

# TLE4954C/51C

Differential Hall Effect Transmission Speed Sensors

TLE4954C  
TLE4954C-E1  
TLE4954C-E2  
TLE4954C-E4  
TLE4954CB  
TLE4954CB-E1  
TLE4954CB-E2  
TLE4951C  
TLE4951CB

## Product Information

2013-10-15

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## 1 General



### 1.1 Target Application

TLE4954C/51C is an integrated differential Hall effect sensor for transmission applications with two wire PWM current interface. Its basic function is to provide information about rotational speed and direction of rotation to the transmission control unit. TLE4954C/51C includes a sophisticated algorithm which actively suppresses vibration while keeping excellent airgap performance. Infineon also offers customers the possibility to purchase sensors with already attached back bias magnets (CB versions).

### 1.2 Features

| Product Name | CCW <sup>1)</sup> | CW <sup>2)</sup> | Pre Low time | Direction signal                                           | Speed                 |
|--------------|-------------------|------------------|--------------|------------------------------------------------------------|-----------------------|
| TLE4954C     | 60 $\mu$ s        | 120 $\mu$ s      | 30 $\mu$ s   |                                                            | 30 $\mu$ s above 1kHz |
| TLE4954C-E1  | 45 $\mu$ s        | 180 $\mu$ s      | 30 $\mu$ s   | Direction signal up to 8kHz typ. (ccw) and 12kHz typ. (cw) | none                  |
| TLE4954C-E2  | 45 $\mu$ s        | 90 $\mu$ s       | 30 $\mu$ s   |                                                            | 180 $\mu$ s           |
| TLE4954C-E4  | 45 $\mu$ s        | 90 $\mu$ s       | 15 $\mu$ s   | Direction signal up to 8kHz min. (ccw) and 12kHz min. (cw) | 30 $\mu$ s            |
| TLE4951C     | Speed signal only |                  |              |                                                            |                       |

All sensors with a B in the product name have an integrated back bias magnet.

|              |                   |        |       |                                                               |                  |
|--------------|-------------------|--------|-------|---------------------------------------------------------------|------------------|
| TLE4954CB    | 60 μs             | 120 μs | 30 μs |                                                               | 30 μs above 1kHz |
| TLE4954CB-E1 | 45 μs             | 180 μs | 30 μs | Direction signal up to 8kHz typ.<br>(ccw) and 12kHz typ. (cw) | none             |
| TLE4954CB-E2 | 45 μs             | 90 μs  | 30 μs |                                                               | 180 μs           |
| TLE4951CB    | Speed signal only |        |       |                                                               |                  |

1) Rotation direction left 2) Rotation direction right

Note: More specific information about the timer-characteristics can be found in the FAQ for TLE4954C/51C.

| Product Name | Order Code  | Marking | Package      |
|--------------|-------------|---------|--------------|
| TLE4954C     | SP000848260 | 54C00A  | PG-SSO-2-53  |
| TLE4954C-E1  | SP000848264 | 54CE1A  | PG-SSO-2-53  |
| TLE4954C-E2  | SP000848268 | 54CE2A  | PG-SSO-2-53  |
| TLE4954C-E4  | SP001050144 | 54CE4A  | PG-SSO-2-53  |
| TLE4954CB    | SP000913564 | 54CB0A  | PG-SSOM-2-11 |
| TLE4954CB-E1 | SP000913568 | 54CB1A  | PG-SSOM-2-11 |
| TLE4954CB-E2 | SP000913572 | 54CB2A  | PG-SSOM-2-11 |
| TLE4951C     | SP000848256 | 51C00A  | PG-SSO-2-53  |
| TLE4951CB    | SP000913560 | 51CB0A  | PG-SSOM-2-11 |

