TLE5046SiC Data Sheet

TLE5046SiC
High End GMR Wheel Speed Sensor ASIL B (D)

Features and Benefits

- Developed according to ISO 26262, compliant to the requirements of ASILB(D)
- Low jitter 0.02% due to high switching accuracy enables iTPMS
- Wide operating junction temperature range -40°C to 190°C
- Two-wire current interface providing speed and direction information
- High sensitivity enables outstanding air gap performance along with immunity against y-displacement effect
- Robustness against external magnetic disturbances up to 2 mT through differential sensing principle
- Advanced stop-start capabilities enabled by
  - Innovative watchdog concept to guarantee maximum signal availability
    - No loss of direction information during start stop condition
- Small sensor package 5 x 3 mm 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

PRO-SIL™ for ISO 26262

TLE5046SiC 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. The provided Safety Manual explains how to use the sensor in safety critical applications and the Safety Analysis Summary Report provides the key results of the safety analysis.

http://www.infineon.com/cms/en/applications/automotive/safety/

Description

The TLE5046SiC-AK-LR is a wheel speed sensor with direction indication designed for sophisticated vehicle control systems. TLE5046SiC-AK-LR shows best in class jitter performance making it 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) has been maximized without the need of additional external components.

Product Variants and Ordering Codes

TLE5046SiC is available in 2 different variants, both are ASIL B (D) compliant and can be integrated in an ASIL D system. Both variants comes up with very low FIT rate, due to the design and technical concept. In addition the TLE5046SiC-AK-ERR Version offers an elaborate safety concept.

Table 1 Product Variants

Product Type	Load Resistor[1)]	Marking	Ordering Code	Package	ASIL
TLE5046SiC-AK-LR[1) 2)]	15 Ω ≤ RM ≤ 50 Ω	462X0A	SP005947803	PG-SSO-2-1	ASIL B (D)
TLE5046SiC-AK-ERR[1) 3)]	15 Ω ≤ RM ≤ 50 Ω	462X0K	SP005965436	PG-SSO-2-1	ASIL B (D)

1) see Application Circuit Chapter 1
2) basic Safety Concept, for details see Safety Manual
3) enhanced Safety Concept, for details see Safety Manual. This sensor offers lower FIT rates

Due to the “Standard VDA AK4.0” document in Chapter 5.2.4 [10] the bit position #0 can be used as indication for “air gap - Luftspaltreserve” or it can be interpreted as “Error bit” which can be interpreted by the ECU and treated in a special way, to initiate corresponding measures on system level. The air gap warning bit is set when the measured magnetic input signal of the sensor drops below the value of the double magnetic input signal based on the limit air gap.

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1 Application Circuit

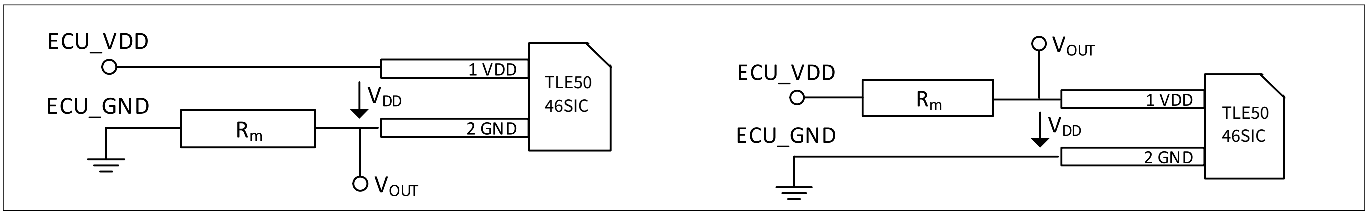


Figure 1 Pin Configuration PG-SSO-2-1

Table 2 Pin Description

Pin No.	Symbol	Function
1	V_{DD}	Supply voltage
2	GND	Ground

2 Absolute Maximum Ratings

Table 3 Maximum Ratings[1)]

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD}	-	-	24	V	max. 30 min @ T_J = 25 +/- 5°C
		-0.6	-	-	V	T_J < 80°C, I_{DD} reverse current limit applies
Reverse current	I_{DD}	-200	-	-	mA	t = max. 4 h
Junction temperature[2)]	T_J	-40	-	190	°C	max. 4 h, V_{DD} < 16.5 V
Magnetic flux density	B_{max_x}	-	-	250	mT	max. 1 min @ $T_A \leq$ 85°C
	B_{max_y}					
	B_{max_z}	-	-	500	mT	max. 1 min @ $T_A \leq$ 85°C

1) Stresses above the maximum values listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability. Maximum ratings are absolute ratings; exceeding only one of these values may cause irreversible damage to the integrated circuit.

2) This life time statement is an anticipation based on extrapolation of Infineon qualification test results. The actual life time of a component depends on its form of application and type of use etc. and may deviate from such a statement. The life time statement shall in no event extend the agreed warranty period.

Table 4 Lifetime Conditions[1)]

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Passive overall lifetime	$L_{Tpassive}$	15	-	-	years	$T_J \leq$ 50°C, V_{DD} = 0 V non active operating condition
Active lifetime	t_L	42500	-	-	hours	incl. 30000 h battery charging time
Power-on cycles	n_{PO}	10^6	-	-	-	V_{DD} = 12 V → 0 V → 12 V; T_A = 25°C

1) This life time statement is an anticipation based on extrapolation of Infineon qualification test results. The actual life time of a component depends on its form of application and type of use etc. and may deviate from such a statement. The life time statement shall in no event extend the agreed warranty period.

3 Operating Range

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

Table 5 Operating Range

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD}	5.2	-	20	V	TLE5046SiC-R050
Load resistor	R_m	15		50	Ω	Chapter 5.2.2
Junction temperature Mission profile[1]	T_J	-40		125	°C	either 10000 h
		-40		150	°C	or, 5000 h
		-40		160	°C	or, 2500 h
		-40		170	°C	or, 500 h
		-40		110	°C	or, 12500 h
		-40		190	°C	additional 4 h, V_{DD} < 16.5 V
		-10		60	°C	additional 30000 h (battery charging time)
Supply voltage modulation[2]	V_{AC}			6	Vpp	V_{DD} = 13.5 V, 10 < f_{mod} < 150 kHz, sinusoidal shape of supply voltage modulation
Magnetic signal frequency[2]	f_{mag}	0	-	3000	Hz	
Minimum differential magnetic input signal amplitude, magnetic encoder application[3]	dB_{limit_x} T_a = 25°C	70	90	110	µT	99% criterion, Figure 15
Minimum differential magnetic input signal amplitude, magnetic encoder application[2] [3]	dB_{limit_x} T_a = -40°C	80	100	120	µT	99% criterion
Minimum differential magnetic input signal amplitude, magnetic encoder application[2] [3]	dB_{limit_x} T_a = 175°C	30	50	70	µT	99% criterion
Magnetic induction amplitude at each GMR sensing element[2]	B_x	-25	-	25	mT	T_J = 25°C
Dynamic and static homogeneous external disturbance fields[2]	B_{ext_XYZ}	-2		2	mT	In calibrated mode. Same field at both probes, no unwanted pulses

(table continues...)

Table 5 (continued) Operating Range

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Differential input signal amplitude after nonrecurring air gap change	k_{jump}	60	-	200	%	Within ≥ 3 signal periods. No pulse failure, period jitter and duty cycle exceeding specification; see Figure 3
Differential input signal amplitude change because of a recurring air-gap variation	k_{runout}	90	-	110	%	Once per revolution with 48 periods; see Figure 2
Typical thermal resistance of sensor module[4)]	R_{thJA}		120		K/W	Including customer overmolding

1) This life time statement is an anticipation based on extrapolation of Infineon qualification test results. The actual life time of a component depends on its form of application and type of use etc. and may deviate from such a statement. The life time statement shall in no event extend the agreed warranty period.
2) Not subject to production test, verified by design/characterization
3) 99% criterion is defined as 1% of the magnetic edges are not represented as signal edges at the electric interface. Test condition: 1 missing pulse out of 100 valid for $f_{mag} \leq 10$ Hz; 10 missing pulses out of 1000 valid for $f_{mag} > 10$ Hz. An implemented temperature coefficient compensates the magnetic material temperature dependency (-0,2% per Kelvin) and keeps the air gap over temperature constant.
4) Calculation ambient temperature T_A --> junction temperature T_J: $T_J = T_A + \Delta T_{JA}$ ΔT_{JA_typ} (typical value) = 13.5 V * 10.5 mA * 120 K/W (typical sensor module RTH) = 17 K

