DATA SHEET

KMI15/4
Rotational speed sensor

Preliminary specification
File under Discrete Semiconductors, SC17

1996 Dec 05

Philips
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Rotational speed sensor KMI15/4

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.

(1) The sensor contains a customized integrated circuit. Usage in hydraulic brake systems and in systems with active brake control is forbidden.

PINNING

PIN	DESCRIPTION
1	V_{CC}
2	V–

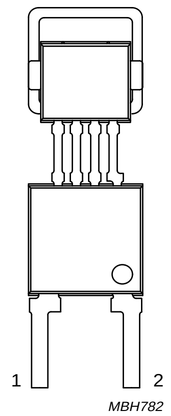


Fig.1 Simplified outline; (SOT453C).

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

Rotational speed sensor KMI15/4

LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V_{CC}	DC supply voltage	T_{amb} = –40 to +85 °C; R_L = 115 Ω	–	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; note 1		

Note

1. With R_L = 115 Ω the device is continuously protected against wrong polarity of DC supply voltage (V_{CC}) to GND (see Fig.7).

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	7.0	8.4	mA
$I_{CC\ (high)}$	current output signal high	see Figs 6 and 8	11.2	14.0	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 ensables 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.

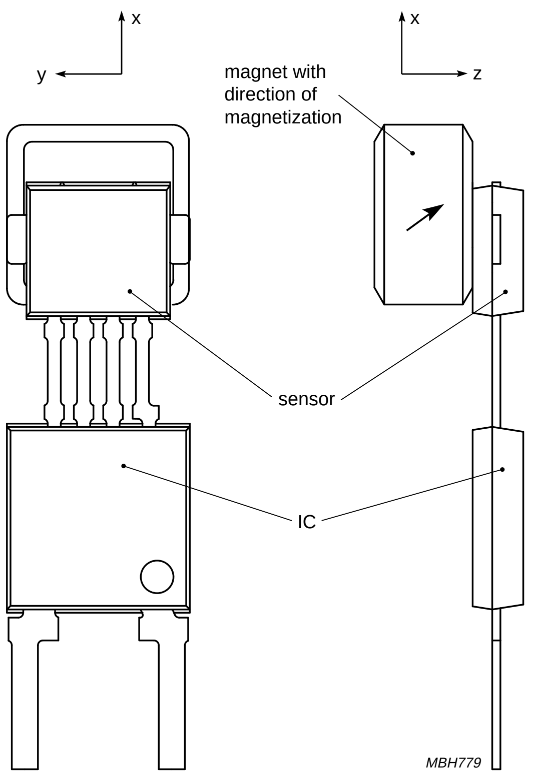


Fig.2 Component detail of the KMI15/4.

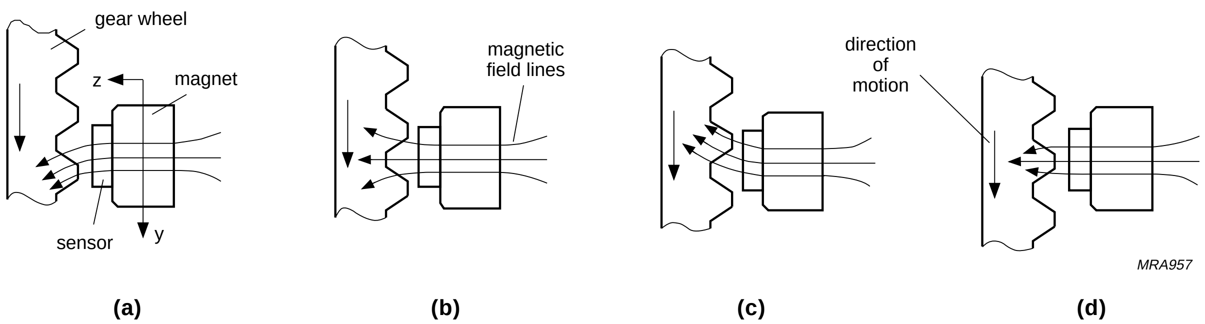


Fig.3 Functional principle.

