

# TLE4966-3K

High Sensitivity Automotive Hall Switch with direction detection

## Datasheet

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**Previous Revision:**

Page	Subjects (major changes since last revision)

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## 1 Overview

### 1.1 Features

- 2.7V to 24V supply voltage operation
- Operation from unregulated power supply
- High sensitivity and high stability of the magnetic switching points
- High resistance to mechanical stress by Active Error Compensation
- Reverse battery protection (-18V)
- Superior temperature stability
- Peak temperatures up to 195°C
- Low jitter (typ. 1µs)
- Digital output signals
- Excellent matching of the 2 Hall probes
- Hall plate distance 1.45mm
- Speed and direction output signal
- SMD package PG-TSOP-6-6-5



### 1.2 Functional Description

The TLE4966-3K is an integrated circuit dual Hall-effect sensor designed specifically for highly accurate applications which use a rotating pole wheel. Precise magnetic switching points and high temperature stability are achieved by active compensation circuits and chopper techniques on chip. The sensor provides a speed output at Q2 with the status (high or low) corresponding to the magnetic field value. For positive magnetic fields (south pole) exceeding the threshold  $B_{OP}$  the output is low, whereas for negative magnetic fields (north pole) lower than  $B_{RP}$  the output switches to high. The output Q1 can be either high or low depending on the direction of rotation of the pole wheel. This direction information is calculated internally.

Product Name	Product Type	Ordering Code	Package
TLE4966-3K	Double Hall Switch	SP000835522	PG-TSOP-6-6-5

### 1.3 Pin Configuration (top view)

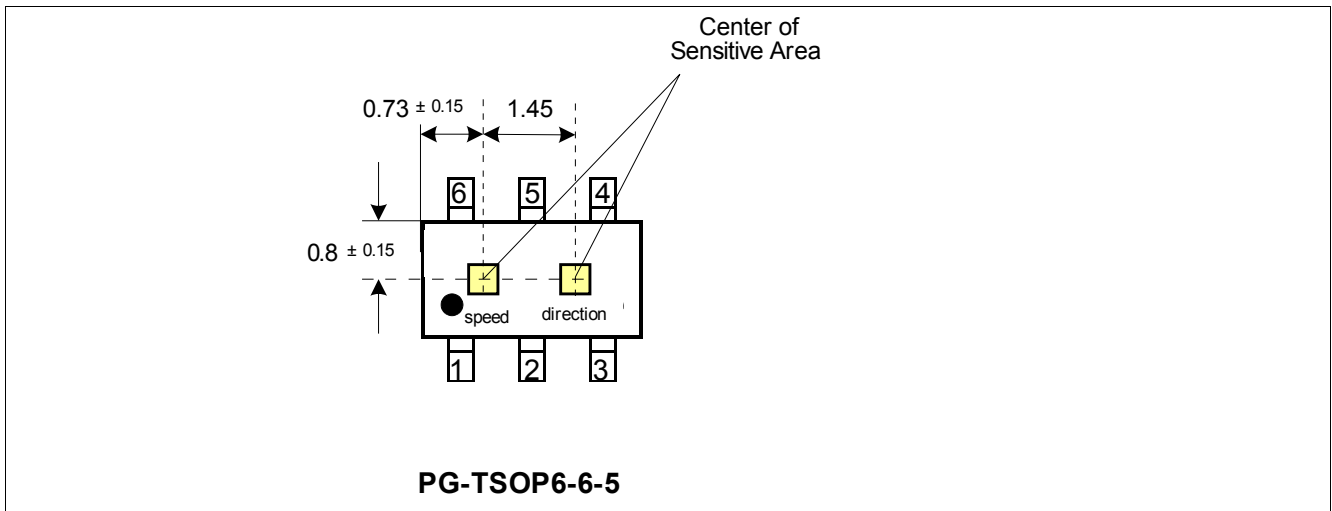


Figure 1 Pin Definition and Center of Sensitive Area

Table 1 Pin Definitions and Functions

Pin No.	Symbol	Function
1	Q2	Speed
2	GND	Recommended connection to GND
3	Q1	Direction
4	$V_{DD}$	Supply voltage
5	GND	Recommended connection to GND
6	GND	Ground

