

TLE4966-3K

High Sensitivity Automotive Hall Switch with direction detection

Datasheet

Rev.1.0, 2010-09-20

Sense & Control

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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)

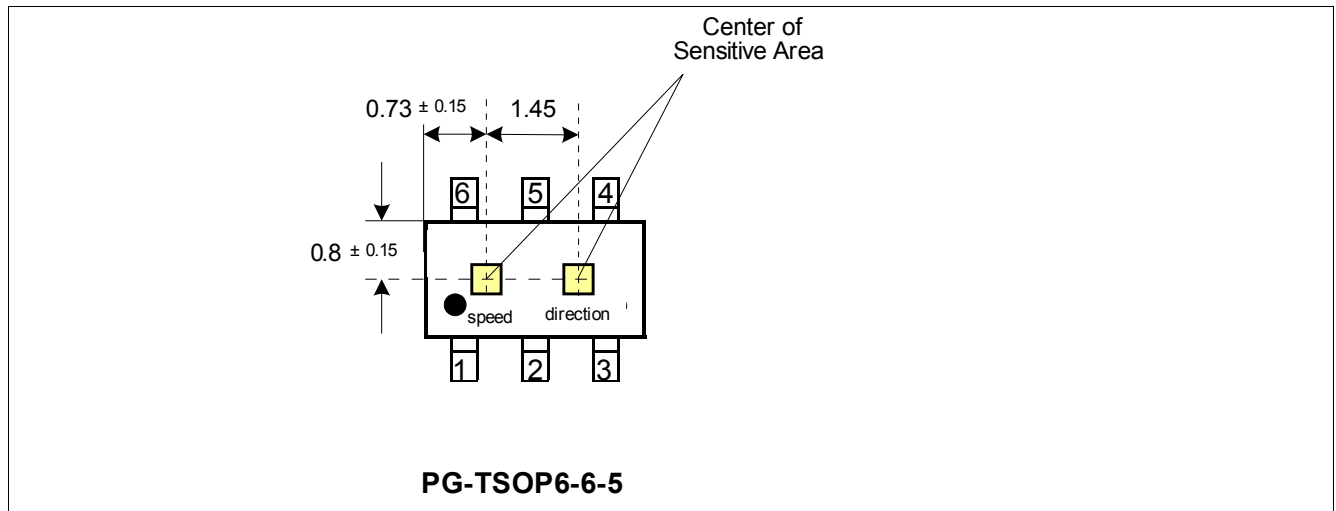


Figure 1 Pin Definition and Center of Sensitive Area

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

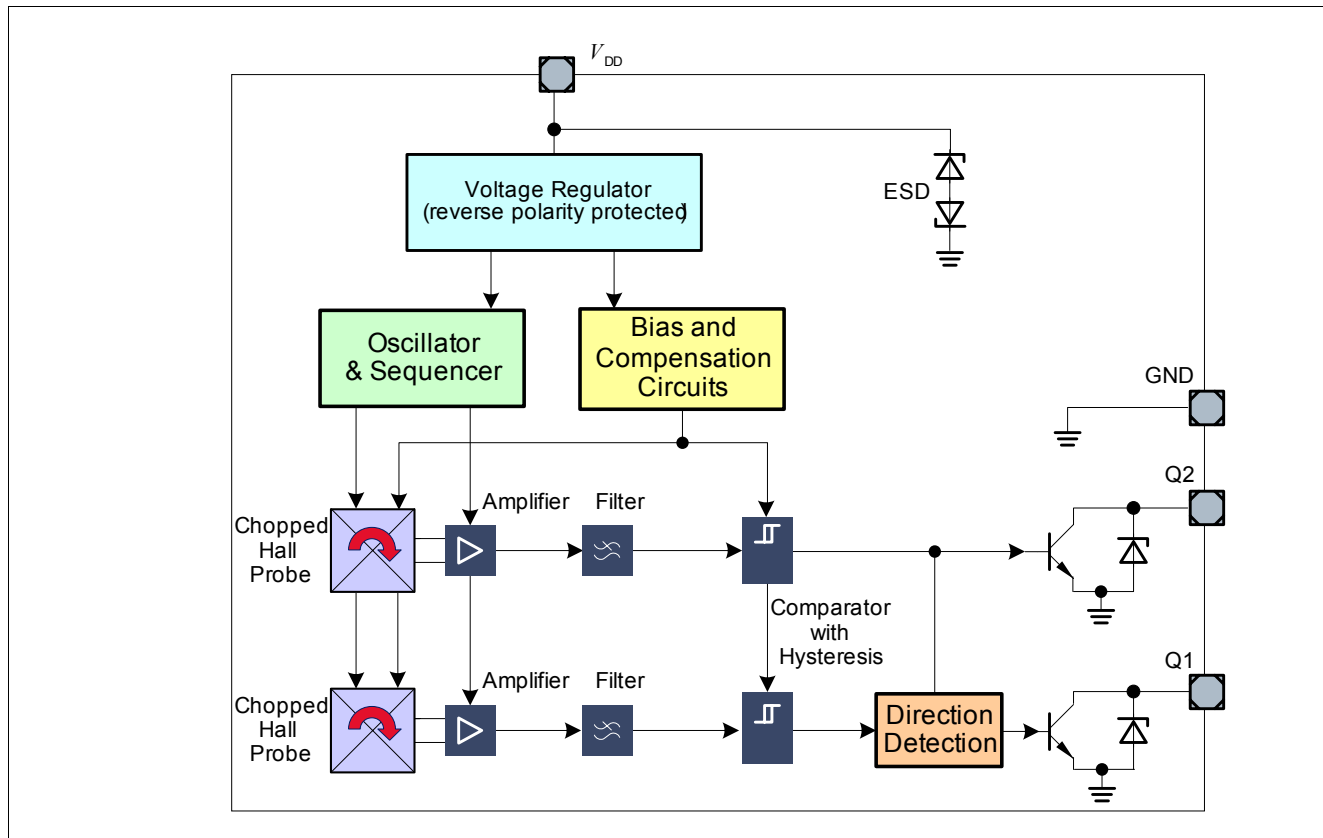


Figure 2 Block Diagram

