

# Infineon<sup>®</sup> Basic LED Driver

## TLE4242EJ

1 Channel High Side Current Source up to 500 mA

### Data Sheet

Rev. 1.0, 2014-02-05

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## 1 Overview

### Features

- Adjustable constant current up to 500 mA
- Wide input voltage range up to 42 V
- Low drop voltage
- Open load detection
- Over temperature protection
- Over load protection
- Integrated reverse polarity protection
- Wide temperature range -40 °C to 150 °C
- Green Product (RoHS compliant)
- AEC Qualified



**PG-DSO-8-27**

### Description

The TLE4242EJ is an integrated adjustable constant current source driving loads up to 500 mA. The output current level can be adjusted via an external resistor. The IC is designed to supply high power LEDs under the severe conditions of automotive applications resulting in constant brightness and extended LED lifetime. It is provided in the surface mounted PG-DSO-8-27 package. Protection circuits prevent damage to the device in case of over load, short circuit, reverse polarity and overheat. The connected LEDs are protected against reverse polarity as well as over voltages up to 45 V.

The integrated PWM input of the TLE4242EJ permits LED brightness regulation by pulse width modulation. Due to the high input impedance of the PWM input the LED driver can be operated as a protected high side switch.

**Table 1 Product Summary**

| Parameter                       | Symbol           | Values         |
|---------------------------------|------------------|----------------|
| Operating voltage               | $V_{I(nom)}$     | 4.5 V ... 42 V |
| Maximum output voltage          | $V_{Q(max)}$     | 40 V           |
| Nominal output (load) current   | $I_{Q(nom)}$     | 135 mA         |
| Minimum current limitation      | $I_{Q(lim,min)}$ | 476 mA         |
| Current consumption in off mode | $I_{I(off,typ)}$ | 0.1 $\mu$ A    |

| Type      | Package     | Marking   |
|-----------|-------------|-----------|
| TLE4242EJ | PG-DSO-8-27 | TLE4242EJ |

