

# TLE4966-2G

High Precision Hall Switch with two Outputs

## 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
- Two independent speed outputs
- SMD package PG-TSOP6-6-9



### 1.2 Functional Description

The TLE4966-2G is an integrated circuit dual Hall-effect sensor designed specifically for highly accurate applications. Precise magnetic switching points and high temperature stability are achieved by active compensation circuits and chopper techniques on chip. The sensor provides two independent speed outputs at Q1 and Q2 with the status (high or low) corresponding to the magnetic field value at the respective Hall element H1 and H2. Both Hall elements have the identical thresholds for  $B_{OP}$  and  $B_{RP}$  ( $B_{OP1} = B_{OP2}$  and  $B_{RP1} = B_{RP2}$ ). For positive magnetic fields (south pole) exceeding the threshold  $B_{OP1}$  and/or  $B_{OP2}$  the corresponding output Q1 and/or Q2 is low, whereas for negative magnetic fields (north pole) lower than  $B_{RP}$  the output switches to high. Due to the spatial distance of the two Hall elements on the chip ( $d = 1.45\text{mm}$ ) the two output signals will show a phase difference in case the sensor is used with a rotating magnetized pole wheel.

Product Name	Product Type	Ordering Code	Package
TLE4966-2G	Double Hall Switch	SP002983188	PG-TSOP6-6-9