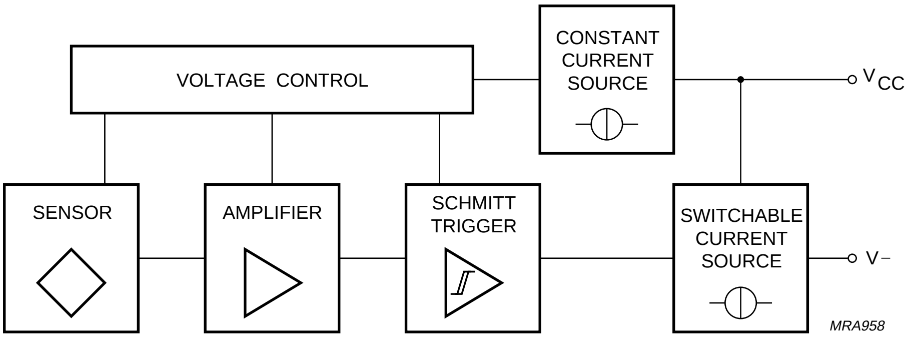


Fig.4 Block diagram.

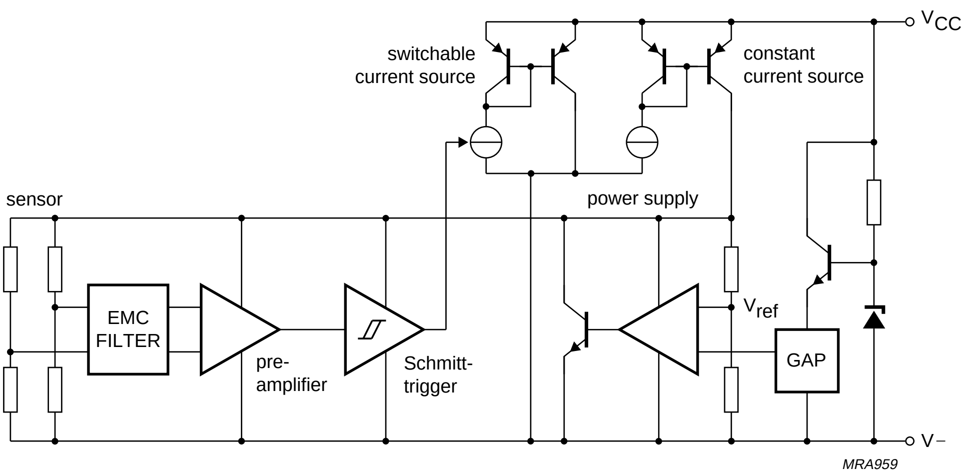
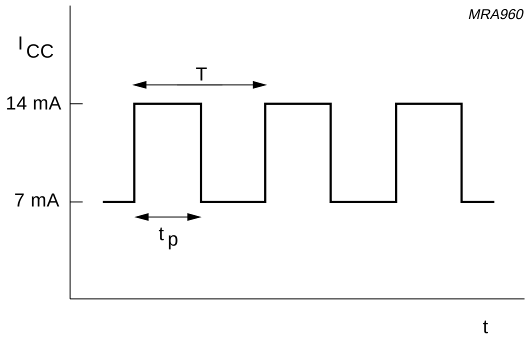


Fig.5 Simplified circuit diagram.



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

Fig.6 Output signal as a function of time.

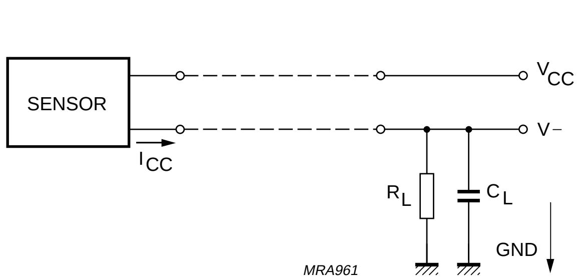


Fig.7 Test and application circuit.

APPLICATION INFORMATION

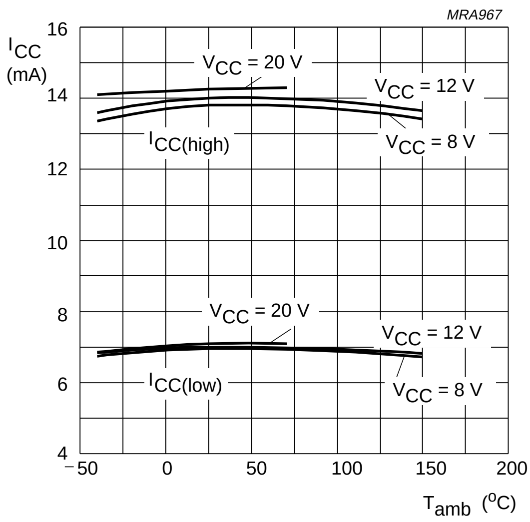


Fig.8 Output current levels as functions of ambient temperature.