## 2 Block Diagram

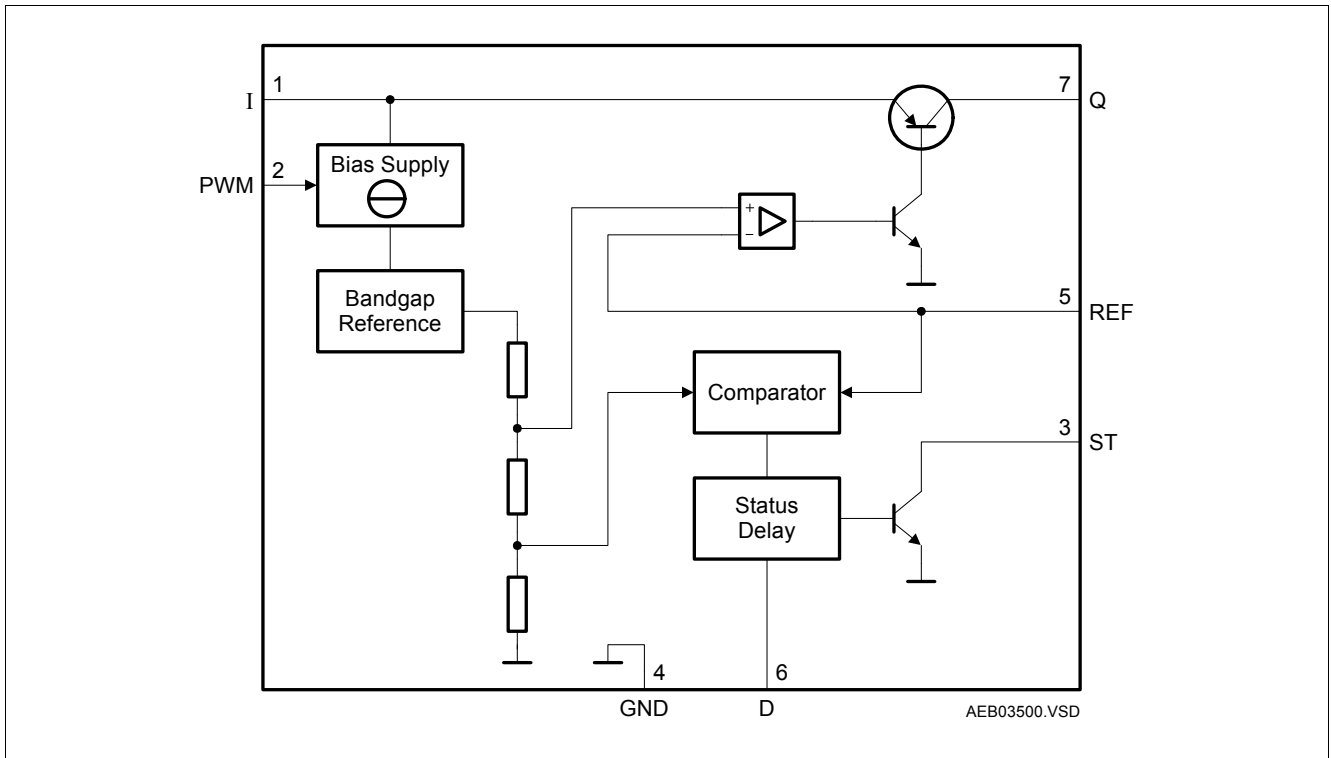


Figure 1 Block Diagram

### 3 Pin Configuration

#### 3.1 Pin Assignment

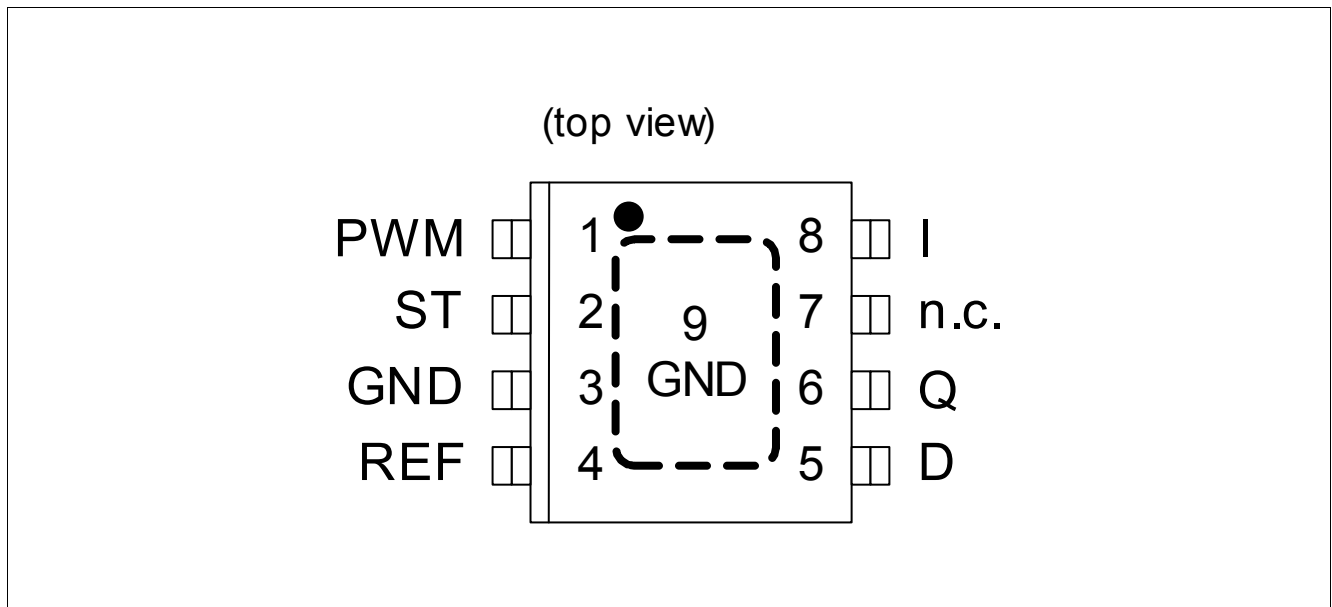


Figure 2 Pin Configuration

#### 3.2 Pin Definitions and Functions

| Pin | Symbol | Input/Output | Function  |
|-----|--------|--------------|---|
| 1   | PWM    | I            | <b>Pulse Width Modulation Input</b> ; if not required, connect to I-pin <sup>1)</sup>   |
| 2   | ST     | O            | <b>Status Output</b> ; open collector output, connect to external pull-up resistor  |
| 3   | GND    | –            | <sup>2)</sup> <b>Ground</b>   |
| 4   | REF    | I            | <b>Reference Input</b> ; connect to shunt resistor  |
| 5   | D      | O            | <b>Status Delay</b> ; optional, connect to GND via an optional capacitor to extend the status reaction time. Leave open, if no delay is required. |
| 6   | Q      | O            | <b>Output</b>   |
| 8   | I      | I            | <b>Input</b> ; battery supply, connect a decoupling ceramic capacitor of at least 100 nF directly at the IC to ground                             |
| 9   | GND    | –            | <sup>2)</sup> <b>Exposed Pad</b> ; connect to GND in application  |

1) Please take care of different maximum ratings of I- and PWM-pins during circuit design.

2) Connect all GND-pins together.

## 4 General Product Characteristics

### 4.1 Absolute Maximum Ratings

**Table 2 Absolute Maximum Ratings <sup>1)</sup>**

$T_j = -40^\circ\text{C}$  to  $+150^\circ\text{C}$ ; all voltages with respect to ground, positive current flowing into pin for input pins, positive currents flowing out of pin for output pins (unless otherwise specified)

| Parameter  | Symbol           | Values |      |      | Unit             | Note / Test Condition  | Number   |
|--|------------------|--------|------|------|------------------|------------------------|----------|
|  |                  | Min.   | Typ. | Max. |                  |                        |          |
| <b>Voltages</b>  |                  |        |      |      |                  |                        |          |
| Input voltage  | $V_I$            | -42    | –    | 45   | V                | –                      | P_4.1.1  |
| Output voltage   | $V_Q$            | -1     | –    | 40   | V                | –                      | P_4.1.2  |
| Status output voltage                                  | $V_{ST}$         | -0.3   | –    | 40   | V                | –                      | P_4.1.3  |
| Status delay voltage                                   | $V_D$            | -0.3   | –    | 7    | V                | –                      | P_4.1.4  |
| Reference input voltage                                | $V_{REF}$        | -1     | –    | 16   | V                | –                      | P_4.1.5  |
| PWM input voltage                                      | $V_{PWM}$        | -40    | –    | 40   | V                | –                      | P_4.1.6  |
| <b>Currents</b>  |                  |        |      |      |                  |                        |          |
| Input current  | $I_I$            | –      | –    | –    | A                | internally limited     | P_4.1.7  |
| Output current   | $I_Q$            | –      | –    | –    | A                | internally limited     | P_4.1.8  |
| Status output current                                  | $I_{ST}$         | -5     | –    | 5    | mA               | –                      | P_4.1.9  |
| Status delay current                                   | $I_D$            | -1     | –    | 1    | mA               | in off-state<br>10 min | P_4.1.17 |
| Reference input current                                | $I_{REF}$        | -2     | –    | 2    | mA               | –                      | P_4.1.10 |
| PWM input current                                      | $I_{PWM}$        | -1     | –    | 1    | mA               | –                      | P_4.1.11 |
| <b>Temperatures</b>                                    |                  |        |      |      |                  |                        |          |
| Junction Temperature                                   | $T_j$            | -40    | –    | 150  | $^\circ\text{C}$ | –                      | P_4.1.12 |
| Storage Temperature                                    | $T_{stg}$        | -55    | –    | 150  | $^\circ\text{C}$ | –                      | P_4.1.13 |
| <b>ESD Susceptibility</b>                              |                  |        |      |      |                  |                        |          |
| ESD Susceptibility                                     | $V_{ESD}$        | -2     | –    | 2    | kV               | HBM <sup>2)</sup>      | P_4.1.14 |
| ESD Susceptibility                                     | $V_{ESD}$        | -500   | –    | 500  | V                | CDM <sup>3)</sup>      | P_4.1.15 |
| ESD Susceptibility Pin 1, 4, 5, 8 (corner pins) to GND | $V_{ESD1,4,5,8}$ | -750   | –    | 750  | V                | CDM <sup>3)</sup>      | P_4.1.16 |

1) Not subject to production test, specified by design.

