

DATA SHEET

KMI15/1 Integrated rotational speed sensor

Preliminary specification
File under Discrete Semiconductors, SC17

1996 Dec 05

Integrated rotational speed sensor

KMI15/1

FEATURES

- Digital current output signal
- Zero speed capability
- Wide air gap
- Wide temperature range
- Insensitive to vibration
- EMC resistant.

DESCRIPTION

The KMI15/1 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 magnetized ferrite magnet. The frequency of the digital current output signal is proportional to the rotational speed of a gear wheel.

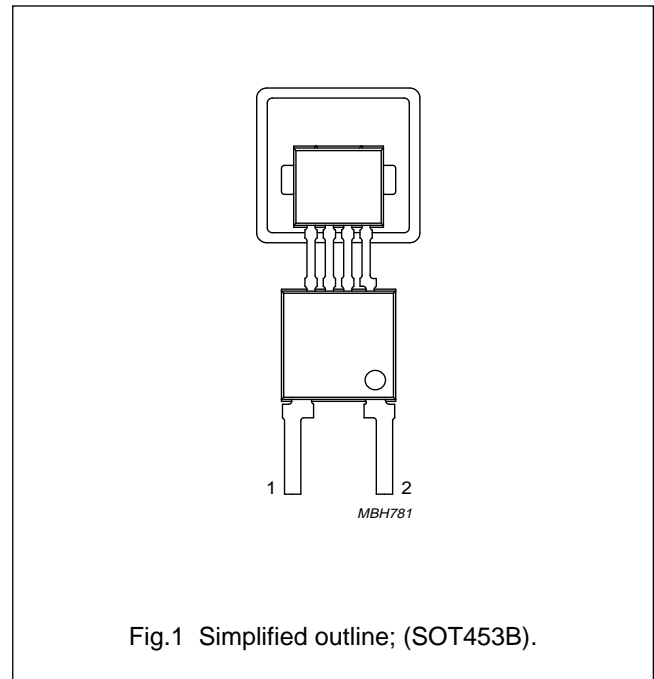
CAUTION

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 ₋



QUICK REFERENCE DATA

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V _{CC}	DC supply voltage	–	12	–	V
I _{CC (low)}	current output signal low	–	7	–	mA
I _{CC (high)}	current output signal high	–	14	–	mA
d	sensing distance	0 to 2.5	0 to 2.9	–	mm
f _t	operating tooth frequency	0	–	25000	Hz
T _{amb}	ambient operating temperature	–40	–	+85	°C

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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}	ambient operating temperature		–40	+85	°C
T_{sld}	soldering temperature	$t \leq 10$ 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; $d = 2.1$ 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	–	μ s
t_f	output signal fall time	$C_L = 100$ pF; see Fig.9; 10 to 90% value	–	0.7	–	μ s
t_d	switching delay time	between stimulation pulse (generated by a coil) and output signal	–	1	–	μ s
f_t	operating tooth frequency	for both rotation directions	0	–	25000	Hz
d	sensing distance	see Fig.15 and note 1	0 to 2.5	0 to 2.9	–	mm
δ	duty cycle	see Fig.6	30	50	70	%

Note

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

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FUNCTIONAL DESCRIPTION

The KMI15/1 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 magneto-resistive sensor element will cause an electrical signal. Because of the chosen sensor orientation and the direction of ferrite magnetization, the KMI15/1 is sensitive to movement in the 'y' direction in front of the sensor only (see Fig.2).

The magneto-resistive 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 independent of the sensing distance within the measuring range (Fig.14). A (2-wire) output current enables safe transfer of the sensor signal 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.

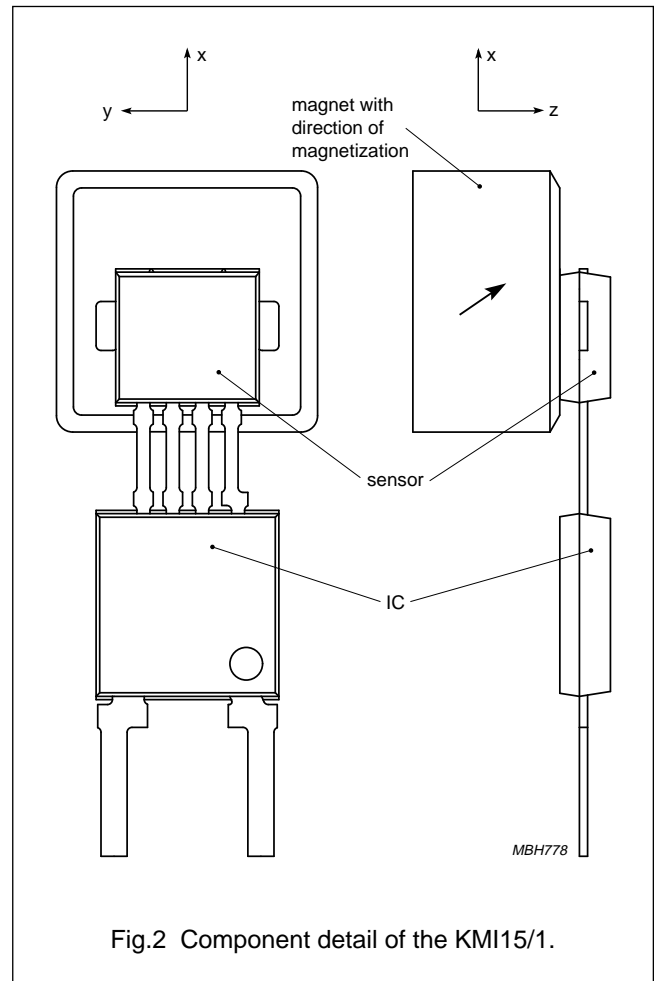


Fig.2 Component detail of the KMI15/1.

