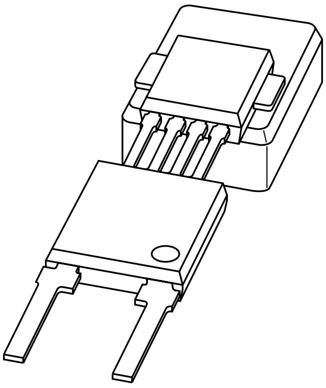
DATA SHEET



KMI15/4
Rotational speed sensor

Product specification
Supersedes data of 2000 Jun 26

2000 Sep 05

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FEATURES

- Digital current output signal
- Zero speed capability
- Wide air gap
- Wide temperature range
- Vibration insensitive
- EMC resistant.

DESCRIPTION

The KMI15/4 sensor detects rotational speed of ferrous gear wheels and reference marks(1).
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 a gear wheel.

CAUTION
Do not press two or more products together against their magnetic forces.

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(1) The sensor contains a customized integrated circuit. Usage in hydraulic brake systems and in systems with active brake control is forbidden. For all other applications, higher temperature versions of up to 150 °C are available on request.

PINNING

PIN	DESCRIPTION
1	V_{CC}
2	V–

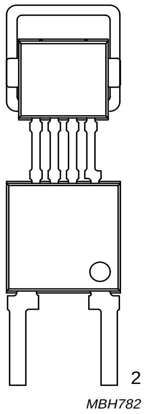


Fig.1 Simplified outline (SOT453C).

QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V_{CC}	DC supply voltage	–	12	–	V
T_{amb}	ambient operating temperature	–40	–	+85	°C
$I_{CC\ (low)}$	current output signal low	–	7	–	mA
$I_{CC\ (high)}$	current output signal high	–	14	–	mA
f_t	operating tooth frequency	0	–	25000	Hz
d	sensing distance	0 to 2.0	0 to 2.3	–	mm

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	DC supply voltage	T_{amb} = –40 to +85 °C; R_L = 115 Ω	–0.5	+16	V
T_{stg}	storage temperature		–40	+150	°C
T_{amb}	operating ambient temperature		–40	+85	°C
T_{sld}	soldering temperature	t ≤ 10 s	–	260	°C
	output short-circuit duration to GND		continuous		

CHARACTERISTICS

T_{amb} = 25 °C; V_{CC} = 12 V; d = 1.5 mm; f_t = 2 kHz; test circuit: see Fig.7; R_L = 115 Ω; sensor positioning: see Fig.15; gear wheel: module 2 mm; material 1.0715; unless otherwise specified.

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{CC\ (low)}$	current output signal low	see Figs 6 and 8	5.6	7	8.4	mA
$I_{CC\ (high)}$	current output signal high	see Figs 6 and 8	11.2	14	16.8	mA
t_r	output signal rise time	C_L = 100 pF; see Fig.9; 10 to 90% value	–	0.5	–	µs
t_f	output signal fall time	C_L = 100 pF; see Fig.9; 10 to 90% value	–	0.7	–	µs
t_d	switching delay time	between stimulation pulse (generated by a coil) and output signal	–	1	–	µs
f_t	operating tooth frequency	for both rotation directions	0	–	25000	Hz
d	sensing distance	see Fig.15 and note 1	0 to 2.0	0 to 2.3	–	mm
δ	duty cycle	see Fig.6	20	50	80	%

Note

1. High rotational speeds of wheels reduce the sensing distance due to eddy current effects (see Fig.17).

FUNCTIONAL DESCRIPTION

The KMI15/4 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 KMI15/4 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 (Figs 4 and 5).
The digital output signal level (see Fig.6) is at a fixed level independent of the sensing distance. A (2-wire) output current enables safe sensor signal transport to the detecting circuit (see Fig.7). The integrated circuit housing is separated from the sensor element housing to optimize the sensor behaviour at high temperatures.

The strength of the magnetic field caused by the Ferroxdure 100 magnet in the different sensor directions, measured at the centre of the magnetoresistive bridge, is typically: H_x = 7 kA/m (auxiliary field) and H_z = 17 kA/m (perpendicular to the sensor surface). H_y is zero due to the trimming process.

