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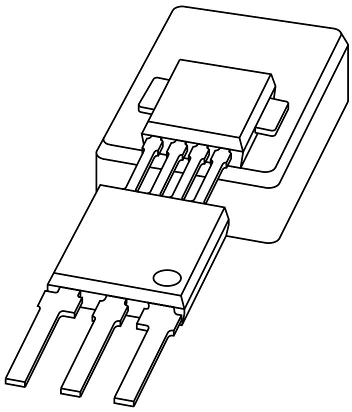

KMI16/1
Integrated rotational speed sensor

Product specification
Supersedes data of 1998 May 15

2000 Sep 05

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DESCRIPTION

The KMI16/1 sensor detects rotational speed of ferrous gear wheels and reference marks.

The sensor consists of a magnetoresistive sensor element, a signal conditioning integrated circuit in bipolar technology and a ferrite magnet.

The frequency of the digital current output signal is proportional to the rotational speed of the target wheel.

The open collector (OC) output allows for a high degree of flexibility in the design of subsequent conditioning electronics.

CAUTION
Do not press two or more products together against their magnetic forces. Do not expose products to strong magnetic fields of more than 30 kA/m.

PINNING

PIN	SYMBOL	DESCRIPTION
1	V_{CC}	DC supply voltage
2	V_{out}	open collector output
3	GND	ground

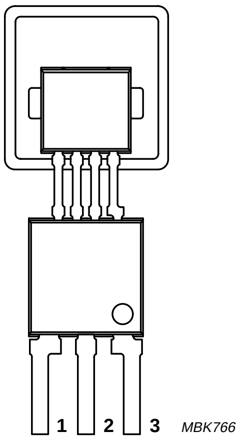


Fig.1 Simplified outline (SOT477B).

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	DC supply voltage	4.5	5	16	V
I_{CC}	DC supply current (pin 1)	4	10	14	mA
V_{CEsat}	OC saturation voltage	–	–	1	V
d_{max}	maximum sensing distance	2.4	2.9	–	mm
f_t	operating tooth frequency	0	–	25000	Hz
T_{amb}	ambient operating temperature	–40	–	+150	°C

LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 60134)

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	DC operating supply voltage	T_{amb} = –40 to +150 °C	4.5	16	V
	voltage pin 1	T_{amb} = –40 to +150 °C; no wrong polarity protection	–0.5	+16	V
V_{out}	OC output voltage	T_{amb} = –40 to +150 °C; no wrong polarity protection; see Fig.5	–0.5	+16	V
$V_{out(max)}$	peak OC output voltage	T_{amb} = –40 to +40 °C; no wrong polarity protection; see Fig.5	–0.5	+26.5	V
$I_{out(max)}$	OC output current	T_{amb} = –40 to +150 °C	–	20	mA
$I_{out(off)}$	OC output leakage current	T_{amb} = –40 to +150 °C	–	100	μA
P_{tot}	total power dissipation	T_{amb} = –40 to +150 °C	–	200	mW
T_{sld}	soldering temperature	t ≤ 10 s	–	260	°C
T_{stg}	storage temperature		–65	+150	°C
T_{amb}	ambient operating temperature		–40	+150	°C

CHARACTERISTICS

T_{amb} = 25 °C; V_{CC} = 5 V; d = 1.9 mm; f_t = 2 kHz; test circuit see Fig.5; gear wheel: module 2.08 mm; material 9SMnPb28k; see Fig.6; centred sensor position; see notes 1, 2 and 3; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
I_{CC}	supply current (pin 1)	T_{amb} = –40 to +150 °C	4	10	14	mA
$V_{out\ (high)}$	OC output voltage high	OC = off state; T_{amb} = –40 to +150 °C	4.7	4.9	–	V
$V_{CE\ sat}$	OC saturation voltage	OC = on state; I_{out} = 20 mA	–	0.4	1	V
t_r	output signal rise time	10% to 90%	5	12	20	μs
t_f	output signal fall time	10% to 90%	0.1	0.4	10	μs
δ	duty cycle	T_{amb} = –40 to +150 °C	30	50	70	%
d_{min}	minimum sensing distance	T_{amb} = –40 to +150 °C	–	0.3	0.5	mm
d_{max}	maximum sensing distance	T_{amb} = –40 to +150 °C	2.4	2.9	–	mm

Notes

1. High rotational wheel speeds reduce the maximum sensing distance because of eddy currents, depending on target wheel dimensions and materials used.
2. Output pins are designed for electrostatic sensitivity for more than 2000 V according to Human Body Model (HBM); MIL-STD-883; method 3015.
3. EMC behaviour depends greatly on design of application circuit.