## 2 General

### 2.1 Block Diagram

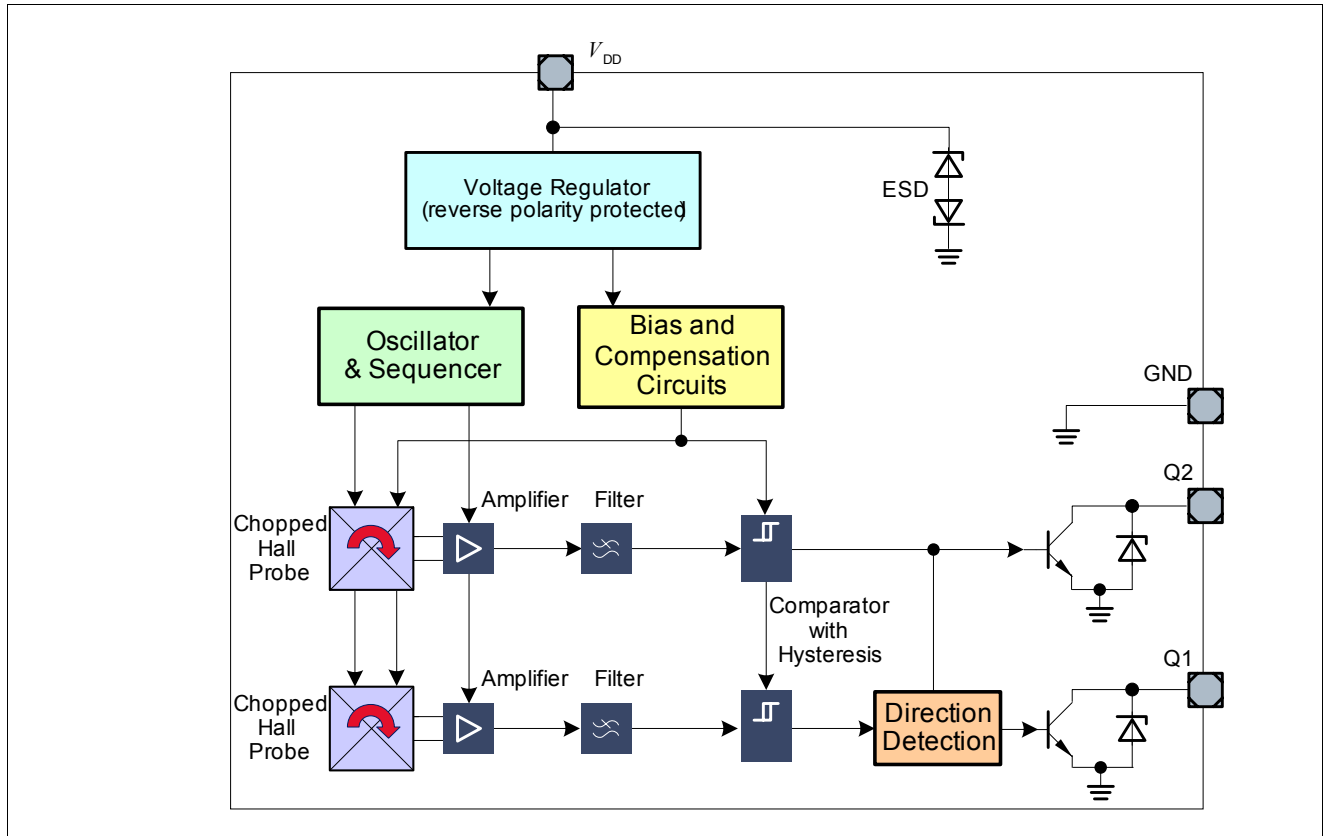


Figure 2 Block Diagram

### 2.2 Circuit Description

The chopped Dual Hall Switch comprises two Hall probes, bias generator, compensation circuits, oscillator, and output transistors.

