

# TLE4906K / TLE4906L

High Precision Hall Effect Switch

Data Sheet

V 2.0

Sensors



Never stop thinking

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**TLE4906K / TLE4906L High Precision Hall Effect Switch**

**Revision History: 2009-01, V 2.0**

**Previous Version: 1.1**

| Page | Subjects (major changes since last revision) |
|------|----------------------------------------------|
|      | Package type "H" changed to "K"              |
|      | General layout changed                       |
|      |                                              |
|      |                                              |
|      |                                              |
|      |                                              |
|      |                                              |
|      |                                              |
|      |                                              |
|      |                                              |

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## 1 Product Description

### 1.1 Overview

The TLE4906 is a high precision Hall effect switch with highly accurate switching thresholds for operating temperatures up to 150°C.

### 1.2 Features

- 2.7V to 24V supply voltage
- 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 without damage
- Low jitter (typ. 1µs)
- High ESD performance (± 6kV HBM)
- Digital output signal
- SMD package SC59 (SOT23 compatible) - (TLE4906K))
- Leaded package PG-SSO-3-2 - (TLE4906L)

### 1.3 Target Applications

Target applications for TLE4906 are all automotive applications which require a high precision Hall switch for position sensing with a operating temperature range from -40°C to +150°C.



| Product Name       | Product Type | Ordering Code | Package    |
|--------------------|--------------|---------------|------------|
| Hall Effect Switch | TLE4906K     | SP000475028   | SC59       |
| Hall Effect Switch | TLE4906L     | SP000012949   | PG-SSO-3-2 |

## 2 Functional Description

### 2.1 General

The TLE4906K and the TLE4906L are integrated circuit Hall-effect sensors 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.

### 2.2 Pin Configuration (top view)

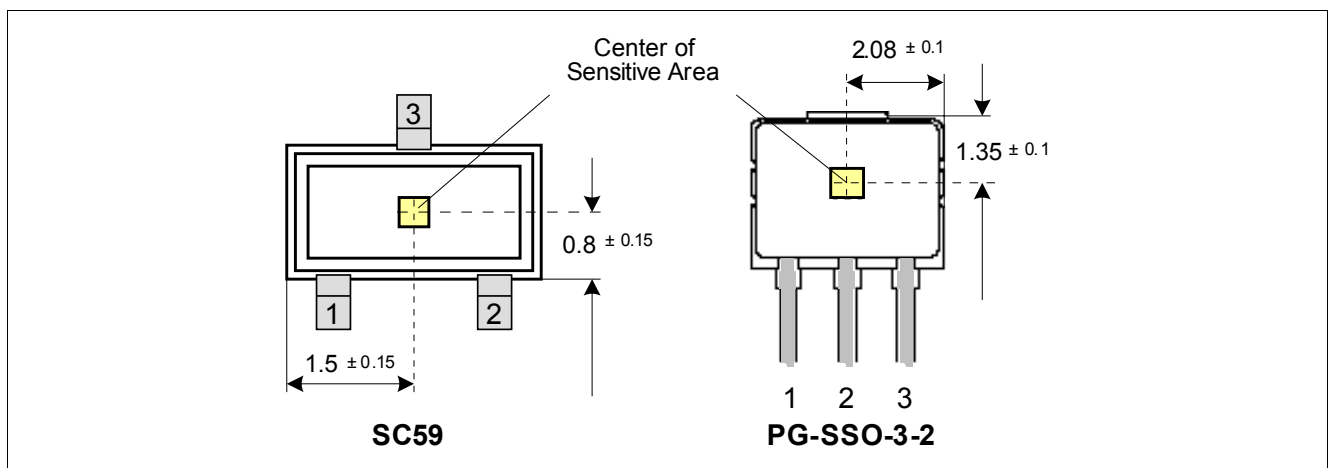


Figure 1 Pin Configuration and Center of Sensitive Area

### 2.3 Pin Description

Table 1 Pin Description SC59

| Pin No. | Symbol | Function       | Comment |
|---------|--------|----------------|---------|
| 1       | $V_S$  | Supply voltage |         |
| 2       | Q      | Output         |         |
| 3       | GND    | Ground         |         |

Table 2 Pin Description PG-SSO-3-2

| Pin No. | Symbol | Function       | Comment |
|---------|--------|----------------|---------|
| 1       | $V_S$  | Supply voltage |         |
| 2       | GND    | Ground         |         |
| 3       | Q      | Output         |         |

