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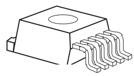
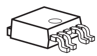
## Low Drop Voltage Regulator

## TLE 4276-2

### Features

- 5 V or variable output voltage
- Output voltage tolerance ≤ ±2%
- 400 mA current capability
- Low-drop voltage
- Inhibit input
- Very low current consumption
- Short-circuit-proof
- Reverse polarity proof
- Suitable for use in automotive electronics
- Green Product (RoHS compliant)
- AEC Qualified





| Type | Package | Marking |
|---|---|---|
| TLE 4276-2 GV50 | PG-TO263-5 | 4276-2V5 |
| TLE 4276-2 GV | PG-TO263-5 | 4276-2V |
| TLE 4276-2 DV50 | PG-TO252-5 | 4276-2V5 |
| TLE 4276-2 DV | PG-TO252-5 | 4276-2V |

## Functional Description

The TLE 4276-2 is a low-drop voltage regulator in a TO package. The IC regulates an input voltage up to 40 V to $V_{Q,nom}$ = 5.0 V (V50) or adjustable voltage (V). The maximum output current is 400 mA. The IC can be switched off via the inhibit input, which causes the current consumption to drop below 10 µA. The IC is short-circuit-proof and includes temperature protection which turns off the device at overtemperature.

## Dimensioning Information on External Components

The input capacitor $C_I$ is necessary for compensation of line influences. Using a resistor of approx. 1 Ω in series with $C_I$, the oscillating of input inductivity and input capacitance can be damped. The output capacitor $C_Q$ is necessary for the stability of the regulation circuit. Stability is guaranteed at values $C_Q \geq$ 22 µF and an ESR of ≤ 3 Ω within the operating temperature range.

## Circuit Description

The control amplifier compares a reference voltage to a voltage that is proportional to the output voltage and drives the base of the series transistor via a buffer. Saturation control as a function of the load current prevents any oversaturation of the power element. The IC also incorporates a number of internal circuits for protection against:

- Overload
- Overtemperature
- Reverse polarity

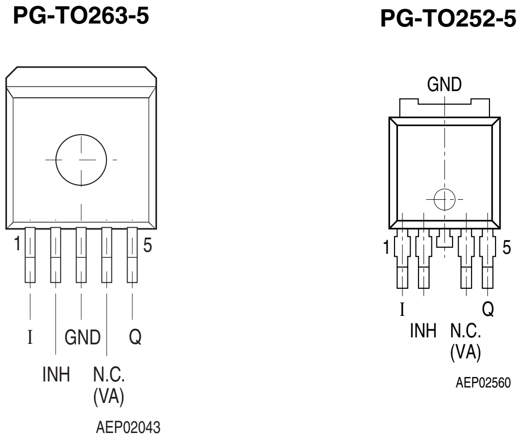



**Figure 1** **Pin Configuration** (top view)

**Table 1** **Pin Definitions and Functions**

| Pin No. | Symbol | Function |
|---|---|---|
| 1 | I | **Input;** block to ground directly at the IC with a ceramic capacitor. |
| 2 | INH | **Inhibit;** low-active input. |
| 3 | GND | **Ground** |
| 4 | N.C.<br>VA | **Not connected** for V50<br>**Voltage Adjust Input;** only for adjustable version. Connect an external voltage divider to determine the output voltage. |
| 5 | Q | **Output;** block to GND with a ≥ 22 µF capacitor, ESR ≤ 3 Ω at 10 kHz |
| Heat Tab | | Connect to GND. |