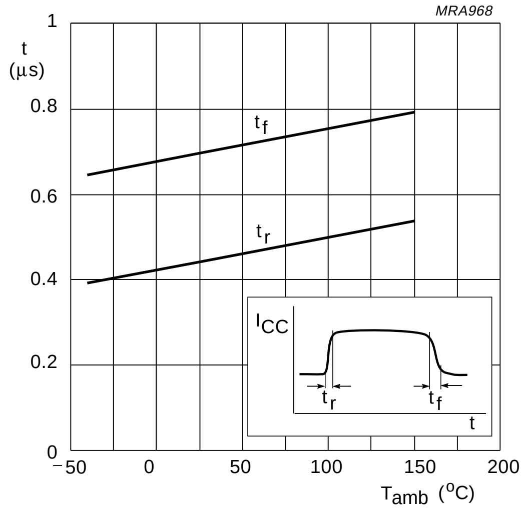


Fig.9 Output current switching times as functions of ambient temperature.

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

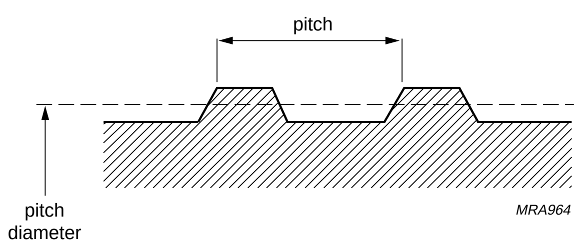
Due to eddy current effects the sensing distance depends on the tooth frequency (see Fig.17). The influence of gear wheel module on the sensing distance is shown in Fig.16.

Gear Wheel Dimensions

SYMBOL	DESCRIPTION	UNIT
German DIN		
z	number of teeth	
d	diameter	mm
m	module m = d/z	mm
p	pitch p = π × 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

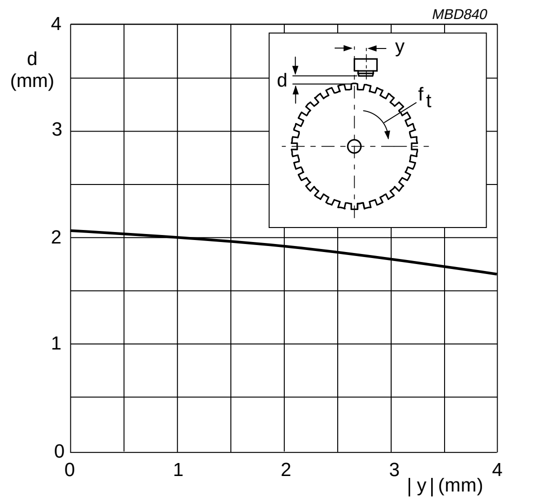
1. For conversion from ASA to DIN: m = 25.4 mm/DP; p = 25.4 mm × CP.



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

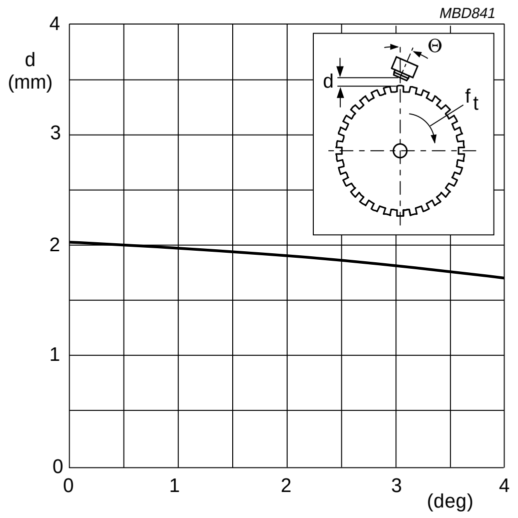
pitch = module × π

Fig.10 Gear wheel dimensions.