### 1.3 Pin Configuration (top view)

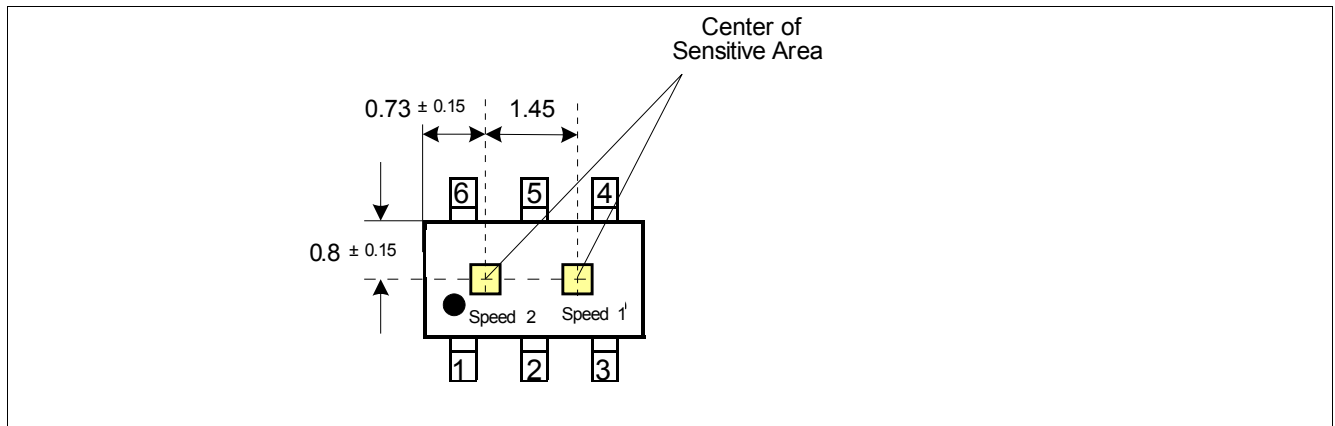


Figure 1 Pin Definition and Center of Sensitive Area

Table 1 Pin Definitions and Functions

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

## 2 General

### 2.1 Block Diagram

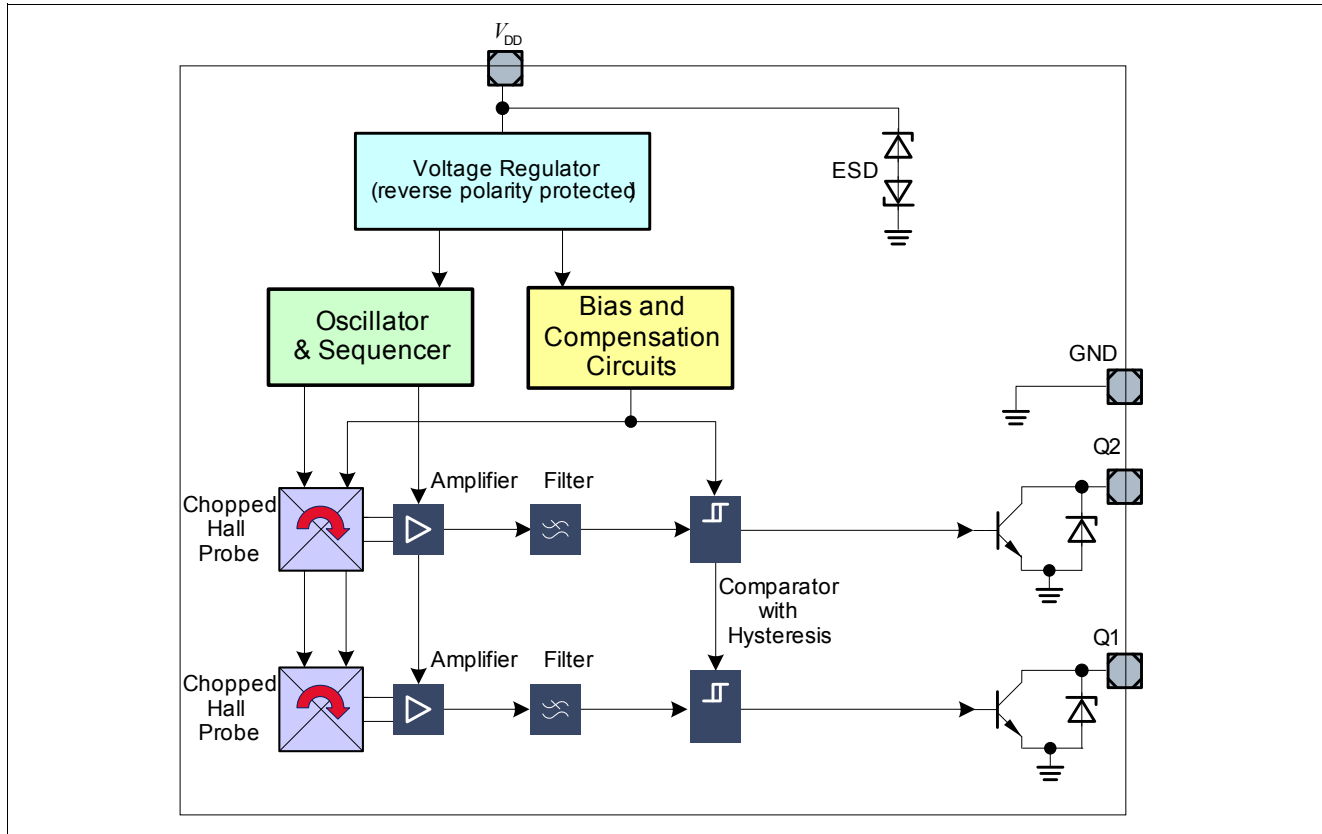


Figure 2 Block Diagram

### 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  $C_S = 4.7nF$  for protection against overvoltage and transients on the supply line. Pull-up resistors  $R_L$  are required for the output pins  $Q_1$  and  $Q_2$ .