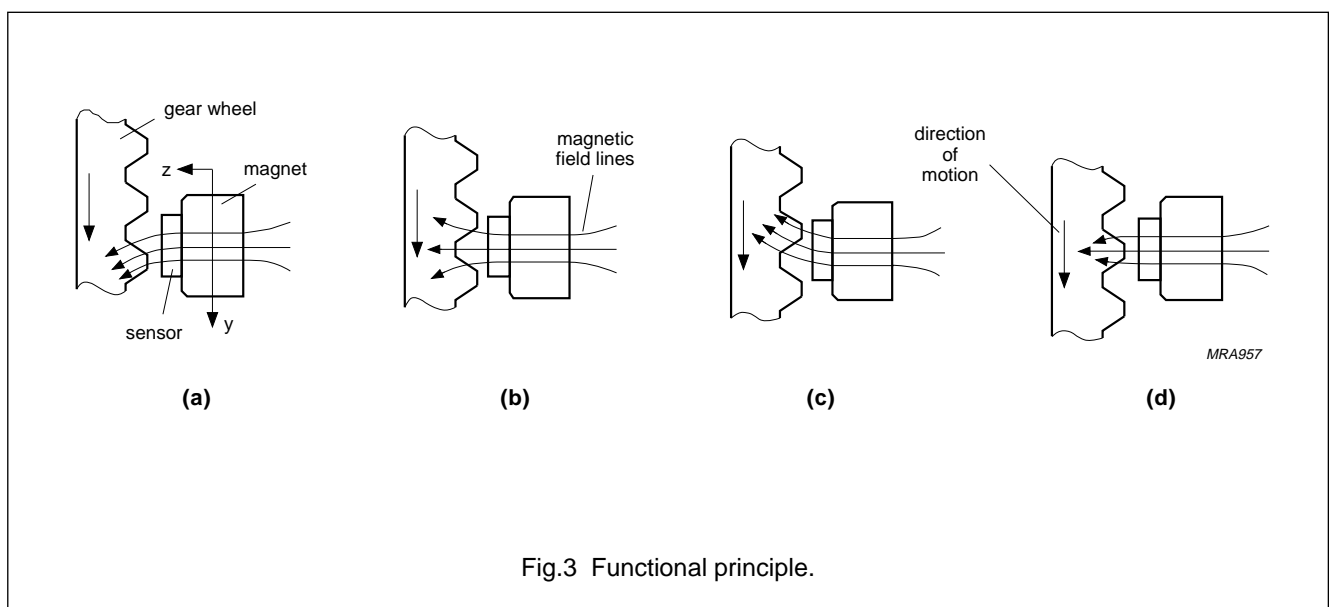


Fig.3 Functional principle.

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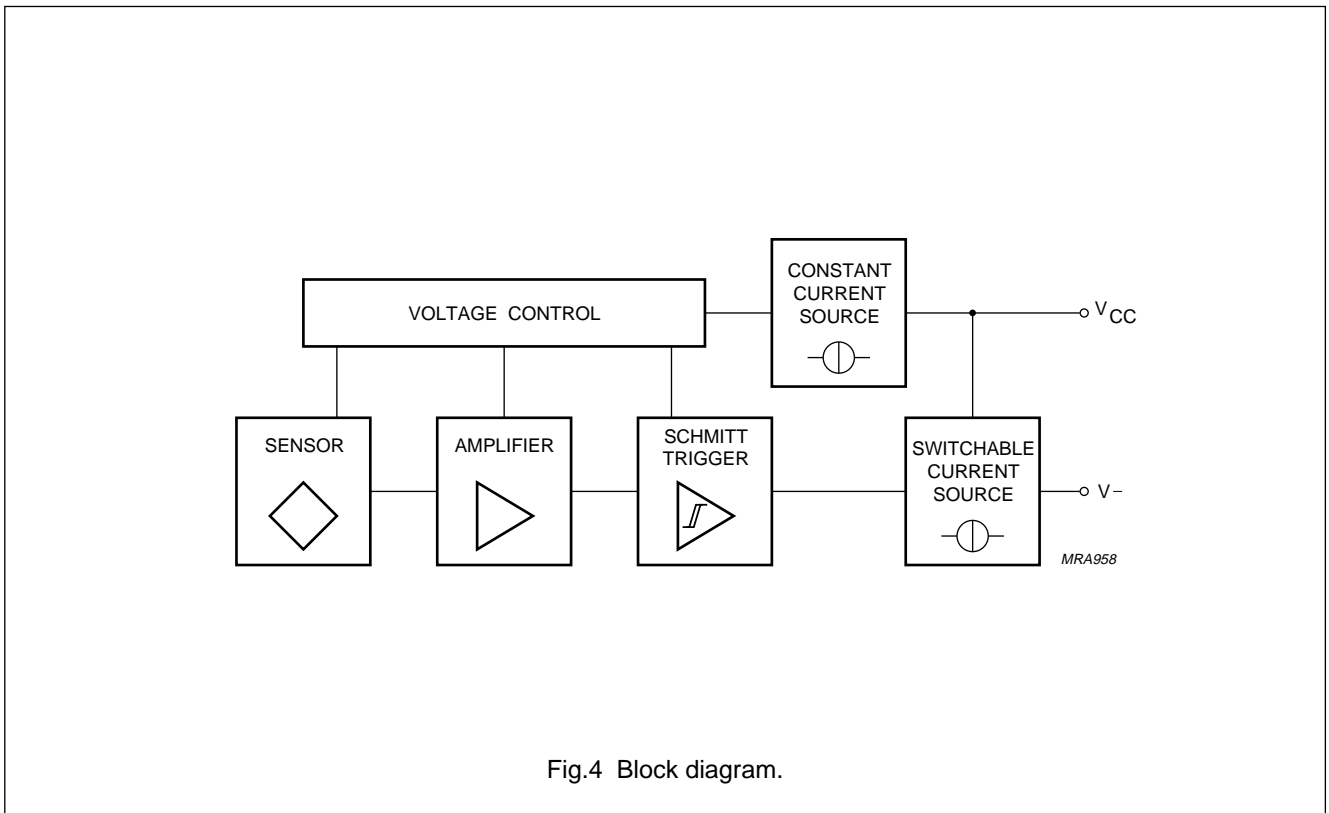