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 200Ω 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 .

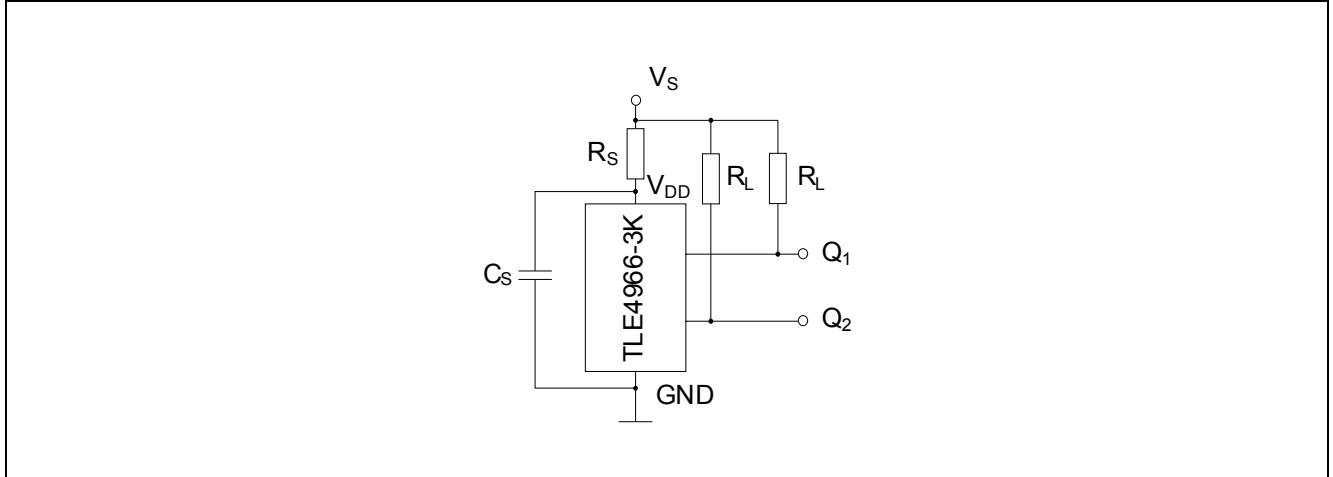


Figure 3 Application Circuit

3 Maximum Ratings

Table 2 Absolute Maximum Ratings

$T_j = -40^\circ\text{C}$ to 150°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 | 18 | V | for 5 min @ $R_L = 1.2\ \text{k}\Omega$ (pull up resistor) |
| | | -0.7 | 26 | | |
| 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.

