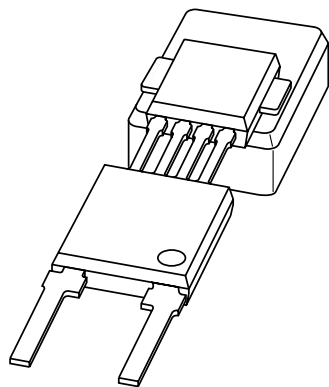


# DATA SHEET



## **KMI20/4**

Rotational speed sensor for  
extended air gap application

Objective specification

2000 Sep 04

# Rotational speed sensor for extended air gap application

KMI20/4

**FEATURES**

- Digital current output signal
- Digital offset compensation
- Extended air gap
- Zero speed capability
- Wide temperature range
- High tolerance to vibration
- EMC resistant
- Tolerant to positioning.

**DESCRIPTION**

The KMI 20/4 is a sensitive rotational speed sensor designed for use in applications utilizing ferrous gear wheels<sup>(1)</sup>.

The sensor consists of a magnetoresistive sensor element, a driver IC in BIMOS technology, a digital signal conditioning IC in highly integrated CMOS technology and a magnetized ferrite magnet. The frequency of the digital current output signal is proportional to the rotational speed of the gear wheel.

<b>CAUTION</b>
Do not press two or more products together against their magnetic forces.

(1) The sensor contains customized integrated circuits. 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	SYMBOL
1	V <sub>CC</sub>
2	V-

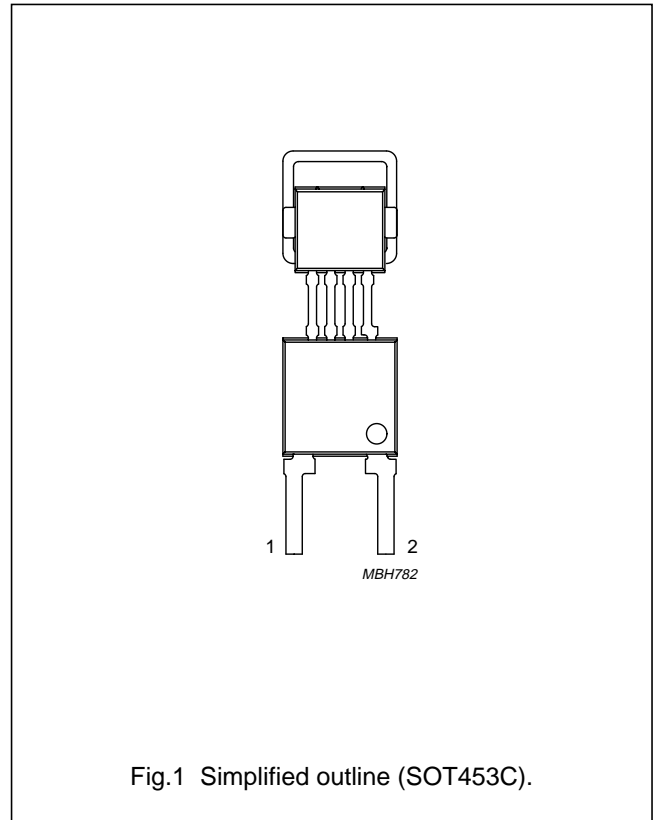


Fig.1 Simplified outline (SOT453C).

**QUICK REFERENCE DATA**

SYMBOL	PARAMETER	MIN.	TYP.	MAX.	UNIT
V <sub>CC</sub>	DC supply voltage	0	12	18	V
I <sub>CC (low)</sub>	current output signal low	5.6	7	8.4	mA
I <sub>CC (high)</sub>	current output signal high	11.2	14	16.8	mA
d	sensing distance	0 to 3.6	0 to 4.1	–	mm
f <sub>t</sub>	operating tooth frequency	0	–	2500	Hz
T <sub>amb</sub>	ambient operating temperature	–40	–	+85	°C

# Rotational speed sensor for extended air gap application

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## LIMITING VALUES

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

SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
$V_{CC}$	DC supply voltage	$T_{amb} = -40$ to $+85$ °C; $R_L = 115$ $\Omega$	0	18	V
$T_{stg}$	storage temperature		-65	+150	°C
$T_{amb}$	operating ambient temperature		-40	+85	°C
$T_{sld}$	soldering temperature	$t < 10$ s	–	260	°C
	output short-circuit duration	$V_{CC}$ to GND; see Fig.7	continuous		
	wrong polarity	$T_{amb} = -40$ to $+65$ °C, $R_L = 115$ $\Omega$ ; note 1	continuous		