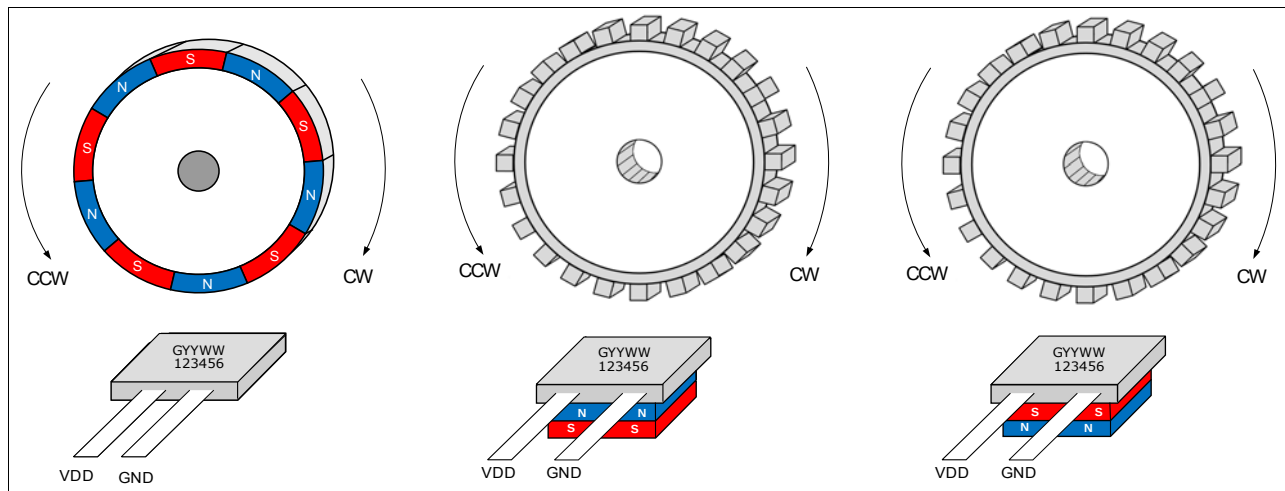
## 2 Functional Description

### 2.1 General

The differential Hall sensor IC detects the motion of tooth and magnet encoder applications. To detect the motion of ferromagnetic objects, the magnetic field must be provided by a back biasing permanent magnet. Either south or north pole of the magnet can be attached to the rear unmarked side of the IC package. The magnetic measurement is based on three equally spaced Hall elements, integrated on the IC. Both magnetic and mechanical offsets are cancelled by a self calibration algorithm. The sensor includes a current output PWM protocol.

### 2.2 Sensor assembly

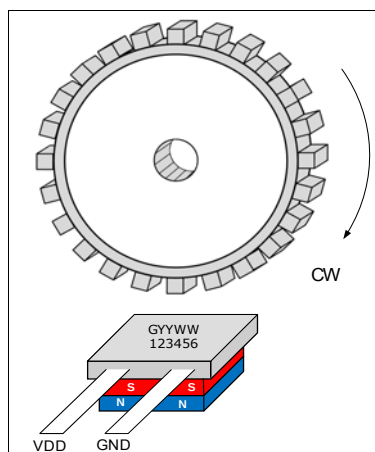
Sensor and back bias magnet can be applied in the following ways:



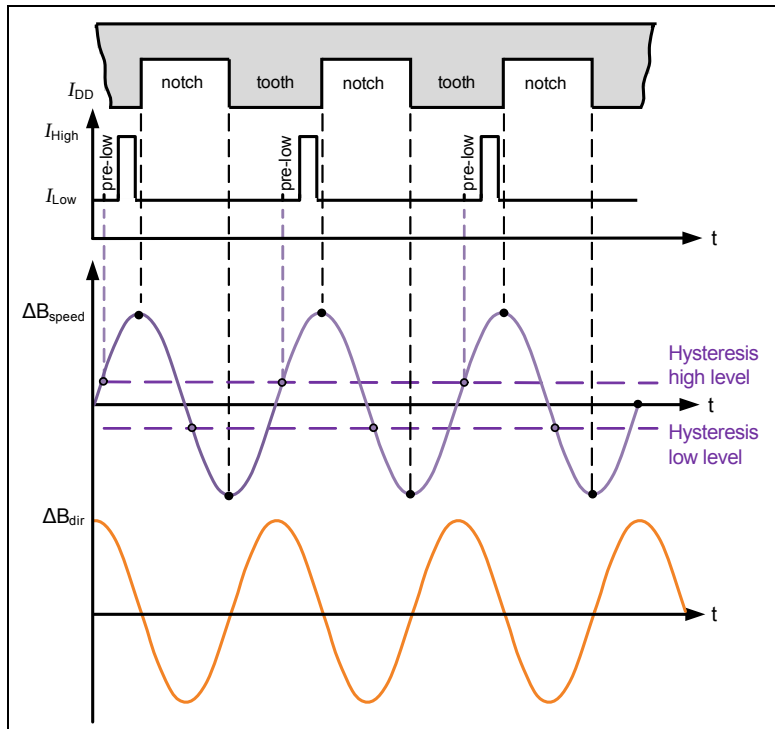
**Figure 2-1 Sensor assembly and definition of rotating directions**

The output signals for a south biased sensor with a magnetic encoder and ferromagnetic tooth wheel will be issued in the following way.

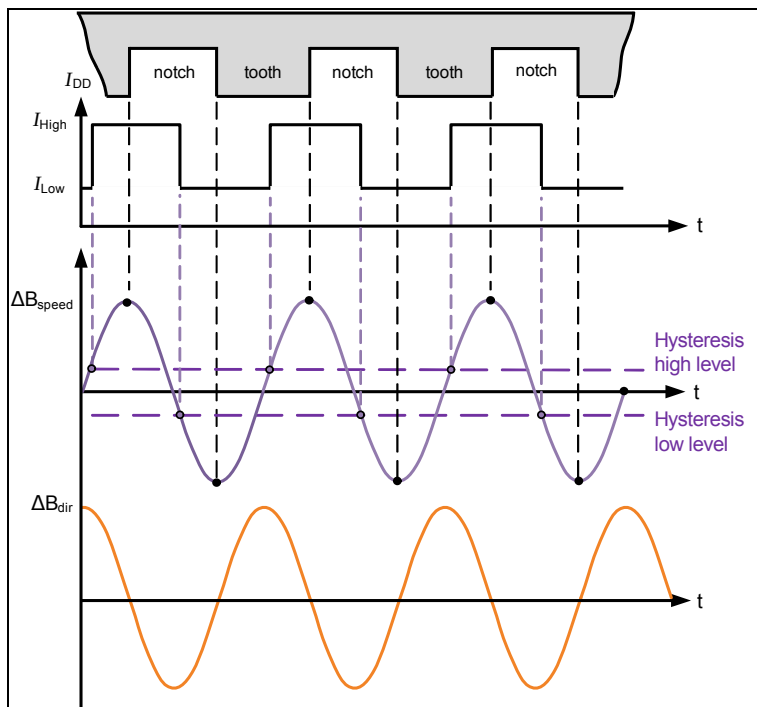
The tooth wheel is rotating in clockwise above the sensor. The output pulse will be issued by reaching the hysteresis levels after the pre low time. For a tooth wheel with ideal pitch (tooth to tooth) 5mm the direction signal achieves a phase shift of 90° compared to the speed signal.



