

# Bipolar Hall Latch

High Precision Hall Effect Latch for 5 V Applications

TLI4963-1M

SP001370094

TLI4963-1M

## Data Sheet

Revision 1.2, 2019-12-20

Sense & Control

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## Product description

# 1 Product description



RoHS



## 1.1 Overview

The TLI4963-1M is a high precision Hall effect sensor with a latch characteristic and highly accurate switching thresholds for operating temperatures up to 125°C.

| Characteristic    | Supply Voltage | Supply Current | Sensitivity                                 | Interface         | Temperature    |
|-------------------|----------------|----------------|---------------------------------------------|-------------------|----------------|
| Hall Effect Latch | 3.0 V ~ 5.5 V  | 1.5 mA         | High<br>$B_{OP}$ : 2 mT<br>$B_{RP}$ : -2 mT | Open Drain Output | -40°C to 125°C |



**Figure 1** TLI4963-1M in the PG-SOT23-3-15 package

## 1.2 Features

- 3.0 V to 5.5 V operating supply voltage
- Operation from regulated power supply
- Active error compensation
- High stability of magnetic thresholds
- Low jitter (typ. 0.28  $\mu$ s)
- 4 kV ESD (HBM) performance
- Small SMD package PG-SOT23-3-15
- 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       |
|--------------|--------------------|---------------|---------------|
| TLI4963-1M   | Bipolar Hall Latch | SP001370094   | PG-SOT23-3-15 |

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**Product description****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.

The magnetic behavior as a latch and switching thresholds of typical  $\pm 2$  mT make the device especially suited for the use with a pole wheel for index counting applications, e.g. power closing and window lifter or brush less DC motors for commutation.

## Functional description

## 2 Functional description

### 2.1 General

The TLI4963-1M is an integrated Hall effect latch designed specifically for highly accurate applications where the sensor is connected to a regulated power supply voltage in the range of 3.0 V to 5.5 V. It provides a temperature stability of the magnetic thresholds.

