Mm	BSR112	SC07/10	FET/Mm
BR216*	SC02	R	BSP61	SC10	Mm	BSR113	SC07/10	FET/Mm
BR220*	SC02	R	BSP62	SC10	Mm	BSR174	SC07/10	FET/Mm
BRY39	SC04	Sm	BSP204	SC07	FET	BSR175	SC07/10	FET/Mm
BRY56	SC04	Sm	BSP204A	SC07	FET	BSR176	SC07/10	FET/Mm
BRY61	SC10	Mm	BSR12	SC10	Mm	BSR177	SC07/10	FET/Mm
BRY62	SC10	Mm	BSR12R	SC10	Mm	BSS38	SC04	Sm
BS107	SC07	FET	BSR13	SC10	Mm	BSS50	SC04	Sm
BS107A	SC07	FET	BSR13R	SC10	Mm	BSS51	SC04	Sm
BS170	SC07	FET	BSR14	SC10	Mm	BSS52	SC04	Sm
BS250	SC07	FET	BSR14R	SC10	Mm	BSS60	SC04	Sm
BSD10	SC07	FET	BSR15	SC10	Mm	BSS61	SC04	Sm
BSD12	SC07	FET	BSR15R	SC10	Mm	BSS62	SC04	Sm
BSD20	SC07/10	FET/m	BSR16	SC10	Mm	BSS63	SC10	Mm
BSD22	SC07/10	FET/M	BSR16R	SC10	Mm	BSS63R	SC10	Mm
BSD212	SC07	FET	BSR17	SC10	Mm	BSS64	SC10	Mm
BSD213	SC07	FET	BSR17R	SC10	Mm	BSS64R	SC10	Mm
BSD214	SC07	FET	BSR17A	SC10	Mm	BSS68	SC04	Sm
BSD215	SC07	FET	BSR17AR	SC10	Mm	BSS83	SC07/10	FET/Mm
BSJ111	SC07	FET	BSR18	SC10	Mm	BSS87	SC07	FET
BSJ112	SC07	FET	BSR18R	SC10	Mm	BSS89	SC07	FET
BSJ113	SC07	FET	BSR18A	SC10	Mm	BSS91	SC07	FET
BSJ174	SC07	FET	BSR18AR	SC10	Mm	BSS92	SC07	FET
BSJ175	SC07	FET	BSR19	SC10	Mm	BST15	SC10	Mm
BSJ176	SC07	FET	BSR19A	SC10	Mm	BST16	SC10	Mm
BSJ177	SC07	FET	BSR20	SC10	Mm	BST39	SC10	Mm
BSN205	SC07	FET	BSR20A	SC10	Mm	BST40	SC10	Mm
BSN205A	SC07	FET	BSR30	SC10	Mm	BST50	SC10	Mm
BSN254	SC07	FET	BSR31	SC10	Mm	BST51	SC10	Mm
BSN254A	SC07	FET	BSR32	SC10	Mm	BST52	SC10	Mm
BSP15	SC10	Mm	BSR33	SC10	Mm	BST60	SC10	Mm
BSP16	SC10	Mm	BSR40	SC10	Mm	BST61	SC10	Mm
BSP19	SC10	Mm	BSR41	SC10	Mm	BST62	SC10	Mm
BSP20	SC10	Mm	BSR42	SC10	Mm	BST70A	SC07	FET
BSP30	SC10	Mm	BSR43	SC10	Mm	BST72A	SC07	FET
BSP31	SC10	Mm	BSR50	SC04	Sm	BST74A	SC07	FET
BSP32	SC10	Mm	BSR51	SC04	Sm	BST76A	SC07	FET
BSP33	SC10	Mm	BSR52	SC04	Sm	BST78	SC07	FET
BSP40	SC10	Mm	BSR56	SC07/10	FET/Mm	BST80	SC07/10	FET/Mm
BSP41	SC10	Mm	BSR57	SC07/10	FET/Mm	BST82	SC07/10	FET/Mm
BSP42	SC10	Mm	BSR58	SC07/10	FET/Mm	BST84	SC07/10	FET/Mm
BSP43	SC10	Mm	BSR60	SC04	Sm	BST86	SC07/10	FET/Mm
BSP50	SC10	Mm	BSR61	SC04	Sm	BST95	SC07	FET