## 2.4 Block Diagram

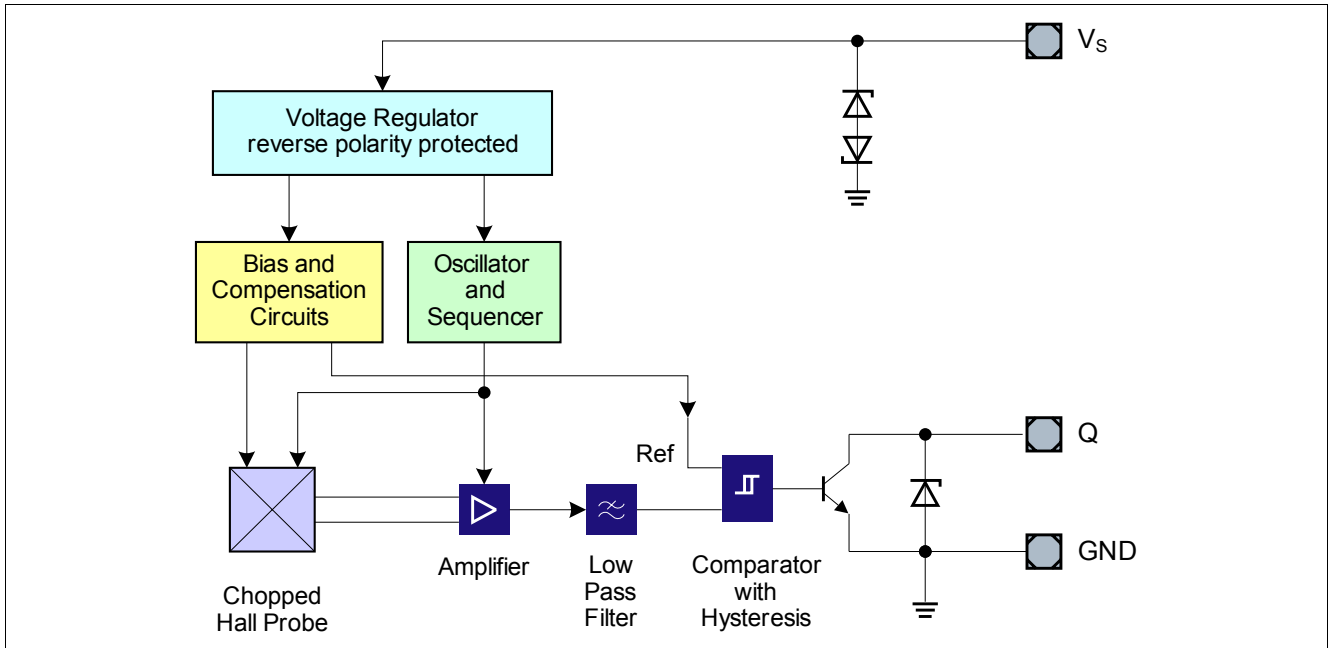


Figure 2 Functional Block Diagram

## 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 technology variations.

The Active Error Compensation rejects offsets in signal stages and the influence of mechanical stress to the Hall probe caused by molding and soldering processes and other thermal stresses in the package.

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

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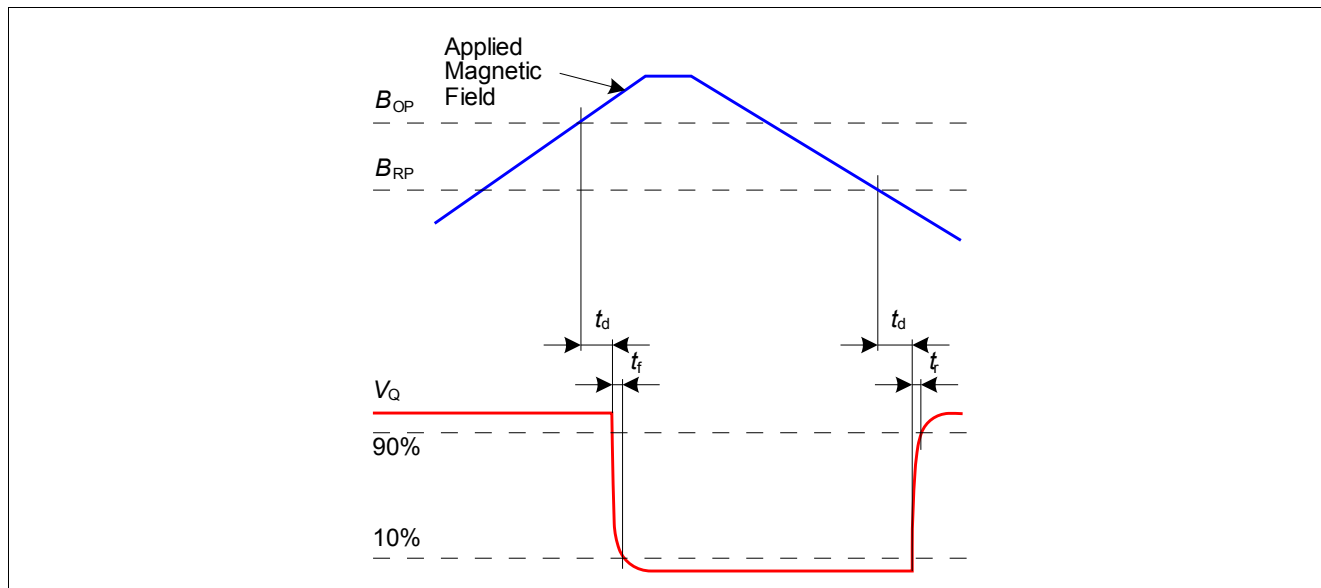


