

# TLE5045iC

## Technical product description

High End GMR Wheel Speed Sensor, ASIL B(D)

## About this document

### Scope and purpose

High-level description of the product features and technical characteristics as primary information about the functionality of the TLE5045iC High End GMR Wheel Speed Sensor, ASIL B(D)

### Intended audience

Automotive suppliers interested in wheel speed sensor applications

## About this product

### Description

Infineon's TLE5045iC is a wheel speed sensor without direction detection designed for sophisticated vehicle control systems. As the successor of the TLE5041plusC the sensor shows best-in-class jitter performance, thus being the best choice for wheel speed applications. The rotational speed is sensed with high accuracy, enabling the sensor to be used as a component of indirect tire pressure monitoring systems (iTPMS). It is based on integrated giant magneto resistance (iGMR). Excellent sensitivity to magnetic field is specified over a wide temperature range. To meet harsh automotive requirements, robustness to electrostatic discharge (ESD) and electromagnetic compatibility (EMC) was maximized without the need of additional external components.

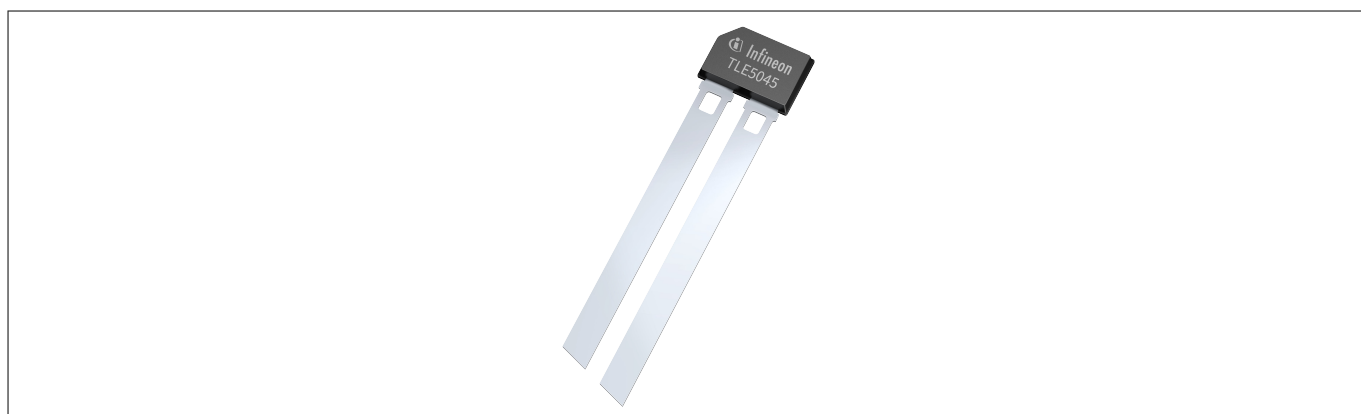


Figure 1

Product photo

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## About this product

### Features & Benefits

- Developed according to ISO 26262, compliant with the requirements of ASIL B(D)
- Low jitter 0.02% due to high switching accuracy enables iTPMS
- Two-wire current interface 7mA/14mA providing speed information
- Wide operating junction temperature range -40°C to 190°C
- Robustness against external magnetic disturbances up to 2mT through differential sensing principle
- High sensitivity enables outstanding air gap performance along with immunity against y-displacement effects
- Small sensor package 5x3mm without need of external capacitor saves module size, increases robustness against mechanical stress, and enables design freedom
- Advanced EMC concept maximizes the availability of the sensor signal
- New established Micro Break feature designed to be immune against disturbances on supply line

### Order Information

**Table 1**

| Type           | Description                                                                                 | Ordering Number |
|----------------|---------------------------------------------------------------------------------------------|-----------------|
| TLE5045iC-R050 | Speed only sensor optimized for use with load resistor $R_m \leq 50 \Omega$                 | SP001649080     |
| TLE5045iC-R100 | Speed only sensor optimized for use with load resistor $50 \Omega \leq R_m \leq 100 \Omega$ | SP001216864     |

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## 1 Product Characteristics

# 1 Product Characteristics

### Absolute Maximum Ratings

Stresses above the maximum values listed here may cause permanent damage to the device.