Fig.4 Block diagram.

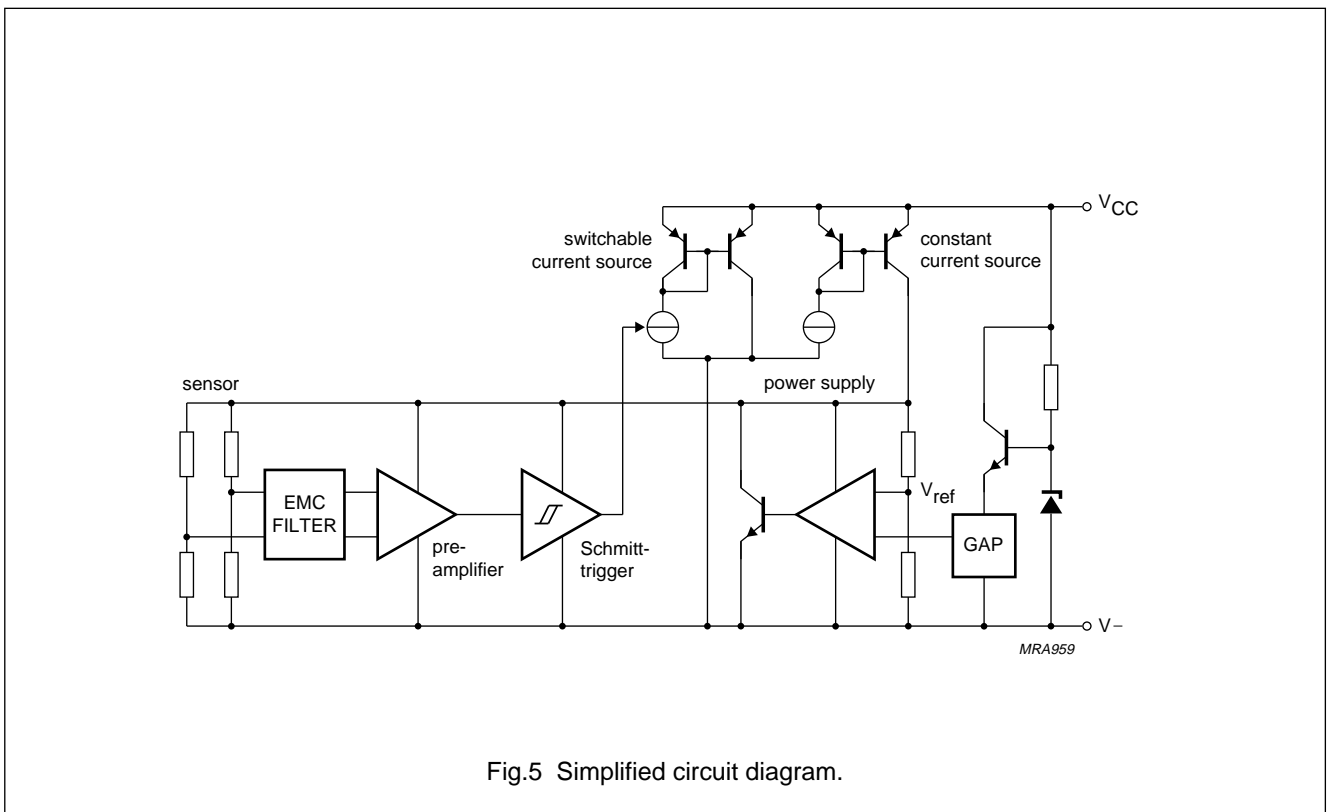
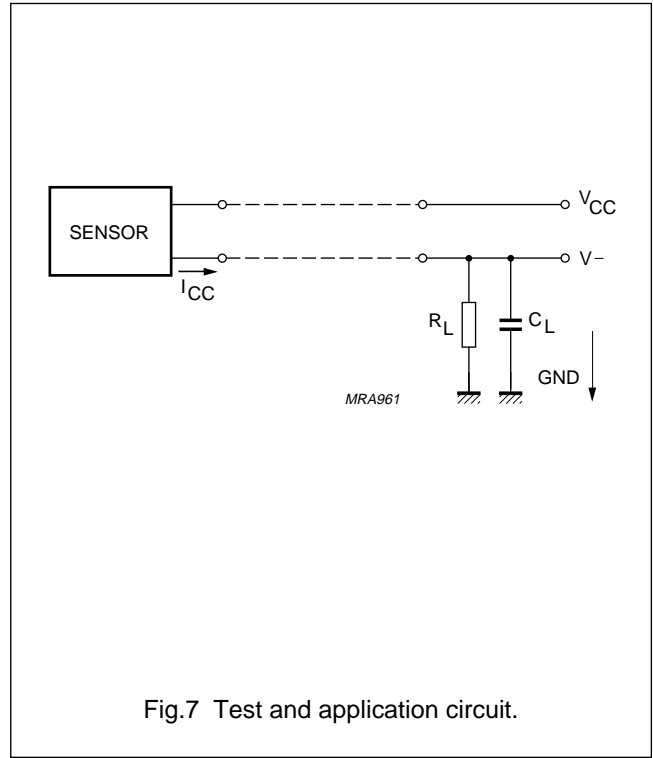
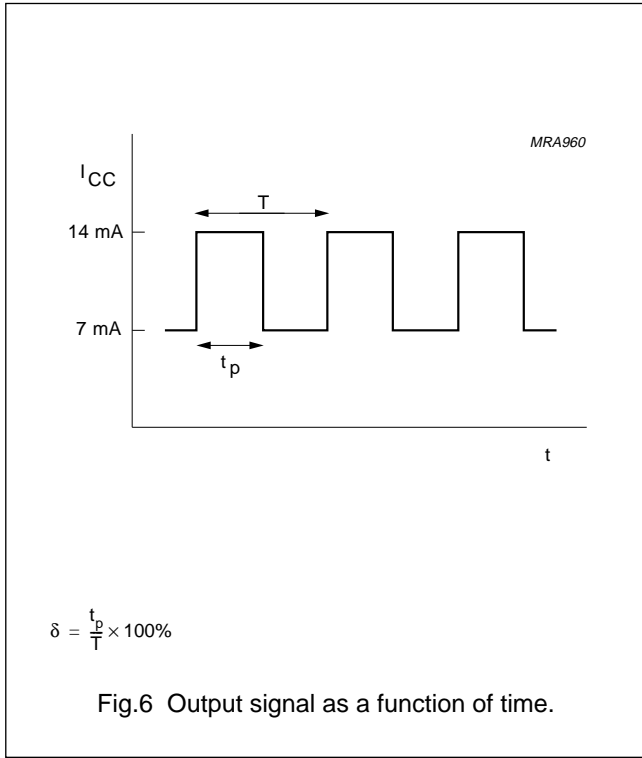