Operating Range

Table 3 ESD Protection ¹⁾

| Parameter | Symbol | Limit Values | | Unit | Notes |
|-------------|------------------|--------------|---------|------|--|
| | | min. | max. | | |
| ESD voltage | V_{ESD} | – | ± 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 $R_{\text{S}} \geq 200 \Omega$ for 5 min $R_{\text{S}} \geq 200 \Omega$ |
| 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 ¹⁾

| 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 | μA | for $V_Q = 18 V$ |
| Output fall time | t_f | – | 0.2 | 1 | μs | $R_L = 1.2 k\Omega$; $C_L < 50 pF$ |
| Output rise time | t_r | – | 0.2 | 1 | μs | see: Figure 4 on Page 11 |
| Chopper frequency | f_{OSC} | – | 320 | – | kHz | |
| Switching frequency | f_{SW} | 0 | – | 15 ²⁾ | kHz | |
| Delay time ³⁾ | t_d | – | 13 | – | μs | |
| Count Signal Delay | t_{dc} | 50 | 200 | 1000 | ns | see: Figure 5 on Page 12 |
| Output jitter ⁴⁾ | t_{QJ} | – | 1 | – | μs_{RMS} | Typ. value for square wave signal 1 kHz |
| Repeatability of magnetic thresholds ⁵⁾ | B_{REP} | – | 40 | – | μT_{RMS} | Typ. value for $\Delta B/\Delta t > 12 mT/ms$ |
| Power-on time ⁶⁾ | t_{PON} | – | 13 | – | μs | $V_{DD} \geq 2.7 V$ |
| Distance of hall plates | d_{HALL} | – | 1.45 | – | mm | |
| Thermal resistance ⁷⁾ | 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: $T_A = 167.8^\circ C$

Timing Diagrams for the Speed and Direction Output

Table 6 Magnetic Characteristics ¹⁾.