**Figure 2-2 Clockwise rotation; south biased sensor**



**Figure 2-3** Tooth wheel vs. sensor output signal in clockwise rotation; south biased sensor - TLE4954C, TLE4954C-E1, TLE4954C-E2, TLE4954C-E4



**Figure 2-4** Tooth wheel vs. sensor output signal in clockwise rotation; south biased sensor - TLE4951C

## 2.2.1 Vibration Suppression

TLE4954C offers two different kinds of vibration suppression:

The magnetic signal amplitude and the direction information are used for detection of parasitic magnetic signals. Unwanted magnetic signal can be caused by angular or airgap vibrations. If an input signal is identified as a vibration the output pulse will be suppressed.

- Vibration suppression via hysteresis. This is available after power on
- Vibration suppression via direction detection. This is available after start up calibration is performed.

## 3 Specifications

### 3.1 Operating Range

Table 3-1 Operating Range

| Parameter                      | Symbol                           | Values |      |      | Unit | Note / Test Condition    |
|--------------------------------|----------------------------------|--------|------|------|------|--------------------------|
|                                |                                  | Min.   | Typ. | Max. |      |                          |
| Supply voltage                 | $V_{DDIC}$                       | 4      |      | 20   | V    | Directly on the IC leads |
| Operation junction temperature | $T_j$                            | -40    |      | 170  | °C   |                          |
| Speed signal range             | $\Delta B_{\text{speed, range}}$ | -120   |      | 120  | mT   |                          |

### 3.2 Electrical Characteristics

Table 3-2 Electrical Characteristics

| Parameter                                             | Symbol                                        | Values |      |      | Unit  | Note / Test Condition                                                                                 |
|-------------------------------------------------------|-----------------------------------------------|--------|------|------|-------|-------------------------------------------------------------------------------------------------------|
|                                                       |                                               | Min.   | Typ. | Max. |       |                                                                                                       |
| Supply current low                                    | $I_{\text{Low}}$                              |        | 7    |      | mA    |                                                                                                       |
| Supply current high                                   | $I_{\text{High}}$                             |        | 14   |      | mA    |                                                                                                       |
| Output rise/fall slew rate                            | $SR_r, SR_f$                                  |        | 17   |      | mA/μs | Valid for $t_r$ and $t_f$ , between 10% and 90% value $R_M=75 \Omega$ , $T_j<175 \text{ °C}$          |
| Reset voltage                                         | $V_{DD \text{ Reset}}$                        |        | 3.7  | 4    | V     |                                                                                                       |
| Power on time                                         | $t_{ON}$                                      |        |      | 1    | ms    | $V_{DD} > 4V$                                                                                         |
| Period Jitter, $f \leq 2500 \text{ Hz}$               | $S_{\text{jit-far}}, T_j \leq 150 \text{ °C}$ |        | 3.2  |      | %     | $\pm 3\sigma$ value, $V_{DD}=12 \text{ V}$ , $\Delta B_{\text{speed}} \geq 4 \text{ mT}$ peak to peak |
| Period Jitter, $2500 \text{ Hz} < f < 12 \text{ kHz}$ | $S_{\text{jit-far}}, T_j \leq 150 \text{ °C}$ |        | 4.2  |      | %     | $\pm 3\sigma$ value, $V_{DD}=12 \text{ V}$ , $\Delta B_{\text{speed}} \geq 4 \text{ mT}$ peak to peak |

### 3.3 ESD Robustness

Table 3-3 ESD Protection

| Parameter      | Symbol           | Test     | Unit | Note                                             |
|----------------|------------------|----------|------|--------------------------------------------------|
| ESD-Protection | $V_{\text{ESD}}$ | $\pm 12$ | kV   | $R = 1.5 \text{ k}\Omega$ , $C = 100 \text{ pF}$ |

### 3.4 Timing Characteristics

Between each magnetic transition and the rising edge of the corresponding output pulse, the output current is low for  $t_{\text{pre-low}}$  in order to allow reliable internal conveyance. After pre low time the output current level is set to high.

After power on the speed pulse is being issued. As soon as the sensor has enough information to recognize the direction of the target wheel, the output pulse will include the direction information.

Rotation direction is evaluated only for low rotation speed. The speed signal will be delivered again if the magnetic frequency is above  $f_{\text{DR,max}}$ .

