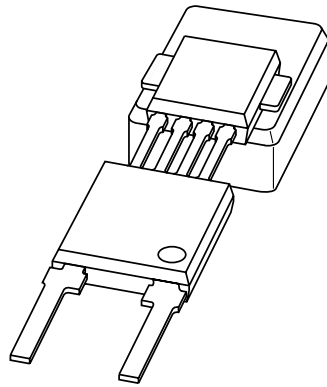


DATA SHEET



KMI15/4 Rotational speed sensor

Product specification
Supersedes data of 2000 Jun 26

2000 Sep 05

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. For all other applications, higher temperature versions of up to 150 °C are available on request.

PINNING

| PIN | DESCRIPTION |
|-----|-----------------|
| 1 | V _{CC} |
| 2 | V- |

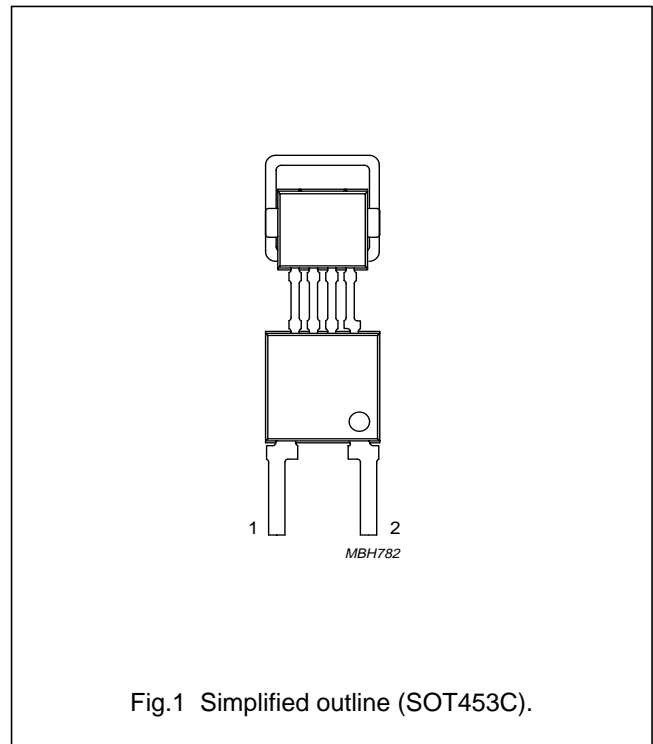


Fig.1 Simplified outline (SOT453C).

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 |

Rotational speed sensor

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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 _{slid} | 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).

Rotational speed sensor

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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 magneto-resistive 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 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 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 magneto-resistive bridge, is typically: $H_x = 7 \text{ kA/m}$ (auxiliary field) and $H_z = 17 \text{ kA/m}$ (perpendicular to the sensor surface). H_y is zero due to the trimming process.

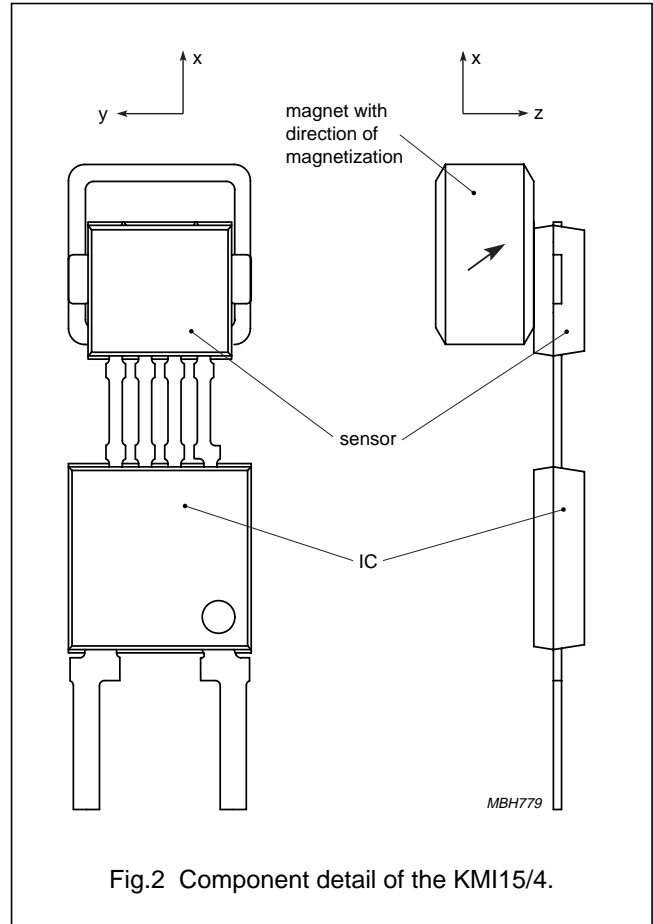


Fig.2 Component detail of the KMI15/4.