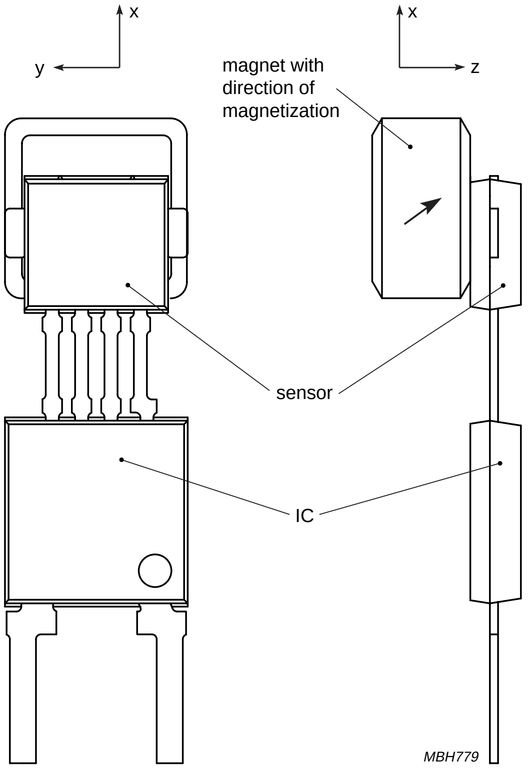
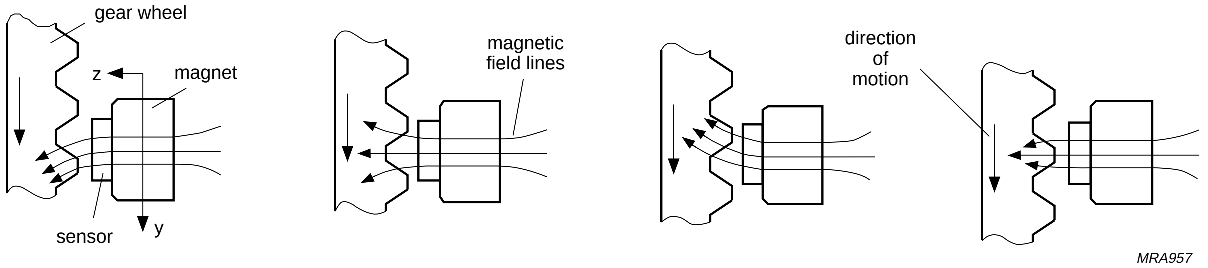


Fig.2 Component detail of the KMI15/4.



(a) (b) (c) (d)

Fig.3 Functional principle.

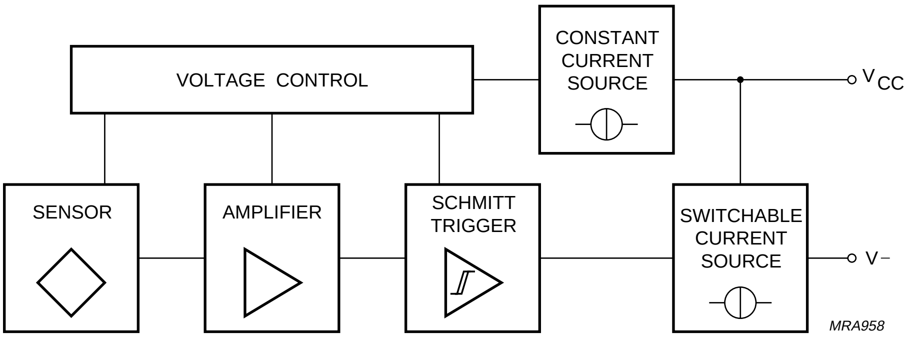


Fig.4 Block diagram.

