

# TLF80511

Low Dropout Linear Fixed Voltage Regulator

TLF80511TC

## Data Sheet

Rev. 1.01, 2016-06-21

Automotive Power



## 1 Overview

### Features

- Output Voltage 5 V
- Output Voltage Precision  $\pm 2\%$
- Output Current up to 400 mA
- Ultra Low Current Consumption 38  $\mu\text{A}$
- Very Low Dropout Voltage: 100 mV at 100 mA Output Current
- Extended Operating Range Starting at 3.3 V
- Small Output Capacitor 1  $\mu\text{F}$
- Output Current Limitation
- Overtemperature Shutdown
- Suitable for Use in Automotive Electronics
- Wide Temperature Range from  $-40\text{ }^\circ\text{C}$  up to  $150\text{ }^\circ\text{C}$
- Green Product (RoHS compliant)
- AEC Qualified



**PG-TO263-3**

### Description

The TLF80511 is a linear low dropout voltage regulator for load currents up to 400 mA. An input voltage of up to 40 V is regulated to  $V_{Q,nom} = 5\text{ V}$  with  $\pm 2\%$  precision.

The TLF80511 with a typical quiescent current of 38  $\mu\text{A}$ , is the ideal solution for systems requiring very low operating currents, such as those permanently connected to a battery.

It features a very low dropout voltage of 100 mV, when the output current is less than 100 mA. In addition, the dropout region begins at input voltages of 3.3 V (extended operating range). This makes the TLF80511 suitable to supply automotive systems.

In addition, the TLF80511's new fast regulation concept requires only a single, 1  $\mu\text{F}$  output capacitor to maintain stable regulation.

The device is designed for the harsh environment of automotive applications. Therefore standard features like output current limitation and overtemperature shutdown are implemented and protect the device against failures like output short circuit to GND, over-current and over-temperatures. The TLF80511 can be also used in all other applications requiring a stabilized 5 V supply voltage.

| Type       | Package    | Marking  |
|------------|------------|----------|
| TLF80511TC | PG-TO263-3 | TLF80511 |

