

# TLI4946K, TLI4946-2K, TLI4946-2L

## High Precision Hall Effect Latches for Industrial and Consumer Applications

### About this document

#### Overview

The TLI4946xy is a high precision Hall Effect Latch with highly accurate switching thresholds for ambient operating temperatures up to 125°C. The TLI4946K and the TLI4946-2K is available in a PG-SC59-3-4 package, the TLI4946-2L in a PG-SSO-3-2 package



#### Features

- 2.7 V to 18 V 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 (-18 V).
- Superior temperature stability.
- Low jitter (typically 1 μs).
- High ESD performance (± 4 kV HBM).
- Digital output signal (open-drain).
- Not suitable for automotive applications



#### Target applications

The TLI4946xy is ideally suited to detect the rotor position in Brushless DC (BLDC) Motors used in industrial and consumer applications, such as: air conditioning systems, pumps, washing machines, DVD players, rolling shutter, etc. The sensor also provides a reliable switching for index counting with small pole wheels and large air gaps. The TLI4946xy can also be used for index counting.

Product name	Product type	Ordering code	Package
Hall Effect Latch	TLI4946K	SP000604398	PG-SC59-3-4
Hall Effect Latch	TLI4946-2K	SP000604328	PG-SC59-3-4
Hall Effect Latch	TLI4946-2L	SP000604336	PG-SSO-3-2

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1 Functional description

1 Functional description

1.1 General

Precise magnetic switching thresholds and high temperature stability are achieved by active compensation circuits and chopper techniques on chip. Offset voltages generated by temperature-induced stress or overmolding are canceled so that high accuracy is achieved. The IC has an open collector output stage with 20 mA current sink capability. A wide operating voltage range from 2.7 V to 18 V with reverse polarity protection down to -18 V makes the TLI4946xy suitable for a wide range of applications. A magnetic south pole with a field strength above  $B_{op}$  turns the output on. A magnetic north pole exceeding  $B_{rp}$  turns it off.

1.2 Pin configuration

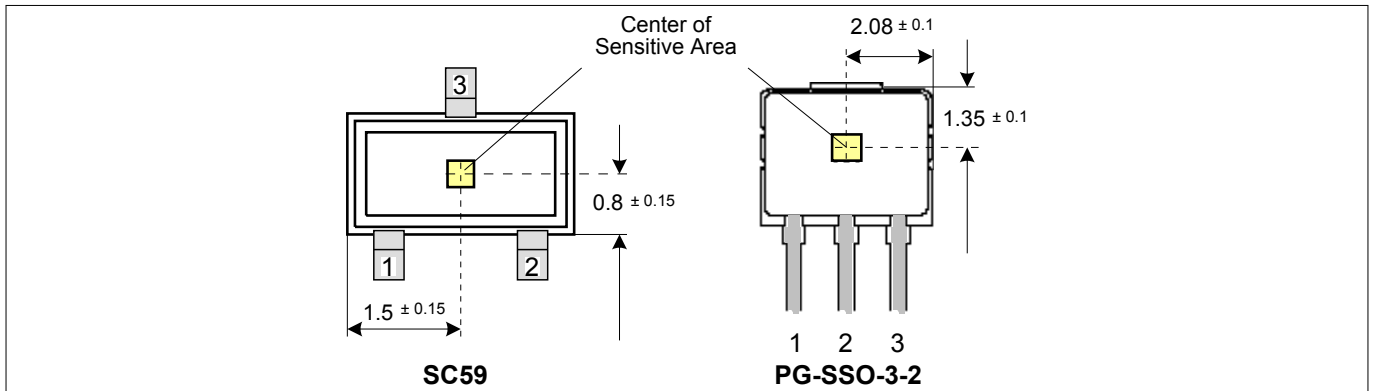


Figure 1 Pin configuration and sensitive area (Top view, figure not to scale)