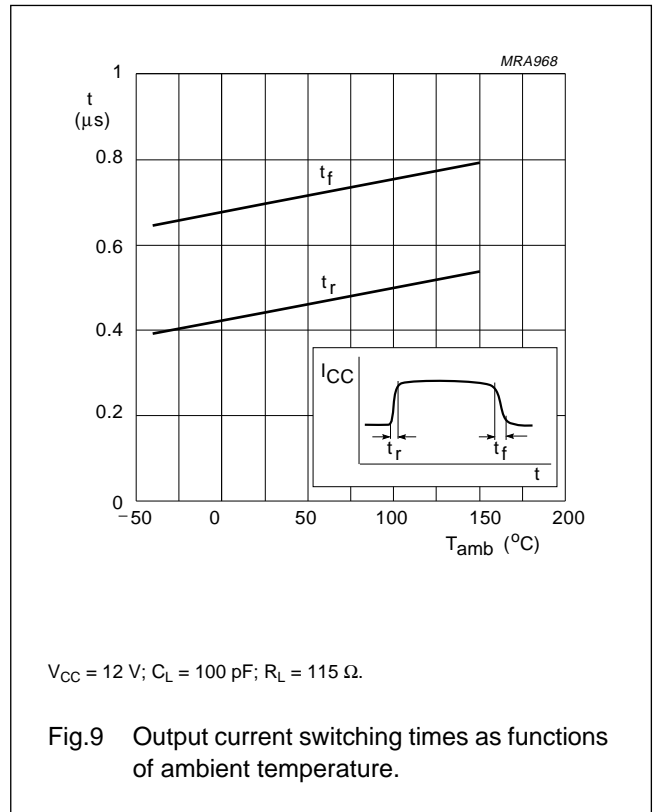
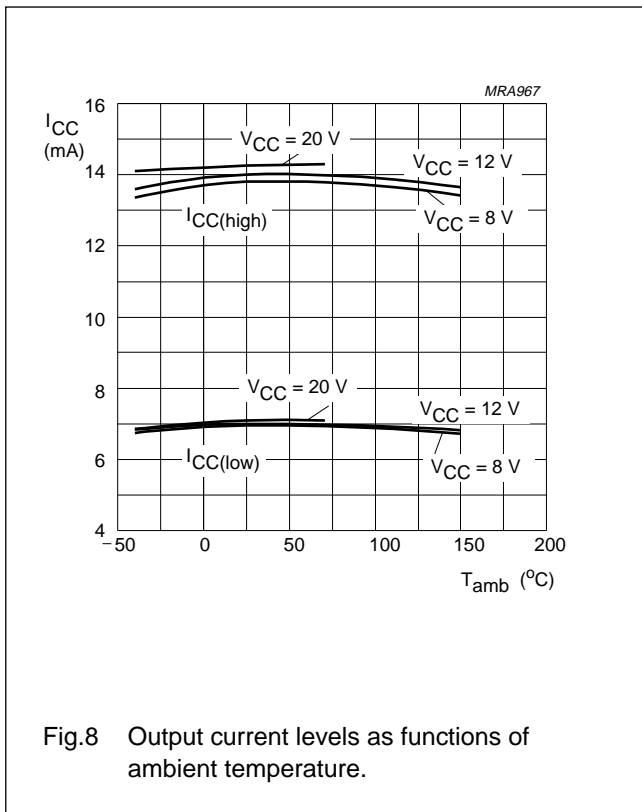
Fig.5 Simplified circuit diagram.