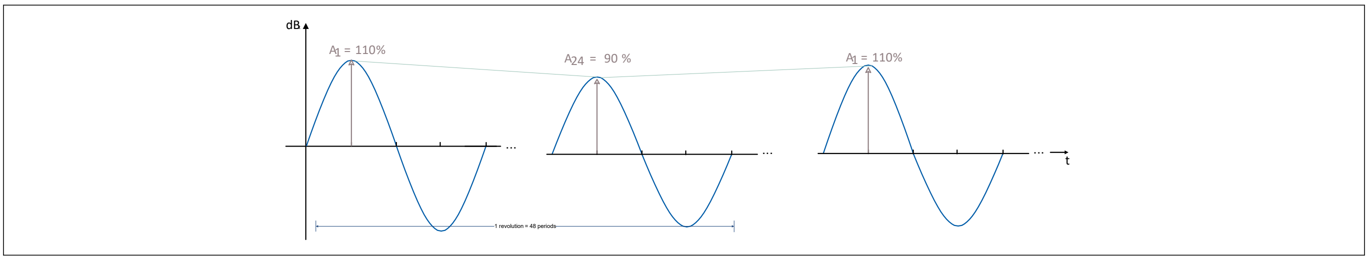


Figure 2 **Recurring air-gap variation**

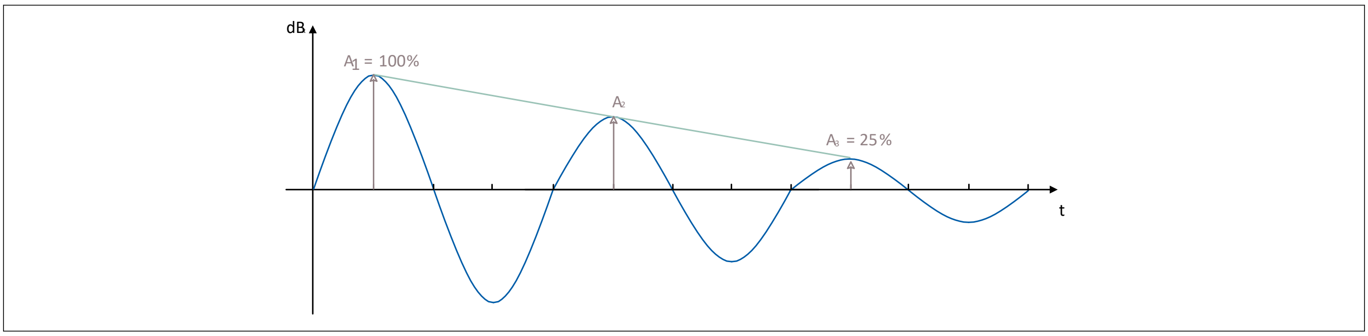


Figure 3 **Non-Recurring air-gap change due to e.g road bumps**

4 Functional Parameters

The magnetic input is assumed sinusoidal with constant amplitude and offset. The typical values shown below are valid for V_{DD} = 12 V and T_A = 25°C.

Table 6 Functional Parameters

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Periodic jitter[1)]	S_{jit}	-	-	±0.07	%	± 1 σ value; differential magnetic input signal and calibrated mode, frequency 1 Hz < f_{mag} < 3 kHz, amplitude 376 µT ≤ ΔB_X ≤ 500 µT; Figure 11, Figure 12, Figure 13
Periodic jitter[1)]	S_{jit}	-	-	±0.05	%	± 1 σ value; differential magnetic input signal and calibrated mode, frequency 1 Hz < f_{mag} < 3 kHz, amplitude 501 µT ≤ ΔB_X ≤ 6.3 mT; Figure 11, Figure 12, Figure 13
Periodic jitter[1)]	S_{jit}	-	±0.02		%	± 1 σ value; differential magnetic input signal and calibrated mode, frequency 1 Hz < f_{mag} < 3 kHz, Amplitude 6.3 mT ≤ ΔB_X ≤ 25 mT; Figure 11, Figure 12, Figure 13
Duty cycle[1)]	DC	40	-	60	%	In calibrated mode; sinusoidal input signal and calibrated mode; f_{mag} > 1 Hz; s; DC = 100% * t1/T, B_{ext_XYZ} = 0 mT, differential magnetic input signal amplitude 2x dB_{limit_x} ≤ ΔB_X ≤50 mT; Figure 14
Power-on time[1)]	t_{on}	-	-	200	µs	
Magnetic edges required for first offset correction[1)]	n_{start}	-	-	4	-	f_{mag} ≥ 1 Hz
Magnetic edges required for first output pulse[1)]	n_{first_pulse}	1	-	2	-	After t_{on}
Supply current during static output low AK 4.0 Protocol	I_{low}	5.95	7	8.05	mA	
Supply current during static output mid state AK 4.0 Protocol	I_{mid}	11.9	14	16.1	mA	
Supply current during static output high AK 4.0 Protocol	I_{high}	23.8	28	32.2	mA	

(table continues...)

Table 6 (continued) Functional Parameters

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
I_{Error} failure indicating current	I_{Error}	1	3.5	3.8	mA	Low current indicates detected error
Output current slew rate	S_{Rr}, S_{Rf}	11	-	28	mA/µs	See Figure 5; $SR_r = (I_{90\%} - I_{10\%})/t_r$; $SR_f = (I_{90\%} - I_{10\%})/t_f$;
Supply current ratio	I_{mid}/I_{low}	1.9		2.2	-	Same temperature and same R_m for both current levels
Supply current ratio	I_{high}/I_{low}	3.8		4.5	-	Same temperature and same R_m for both current levels
Supply current ratio[1)]	I_{high}/I_{mid}	1,9		2.2	-	Same temperature and same R_m for both current levels
Switch-off voltage	V_{reset}			3.5	V	Direct on sensor pins Chapter 5.2.2
Supply voltage hysteresis TLE5046SiC-AK	V_{Hys}	1.5		1.7	V	Chapter 5.2.2

1) Not subject to production test, verified by design/characterization.

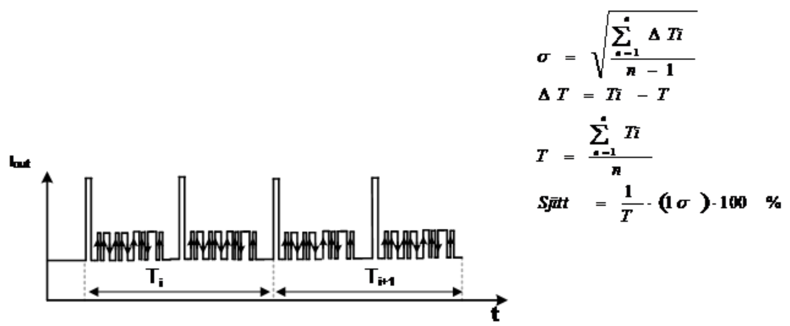


Figure 4 Period jitter definition for coil measurements for AK 4.0 protocol

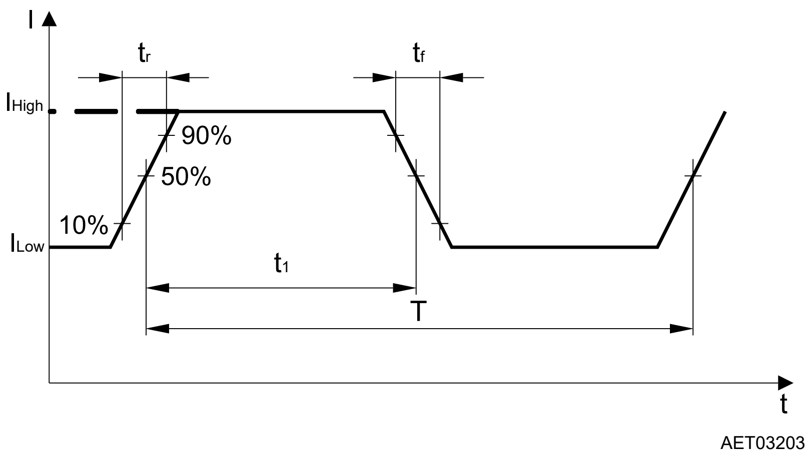


Figure 5 Definition of Duty Cycle = t1/T x 100% ; Rise and Fall Time

5 Functional Description

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

In Figure 6 the typical placement of the TLE5046SiC-AK facing a magnetic encoder wheel is shown.