Figure 3 Timing Diagram

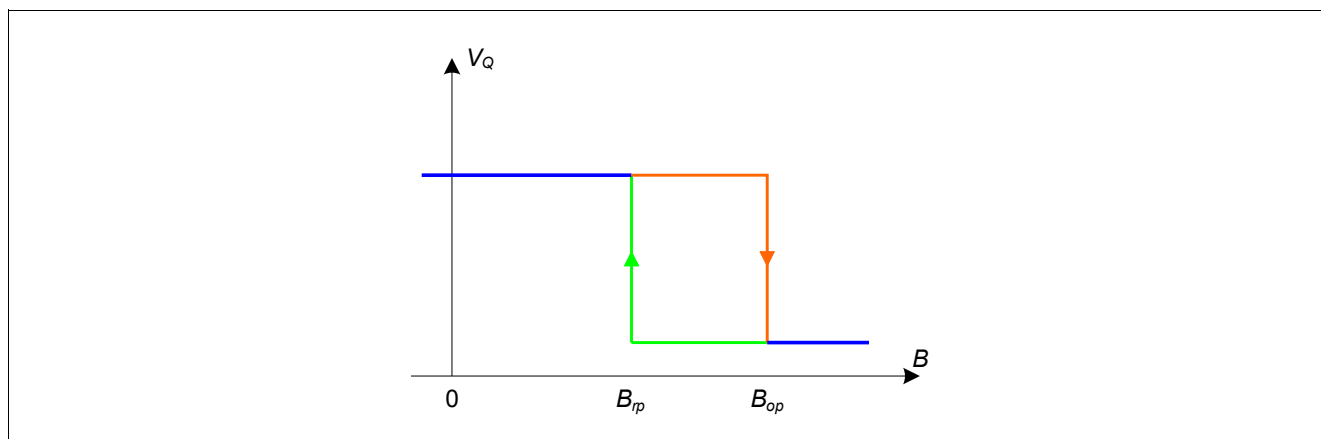


Figure 4 Output Signal

## 3 Specification

### 3.1 Absolute Maximum Ratings

**Table 3 Absolute Maximum Rating Parameters**
 $T_j = -40^{\circ}\text{C to } 150^{\circ}\text{C}$ 

| Parameter                                | Symbol | Limit Values      |                          | Unit               | Note / Test Condition                                                                                    |
|------------------------------------------|--------|-------------------|--------------------------|--------------------|----------------------------------------------------------------------------------------------------------|
|                                          |        | Min.              | Max.                     |                    |                                                                                                          |
| Supply voltage                           | $V_S$  | -18<br>-18<br>-18 | 18<br>24<br>26           | V                  | for 1h, $R_S \geq 200\Omega$<br>for 5min, $R_S \geq 200\Omega$                                           |
| Supply current through protection device | $I_S$  | -50               | 50                       | mA                 |                                                                                                          |
| Output voltage                           | $V_Q$  | -0.7<br>-0.7      | 18<br>26                 | V                  | for 5min @ 1.2k $\Omega$ pull up                                                                         |
| Continuous output current                | $I_Q$  | -50               | 50                       | mA                 |                                                                                                          |
| Junction temperature                     | $T_j$  | –<br>–<br>–<br>–  | 155<br>165<br>175<br>195 | $^{\circ}\text{C}$ | for 2000h (not additive)<br>for 1000h (not additive)<br>for 168h (not additive)<br>for 3 x 1h (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.*

**Table 4 ESD Protection<sup>1)</sup>**

| Parameter   | Symbol           | Limit Values |         | Unit | Note / Test Condition                                                              |
|-------------|------------------|--------------|---------|------|------------------------------------------------------------------------------------|
|             |                  | Min.         | Max.    |      |                                                                                    |
| ESD Voltage | $V_{\text{ESD}}$ |              | $\pm 6$ | kV   | HBM, $R = 1.5\text{k}\Omega$ ,<br>$C = 100\text{pF}$<br>$T_A = 25^{\circ}\text{C}$ |

1) Human Body Model (HBM) tests according to: EOS/ESD Association Standard S5.1-1993 and Mil. Std. 883D method 3015.7

## 3.2 Operating Range

The following operating conditions must not be exceeded in order to ensure correct operation of the TLE4906K / TLE4906L.