| 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 $T_A = 25^\circ\text{C}$

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

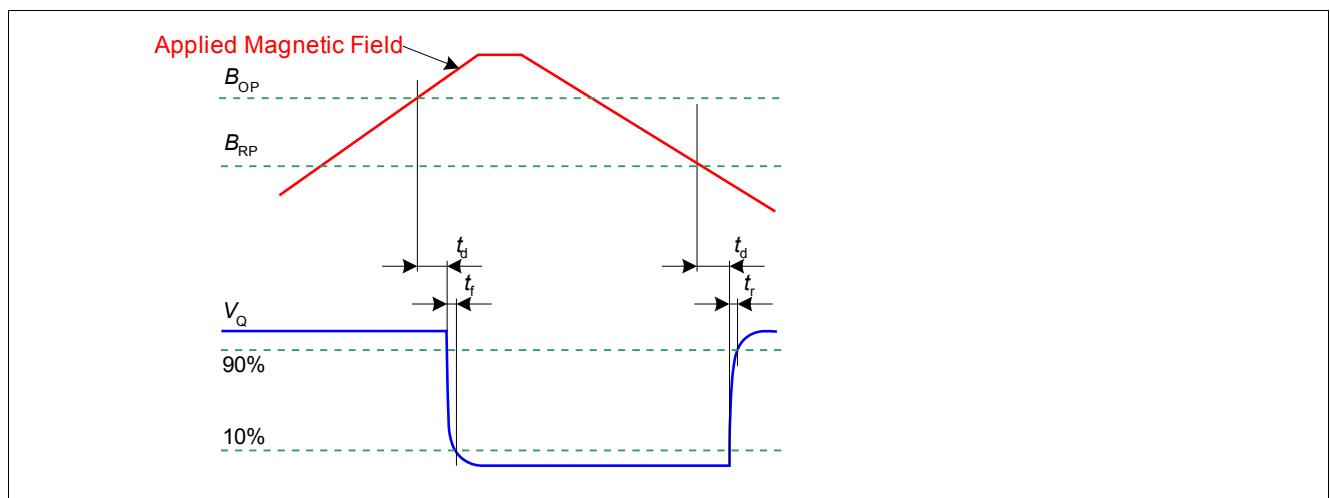


Figure 4 Timing Definition of the Speed Signal

Timing Diagrams for the Speed and Direction Output

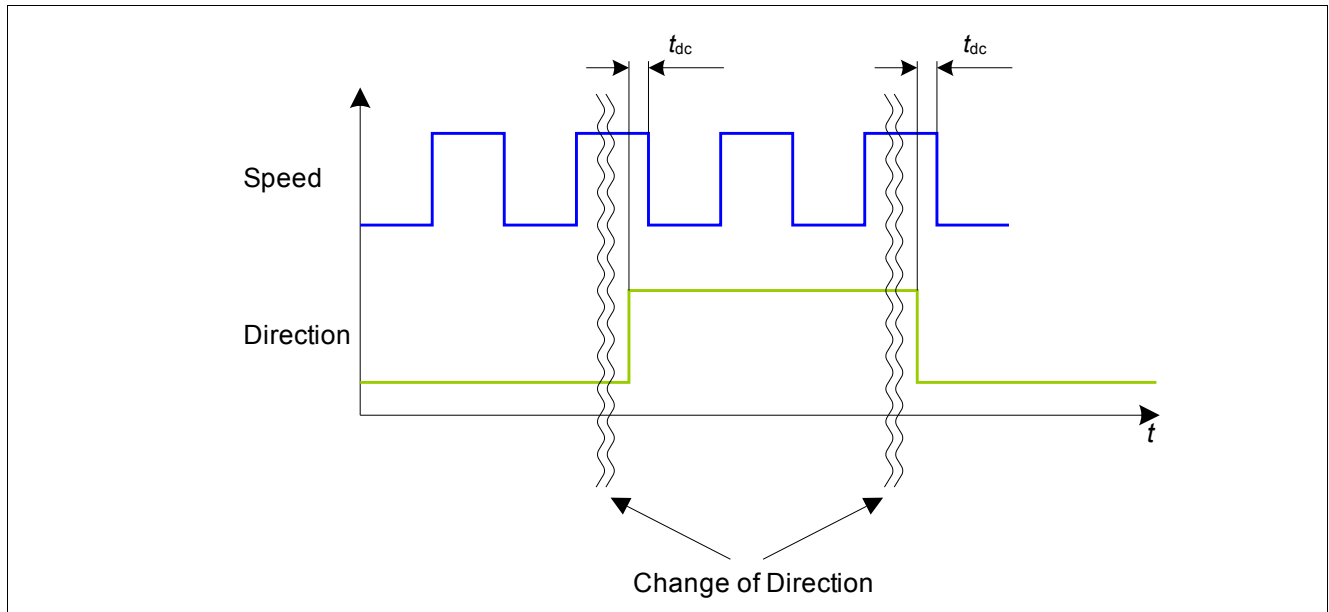


Figure 5 Timing Definition of the direction signal