2) ESD susceptibility, HBM according to ANSI/ESDA/JEDEC JS001 (1.5k  $\Omega$ , 100 pF)

3) ESD susceptibility, Charged Device Model "CDM" ESDA STM5.3.1 or ANSI/ESD S.5.3.1

#### Notes

1. Stresses above the ones listed here may cause permanent damage to the device. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

2. *Integrated protection functions are designed to prevent IC destruction under fault conditions described in the data sheet. Fault conditions are considered as “outside” normal operating range. Protection functions are not designed for continuous repetitive operation.*

## 4.2 Functional Range

**Table 3 Functional Range**

| Parameter                | Symbol           | Values |      |      | Unit               | Note / Test Condition | Number  |
|--------------------------|------------------|--------|------|------|--------------------|-----------------------|---------|
|                          |                  | Min.   | Typ. | Max. |                    |                       |         |
| Input voltage range      | $V_I$            | 4.5    | –    | 42   | V                  | –                     | P_4.2.1 |
| Status output voltage    | $V_{ST}$         | –      | –    | 16   | V                  | –                     | P_4.2.2 |
| Status delay capacitance | $C_D$            | 0      | –    | 2.2  | $\mu\text{F}$      | –                     | P_4.2.3 |
| PWM voltage              | $V_{\text{PWM}}$ | 0      | –    | 40   | V                  | –                     | P_4.2.4 |
| Reference resistor       | $R_{\text{REF}}$ | 0      | –    | 1.8  | $\Omega$           | –                     | P_4.2.5 |
| Junction Temperature     | $T_j$            | -40    | –    | 150  | $^{\circ}\text{C}$ | –                     | P_4.2.6 |

*Note: Within the functional or operating range, the IC operates as described in the circuit description. The electrical characteristics are specified within the conditions given in the Electrical Characteristics table.*

### 4.3 Thermal Resistance

Note: This thermal data was generated in accordance with JEDEC JESD51 standards. For more information, go to [www.jedec.org](http://www.jedec.org).

**Table 4 Thermal Resistance**

| Parameter                      | Symbol     | Values |      |      | Unit | Note / Test Condition              | Number  |
|--------------------------------|------------|--------|------|------|------|------------------------------------|---------|
|                                |            | Min.   | Typ. | Max. |      |                                    |         |
| Junction to Case <sup>1)</sup> | $R_{thJC}$ | –      | 8    | 10   | K/W  | –                                  | P_4.3.1 |
| Junction to Ambient            | $R_{thJA}$ | –      | 39   | –    | K/W  | <sup>2)</sup> $T_a = 85\text{ °C}$ | P_4.3.2 |

1) Not subject to production test, specified by design.

2) Specified  $R_{thJA}$  value is according to Jedec JESD51-2,-5,-7 at natural convection on FR4 2s2p board; The Product (Chip + Package) was simulated on a 76.2 × 114.3 × 1.5 mm board with 2 inner copper layers (2 × 70 mm Cu, 2 × 35 mm Cu). Where applicable a thermal via array under the exposed pad contacted the first inner copper layer.



## 5 Product Description

The TLE4242EJ is an adjustable constant current source providing currents up to 500 mA. The product is optimized for automotive applications, but is suitable for industrial applications as well, where high currents are required.

### 5.1 Output Current Setting

An external shunt resistor in the ground path of the connected LEDs is used to sense the LED current. A regulation loop regulates the voltage drop at the shunt resistor  $R_{REF}$  on a constant level of typ. 175 mV. Selecting the appropriate shunt resistance allows to adjust the desired constant current level. The typical output current is calculated according to [Equation \(1\)](#).

$$I_{Q(\text{typ})} = \frac{V_{REF}}{R_{REF}} \quad (1)$$

$V_{REF}$  is the reference voltage with a typical value of 175 mV, details at [Reference voltage](#). The equation applies in a range of  $0.39 \Omega \leq R_{REF} \leq 1.8 \Omega$ .

The output current is shown as a function of the reference resistance in [Chapter 5.3.1](#). With the PWM input the LED brightness can be regulated via duty cycle. Also PWM = 0 V sets the TLE4242EJ in sleep mode resulting in a very low current consumption  $I_{I(\text{off})}$  [Current consumption at Input-pin during off-state](#). Due to the high impedance of the PWM input the PWM pin can also be used as an enable input.

The application example in [Figure 9](#) shows a typical application with the TLE4242EJ LED driver. The three LEDs are driven with an adequate supply current adjusted by the resistor  $R_{REF}$ . Thus brightness variations due to forward voltage spread of the LEDs are prevented. The luminosity spread arising from the LED production process can be compensated via software by an appropriate duty cycle applied to the PWM pin. Therefore, selection of the LEDs to forward voltage as well as to luminosity classes can be spared. The minimum supply voltage for the application is the sum of the LED forward voltages, the TLE4242EJ drop voltage [Minimum drop voltage  \$V\_{dr} = V\_I - V\_Q\$](#)  and the max. voltage drop at the shunt resistor  $R_{REF}$  of  $V_{REF(\text{max})}$  according to [Reference voltage](#).

The status output of the LED driver (ST) detects an open load condition enabling to supervise correct LED function. A LED failure is detected, if the voltage drop at the shunt resistor  $R_{REF}$  falls below typ. 25 mV. In this case the status output pin ST is set low after a delay time, which is adjustable via an optional capacitor connected to the pin D.

The functionality of the status ST and PWM-pin as well as their timings are shown in [Figure 3](#). The pull up resistor value at the ST-pin is recommended with  $R_{ST\_pu} \geq 4.7 \text{ k}\Omega$ . The status delay can be adjusted via the capacitor connected to the timing pin D. The delay time  $t_{ST(\text{HL})}$  and  $t_{ST(\text{LH})}$  scales linearly with the capacitance  $C_D$ :

$$t_{ST(\text{HL}, \text{typ})} = \frac{C_D}{47 \text{ nF}} \cdot 10 \text{ ms} \quad (2)$$

$$t_{ST(\text{LH}, \text{typ})} = \frac{C_D}{47 \text{ nF}} \cdot 10 \mu\text{s} \quad (3)$$