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

**Table 5 Operating Conditions Parameters**

| 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    |                       |
| Junction temperature | $T_J$  | -40    |      | 150  | °C   |                       |
| Output current       | $I_Q$  | 0      |      | 20   | mA   |                       |

### 3.3 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.

**Table 6 General Electrical Characteristics<sup>1)</sup>**

| Parameter                        | Symbol      | Values |      |                  | Unit          | Note / Test Condition                                             |
|----------------------------------|-------------|--------|------|------------------|---------------|-------------------------------------------------------------------|
|                                  |             | Min.   | Typ. | Max.             |               |                                                                   |
| Supply current                   | $I_S$       | 2      | 4    | 6                | mA            | $V_S = 2.7V \dots 18V$                                            |
| Reverse current                  | $I_{SR}$    | 0      | 0.2  | 1                | mA            | $V_S = -18V$                                                      |
| Output saturation voltage        | $V_{QSAT}$  | -      | 0.3  | 0.6              | V             | $I_Q = 20mA$                                                      |
| Output leakage current           | $I_{QLEAK}$ | -      | 0.05 | 10               | $\mu A$       | for $V_Q = 18V$                                                   |
| Output fall time                 | $t_f$       | -      | 0.02 | 1                | $\mu s$       | $R_L = 1.2k\Omega$ ; $C_L = 50pF$<br>see <a href="#">Figure 3</a> |
| Output rise time                 | $t_r$       | -      | 0.4  | 1                | $\mu s$       |                                                                   |
| Chopper frequency                | $f_{OSC}$   | -      | 320  | -                | kHz           |                                                                   |
| Switching frequency              | $f_{SW}$    | 0      | -    | 15 <sup>2)</sup> | kHz           |                                                                   |
| Delay time <sup>3)</sup>         | $t_d$       | -      | 13   | -                | $\mu s$       |                                                                   |
| Output jitter <sup>4)</sup>      | $t_{QJ}$    | -      | 1    | -                | $\mu s_{RMS}$ | typical value for square wave signal with 1kHz                    |
| Power-on time <sup>5)</sup>      | $t_{PON}$   | -      | 13   | -                | $\mu s$       | $V_S \geq 2.7V$                                                   |
| Thermal resistance <sup>6)</sup> | $R_{thJA}$  | -      | 100  | -                | K/W           | SC59                                                              |
|                                  |             | -      | -    | 190              |               | PG-SSO-3-2                                                        |

- 1) over operating range, unless otherwise specified. Typical values correspond to  $V_S = 12V$  and  $T_A = 25^\circ C$
- 2) To operate the sensor at the max. switching frequency, the value of the magnetic signal amplitude must be 1.4 times higher than for static fields. This is due to the -3dB 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) Time from applying  $V_S \geq 2.7V$  to the sensor until the output state is valid.
- 6) Thermal resistance from junction to ambient.

#### Calculation of the ambient temperature (SC59 example)

e.g. for  $V_S = 12.0V$ ,  $I_{Styp} = 4mA$ ,  $V_{QSATtyp} = 0.3V$  and  $I_Q = 20mA$

Power dissipation  $P_{DIS} = 54.0mW$

In  $T_A = T_j - (R_{thJA} \times P_{DIS}) = 175^\circ C - (100K/W \times 0.054W)$

Resulting max. ambient temperature:  $T_A = 169.6^\circ C$

**Table 7** Magnetic Characteristics<sup>1)</sup>

| Parameter                                          | Symbol           | Tj[°C] | Values |      |      | Unit              | Note / Test Condition          |
|----------------------------------------------------|------------------|--------|--------|------|------|-------------------|--------------------------------|
|                                                    |                  |        | Min.   | Typ. | Max. |                   |                                |
| Operating point                                    | B <sub>OP</sub>  | -40    | 6.7    | 10.3 | 13.9 | mT                |                                |
|                                                    |                  | 25     | 6.5    | 10.0 | 13.5 |                   |                                |
|                                                    |                  | 150    | 6.2    | 9.5  | 12.9 |                   |                                |
| Release point                                      | B <sub>RP</sub>  | -40    | 5.2    | 8.7  | 12.3 | mT                |                                |
|                                                    |                  | 25     | 5.0    | 8.5  | 12.0 |                   |                                |
|                                                    |                  | 150    | 4.7    | 8.1  | 11.4 |                   |                                |
| Hysteresis                                         | B <sub>HYS</sub> | -40    | -      | -    | -    | mT                |                                |
|                                                    |                  | 25     | 0.7    | 1.5  | 3.0  |                   |                                |
|                                                    |                  | 150    | -      | -    | -    |                   |                                |
| Temperature compensation of magnetic thresholds    | T <sub>C</sub>   |        | -      | -350 | -    | ppm/°C            |                                |
| Repeatability of magnetic thresholds <sup>2)</sup> | B <sub>REP</sub> |        | -      | 20   | -    | μT <sub>RMS</sub> | typ. value for ΔB/Δt > 12mT/ms |