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APPLICATION INFORMATION



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Mounting conditions

The recommended sensor position in front of a gear wheel is shown in Fig.15. The distance 'd' is measured between the sensor front and the tip of a gear wheel tooth. The KMI15/1 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 11, 12 and 13. The symmetrical reference axis of the sensor corresponds to the axis of the ferrite magnet.

Environmental conditions

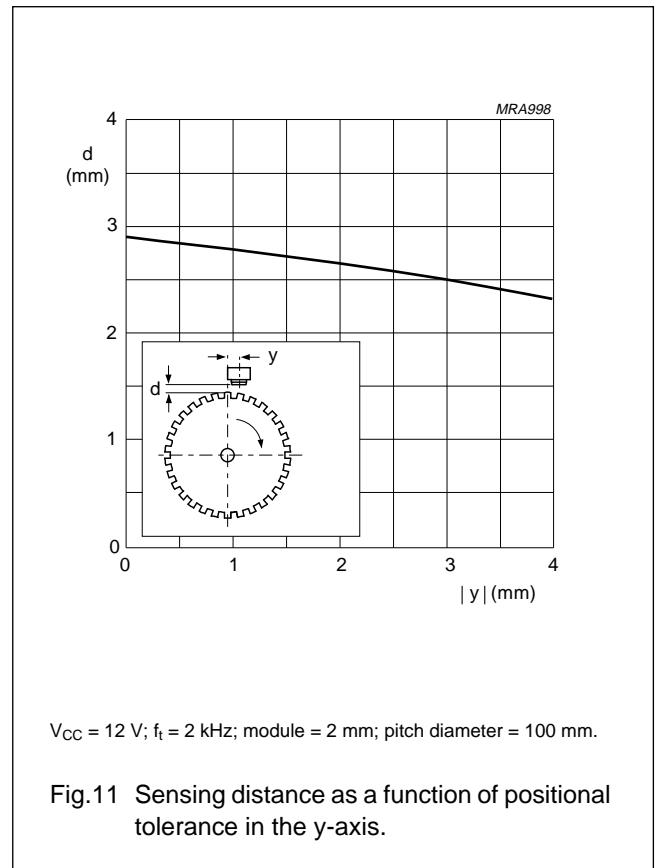
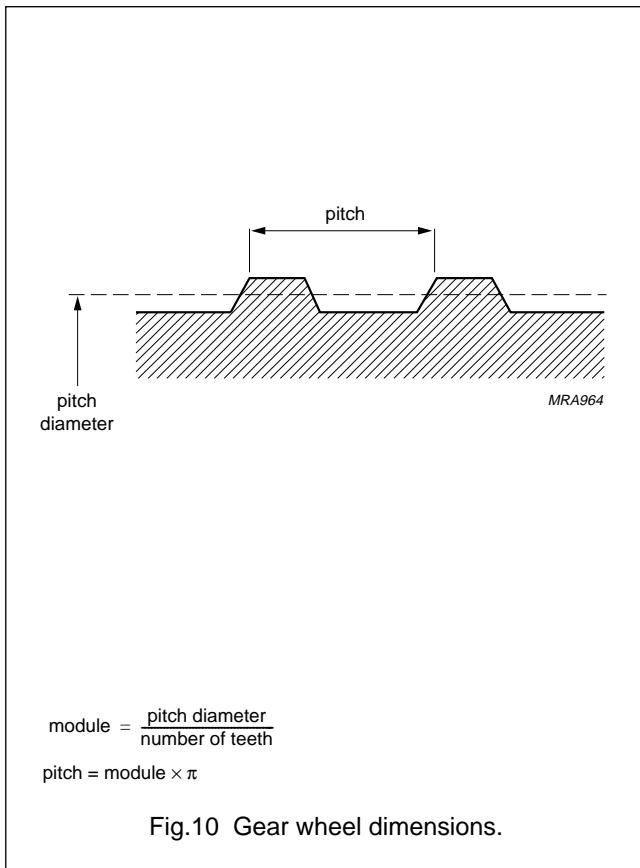
Due to eddy current effects the sensing distance depends on the tooth frequency (Fig.17). The influence of gear wheel module on the sensing distance is shown in Fig.16.