Type no.	book	section	Type no.	book	section	Type no.	book	section
BST97	SC07	FET	BT169*	SC03	Th	BUS133*	SC06	SP
BST100	SC07	FET	BT169W*	SC03	Th	BUT11	SC06	SP
BST110	SC07	FET	BTA140*	SC03	Tri	BUT11A	SC06	SP
BST120	SC07/10	FET/Mm	BTR59*	SC03	Tri	BUT11F	SC06	SP
BST122	SC07/10	FET/Mm	BTS59*	SC03	Tri	BUT11AF	SC06	SP
BSV15	SC04	Sm	BTV58*	SC03	Th	BUT12	SC06	SP
BSV16	SC04	Sm	BTW38*	SC03	Th	BUT12A	SC06	SP
BSV17	SC04	Sm	BTW40*	SC03	Th	BUT12F	SC06	SP
BSV52	SC10	Mm	BTW42*	SC03	Th	BUT12AF	SC06	SP
BSV52R	SC10	Mm	BTW43*	SC03	Tri	BUT18	SC06	SP
BSV64	SC04	Sm	BTW45*	SC03	Th	BUT18A	SC06	SP
BSV78	SC07	FET	BTW58*	SC03	Th	BUT18F	SC06	SP
BSV79	SC07	FET	BTY79*	SC03	Th	BUT18AF	SC06	SP
BSV80	SC07	FET	BTY91*	SC03	Th	BUT21B	SC06	SP
BSV81	SC07	FET	BU306	SC06	SP	BUT21C	SC06	SP
BSW66A	SC04	Sm	BU306F	SC06	SP	BUT21BF	SC06	SP
BSW67A	SC04	Sm	BU505	SC06	SP	BUT21CF	SC06	SP
BSW68A	SC04	Sm	BU506	SC06	SP	BUT22B	SC06	SP
BSX19	SC04	Sm	BU506D	SC06	SP	BUT22C	SC06	SP
BSX20	SC04	Sm	BU508A	SC06	SP	BUT22BF	SC06	SP
BSX32	SC04	Sm	BU508D	SC06	SP	BUT22CF	SC06	SP
BSX45	SC04	Sm	BU705	SC06	SP	BUT131	SC06	SP
BSX46	SC04	Sm	BU706	SC06	SP	BUV26	SC06	SP
BSX47	SC04	Sm	BU706D	SC06	SP	BUV26A	SC06	SP
BSX59	SC04	Sm	BU806	SC06	SP	BUV26F	SC06	SP
BSX60	SC04	Sm	BU807	SC06	SP	BUV26AF	SC06	SP
BSX61	SC04	Sm	BU808	SC06	SP	BUV27	SC06	SP
BT134*	SC03	Tri	BU824	SC06	SP	BUV27A	SC06	SP
BT134W*	SC03	Tri	BU826	SC06	SP	BUV27F	SC06	SP
BT136*	SC03	Tri	BUP22*	SC06	SP	BUV27AF	SC06	SP
BT136F*	SC03	Tri	BUP23*	SC06	SP	BUV28	SC06	SP
BT137*	SC03	Tri	BUS11	SC06	SP	BUV28A	SC06	SP
BT137F*	SC03	Tri	BUS11A	SC06	SP	BUV28F	SC06	SP
BT138*	SC03	Tri	BUS12	SC06	SP	BUV28AF	SC06	SP
BT138F*	SC03	Tri	BUS12A	SC06	SP	BUV47	SC06	SP
BT139*	SC03	Tri	BUS13	SC06	SP	BUV47A	SC06	SP
BT139F*	SC03	Tri	BUS13A	SC06	SP	BUV48	SC06	SP.
BT145*	SC03	Tri	BUS14	SC06	SP	BUV48A	SC06	SP
BT148*	SC03	Th	BUS14A	SC06	SP	BUV82	SC06	SP
BT149*	SC03	Th	BUS21*	SC06	SP	BUV83	SC06	SP
BT150	SC03	Th	BUS22*	SC06	SP	BUV89	SC06	SP
BT151*	SC03	Th	BUS23*	SC06	SP	BUV90	SC06	SP
BT151F*	SC03	Th	BUS24*	SC06	SP	BUV90F	SC06	SP
BT152*	SC03	Th	BUS131*	SC06	SP	BUV98(V)	SC06	SP
BT153	SC03	Th	BUS132*	SC06	SP	BUV98A	SC06	SP