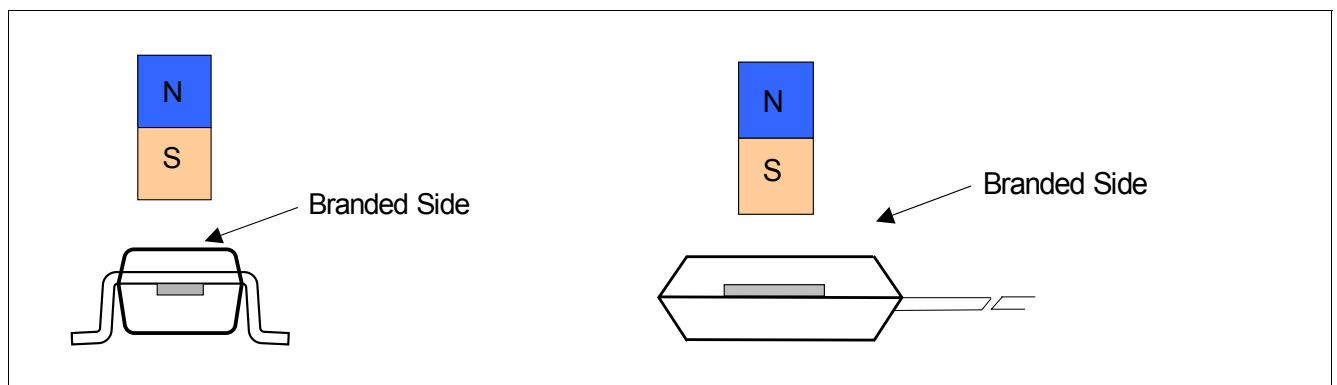
1) over operating range, unless otherwise specified. Typical values correspond to V<sub>S</sub> = 12V and T<sub>A</sub> = 25°C.

2) B<sub>REP</sub> is equivalent to the noise constant

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

### Field Direction Definition

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



**Figure 5** Definition of magnetic field direction (left: SC59, right: PG-SSO-3-2)

## 4 Package Information

### 4.1 Package Outline

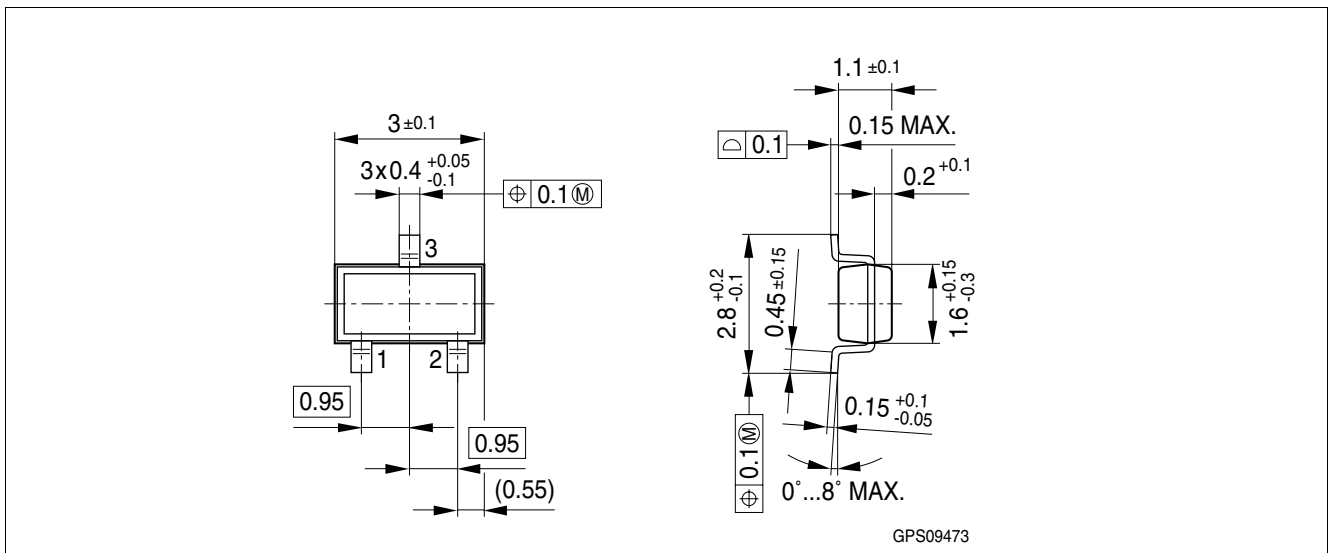


Figure 6 SC59 Package Outline (all dimensions in mm)

The following picture shows a recommendation for the PCB layout.