**Table 2**

| Parameter             | Symbol             | Min. | Typ. | Max. | Unit             | Note / Test Condition                                             |
|-----------------------|--------------------|------|------|------|------------------|-------------------------------------------------------------------|
| Supply voltage        | $V_{DD}$           | -    | -    | 24   | V                | max. 30 min @ $T_J = 25 \pm 5^\circ\text{C}$                      |
|                       |                    | -0.6 | -    | -    | V                | $T_J < 80^\circ\text{C}$ , $I_{DD}$ reverse current limit applies |
| Reverse current       | $I_{DD}$           | -200 | -    | -    | mA               | t = max 4 h                                                       |
| Junction temperature  | $T_J$              | -40  | -    | 190  | $^\circ\text{C}$ | max 4 h, < 16.5 V                                                 |
| Magnetic flux density | $B_{\text{max}_x}$ | -    | -    | 250  | mT               | max. 1min @ $T_A \leq 85^\circ\text{C}$                           |
|                       | $B_{\text{max}_y}$ | -    | -    |      |                  |                                                                   |
|                       | $B_{\text{max}_z}$ | -    | -    | 500  | mT               | max. 1min @ $T_A \leq 85^\circ\text{C}$                           |

### Operating Range

The following operating conditions must not be exceeded in order to ensure correct operation.

**Table 3**

| Parameter                                                                          | Symbol                                            | Min. | Typ. | Max. | Unit             | Note / Test Condition |
|------------------------------------------------------------------------------------|---------------------------------------------------|------|------|------|------------------|-----------------------|
| Supply voltage                                                                     | $V_{DD}$                                          | 5.2  | -    | 20   | V                | TLE5045iC-R100        |
|                                                                                    | $V_{DD}$                                          | 4.25 | -    | 20   | V                | TLE5045iC-R050        |
| Operating Temperature                                                              | $T_J$                                             | -40  |      | 190  | $^\circ\text{C}$ |                       |
| Magnetic signal frequency                                                          | $f_{\text{mag}}$                                  | 0.03 | -    | 3000 | Hz               |                       |
| Minimum differential magnetic input signal amplitude, magnetic encoder application | $dB_{\text{limit}_x}$<br>$T_A = 25^\circ\text{C}$ | 70   | 90   | 110  | $\mu\text{T}$    | 99% criterium         |
| Magnetic induction amplitude at each GMR sensing element                           | $B_x$                                             | -25  | -    | 25   | mT               |                       |
| Dynamic and static homogeneous external disturbance fields                         | $B_{\text{ext}_{XYZ}}$                            | -2   |      | 2    | mT               | no unwanted pulses    |

## 1 Product Characteristics

### Functional Parameters

The magnetic input is assumed sinusoidal with constant amplitude and offset. The typical values shown below are valid for  $V_{DD} = 12\text{ V}$  and  $T_A = 25^\circ\text{C}$ . For a more detailed specification please refer to our product datasheets which are available on request.