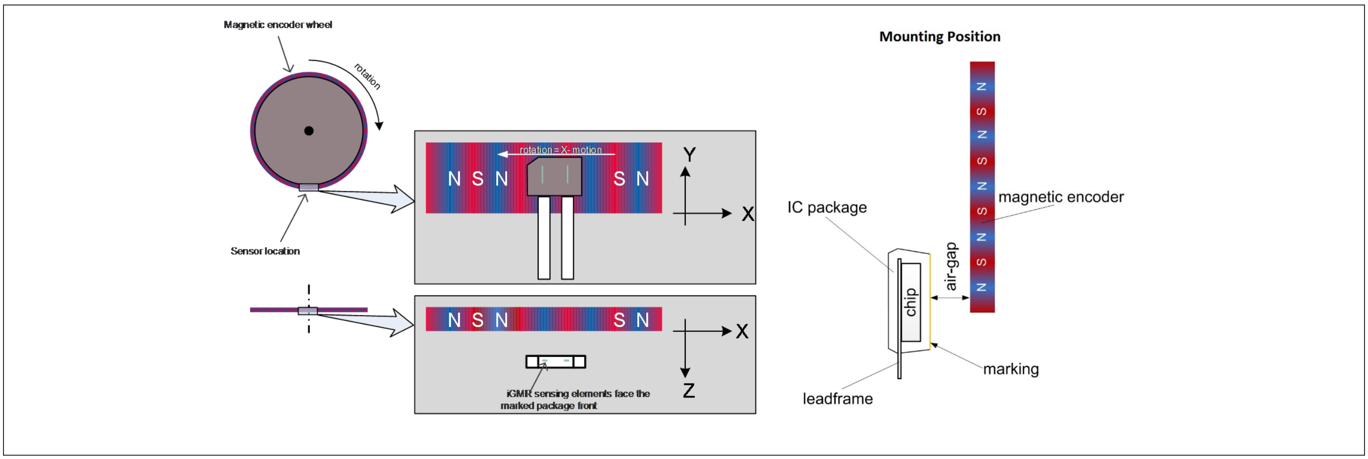


Figure 6 **TLE5046SiC in Magnetic Encoder Mounting Position**

Note: Y = 0 mm refers to the B_y *= 0 mT line of the magnetized stripe.*

5.1 Block Diagram

The sensing elements are integrated on the chip in a Wheatstone Bridge. The bridge is sensing a differential speed signal and suppressing external homogeneous fields. Each half bridge consists of two GMR elements 1.63 mm apart. The direction element is placed almost in the middle of the two speed elements. The signal path comprises a differential amplifier and a noise limiting low pass filter and a comparator. An offset cancellation loop is in place to compensate magnetic and electric offsets. The regulation loop consists of a tracking A/D converter, the digital core to evaluate the offset and the offset DAC to feed in the corrective voltage.

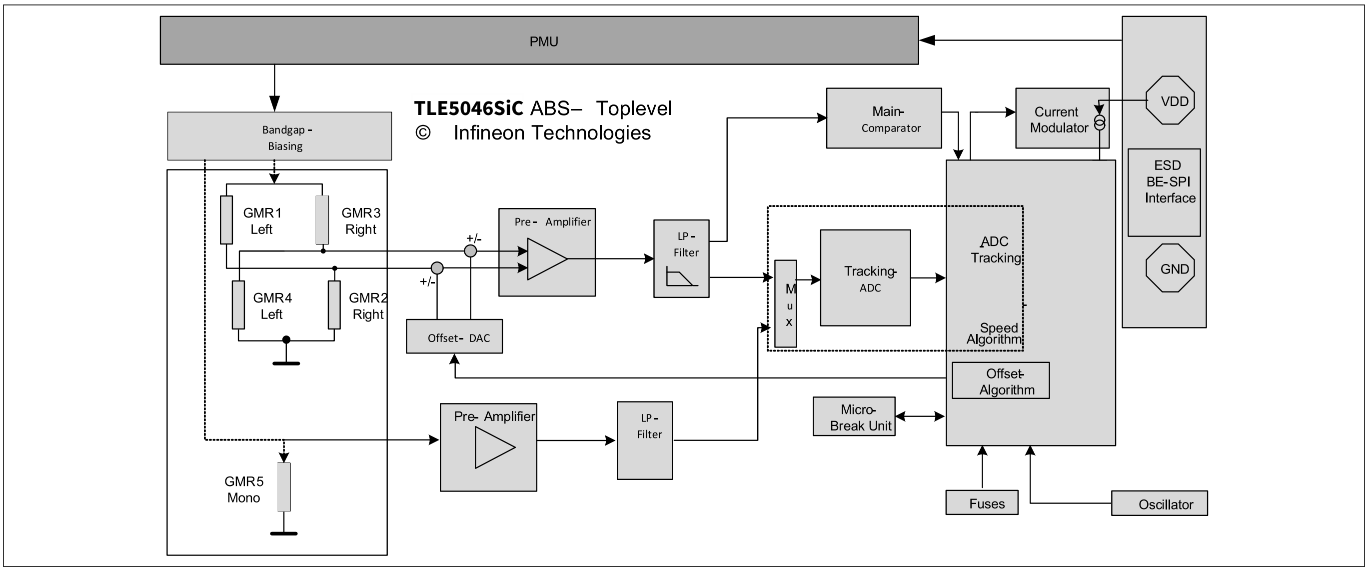


Figure 7 **Block diagram**

5.2 Switching Behavior

The first output pulse is generated when the input field exceeds the minimal magnetic threshold “2 x dBlimit”. This leads to phase shift in the Duty Cycle during uncalibrated mode (see Figure 11), but ensures the first pulse occurs on first pole pair, so the speed information is immediately available.

After minimum and maximum are detected and offset is compensated, output switching occurs at zero-crossing of the differential magnetic signal.

Direction information on the first output pulse in uncalibrated mode is unknown, this is indicated via the GDR bit in the protocol, but ensures that after startup, while direction is still invalid, a valid speed signal is issued.

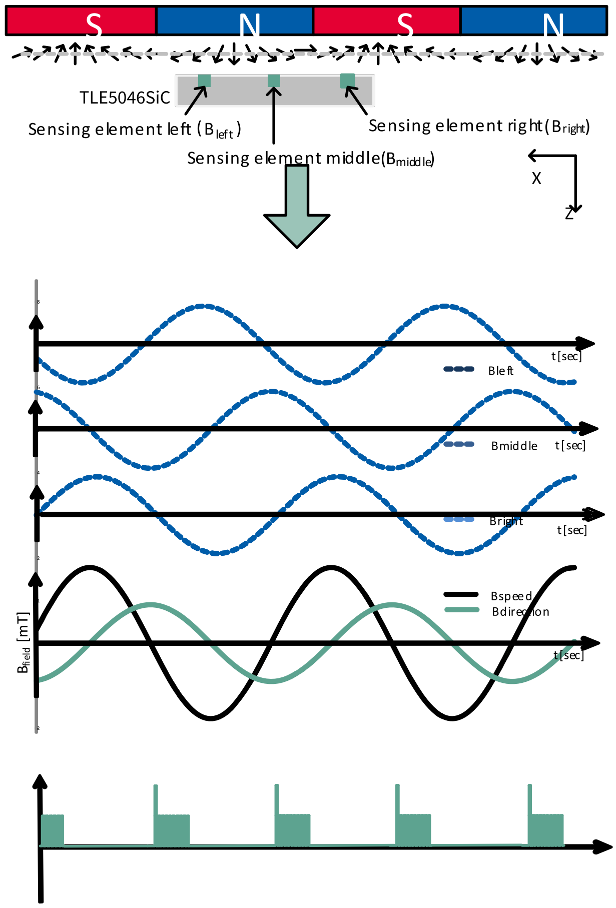


Figure 8 **Magnetic input signal and corresponding output switching**

5.2.1 Operating Modes

The device can be in one of two operating modes, namely uncalibrated mode or calibrated mode.

5.2.1.1 Uncalibrated Mode

After supplying the device it starts tracking the input signal after power on time t_{on}. The device is now in uncalibrated mode with an initial fast offset compensation. In order to trigger the first edge, the magnetic input signal has to exceed 2 * dB_{limit_x}.

The devices switches over to calibrated mode when proper offset compensation is achieved. After the calibration is finished the device operates with its full performance.

