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Bipolar Hall Latch

Hall Effect Latch for Industrial Applications

TLI4961-1L
TLI4961-1M

SP001052198
SP001031008

TLI4964-1L/1M

Data Sheet

Revision 1.2, 2019-12-20

Sense & Control

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1 Product description

RoHS HAL 1)

1.1 Overview

Characteristic	Supply Voltage	Supply Current	Sensitivity	Interface	Temperature
Bipolar Hall Effect Latch	3.0 V ~ 32 V	1.6 mA	B_{OP}: 2 mT B_{RP}: -2 mT	Open Drain Output	-40°C to 125°C



Figure 1 TLI4961-1M in the PG-SOT23-3-15 (left hand) and TLI4961-1L in the PG-SSO-3-2 (right hand) package

1.2 Features

- 3.0 V to 32 V operating supply voltage
- Operation from unregulated power supply
- Reverse polarity protection (-18 V)
- Overvoltage capability up to 42 V without external resistor
- Output overcurrent and overtemperature protection
- Active error compensation
- High stability of magnetic thresholds
- Low jitter (typ. 0.35 µs)
- High ESD performance
- Leaded, non halogen-free package PG-SSO-3-2 (TLI4961-1L)
- Small, halogen-free SMD package PG-SOT23-3-15 (TLI4961-1M)
- For industrial and consumer applications, not qualified for automotive applications
  For automotive applications please refer to the Infineon TLE Hall Switches/Latches series

Table 1 Ordering information

Product name	Product type	Ordering code	Package
TLI4961-1L	Bipolar Hall Latch	SP001052198	PG-SSO-3-2
TLI4961-1M	Bipolar Hall Latch	SP001031008	PG-SOT23-3-15

1) Only the PG-SOT23-3-15 package (TLI4961-1M) is halogen-free.

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1.3 Target applications

Target applications for the TLI496x Hall Latch family are all applications which require a high precision Hall Latch with an operating temperature range from -40°C to 125°C. Its superior supply voltage range from 3.0 V to 32 V with overvoltage capability up to 42 V without external resistor makes it ideally suited for industrial applications.

The magnetic behavior as a latch and switching thresholds of typical ±2 mT make the device especially suited for the use with a pole wheel for index counting applications and for rotor position detection as in brushless DC motor commutation.

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2 Functional description

2.1 General

The TLI4964-1L/1M is an integrated Hall effect designed specifically for highly accurate applications with superior supply voltage capability and temperature stability of the magnetic thresholds.