1.3 Pin description

Table 1 PIN Definitions for the PG-SC59-3-4 package

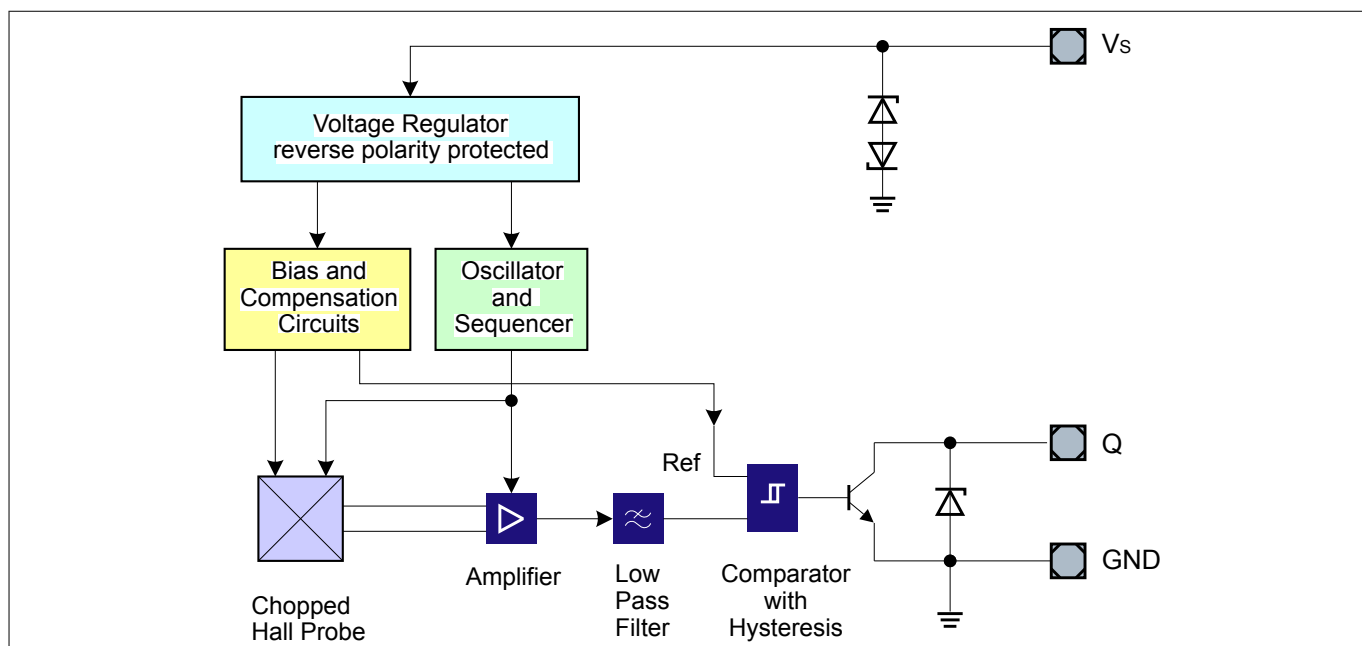
PIN No.	Name	Function
1	$V_S$	Supply Voltage
2	$Q$	Output
3	$GND$	Ground

Table 2 PIN Definitions for the PG-SSO-3-2 package

PIN No.	Name	Function
1	$V_S$	Supply Voltage
2	$GND$	Ground
3	$Q$	Output

**1 Functional description**

**1.4 Block diagram**



**Figure 2 TLI4946xy Block diagram**

1 Functional description

1.5 Operating modes and states

Field Direction and Definition

Positive magnetic fields correspond to the south pole of the magnet targeting the branded side of the package.