FUNCTIONAL DESCRIPTION

The KMI16/1 sensor is sensitive to the motion of ferrous gear wheels or reference marks. The functional principle is shown in Fig.3. Due to the effect of flux bending, the different directions of magnetic field lines in the magnetoresistive sensor element will cause an electrical signal. Because of the chosen sensor orientation and the direction of ferrite magnetization, the KMI16/1 is sensitive to movement in the ‘y’ direction in front of the sensor only (see Fig.2).

The magnetoresistive sensor element signal is amplified, temperature compensated and passed to a Schmitt trigger in the conditioning integrated circuit (see Fig.4). The digital output signal level is independent of the sensing distance within the measuring range (see Fig.10). A (3-wire) output current enables safe transfer of the sensor signal to the detecting circuit (see Fig.5). The integrated circuit housing is separated from the sensor element housing to optimize the sensor behaviour at high temperatures.

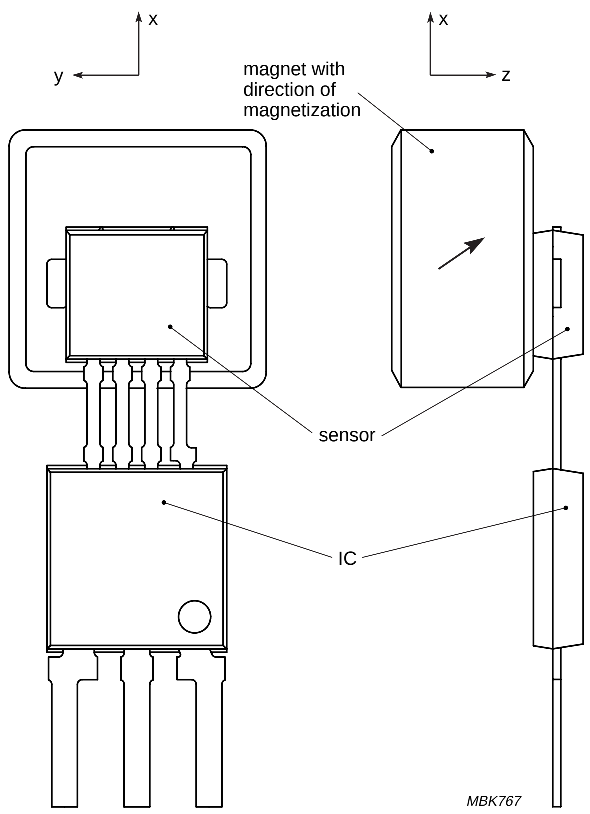


Fig.2 Component detail of the KMI16/1.

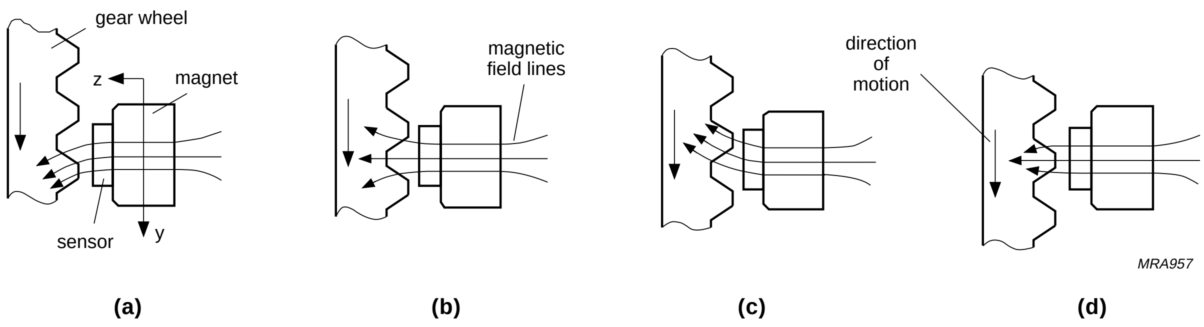


Fig.3 Functional principle.