### 2.2 Pin configuration (top view)



**Figure 2** Pin configuration and center of sensitive area

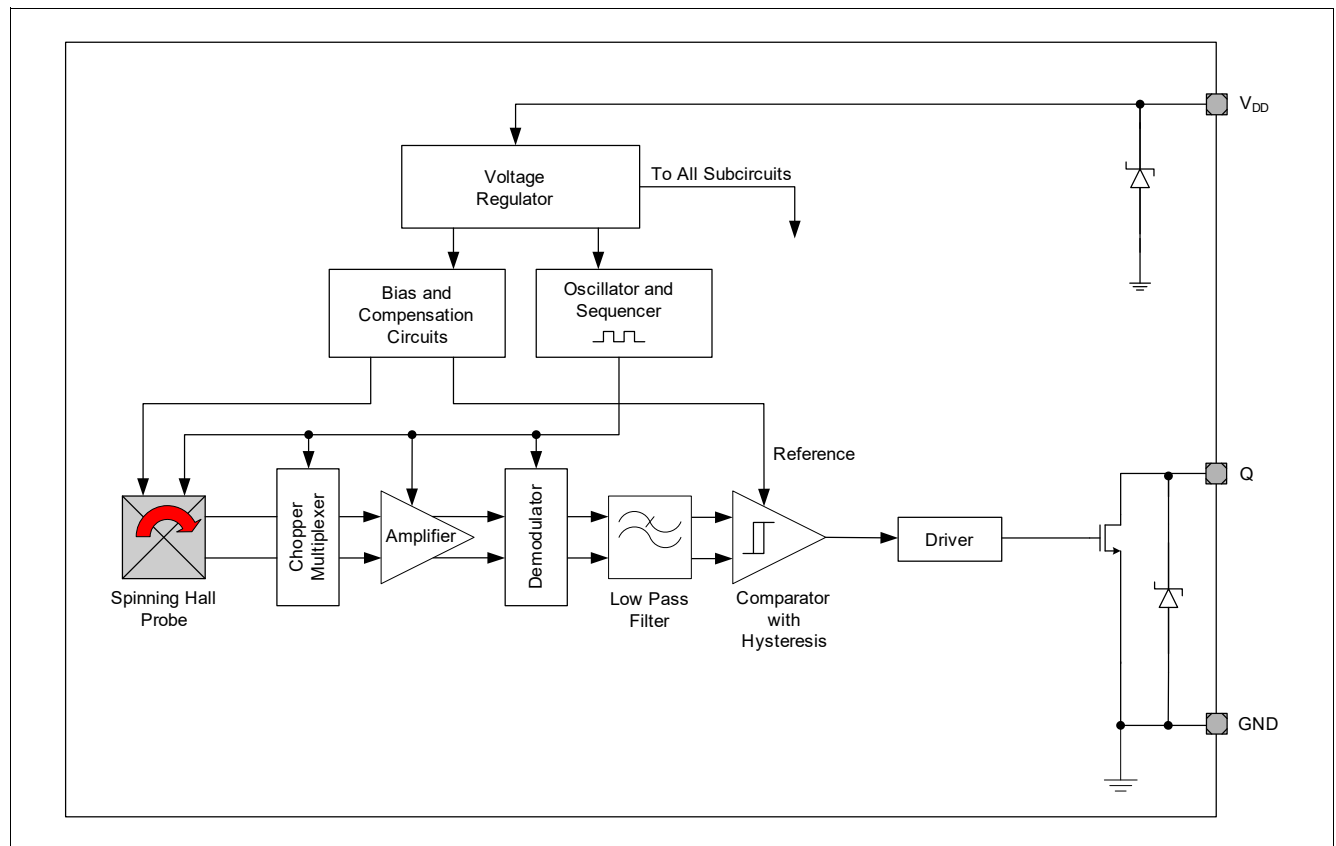
### 2.3 Pin description

**Table 2** Pin description PG-SOT23-3-15

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

## Functional description

### 2.4 Block diagram



**Figure 3** Functional block diagram TLI4963-1M

## Functional description

### 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.

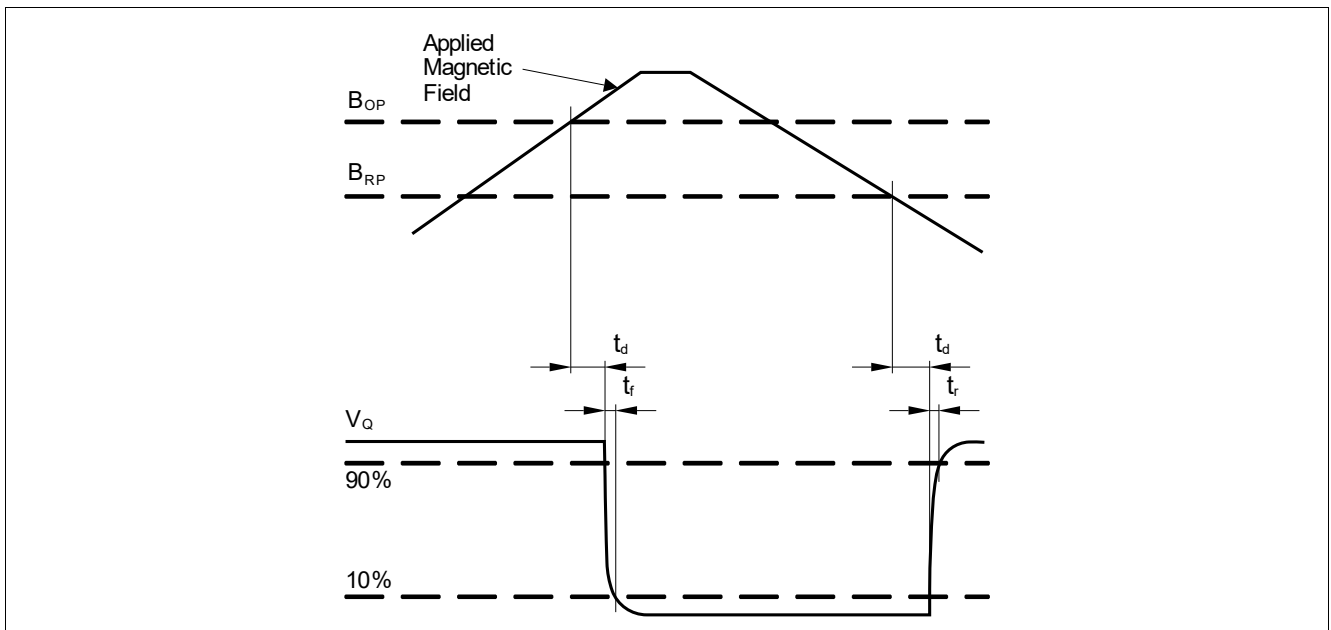


Figure 4 Timing diagram TLI4963-1M

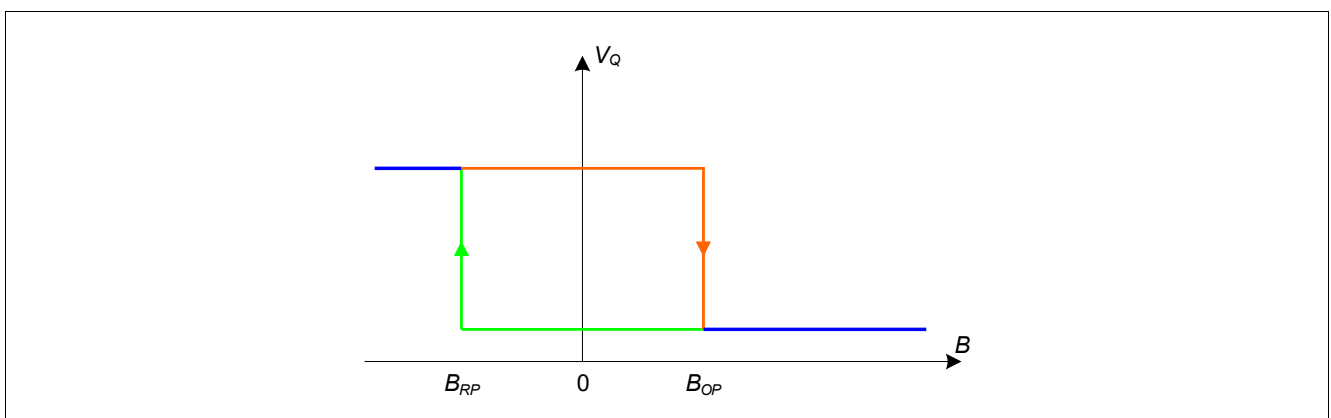


Figure 5 Output signal TLI4963-1M

## Functional description

### 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  $V_Q$ .

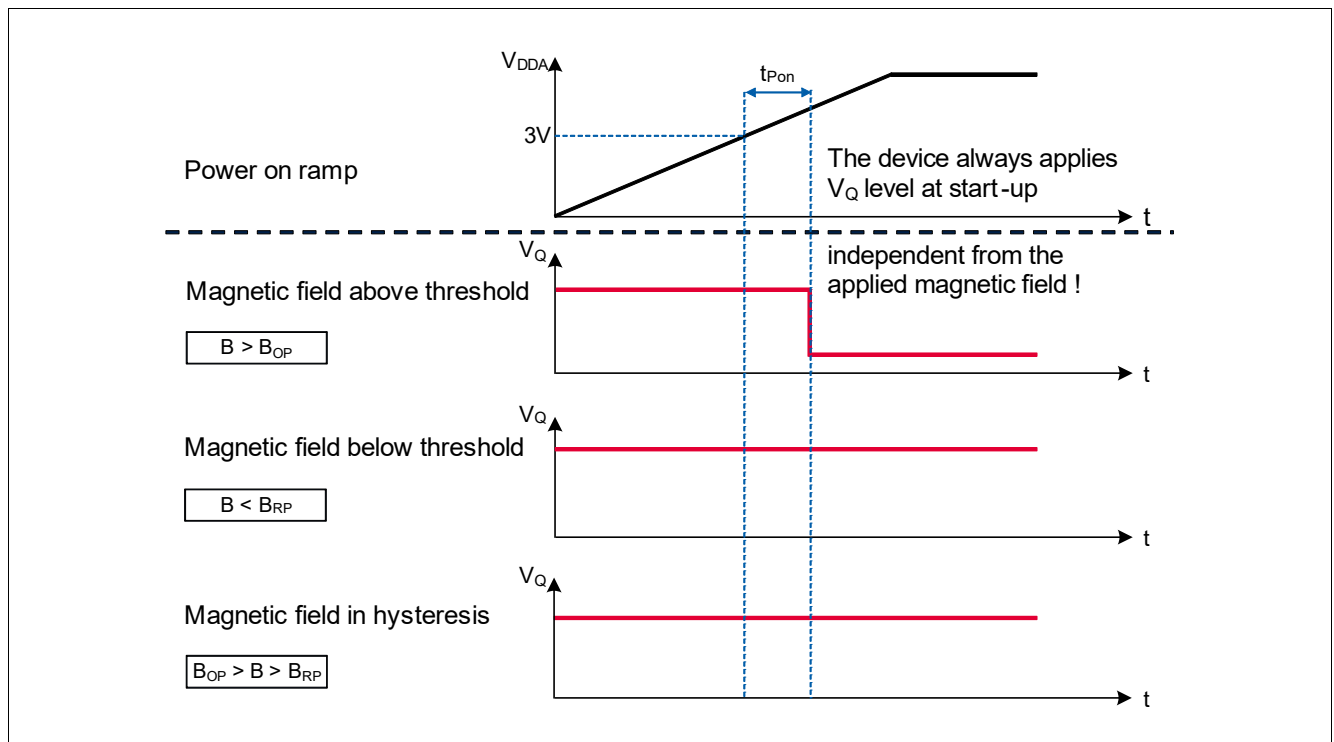


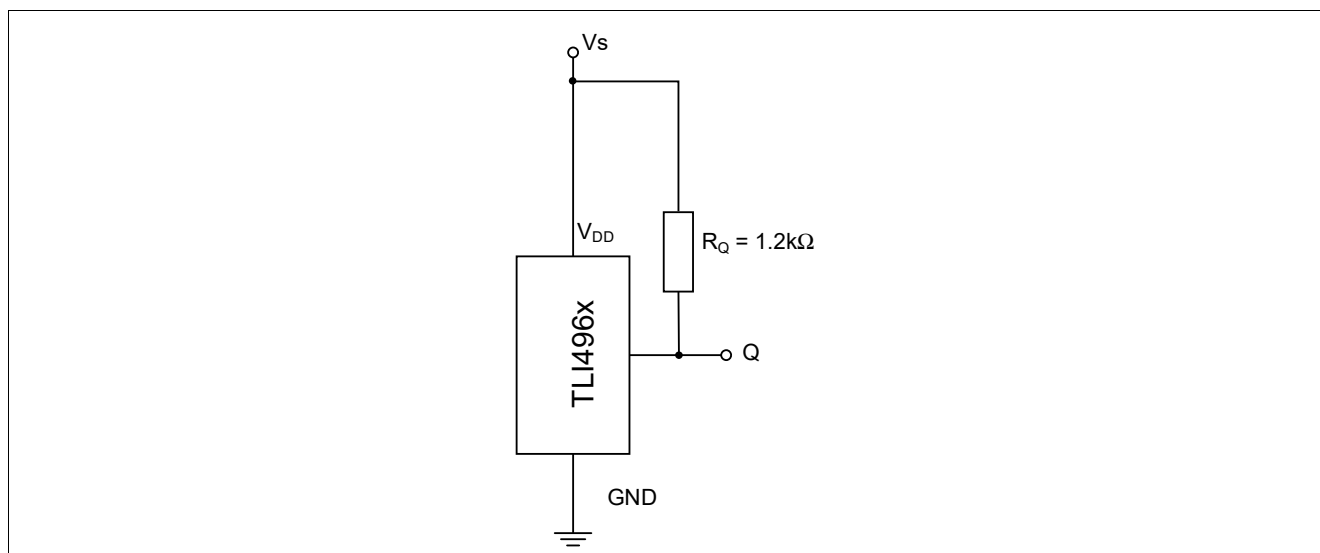