The bias generator provides currents for the Hall probes and the active circuits. Compensation circuits stabilize the temperature behavior and reduce influence of technology variations.

The Active Error Compensation rejects offsets in signal stages and the influence of mechanical stress to the Hall probes caused by molding and soldering processes and other thermal stresses in the package. This chopper technique together with the threshold generator and the comparator ensures high accurate magnetic switching thresholds.



### 2.3 Application Circuit

It is recommended to use a series resistor  $R_S$  with  $200\Omega$  and a capacitor of  $C_S = 4.7\text{nF}$  for protection against overvoltage and transients on the supply line. Pull-up resistors  $R_L$  are required for the output pins  $Q_1$  and  $Q_2$ .

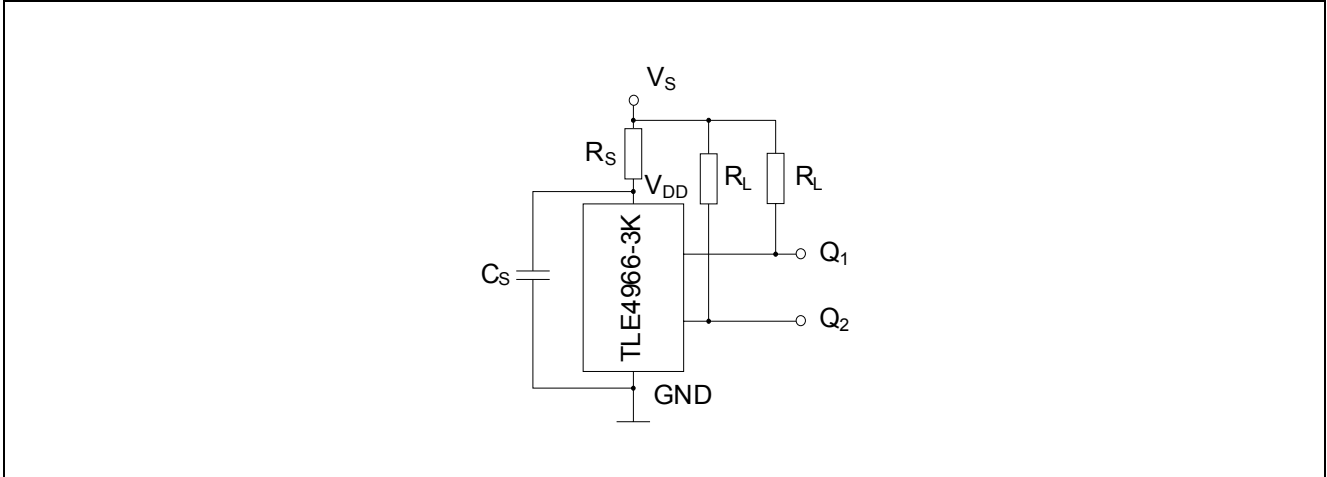


Figure 3 Application Circuit

## 3 Maximum Ratings

Table 2 Absolute Maximum Ratings

$T_j = -40^\circ\text{C}$  to  $150^\circ\text{C}$

Parameter	Symbol	Limit Values		Unit	Conditions
		min.	max.		
Supply voltage	$V_{DD}$	-18	18	V	for 1 h, $R_S \geq 200 \Omega$ for 5 min, $R_S \geq 200 \Omega$
	$V_S$	-18	24		
	$V_S$	-18	26		
Supply current through protection device	$I_{DD}$	-50	50	mA	
Output voltage	$V_Q$	-0.7 -0.7	18 26	V	for 5 min @ $R_L = 1.2 \text{ k}\Omega$ (pull up resistor)
Continuous output current	$I_Q$	-50	50	mA	
Junction temperature	$T_j$	-	155	$^\circ\text{C}$	for 2000 h (not additive)
		-	165		for 1000 h (not additive)
		-	175		for 168 h (not additive)
		-	195		for 3 x 1 h (additive)
Storage temperature	$T_S$	-40	150	$^\circ\text{C}$	
Magnetic flux density	$B$	-	unlimited	mT	

Note: Stresses above the max. 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.