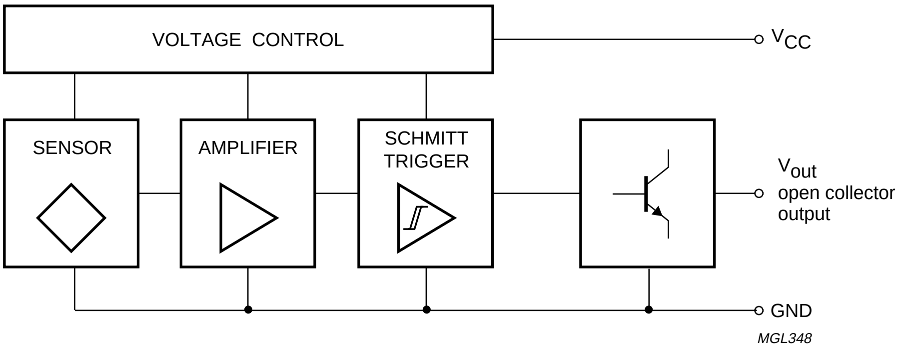


Fig.4 Block diagram.

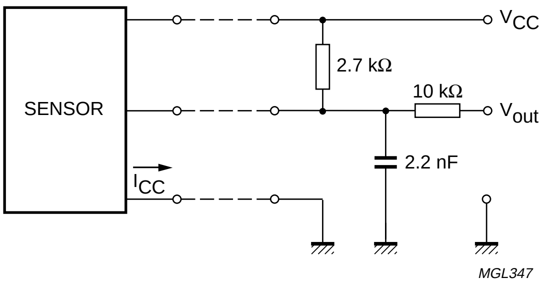


Fig.5 Test and application circuit.

APPLICATION INFORMATION

Mounting conditions

The recommended sensor position in front of a gear wheel is shown in Fig.11. The distance ‘d’ is measured between the sensor front and the tip of a gear wheel tooth. The KMI16/1 senses ferrous indicators like gear wheels in the ‘y’ direction only (no rotational symmetry of the sensor); see Fig.2. The effect of incorrect mounting positions on sensing distance is shown in Figs 7, 8 and 9. The symmetrical reference axis of the sensor corresponds to the axis of the ferrite magnet.

Environmental conditions

Due to eddy current effects the sensing distance depends on the tooth frequency (see Fig.13). The influence of the gear wheel module on the sensing distance is shown in Fig.12.

Gear Wheel Dimensions

SYMBOL	DESCRIPTION	UNIT
German DIN		
z	number of teeth	–
d	diameter	mm
m	module m = d/z	mm
p	pitch p = $\pi \times$ m	mm
ASA; note 1		
PD	pitch diameter (d in inch)	inch
DP	diametric pitch DP = z/PD	inch^{-1}
CP	circular pitch CP = π/DP	inch