Type no.	book	section	Type no.	book	section	Type no.	book	section
BUV298(V)	SC06	SP	BUZ24	S9	PM	BUZ311	S9	PM
BUV298A	SC06	SP	BUZ25	S9	PM	BUZ326	S9	PM
BUW11	SC06	SP	BUZ31	S9	PM	BUZ330	S9	PM
BUW11A	SC06	SP	BUZ32	S9	PM	BUZ331	S9	PM
BUW12	SC06	SP	BUZ34	S9	PM	BUZ347	S9	PM
BUW12A	SC06	SP	BUZ35	S9	PM	BUZ348	S9	PM
BUW12F	SC06	SP	BUZ36	S9	PM	BUZ349	S9	PM
BUW12AF	SC06	SP	BUZ41A	S9	PM	BUZ350	S9	PM
BUW13	SC06	SP	BUZ42	S9	PM	BUZ351	S9	PM
BUW13A	SC06	SP	BUZ45	S9	PM	BUZ355	S9	PM
BUW13F	SC06	SP	BUZ45A	S9	PM	BUZ356	S9	PM
BUW13AF	SC06	SP	BUZ45B	S9	PM	BUZ357	S9	PM
BUW84	SC06	SP	BUZ50A	S9	PM	BUZ358	S9	PM
BUW85	SC06	SP	BUZ50B	S9	PM	BUZ384	S9	PM
BUW86	SC06	SP	BUZ50C	S9	PM	BUZ385	S9	PM
BUW87	SC06	SP	BUZ53A	S9	PM	BY228	SC01	R
BUW87A	SC06	SP	BUZ54	S9	PM	BY229*	SC02	R
BUW131*	SC06	SP	BUZ54A	S9	PM	BY229F*	SC02	R
BUW132*	SC06	SP	BUZ60	S9	PM	BY249*	SC02	R
BUW133*	SC06	SP	BUZ63	S9	PM	BY249F*	SC02	R
BUX46	SC06	SP	BUZ64	S9	PM	BY260*	SC02	R
BUX46A	SC06	SP	BUZ71	S9	PM	BY328	SC01	SD
BUX47	SC06	SP	BUZ71A	S9	PM	BY329*	SC02	R
BUX47A	SC06	SP	BUZ72	S9	PM	BY359*	SC02	R
BUX48	SC06	SP	BUZ72A	S9	PM	BY359F	SC02	R
BUX48A	SC06	SP	BUZ73	S9	PM	BY438	SC01	R
BUX84	SC06	SP	BUZ73A	S9	PM	BY448	SC01	R
BUX84F	SC06	SP	BUZ74	S9	PM	BY458	SC01	R
BUX85	SC06	SP	BUZ74A	S9	PM	BY505	SC01	R
BUX85F	SC06	SP	BUZ76	S9	PM	BY509	SC01	R
BUX86	SC06	SP	BUZ76A	S9	PM	BY527	SC01	R
BUX87	SC06	SP	BUZ78	S9	PM	BY584	SC01	R
BUX88	SC06	SP	BUZ80	S9	PM	BY588	SC01	R
BUX98	SC06	SP	BUZ80A	S9	PM	BY609	SC01	R
BUX98A	SC06	SP	BUZ83	S9	PM	BY610	SC01	R
BUX99	SC06	SP	BUZ83A	S9	PM	BY614	SC01	R
BUY89	SC06	SP	BUZ84	S9	PM	BY619	SC01	R
BUZ10	S9	PM	BUZ84A	S9	PM	BY620	SC01	R
BUZ11	S9	PM	BUZ90	S9	PM	BY627	SC01	R
BUZ11A	S9	PM	BUZ90A	S9	PM	BY705	SC01	R
BUZ14	S9	PM	BUZ94	S9	PM	BY706	SC01	R
BUZ15	S9	PM	BUZ211	S9	PM	BY707	SC01	R
BUZ20	S9	PM	BUZ307	S9	PM	BY708	SC01	R
BUZ21	S9	PM	BUZ308	S9	PM	BY709	SC01	R
BUZ23	S9	PM	BUZ310	S9	PM	BY710	SC01	R