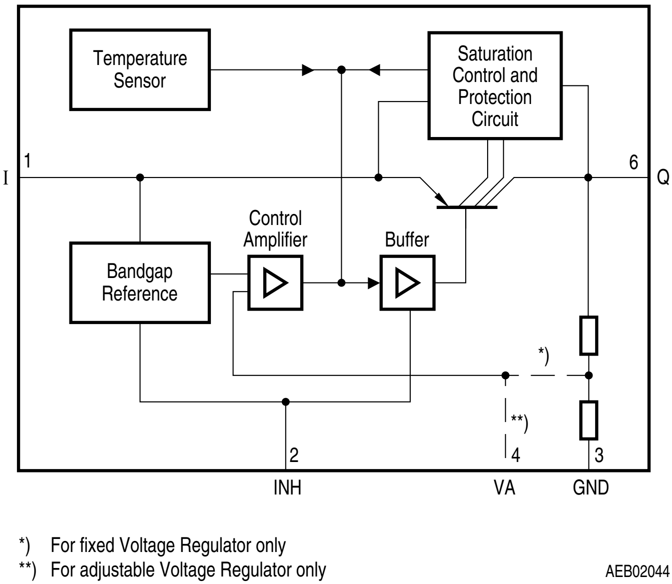



**Figure 2 Block Diagram**

**Table 2 Absolute Maximum Ratings**

| Parameter | Symbol | Limit Values | | Unit | Test Condition |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| **Input I** | | | | | |
| Voltage | $V_I$ | -42 | 45 | V | – |
| Current | $I_I$ | – | – | – | Internally limited |
| **Inhibit INH** | | | | | |
| Voltage | $V_{INH}$ | -42 | 45 | V | – |
| **Voltage Adjust Input VA** | | | | | |
| Voltage | $V_{VA}$ | -0.3 | 10 | V | – |
| **Output Q** | | | | | |
| Voltage | $V_Q$ | -1.0 | 40 | V | – |
| Current | $I_Q$ | – | – | – | Internally limited |
| **Ground GND** | | | | | |
| Current | $I_{GND}$ | – | 100 | mA | – |
| **Temperature** | | | | | |
| Junction temperature | $T_j$ | -40 | 150 | °C | – |
| Storage temperature | $T_{stg}$ | -50 | 150 | °C | – |

*Note: Maximum ratings are absolute ratings; exceeding any one of these values may cause irreversible damage to the integrated circuit.*

**Table 3 ESD Rating**

| Parameter | Symbol | Limit Values | | Unit | Notes |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| ESD Capability | $V_{ESD,HBM}$ | -2 | 2 | kV | Human Body Model |

**Table 4 Operating Range**

| Parameter | Symbol | Limit Values | | Unit | Remarks |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| Input voltage | $V_I$ | $V_Q + 0.5$ | 40 | V | Fixed voltage device V50 |
| Input voltage | $V_I$ | $V_Q + 0.5$ | 40 | V | Variable device V |
| Input voltage | $V_I$ | 4.5 V | 40 | V | Variable device V, $V_Q < 4$ V |
| Junction temperature | $T_j$ | -40 | 150 | °C | – |

**Table 5 Thermal Resistance**

| Parameter | Symbol | Limit Value | | | Unit | Conditions |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Junction to Case[1)] | $R_{thJC}$ | – | 3.0 | – | K/W | – |
| Junction to Ambient[1)] | $R_{thJA}$ | – | 78 | – | K/W | PG-TO252-5 300mm² heatsink area on PCB[2)] |
| Junction to Ambient[1)] | $R_{thJA}$ | – | 53 | – | K/W | PG-TO263-5 300mm² heatsink area on PCB[2)] |

1) not subject to production test, specified by design

2) EIA/JESD 52_2, FR4, 80 × 80 × 1.5 mm; 35µ Cu, 5µ Sn

**Table 6 Characteristics**

$V_I$ = 13.5 V; -40 °C < $T_j$ < 150 °C (unless otherwise specified)