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 $CP = \pi/DP$	inch

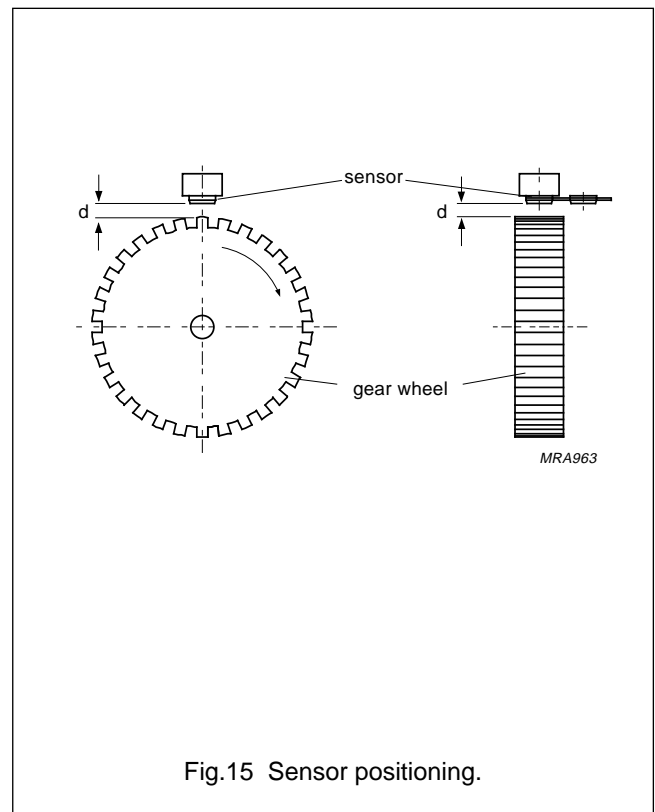
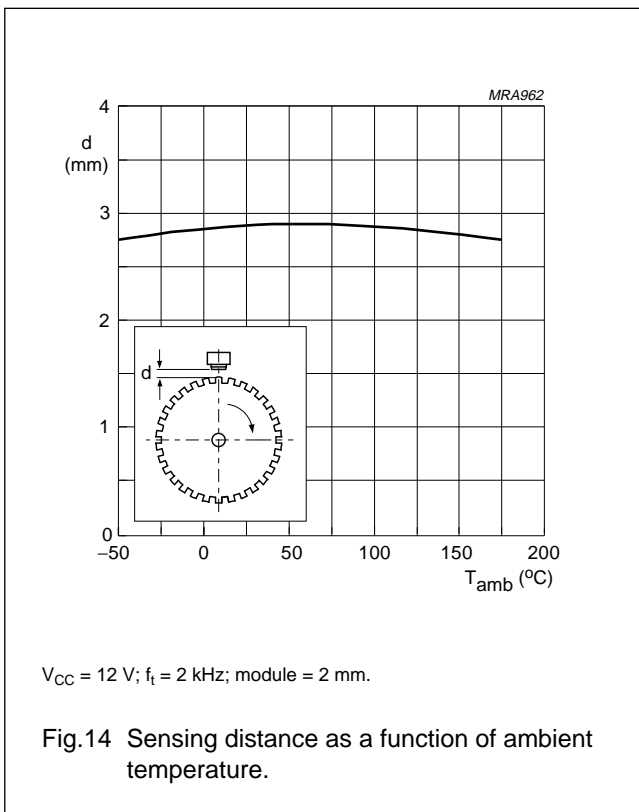
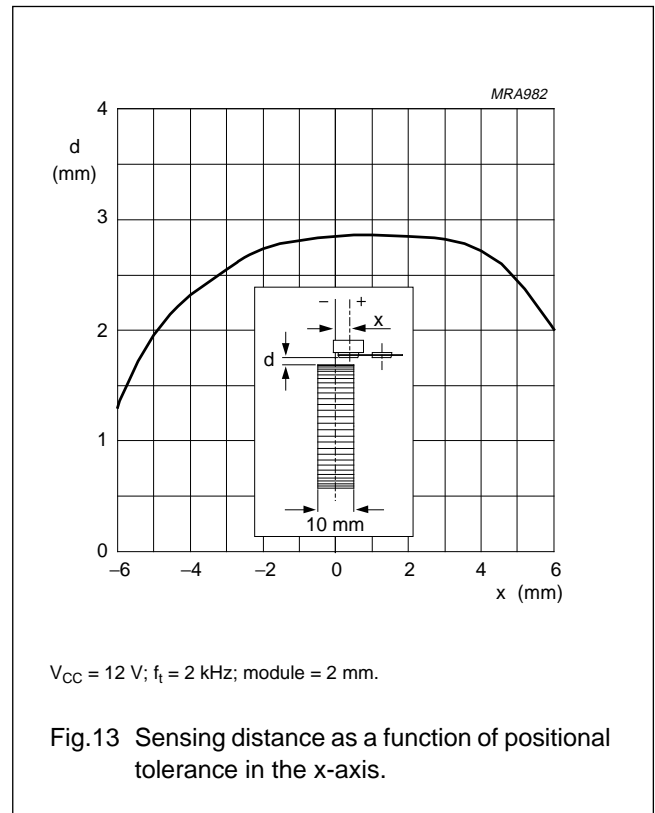
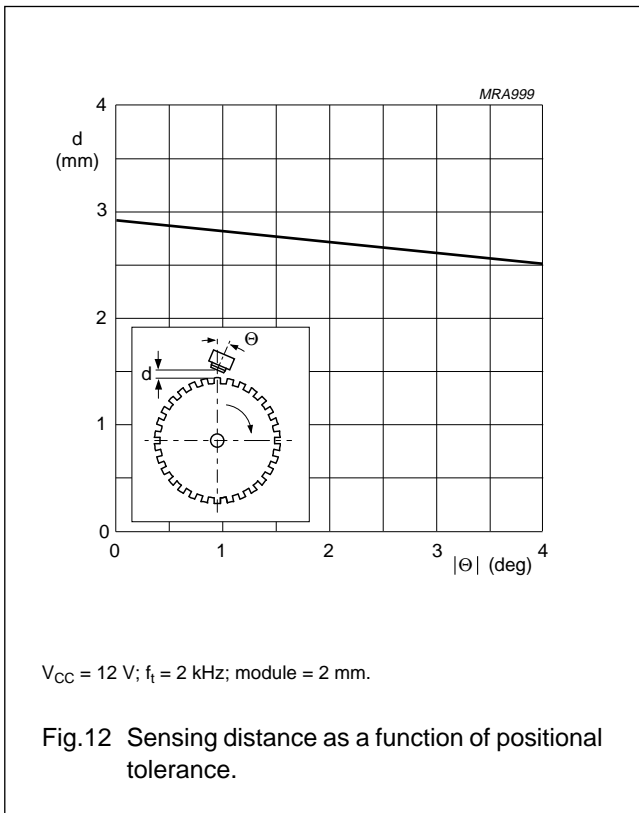
Note