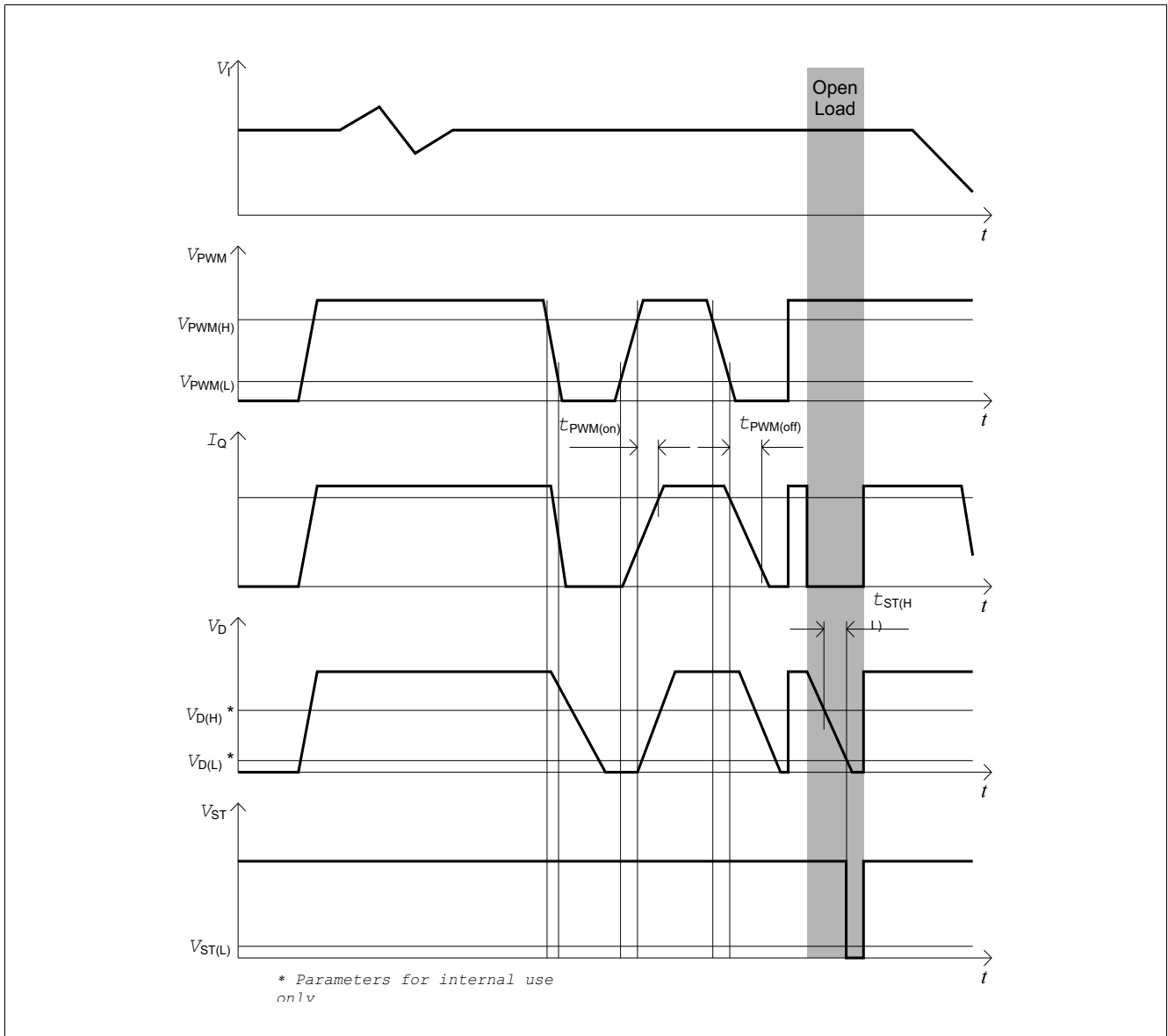


Figure 3 Function and Timing Diagram

## 5.2 Protection Functions

The TLE4242EJ provides embedded protection functions, which are designed to prevent IC destruction under fault conditions described in the data sheet. Fault conditions are considered as “outside” normal operating range. Protection functions are neither designed for continuous nor for repetitive operation.

The following protection functions are embedded:

- Over temperature protection realized by over temperature switch off (see [Figure 4](#))
- Over load protection realized by output current limitation and over temperature protection
- Integrated reverse polarity protection

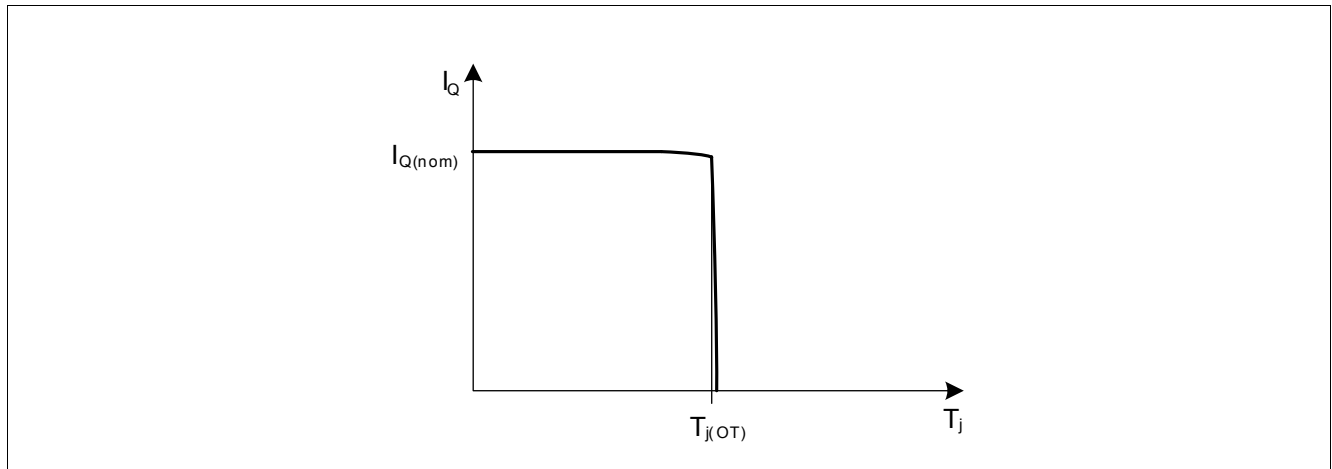


Figure 4 Over Temperature Protection

### 5.3 Electrical Characteristics

Table 5 Electrical Characteristics

$V_I = 13.5\text{ V}$ ,  $R_{REF} = 0.47\ \Omega$ ,  $V_{PWM} = 5.0\text{ V}$ ,  $T_j = -40^\circ\text{C}$  to  $+150^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin for input pins, positive currents flowing out of pin for output pins (unless otherwise specified)

| Parameter   | Symbol       | Values |      |      | Unit          | Note / Test Condition  | Number  |
|---|--------------|--------|------|------|---------------|--|---------|
|   |              | Min.   | Typ. | Max. |               |  |         |
| Current consumption at Input-pin during off-state                   | $I_{I(off)}$ | –      | 0.1  | 2    | $\mu\text{A}$ | <sup>1)</sup> $T_j = 85^\circ\text{C}$<br>$V_{PWM} = 0.0\text{ V}$ | P_5.3.1 |
| Operational current consumption in on-state<br>$I_{op} = I_I - I_Q$ | $I_{op(on)}$ | –      | 12   | 22   | $\text{mA}$   | $V_Q = 6.6\text{ V}$   | P_5.3.2 |