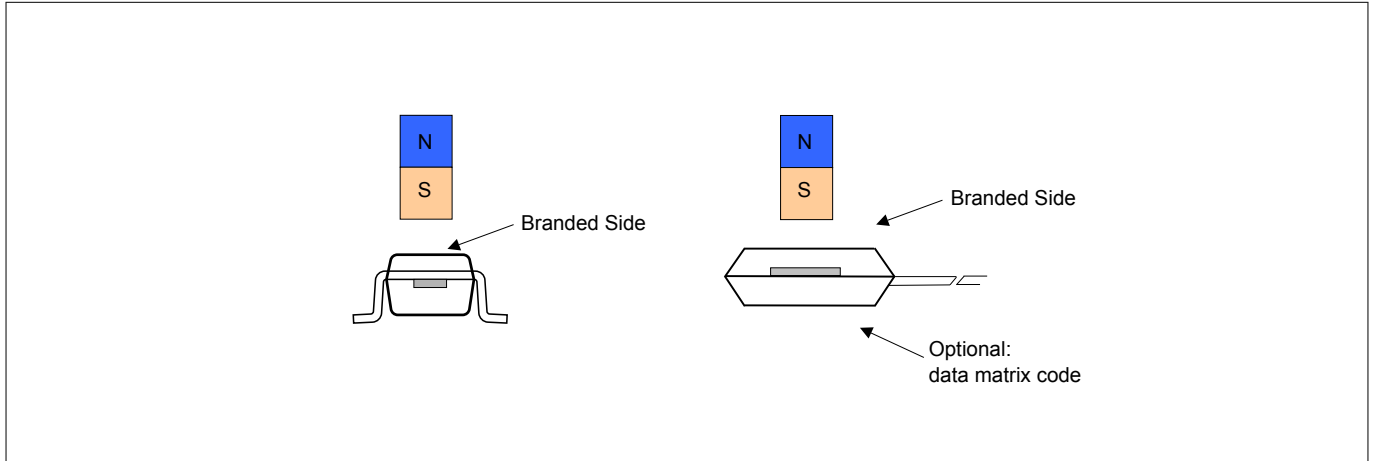


Figure 3 Definition of the magnetic field direction

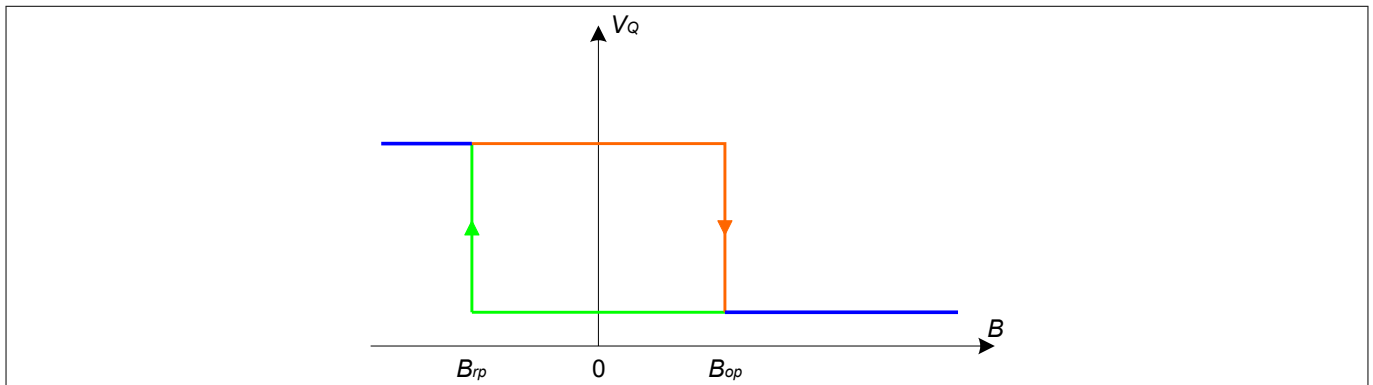


Figure 4 Output signal

1.6 Functional block description

The chopped Hall Effect Latch comprises a Hall probe, a bias generator, compensation circuits, an oscillator and an output transistor. The bias generator provides currents to the Hall probe and the active circuits. Compensation circuits stabilize response of the IC over temperature and reduce the impact of process variations.

The Active Error Compensation rejects offsets in the signal path and reduces the impact of mechanical stress in the package caused by molding, soldering and thermal effects.

The chopper technique together with the threshold generator and the comparator ensure high accurate magnetic switching points.

2 Specification

2 Specification

2.1 Application circuit

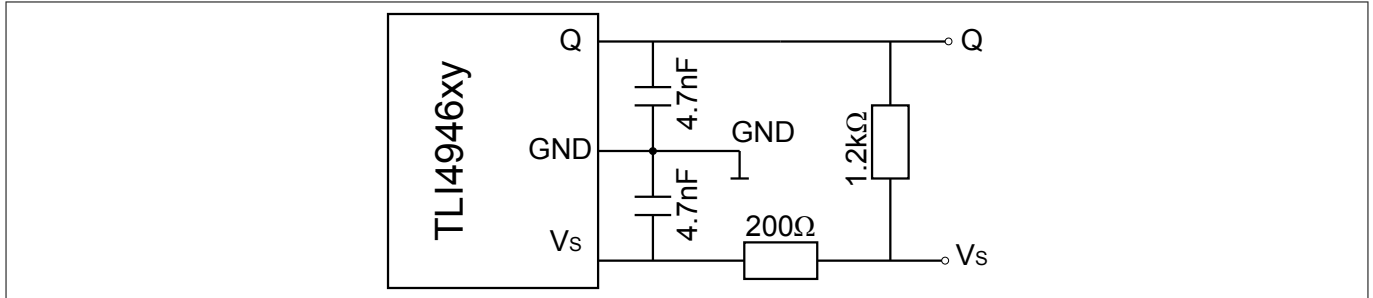


Figure 5 Application circuit

It is recommended to use a resistor of 200 Ω in the supply line for current limitation in the case of an overvoltage pulse. Two capacitors of 4.7 nF enhance the EMC performance. The pull-up of 1.2 kΩ limits the current through the output transistor.