Figure 6 Start-up behavior of the TLI4963-1M

## Specification

### 3 Specification

#### 3.1 Application circuit

The following [Figure 7](#) shows one option of an application circuit.



**Figure 7** Application circuit

## Specification

### 3.2 Absolute maximum ratings

**Table 3 Absolute maximum rating parameters**

| Parameter                              | Symbol     | Values |      |      | Unit | Note or Test Condition   |
|----------------------------------------|------------|--------|------|------|------|--------------------------|
|                                        |            | Min.   | Typ. | Max. |      |                          |
| Supply voltage <sup>1)</sup>           | $V_{DD}$   | -0.3   | –    | 6    | V    | –                        |
| Output voltage                         | $V_Q$      | -0.5   | –    | 6    | V    | –                        |
| Ambient temperature <sup>1)</sup>      | $T_A$      | -40    | –    | 150  | °C   | for 2000h (not additive) |
| Thermal resistance<br>Junction ambient | $R_{thJA}$ | –      | –    | 300  | K/W  | for PG-SOT23-3-15 (2s2p) |
| Thermal resistance<br>Junction lead    | $R_{thJL}$ | –      | –    | 100  | K/W  | for PG-SOT23-3-15        |

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:  $V_{DD} = 5\text{ V}$ ,  $I_S = 2\text{ mA}$ ,  $V_{QSAT} = 0.5\text{ V}$ ,  $I_Q = 1\text{ mA}$

Power dissipation:  $P_{DIS} = 5\text{ V} \times 2\text{ mA} + 0.5\text{ V} \times 1\text{ mA} = 10\text{ mW} + 0.5\text{ mW} = 10.5\text{ mW}$

Temperature  $\Delta T = R_{thJA} \times P_{DIS} = 300\text{ K/W} \times 10.5\text{ mW} = 3.15\text{ K}$