**Table 4**

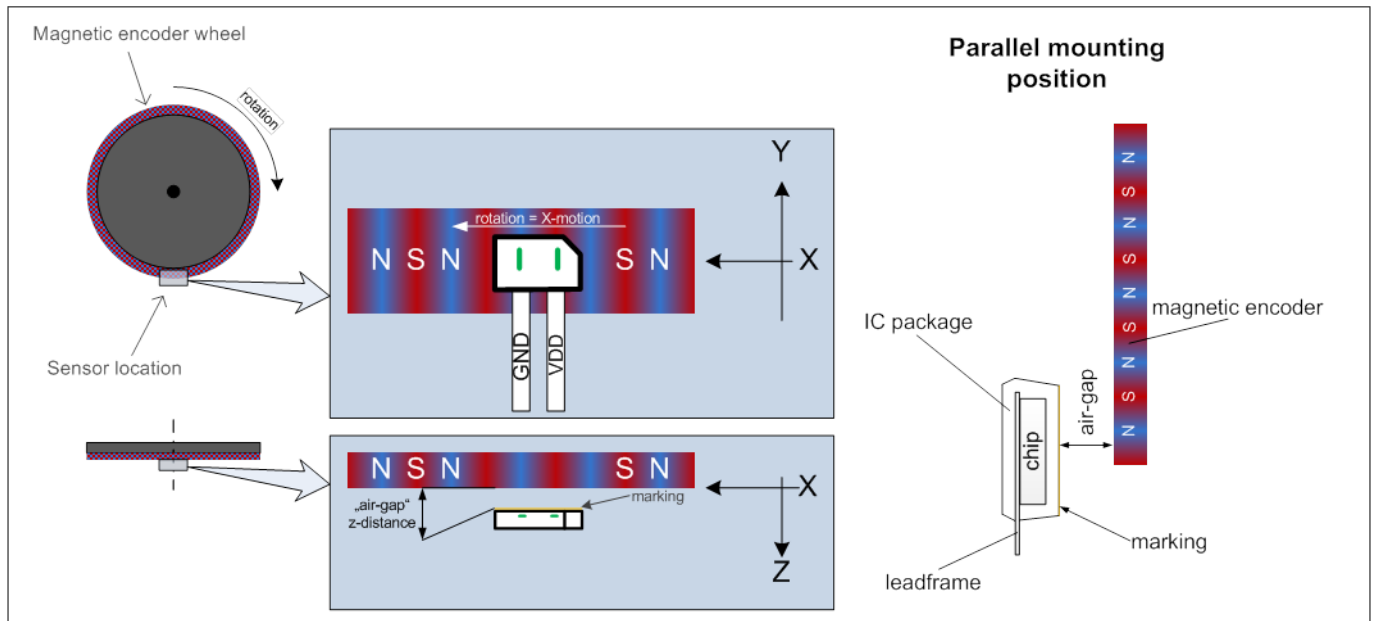
| Parameter                                      | Symbol       | Min. | Typ.       | Max. | Unit                 | Note / Test Condition                                                        |
|------------------------------------------------|--------------|------|------------|------|----------------------|------------------------------------------------------------------------------|
| Period jitter                                  | $S_{jit}$    | -    | $\pm 0.02$ |      | %                    | $\pm 1\sigma$ value                                                          |
| Duty cycle                                     | DC           | 40   | -          | 60   | %                    | in calibrated mode                                                           |
| Supply current during static output low state  | $I_{low}$    | 5.95 | 7          | 8.05 | mA                   |                                                                              |
| Supply current during static output high state | $I_{high}$   | 11.9 | 14         | 16.1 | mA                   |                                                                              |
| Current level for indicating errors            | $I_{Error}$  | 1    | 3.5        | 3.8  | mA                   |                                                                              |
| Output current slew rate                       | $SR_r, SR_f$ | 11   | -          | 28   | mA/<br>$\mu\text{s}$ | $SR_r = (I_{90\%} - I_{10\%}) / t_r$<br>$SR_f = (I_{90\%} - I_{10\%}) / t_f$ |
| Switch-off voltage                             | $V_{reset}$  |      |            | 3.5  | V                    | direct on sensor pins                                                        |
| Supply voltage hysteresis                      | $V_{Hys}$    | 1.5  |            | 1.7  | V                    | TLE5045iC-R100                                                               |
| Supply voltage hysteresis                      | $V_{Hys}$    | 0.65 |            | 0.75 | V                    | TLE5045iC-R050                                                               |

## 2 Functional Description

### 2 Functional Description

The sensor element has a magnetic interface to detect the increments of a magnetized encoder: the sensing principle is based on the giant magneto resistance (GMR) principle sensitive to magnetic fields in x-direction. It is designed for maximum sensitivity and suppression of homogeneous fields.

In the figure below the typical placement of the TLE5045iC facing a magnetic encoder wheel is shown. The figure also indicates the coordinate system, which is valid throughout this document.