Note

1. For conversion from ASA to DIN: m = 25.4 mm/DP; p = 25.4 mm $\times$ CP.

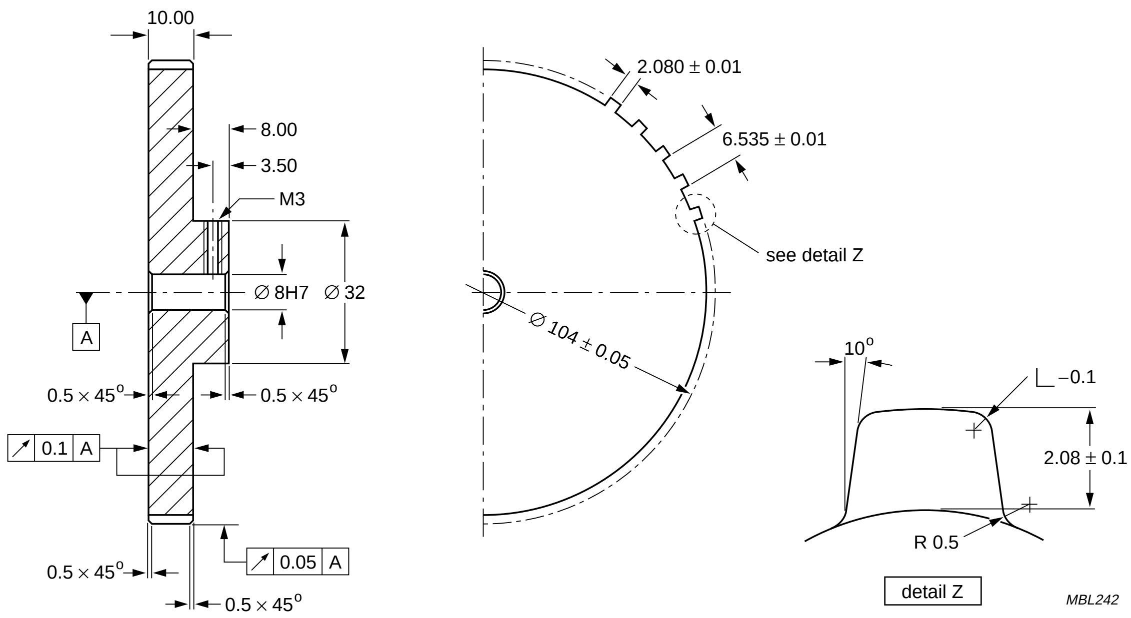
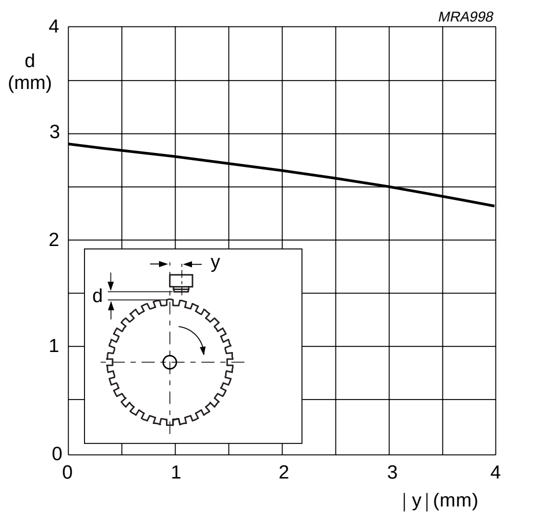
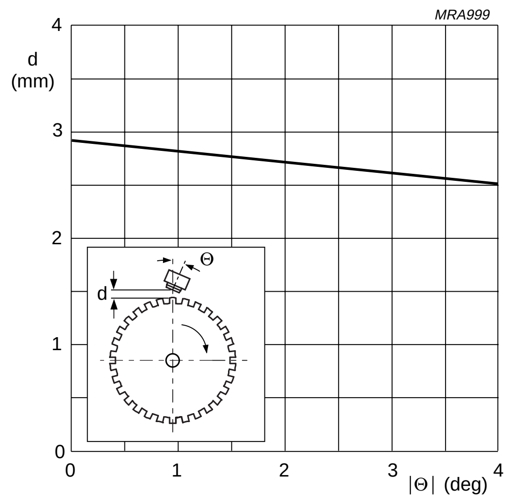


Fig.6 Gear wheel dimensions.



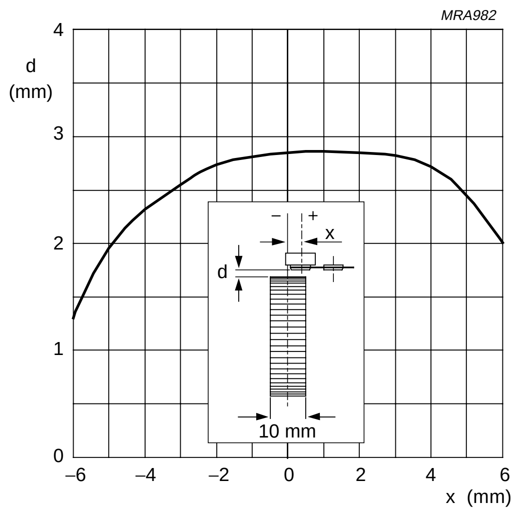
V_{CC} = 12 V; f_t = 2 kHz; module = 2 mm; pitch diameter = 100 mm.

Fig.7 Sensing distance as a function of positional tolerance in the y-axis; typical values.



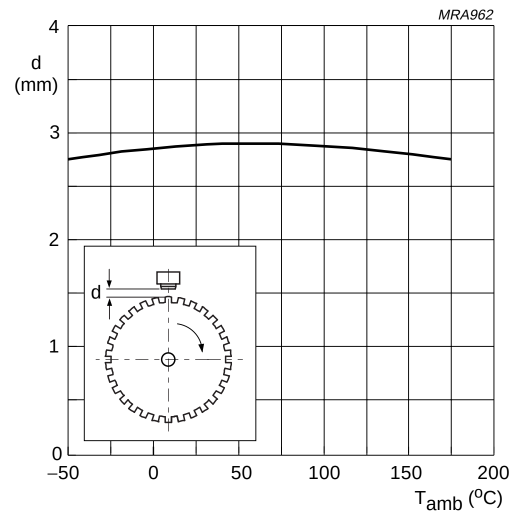
V_{CC} = 12 V; f_t = 2 kHz; module = 2 mm.