### Note

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

## CHARACTERISTICS

$T_{amb} = 25$  °C;  $V_{CC} = 12$  V;  $d = 1.7$  mm;  $f_t = 2$  kHz; test circuit; see Fig.7;  $R_L = 115$   $\Omega$ ; central sensor positioning; see Fig.9; gear wheel: module 2 mm; material 95MnPb28k; unless otherwise specified.

SYMBOLS	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$I_{CC (low)}$	current output low	-40 to +85 °C; see Figs 7 and 9	5.6	7	8.4	mA
$I_{CC (high)}$	current output high	-40 to +85 °C; see Figs 7 and 9	11.2	14	16.8	mA
$t_r$	output signal rise time	$C_L = 100$ pF; 10% to 90% value; see Fig.11	–	0.5	–	$\mu$ s
$t_f$	output signal fall time	$C_L = 100$ pF; 90% to 10% value; see Fig.11	–	0.5	–	$\mu$ s
$f_t$	operating tooth frequency	for both rotational directions	0	–	2500	Hz
$d_{in 0 Hz}$	sensing distance in initial mode for signals $0 Hz < f_t < 1 Hz$	see Fig.9	0 to 2.1	0 to 2.5	–	mm
$d_{in 1 Hz}$	sensing distance in initial mode for signals $>1 Hz$	see Fig.9	0 to 3.1	0 to 3.5	–	mm
$d_{act}$	sensing distance in active mode	see Fig.9	0 to 3.6	0 to 4.1	–	mm
$\delta_{in 0 Hz}$	duty cycle in initial mode for signals $>0 Hz$	see Fig.5	20	50	80	%
$\delta_{in 1 Hz}$	duty cycle in initial mode for signals $>1 Hz$	see Fig.5	20	50	80	%
$\delta_{act}$	duty cycle in active mode	see Fig.5	40	50	60	%

# Rotational speed sensor for extended air gap application

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## FUNCTIONAL DESCRIPTION

The KMI 20/4 is sensitive to the motion of ferrous gear wheels. 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 KMI20/4 is sensitive to movement in the 'y' direction in front of the sensor only (see Fig.2).

The KMI 20/4 contains a magnetoresistive sensor element and two ICs: a Position Detector IC (PDIC) and a Line Driver IC (LDIC). The sensor signal is fed into the PDIC. The PDIC converts the signal to the digital domain, applies digital compensation and after additional processing, converts it back to analogue. The LDIC contains two current sources (one constant, one switchable) and a voltage control unit (see Fig.4).