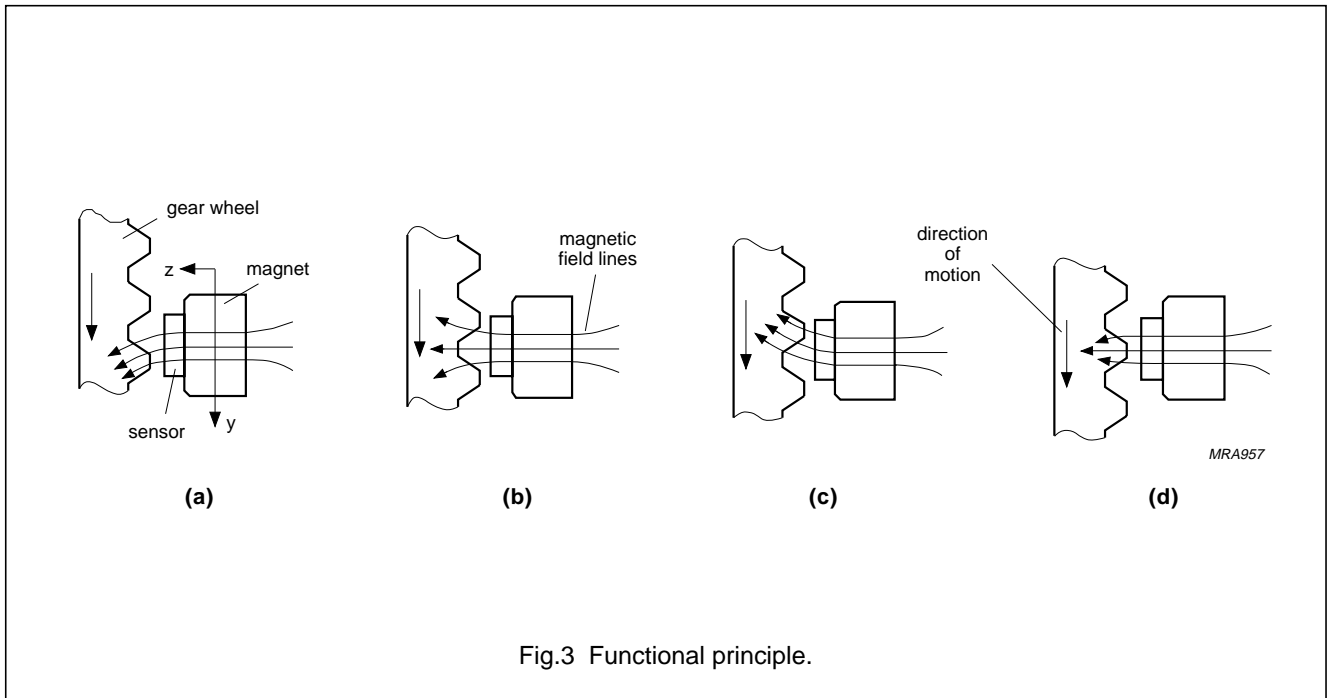


Fig.3 Functional principle.

Rotational speed sensor

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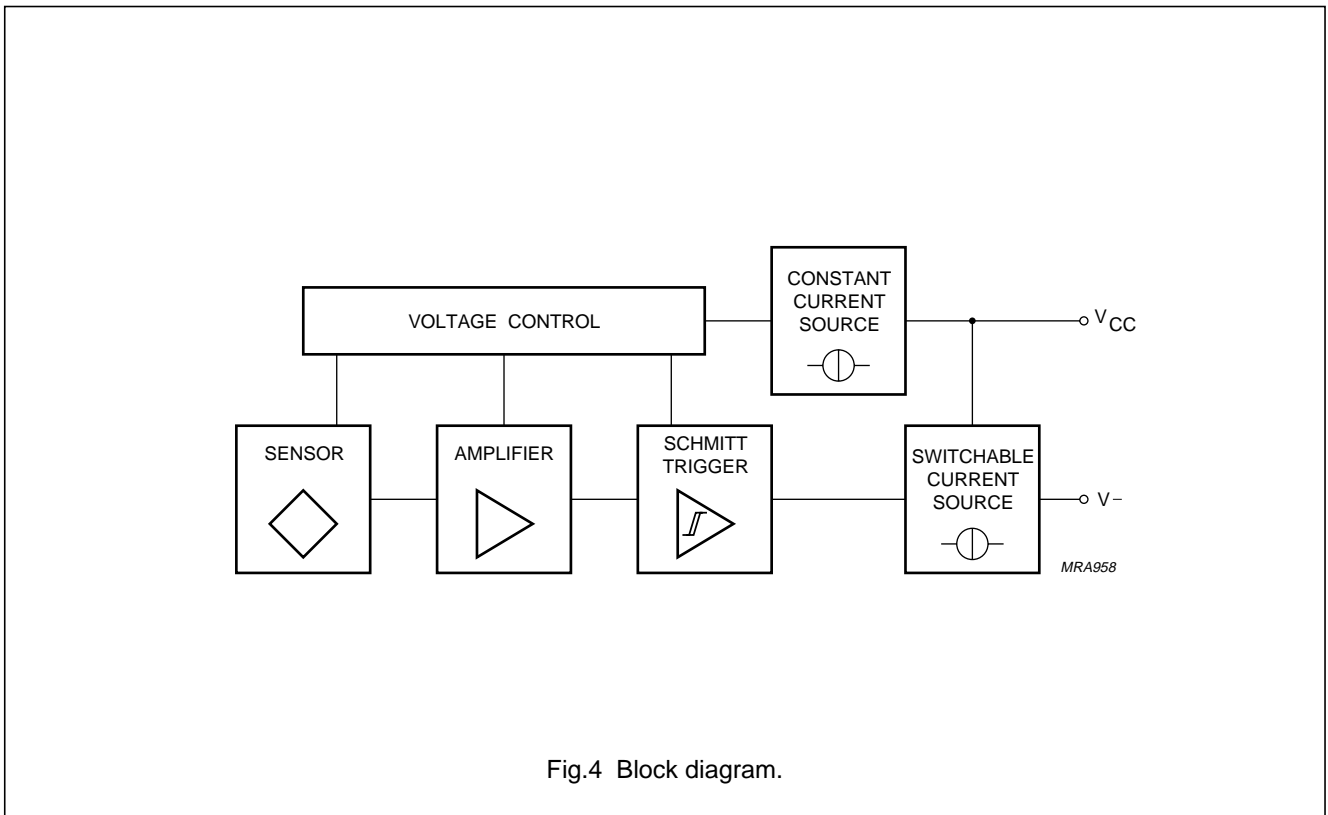