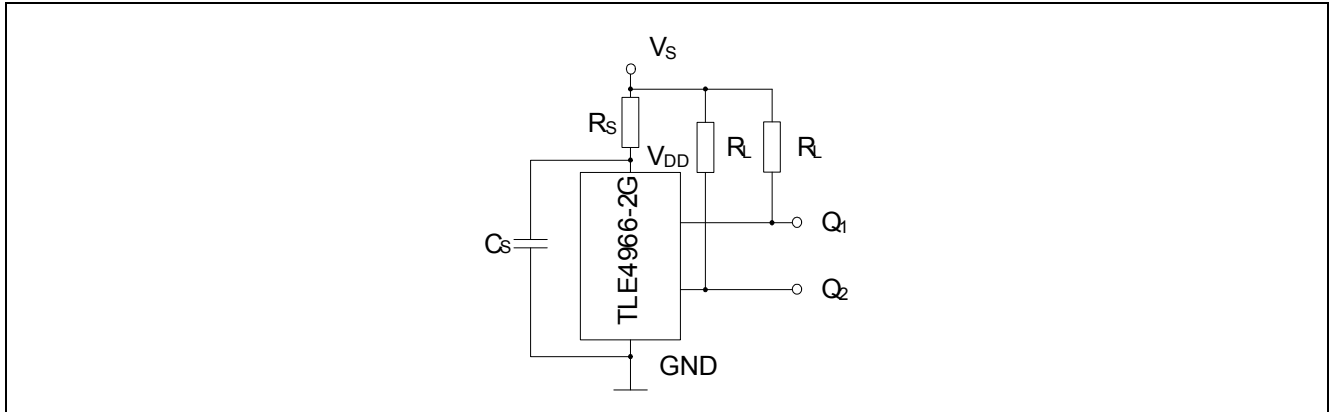


Figure 3 Application Circuit

## 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	18	V	for 5 min @ 1.2 k $\Omega$ pull up
		-0.7	26		
Continuous output current	$I_Q$	-50	50	mA	
Junction temperature	$T_j$	-	155	$^\circ\text{C}$	for 2000 h (not additive) for 1000 h (not additive) for 168 h (not additive) for 3 x 1 h (additive)
		-	165		
		-	175		
		-	195		
Storage temperature	$T_S$	-40	150	$^\circ\text{C}$	
Magnetic flux density	$B$	-	unlimited	mT	

Note: Stresses above those 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	$V_{ESD}$	–	±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 TLE4966-2G. 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	$V_{DD}$	2.7	–	18	V	1 h with $R_S \geq 200 \Omega$ for 5 min $R_S \geq 200 \Omega$
	$V_S$	–	–	24		
	$V_S$	–	–	26		
Output voltage	$V_Q$	-0.7	–	18	V	
Junction temperature	$T_j$	-40	–	150	°C	for 168 h
		–	–	175		
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.

**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	$V_{DD} = 2.7 \text{ V} \dots 18 \text{ V}$
Reverse current	$I_{SR}$	0	0.2	1	mA	$V_{DD} = -18 \text{ V}$
Output saturation voltage	$V_{QSAT}$	–	0.3	0.6	V	$I_Q = 10 \text{ mA}$
Output leakage current	$I_{QLEAK}$	–	0.05	10	$\mu\text{A}$	for $V_Q = 18 \text{ V}$
Output fall time	$t_f$	–	0.2	1	$\mu\text{s}$	$R_L = 1.2 \text{ k}\Omega$ ; $C_L < 50 \text{ pF}$
Output rise time	$t_r$	–	0.2	1	$\mu\text{s}$	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	–	$\mu\text{s}$	
Count Signal Delay	$t_{dc}$	50	200	1000	ns	
Output jitter <sup>4)</sup>	$t_{QJ}$	–	1	–	$\mu\text{s}_{RMS}$	Typ. value for square wave signal 1 kHz
Repeatability of magnetic thresholds <sup>5)</sup>	$B_{REP}$	–	40	–	$\mu\text{T}_{RMS}$	Typ. value for $\Delta B/\Delta t > 12 \text{ mT/ms}$
Power-on time <sup>6)</sup>	$t_{PON}$	–	13	–	$\mu\text{s}$	$V_{DD} \geq 2.7 \text{ V}$
Distance of hall plates	$d_{HALL}$	–	1.45	–	mm	
Thermal resistance <sup>7)</sup>	$R_{thJA}$	–	100	–	K/W	PG-TSOP6-6-9

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

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  $V_{DD} \geq 2.7 \text{ V}$  to the sensor until the output state is valid

7) Thermal resistance from junction to ambient

### Calculation of the ambient temperature (PG-TSOP6-6-9 example)

e.g. for  $V_{DD} = 12.0 \text{ V}$ ,  $I_{DDtyp} = 5.5 \text{ mA}$ ,  $V_{QSATtyp} = 0.3 \text{ V}$  and  $2 \times I_Q = 10 \text{ mA}$  :

Power Dissipation:  $P_{DIS} = 72.0 \text{ mW}$ .