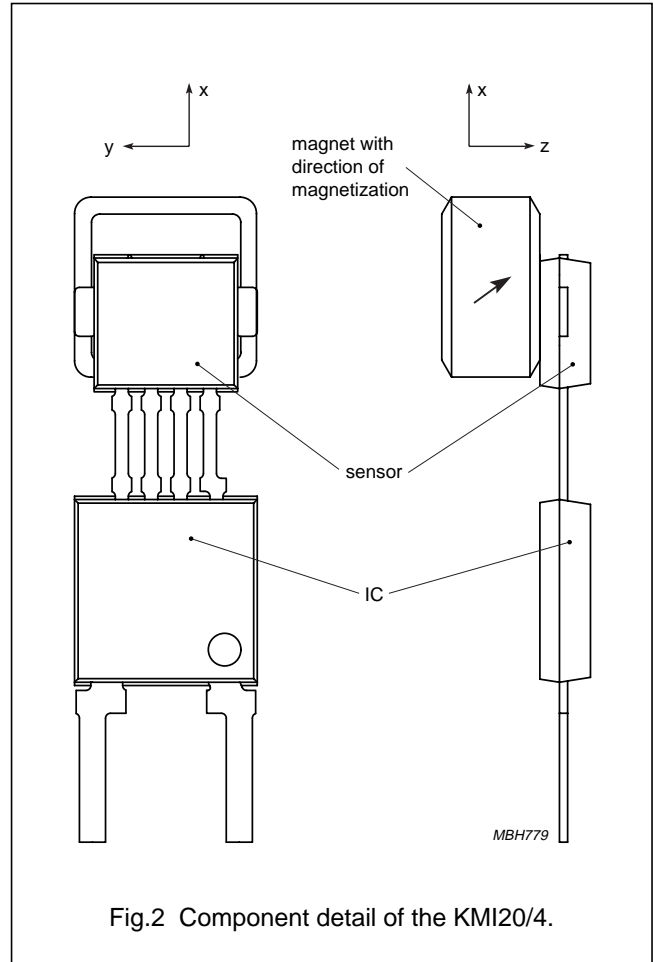


Fig.2 Component detail of the KMI20/4.

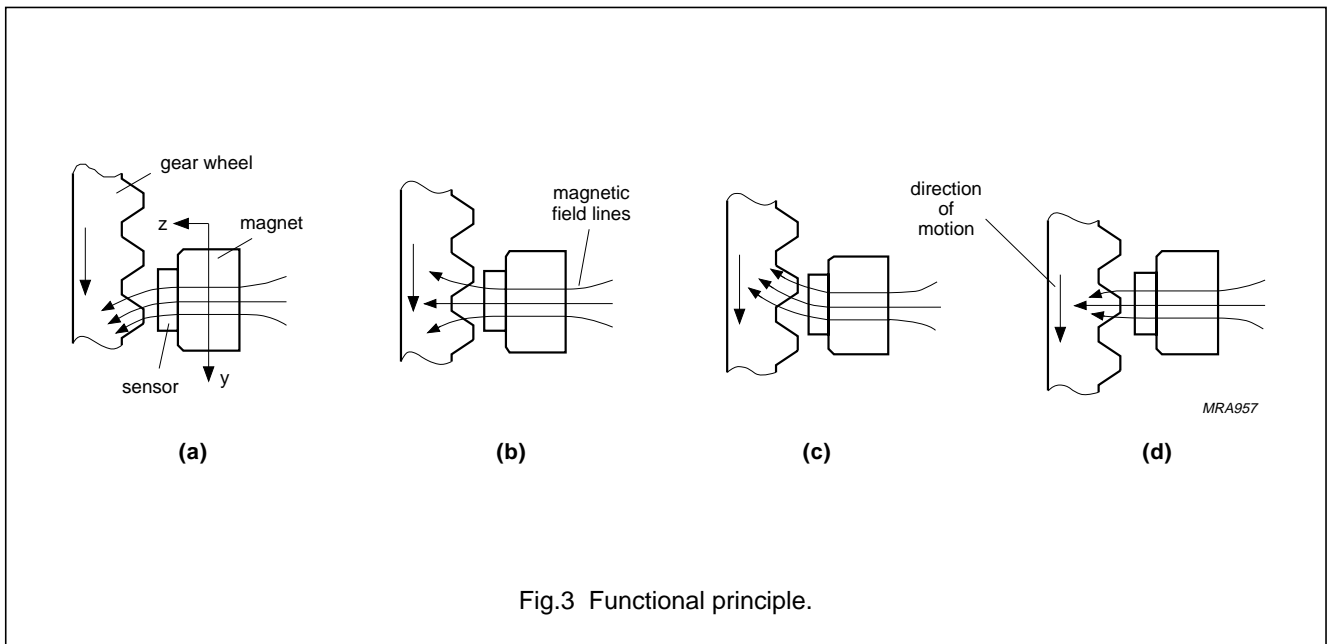


Fig.3 Functional principle.