2.2 Absolute maximum ratings

Stress above the maximum values listed in this section may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect the reliability of the device. Exceeding only one of these values may cause irreversible damage to the device.

Table 3 Absolute maximum ratings

Parameter	Symbol	Values			Unit	Note or Test Condition
		Min.	Typ.	Max.		
Maximum Ambient Temperature	$T_A$	-40	-	125	°C	
Maximum Junction Temperature	$T_J$	-40	-	150	°C	
Supply Voltage	$V_S$	-18	-	18	V	
Supply current through protection device	$I_S$	-50	-	50	mA	
Output Voltage	$V_{OUT}$	-0.7	-	18	V	
Storage Temperature	$T_S$	-40	-	150	°C	
Magnetic flux density	$B$	-	-	unlimited	mT	
ESD Robustness HBM: 1.5 kΩ, 100 pF	$V_{ESD,HBM}^{(1)}$	-	-	4	kV	

(1) According to EIA/JESD22-A114-E

## 2 Specification

### 2.3 Operating range

The following operating conditions must not be exceeded in order to ensure correct operation of the TLI4946xy. All parameters specified in the following sections refer to these operating conditions unless otherwise mentioned.

**Table 4 Operating range**

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Supply Voltage	$V_S$	2.7	–	18	V	
Output Voltage	$V_Q$	-0.7	–	18	V	
Output Current	$I_Q$	0	–	20	mA	
Maximum Ambient Temperature	$T_A$	-40	–	125	°C	

### 2.4 Electrical characteristics

Product characteristics include the spread of values guaranteed within the specified voltage and ambient temperature range. typical characteristics are the median of the production (at  $V_S = 12\text{ V}$  and  $T_A = 25^\circ\text{C}$ ).

**Table 5 Electrical characteristics**

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Supply Current	$I_S$	2	4	6	mA	$V_S = 2.7\text{ V} \dots 18\text{ V}$
Reverse Current	$I_{SR}$	0	0.2	1	mA	$V_S = -18\text{ V}$
Output Saturation Voltage	$V_{QSAT}$	–	0.3	0.6	V	$I_Q = 20\text{ mA}$
Output leakage current	$I_{QLEAK}$	–	0.05	10	$\mu\text{A}$	$V_Q = 18\text{ V}$
Output fall time <sup>(1)</sup>	$t_f$	–	0.02	1	$\mu\text{s}$	$R_L = 1.2\text{ k}\Omega$ , $C_L = 50\text{ pF}$
Output rise time <sup>(1)</sup>	$t_r$	–	0.4	1	$\mu\text{s}$	
Chopper frequency	$f_{OSC}$	–	320	–	kHz	
Switching frequency	$f_{SW}$	0	–	15 <sup>(2)</sup>	kHz	
Delay time <sup>(3)</sup>	$t_d$	–	13	–	$\mu\text{s}$	
Output jitter <sup>(4)</sup>	$t_{QJ}$	–	1	–	$\mu\text{s}_{RMS}$	Typical value for a 1 kHz square wave signal
Power-on Time <sup>(5)</sup>	$t_{PON}$	–	13	–	$\mu\text{s}$	$V_S > 2.7\text{ V}$
Thermal Resistance junction to ambient <sup>(6)</sup>	$R_{thja}$	–	100	–	K/W	TLI4946K, TLI4946-2K
		–		190	K/W	TLI4946-2L