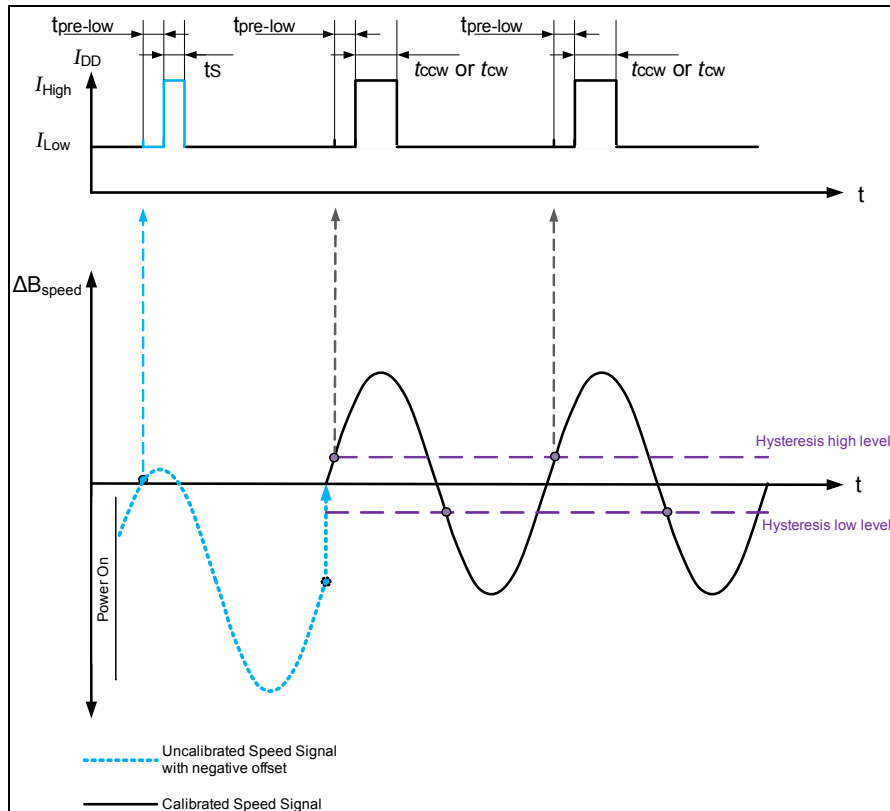
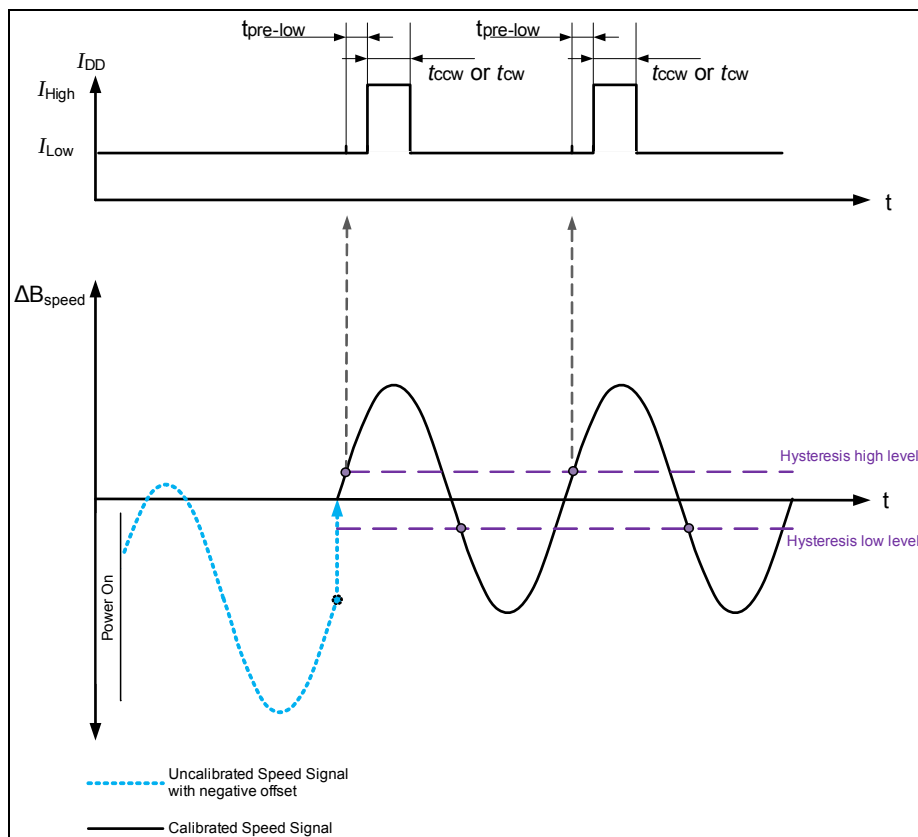
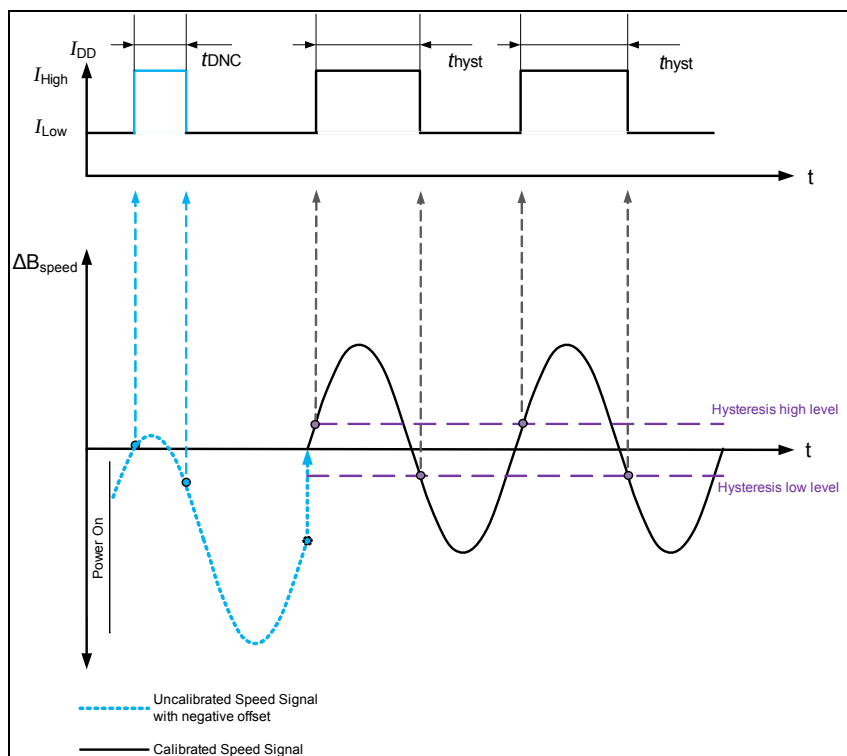