**Table 3 ESD Protection <sup>1)</sup>**

Parameter	Symbol	Limit Values		Unit	Notes
		min.	max.		
ESD voltage	$V_{ESD}$	–	$\pm 4$	kV	HBM, $R = 1.5 \text{ k}\Omega$ , $C = 100 \text{ pF}$ $T_A = 25^\circ\text{C}$

1) Human Body Model (HBM) tests according to: EOS/ESD Association Standard S5.1-1993 and Mil. Std. 883D method 3015.7

## 4 Operating Range

The following operating conditions must not be exceeded in order to ensure correct operation of the TLE4966-3K. All parameters specified in the following sections refer to these operating conditions unless otherwise mentioned.

**Table 4 Operating Range**

Parameter	Symbol	Limit Values			Unit	Conditions
		min.	typ.	max.		
Supply voltage	$V_{DD}$ $V_S$ $V_S$	2.7 – –	– – –	18 24 26	V	1 h with $R_S \geq 200 \Omega$ for 5 min $R_S \geq 200 \Omega$
Output voltage	$V_Q$	-0.7	–	18	V	
Junction temperature	$T_j$	-40 –	– –	150 175	$^\circ\text{C}$	for 168 h
Output current	$I_Q$	0	–	10	mA	

## 5 Electrical and Magnetic Parameters

Product characteristics involve the spread of values guaranteed within the specified voltage and temperature range. Typical characteristics are the median of the production and correspond to  $V_D = 12V$  and  $T_A = 25^\circ C$ .

**Table 5 Electrical Characteristics** <sup>1)</sup>

Parameter	Symbol	Limit Values			Unit	Conditions
		min.	typ.	max.		
Supply current	$I_{DD}$	4	5.2	7	mA	$V_{DD} = 2.7 V \dots 18 V$
Reverse current	$I_{SR}$	0	0.2	1	mA	$V_{DD} = -18 V$
Output saturation voltage	$V_{QSAT}$	–	0.3	0.6	V	$I_Q = 10 mA$
Output leakage current	$I_{QLEAK}$	–	0.05	10	$\mu A$	for $V_Q = 18 V$
Output fall time	$t_f$	–	0.2	1	$\mu s$	$R_L = 1.2 k\Omega$ ; $C_L < 50 pF$
Output rise time	$t_r$	–	0.2	1	$\mu s$	see: <a href="#">Figure 4</a> on <a href="#">Page 11</a>
Chopper frequency	$f_{OSC}$	–	320	–	kHz	
Switching frequency	$f_{SW}$	0	–	15 <sup>2)</sup>	kHz	
Delay time <sup>3)</sup>	$t_d$	–	13	–	$\mu s$	
Count Signal Delay	$t_{dc}$	50	200	1000	ns	see: <a href="#">Figure 5</a> on <a href="#">Page 12</a>
Output jitter <sup>4)</sup>	$t_{QJ}$	–	1	–	$\mu s_{RMS}$	Typ. value for square wave signal 1 kHz
Repeatability of magnetic thresholds <sup>5)</sup>	$B_{REP}$	–	40	–	$\mu T_{RMS}$	Typ. value for $\Delta B/\Delta t > 12 mT/ms$
Power-on time <sup>6)</sup>	$t_{PON}$	–	13	–	$\mu s$	$V_{DD} \geq 2.7 V$
Distance of hall plates	$d_{HALL}$	–	1.45	–	mm	
Thermal resistance <sup>7)</sup>	$R_{thJA}$	–	100	–	K/W	PG-TSOP-6-6-5

- 1) over operating range, unless otherwise specified. Typical values correspond to  $V_{DD} = 12 V$  and  $T_A = 25^\circ C$
- 2) To operate the sensor at the max. switching frequency, the magnetic signal amplitude must be 1.4 times higher than for static fields. This is due to the -3 dB corner frequency of the low pass filter in the signal path.
- 3) Systematic delay between magnetic threshold reached and output switching
- 4) Jitter is the unpredictable deviation of the output switching delay
- 5)  $B_{REP}$  is equivalent to the noise constant
- 6) Time from applying  $V_{DD} \geq 2.7 V$  to the sensor until the output state is valid
- 7) Thermal resistance from junction to ambient