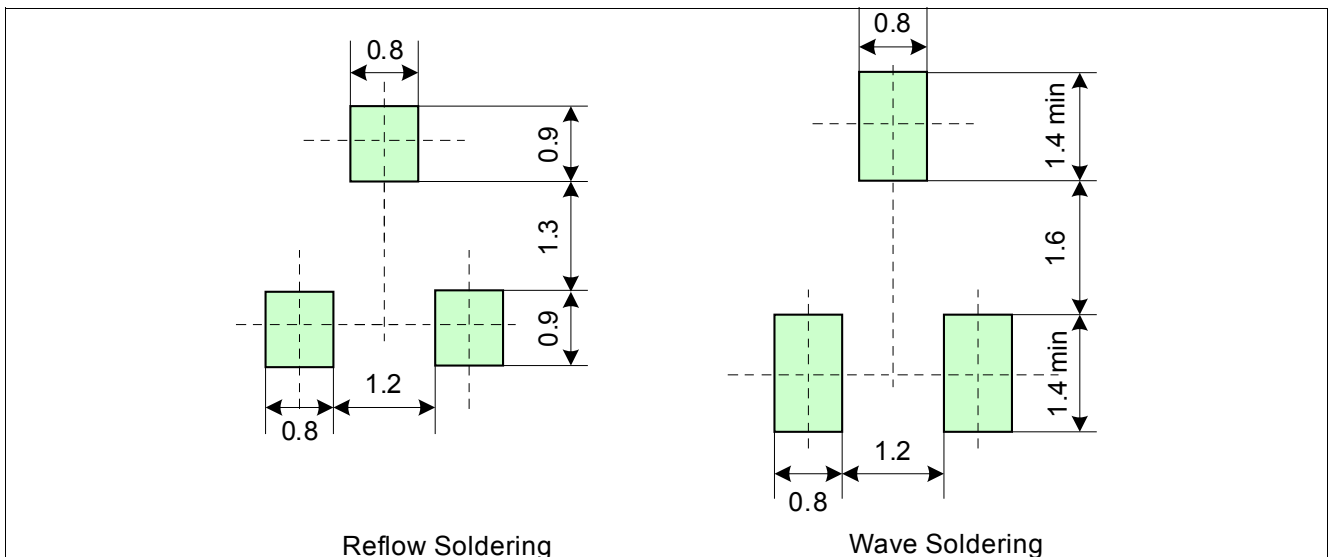


Figure 7 SC59 Footprint (SOT23 compatible, all dimensions in mm)