2.2 Pin configuration (top view)

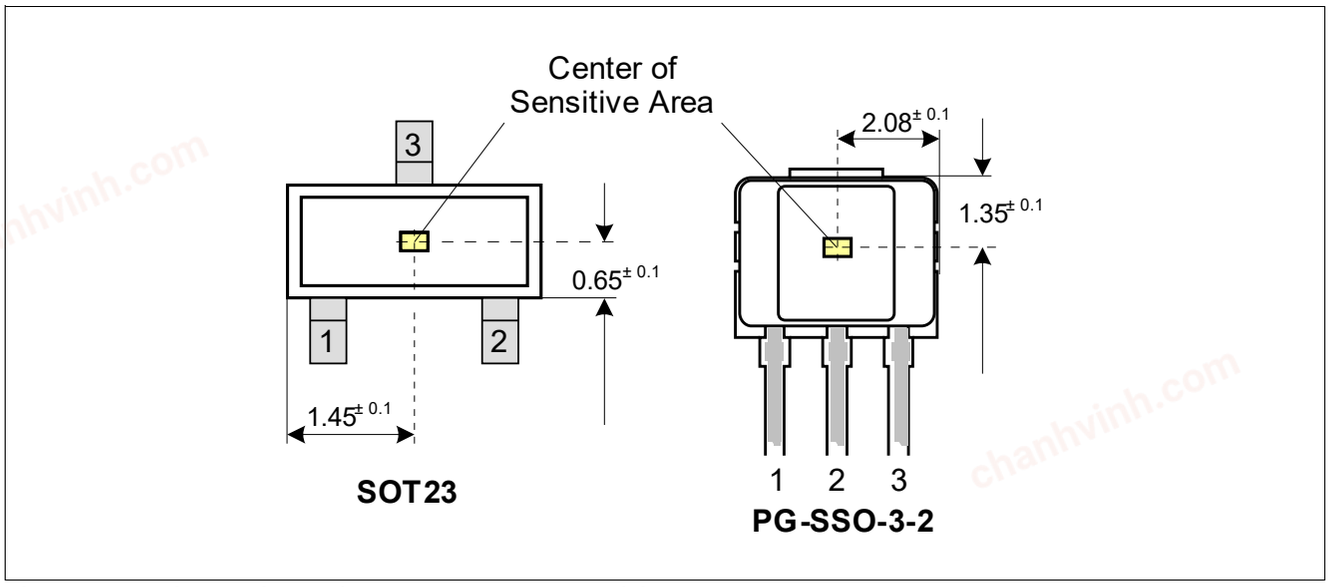


Figure 2 Pin configuration and center of sensitive area

2.3 Pin description

Table 2 Pin description PG-SOT23-3-15

Pin no.	Symbol	Function
1	VDD	Supply voltage
2	Q	Output
3	GND	Ground

Table 3 Pin description PG-SSO-3-2

Pin no.	Symbol	Function
1	VDD	Supply voltage
2	GND	Ground
3	Q	Output

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2.4 Block diagram

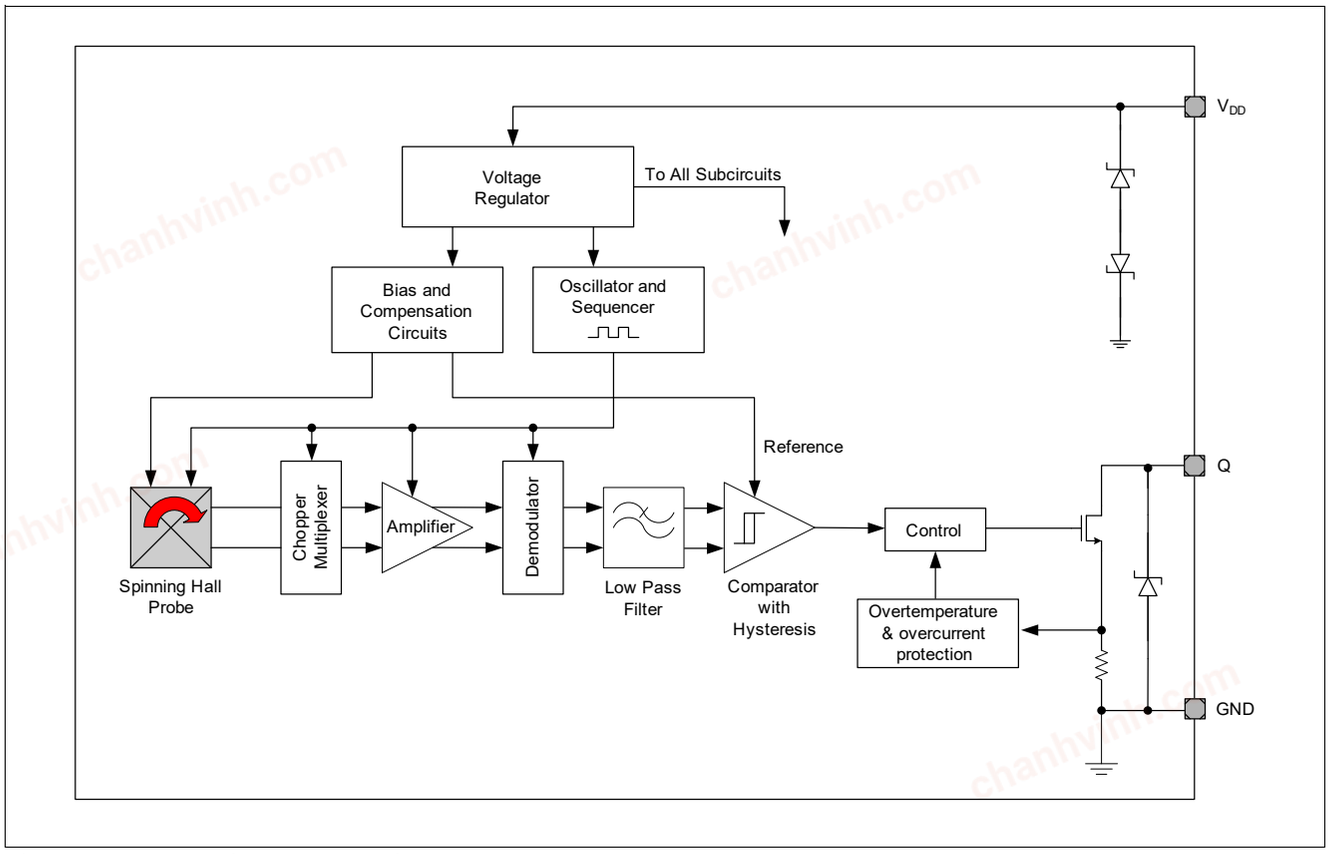


Figure 3 Functional block diagram TLI4964-1L/1M

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2.5 Functional block description

The chopped Hall IC switch comprises a Hall probe, bias generator, compensation circuits, oscillator and output transistor.

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

The active error compensation (chopping technique) rejects offsets in the signal path and the influence of mechanical stress to the Hall probe caused by molding and soldering processes and other thermal stress in the package. The chopped measurement principle together with the threshold generator and the comparator ensures highly accurate and temperature stable magnetic thresholds.

The output transistor has an integrated overcurrent and overtemperature protection.