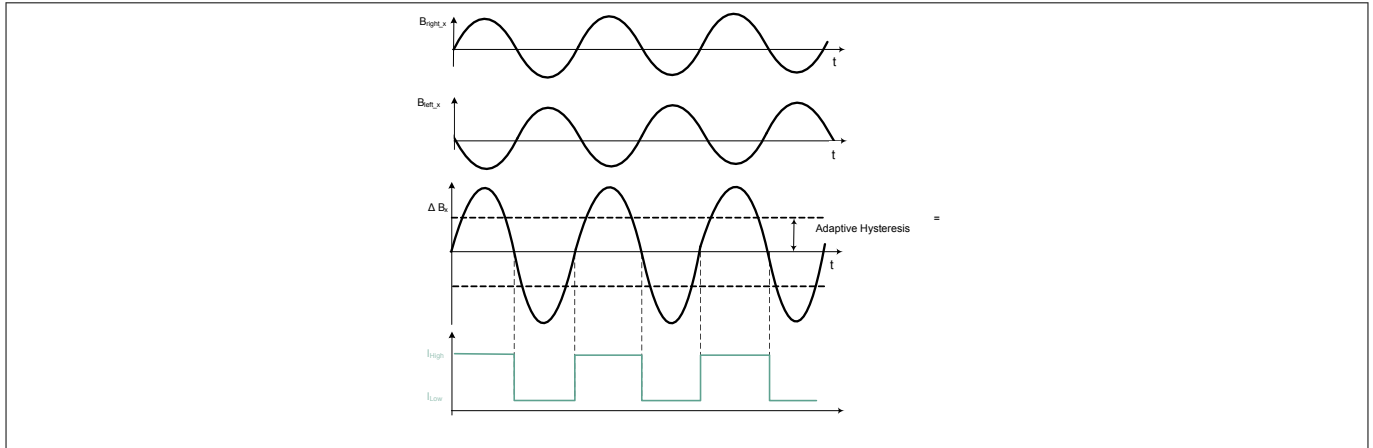


**Figure 2** Typical placement of the TLE5045iC

### 3 Speed Protocol

## 3 Speed Protocol

The first output pulse is generated when the input field exceeds the minimal magnetic threshold  $2 \times dB_{limit}$ . After minimum and maximum are detected and offset is compensated, output switching occurs at zerocrossing of the differential magnetic signal.



**Figure 3**      **Signal output pulse**

## 4 Safety Mechanisms

The TLE5045iC offers safety features to support the Automotive Safety Integrity Level ASIL B and is designed to be used in ASIL D systems.

An embedded safety concept was developed to notify the Control System in case of an internal error by setting the output current level to a constant failure indication level  $I_{Error}$ .

Following safety mechanisms have been implemented:

- **Undervoltage detection:** This safety mechanism detects voltage drops to values where the correct functionality of the circuitry is no more ensured. The sensor remains in this state until the error condition is solved and  $V_{DD}$  is back into normal operating range.
- **Detection of discrepancy between number of active fuses and internally stored number of fuses:** This safety mechanism compares the active fuse bits against the internal stored quantity. The sensor remains in this failure indication state  $I_{Error}$  until the device is powered off and on again and the error condition is not present any longer.

The entirety of Infineon experience has been used to identify and prevent common cause of failure in the application including EMC disturbances and mechanical tolerances. An advanced EMC concept, inclusive of microbreak feature, without the need of external components, maximizes the availability of the sensor signal at the electrical interface. Also, the speed algorithm is designed for fast start-up and optimization of duty cycle. The extremely low jitter of the sensor contributes to high time accuracy of the speed signal.

TLE5045iC is accompanied by accurate safety analysis and complete documentation to enable the system integrator to quickly evaluate the compatibility with the system/item and start the integration process. A detailed description of how the sensor is to be used in an ISO26262 compliant system can be found in the Safety Manual and Safety Analysis Summary Report, which are available on request.

## 5 ESD and EMC Characteristics

The TLE5045iC is characterized according to the IC level EMC requirements described in the "Generic IC EMC Test Specification" Version 2.0 from 2014. EMC testreport is available on request.

## 6 ESD HBM Model

Additionally component level EMC characterizations are performed according to ISO 7637-2:2011, ISO 7637-3:2007 and ISO 16750-2:2010 regarding pulse immunity, and CISPR 25 (2009-01) Ed. 3.0 regarding conducted emissions.