Fig.4 Block diagram.

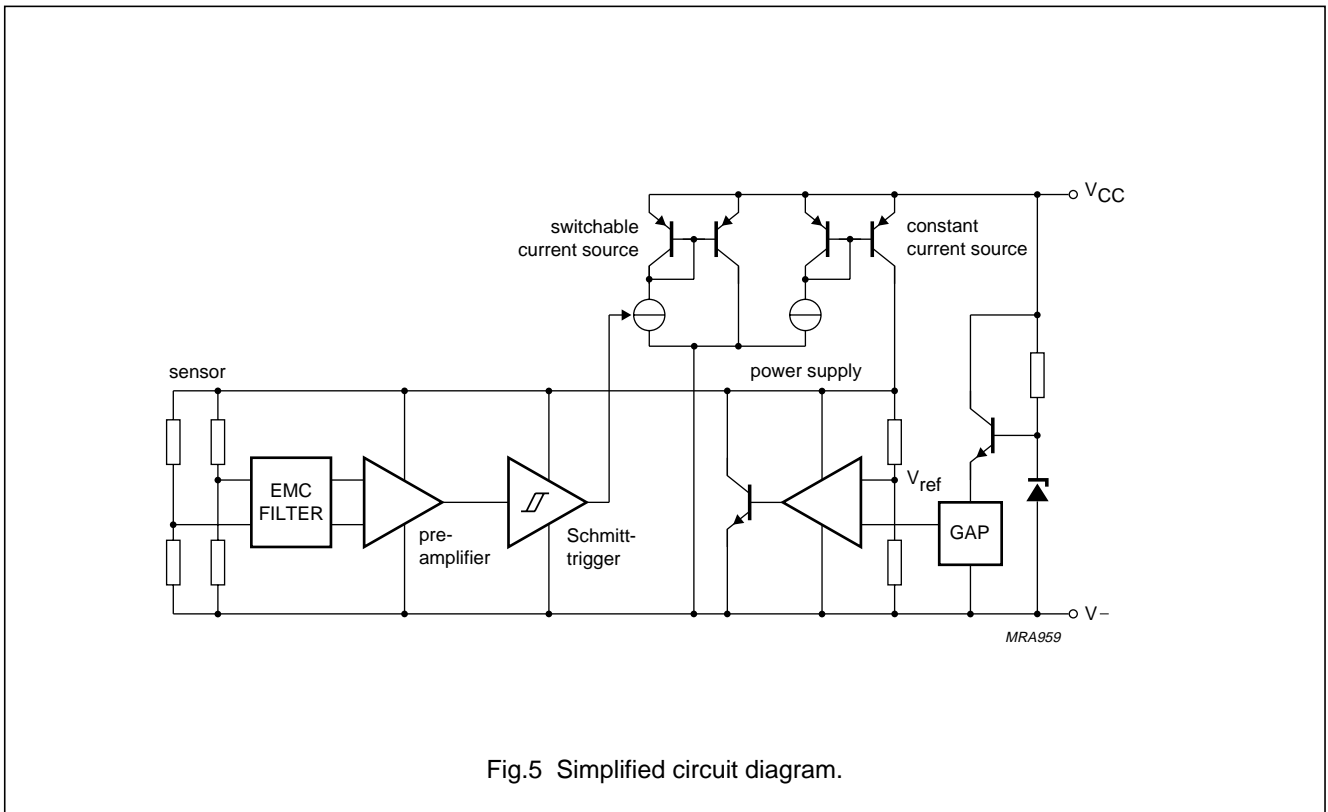
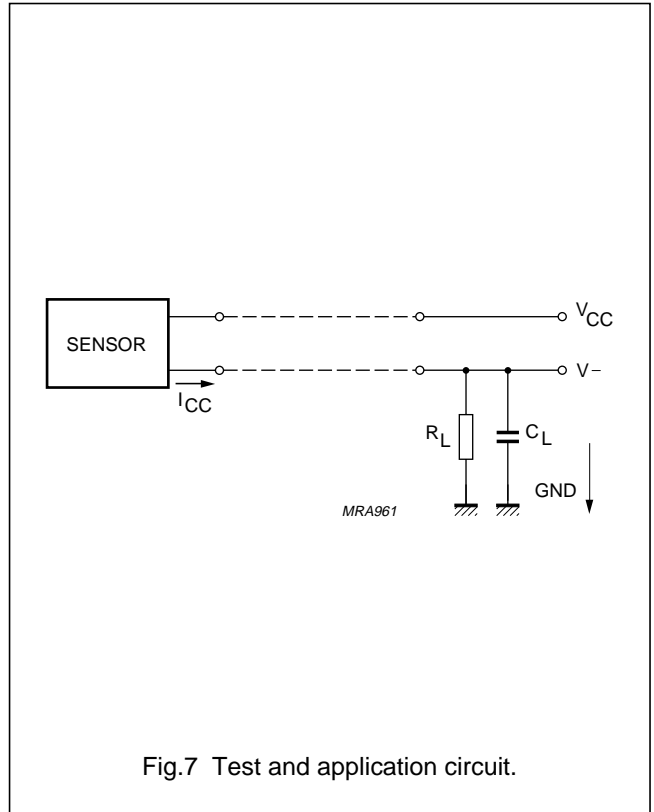
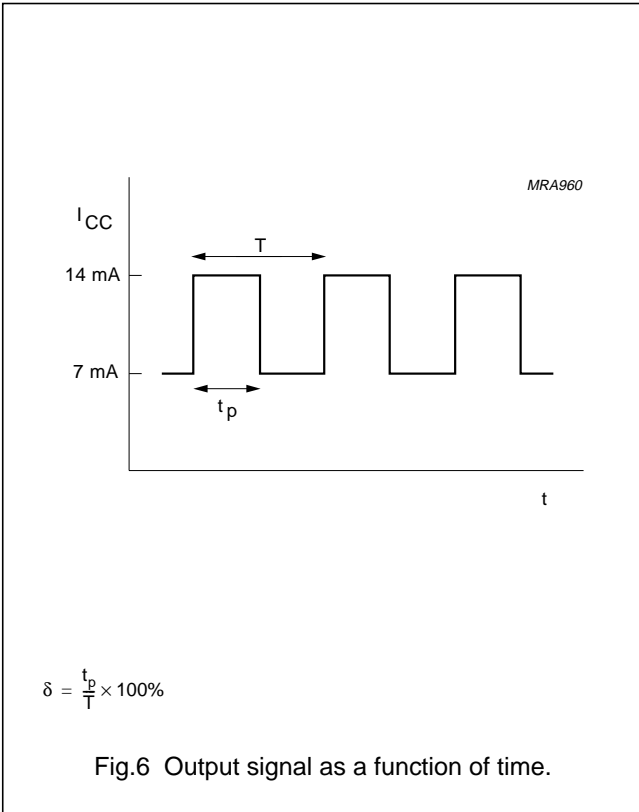