### Calculation of the ambient temperature (PG-TSOP-6-6-5 example)

e.g. for  $V_{DD} = 12.0 V$ ,  $I_{DDtyp} = 5.5 mA$ ,  $V_{QSATtyp} = 0.3 V$  and  $2 \times I_Q = 10 mA$  :  
 Power Dissipation:  $P_{DIS} = 72.0 mW$ .  
 In  $T_A = T_j - (R_{thJA} \times P_{DIS}) = 175^\circ C - (100 K/W \times 0.072 W)$   
 Resulting max. ambient temperature:  $T_A = 167.8^\circ C$

**Table 6 Magnetic Characteristics** <sup>1)</sup>.

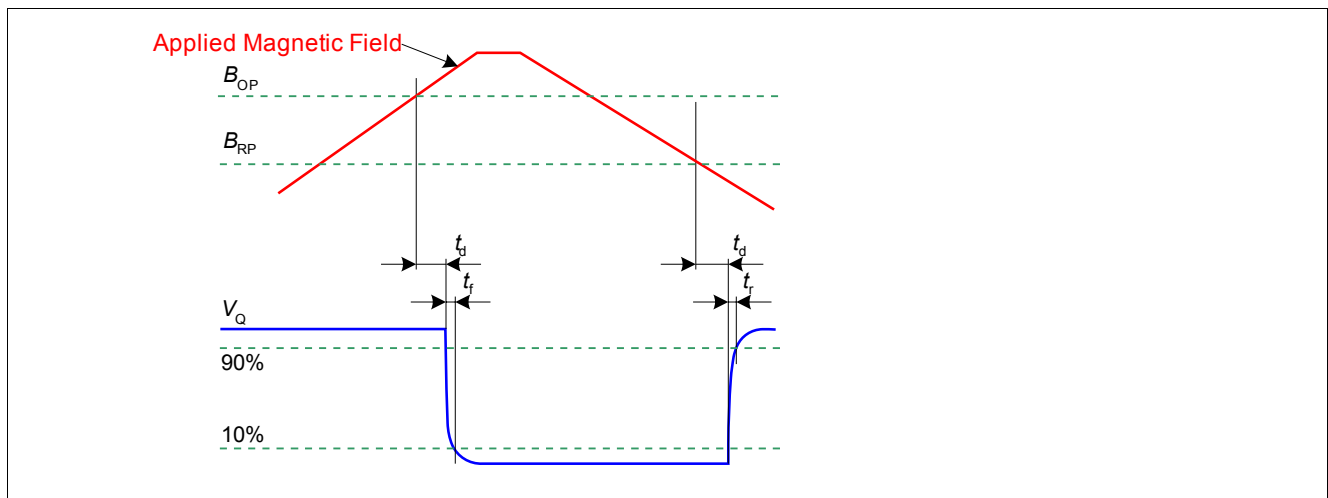
Parameter	Symbol	Limit Values			Unit	Conditions
		min.	typ.	max.		
Operate point	$B_{OP}$	0.8	2.5	4.2	mT	
Release point	$B_{RP}$	-4.2	-2.5	-0.8	mT	
Hysteresis	$B_{HYS}$	3.7	5.0	6.3	mT	
Magnetic matching	$B_{MATCH}$	-2.0		2.0	mT	Valid for $T_A = 25^\circ\text{C}$ $B_{OP1} - B_{OP2}$ and $B_{RP1} - B_{RP2}$
Temperature compensation of magnetic thresholds	$TC$	-	-350	-	ppm/ $^\circ\text{C}$	

1) over operating range, unless otherwise specified. Typical values correspond to  $V_{DD} = 12\text{ V}$  and  $T_A = 25\text{C}$

**Field Direction Definition**

Positive magnetic fields related with south pole of the magnet to the branded side of package.