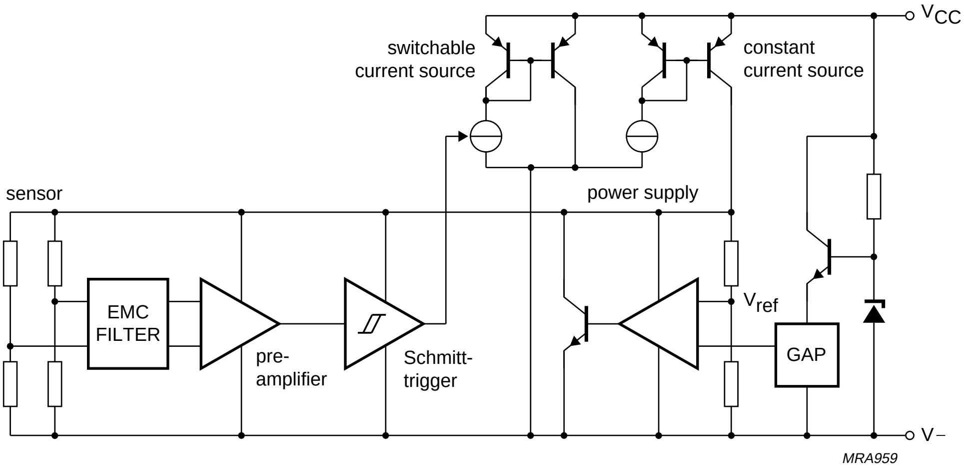
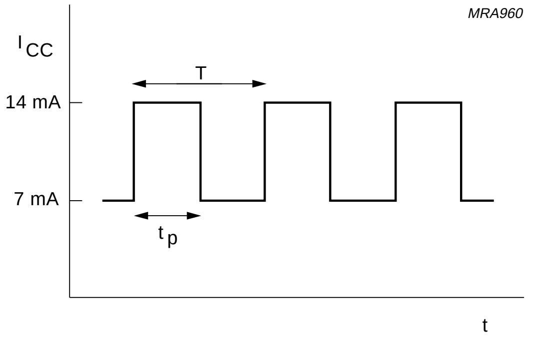


Fig.5 Simplified circuit diagram.



$$\delta = \frac{t_p}{T} \times 100\%$$

Fig.6 Output signal as a function of time.

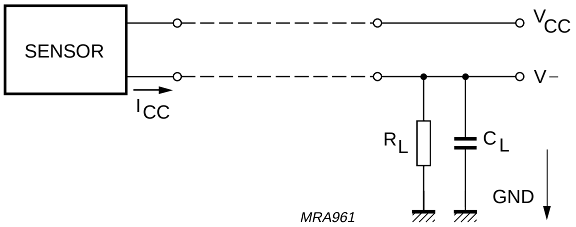


Fig.7 Test and application circuit.

APPLICATION INFORMATION

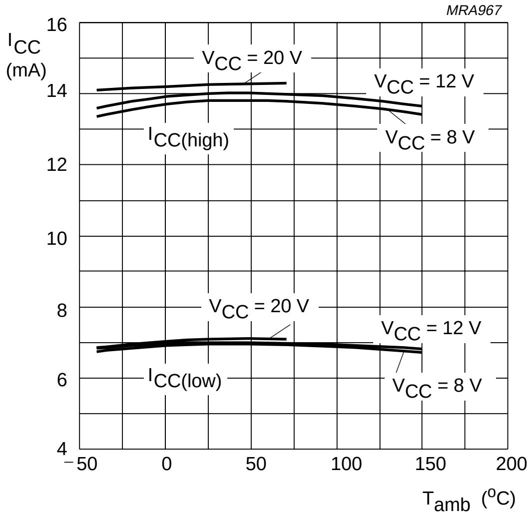


Fig.8 Output current levels as functions of ambient temperature; typical values.

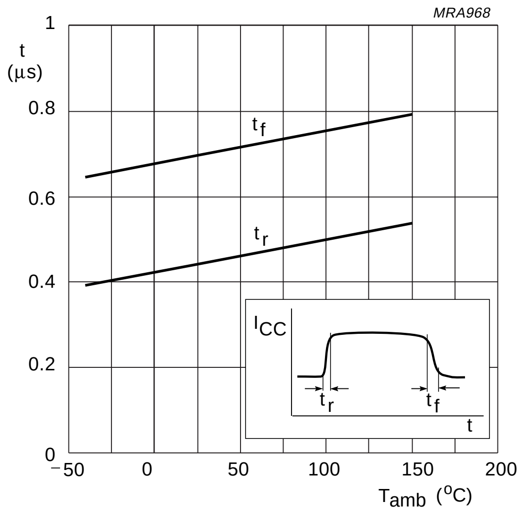


Fig.9 Output current switching times as functions of ambient temperature; typical values.

Mounting conditions

The recommended sensor position in front of a gear wheel is shown in Fig.15. Distance ‘d’ is measured between the sensor front and the tip of a gear wheel tooth. The KMI15/4 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 11, 12 and 13.
The symmetrical reference axis of the sensor corresponds to the axis of the ferrite magnet.

Environmental conditions

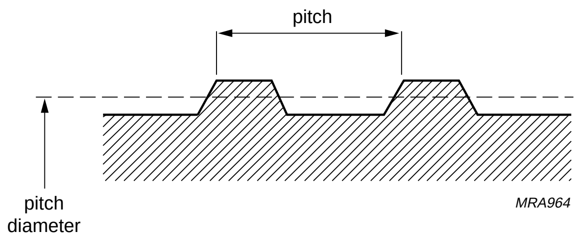
Due to eddy current effects the sensing distance depends on the tooth frequency (see Fig.17). The influence of gear wheel module on the sensing distance is shown in Fig.16.