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



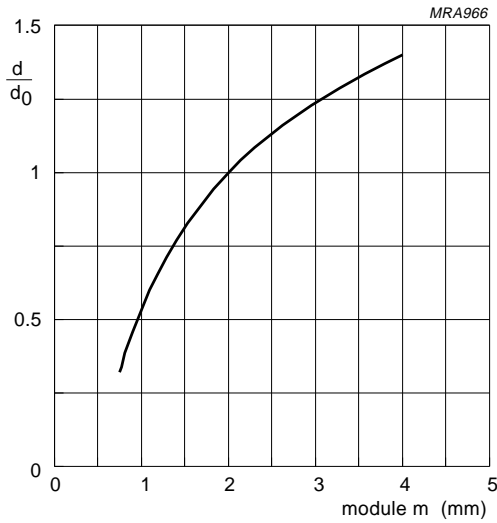
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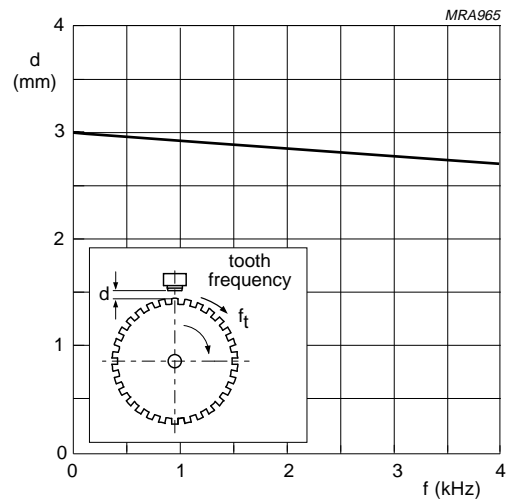
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d_0 = measuring distance for a gear wheel with module $m = 2$ mm.

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



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

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

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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 KMI15/1's handling capabilities. The "IEC 801-2" test conditions were: $C = 150$ pF, $R = 150 \Omega$, $V = 2$ 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	-	$t_d = 0.1 \mu s$	A
Test pulse 3b	V_{LD}	-	100	$t_d = 0.1 \mu s$	A
Test pulse 4	V_{LD}	-7	-	$t_d = 130$ ms	B
Test pulse 5	V_{LD}	-	120	$t_d = 400$ ms	B