Type no.	book	section	Type no.	book	section	Type no.	book	section
BY711	SC01	R	BYV26*	SC01	R	BYW95C	SC01	R
BY712	SC01	R	BYV27*	SC01	R	BYW96D	SC01	R
BY713	SC01	R	BYV28*	SC01	R	BYW96E	SC01	R
BY714	SC01	R	BYV29*	SC02	R	BYX10G	SC01	R
BY715	SC01	R	BYV29F*	SC02	R	BYX25*	SC02	R
BY716	SC01	R	BYV30*	SC02	R	BYX30*	SC02	R
BY717	SC01	R	BYV31*	SC02	R	BYX38*	SC02	R
BY718	SC01	R	BYV32*	SC02	R	BYX39*	SC02	R
BY719	SC01	R	BYV32F*	SC02	R	BYX42*	SC02	R
BY720	SC01	R	BYV34*	SC02	R	BYX46*	SC02	R
BY721	SC01	R	BYV36*	SC01	R	BYX52*	SC02	R
BY722	SC01	R	BYV42*	SC02	R	BYX56*	SC02	R
BY723	SC01	R	BYV44*	SC02	R	BYX90G	SC01	R
BY724	SC01	R	BYV54V	SC02	R	BYX96*	SC02	R
BYD11*	SC01	R	BYV72*	SC02	R	BYX97*	SC02	R
BYD13*	SC01	R	BYV72F*	SC02	R	BYX98*	SC02	R
BYD14*	SC01	R	BYV74*	SC02	R	BYX99*	SC02	R
BYD17*	SC01/10	R/Mm	BYV74F*	SC02	R	BZD23	SC01	Vrg
BYD31*	SC01	R	BYV79*	SC02	R	BZD27	SC01/10	Vrg/Mm
BYD33*	SC01	R	BYV92*	SC02	R	BZT03	SC01	Vrg
BYD34*	SC01	R	BYV95A	SC01	R	BZV10	SC01	Vrf
BYD37*	SC01/10	R/Mm	BYV95B	SC01	R	BZV11	SC01	Vrf
BYD73*	SC01	R	BYV95C	SC01	R	BZV12	SC01	Vrf
BYD74*	SC01	R	BYV96D	SC01	R	BZV13	SC01	Vrf
BYD77*	SC01	R	BYV96E	SC01	R	BZV14	SC01	Vrf
BYM26*	SC01	R	BYV118*	SC02	R	BZV37	SC01	Vrf
BYM36*	SC01	R	BYV118F*	SC02	R	BZV49*	SC01/10	Vrg/Mm
BYM56*	SC01	R	BYV120*	SC02	R	BZV55*	SC10	Mm
BYP20*	SC02	R	BYV121*	SC02	R	BZV60	SC01	Vrg
BYP21*	SC02	R	BYV133*	SC02	R	BZV80	SC01	Vrf
BYP22*	SC02	R	BYV133F*	SC02	R	BZV81	SC01	Vrf
BYQ27*	SC01	R	BYV143*	SC02	R	BZV85*	SC01	Vrg
BYQ28*	SC02	R	BYV143F*	SC02	R	BZV86	SC01	SD
BYQ28F*	SC02	R	BYW25*	SC02	R	BZW03*	SC01	Vrg
BYR28*	SC02	R	BYW29*	SC02	R	BZW14	SC01	Vrg
BYR29*	SC02	R	BYW29F*	SC02	R	BZW86*	SC02	TS
BYR29F*	SC02	R	BYW30*	SC02	R	BZX55*	SC01	Vrg
BYR30*	SC02	R	BYW31*	SC02	R	BZX70*	SC02	Vrg
BYR34*	SC02	R	BYW54	SC01	R	BZX75*	SC01	Vrg
BYR79*	SC02	R	BYW55	SC01	R	BZX79*	SC01	Vrg
BYT28*	SC02	R	BYW56	SC01	R	BZX84*	SC01/10	Vrg/Mm
BYT79*	SC02	R	BYW92*	SC02	R	BZY91*	SC02	Vrg
BYT230PIV	SC02	R	BYW93*	SC02	R	BZY93*	SC02	Vrg
BYV10*	SC01	R	BYW95A	SC01	R	CNG35	SC12	PhC
BYV24*	SC02	R	BYW95B	SC01	R	CNG36	SC12	PhC

NOTES

DATA HANDBOOK SYSTEM

DATA HANDBOOK SYSTEM

Our Data Handbook System comprises more than 60 books with specifications on electronic components, subassemblies and materials. It is made up of seven series of handbooks:

INTEGRATED CIRCUITS

DISCRETE SEMICONDUCTORS

DISPLAY COMPONENTS

PASSIVE COMPONENTS*

PROFESSIONAL COMPONENTS**

MAGNETIC PRODUCTS*

LIQUID CRYSTAL DISPLAYS

The contents of each series are listed on pages iii to ix.

The data handbooks contain all pertinent data available at the time of publication, and each is revised and reissued periodically.

Where application is given it is advisory and does not form part of the product specification.

Condensed data on the preferred products of Philips Components is given in our Preferred Type Range catalogue (issued annually).

Information on current Data Handbooks and how to obtain a subscription for future issues is available from any of the Organizations listed on the back cover.
Product specialists are at your service and enquiries will be answered promptly.

* Will replace the Components and materials (green) series of handbooks.
** Will replace the Electron tubes (blue) series of handbooks.