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; note1		
PD	pitch diameter (d in inch)	inch
DP	diametric pitch DP = z/PD	inch^{-1}
CP	circular pitch CP = π/DP	inch

Note

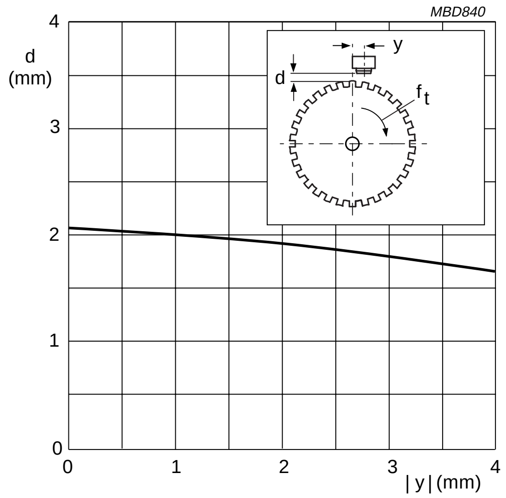
1. For conversion from ASA to DIN: m = 25.4 mm/DP; p = 25.4 mm × CP.



$$\text{module} = \frac{\text{pitch diameter}}{\text{number of teeth}}$$

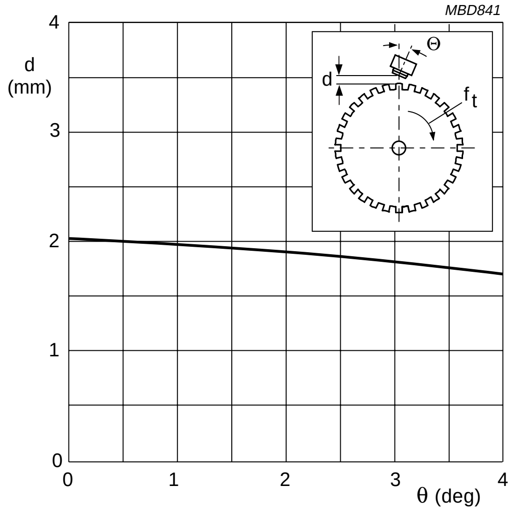
pitch = module $\times \pi$

Fig.10 Gear wheel dimensions.



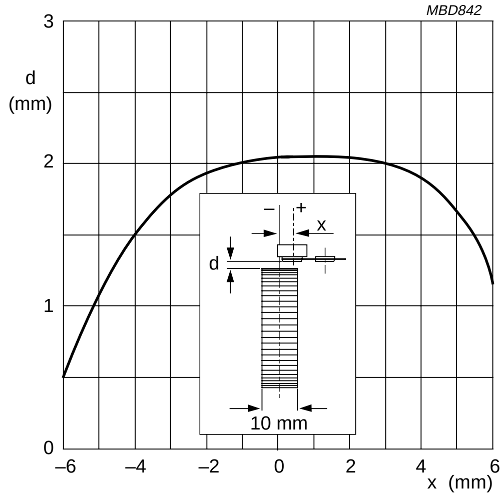
V_{CC} = 12 V; f_t = 2 kHz; module = 2 mm; pitch diameter = 100 mm.

Fig.11 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.12 Sensing distance as a function of positional tolerance; typical values.



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

Fig.13 Sensing distance as a function of positional tolerance in the x-axis; typical values.

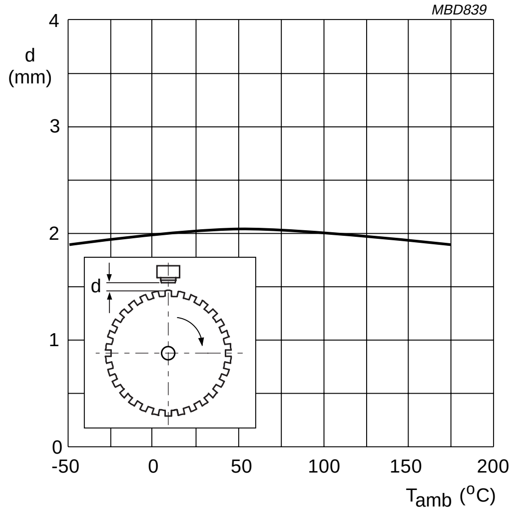


Fig.14 Typical sensing distance as a function of ambient temperature; typical values.