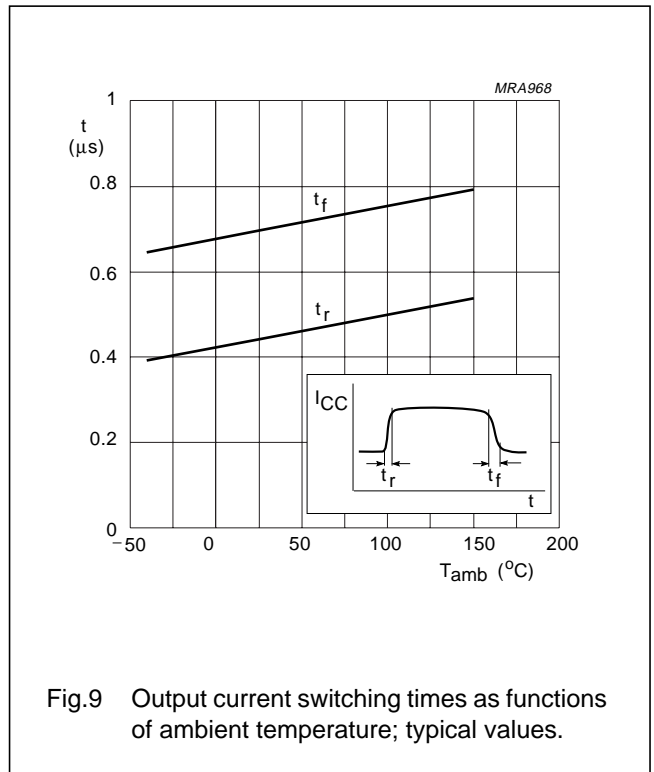
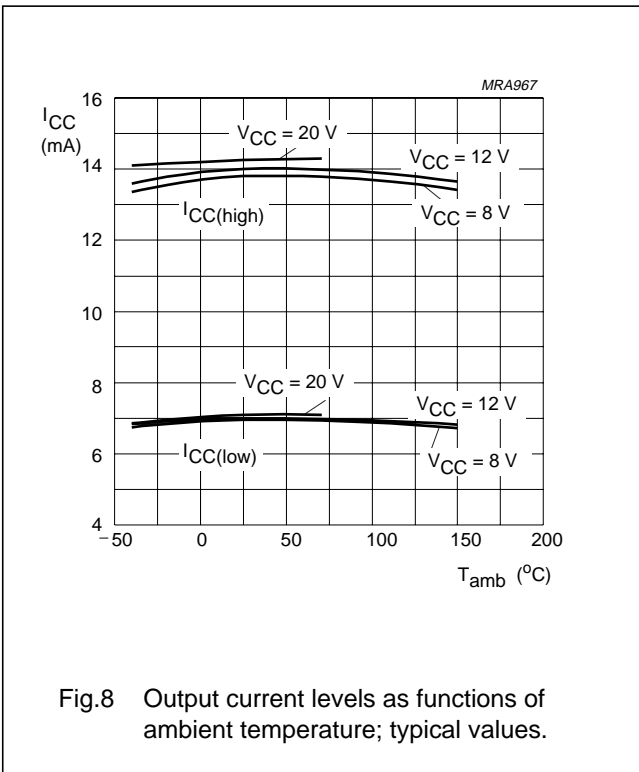
Fig.5 Simplified circuit diagram.