For  $T_A = 150^\circ\text{C}$ :  $T_J = T_A + \Delta T = 150^\circ\text{C} + 3.15\text{ K} = 153.15^\circ\text{C}$

## Specification

**Table 4 ESD protection<sup>1)</sup> ( $T_A = 25^\circ\text{C}$ )**

| Parameter                       | Symbol           | Values |      |      | Unit | Note or Test Condition                           |
|---------------------------------|------------------|--------|------|------|------|--------------------------------------------------|
|                                 |                  | Min.   | Typ. | Max. |      |                                                  |
| ESD voltage (HBM) <sup>2)</sup> | $V_{\text{ESD}}$ | -4     | –    | 4    | kV   | $R = 1.5 \text{ k}\Omega$ , $C = 100 \text{ pF}$ |
| ESD voltage (CDM) <sup>3)</sup> | $V_{\text{ESD}}$ | -1     | –    | 1    | kV   | –                                                |

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.

### 3.3 Operating range

The following operating conditions must not be exceeded in order to ensure correct operation of the TLI4963-1M.

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

The maximum tested magnetic field is 600 mT.

**Table 5 Operating conditions parameters**

| Parameter                                     | Symbol          | Values |      |      | Unit             | Note or Test Condition |
|-----------------------------------------------|-----------------|--------|------|------|------------------|------------------------|
|                                               |                 | Min.   | Typ. | Max. |                  |                        |
| Supply voltage                                | $V_{\text{DD}}$ | 3.0    | –    | 5.5  | V                | –                      |
| Output voltage                                | $V_{\text{Q}}$  | -0.3   | –    | 5.5  | V                | –                      |
| Ambient temperature                           | $T_A$           | -40    | –    | 125  | $^\circ\text{C}$ | –                      |
| Output current                                | $I_{\text{Q}}$  | 0      | –    | 5    | mA               | –                      |
| Magnetic signal input frequency <sup>1)</sup> | $f_{\text{SW}}$ | 0      | –    | 10   | kHz              | –                      |

1) 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.

## Specification

### 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  $V_{DD} = 5\text{ V}$  and  $T_A = 25^\circ\text{C}$ . The below listed specification is valid in combination with the application circuit shown in [Figure 7](#).

**Table 6 General electrical characteristics**

| Parameter                       | Symbol      | Values |      |      | Unit          | Note or Test Condition                                                                     |
|---------------------------------|-------------|--------|------|------|---------------|--------------------------------------------------------------------------------------------|
|                                 |             | Min.   | Typ. | Max. |               |                                                                                            |
| Supply current                  | $I_S$       | 1.1    | 1.5  | 2.5  | mA            | –                                                                                          |
| Reverse current <sup>1)</sup>   | $I_{SR}$    | –      | –    | 2.5  | mA            | for $V_{DD} = -0.3\text{ V}$ and $125^\circ\text{C}$                                       |
| Output saturation voltage       | $V_{QSAT}$  | –      | 0.2  | 0.5  | V             | $I_Q = 5\text{ mA}$                                                                        |
| Output leakage current          | $I_{QLEAK}$ | –      | –    | 10   | $\mu\text{A}$ | –                                                                                          |
| Output fall time <sup>1)</sup>  | $t_f$       | 0.17   | 0.24 | 1    | $\mu\text{s}$ | 1.2 k $\Omega$ / 50 pF, see <a href="#">Figure 4</a>                                       |
| Output rise time <sup>1)</sup>  | $t_r$       | 0.4    | 0.5  | 1    | $\mu\text{s}$ | 1.2 k $\Omega$ / 50 pF, see <a href="#">Figure 4</a>                                       |
| Output jitter <sup>1)2)</sup>   | $t_{QJ}$    | –      | 0.28 | 1    | $\mu\text{s}$ | for square wave signal with 1 kHz                                                          |
| Delay time <sup>1)3)</sup>      | $t_d$       | 11.5   | 15   | 30   | $\mu\text{s}$ | see <a href="#">Figure 4</a>                                                               |
| Power-on time <sup>1)4)</sup>   | $t_{PON}$   | –      | 50   | 100  | $\mu\text{s}$ | $V_{DD} = 3\text{ V}$ , $B \leq B_{RP} - 0.5\text{ mT}$ or $B \geq B_{OP} + 0.5\text{ mT}$ |
| Chopper frequency <sup>1)</sup> | $f_{OSC}$   | –      | 350  |      | kHz           | –                                                                                          |

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

2) Output jitter is the  $1\sigma$  value of the output switching distribution.

3) Systematic delay between magnetic threshold reached and output switching.