Rotational speed sensor for extended air gap application

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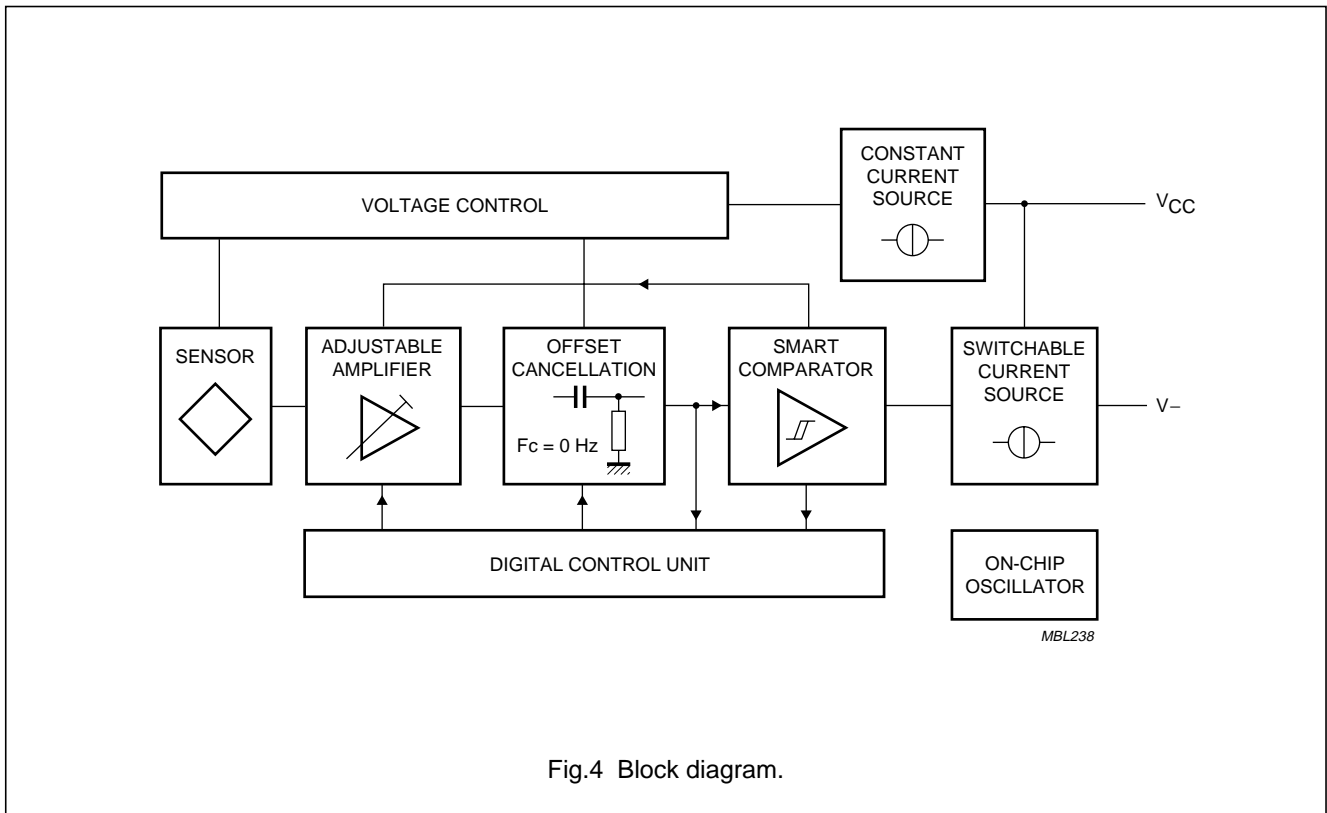
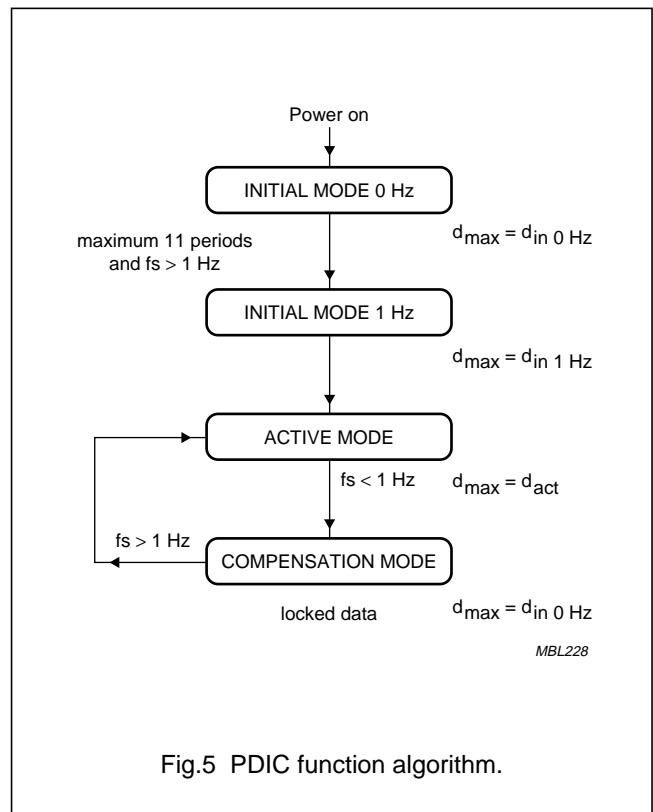