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APPLICATION INFORMATION



Rotational speed sensor

KMI15/4

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

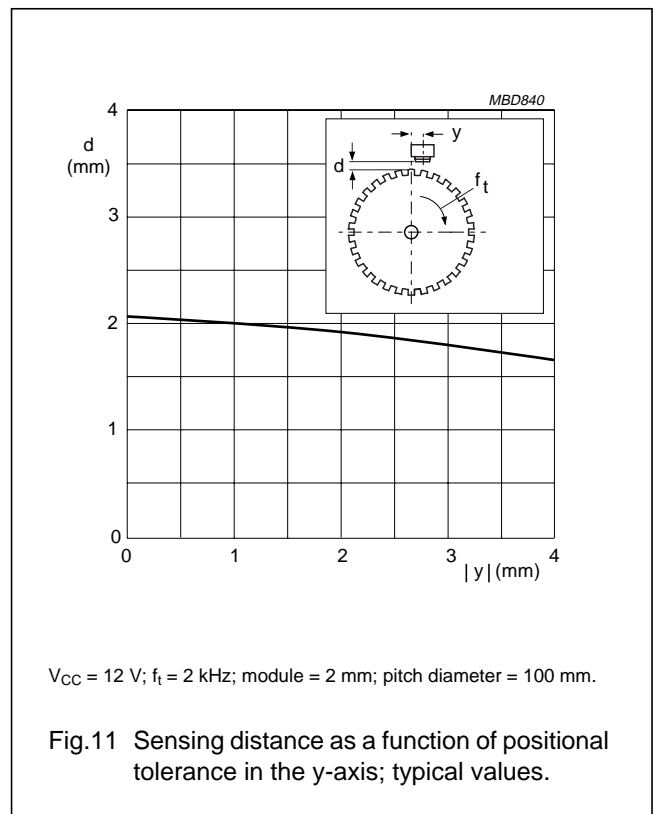
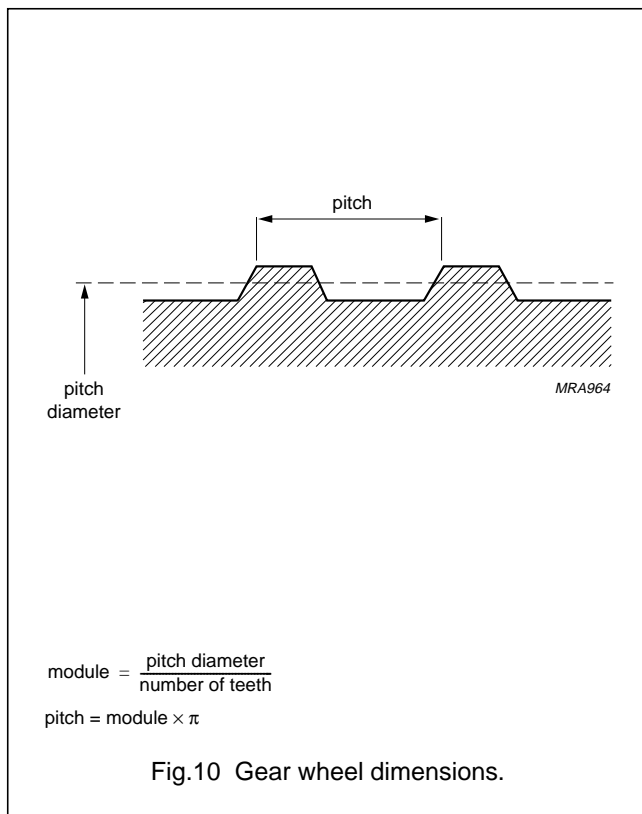
Due to eddy current effects the sensing distance depends on the tooth frequency (see Fig.17). The influence of gear wheel module on the sensing distance is shown in Fig.16.