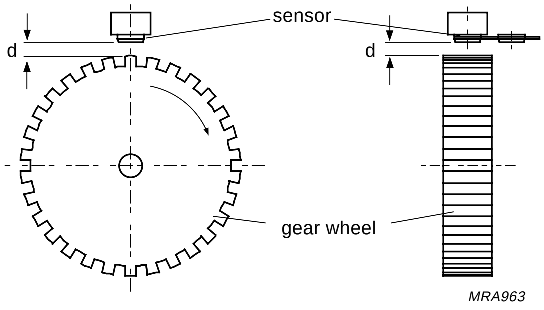
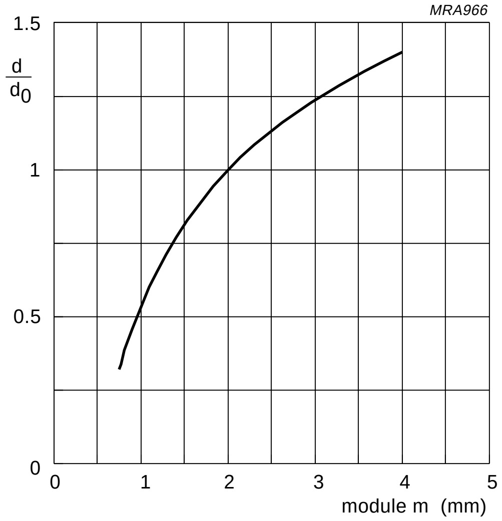
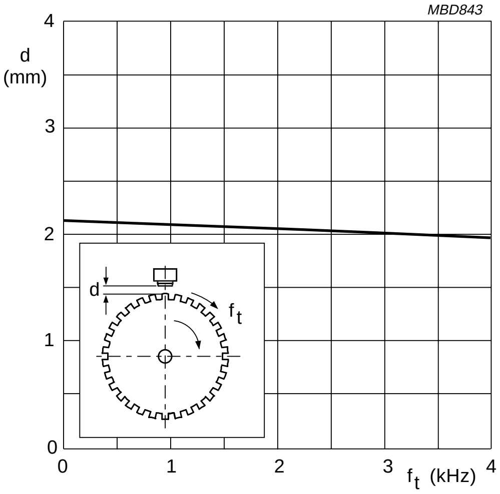


Fig.15 Sensor positioning.



d_0 = sensing distance for gear wheel with module = 2 mm.

Fig.16 Normalized maximum sensing distance as a function of a gear wheel module; typical values.



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

Fig.17 Sensing distance as a function of tooth frequency; typical values.

EMC

Figure 18 shows a recommended application circuit for automotive applications (wheel sensing $f_t < 5$ kHz).
It provides a protection interface to meet Electromagnetic Compatibility (EMC) standards and safeguard against voltage spikes Table 1 lists the tests which are applicable to this circuit and the achieved class of functional status. Protection against ‘load dump’ (test pulse 5 according to *“DIN 40839”*) means a very high demand on the protection circuit and requires a suitable suppressor diode with sufficient energy absorption capability.

The board net often contains a central load dump protection that makes such a device in the protection circuit of the sensor module unnecessary.

Tests for electrostatic discharge (ESD) were conducted in line with *“IEC 801-2”* to demonstrate the KMI15/4’s handling capabilities. The *“IEC 801-2”* test conditions were: C = 150 pF, R = 150 Ω, V = 2 kV.

Electromagnetic disturbances with fields up to 150 V/m and f = 1 GHz (ref. *“DIN 40839”*) have no influence on performance.

Table 1 EMC test results

EMC REF. DIN 40839	SYMBOL	MIN. (V)	MAX. (V)	REMARKS	CLASS
Test pulse 1	V_{LD}	–100	–	t_d = 2 ms	C
Test pulse 2	V_{LD}	–	100	t_d = 0.2 ms	A
Test pulse 3a	V_{LD}	–150	–	t_d = 0.1 μs	A
Test pulse 3b	V_{LD}	–	100	t_d = 0.1 μs	A
Test pulse 4	V_{LD}	–7	–	t_d = 130 ms	B
Test pulse 5	V_{LD}	–	120	t_d = 400 ms	B