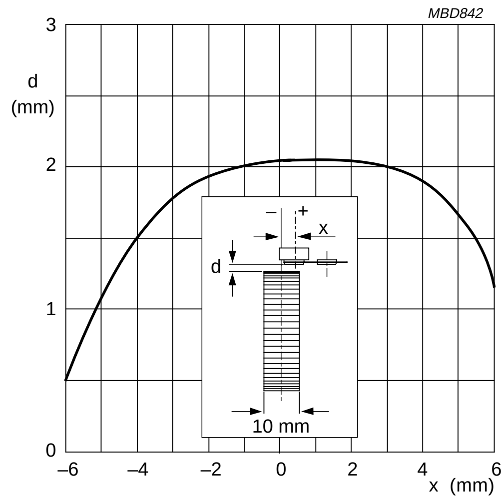
V_{CC} = 12 V; f_t = 2 kHz; module = 2 mm; pitch diameter = 100 mm.

Fig.11 Sensing distance as a function of positional tolerance in the y-axis.



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

Fig.12 Sensing distance as a function of positional tolerance.



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.

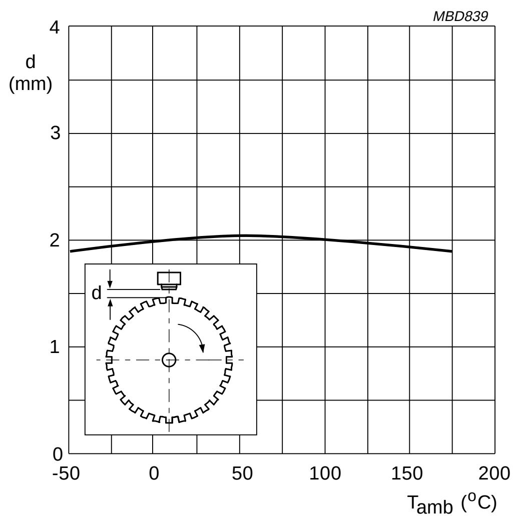


Fig.14 Typical sensing distance as a function of ambient temperature.

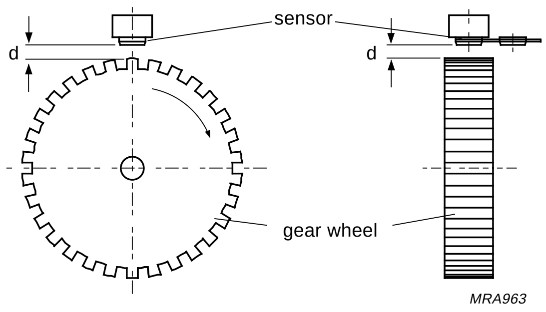
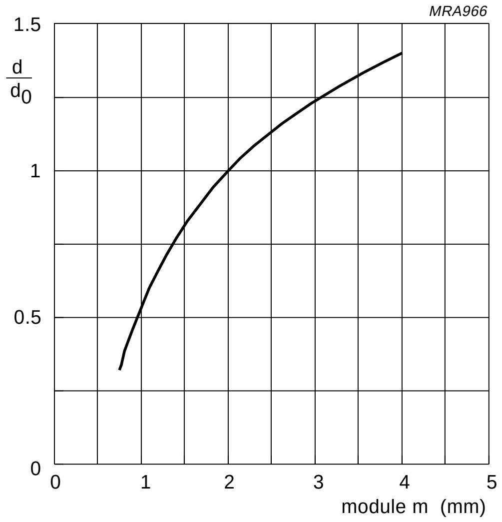
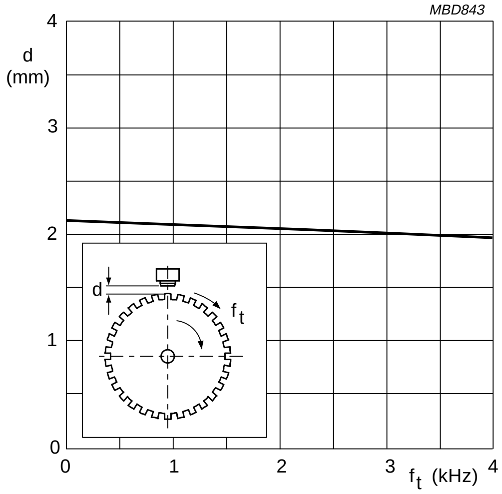


Fig.15 Sensor positioning.