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 $CP = \pi/DP$ | inch |

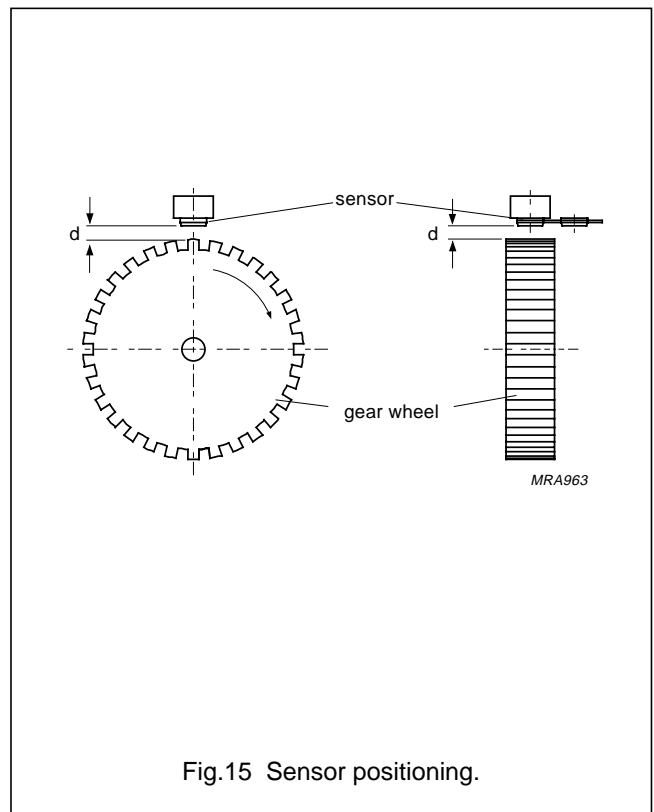
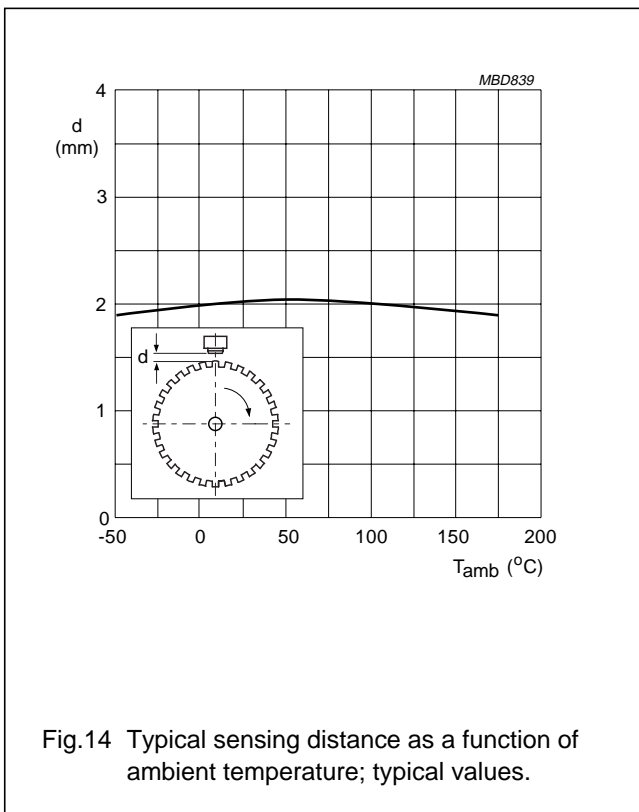
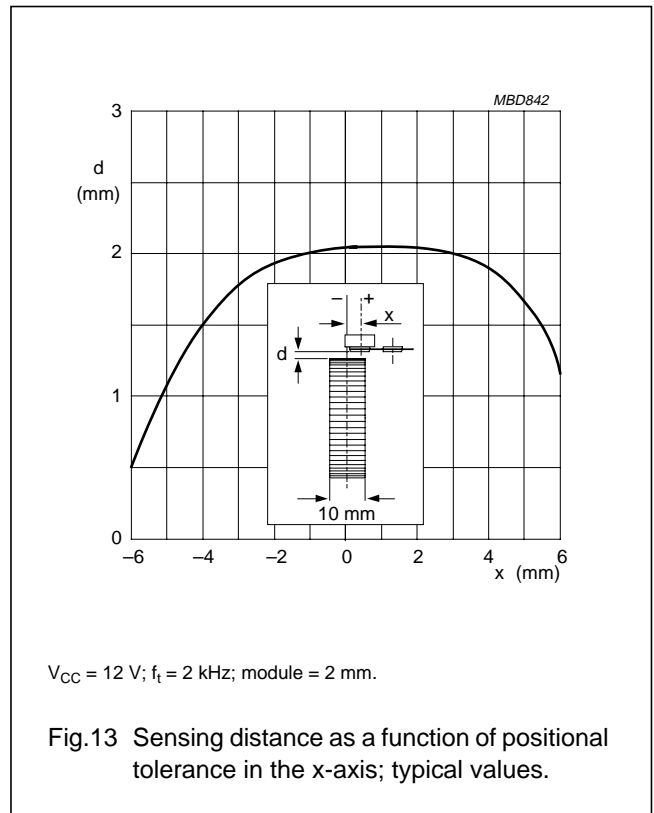
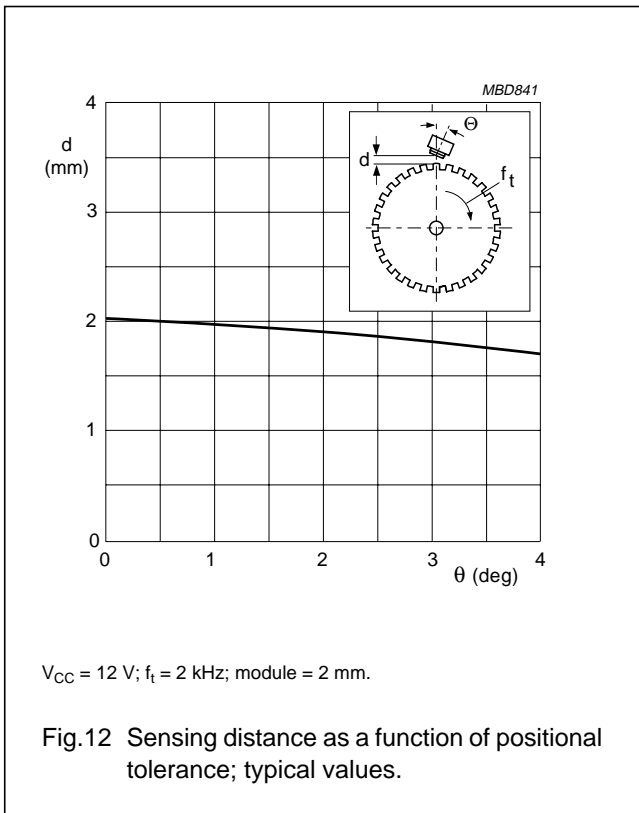
Note