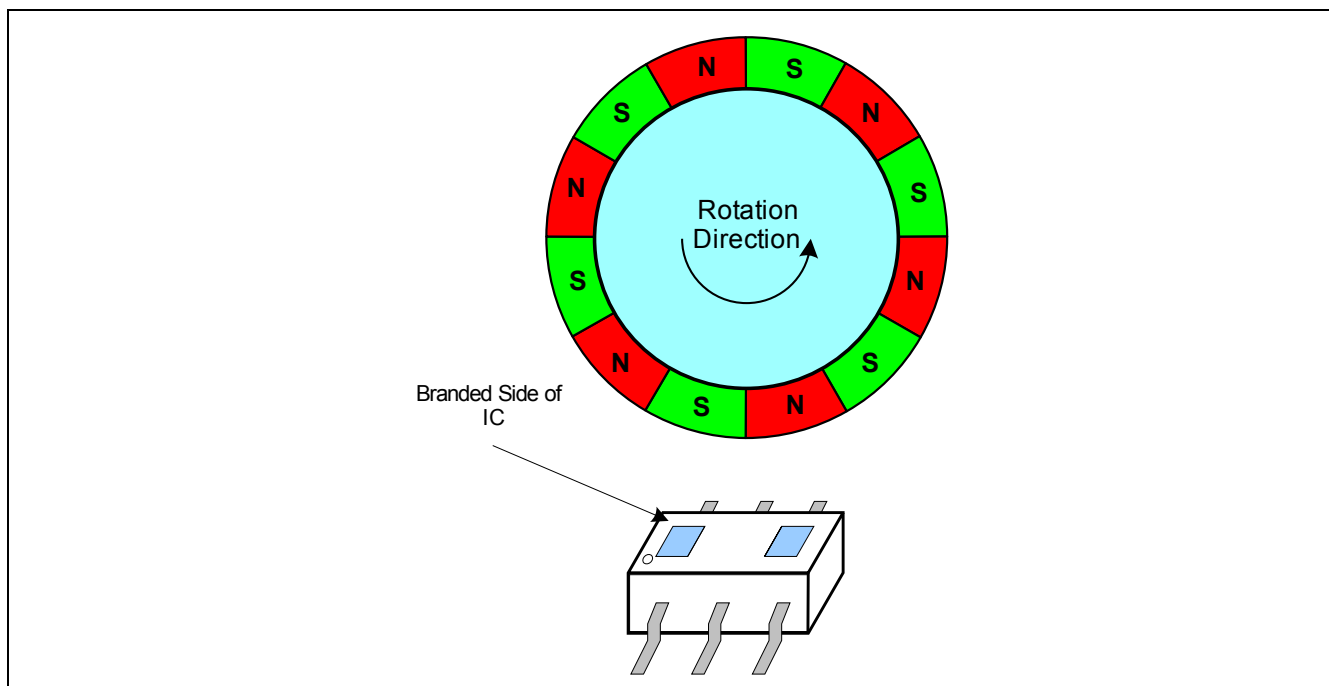


Figure 6 Definition of the direction signal

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

7 Package Information

7.1 Package Marking

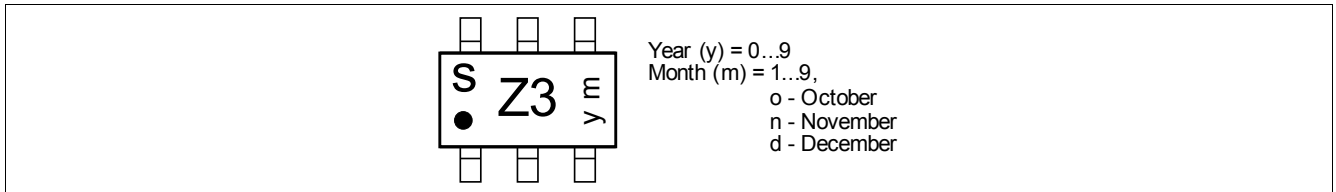


Figure 7 Marking PG-TSOP-6-6-5

7.2 Distance between Chip and Package Surface

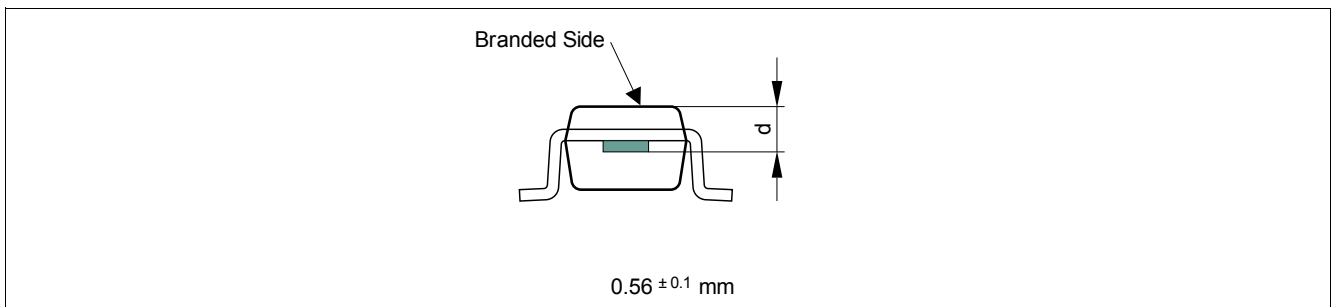


Figure 8 Distance Chip to Upper Side of IC