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.



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

Fig.17 Sensing distance as a function of tooth frequency.

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

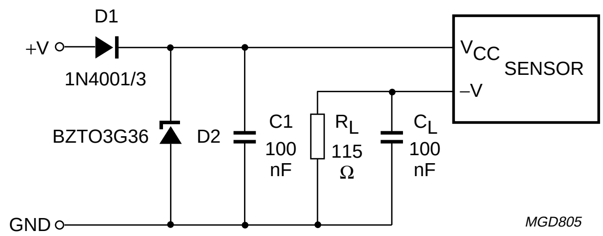
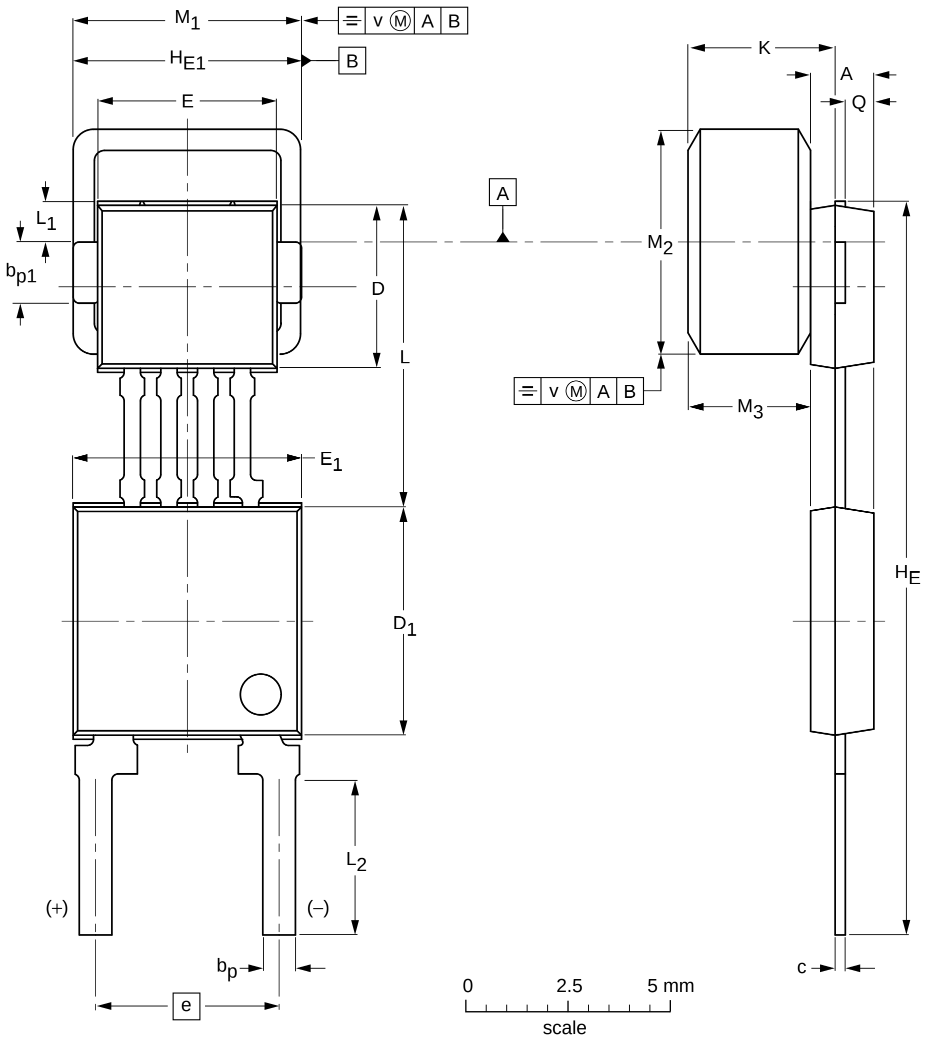


Fig.18 Test/application circuit for the KMI15/4.