#### Output

|  |              |     |      |     |             |   |         |
|--|--------------|-----|------|-----|-------------|---|---------|
| Output current                               | $I_Q$        | 350 | 373  | 395 | $\text{mA}$ | <sup>2)</sup> $V_Q - V_{REF} = 6.6\text{ V}$  | P_5.3.3 |
| Output current                               | $I_Q$        | 165 | 175  | 185 | $\text{mA}$ | $V_Q - V_{REF} = 6.6\text{ V}$ ,<br>$R_{REF} = 1.0\ \Omega$                                       | P_5.3.4 |
| Output current                               | $I_Q$        | 425 | 451  | 476 | $\text{mA}$ | $V_Q - V_{REF} = 6.6\text{ V}$ ,<br>$R_{REF} = 0.39\ \Omega$                                      | P_5.3.5 |
| Output current                               | $I_Q$        | 357 | 384  | 410 | $\text{mA}$ | $5.4\text{ V} \leq (V_Q - V_{REF}) \leq 7.8\text{ V}$ ;<br>$9\text{ V} \leq V_I \leq 16\text{ V}$ | P_5.3.6 |
| Output current limit                         | $I_{Q(lim)}$ | 476 | 600  | –   | $\text{mA}$ | $R_{REF} = 0\ \Omega$   | P_5.3.7 |
| Minimum drop voltage<br>$V_{dr} = V_I - V_Q$ | $V_{dr}$     | –   | 0.35 | 0.7 | $\text{V}$  | $I_Q = 300\text{ mA}$   | P_5.3.8 |

#### PWM Input

|                              |              |     |   |     |               |                          |          |
|------------------------------|--------------|-----|---|-----|---------------|--------------------------|----------|
| PWM high level               | $V_{PWM(H)}$ | 2.6 | – | –   | $\text{V}$    | –                        | P_5.3.9  |
| PWM low level                | $V_{PWM(L)}$ | –   | – | 0.7 | $\text{V}$    | –                        | P_5.3.10 |
| PWM input current high level | $I_{PWM(H)}$ | –   | – | 10  | $\mu\text{A}$ | $V_{PWM} = 5.0\text{ V}$ | P_5.3.11 |

**Table 5 Electrical Characteristics**
 $V_I = 13.5\text{ V}$ ,  $R_{REF} = 0.47\ \Omega$ ,  $V_{PWM} = 5.0\text{ V}$ ,  $T_j = -40^\circ\text{C}$  to  $+150^\circ\text{C}$ , all voltages with respect to ground, positive current flowing into pin for input pins, positive currents flowing out of pin for output pins (unless otherwise specified)

| Parameter                             | Symbol         | Values |      |      | Unit             | Note / Test Condition  | Number   |
|---------------------------------------|----------------|--------|------|------|------------------|--|----------|
|                                       |                | Min.   | Typ. | Max. |                  |  |          |
| PWM input current low level           | $I_{PWM(L)}$   | -1     | –    | 1    | $\mu\text{A}$    | $V_{PWM} = 0.0\text{ V}$   | P_5.3.12 |
| Turn on delay time                    | $t_{PWM(on)}$  | 0      | 15   | 40   | $\mu\text{s}$    | 70% of $V_{REF}/R_{REF}$ , see <a href="#">Figure 3</a>  | P_5.3.13 |
| Turn off delay time                   | $t_{PWM(off)}$ | 0      | 15   | 40   | $\mu\text{s}$    | 30% of $V_{REF}/R_{REF}$ , see <a href="#">Figure 3</a>  | P_5.3.14 |
| <b>Reference</b>                      |                |        |      |      |                  |  |          |
| Reference voltage                     | $V_{REF}$      | 165    | 175  | 185  | mV               | $0.39\ \Omega \leq R_{REF} \leq 1.0\ \Omega$<br>$V_Q - V_{REF} = 6.6\text{ V}$                   | P_5.3.15 |
| Reference input current               | $I_{REF}$      | -1     | 0.1  | 1    | $\mu\text{A}$    | $V_{REF} = 180\text{ mV}$  | P_5.3.16 |
| <b>Status Output</b>                  |                |        |      |      |                  |  |          |
| Lower status switching threshold      | $V_{IQ(L)}$    | 15     | 25   | –    | mV               | –  | P_5.3.17 |
| Upper status switching threshold      | $V_{IQ(H)}$    | –      | 30   | 40   | mV               | –  | P_5.3.18 |
| Status low voltage                    | $V_{ST(L)}$    | –      | –    | 0.4  | V                | $I_{ST} = 1.5\text{ mA}$   | P_5.3.19 |
| Leakage current                       | $I_{ST(leak)}$ | –      | –    | 5    | $\mu\text{A}$    | $V_{ST} = 5.0\text{ V}$  | P_5.3.20 |
| <b>Status Delay</b>                   |                |        |      |      |                  |  |          |
| Status reaction delay                 | $t_{ST(HL)}$   | 6      | 10   | 14   | ms               | <sup>1)</sup> $C_D = 47\text{ nF}$<br>ST H $\rightarrow$ L                                       | P_5.3.21 |
| Status release delay                  | $t_{ST(LH)}$   | –      | 10   | 20   | $\mu\text{s}$    | <sup>1)</sup> $C_D = 47\text{ nF}$<br>ST L $\rightarrow$ H                                       | P_5.3.22 |
| <b>Protection</b>                     |                |        |      |      |                  |  |          |
| Over temperature protection threshold | $T_{j(OT)}$    | 150    | –    | –    | $^\circ\text{C}$ | <sup>1)</sup>  | P_5.3.23 |
| Reverse output current                | $-I_{Q(rev)}$  | –      | –    | 2    | $\mu\text{A}$    | <sup>1)</sup> $V_I = -16\text{ V}$<br>Output load: LED with break down voltage $< -0.6\text{ V}$ | P_5.3.27 |

1) Not subject to production test, specified by design

2)  $V_Q - V_{REF}$  equals the forward voltage sum of the connected LEDs, see [Figure 9](#)

### 5.3.1 Typical Performance Characteristics

Data below show the behavior of a typical device.