5.2.1.1.1 Calibrated Mode

In calibrated mode the output will switch at zero-crossing of the input signal. Signals below a defined threshold dB_{limit_x} do not trigger the current interface to avoid noise induced unwanted output switching. The calibrated mode provides a slower offset compensation to achieve the best jitter performance.

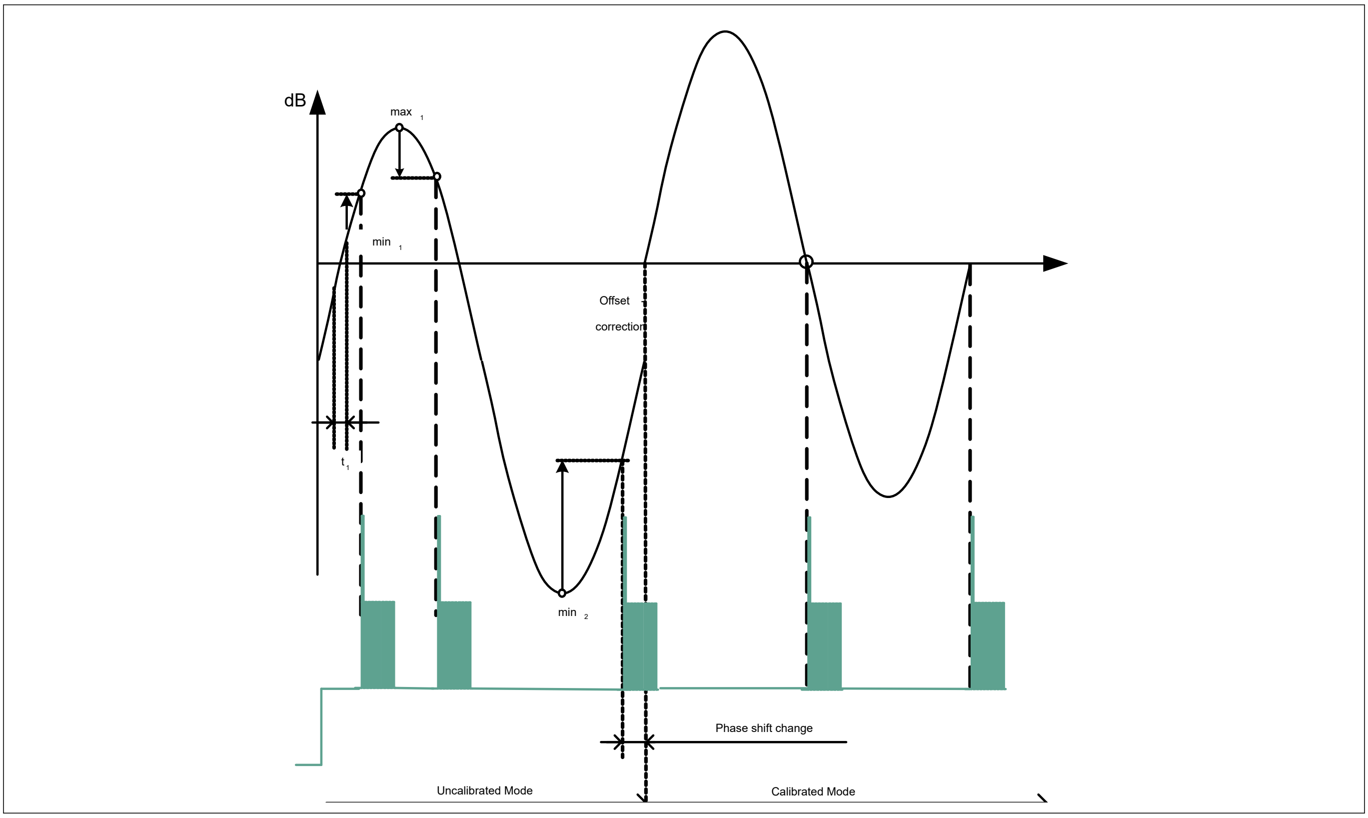


Figure 9 **First positive offset correction**

5.2.2 Undervoltage Behavior

A hysteresis V_{hys} is implemented depending on the resistor in use avoiding a toggling of the output when the supply voltage V_{DD} is modulated due to the additional voltage drop at R_M when switching from low to high current level.

If the supply voltage V_{DD} drops below the switch-off level V_{reset} the sensor reduces its current consumption to I_{Error} regardless of the magnetic encoder input signal. After V_{DD} exceeding again the voltage release level $V_{release}$ the sensor restarts and resumes in normal operation. The minimum required supply voltage V_{DD} for the chip to power on is defined by the voltage release level V_{rel}. During $t_{power\text{-}on}$, the current I will not exceed the level for I_{low}.

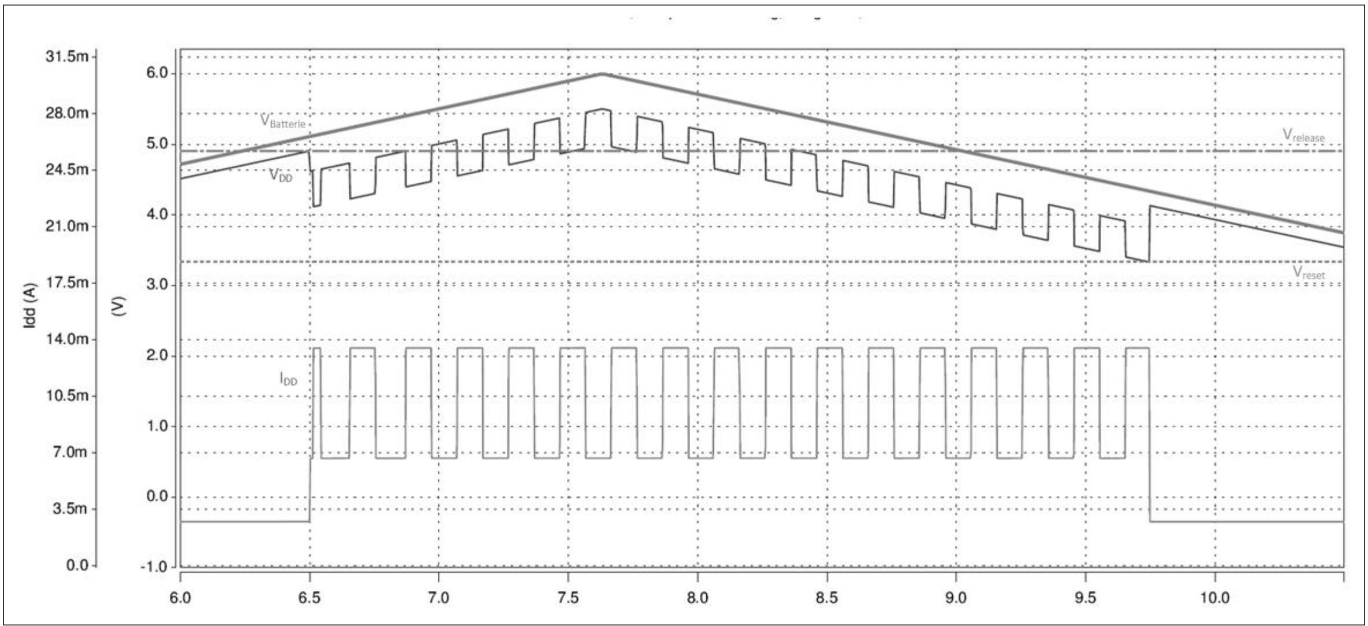


Figure 10 **Undervoltage behavior**

5.2.3 Watchdog

An innovative temperature watchdog has been designed to maximize the sensor availability and avoid wrong sensor output in extreme conditions created by temperature drift in absence of motion.

5.2.4 Safety Mechanisms

The TLE5046SiC 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 minimize the effect of hard and soft random errors by the introduction of specific safety mechanisms. In case of an internal error a notification to the ECU is transmitted by either setting the output current level to a constant failure indication level I_{Error} or transmitting an error flag via the protocol.

Following safety mechanisms have been implemented including:

- 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
- Detection of clock malfunction
  - This safety mechanism forces the failure indication state if the clock is either stuck or below 25% of the nominal value

- Detection of different numbers between speed and direction path
  - This safety mechanism verifies if more than two consecutive electric events are generated without any detected event in the direction path or vice versa
- Detection of critical airgap, ADC clipping and temperature monitoring
  - This safety mechanisms verifies critical states inside the ASIC itself

The full overview including detailed descriptions of the functionality of each safety mechanism and the detailed failure reaction can be found in the safety manual.