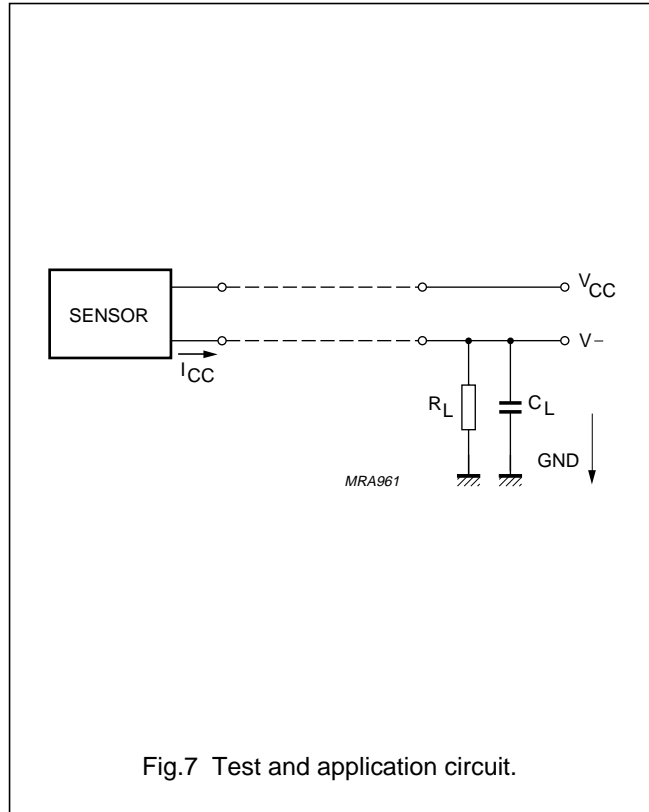
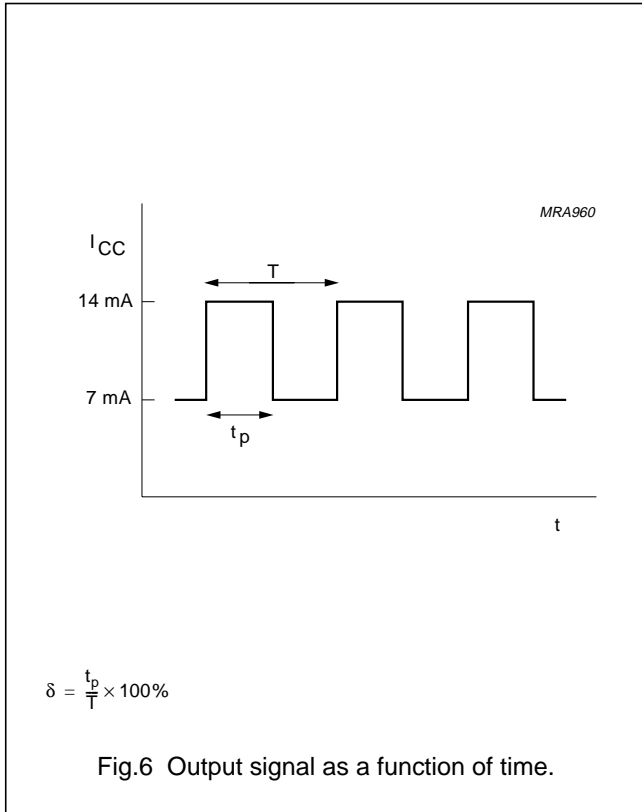
Figure 5 shows the digital compensation function in algorithmic format. After power on the sensor system is running in INITIAL MODE 0 Hz. The sensor signal is preamplified but not offset compensated. The output signal represents the specified sensing distances (see Chapter "Characteristics") for every tooth of the wheel, totally speed independent. When  $d_{in 0 Hz} < d < d_{in 1 Hz}$  the system must first detect the sensor signal amplitudes to compensate for the sensor offset (INITIAL MODE 1 Hz<sup>1</sup>). An output signal is produced (first compensation run finished) at the latest after 11 wheel teeth, with a frequency above 1 Hz.