## 6 ESD HBM Model

**Table 5**

| Parameter   | Symbol    | Min. | Typ. | Max.     | Unit | Note / Test Condition                           |
|-------------|-----------|------|------|----------|------|-------------------------------------------------|
| ESD Voltage | $V_{HBM}$ | -    | -    | $\pm 12$ | kV   | Method AEC-Q100 Rev H (1.5 k $\Omega$ , 100 pF) |

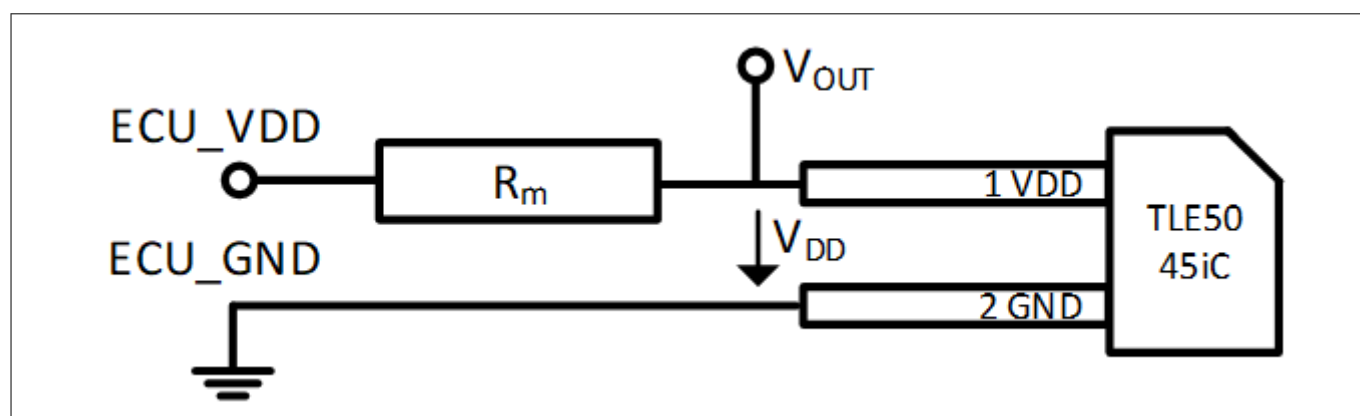
## 7 Product Qualification

Product qualification according to AEC-Q100 Grade 0 is performed.