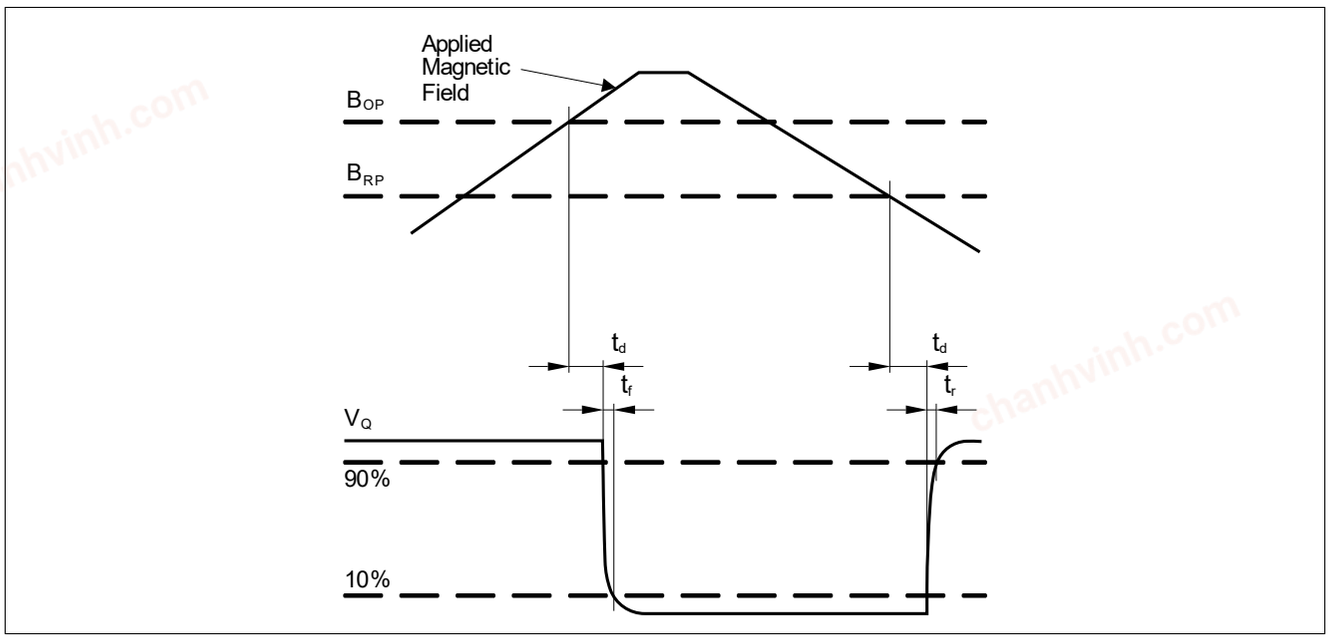


Figure 4 Timing diagram TLI4964-1L/1M

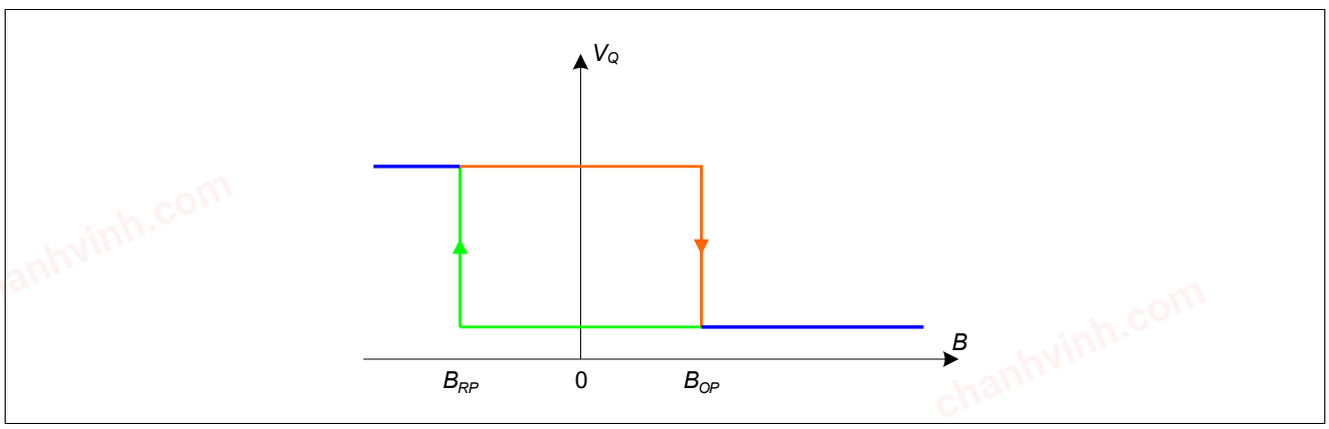


Figure 5 Output signal TLI4964-1L/1M

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2.6 Default start-up behavior

The magnetic thresholds exhibit a hysteresis $B_{HYS} = B_{OP} - B_{RP}$. In case of a power-on with a magnetic field B within hysteresis ($B_{OP} > B > B_{RP}$) the output of the sensor is set to the pull up voltage level (V_Q) per default. After the first crossing of B_{OP} or B_{RP} of the magnetic field the internal decision logic is set to the corresponding magnetic input value.

V_{DDA} is the internal supply voltage which is following the external supply voltage V_{DD}.

This means for $B > B_{OP}$ the output is switching, for $B < B_{RP}$ and $B_{OP} > B > B_{RP}$ the output stays at V_Q.

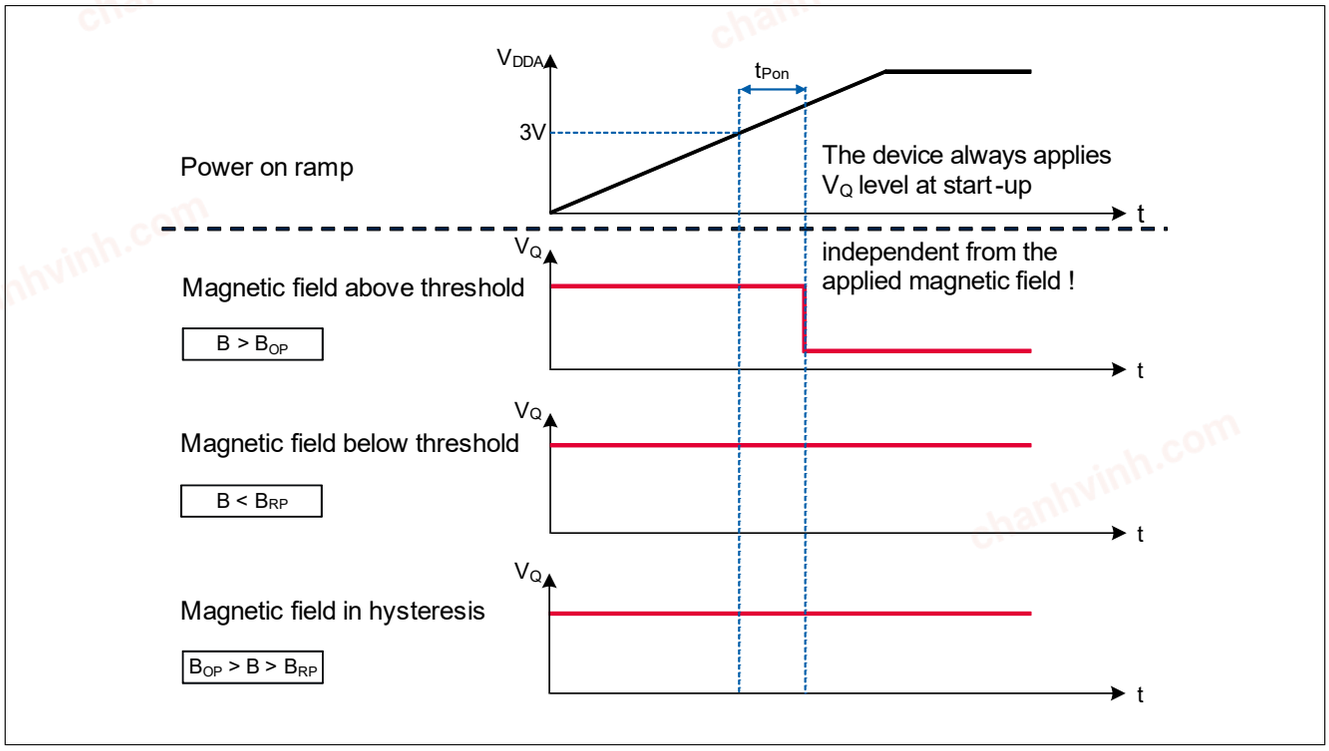


Figure 6 Start-up behavior of the TLI4964-1L/1M

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3 Specification

3.1 Application circuit

The following **Figure 7** shows one option of an application circuit. As explained above the resistor R_S can be left out (see **Figure 8**). The resistor R_Q has to be in a dimension to match the applied V_S to keep I_Q limited to the operating range of maximum 25 mA.