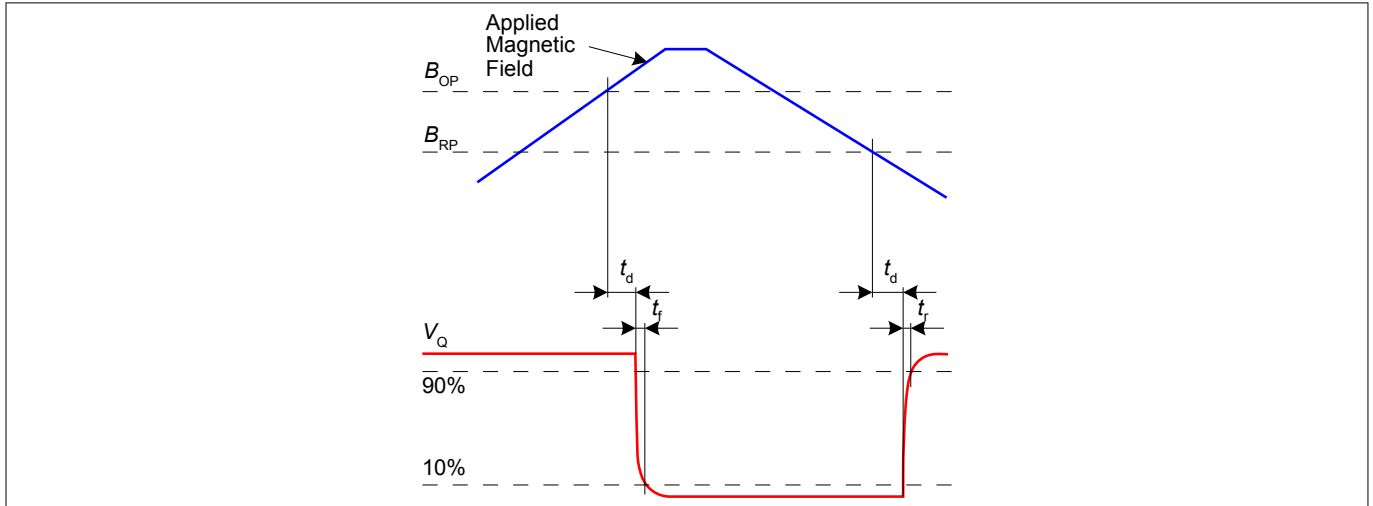
(1) See [Figure 6](#)

(2) To operate the sensor at maximum switching frequency, the value of the magnetic signal amplitude must be 1.4 times higher than the 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.

**2 Specification**

- (4) Jitter is the unpredictable deviation of the output switching delay.
- (5) Time from applying  $V_S > 2.7\text{ V}$  to the sensor until the output state is valid.
- (6) Relationship between junction and ambient temperature:  $T_J = T_{amb} + R_{thja} \times (V_S \times I_S + V_{QS} \times I_Q)$ .



**Figure 6** Timing diagram

**Table 6** Magnetic characteristics<sup>(1)</sup>

Parameter	Symbol	Values			Unit	Note/Test Condition
		Min.	Typ.	Max.		
Operate point	$B_{OP}$	6.1	14.0	19.2	mT	TLI4946K
		0.5	2.0	3.5	mT	TLI4946-2K, TLI4946-2L
Release point	$B_{RP}$	-19.2	-14.0	-6.1	mT	TLI4946K
		-3.5	-2.0	-0.5	mT	TLI4946-2K, TLI4946-2L
Hysteresis	$B_{HYS}$	22.0	28.0	34.0	mT	TLI4946K <sup>(2)</sup>
		1.0	4.0	6.0	mT	TLI4946-2K, TLI4946-2L
Magnetic offset <sup>(3)</sup>	$B_{OFF}$	-3.0	-	3.0	mT	TLI4946K <sup>(2)</sup>
		-1.5	0	1.5	mT	TLI4946-2K, TLI4946-2L
Temperature compensation of magnetic thresholds	$TC$	-	-2000	-	ppm/°C	TLI4946K
		-	-350	-	ppm/°C	TLI4946-2K, TLI4946-2L
Repeatability of magnetic thresholds <sup>(4)</sup>	$B_{REP}$	-	20	-	$\mu T_{RMS}$	typical value for $\Delta B/\Delta t > 12\text{ mT/ms}$

- (1) Over all operating conditions
- (2) at 25°C
- (3)  $B_{OFF} = (B_{OP} + B_{RP}) / 2$ .
- (4)  $B_{REP}$  is equivalent to the noise constant.