| Parameter | Symbol | Limit Values | | | Unit | Measuring Condition | Measuring Circuit |
|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | | |
| Output voltage | $V_Q$ | 4.9 | 5.0 | 5.1 | V | V50-Version<br>5 mA < $I_Q$ < 300 mA<br>6 V < $V_I$ < 28 V | 1 |
| Output voltage | $V_Q$ | 4.8 | 5.0 | 5.2 | V | V50-Version<br>5 mA < $I_Q$ < 400 mA<br>6 V < $V_I$ < 28 V | 1 |
| Output voltage | $V_Q$ | 4.8 | 5.0 | 5.2 | V | V50-Version<br>5 mA < $I_Q$ < 200 mA<br>6 V < $V_I$ < 40 V | 1 |
| Output voltage tolerance | $\Delta V_Q$ | -2 | – | 2 | % | V-Version<br>$R_2$ < 50 kΩ<br>$V_Q$ + 1 V ≤ $V_I$ ≤ 28 V<br>$V_I$ > 4.5 V<br>5 mA ≤ $I_Q$ ≤ 300 mA | 1 |
| Output voltage tolerance | $\Delta V_Q$ | -4 | – | 4 | % | V-Version<br>$R_2$ < 50 kΩ<br>$V_Q$ + 1 V ≤ $V_I$ ≤ 40V<br>$V_I$ > 4.5 V<br>5 mA ≤ $I_Q$ ≤ 400 mA | 1 |
| Output current limitation[1)] | $I_Q$ | 400 | 600 | 1100 | mA | – | 1 |
| Current consumption; $I_q = I_I - I_Q$ | $I_q$ | – | – | 10 | µA | $V_{INH}$ = 0 V;<br>$T_j$ ≤ 100 °C | 1 |
| Current consumption; $I_q = I_I - I_Q$ | $I_q$ | – | 100 | 220 | µA | $I_Q$ = 1 mA | 1 |
| Current consumption; $I_q = I_I - I_Q$ | $I_q$ | – | 5 | 10 | mA | $I_Q$ = 250 mA | 1 |
| Current consumption; $I_q = I_I - I_Q$ | $I_q$ | – | 15 | 25 | mA | $I_Q$ = 400 mA | 1 |

**Table 6 Characteristics** (cont'd)

$V_I$ = 13.5 V; -40 °C < $T_j$ < 150 °C (unless otherwise specified)

| Parameter | Symbol | Limit Values Min. | Typ. | Max. | Unit | Measuring Condition | Measuring Circuit |
|---|---|---|---|---|---|---|---|
| Drop voltage[1] | $V_{DR}$ | – | 250 | 500 | mV | V50<br>$I_Q$ = 250 mA<br>$V_{DR} = V_I - V_Q$ | 1 |
| Drop voltage[1] | $V_{DR}$ | – | 250 | 500 | mV | variable devices<br>$I_Q$ = 250 mA<br>$V_I$ > 4.5 V<br>$V_{DR} = V_I - V_Q$ | 1 |
| Load regulation | $\Delta V_{Q,Lo}$ | – | 5 | 35 | mV | $I_Q$ = 5 mA to 400 mA | 1 |
| Line regulation | $\Delta V_{Q,Li}$ | – | 15 | 25 | mV | $\Delta V_I$ = 12 V to 32 V<br>$I_Q$ = 5 mA | 1 |
| Power supply ripple rejection | $PSRR$ | – | 54 | – | dB | $f_r$ = 100 Hz;<br>$V_r$ = 0.5 Vpp | 1 |
| Temperature output voltage drift | $dV_Q/dT$ | – | 0.5 | – | – | – | mV/K |
| **Inhibit** | | | | | | | |
| Inhibit on voltage | $V_{INH}$ | – | 2 | 3.5 | V | $V_Q \geq 4.9$ V | 1 |
| Inhibit off voltage | $V_{INH}$ | 0.5 | 1.7 | – | V | $V_Q \leq 0.1$ V | 1 |
| Input current | $I_{INH}$ | 5 | 10 | 20 | µA | $V_{INH}$ = 5 V | 1 |

1) Measured when the output voltage $V_Q$ has dropped 100 mV from the nominal value obtained at $V_I$ = 13.5 V.