e.g.: V_S = 12 V; I_Q = 12 V/1200 Ω = 10 mA

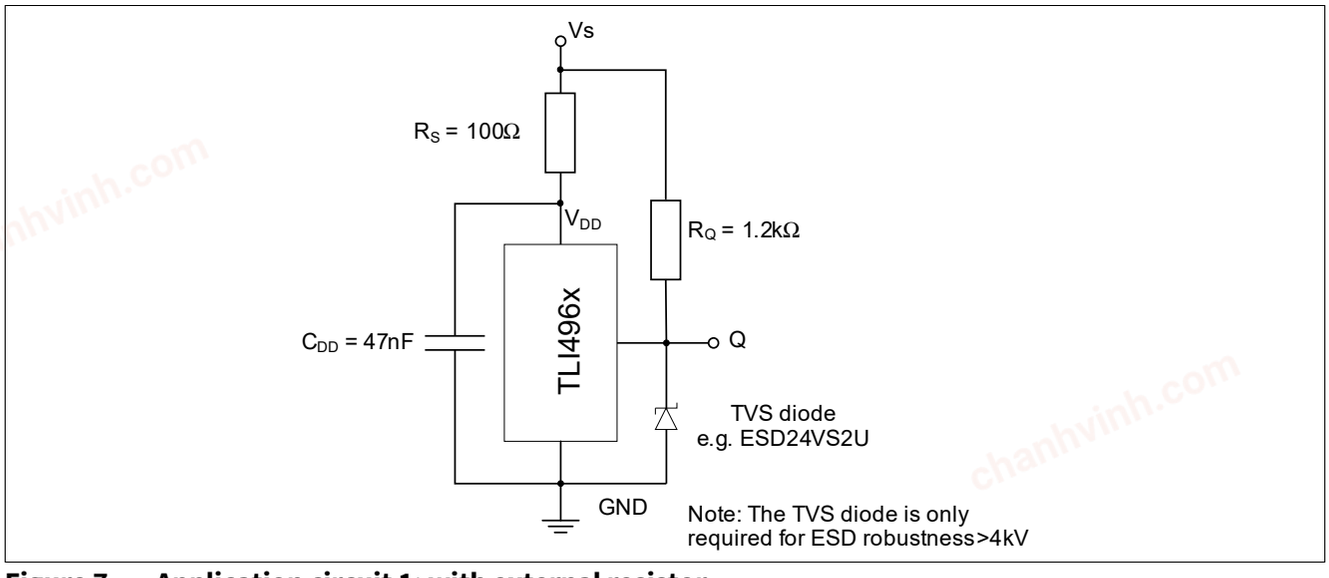


Figure 7 Application circuit 1: with external resistor

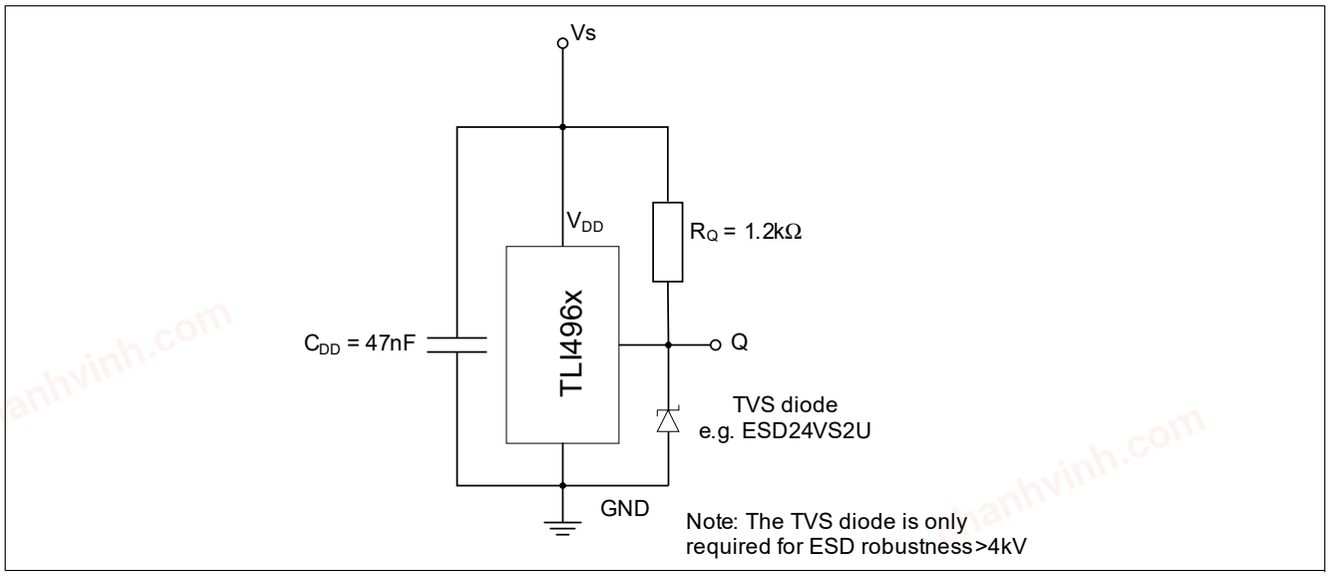


Figure 8 Application circuit 2: without external resistor

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3.2 Absolute maximum ratings

Table 4 Absolute maximum rating parameters

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Supply voltage[1)]	V_{DD}	-18	–	32 42	V	– 10h, no external resistor required
Output voltage	V_Q	-0.5	–	32	V	–
Reverse output current	I_Q	-70	–	–	mA	–
Junction temperature[1)]	T_J	-40	–	150	°C	for 2000h
Storage temperature	T_S	-40	–	150	°C	–
Thermal resistance Junction ambient	R_{thJA}	–	–	300 200	K/W	for PG-SOT23-3-15 (2s2p) for PG-SSO-3-2 (2s2p)
Thermal resistance Junction lead	R_{thJL}	–	–	100 150	K/W	for PG-SOT23-3-15 for PG-SSO-3-2

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

Attention: 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.