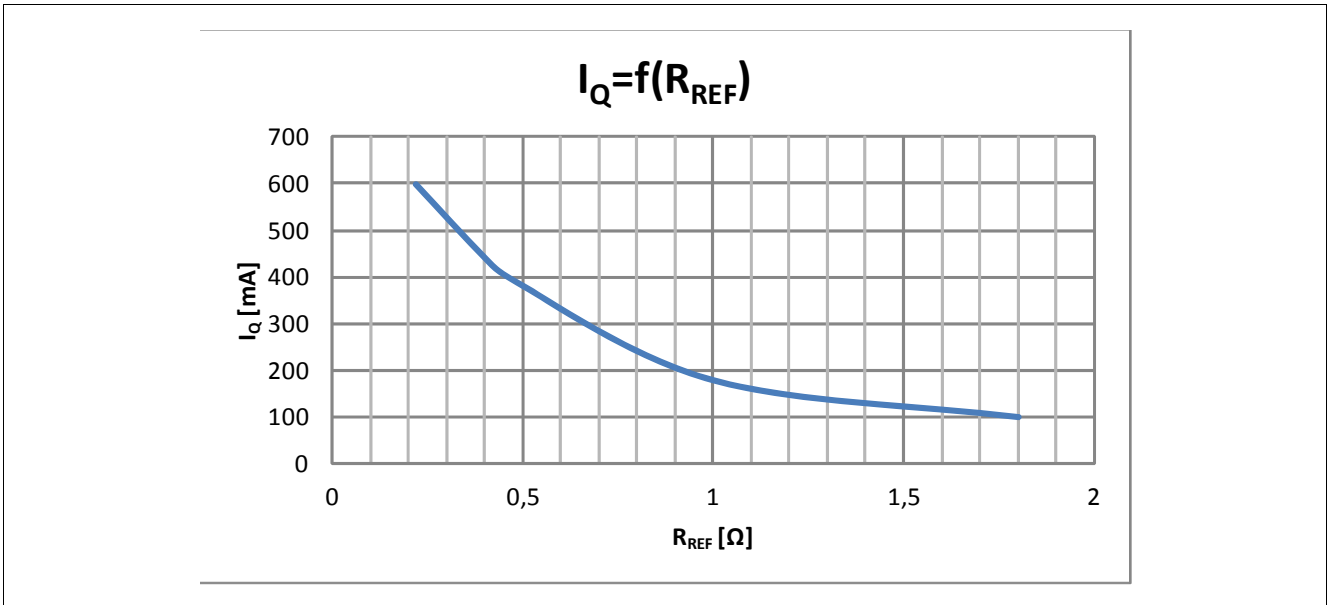


Figure 5 Output Current  $I_Q$  versus Reference Resistor  $R_{REF}$  with  $V_Q = 6.6 V$

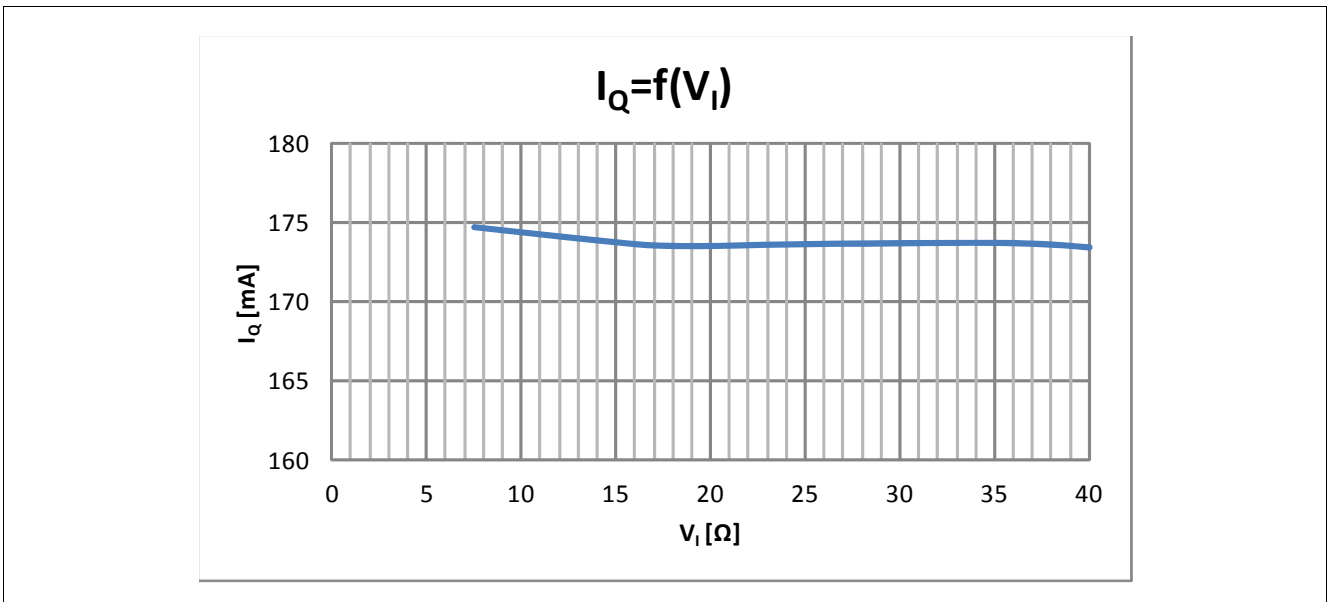


Figure 6 Output Current  $I_Q$  versus Supply Voltage  $V_I$  with  $V_Q - V_{REF} = 6.6 V$  and  $R_{REF} = 1 \Omega$