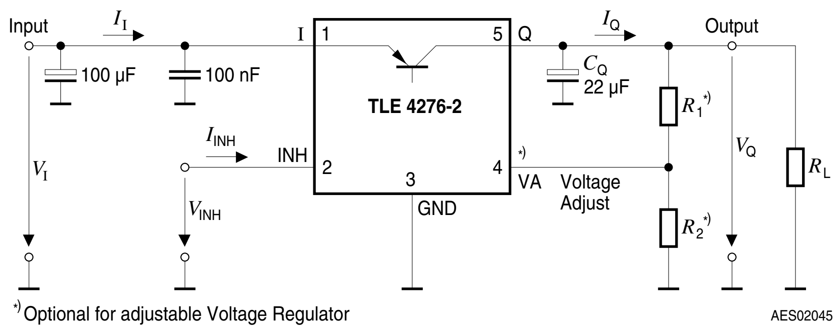



**Figure 3 Measuring Circuit**

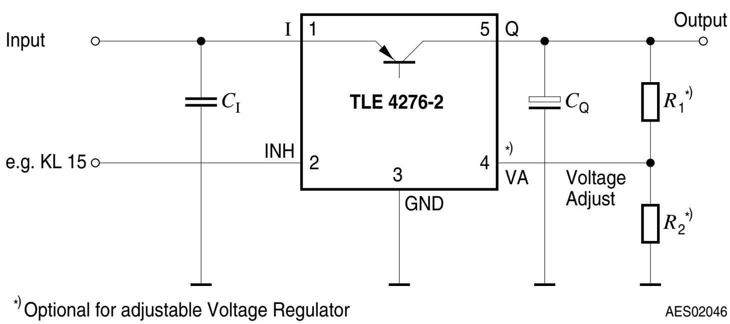



**Figure 4 Application Circuit**

## Application Information for Variable Output Regulator TLE 4276-2 DV, GV

The output voltage of the TLE 4276-2 DV, GV can be adjusted between 2.5 V and 20 V by an external output voltage divider, closing the control loop to the voltage adjust pin VA.

The voltage at pin VA is compared to the internal reference of typical 2.5 V in an error amplifier. It controls the output voltage.

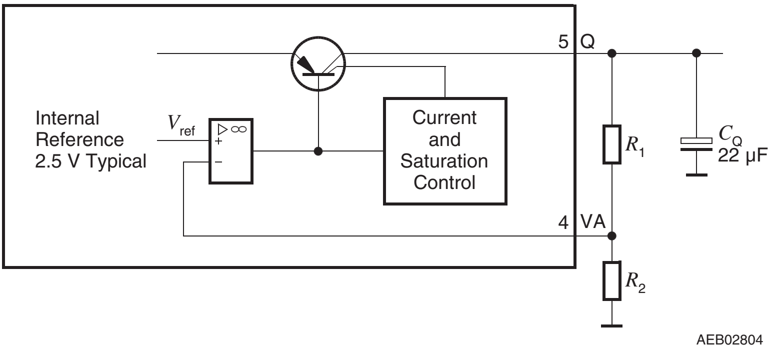



**Figure 5 Application Detail External Components at Output for Variable Voltage Regulator**

The output voltage is calculated according to **Equation (1)**:

$$V_Q = (R_1 + R_2)/R_2 \times V_{ref}, \text{ neglecting } I_{VA} \tag{1}$$

$V_{ref}$ is typically 2.5 V.