Calculation of the dissipated power P_{DIS} and junction temperature T_J of the chip (SOT23 example):
e.g. for: V_{DD} = 12 V, I_S = 2.5 mA, V_{QSAT} = 0.5 V, I_Q = 20 mA
Power dissipation: P_{DIS} = 12 V x 2.5 mA + 0.5 V x 20 mA = 30 mW + 10 mW = 40 mW
Temperature $\Delta T = R_{thJA}$ x P_{DIS} = 300 K/W x 40 mW = 12 K
For T_A = 50°C: $T_J = T_A + \Delta T$ = 50°C + 12 K = 62°C

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Table 5 ESD protection[1] (T_A = 25°C)

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
ESD voltage (HBM)[2]	V_{ESD}	-4	–	4	kV	R = 1.5 kΩ, C = 100 pF
ESD voltage (CDM)[3]	V_{ESD}	-1	–	1	kV	–
ESD voltage (system level)[4]	V_{ESD}	-15	–	15	kV	with circuit shown in **Figure 7** and **Figure 8**

1) Characterization of ESD is carried out on a sample basis, not subject to production test.
2) Human Body Model (HBM) tests according to ANSI/ESDA/JEDEC JS-001.
3) Charge device model (CDM) tests according to JESD22-C101.
4) Gun test (2 kΩ / 330 pF or 330 Ω / 150 pF) according to ISO 10605-2008.

3.3 Operating range

The following operating conditions must not be exceeded in order to ensure correct operation of the TLI4964-1L/1M.

All parameters specified in the following sections refer to these operating conditions unless otherwise mentioned.

The maximum tested magnetic field is 600 mT.

Table 6 Operating conditions parameters

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Supply voltage	V_{DD}	3.0	–	32[1]	V	–
Output voltage	V_Q	-0.3	–	32	V	–
Junction temperature	T_J	-40	–	125	°C	–
Output current	I_Q	0	–	25	mA	–
Magnetic signal input frequency[2]	f_{SW}	0	–	10	kHz	–

1) Latch-up test with factor 1.5 is not covered. Please see max ratings also.
2) For operation at the maximum switching frequency the magnetic input signal must be 1.4 times higher than for static fields.This is due to the -3 dB corner frequency of the internal low-pass filter in the signal path.

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3.4 Electrical and magnetic characteristics

Product characteristics involve the spread of values guaranteed within the specified voltage and ambient temperature range. Typical characteristics are the median of the production and correspond to V_{DD} = 12 V and T_A = 25°C. The below listed specification is valid in combination with the application circuit shown in **Figure 7** and **Figure 8**.

Table 7 General electrical characteristics

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Supply current	I_S	1.1	1.6	2.5	mA	–
Reverse current	I_{SR}	–	0.05	1	mA	for V_{DD} = -18 V
Output saturation voltage	V_{QSAT}	–	0.2	0.5	V	I_Q = 20 mA
		–	0.24	0.6	V	I_Q = 25 mA
Output leakage current	I_{QLEAK}	–	–	10	µA	–
Output current limitation	I_{QLIMIT}	30	56	70	mA	internally limited and thermal shutdown
Output fall time[1)]	t_f	0.17	0.4	1	µs	1.2 kΩ / 50 pF, see **Figure 4**
Output rise time[1)]	t_r	0.4	0.5	1	µs	1.2 kΩ / 50 pF, see **Figure 4**
Output jitter[1)2)]	t_{QJ}	–	0.35	1	µs	for square wave signal with 1 kHz
Delay time[1)3)]	t_d	12	15	30	µs	see **Figure 4**
Power-on time[1)4)]	t_{PON}	–	80	150	µs	V_{DD} = 3 V, $B \le B_{RP}$ - 0.5 mT or $B \ge B_{OP}$ + 0.5 mT
Chopper frequency[1)]	f_{OSC}	–	350		kHz	–

1) Not subject to production test, verified by design/characterization.
2) Output jitter is the 1 σ value of the output switching distribution.
3) Systematic delay between magnetic threshold reached and output switching.
4) Time from applying V_{DD} = 3.0 V to the sensor until the output is valid.

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Table 8 Magnetic characteristics

Parameter	Symbol	T (°C)	Values			Unit	Note / Test Condition
			Min.	Typ.	Max.		
Operating point	B_{OP}	-40	0.6	2.1	3.6	mT	–
		25	0.5	2.0	3.5		
		125	0.3	1.8	3.2		
Release point	B_{RP}	-40	-3.6	-2.1	-0.6	mT	–
		25	-3.5	-2.0	-0.5		
		125	-3.2	-1.8	-0.3		
Hysteresis	B_{HYS}	-40	2.5	4.2	5.9	mT	–
		25	2.4	4.0	5.6		
		125	2.1	3.2	5.0		
Effective noise value of the magnetic switching points[1)]	B_{Neff}	25	–	62	–	µT	–
Temperature compensation of magnetic thresholds[2)]	T_C	–	–	-1200	–	ppm/K	–

1) The magnetic noise is normal distributed and can be assumed as nearly independent to frequency without sampling noise or digital noise effects. The typical value represents the rms-value and corresponds therefore to a 1 σ probability of normal distribution. Consequently a 3 σ value corresponds to 99.7% probability of appearance.