Figure 3-1 Definition of PWM Current Interface - TLE4954C, TLE4954C-E2, TLE4954C-E4





**Figure 3-2 Definition of PWM Current Interface - TLE4954C-E1**



**Figure 3-3 Definition of Current interface - TLE4951C**



### 3.5 Operation characteristics - TLE4951CB, TLE4954CB, TLE4954CB-E1, TLE4954CB-E2

**Table 3-4 TLE4954CB, TLE4951CB**

| Parameter                | Symbol                          | Values |      |     | Unit | Remarks                                                                                                                           |
|--------------------------|---------------------------------|--------|------|-----|------|-----------------------------------------------------------------------------------------------------------------------------------|
|                          |                                 | min    | typ  | max |      |                                                                                                                                   |
| Operational airgap       | AG                              |        | 3.3  |     | mm   | Valid in running mode, measured from sensor housing (branded side) to target tooth. Valid at 25°C & 0h. No missing output pulses. |
| Minimum speed signal     | $\Delta B_{\text{speed-limit}}$ |        | 2.2  |     | mT   | Peak to peak value<br>99% criteria                                                                                                |
| Minimum direction signal | $\Delta B_{\text{Bdir-limit}}$  |        | 0.36 |     | mT   | Peak to peak value<br>99% criteria                                                                                                |

**Table 3-5 TLE4954CB-E1, TLE4954CB-E2**

| Parameter                | Symbol                          | Values |     |     | Unit | Remarks                                                                                                                           |
|--------------------------|---------------------------------|--------|-----|-----|------|-----------------------------------------------------------------------------------------------------------------------------------|
|                          |                                 | min    | typ | max |      |                                                                                                                                   |
| Operational airgap       | AG                              |        | -   |     | mm   | Valid in running mode, measured from sensor housing (branded side) to target tooth. Valid at 25°C & 0h. No missing output pulses. |
| Minimum speed signal     | $\Delta B_{\text{speed-limit}}$ |        | 2.2 |     | mT   | Peak to peak value<br>99% criteria                                                                                                |
| Minimum direction signal | $\Delta B_{\text{Bdir-limit}}$  |        | 0.9 |     | mT   | Peak to peak value<br>99% criteria                                                                                                |

### 3.6 Reference Target Wheel for TLE4951CB, TLE4954CB, TLE4954CB-E1, TLE4954CB-E2

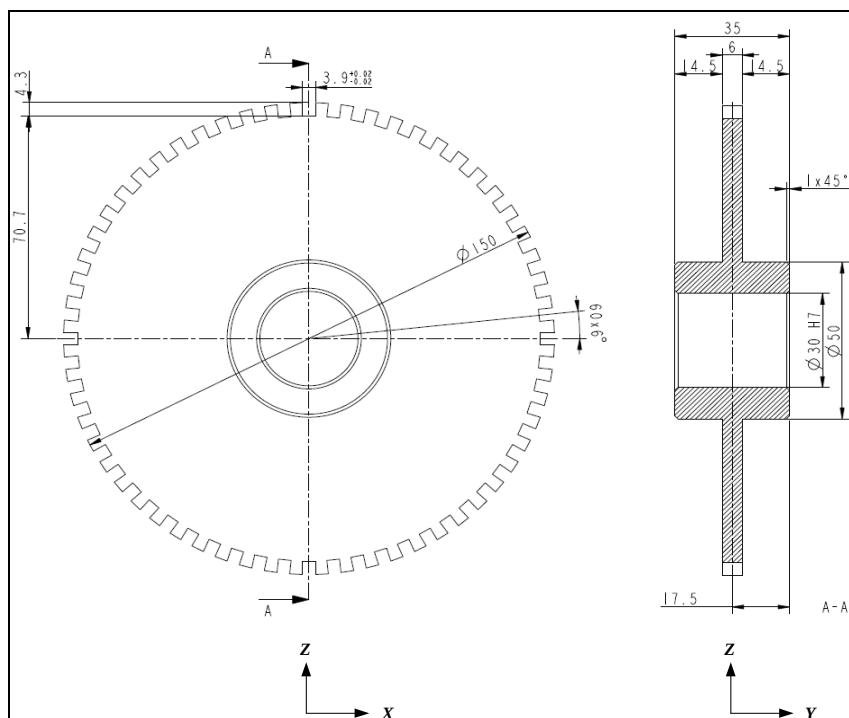


Figure 3-4 Reference target wheel

Table 3-6 Reference target wheel geometry

| Parameter        | Symbol | Typ value | Unit | Remarks |
|------------------|--------|-----------|------|---------|
| Outside diameter | $d$    | 150       | mm   |         |
| Number of teeth  | $Z$    | 60        | -    |         |
| Pitch Ratio      |        | 50:50     | %    |         |
| Material         |        | ST37      |      |         |