All 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. And the speed algorithm is designed for fast start-up and optimization of duty cycle. The extreme low jitter of the sensor contributes to high time accuracy of the speed signal.

TLE5046SiC 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.

5.3 Typical Performance

Based on characterization results the following typical data was evaluated. The extreme low jitter of the sensor contributes to high time accuracy of the speed signal. In general a very low jitter floor can be seen over the full frequency and temperature range at small fields as well as larger fields.

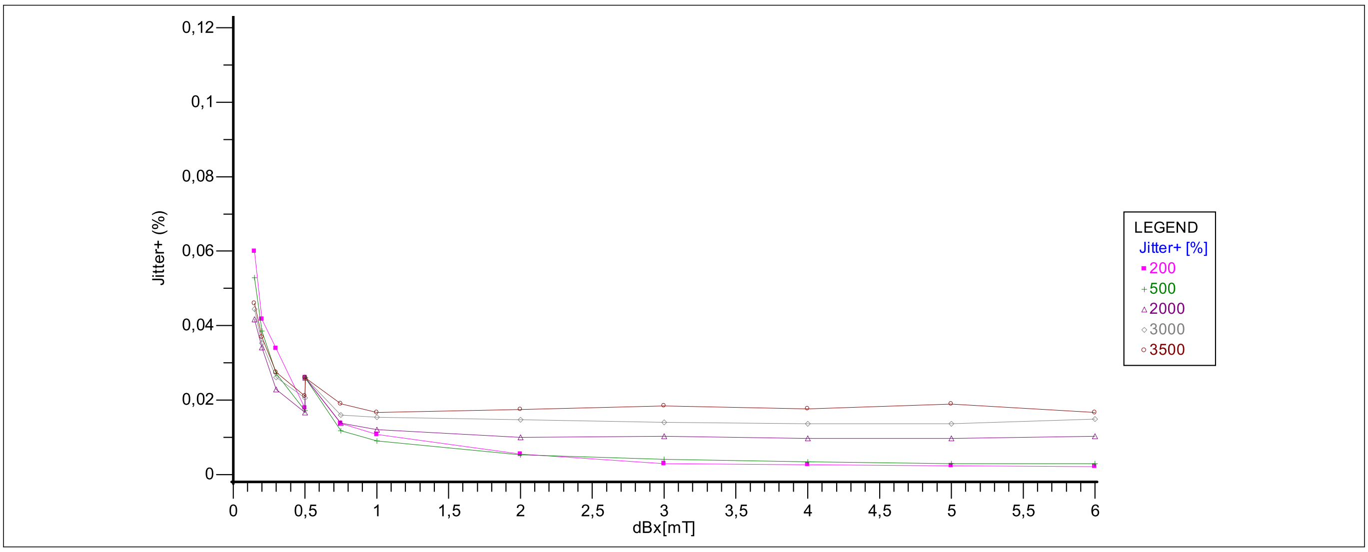


Figure 11 **Jitter performance over different frequencies Ta = -40°C**

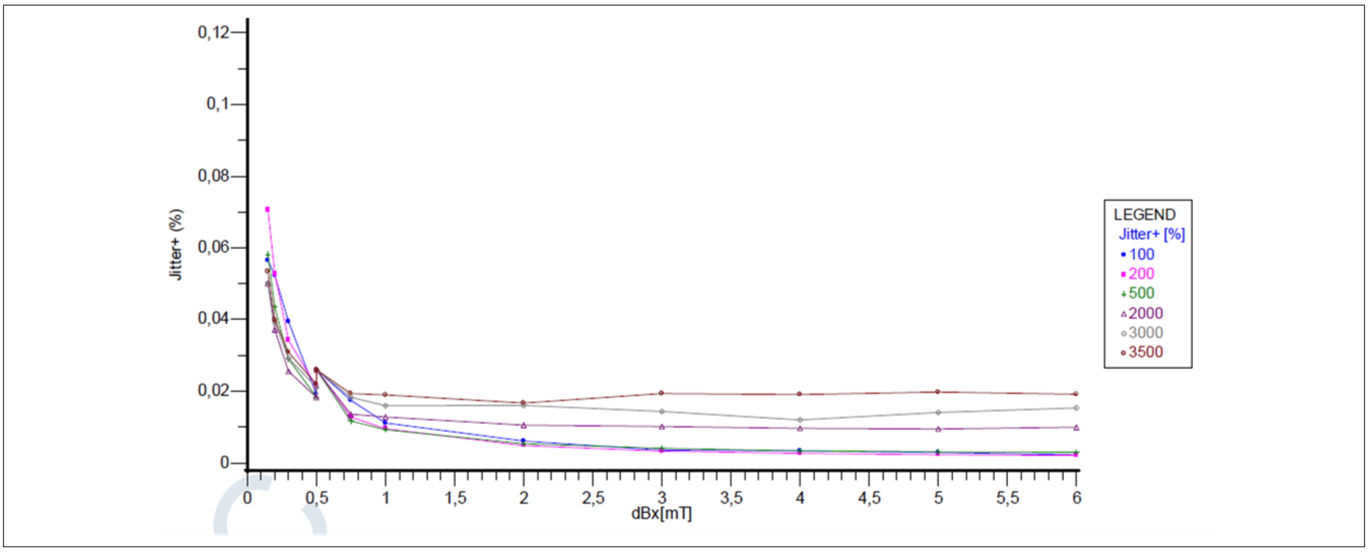


Figure 12 **Jitter performance over different frequencies Ta = 25°C**

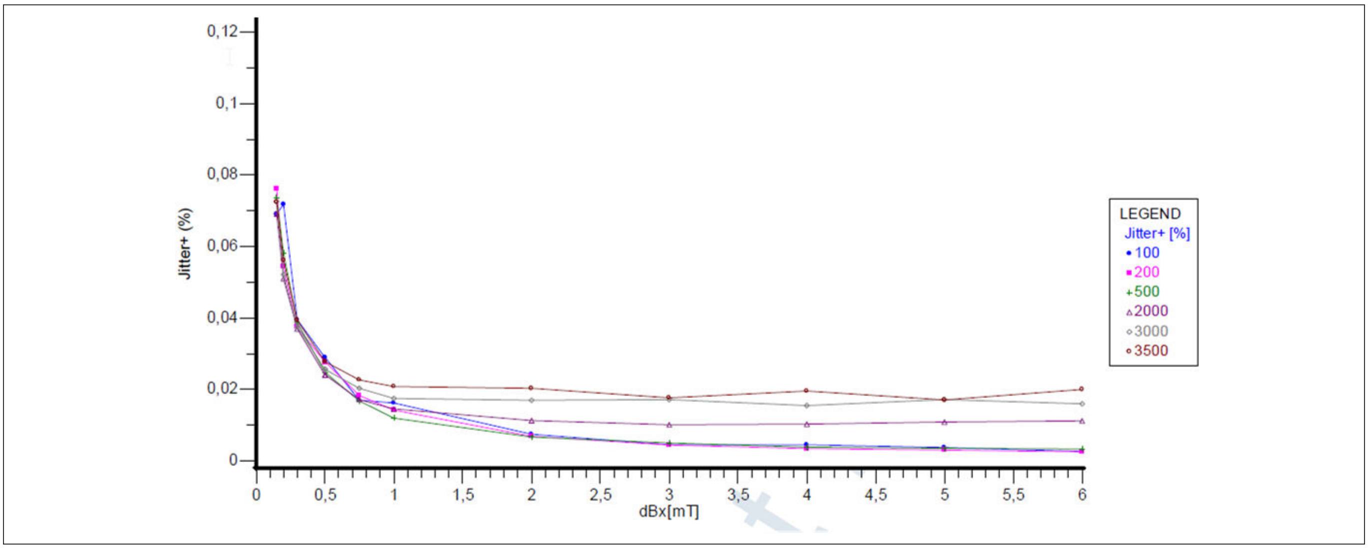


Figure 13 **Jitter performance over frequency Ta = 175°C**

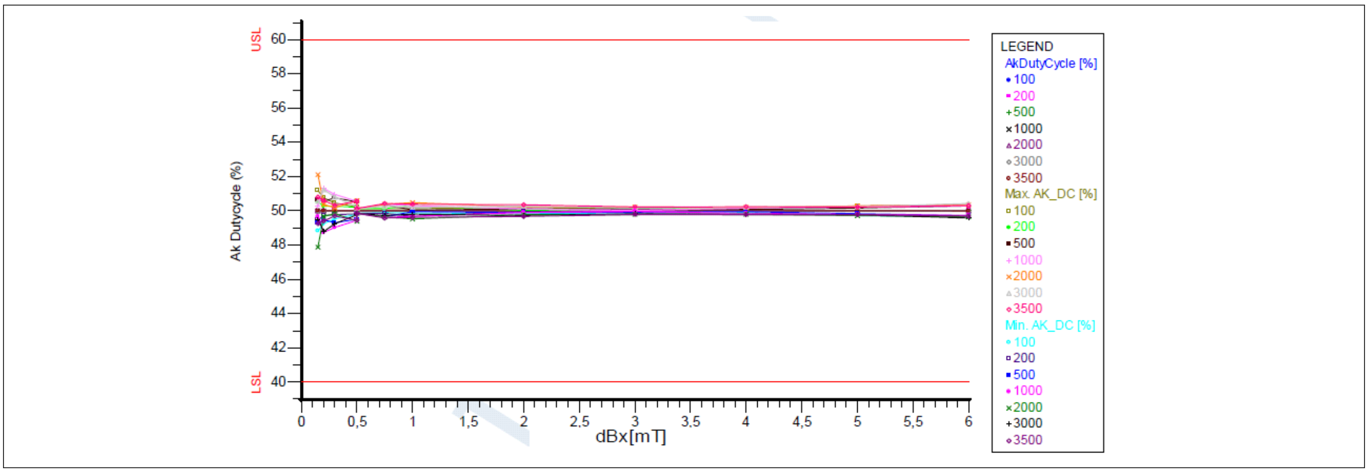


Figure 14 **Duty Cycle performance**

The sensor is designed with a temperature coefficient of -2000 ppm/K to compensate the temperature dependency of magnetic materials. This ensures, that with varying temperature the airgap stays constant.

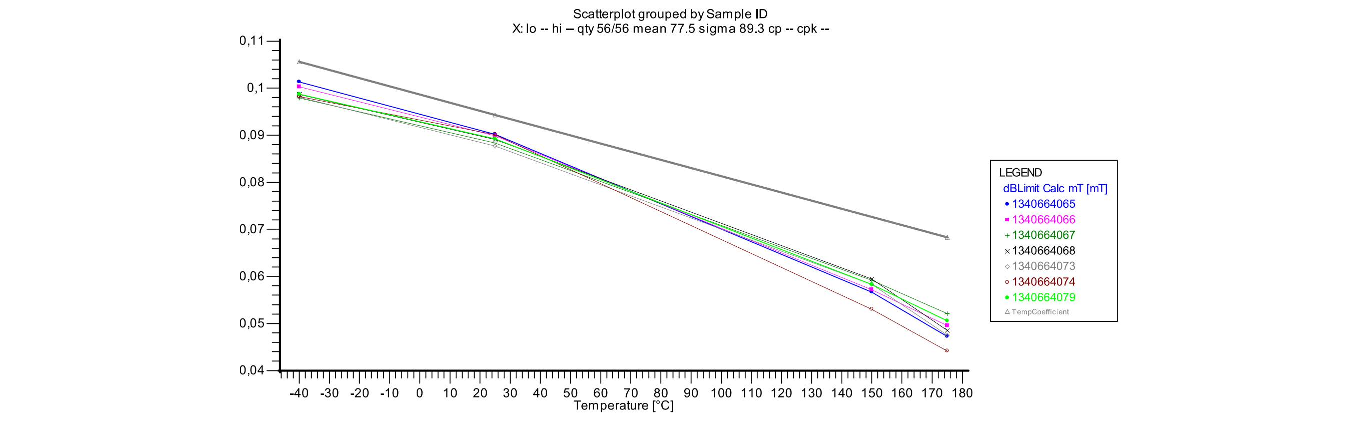


Figure 15 **dBlimit over temperature with implemented Temperature coefficient of -2000 ppm/K**

6 VDA AK 4.0

The devices are compliant to Version: "Requirement Specifications for Standardized Interface for Wheel Speed Sensors with Additional Information "AK-Protocol" Version: 4.0 13.02.2008 of Daimler AG" unless otherwise stated in this document.

6.1 Bit Definition

This following illustration defines the meaning of the data protocol. The bits 0 - 8 in the illustration are designated as the data protocol and their purpose is to transfer the additional information to the speed pulse. The usage of the bits can be seen in Table 7.

Bit position #0, can be used as an indication for air gap reserve (LR), or can be interpreted by the ECU as an "error bit" and treated in a special way. The two different variants TLE5046SiC-AK-LR and TLE5046SiC-AK-ERR perform this behavior, see Table 1.

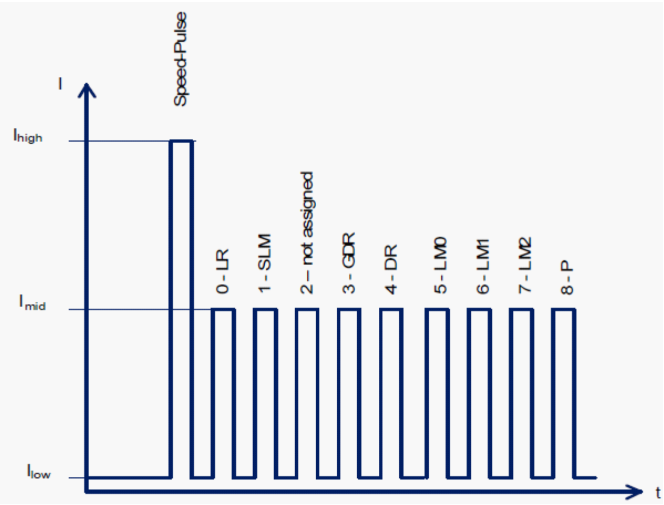


Figure 16 Coding of data bits AK 4.0

Table 7 Coding of Additional Information

Bit	Meaning	Name	Value after power up/under voltage	Condition