3 Package information

3 Package information

3.1 TLI4946K and TLI4946-2K package outline

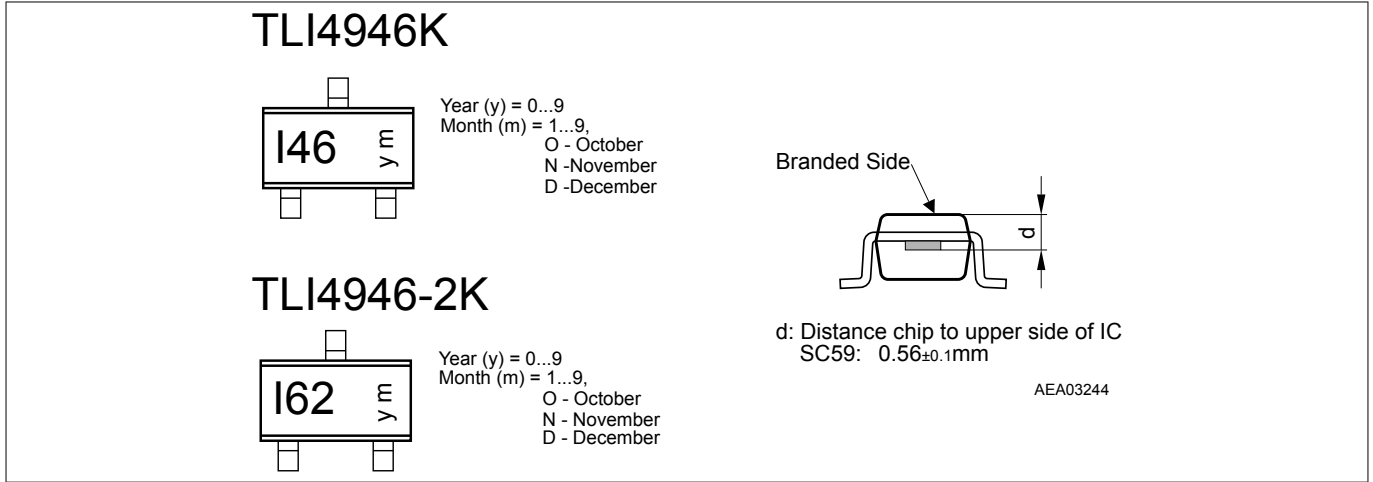


Figure 7 Marking of the TLI4946K and TLI4946-2K distance of the chip to the upper side