After detecting the teeth in initial mode the PDIC changes to ACTIVE MODE and the sensor signal is permanently offset compensated. The available sensing distance is increased to  $d_{act}$ . Quitting ACTIVE MODE is caused by power off or by the teeth frequency falling below 1 Hz. The system is locked into COMPENSATION MODE and continues to detect every wheel tooth down to zero speed.



Rotational speed sensor for extended air gap application

KMI20/4



**Mounting conditions**

The recommended sensor position in front of a gear wheel is shown in Fig.9. The distance 'd' is measured between the sensor front and the tip of a gear wheel tooth. The KMI20/4 senses ferrous indicators like gear wheels in the ±y direction only (no rotational symmetry of the sensor); see Fig.2. The symmetrical reference axis of the sensor corresponds to the axis of the ferrite magnet.

**Gear wheel dimensions**

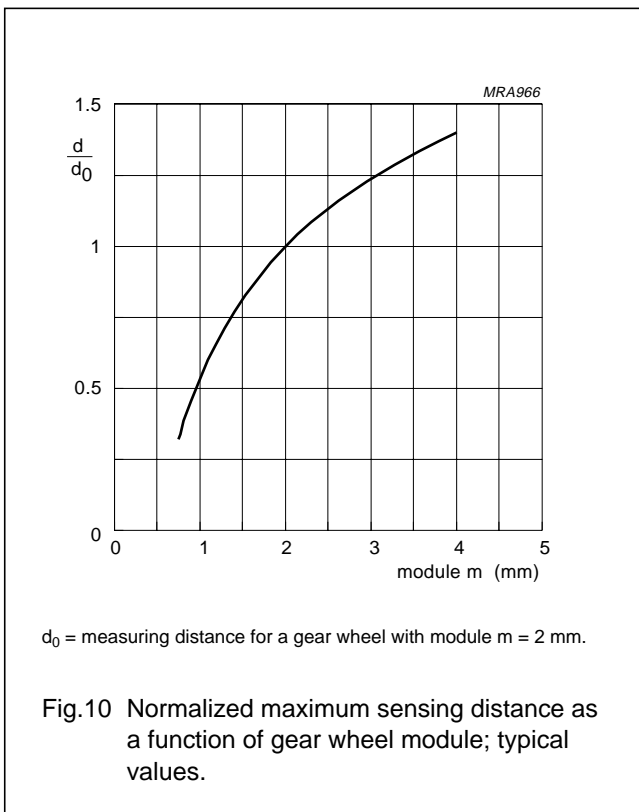
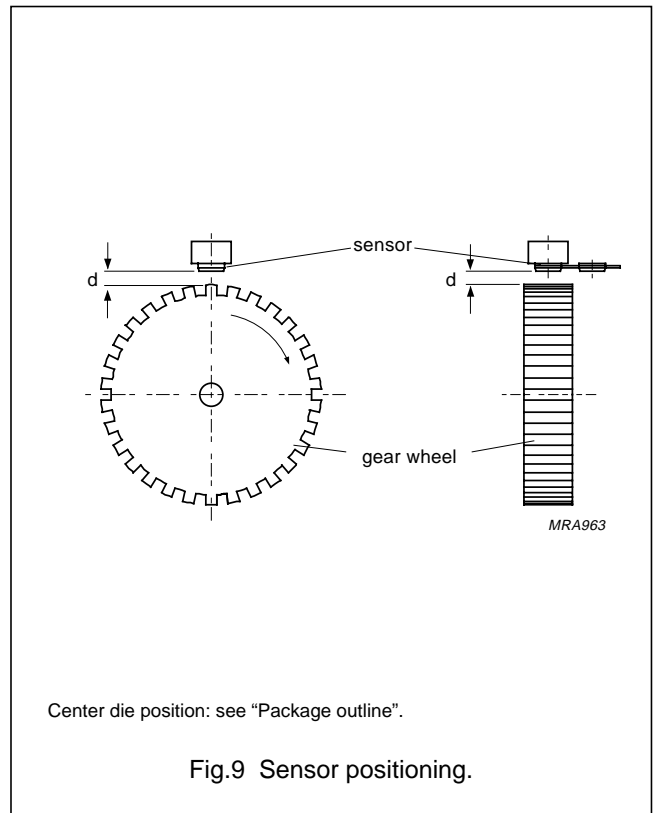
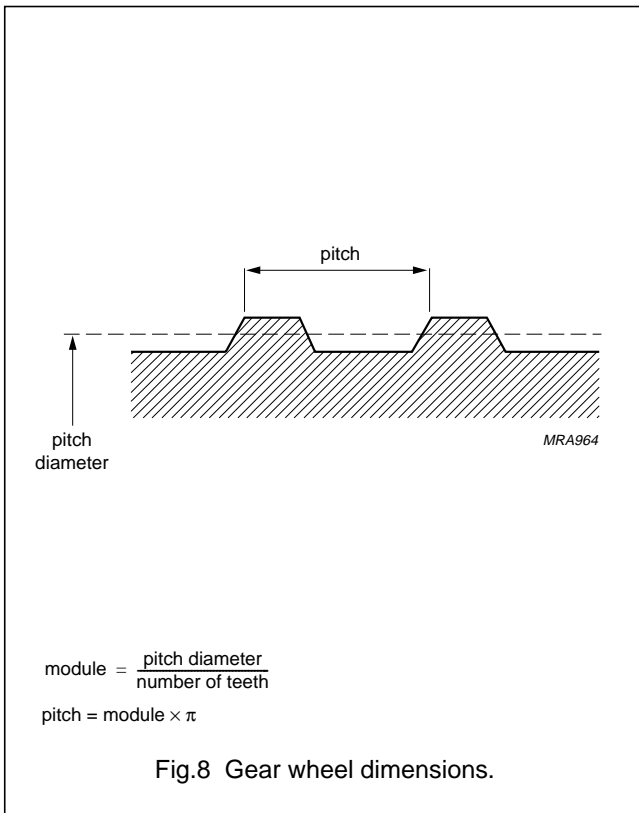
SYMBOL	DESCRIPTION	UNIT
<b>German DIN</b>		
z	number of teeth	
d	diameter	mm
m	module $m = d/z$	mm
p	pitch $p = \pi \times m$	mm
<b>ASA; note 1</b>		
PD	pitch diameter (d in inch)	inch
DP	diametric pitch $DP = z/PD$	inch <sup>-1</sup>
CP	circular pitch $CP = \pi/DP$	inch