0	Error bit or	ERR or	0	1 = error
0	Airgap reserve	LR	0	"1" if $dB < 2* dB_{limit}$
1	Validity of signal amplitude measurement	SLM	1	0 = measurement of LM0, LM1, LM2 is valid; 1 = invalid
2	Not assigned		0	Default 0
3	Direction validity	GDR	0	"1" = valid, "0" = invalid
4	Direction of rotating information	DR	0	"0" = direction positive
5	Air gap gauge	LM0	0	LSB of airgap gauge
6		LM1	0	
7		LM2	0	MSB of airgap gauge

(table continues...)

Table 7 (continued) Coding of Additional Information

Bit	Meaning	Name	Value after power up/under voltage	Condition
8	Parity	P	To be currently calculated	Always set to get even parity (inclusive Parity bit itself)

Bit 0 used as LR

The LR bit is set to “1” when the measured magnetic input signal of the sensor drops below 2* dB_{limit} based on the limit air gap see Table 1

Bit 0 used as ERR

With a change from logic “0” to logic “1”, a status is displayed that is interpreted by the ECU as an “error” in the sensor for example internal errors. Then corresponding measures can be initiated in the safety concept see Table 1

6.2 AK 4.0 in TLE5046SiC-AK-LR and TLE5046SiC-AK-ERR

For behavior of AK 4.0 we refer to the official “Requirement Specifications for Standardized Interface for Wheel Speed Sensors with Additional Information “AK-Protocol” Version: 4.0 13.02.2008 of Daimler AG“ additional properties or properties which are marked as optional in the official document mentioned above, are described in the following sections.

6.2.1 Bit stump suppression - Constant time shift of output of speed pulse and data protocol

The suppression of bit stumps in the Wheel Speed Sensor is required, so that the combination of sensors and ECUs from different manufacturers is as robust as possible. In this case, the sensor output is always completely shifted by a constant bit time when a new protocol start occurs. This is equivalent to a time output offset.

The suppression of bit stumps does function reliably in all speed ranges and in all regular operating states of the sensor, that is also in the standstill protocol. This ensures that no compatibility problems occur in any regular operating cases caused by for example EMC.

6.2.2 Air Gap Dimension

The measured value can be transmitted in the AK protocol using the LM bits, with 8 available gradation according to Table 8.