In  $T_A = T_j - (R_{thJA} \times P_{DIS}) = 175^\circ\text{C} - (100 \text{ K/W} \times 0.072 \text{ W})$

Resulting max. ambient temperature:  $T_A = 167.8^\circ\text{C}$

Timing Diagrams for the Speed Outputs

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

Parameter	Symbol	$T_j$ [°C]	Limit Values			Unit	Conditions
			min.	typ.	max.		
Operate point	$B_{OP1}, B_{OP2}$	-40	5.2	7.7	10.3	mT	$B_{OP1}$ for Hall element 1 $B_{OP2}$ for Hall element 2
		25	5.0	7.5	10.0		
		150	4.7	7.1	9.5		
Release point	$B_{RP1}, B_{RP2}$	-40	-10.3	-7.7	-5.2	mT	$B_{RP1}$ for Hall element 1 $B_{RP2}$ for Hall element 2
		25	-10.0	-7.5	-5.0		
		150	-9.5	-7.1	-4.7		
Hysteresis	$B_{HYS1}, B_{HYS2}$	-40	–	–	–	mT	$B_{HYS1} = B_{OP1} - B_{RP1}$ $B_{HYS2} = B_{OP2} - B_{RP2}$
		25	10.0	15.0	20.0		
		150	–	–	–		
Magnetic matching	$B_{MATCH}$	-40	–	–	–	mT	Valid for $B_{OP1} - B_{OP2}$ and $B_{RP1} - B_{RP2}$
		25	-2.0	0	2.0		
		150	–	–	–		
Magnetic offset	$B_{OFF1}, B_{OFF2}$	-40	–	–	–	mT	$B_{OFF1} = (B_{OP1} + B_{RP1})/2$ $B_{OFF2} = (B_{OP2} + B_{RP2})/2$
		25	-2.0	0	2.0		
		150	–	–	–		
Temperature compensation of magnetic thresholds	$TC$	–	–	-350	–	ppm/°C	

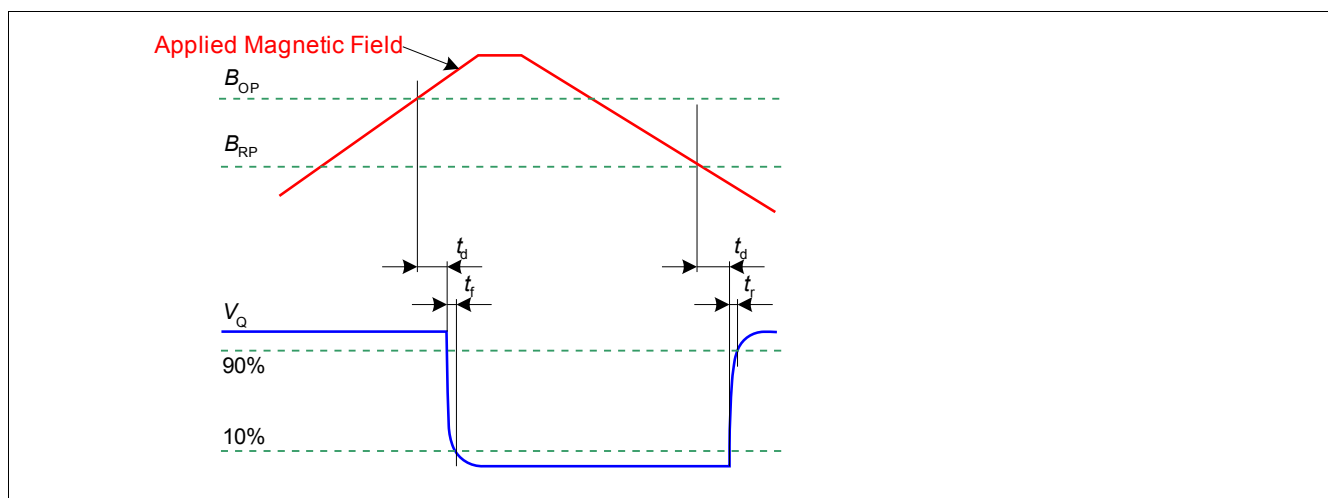
1) over operating range, unless otherwise specified. Typical values correspond to  $V_{DD} = 12\text{ V}$

Note: Typical characteristics specify mean values expected over the production spread.