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



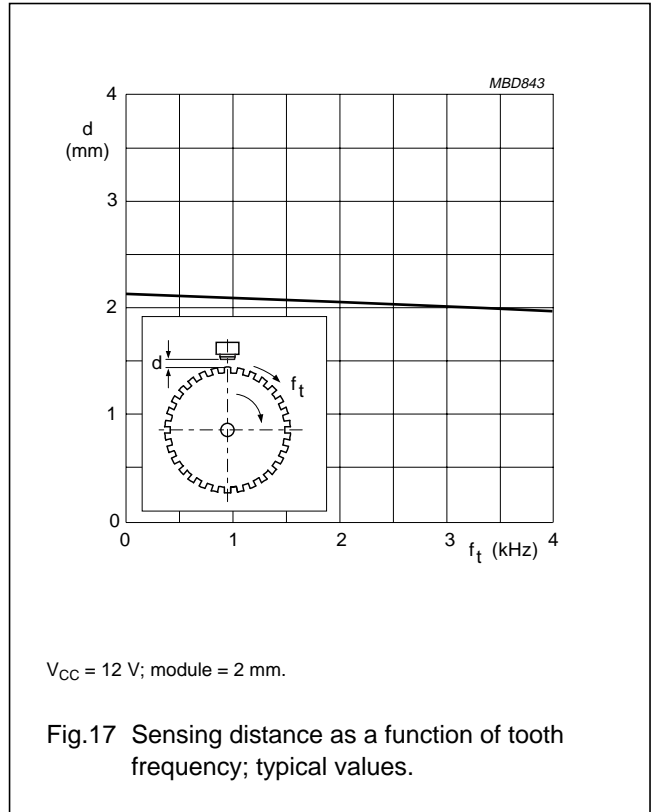
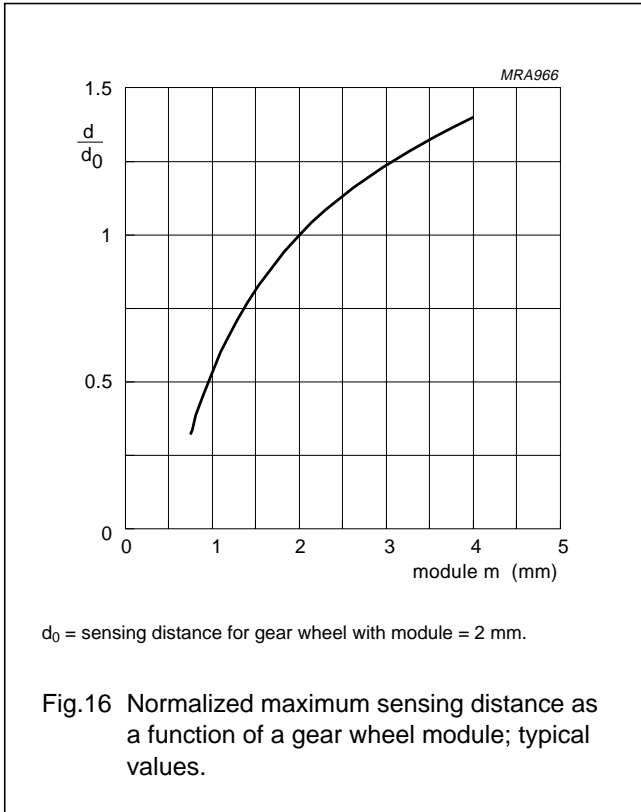
Rotational speed sensor

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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 KMI15/4'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 |