Fig.8 Sensing distance as a function of positional tolerance; typical values.



V_{CC} = 12 V; f_t = 2 kHz; module = 2 mm.

Fig.9 Sensing distance as a function of positional tolerance in the x-axis; typical values.



V_{CC} = 12 V; f_t = 2 kHz; module = 2 mm.

Fig.10 Sensing distance as a function of ambient temperature; typical values.

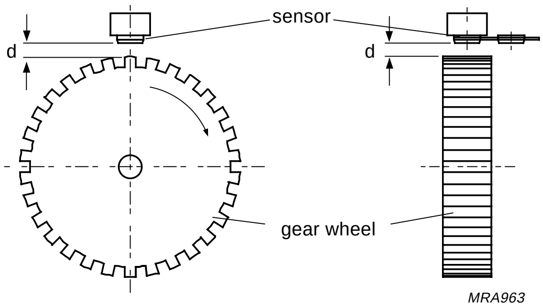
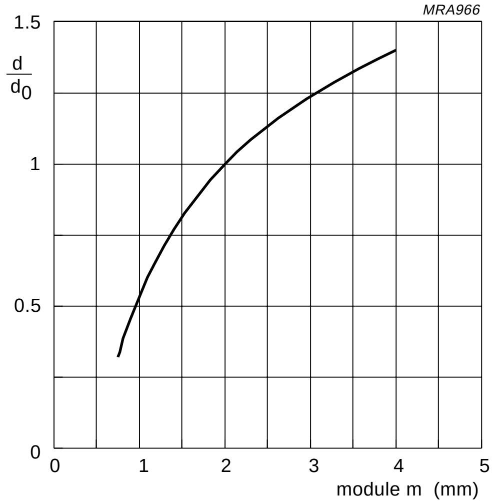
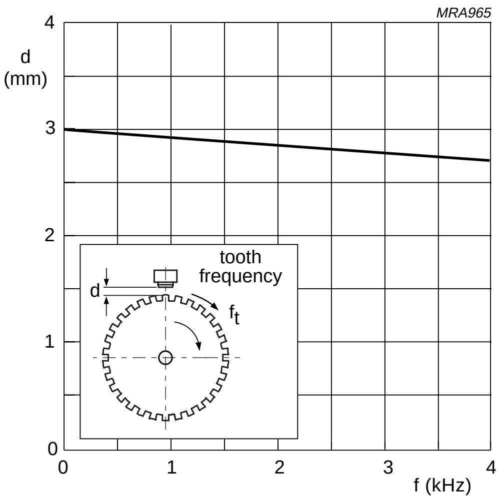


Fig.11 Sensor positioning.



d_o = measuring distance for a gear wheel with module m = 2 mm.

Fig.12 Normalized maximum sensing distance as a function of gear wheel module; typical values.