**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 Outputs**



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

## 7 Package Information

### 7.1 Package Marking

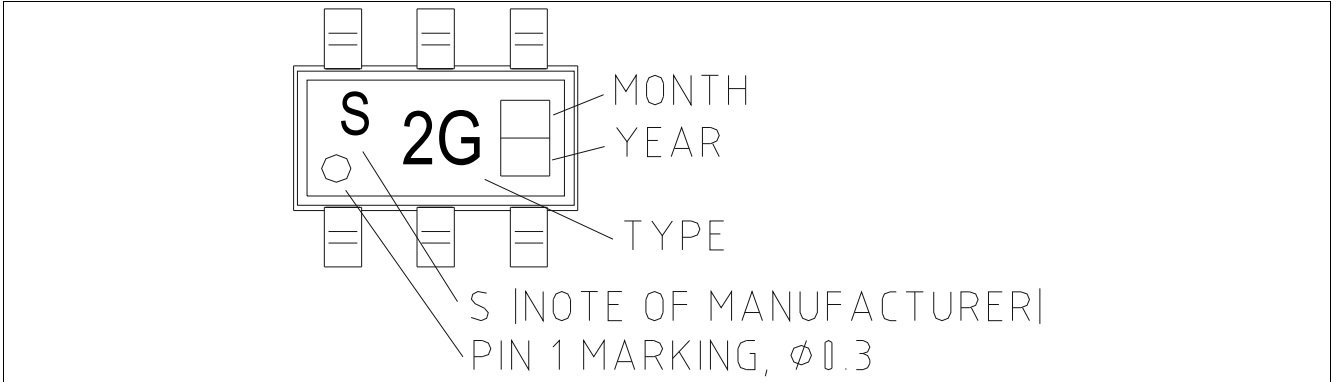


Figure 5 Marking PG-TSOP6-6-9

### 7.2 Distance between Chip and Package Surface

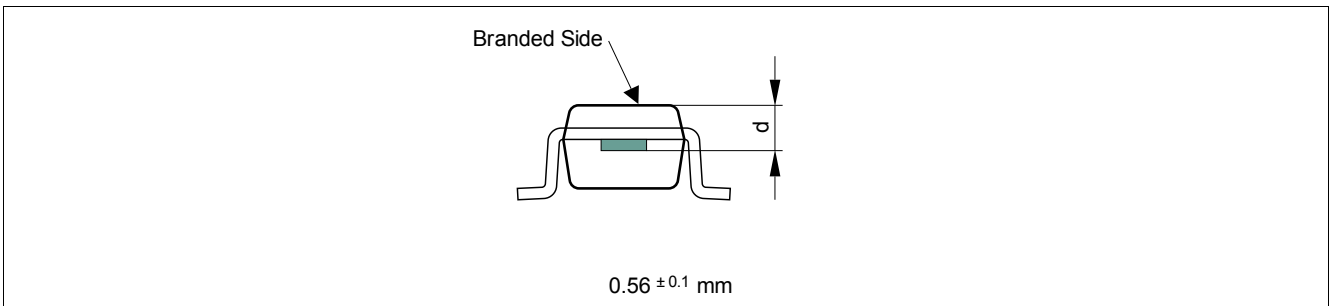


Figure 6 Distance Chip to Upper Side of IC