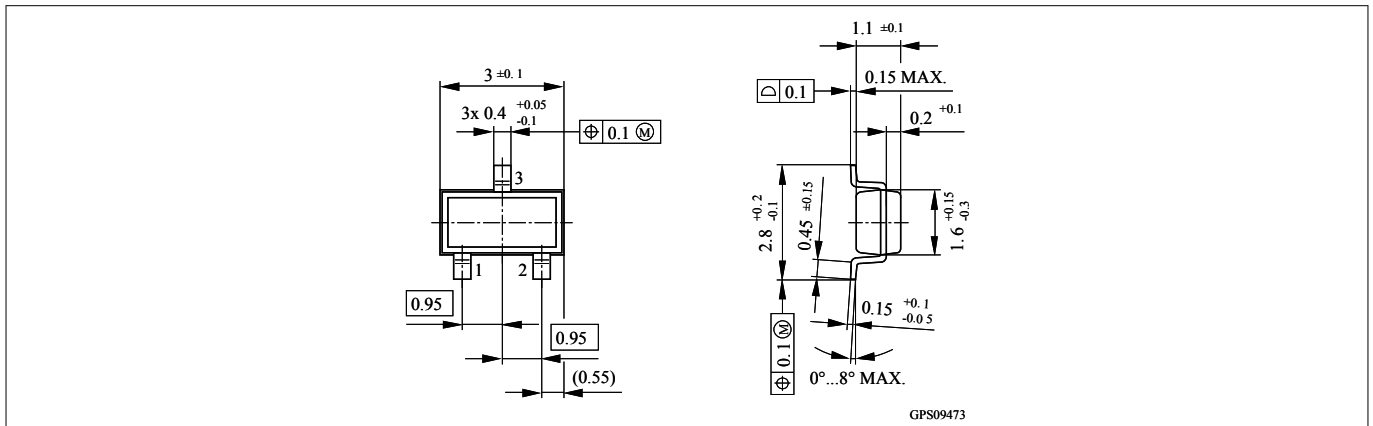


Figure 8 PG-SC59-3-4 package outline

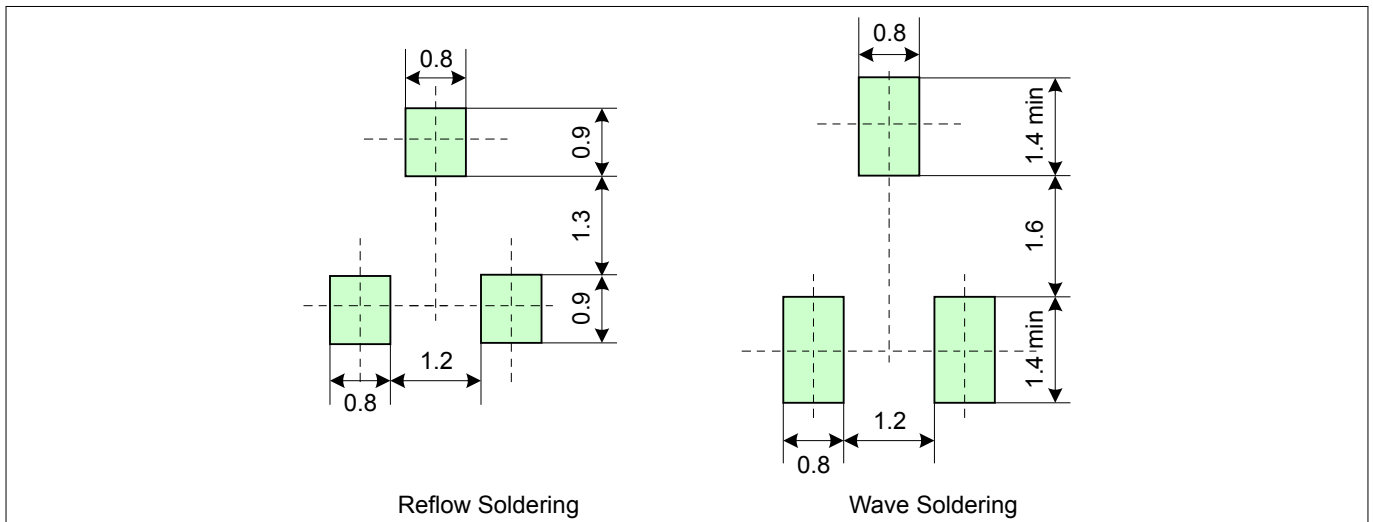
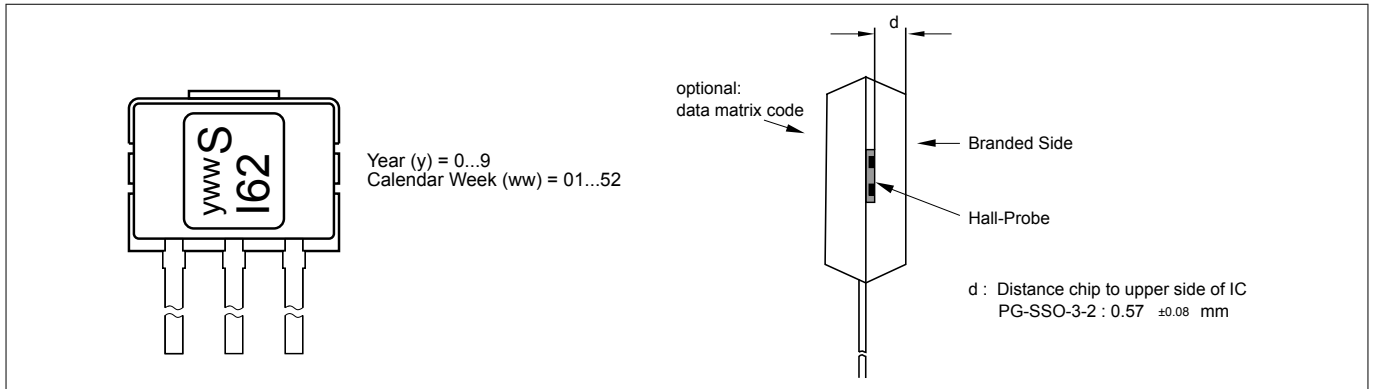


Figure 9 Footprint PG-SC59-3-4 (SOT23 compatible)