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

Field direction definition

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

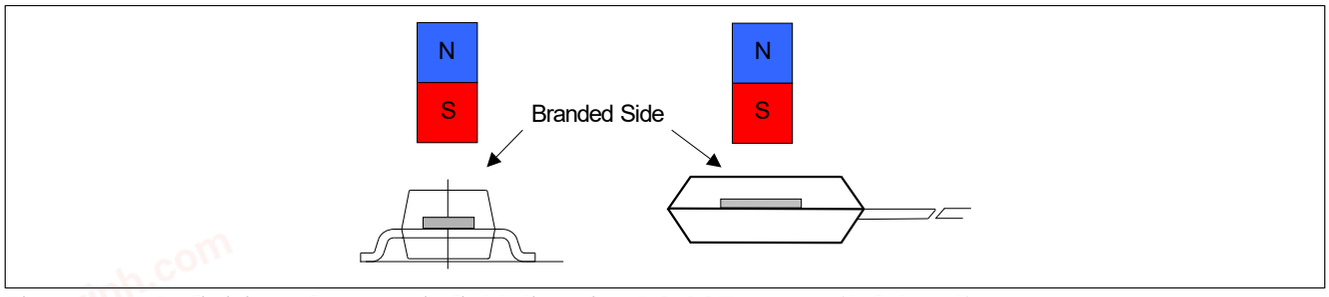


Figure 9 Definition of magnetic field direction PG-SOT23-3-15 (left hand) and PG-SSO-3-2 (right hand)

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4 Package information

The TLI4964-1L/1M is available in the small halogen-free SMD package PG-SOT23-3-15 and the through-hole leaded package PG-SSO-3-2.

4.1 Package outline PG-SOT23-3-15

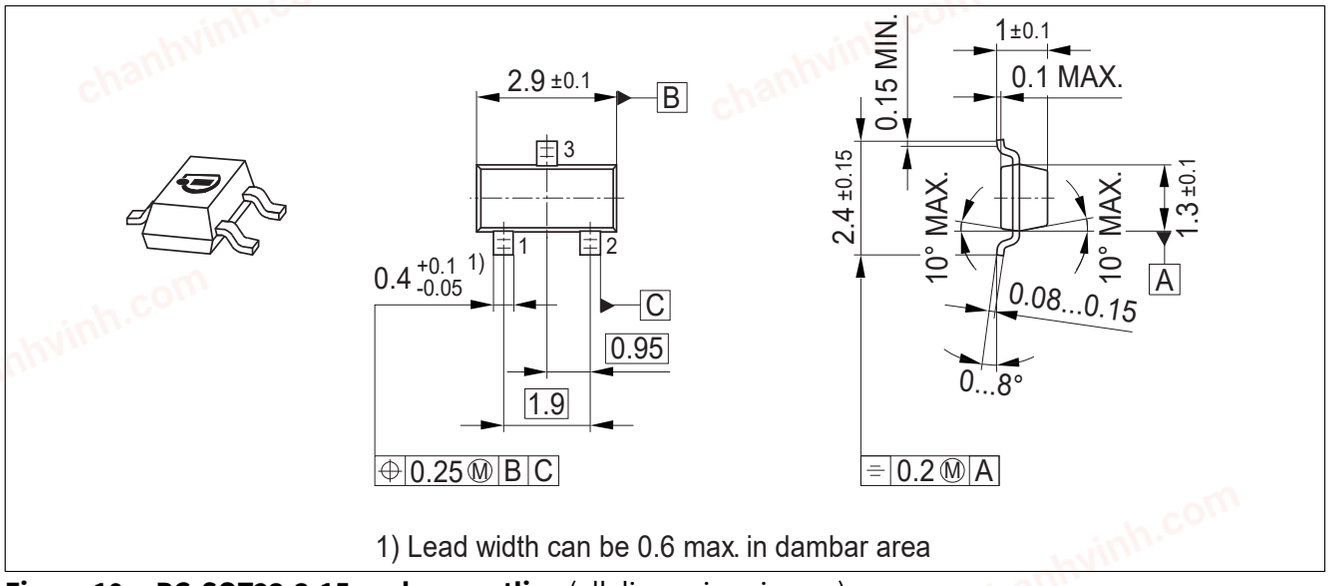


Figure 10 PG-SOT23-3-15 package outline (all dimensions in mm)

4.2 Packing information PG-SOT23-3-15

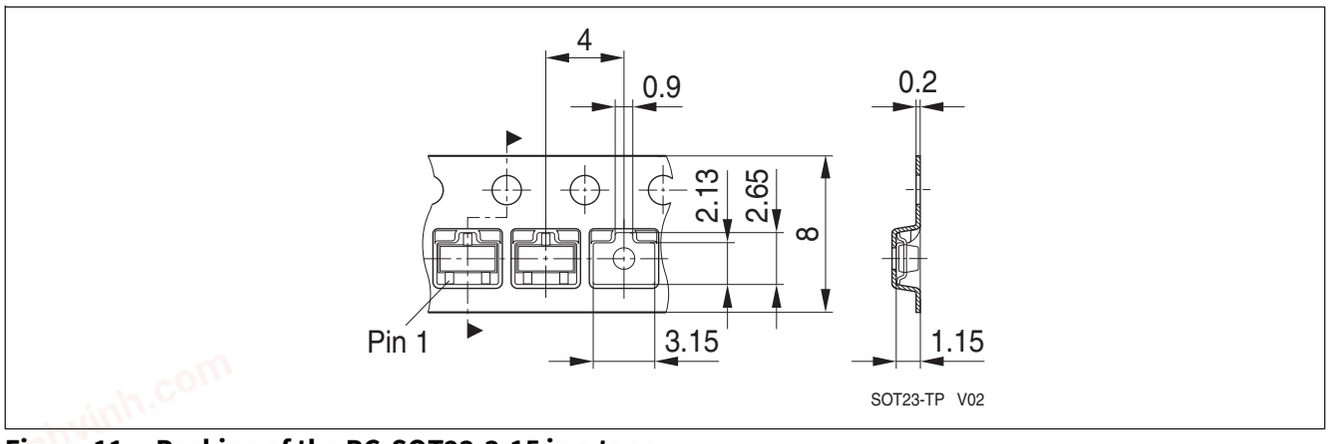


Figure 11 Packing of the PG-SOT23-3-15 in a tape

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4.3 Package outline PG-SSO-3-2