To avoid errors caused by leakage current $I_{VA}$, we recommend to choose the resistor value $R_2$ according to **Equation (2)**:

$$R_2 < 50\ \text{k}\Omega \tag{2}$$

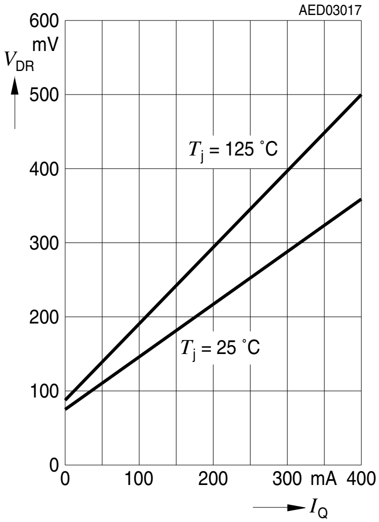
For a 2.5 V output voltage the output pin Q is directly connected to the adjust pin VA.

The accuracy of the resistors $R_1$ and $R_2$ add an additional error to the output voltage tolerance.

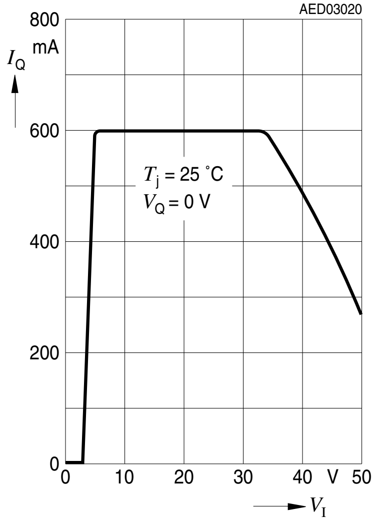
The operation range of the variable TLE 4276-2 DV, GV is $V_Q$ + 0.5 V to 40 V. For internal biasing a minimum input voltage of 4.3 V is required. For output voltages below 4 V the voltage drop is 4.3 V - $V_Q$

## Typical Performance Characteristics V50:

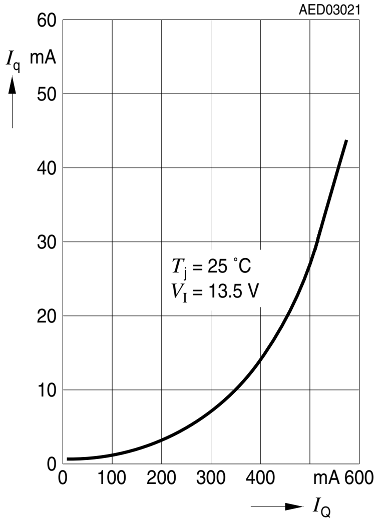
### Voltage $V_{DR}$ versus Output Current $I_Q$