**6 Timing Diagrams for the Speed and Direction Output**



**Figure 4 Timing Definition of the Speed Signal**

Timing Diagrams for the Speed and Direction Output

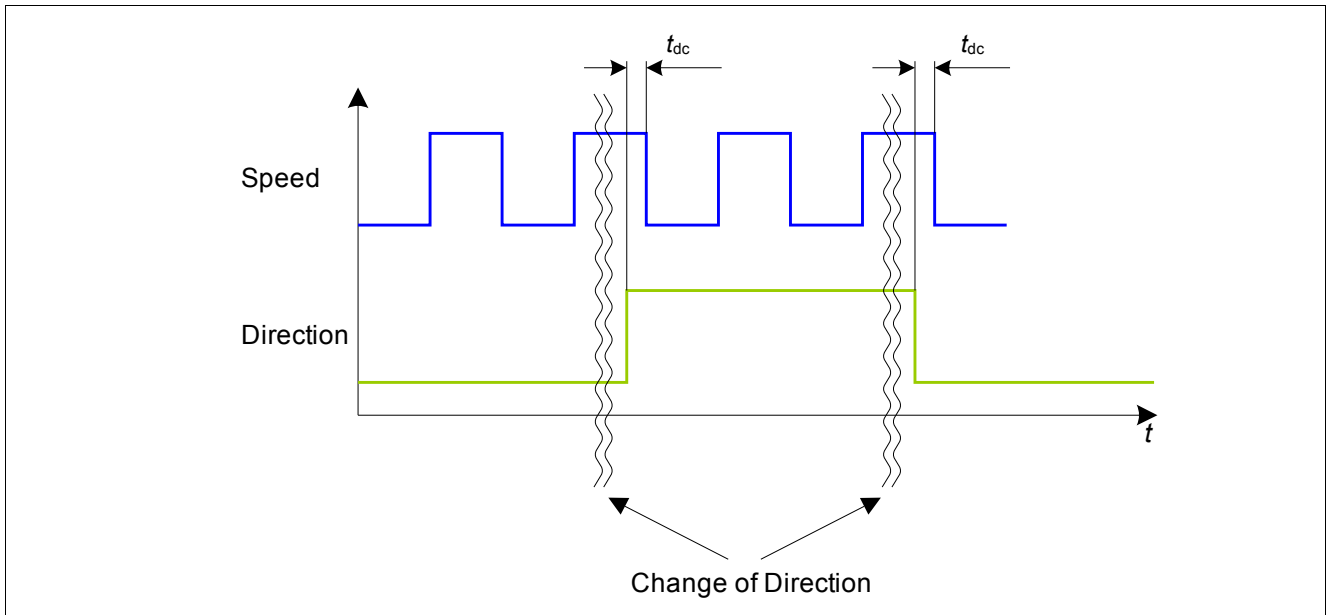


Figure 5 Timing Definition of the direction signal

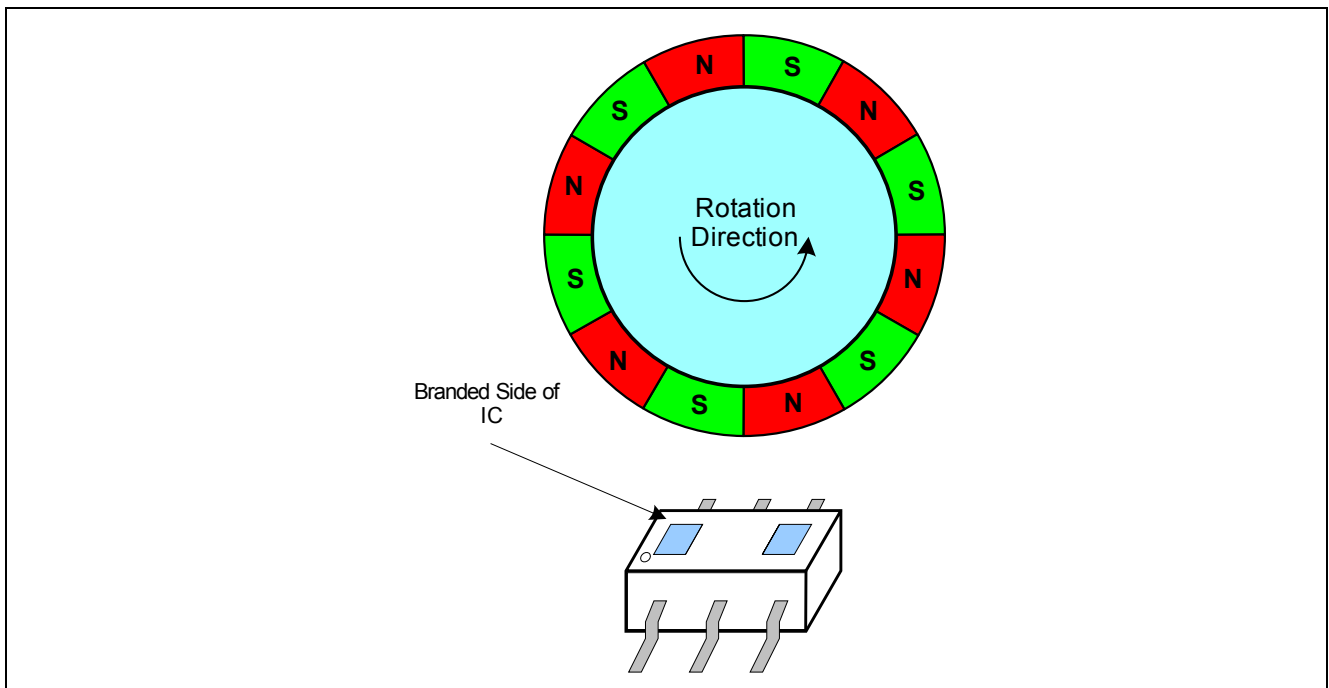


Figure 6 Definition of the direction signal

Rotation direction	State of direction output Q1
Left to right	Low
Right to Left	High