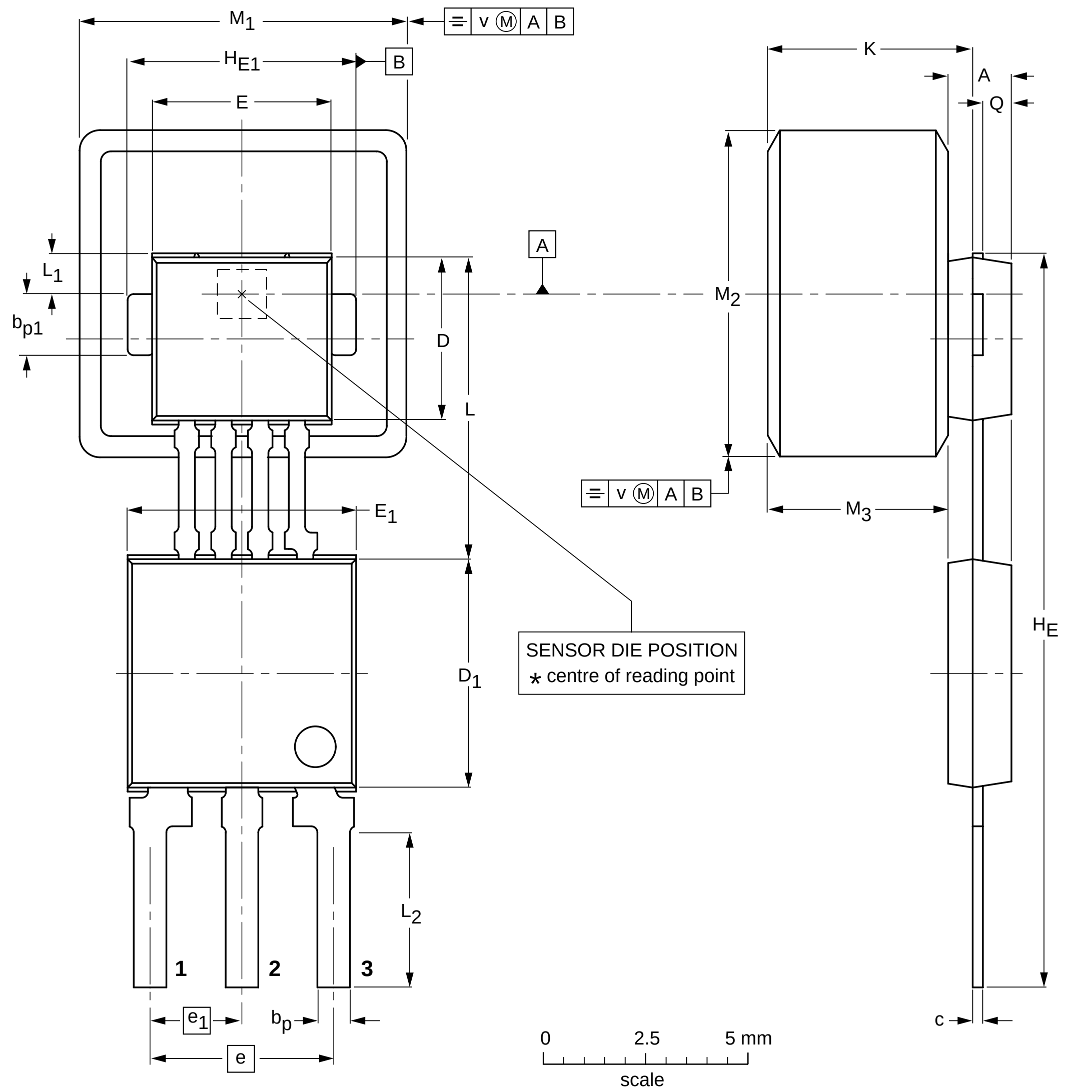


V_{CC} = 12 V; module = 2 mm.

Fig.13 Sensing distance as a function of tooth frequency; typical values.

PACKAGE OUTLINE

Plastic single-ended multi-chip package;
magnetized ferrite magnet (8 x 8 x 4.5 mm); 4 interconnections; 3 in-line leads **SOT477B**



DIMENSIONS (mm are the original dimensions)

UNIT	$A^{(1)}$	b_p	b_{p1}	c	$D^{(2)}$	$D_1^{(2)}$	$E^{(2)}$	$E_1^{(2)}$	e	e_1	H_E	H_{E1}	K max.	L	L_1	L_2	M_1	M_2	$M_3^{(1)}$	Q	v
mm	1.7 1.4	0.8 0.7	1.57 1.47	0.3 0.24	4.1 3.9	5.7 5.5	4.5 4.3	5.7 5.5	4.6 4.4	2.35 2.15	18.2 17.8	5.6 5.5	5.37	7.55 7.25	1.2 0.9	3.9 3.5	8.15 7.85	8.15 7.85	4.7 4.3	0.75 0.65	0.25

Notes

1. Glue thickness not included.
2. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT477B						~~99-09-23~~ 00-08-31

DATA SHEET STATUS

DATA SHEET STATUS	PRODUCT STATUS	DEFINITIONS [1]
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
Preliminary specification	Qualification	This data sheet contains preliminary data, and supplementary data will be published at a later date. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.
Product specification	Production	This data sheet contains final specifications. Philips Semiconductors reserves the right to make changes at any time without notice in order to improve design and supply the best possible product.

Note

1. Please consult the most recently issued data sheet before initiating or completing a design.

DEFINITIONS

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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