### 7.3 Package Outlines

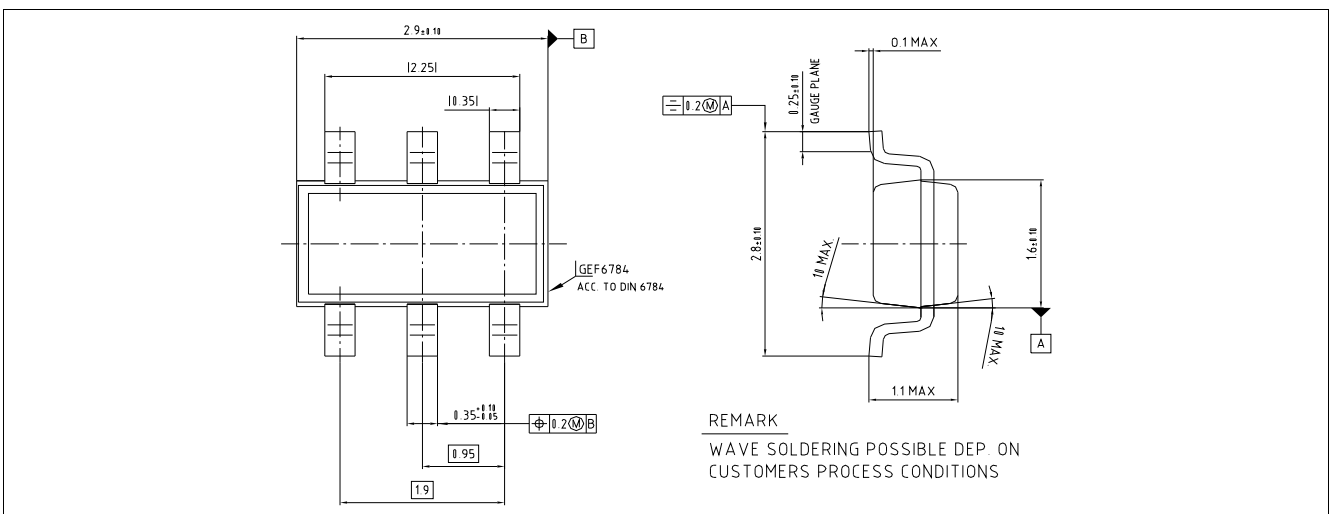
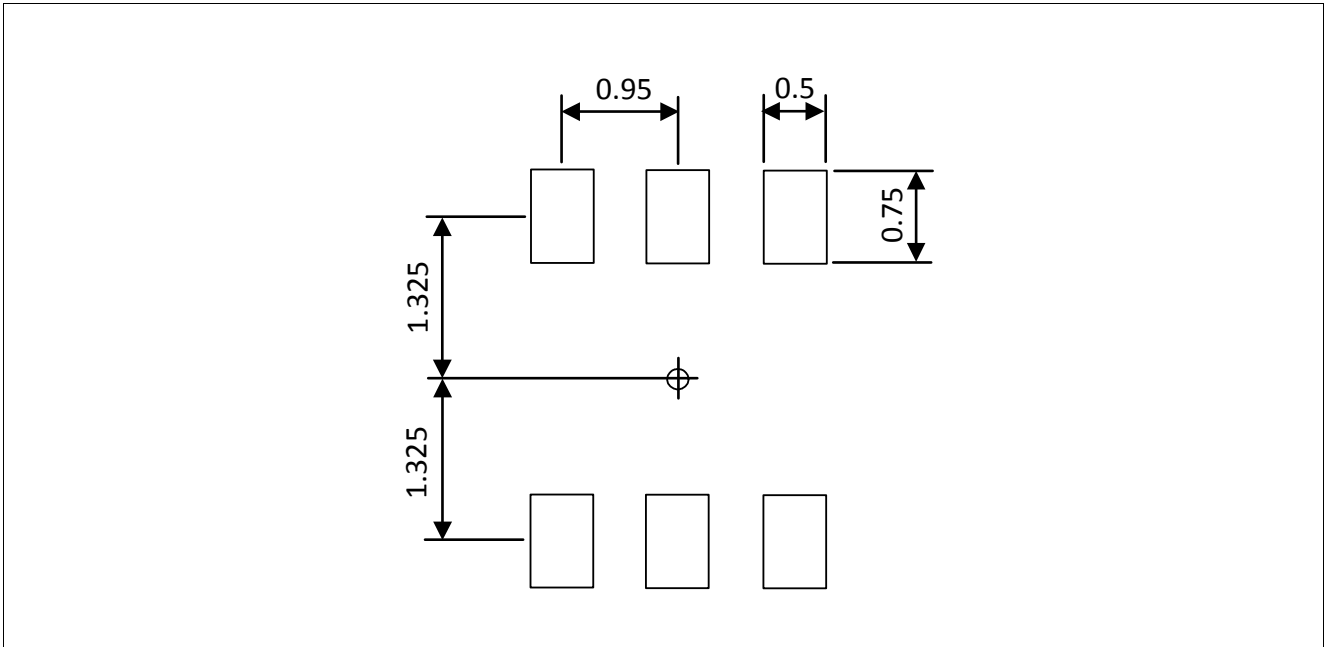


Figure 7 PG-TSOP6-6-9 (Plastic Thin Small Outline Package)

**PCB Footprint for PG-TSOP6-6-9**

The following picture shows a recommendation for the PCB layout.



**Figure 8 Footprint PG-TSOP6-6-9**

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