## 7 Package Information

### 7.1 Package Marking

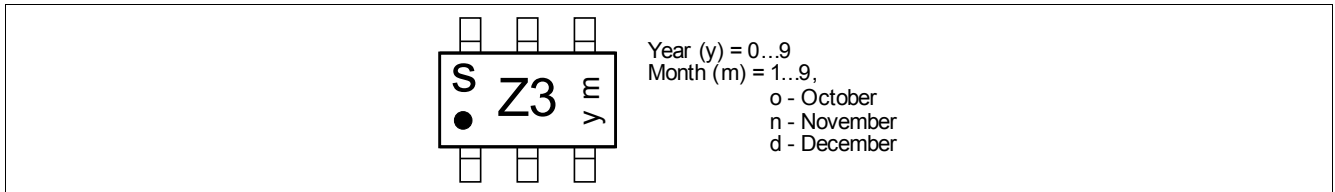


Figure 7 Marking PG-TSOP-6-6-5

### 7.2 Distance between Chip and Package Surface

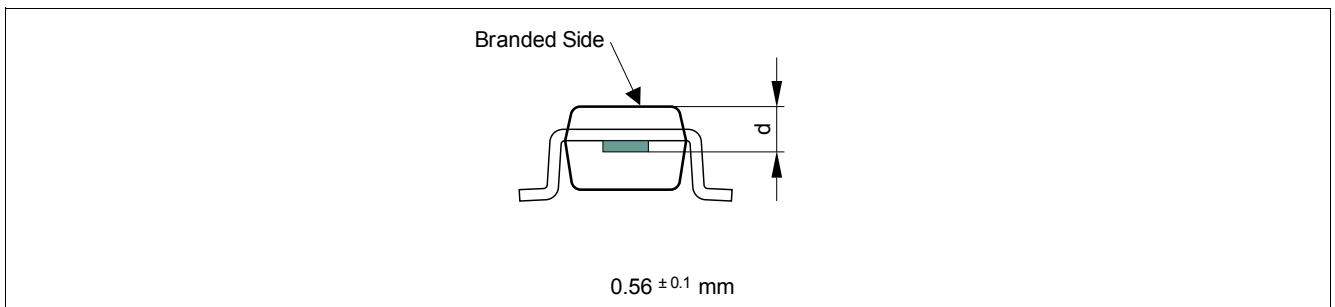


Figure 8 Distance Chip to Upper Side of IC

### 7.3 Package Outlines

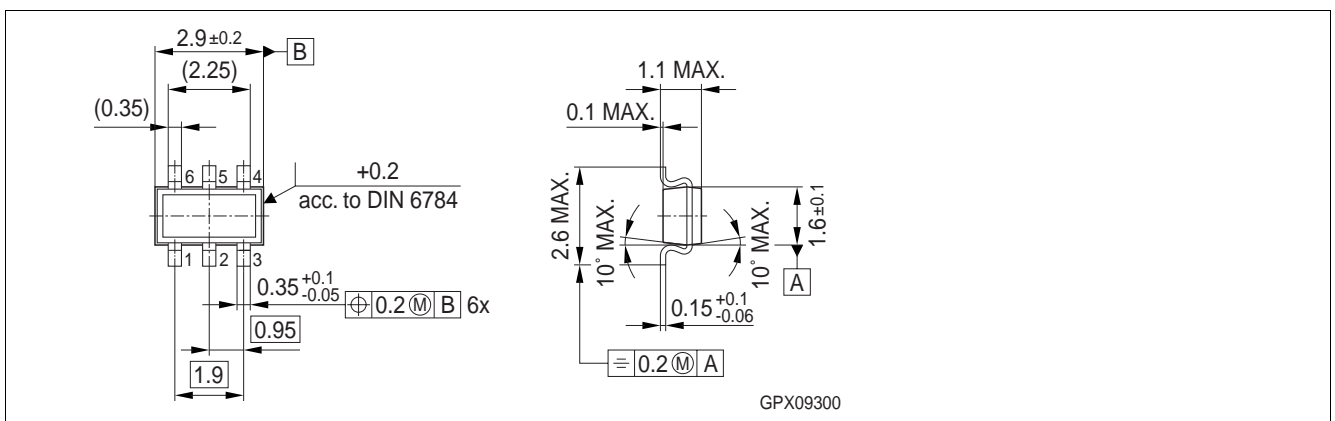