7.3 Package Outlines

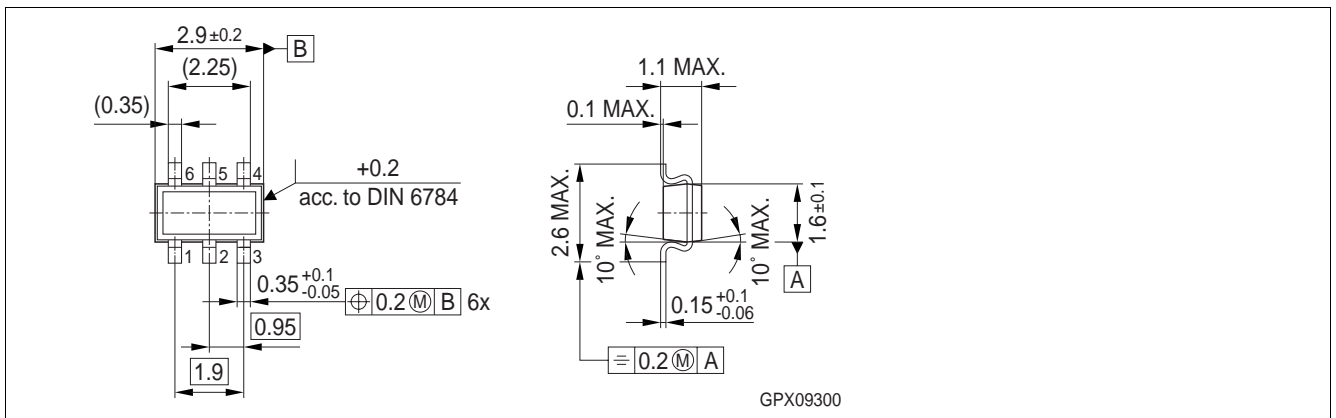


Figure 9 PG-TSOP-6-6-5 (Plastic Thin Small Outline Package)

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

The following picture shows a recommendation for the PCB layout.

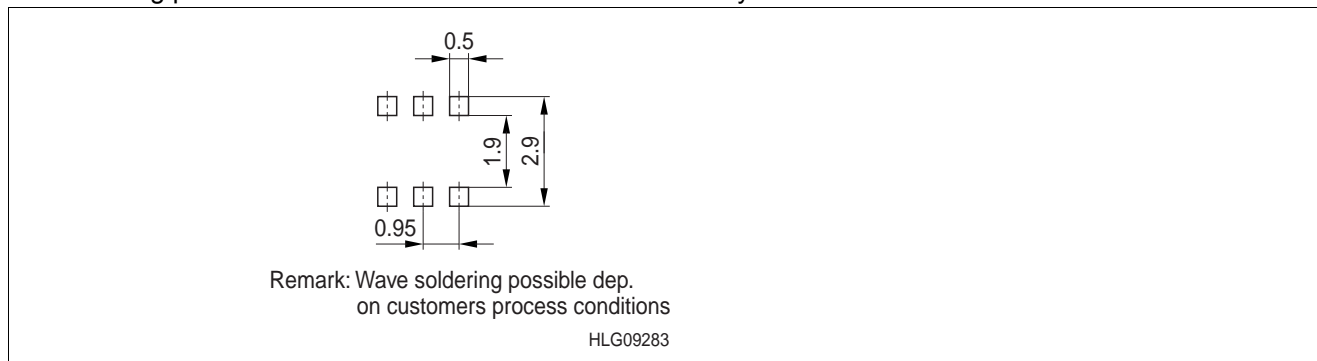


Figure 10 Footprint PG-TSOP-6-6-5

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