PACKAGE OUTLINE

Package description **SOT453C**



DIMENSIONS (mm are the original dimensions)

UNIT	A	b_p	b_{p1}	c	$D^{(1)}$	$D_1^{(1)}$	$E^{(1)}$	$E_1^{(1)}$	e	H_E	H_{E1}	K max.	L	L_1	L_2	M_1	M_2	M_3	Q	v
mm	1.7 1.4	0.8 0.7	1.5 1.4	0.3 0.24	4.1 3.9	5.7 5.5	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	5.65 5.35	5.65 5.35	3.15 2.85	0.75 0.65	0.25

Note

1. 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						96-11-12

DEFINITIONS

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

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SCA52

Printed in The Netherlands 147021/1200/01/pp16 Date of release: 1996 Dec 05 Document order number: 9397 750 01314

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SUNSTAR商斯达实业集团是集研发、生产、工程、销售、代理经销 、技术咨询、信息服务等为一体的高科技企业，是专业高科技电子产品生产厂家，是具有 10 多年历史的专业电子元器件供应商，是中国最早和最大的仓储式连锁规模经营大型综合电子零部件代理分销商之一,是一家专业代理和分銷世界各大品牌IC芯片和電子元器件的连锁经营綜合性国际公司。在香港、北京、深圳、上海、西安、成都等全国主要电子市场设有直属分公司和产品展示展销窗口门市部专卖店及代理分销商，已在全国范围内建成强大统一的供货和代理分销网络。 我们专业代理经销、开发生产电子元器件、集成电路、传感器、微波光电元器件、工控机/DOC/DOM电子盘、专用电路、单片机开发、MCU/DSP/ARM/FPGA软件硬件、二极管、三极管、模块等，是您可靠的一站式现货配套供应商、方案提供商、部件功能模块开发配套商。**专业以现代信息产业（计算机、通讯及传感器）三大支柱之一的传感器为主营业务，专业经营各类传感器的代理、销售生产、网络信息、科技图书资料及配套产品设计、工程开发。我们的专业网站——中国传感器科技信息网（全球传感器数据库） www.SENSOR-IC.COM 服务于全球高科技生产商及贸易商，为企业科技产品开发提供技术交流平台。欢迎各厂商互通有无、交换信息、交换链接、发布寻求代理信息。欢迎国外高科技传感器、变送器、执行器、自动控制产品厂商介绍产品到 中国，共同开拓市场。**本网站是关于各种传感器-变送器-仪器仪表及工业自动化大型专业网站,深入到工业控制、系统工程计 测计量、自动化、安防报警、消费电子等众多领域，把最新的传感器-变送器-仪器仪表买卖信息,最新技术供求,最新采购商,行业动态，发展方向，最新的技术应用和市场资讯及时的传递给广大科技开发、科学研究、产品设计人员。本网站已成功为石油、化工、电力、医药、生物、航空、航天、国防、能源、冶金、电子、工业、农业、交通、汽车、矿山、煤炭、纺织、信息、通信、IT、安防、环保、印刷、科研、气象、仪器仪表等领域从事科学研究、产品设计、开发、生产制造的科技人员、管理人员 、和采购人员提供满意服务。 **我公司专业开发生产、代理、经销、**销售各种传感器、变送器、敏感元器件、开关、执行器、仪器仪表、自动化控制系统： 专门从事设计、生产、销售各种传感器、变送器、各种测控仪表、热工仪表、现场控制器、计算机控制系统、数据采集系统、各类环境监控系统、专用控制系统应用软件以及嵌入式系统开发及应用等工作。如热敏电阻、压敏电阻、温度传感器、温度变送器、湿度传感器、 湿度变送器、气体传感器、 气体变送器、压力传感器、 压力变送、称重传感器、物（液）位传感器、物（液）位变送器、流量传感器、 流量变送器、电流（压）传感器、溶氧传感器、霍尔传感器 、图像传感器、超声波传感器、位移传感器、速度传感器、加速度传感器、扭距传感器、红外传感器、紫外传感器、 火焰传感器、激光传感器、振动传感器、轴角传感器、光电传感器、接近传感器、干簧管传感器、继电器传感器、微型电泵、磁敏（阻）传感器 、压力开关、接近开关、光电开关、色标传感器、光纤传感器、齿轮测速传感器、 时间继电器、计数器、计米器、温控仪、固态继电器、调压模块、电磁铁、电压表、电流表等特殊传感器 。 同时承接传感器应用电路、产品设计和自动化工程项目。

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