## 4 Package Information

### 4.1 Package Information TLE4954C, TLE4954C-E1, TLE4954C-E2, TLE4951C

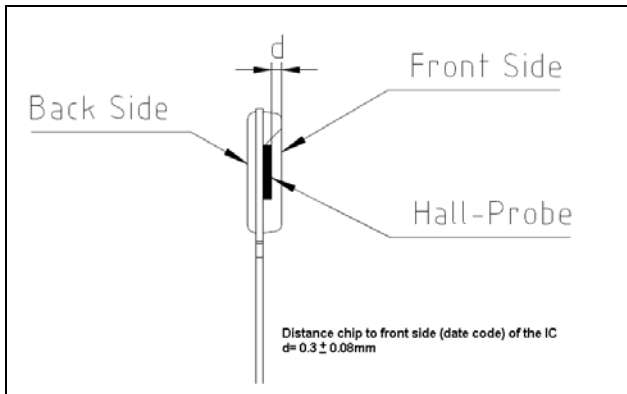


Figure 4-1 Distance of the chip to the upper package edge

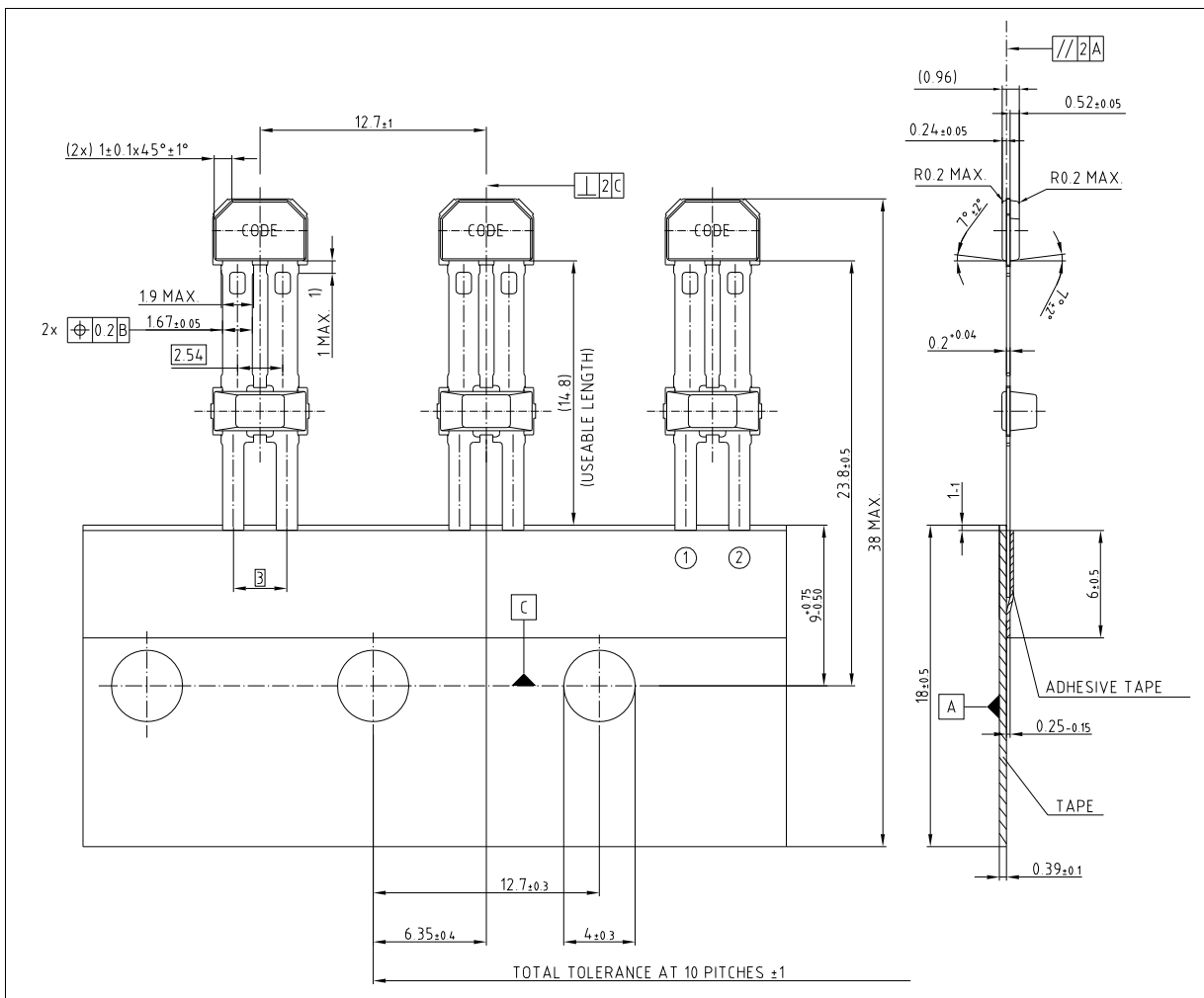
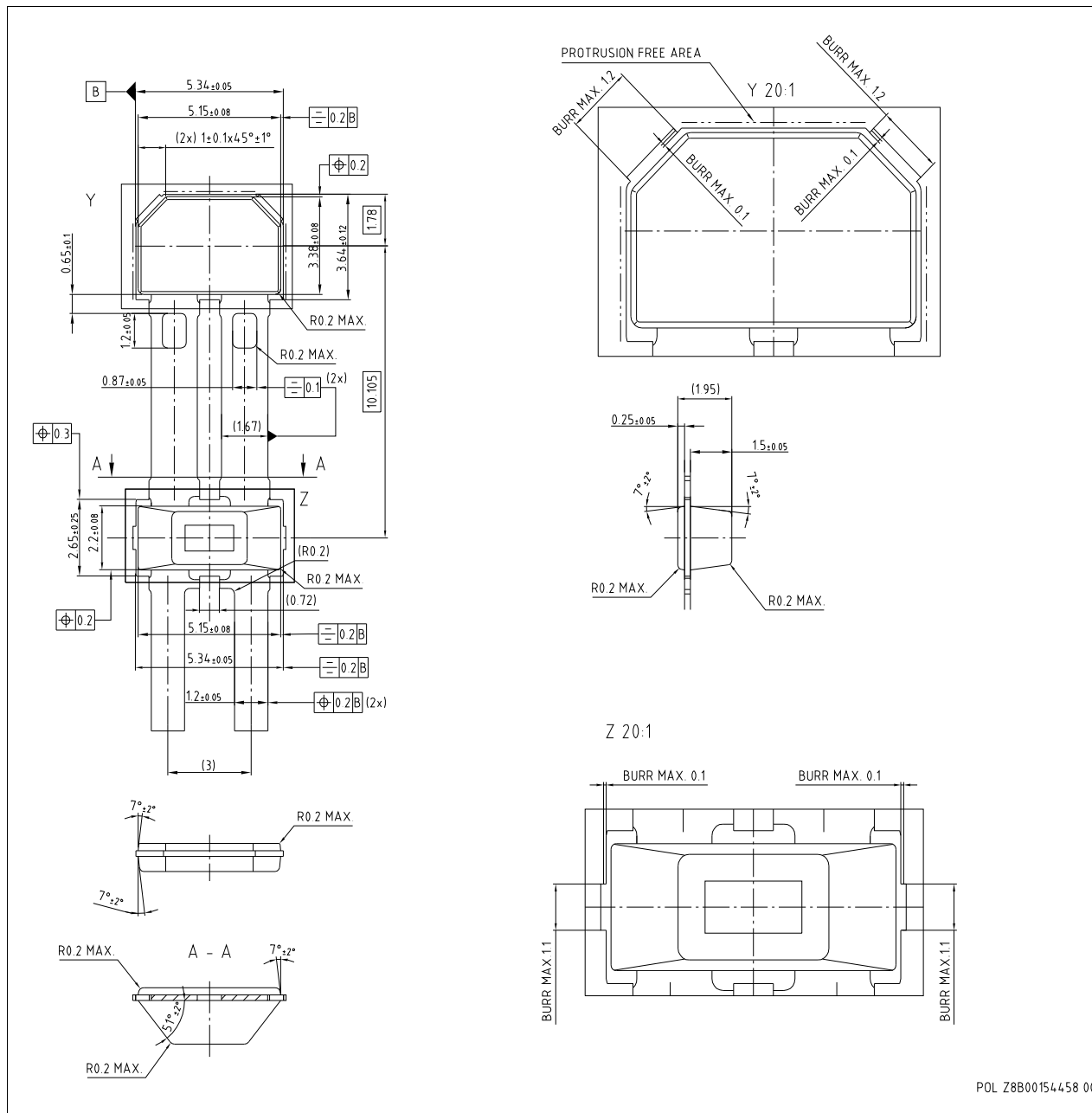


Figure 4-2 PG-SSO-2-53 (Plastic Single Small Outline Package) packing, all dimensions in mm