4) Time from applying  $V_{DD} = 3.0\text{ V}$  to the sensor until the output is valid.

## Specification

**Table 7 Magnetic characteristics**

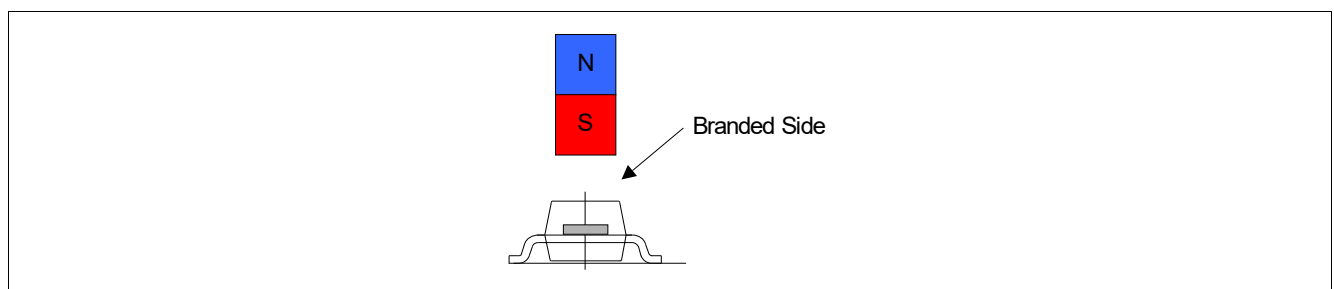
| Parameter                                                              | Symbol     | T (°C) | Values |       |      | Unit  | Note / Test Condition |
|------------------------------------------------------------------------|------------|--------|--------|-------|------|-------|-----------------------|
|                                                                        |            |        | Min.   | Typ.  | Max. |       |                       |
| Operating point                                                        | $B_{OP}$   | -40    | 0.6    | 2.2   | 3.7  | mT    | –                     |
|                                                                        |            | 25     | 0.5    | 2.0   | 3.5  |       |                       |
|                                                                        |            | 125    | 0.3    | 1.7   | 3.1  |       |                       |
| Release point                                                          | $B_{RP}$   | -40    | -3.7   | -2.2  | -0.6 | mT    | –                     |
|                                                                        |            | 25     | -3.5   | -2.0  | -0.5 |       |                       |
|                                                                        |            | 125    | -3.1   | -1.7  | -0.3 |       |                       |
| Hysteresis                                                             | $B_{HYS}$  | -40    | 2.8    | 4.4   | 5.7  | mT    | –                     |
|                                                                        |            | 25     | 2.6    | 4.0   | 5.4  |       |                       |
|                                                                        |            | 125    | 2.2    | 3.4   | 4.6  |       |                       |
| Effective noise value of the magnetic switching points <sup>1)2)</sup> | $B_{Neff}$ | 25     | –      | 39    | –    | μT    | –                     |
| Temperature compensation of magnetic thresholds <sup>2)</sup>          | $T_C$      | –      | –      | -1500 | –    | 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  $1\sigma$  probability of normal distribution. Consequently a  $3\sigma$  value corresponds to 0.3% 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.