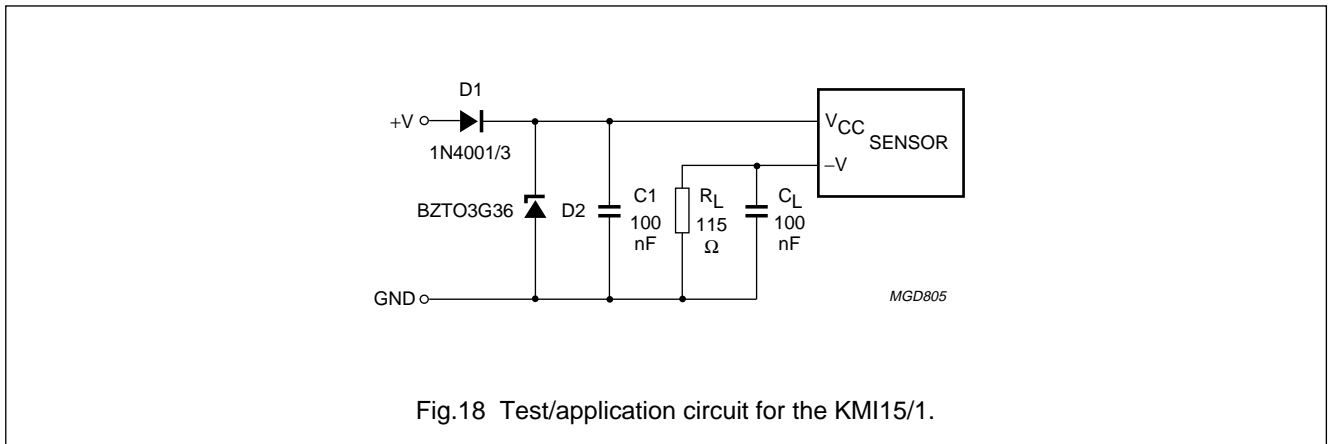


Fig.18 Test/application circuit for the KMI15/1.

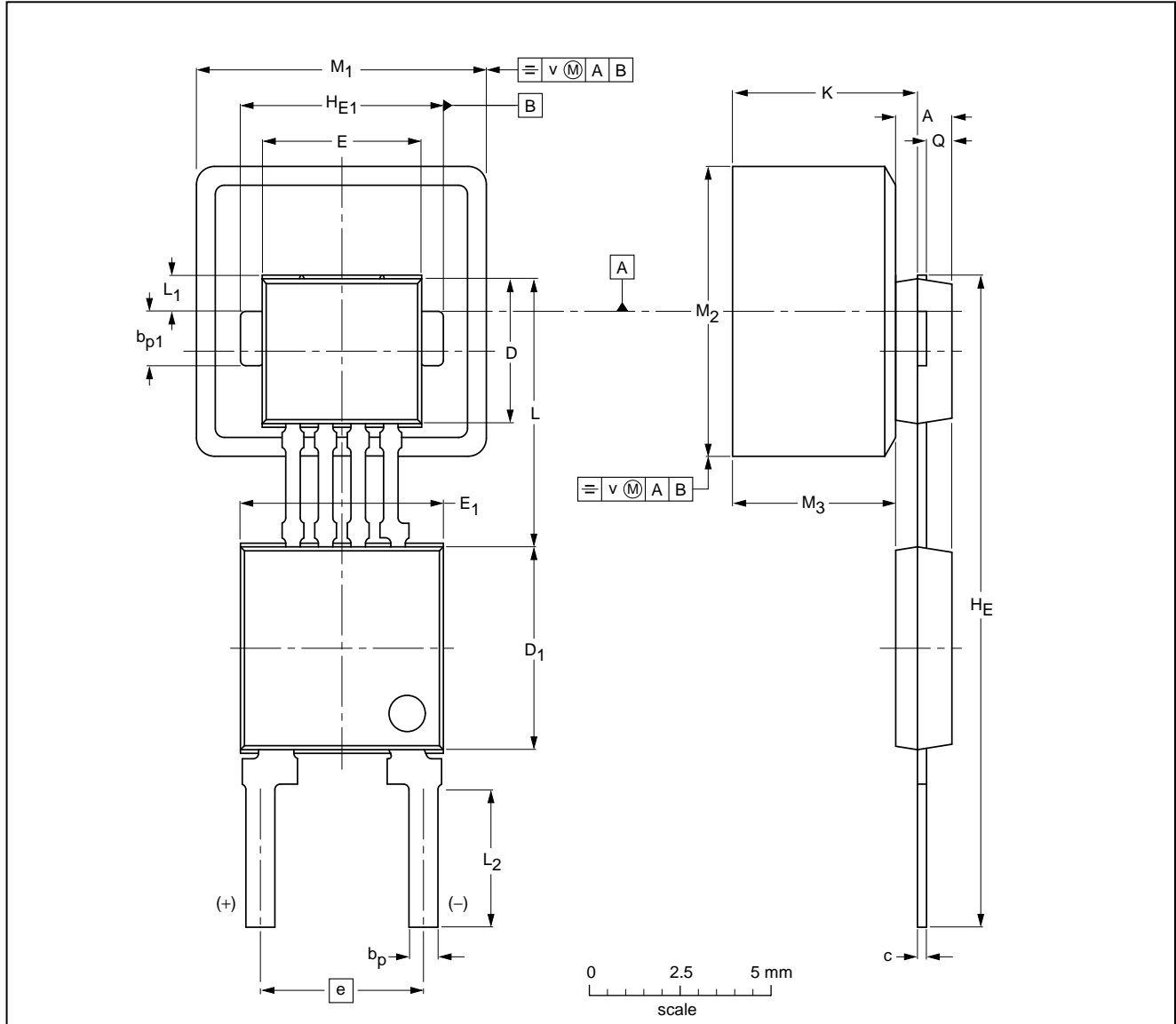
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PACKAGE OUTLINE

Package description

SOT453B



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	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

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			
SOT453B						96-11-12

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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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