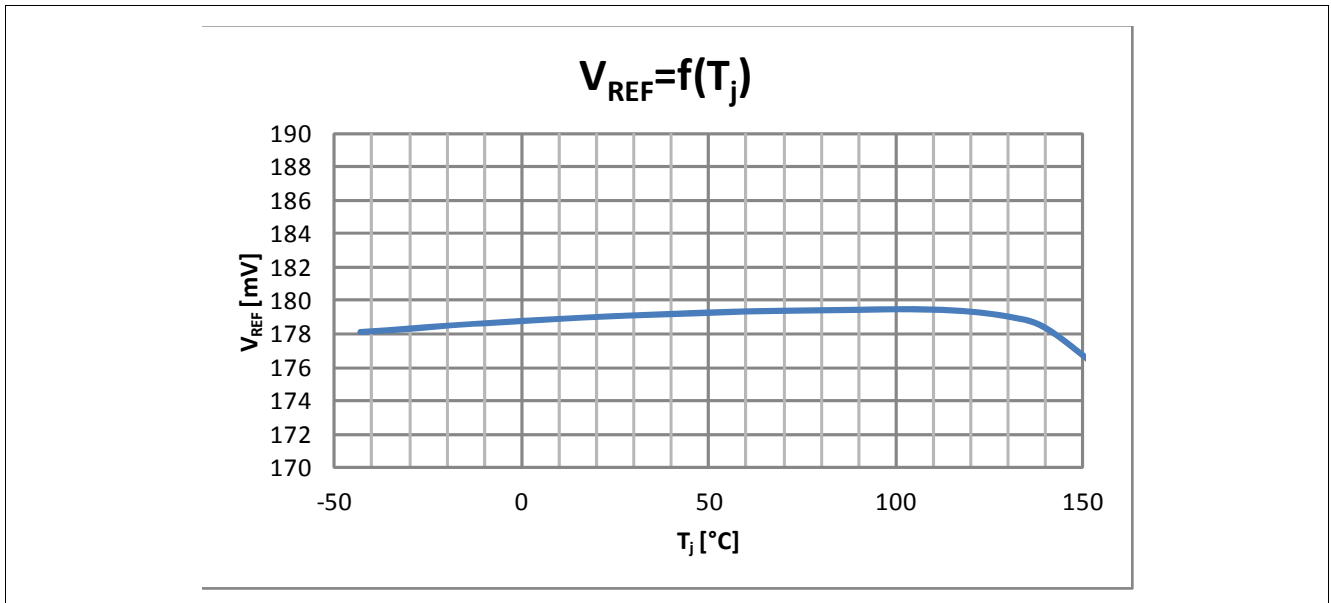


Figure 7 Reference Voltage  $V_{REF}$  versus Junction Temperature  $T_j$

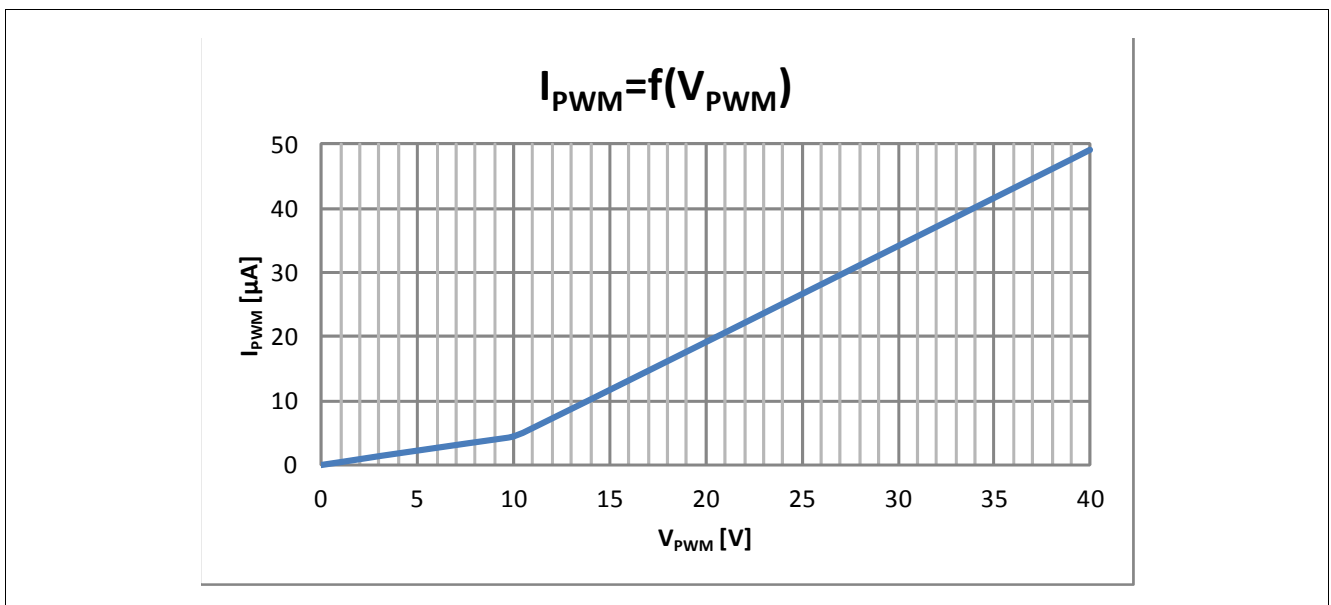


Figure 8 PWM Pin Input Current  $I_{PWM}$  versus PWM Voltage  $V_{PWM}$  at  $T_j = 25^\circ\text{C}$  and  $V_i = 13.5\text{ V}$

## 6 Application Information

Note: The following information is given as a hint for the implementation of the device only and shall not be regarded as a description or warranty of a certain functionality, condition or quality of the device.