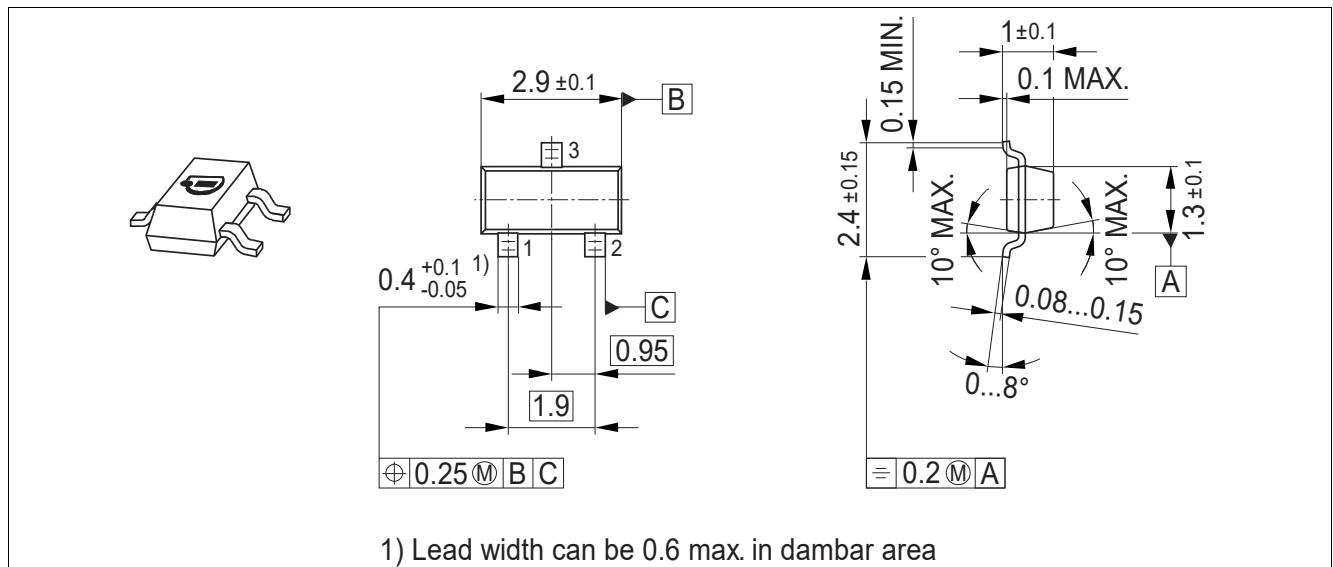

**Figure 8 Definition of magnetic field direction PG-SOT23-3-15**

## Package information

### 4 Package information

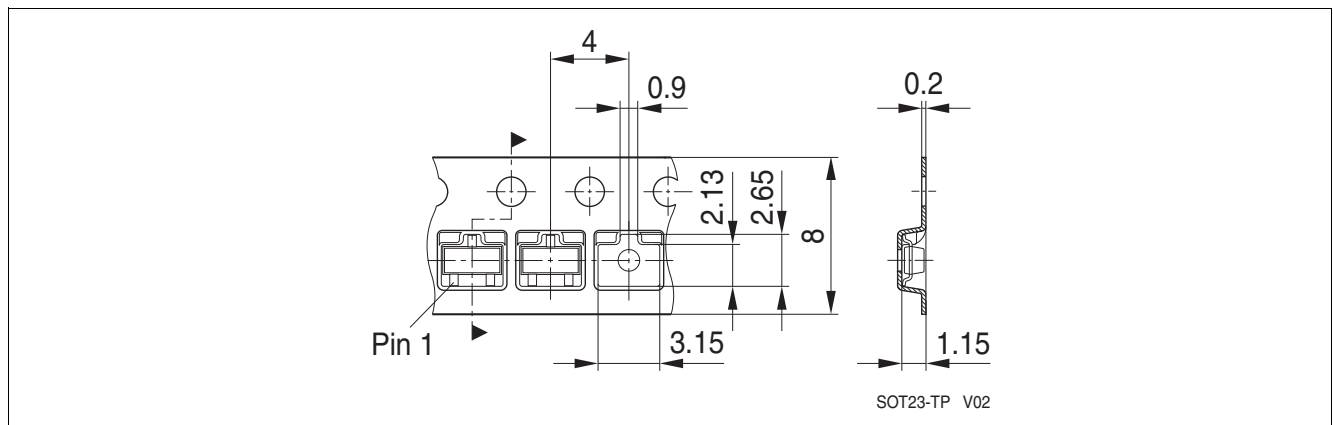
The TLI4963-1M is available in the small halogen-free SMD package PG-SOT23-3-15.