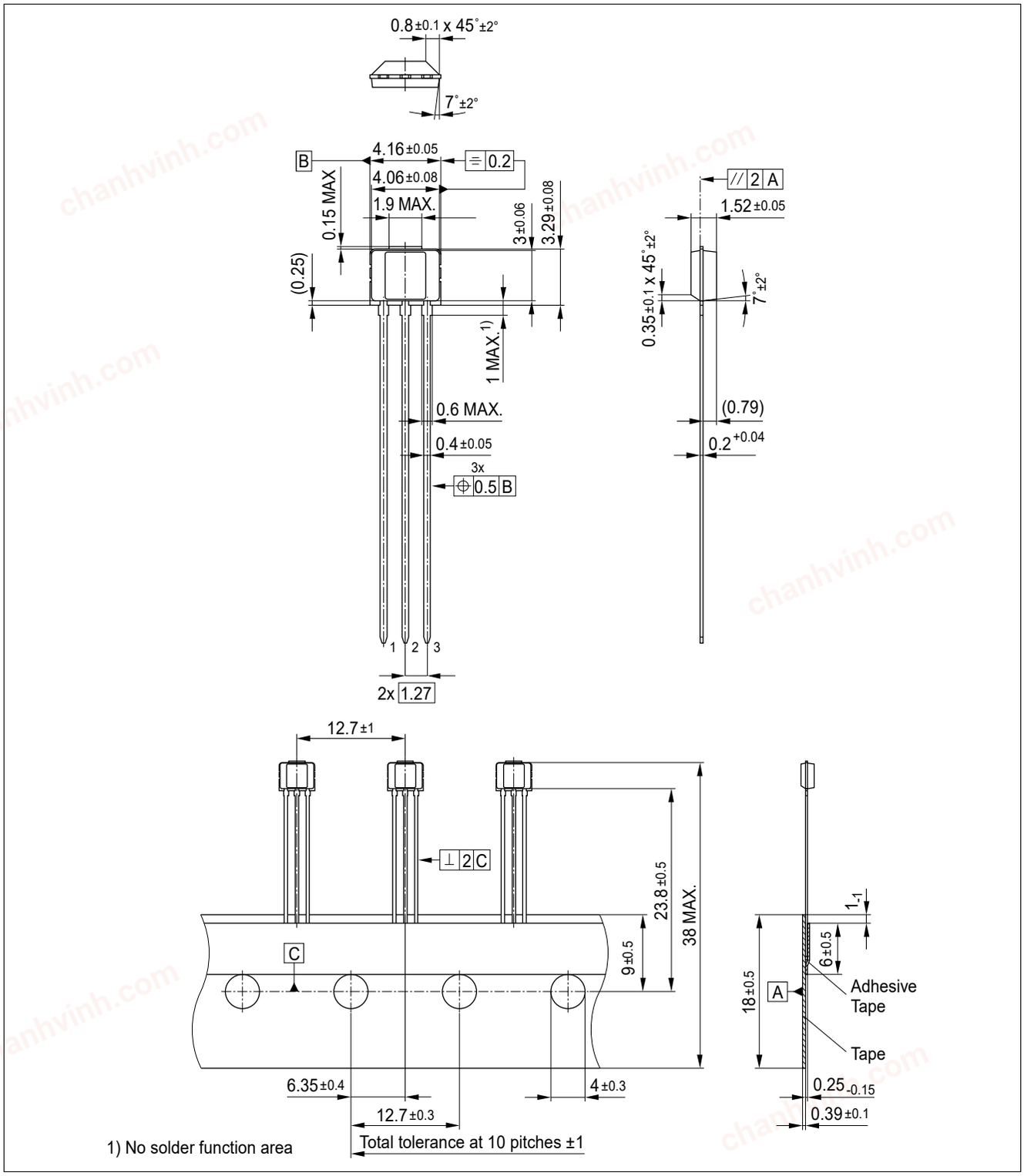


Figure 12 PG-SSO-3-2 package outline (all dimensions in mm)