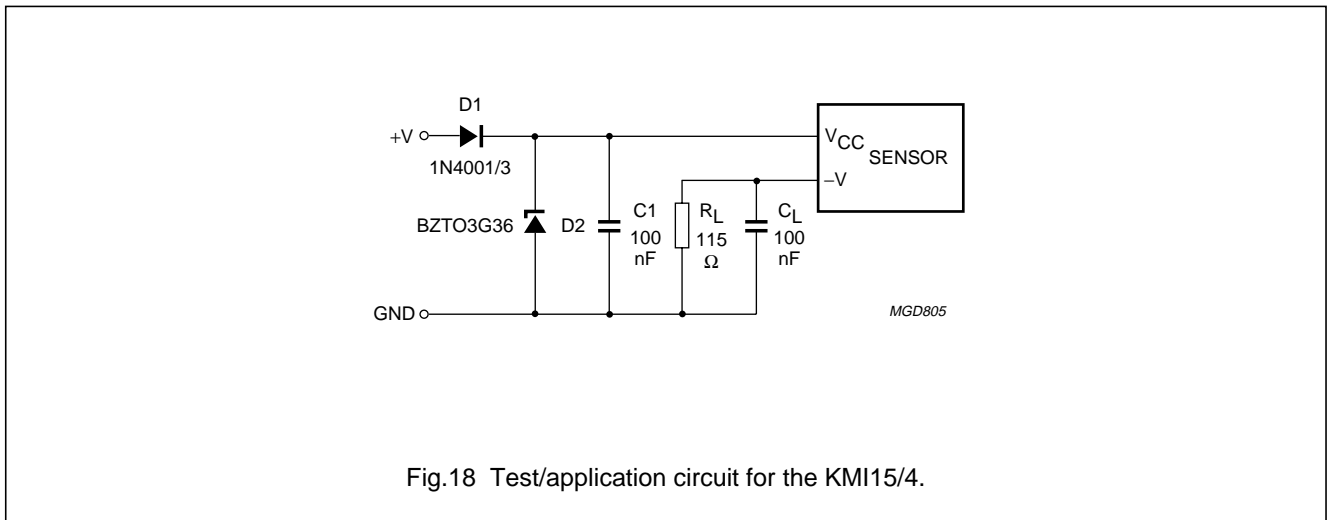


Fig.18 Test/application circuit for the KMI15/4.

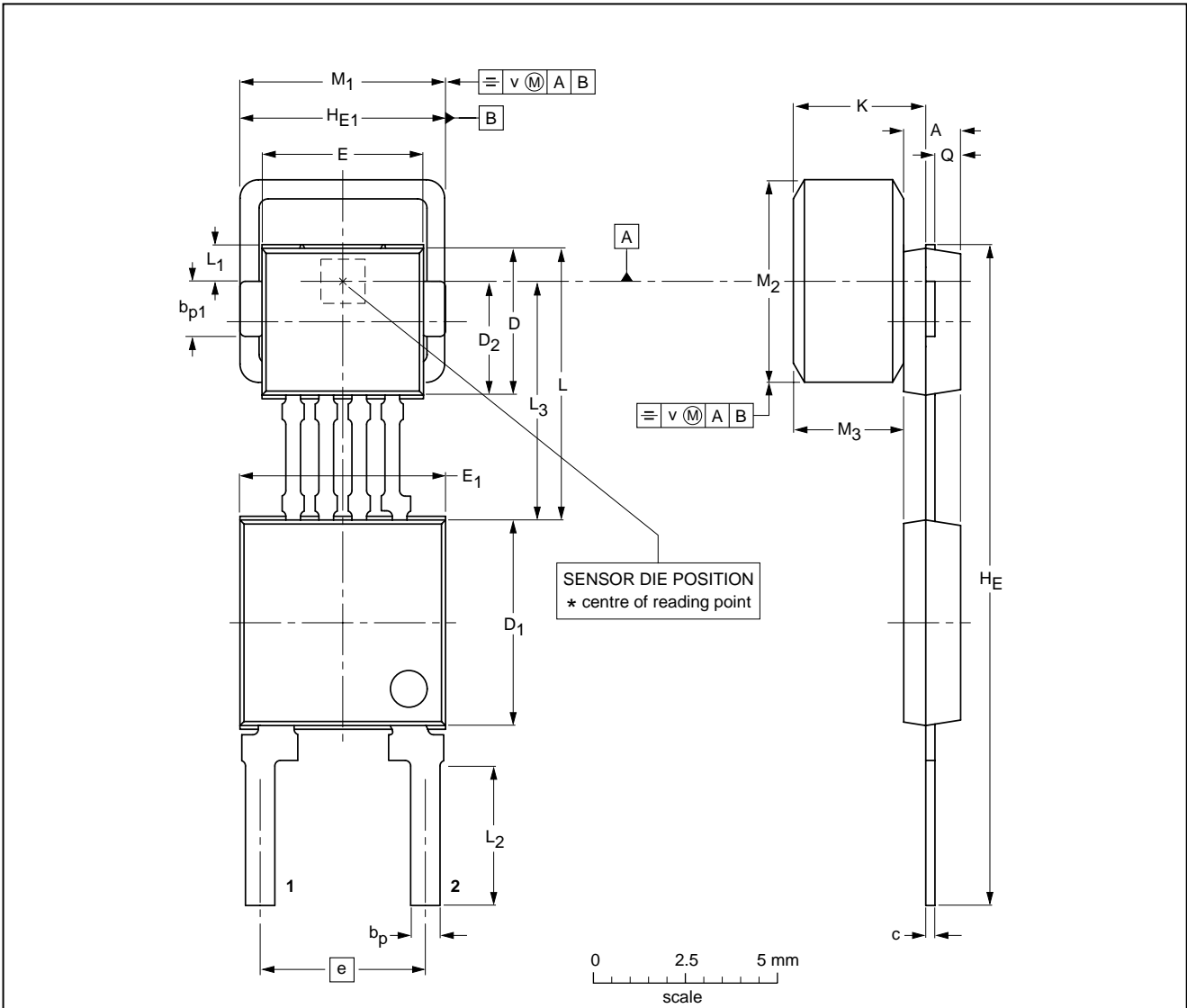
Rotational speed sensor

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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 |

Rotational speed sensor

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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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