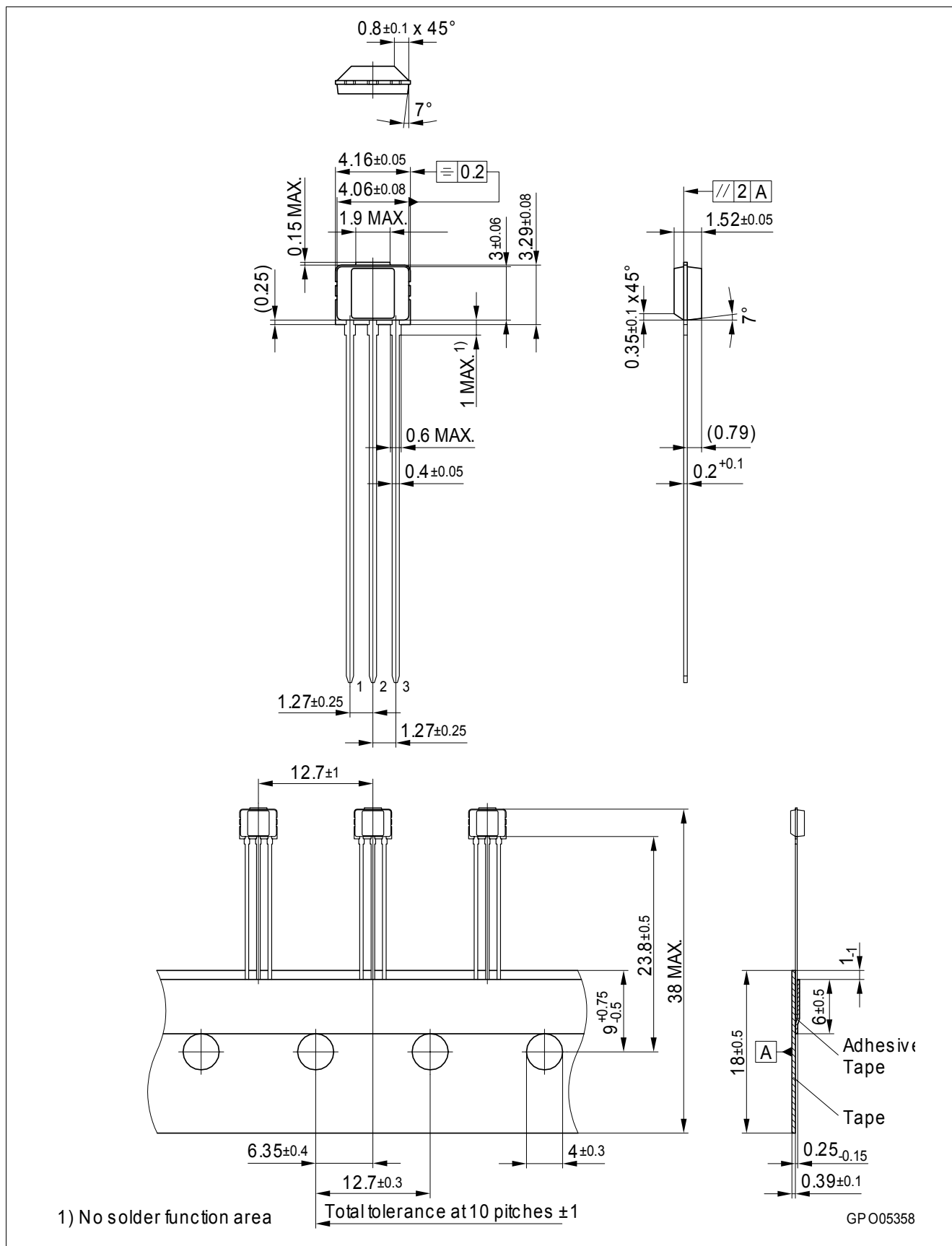


Figure 8 PG-SSO-3-2 Package Outline (All dimensions in mm)