## 8 Pin Configuration

**Table 6**

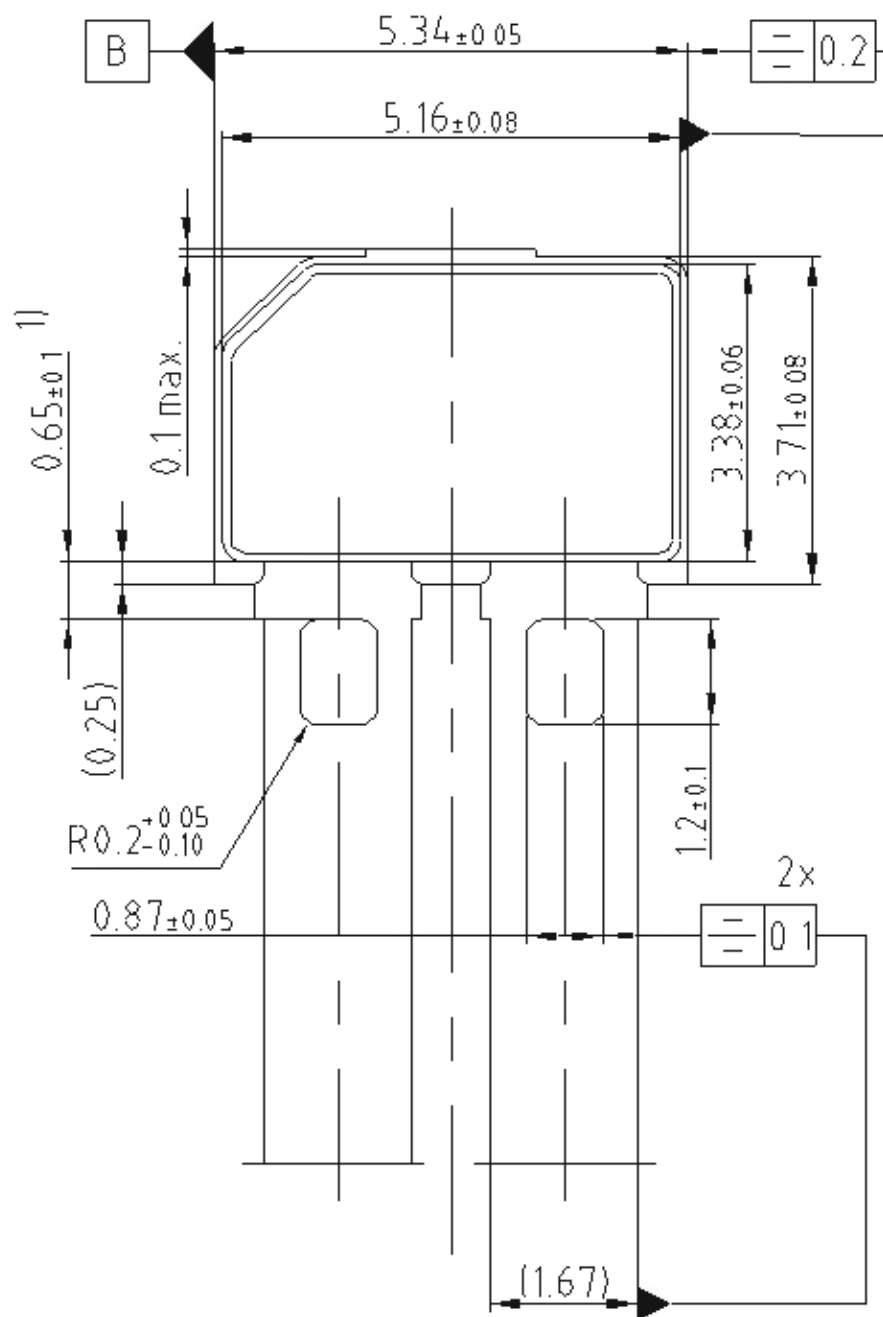
| Pin No. | Symbol | Function       |
|---------|--------|----------------|
| 1       | VDD    | Supply voltage |
| 2       | GND    | Ground         |



**Figure 4** Pin configuration

## 9 Package Outline

### 9 Package Outline



Z8B00008288\_06

Figure 5 Package Outline

## 10 Terminology

# 10 Terminology

**Table 7**

|       |                                                                 |
|-------|-----------------------------------------------------------------|
| μs    | microsecond                                                     |
| μT    | micro-Tesla                                                     |
| A     | Ampere                                                          |
| AEC   | Automotive Electronics Council                                  |
| AK    | Arbeitskreis                                                    |
| ASIC  | application specific integrated circuit                         |
| ASIL  | automotive safety integrity Level                               |
| C     | Celsius                                                         |
| CISP  | Comité international spécial des perturbations radioélectriques |
| EMC   | electromagnetic compatibility                                   |
| ESD   | electrostatic discharge                                         |
| GMR   | giant magneto resistance                                        |
| GND   | ground                                                          |
| h     | hour                                                            |
| HBM   | human body model                                                |
| Hz    | Hertz                                                           |
| IC    | integrated circuit                                              |
| iGMR  | integrated giant magneto resistance                             |
| ISO   | International Organization for Standardization                  |
| iTPMS | integrated tire pressure monitoring system                      |
| kΩ    | kilo-Ohm                                                        |
| kV    | kilo-Volt                                                       |
| mA    | milli-Ampere                                                    |
| min   | minute                                                          |
| mm    | millimeter                                                      |
| ms    | millisecond                                                     |
| mT    | milli-Tesla                                                     |
| Ω     | Ohm                                                             |
| pF    | picofarad                                                       |
| PWM   | pulse width modulation                                          |
| V     | Volt                                                            |
| VDD   | supply voltage                                                  |

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**Revision history**

**Revision history**

| Document version | Date of release | Description of changes                                          |
|------------------|-----------------|-----------------------------------------------------------------|
| 1.0              | 2018-11-06      | <ul style="list-style-type: none"><li>Initial version</li></ul> |

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**Edition 2018-11-06**

**Published by**  
**Infineon Technologies AG**  
**81726 Munich, Germany**

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