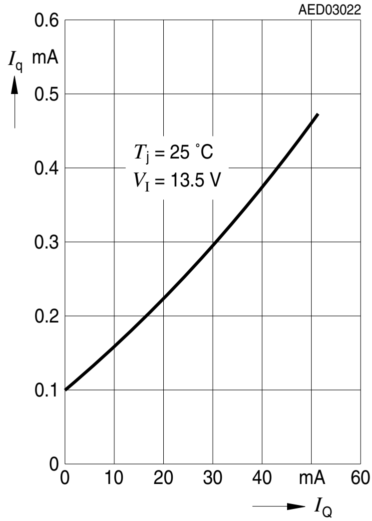

### Max. Output Current $I_Q$ versus Input Voltage $V_I$




### Current Consumption $I_q$ versus Output Current $I_Q$ (high load)

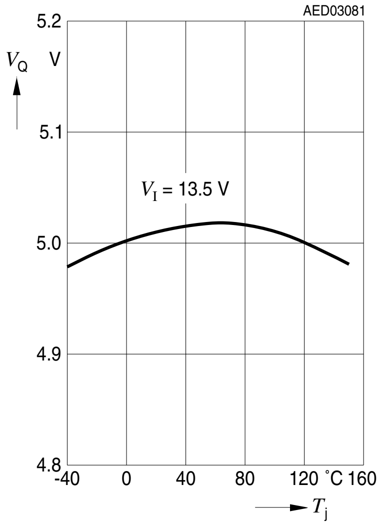



### Current Consumption $I_q$ versus Output Current $I_Q$ (low load)

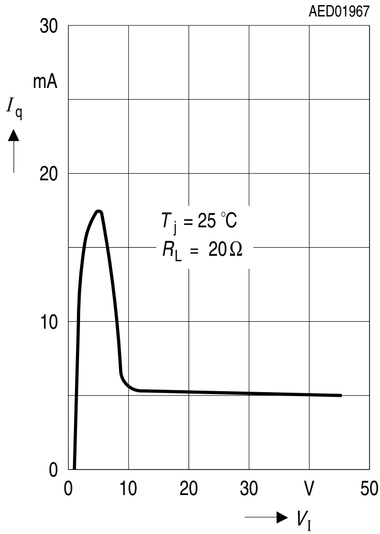


## Typical Performance Characteristics for V50:

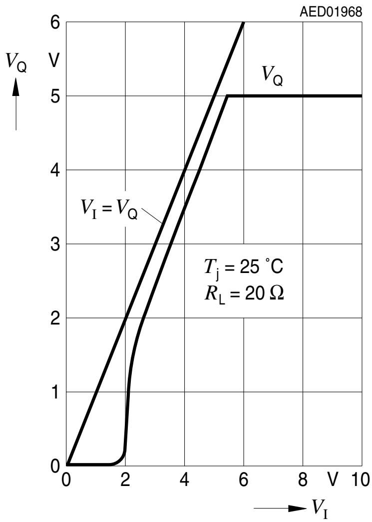
### Output Voltage $V_Q$ versus Temperature $T_j$