INTEGRATED CIRCUITS

This series of handbooks comprises:

code	handbook title
IC01	**Radio, audio and associated systems** Bipolar, MOS
IC02a/b	**Video and associated systems** Bipolar, MOS
IC03	**ICs for Telecom** Bipolar, MOS Subscriber sets, Cordless Telephones
IC04	**HE4000B logic family** CMOS
IC05	**Advanced Low-power Schottky (ALS) Logic Series**
IC06	**High-speed CMOS; PC74HC/HCT/HCU** Logic family
IC07	**Advanced CMOS logic (ACL)**
IC08	**10/100K ECL Logic/Memory/PLD**
IC09	**TTL logic series**
IC10	**Memories** MOS, TTL, ECL
IC11	**Linear Products**
IC12	**I^2C-bus compatible ICs**
IC13	**Semi-custom** Programmable Logic Devices (PLD)
IC14	**Microcontrollers** NMOS, CMOS
IC15	**FAST TTL logic series**
IC16	**CMOS integrated circuits for clocks and watches**
IC17	**ICs for Telecom** Bipolar, MOS Radio pagers Mobile telephones ISDN
IC18	**Microprocessors and peripherals**
IC19	**Data communication products**
IC23*	**Solid state image sensors and peripheral integrated circuits**

* Not yet issued in this series of handbooks: previously issued as PC11.

DISCRETE SEMICONDUCTORS

This series of data handbooks comprises:

current code	new code	handbook title
S1	**SC01**	**Diodes** High-voltage tripler units
S2a	**SC02**	**Power diodes**
S2b	**SC03**	**Thyristors and triacs**
S3	**SC04**	**Small-signal transistors**
S4a	**SC05**	**Low-frequency power transistors and hybrid IC power modules**
S4b	**SC06**	**High-voltage and switching power transistors**
S5	**SC07**	**Small-signal field-effect transistors**
S6	**SC08a***	**RF bipolar transistors**
	SC08b*	**RF power transistors**
	SC09	**RF power modules**
S7	**SC10**	**Surface mounted semiconductors**
S8b	**SC12**	**Optocouplers**
S9	**SC13***	**PowerMOS transistors**
S10	**SC14**	**Wideband transistors and wideband hybrid IC modules**
S11	**SC15**	**Microwave transistors**
S15**	**SC16**	**Laser diodes**
S13	**SC17**	**Semiconductor sensors**

* Not yet issued with the new code in this series of handbooks.
** New handbook in this series; will be issued shortly.

DISPLAY COMPONENTS

This series of data handbooks comprises:

code	handbook title
DC01	**Colour display components**
DC02	**Monochrome monitor tubes and deflection units**
DC03	**Television tuners, coaxial aerial input assemblies**
DC04	**Loudspeakers**
DC05	**Flyback transformers, mains transformers and general-purpose FXC assemblies**

PASSIVE COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
C14	**PA01**	**Electrolytic capacitors; solid and non-solid**
C11	**PA02**	**Varistors, thermistors and sensors**
C12	**PA03**	**Potentiometers and switches**
C7	**PA04**	**Variable capacitors**
C22	**PA05***	**Film capacitors**
C15	**PA06***	**Ceramic capacitors**
C9	**PA07***	**Piezoelectric quartz devices**
C13	**PA08**	**Fixed resistors**

* Not yet issued with the new code in this series of handbooks.

PROFESSIONAL COMPONENTS

This series of data handbooks comprises:

current code	new code	handbook title
T3	**PC01**	**High-power klystrons and accessories**
T5	**PC02***	**Cathode-ray tubes**
T6	**PC03***	**Geiger-Müller tubes**
T9	**PC04**	**Photo multipliers**
T10	**PC05**	**Plumbicon camera tubes and accessories**
T11	**PC06**	**Circulators and Isolators**
T12	**PC07**	**Vidicon and Newvicon camera tubes and deflection units**
T13	**PC08**	**Image intensifiers**
T15	**PC09**	**Dry-reed switches**
	PC11**	**Solid state image sensors and peripheral integrated circuits**
T9	**PC12***	**Electron multipliers**

* Not yet issued with the new code in this series of handbooks.
** Will be issued as IC23 in the future.

MAGNETIC PRODUCTS

This series of data handbooks comprises:

current code	new code	handbook title
C4 **C5**	**MA01**	**Soft Ferrites**
C16	**MA02***	**Permanent magnet materials**
C19	**MA03***	**Piezoelectric ceramics**

* Not yet issued with the new code in this series of handbooks.

LIQUID CRYSTAL DISPLAYS

current code	new code	handbook title
S14	**LCD01**	**Liquid Crystal Displays and driver ICs for LCDs**

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