**Note**

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

# Rotational speed sensor for extended air gap application

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# Rotational speed sensor for extended air gap application

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## EMC

Figure 11 shows a recommended application circuit for automotive applications. 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 pulses 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 "MIL Std. 883D, Method 3015.7" to demonstrate the KMI20\_2's handling capabilities. The test conditions were: C = 150 pF, R = 150 Ω, V = 4 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 <sub>LD</sub>	-100	-	t <sub>d</sub> = 2 ms	C
Test pulse 2	V <sub>LD</sub>	-	100	t <sub>d</sub> = 0.2 ms	A
Test pulse 3a	V <sub>LD</sub>	-150	-	t <sub>d</sub> = 0.1 μs	A
Test pulse 3b	V <sub>LD</sub>	-	100	t <sub>d</sub> = 0.1 μs	A
Test pulse 4	V <sub>LD</sub>	-7	-	t <sub>d</sub> = 130 ms	B
Test pulse 5	V <sub>LD</sub>	-	120	t <sub>d</sub> = 400 ms	B

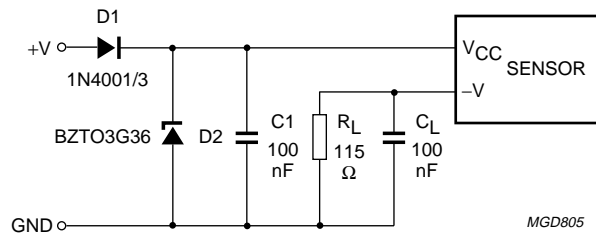


Fig.11 Test/application circuit for the KMI20/4.