## 4.2 Distance between Chip and Package

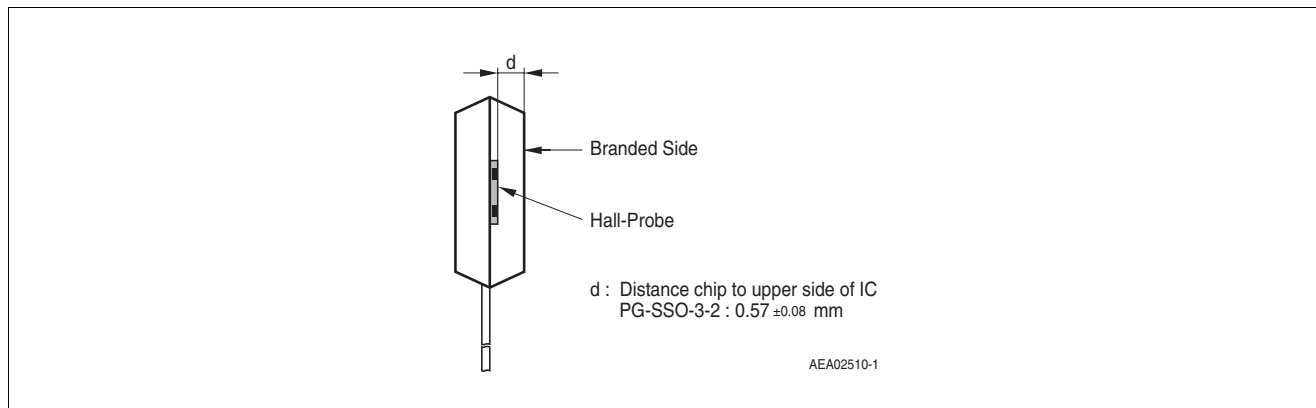


Figure 9 Distance between chip and package PG-SSO-3-2

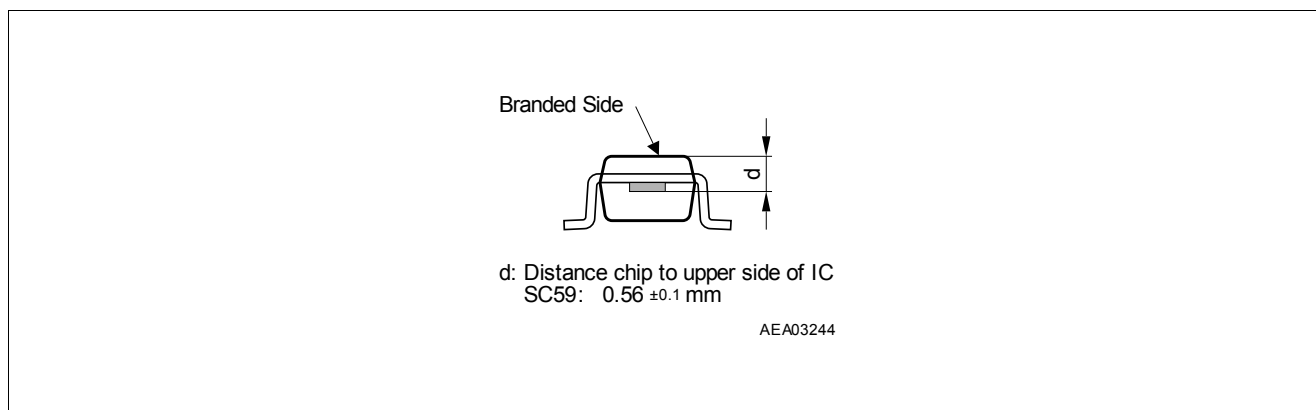


Figure 10 Distance between chip and package SC59

## 4.3 Package Marking

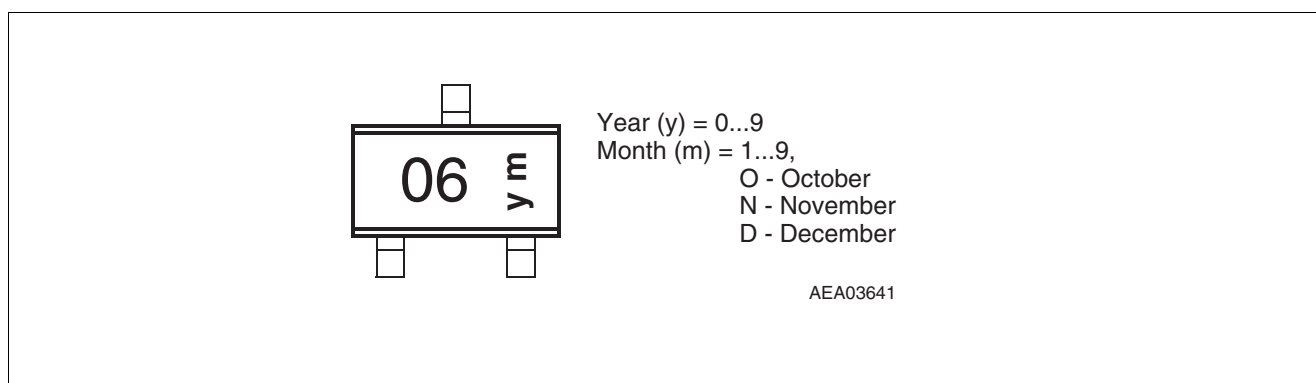


Figure 11 Marking of TLE4906K

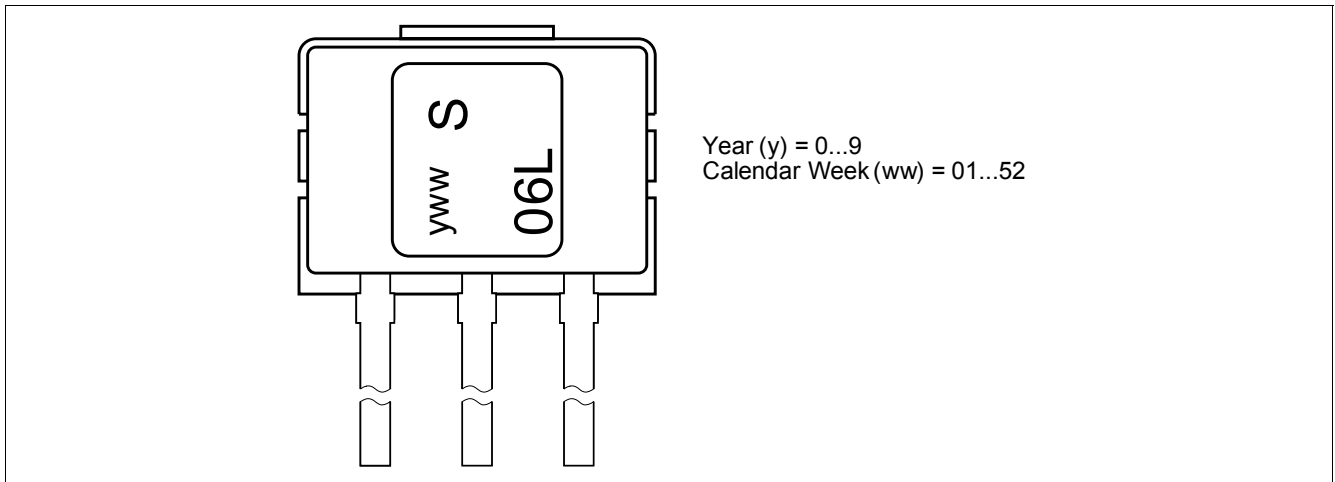


Figure 12 Marking of TLE4906L

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