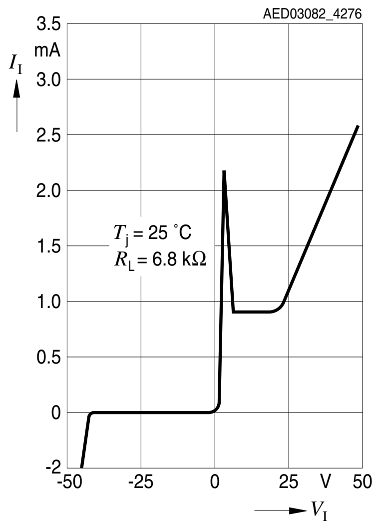

### Current Consumption $I_q$ versus Input Voltage $V_I$




### Low Voltage Behavior




### High Voltage Behavior



## Package Outlines

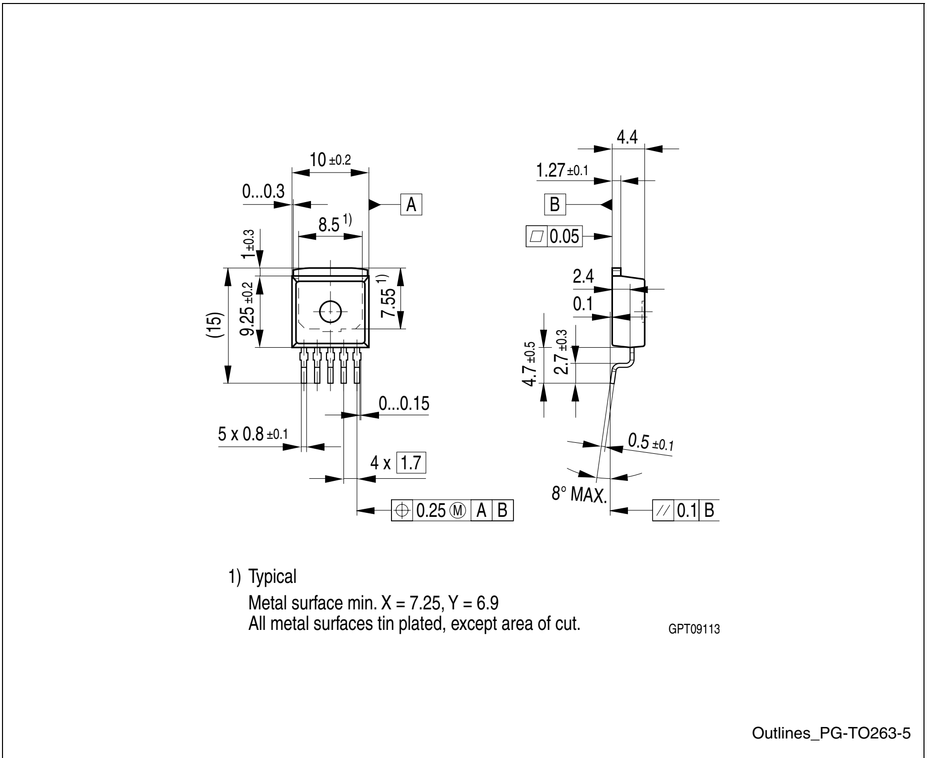



**Figure 6** **PG-TO263-5** (Plastic Green Transistor Single Outline)

**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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SMD = Surface Mounted Device

Dimensions in mm

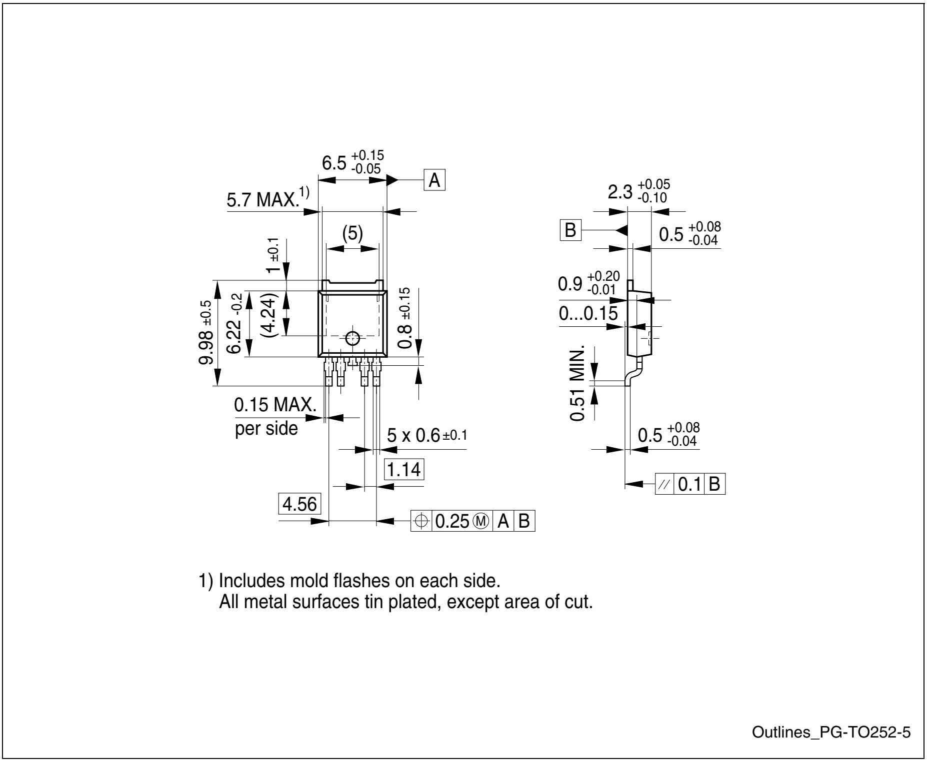


**Figure 7** **PG-TO252-5** (Plastic Green Transistor Single Outline)

**Green Product** (RoHS compliant)

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SMD = Surface Mounted Device

Dimensions in mm

| Version | Date | Changes |
|---|---|---|
| Rev. 1.0 | 2007-08-07 | First Version Data Sheet |
| Rev. 1.1 | 2007-09-21 | Second Version Data Sheet |

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