There is no hysteresis implemented for setting/resetting the LM bits and the air gap is measured in calibrated mode only. In uncalibrated mode, no evaluation takes place, and all bits retain their last value. After power up all bits are set to 0 as a default value. The typical relation between switching field strength and bits put out is given in the subsequent table:

Table 8 Air Gap Table

LM decimal	LM binary	Level in relation to dB_{limit_x}	Tolerance for TA = -40°C to +150°C
0	000	0 < ... <= 2	+/- 20%
1	001	> 2	+/- 20%
2	010	> 4	+/- 20%
3	011	> 8	+/- 20%
4	100	> 16	+/- 20%
5	101	> 32	+/- 20%
6	110	> 64	+/- 20%
7	111	> 96	+/- 20%

6.2.3 Failure indication state

TLE5046SiC offers an enhanced safety concept with very low FIT rates. A failure indication state is introduced in this new ABS sensor family. For indicating failures a constant low current I_{Error} is implemented to signalize to the ECU a potentially severe effect on functionality. Furthermore the protocol offers the possibility to transmit information regarding the safety concept to the ECU. The whole safety concept including the functional behavior in case of an error is described in the Safety Manual [11] and the SASR [12].

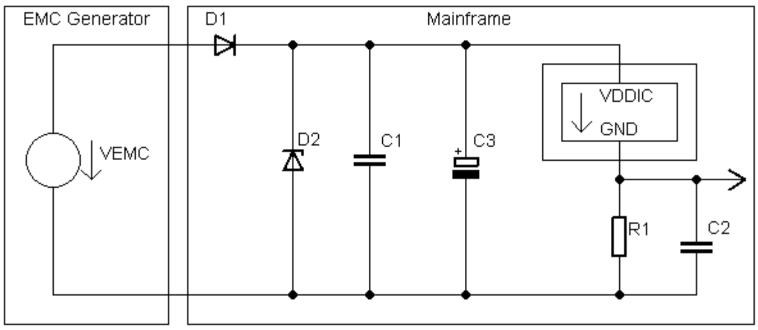
7 EMC and ESD Characteristics

The TLE5046SiC is characterized according to the IC level EMC requirements described in the “Generic IC EMC Test Specification” Version 2.0 from 2014[1]. EMC test report is available on request.

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 are performed.

Characterization of Electro Magnetic Compatibility are carried out on a sample base of one qualification lot. Not all specification parameters have been monitored during EMC exposure. Only current levels and duty cycle have been monitored.

7.1 Transient Immunity



Components:
D1: reverse polarity protection diode
D2: Zener diode with specific clamping voltage (e.g.27V)
C1: 10µF, 35V
C2: 1nF,100V
C3: 10nF
R1: 75Ω

Figure 17 EMC Test circuit

7.1.1 Electrical Transient Conduction along Supply Lines

General requirements:

- The supply voltage has a value of 13.5 V ± 0.2 V (for test pulse 4 supply voltage is 12 V ± 0.2 V)
- The ambient temperature for these tests is 23°C ± 5°C

Test setup:

- According to ISO 7637-2, 2011 chapter 4.4 for pulses 1, 2a, 2b, 3a and 3b
- According to ISO 16750-2, 2010 chapter 4.6.3 and 4.6.4 for pulses 4 and 5b
- The Loadbox is placed directly on the ground plane
- The wiring harness and the monitoring equipment are insulated 50 mm from the ground plane
- Total wire harness length from the test pulse generator to the DUT does not exceed 500 mm and does not fall below 400 mm including a harness length from the load simulator to the DUT of 200 mm ± 50 mm
- Pulses are applied to the input terminal of the Loadbox

1 The document is available at http://www.zvei.org/generic-ic-emc-test-specification

Table 9 Applicable Pulses, Parameters and Functional Class Requirements

Test Pulses	Test Level	Number/Duration	Pulse parameters	Functional class
1	-150 V	500	t_d = 2 ms, t_1 = 0.5 s	C
2a	+112 V	5000	t_d = 50 µs, t_1 = 0.5 s, R_i = 2 Ω	A
2b	+10 V	10	t_d = 1, R_i = 0.01 Ω	C
3a	-220 V	10 min	t_d = 150 ns, R_i = 50 Ω	A[1]
3b	+150 V	10 min	t_d = 150 ns, R_i = 50 Ω	A[1]
4- I	U_{S6} = 8 V | U_S = 9.5 V	10	t_8 = 1 s, t_r= 40 ms, pulse cycle time: 2 s[2]	A
4- II	U_{S6} = 4.5 V | U_S = 6.5 V	10	t_8 = 10 s, t_r= 100 ms, pulse cycle time: 2 s[3]	C
4 - III	U_{S6} = 3 V | U_S = 5 V	10	t_8 = 1 s, t_r= 100 ms, pulse cycle time: 2 s[3]	C
4 - IV	U_{S6} = 6 V | U_S = 6.5 V	10	t_8 = 10 s, t_r= 100 ms, pulse cycle time: 2 s[3]	C
5b	+35 V[4]	1	t_d = 400 ms, R_i= 1 Ω, pulse cycle time: 60 s[3] [5]	C

1) Output signal overlaid by burst pulses
2) Additional Pulse parameters: t_f = 5 ms, t_6 = 15 ms, t_7 = 50 ms
3) Non-specified pulse parameters according ISO16750-2, 2010
4) Clamping voltage
5) The 18 V Zener-Diode D2 in the load replacement circuit will be replaced by a special suppressor diode for this pulse to limit the pulse voltage to approximately 20 V and to prevent a damage of D2 during the test

7.1.2 Electrical Transient Transmission by Capacitive Coupling Clamp (CCC)

Conditions:

- The supply voltage has a value of 13.5 V ± 0.2 V
- The ambient temperature for these tests is 23°C ± 5°C

Test setup:

- According to ISO 7637-3, 2007 Chapter 3.4.2
- The monitoring equipment is insulated 50 mm from the ground plane
- Wire harness length is 1700 mm, wiring harness outside the Capacitive Coupling Clamp is 100 mm insulated
- All lines are tested simultaneously under the CCC

Table 10 Test Level and Criteria for Fast Pulses Measurement

Test Pulse	Test Level U_S	Internal resistance	Pulse parameters[1] t_1 | t_d	Minimum number of pulses or test time	Functional class
3a	-220 V	R_i = 50 Ω	100 µs | 100 ns	10 min	A
3b	+150 V	R_i = 50 Ω	100 µs | 100 ns	10 min	A

1) Non-specified pulse parameters according to ISO 7637-3, 2007

7.1.3 ESD HBM & CDM

Table 11 ESD Voltage

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
ESD voltage	V_{HBM}	-	-	+/-12	kV	Method AEC-Q100-002 (1.5 kΩ, 100 pF)
ESD voltage	V_{CDM}	-	-	+/-1	kV	Method AEC-Q100-011 (0 kΩ, 200 pF)

8 Product Qualification

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

9 Package Outlines

9.1 Bending and assembly

By following our package handling and assembly recommendation[2] remarks for Sensor-packages the sensor terminals can be bent without causing incipient cracks influencing the sensor element function, please contact your key account team for further information. The product is RoHS (restriction of hazardous substances) compliant when marked with letter G in front or after the data code marking and contains a data matrix code. Please refer to your key account team or regional sales if you need further information.

Table 12 Package Parameters PG-SSO-2-1

Parameter		Material
Lead Frame	CuSn1CrNiTi	K62 (UNS:C18090)
Lead Plating	Sn	Tinn

9.2 Package surface to silicon

The distance from the package surface to the surface of the silicon chip.