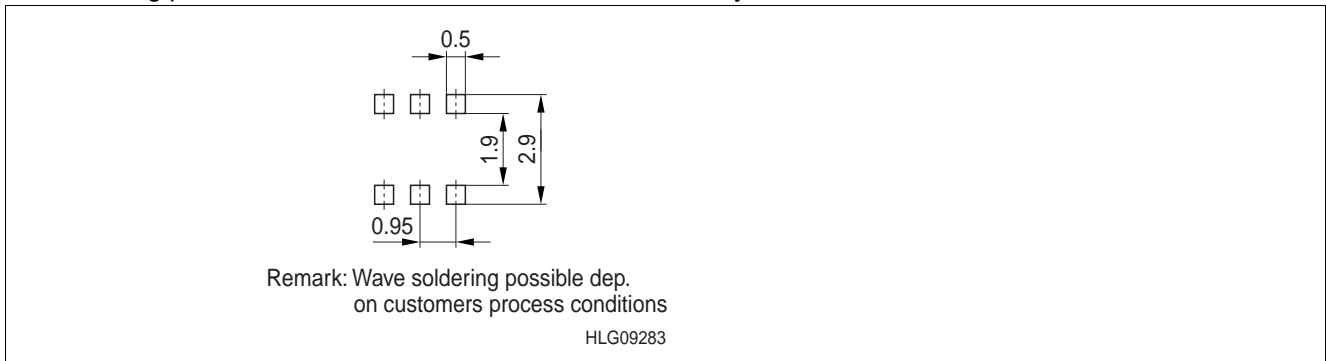


Figure 9 PG-TSOP-6-6-5 (Plastic Thin Small Outline Package)

**PCB Footprint for PG-TSOP-6-6-5**

The following picture shows a recommendation for the PCB layout.



**Figure 10 Footprint PG-TSOP-6-6-5**

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