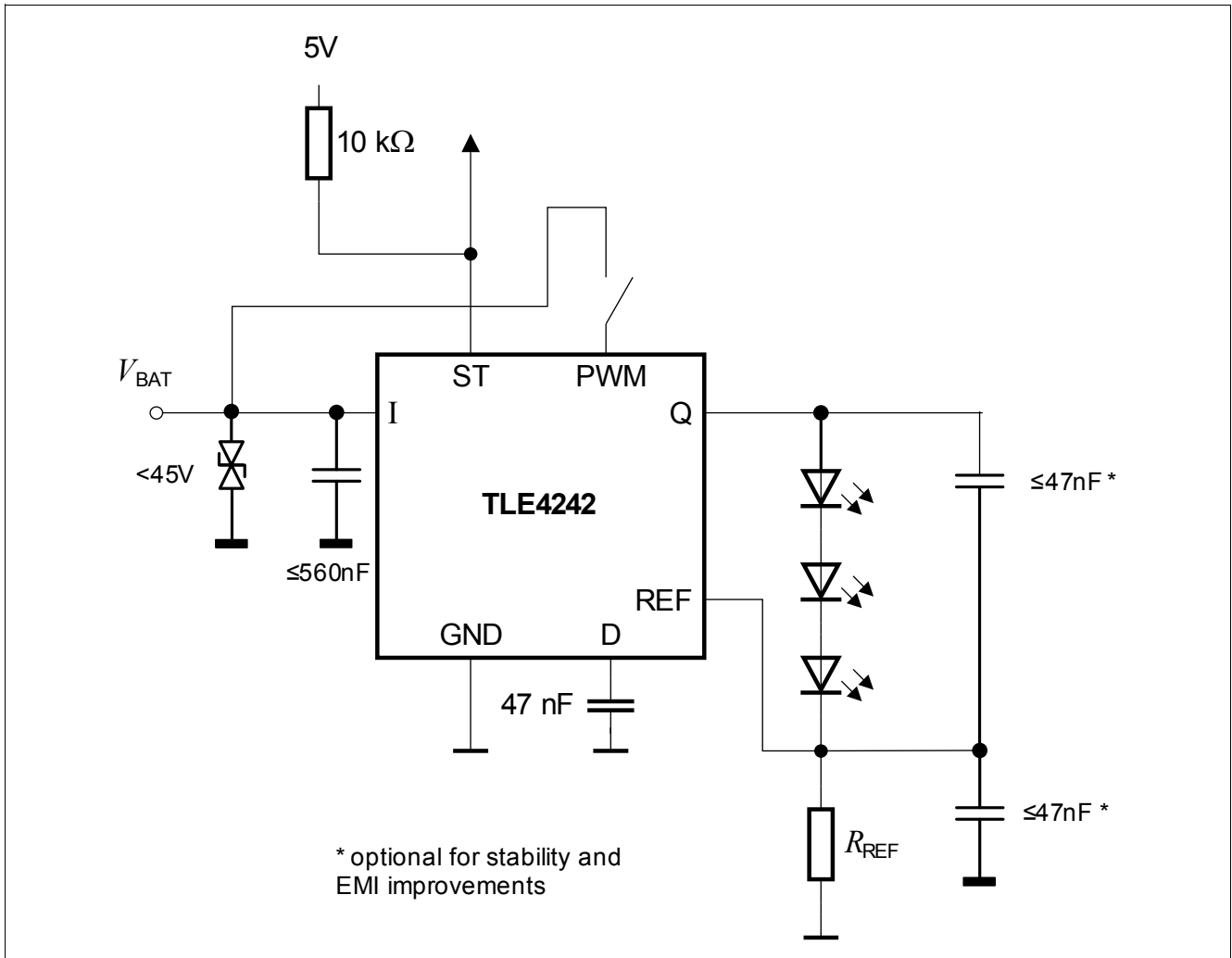


Figure 9 Application Diagram

Note: This is a very simplified example of an application circuit. The function must be verified in the real application.

### 6.1 Further Application Information

- Please contact us for information regarding the FMEA pin
- Existing App. Note: LED Driving Concepts and Infineon Basic LED Drivers
- For further information you may contact <http://www.infineon.com/>

## 7 Revision History

| Revision | Date       | Changes          |
|----------|------------|------------------|
| 1.0      | 2014-02-05 | Final data sheet |
|          |            |                  |
|          |            |                  |
|          |            |                  |

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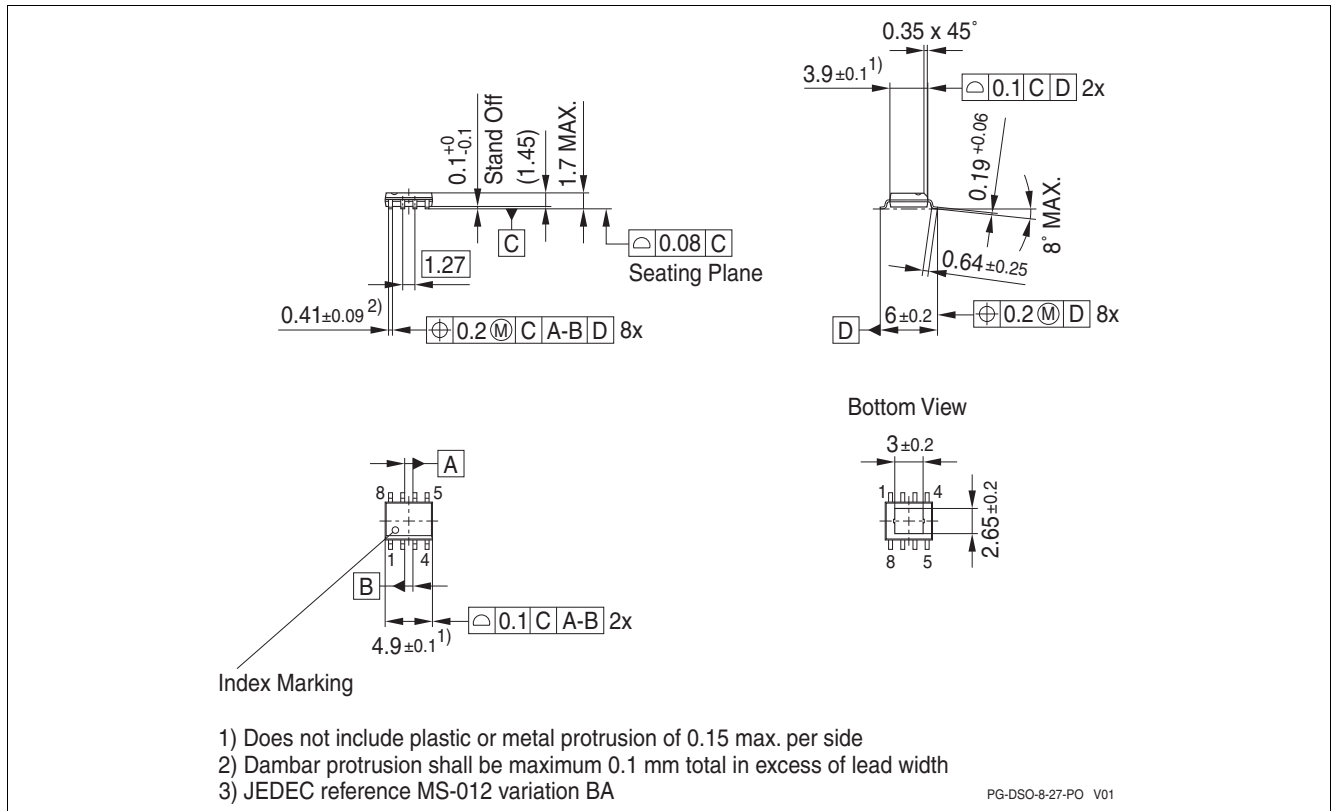
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## 8 Package Outlines



**Figure 10 PG-DSO-8-27 (Please Insert Package Long Name!)**

### Green Product (RoHS compliant)

To meet the world-wide customer requirements for environmentally friendly products and to be compliant with government regulations the device is available as a green product. Green products are RoHS-Compliant (i.e Pb-free finish on leads and suitable for Pb-free soldering according to IPC/JEDEC J-STD-020).

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