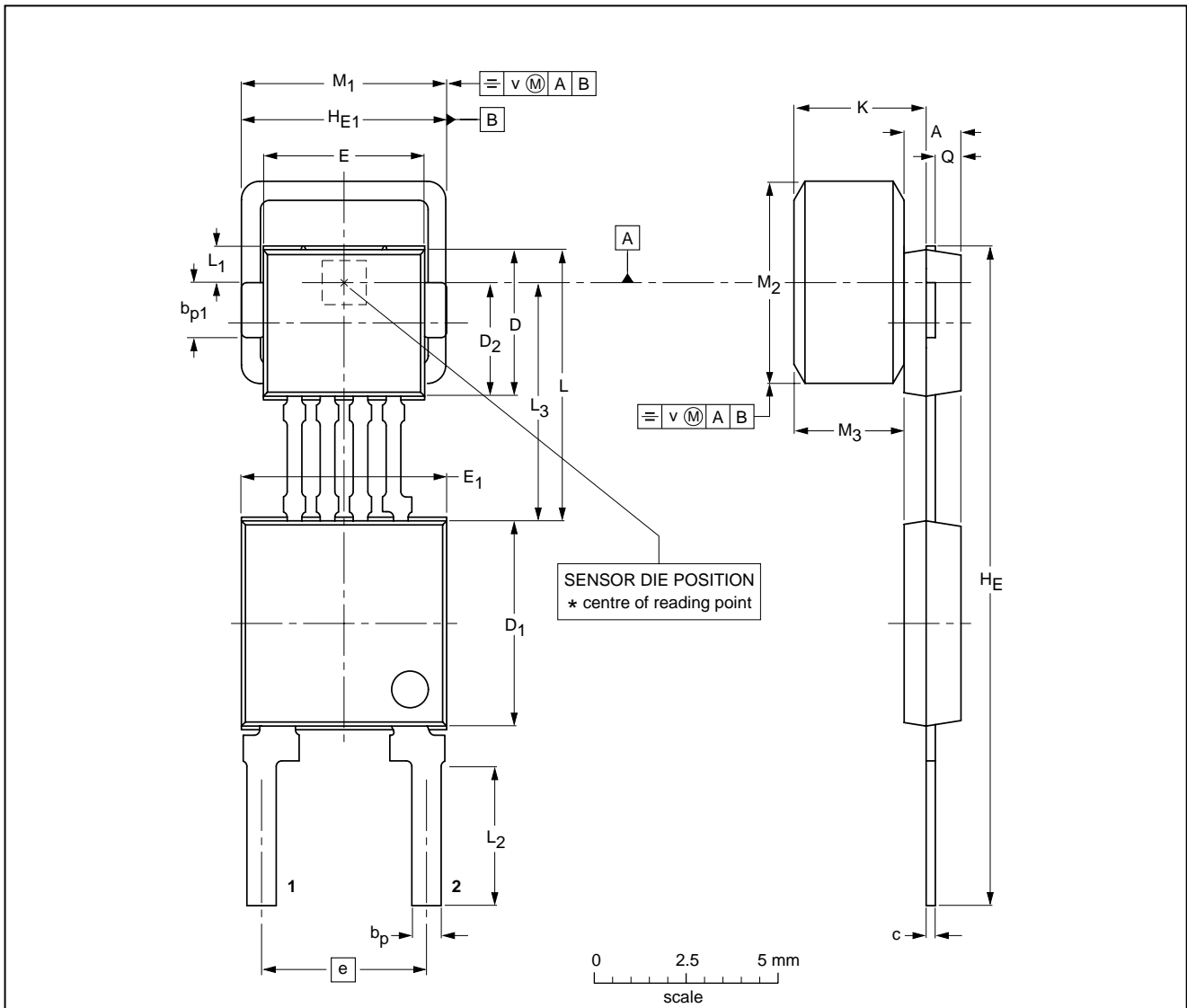
# Rotational speed sensor for extended air gap application

KMI20/4

## 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 <sup>(1)</sup>	b <sub>p</sub>	b <sub>p1</sub>	c	D <sup>(2)</sup>	D <sub>1</sub> <sup>(2)</sup>	D <sub>2</sub> <sup>(2)</sup>	E <sup>(2)</sup>	E <sub>1</sub> <sup>(2)</sup>	e	H <sub>E</sub>	H <sub>E1</sub>	K <sub>max.</sub>	L	L <sub>1</sub>	L <sub>2</sub>	L <sub>3</sub>	M <sub>1</sub>	M <sub>2</sub>	M <sub>3</sub> <sup>(1)</sup>	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

# Rotational speed sensor for extended air gap application

KMI20/4

## DATA SHEET STATUS

DATA SHEET STATUS	PRODUCT STATUS	DEFINITIONS <sup>(1)</sup>
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

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KMI20/4

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