**Figure 4-3 PG-SSO-2-53 package outline, dimensions in mm.**

## 4.2 Package Information TLE4951CB, TLE4954CB, TLE4954CB-E1, TLE4954CB-E2

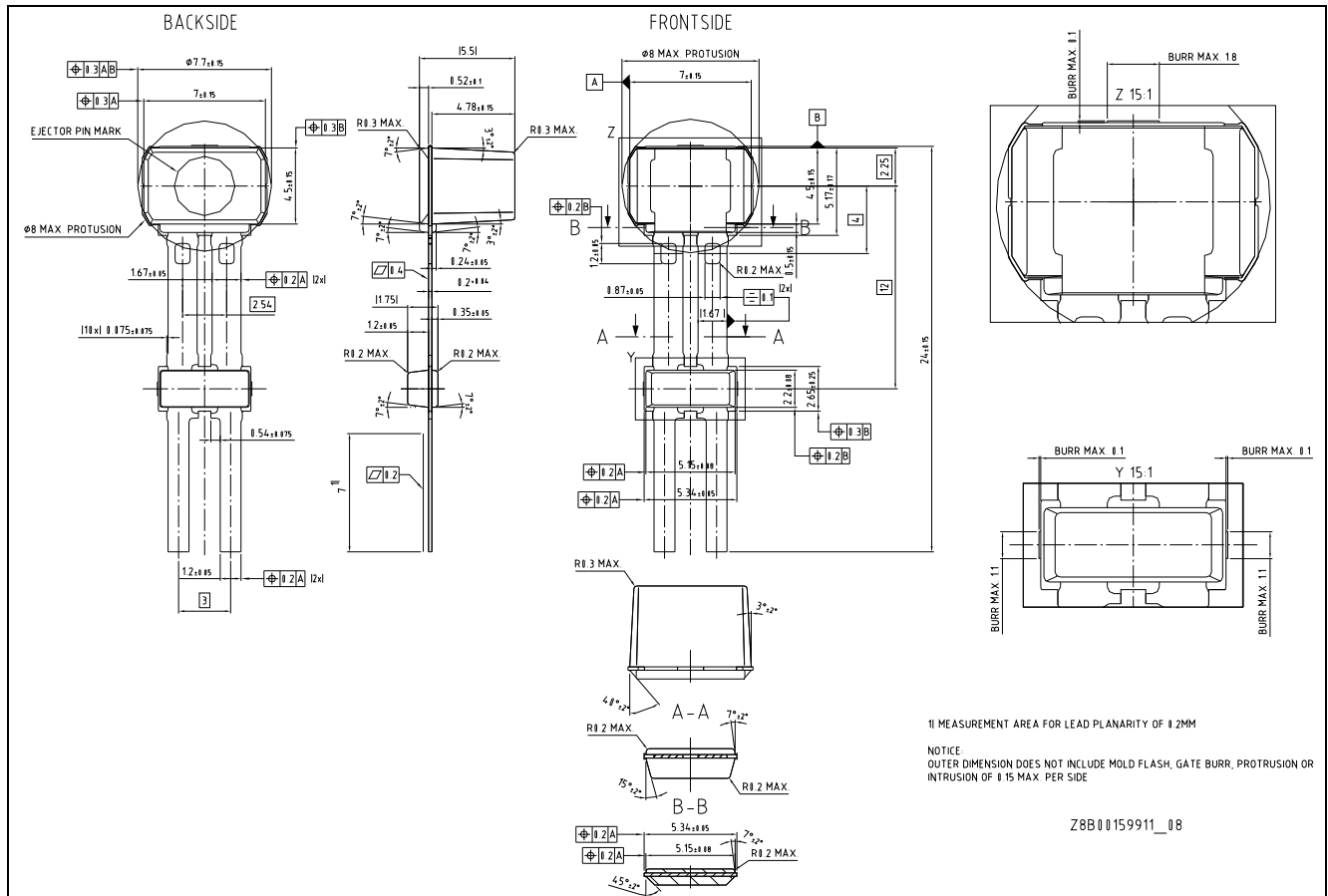


Figure 4-4 PG-SSOM-2-11 package outline

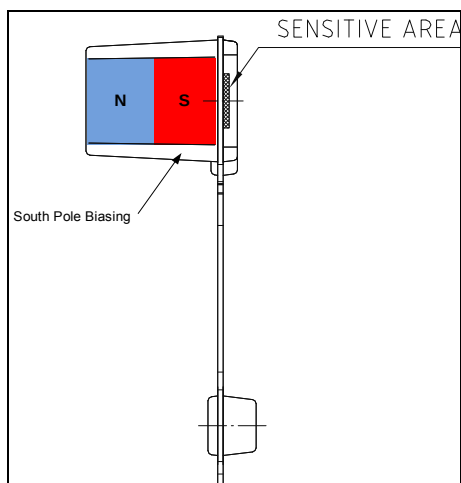
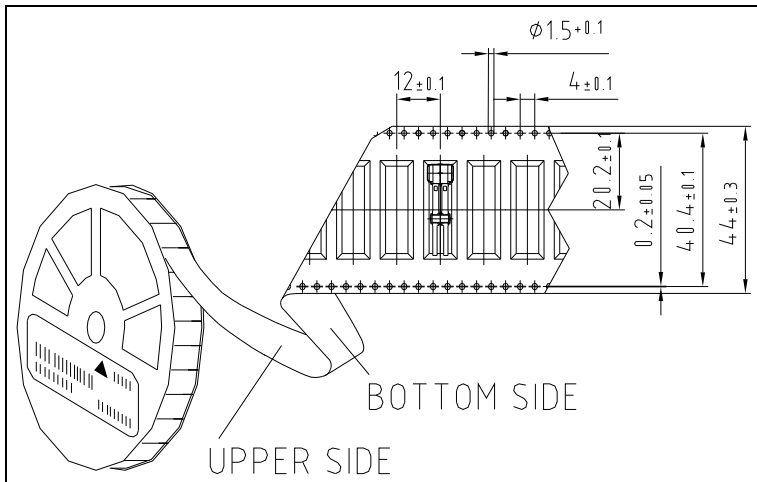


Figure 4-5 Back-bias field orientation



**Figure 4-6 PG-SSOM-2-11 blister tape packing information**

For additional and more detailed information about the chip and package please visit the Infineon web page <http://www.infineon.com>.

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