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4.4 Footprint PG-SOT23-3-15

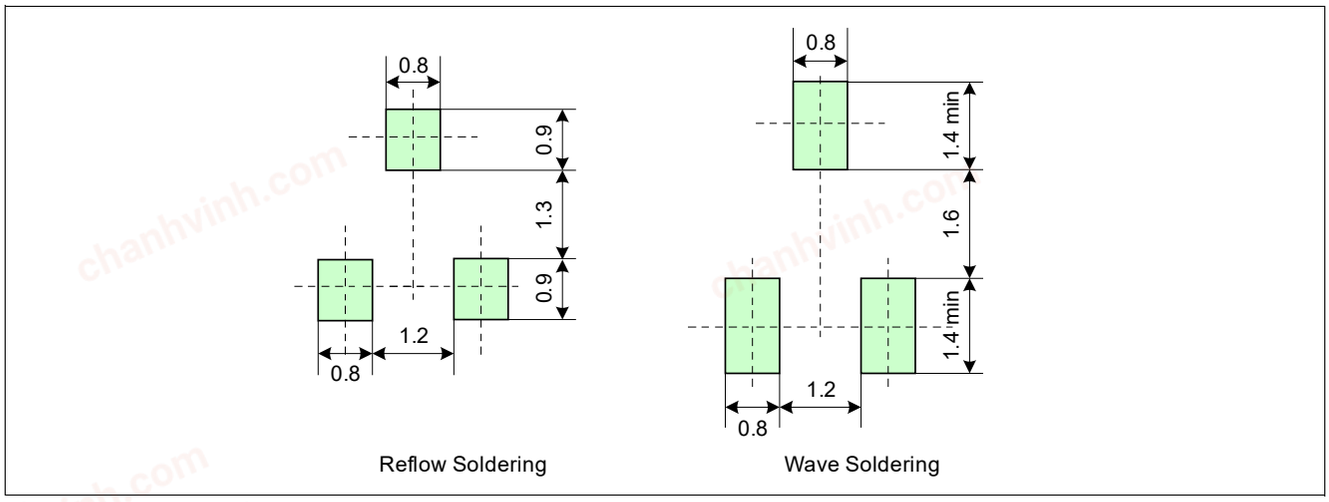


Figure 13 Footprint PG-SOT23-3-15

4.5 PG-SOT23-3-15 distance between chip and package

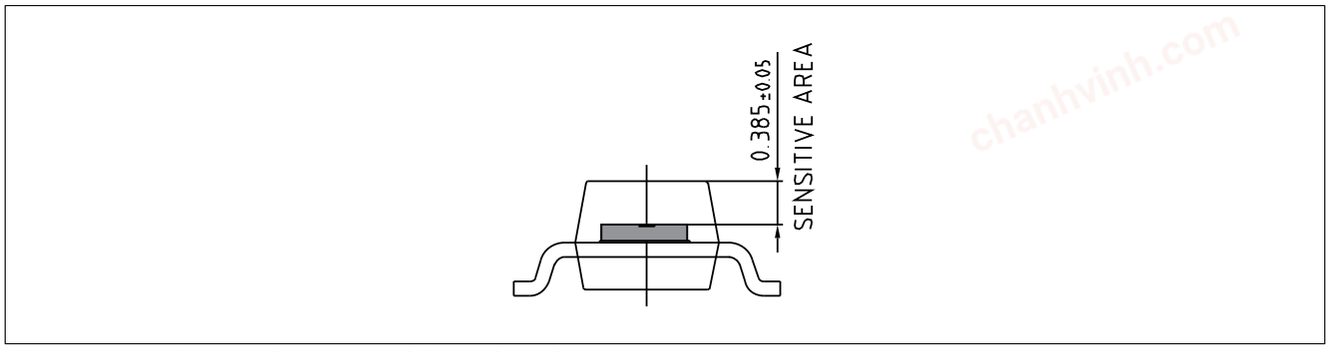


Figure 14 Distance between chip and package

4.6 PG-SSO-3-2 distance between chip and package

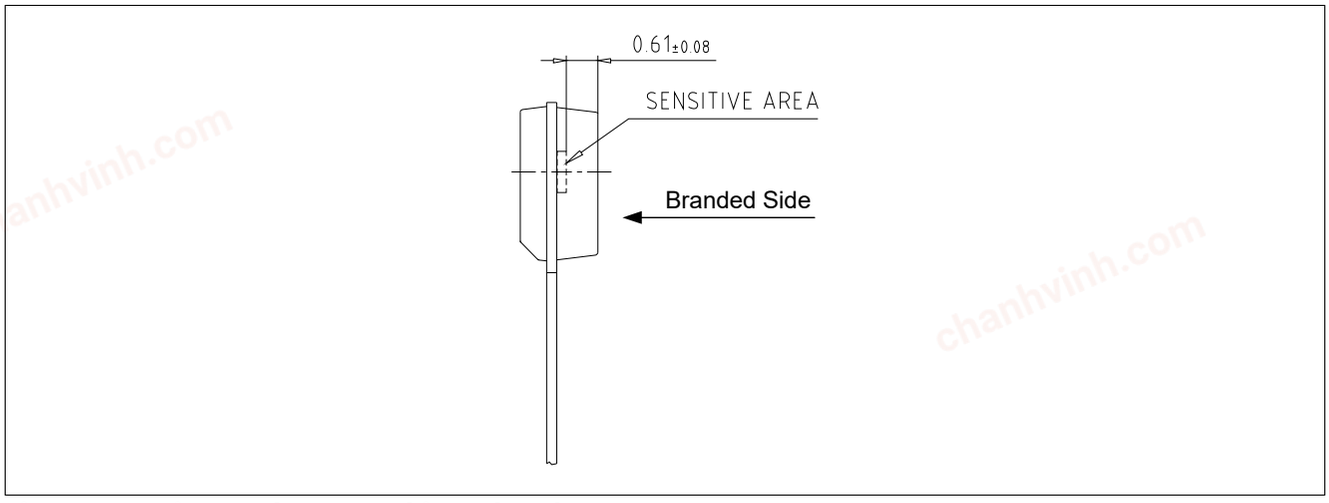
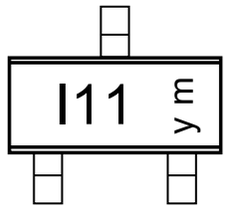


Figure 15 Distance between chip and package

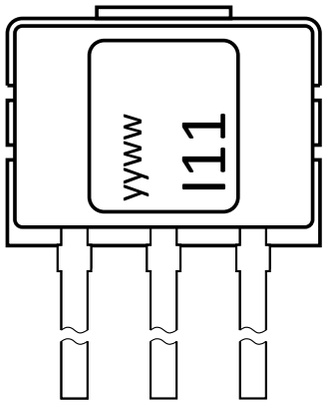
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4.7 Package marking



Year (y) = 0...9
Month (m) = 1...9,
o - October
n - November
d - December

Figure 16 Marking of TLI4961-1M



Year (y) = 0...9
Calendar Week (ww) = 01...52

Figure 17 Marking of TLI4961-1L

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5 Revision history

Revision	Date	Changes
Revision 1.2	2019-12-20	Updated text and figure in **Chapter 2.6** Updated standards in **Table 5** Added maximum tested magnetic field in **Chapter 3.3** Updated **Figure 15** Editorial changes
Revision 1.1	2012-10-15	Added TLI4961-1L with PG-SSO-3-2 package
Revision 1.0		Initial release

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