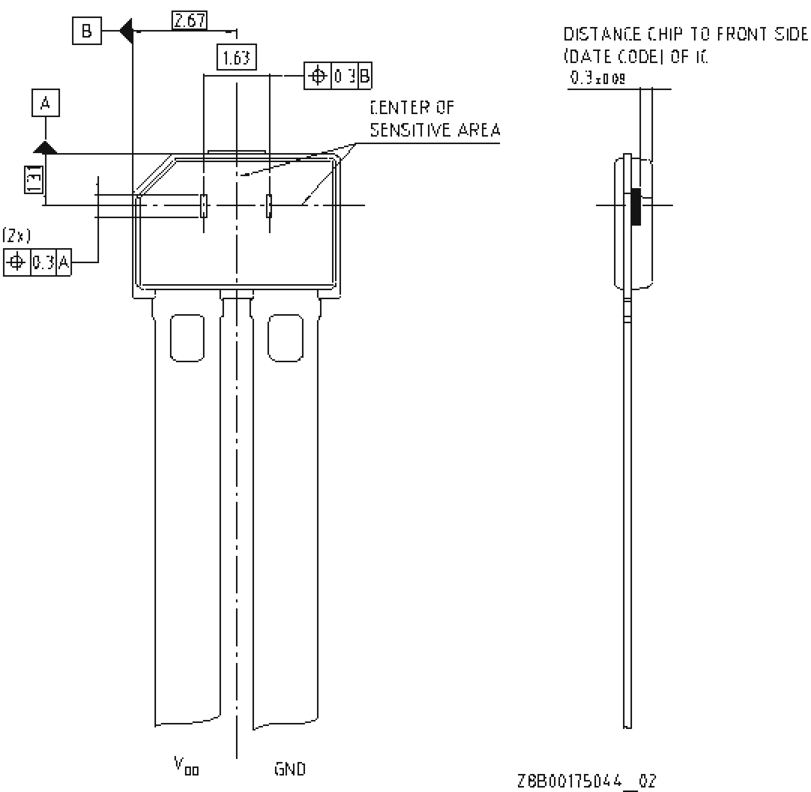


Figure 18 Distance from package surface to silicon (= sensing element)

2 The document is available at https://www.infineon.com/dgdl/Infineon-Recommendation

9.3 Package

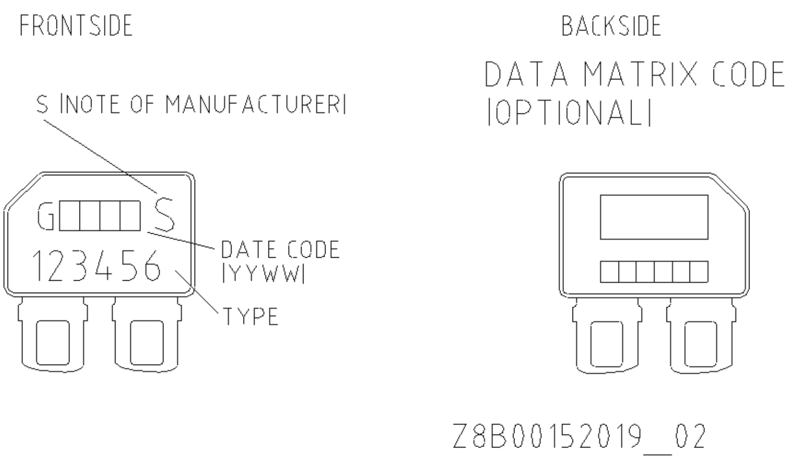


Figure 19 **PG-SSO-2-1 marking**

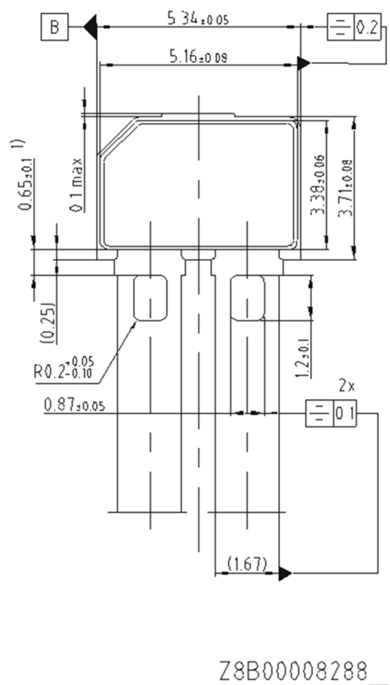


Figure 20 **PG-SSO-2-1 package outline**

9 Package Outlines

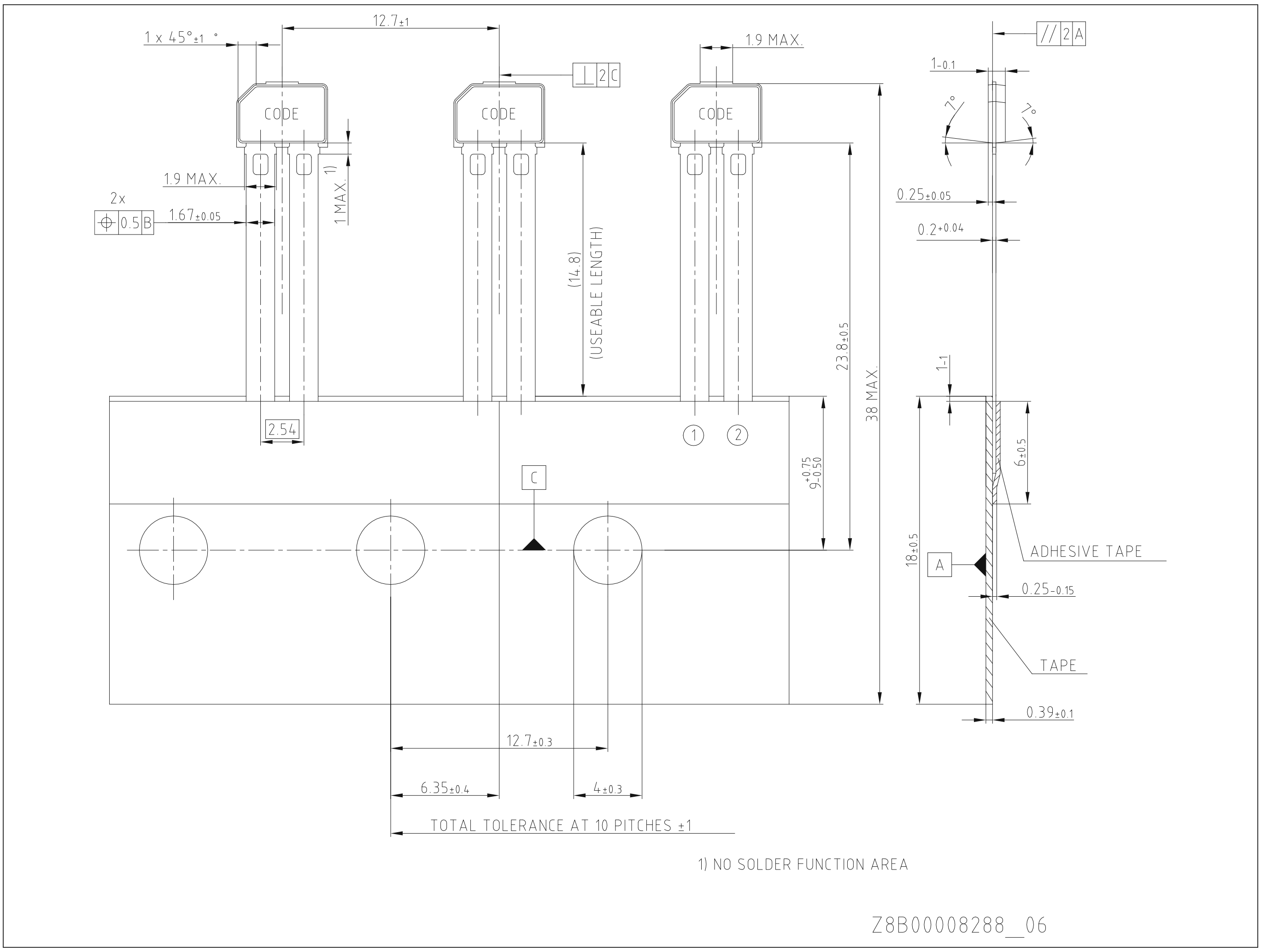


Figure 21 **PG-SSO-2-1 packing**

Dimensions in mm

Note: For further information on alternative packages, please visit our website.

10 Revision History

Revision	Date	Changes
1.0	2023-08-23	First release

11 Terminology

Reference	Description
ADC	Analog to Digital Converter
ASIC	Application Specific Integrated Circuit
CCC	Capacitive Coupling Clamp
CDM	Charged Device Model
DAC	Digital Analog Converter
DUT	Device Under Test
ECU	Electronic Control Unit
EMC	Electro Magnetic Compatibility
ESD	Electro Static Discharge
GMR	Giant Magneto Resistance
HBM	Human Body Model
IC	Integrated Circuit
PMU	Power Management Unit
RF	Radio Frequency

12 References

[1] AEC-Q100

[2] CISPR 25, 2009

[3] IEC 61967-4, 2002

[4] ISO 10605, 2008

[5] ISO 11452-8, 2007

[6] ISO 16750-2, 2010

[7] ISO 26262, 2011

[8] ISO 7637-2, 2011

[9] ISO 7637-3, 2007

[10] Requirement Specifications for Standardized Interface for Wheel Speed Sensors with Additional Information “AK-Protokoll” Version 4.0 2008

[11] Safety Manual TLE5046SiC

[12] Safety Analysis Summary Report TLE5046SiC

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