**3 Package information**

**3.2 TLI4946-2L package outline**



**Figure 10 Marking of the TLI4946-2L and distance of the chip to the upper side**

3 Package information

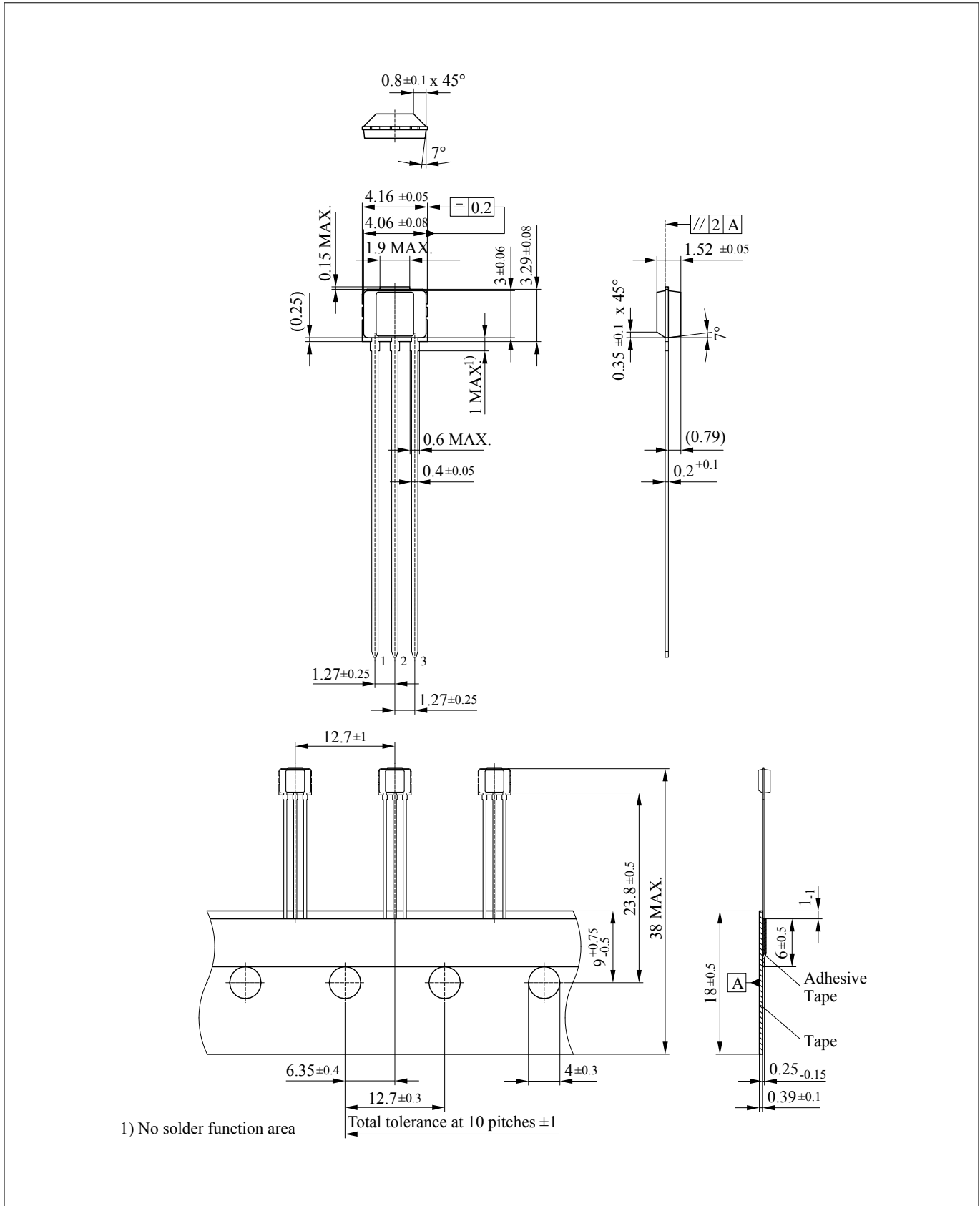


Figure 11 PG-SSO-3-2 package outline

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4 Revision history

## 4 Revision history

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**Revision History**

Page	Subjects (major changes since last revision)
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Revision History: 2020-08, Rev. 1.1

Previous Revisions: Rev. 1.0

10	Edited figure 10 (optional: data matrix code)
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