#### 4.1 Package outline PG-SOT23-3-15



**Figure 9 PG-SOT23-3-15 package outline** (all dimensions in mm)

#### 4.2 Packing information PG-SOT23-3-15



**Figure 10 Packing of the PG-SOT23-3-15 in a tape**

## Package information

### 4.3 Footprint PG-SOT23-3-15

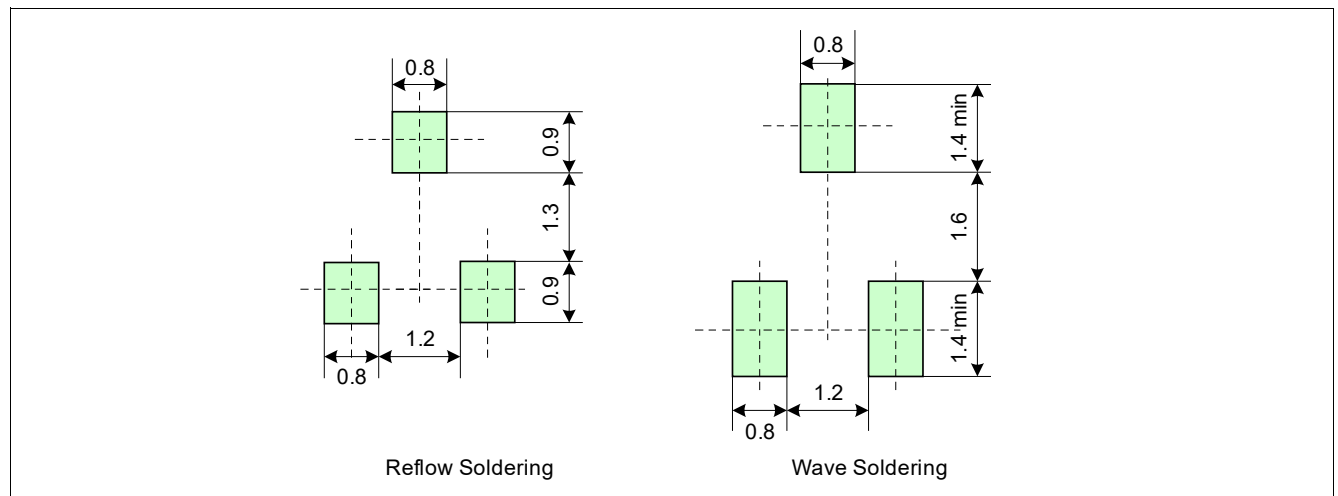


Figure 11 Footprint PG-SOT23-3-15

### 4.4 PG-SOT23-3-15 distance between chip and package

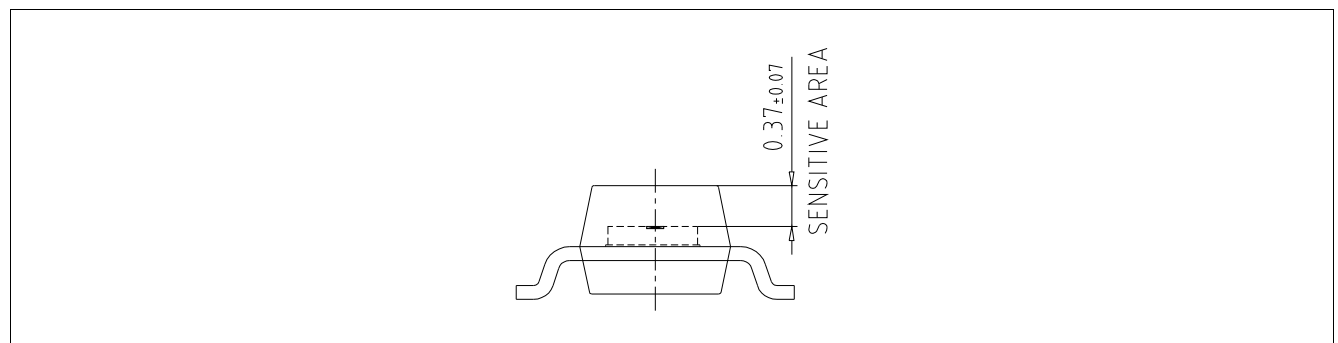


Figure 12 Distance between chip and package

### 4.5 Package marking

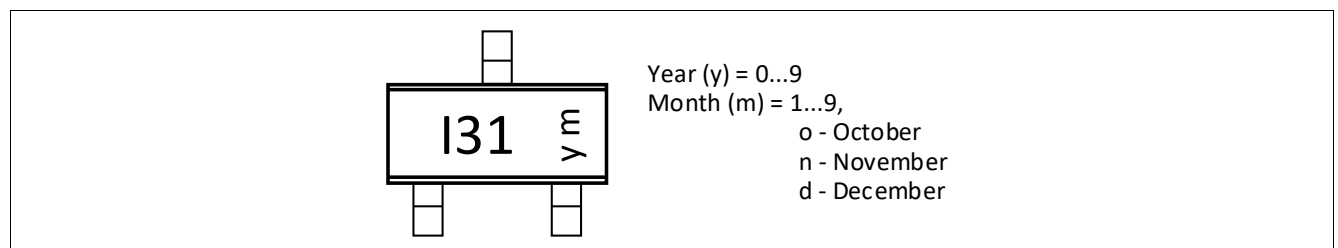


Figure 13 Marking of TLI4963-1M

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**Revision history**

## **5 Revision history**

| <b>Revision</b> | <b>Date</b> | <b>Changes</b>                                                                                                                                                                                     |
|-----------------|-------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Revision 1.2    | 2019-12-20  | Updated text and figure in <b>Chapter 2.6</b><br>Updated standards in <b>Table 4</b><br>Added maximum tested magnetic field in <b>Chapter 3.3</b><br>Updated <b>Figure 12</b><br>Editorial changes |
| Revision 1.0    | 2016-01-11  | Initial release                                                                                                                                                                                    |

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