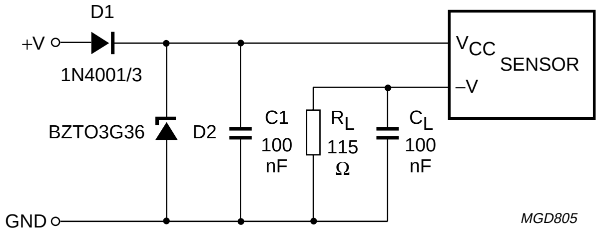
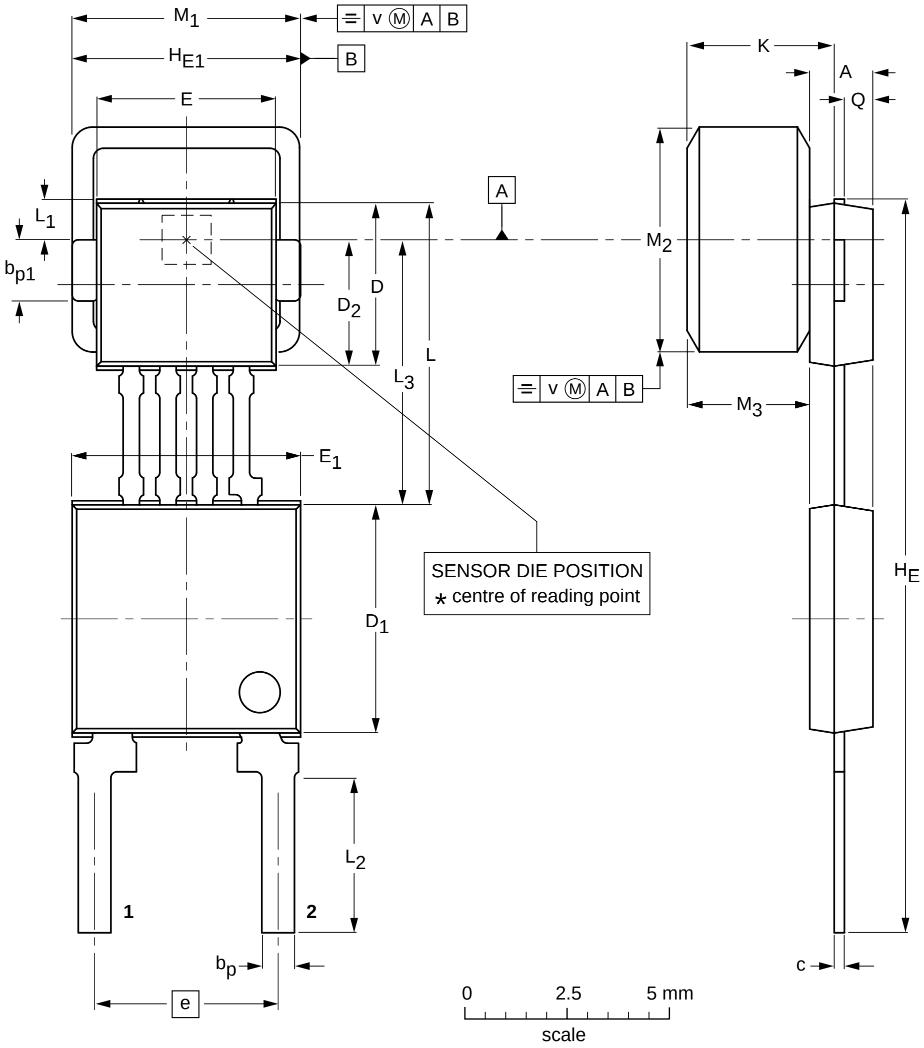


Fig.18 Test/application circuit for the KMI15/4.

PACKAGE OUTLINE

Plastic single-ended multi-chip package; magnetized ferrite magnet (5.5 x 5.5 x 3 mm); 4 interconnections; 2 in-line leads **SOT453C**



DIMENSIONS (mm are the original dimensions)

UNIT	$A^{(1)}$	b_p	b_{p1}	c	$D^{(2)}$	$D_1^{(2)}$	$D_2^{(2)}$	$E^{(2)}$	$E_1^{(2)}$	e	H_E	H_{E1}	K max.	L	L_1	L_2	L_3	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	3.15 2.95	4.5 4.3	5.7 5.5	4.6 4.4	18.2 17.8	5.6 5.5	3.87	7.55 7.25	1.2 0.9	3.9 3.5	6.55 6.35	5.65 5.35	5.65 5.35	3.15 2.85	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			
SOT453C						~~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.

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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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