## 2 Block Diagram

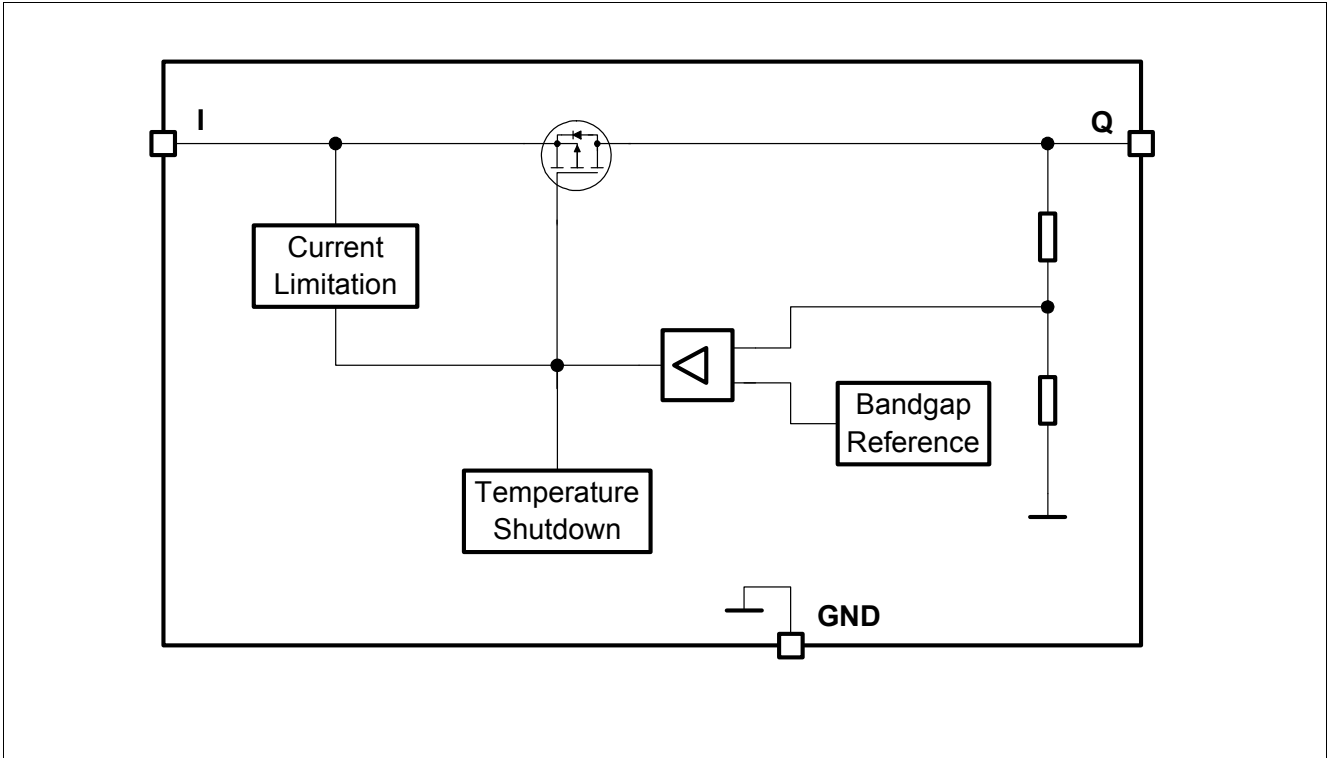


Figure 1 Block Diagram

### 3 Pin Configuration

#### 3.1 Pin Assignment PG-TO263-3

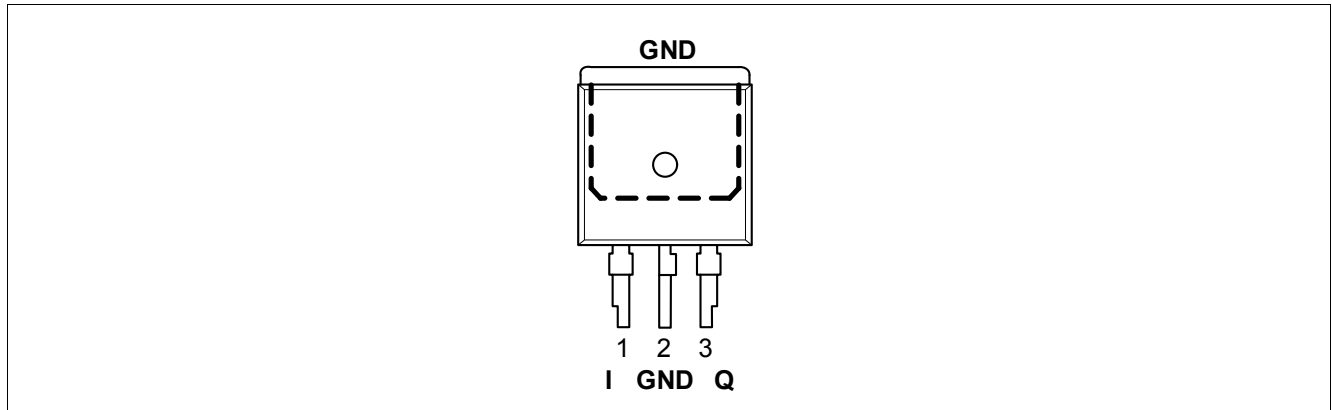


Figure 2 Pin Configuration

#### 3.2 Pin Definitions and Functions PG-TO263-3

| Pin | Symbol | Function  |
|-----|--------|---|
| 1   | I      | <b>Input</b><br>for compensating line influences, a capacitor to GND close to the IC terminals is recommended   |
| 2   | GND    | <b>Ground</b>   |
| 3   | Q      | <b>Output</b><br>block to GND with a capacitor close to the IC terminals, respecting the values given for its capacitance $C_Q$ and ESR in the table <a href="#">“Functional Range” on Page 6</a> |
| Tab | GND    | <b>Heat Slug</b><br>connect to heatsink area;<br>connect with GND on PCB  |

## 4 General Product Characteristics

### 4.1 Absolute Maximum Ratings

#### Absolute Maximum Ratings <sup>1)</sup>

-40 °C ≤  $T_j$  ≤ 150 °C; all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

| Pos.                  | Parameter            | Symbol        | Limit Values |      | Unit | Conditions                              |
|-----------------------|----------------------|---------------|--------------|------|------|---|
|                       |                      |               | Min.         | Max. |      |   |
| <b>Input I</b>        |                      |               |              |      |      |   |
| 4.1.1                 | Voltage              | $V_I$         | -0.3         | 45   | V    | –                                       |
| <b>Output Q</b>       |                      |               |              |      |      |   |
| 4.1.2                 | Voltage              | $V_Q$         | -0.3         | 7    | V    | –                                       |
| <b>Temperature</b>    |                      |               |              |      |      |   |
| 4.1.3                 | Junction Temperature | $T_j$         | -40          | 150  | °C   | –                                       |
| 4.1.4                 | Storage Temperature  | $T_{stg}$     | -50          | 150  | °C   | –                                       |
| <b>ESD Absorption</b> |                      |               |              |      |      |   |
| 4.1.5                 | ESD Absorption       | $V_{ESD,HBM}$ | -4           | 4    | kV   | Human Body Model (HBM) <sup>2)</sup>    |
| 4.1.6                 |                      | $V_{ESD,CDM}$ | -1.5         | 1.5  | kV   | Charge Device Model (CDM) <sup>3)</sup> |

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

2) ESD HBM Test according AEC-Q100-002 - JESD22-A114 (1.5kOhm, 100pF)

3) ESD CDM Test according ESDA STM5.3.1

*Note: 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.*

*Note: 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

| Pos.  | Parameter                                     | Symbol      | Limit Values         |      | Unit | Conditions      |
|-------|---|-------------|----------------------|------|------|-----------------|
|       |   |             | Min.                 | Max. |      |                 |
| 4.2.1 | Input Voltage Range for Normal Operation      | $V_I$       | $V_{Q,nom} + V_{dr}$ | 40   | V    | –               |
| 4.2.2 | Extended Input Voltage Range                  | $V_{I,ext}$ | 3.3                  | 40   | V    | – <sup>1)</sup> |
| 4.2.3 | Output Capacitor's Requirements for Stability | $C_Q$       | 1                    | –    | μF   | – <sup>2)</sup> |
|       |   | $ESR(C_Q)$  | –                    | 5    | Ω    | – <sup>3)</sup> |
| 4.2.4 | Junction Temperature                          | $T_j$       | -40                  | 150  | °C   | –               |

1) Between min. value and  $V_{Q,nom} + V_{dr}$ :  $V_Q = V_I - V_{dr}$ . Below min. value:  $V_Q = 0$  V

2) the minimum output capacitance requirement is applicable for a worst case capacitance tolerance of 30%

3) relevant ESR value at  $f = 10$  kHz

*Note: Within the functional range the IC operates as described in the circuit description. The electrical characteristics are specified within the conditions given in the related 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).*

| Pos.                               | Parameter                         | Symbol     | Limit Values |      |      | Unit | Conditions   |
|------------------------------------|-----------------------------------|------------|--------------|------|------|------|--|
|                                    |                                   |            | Min.         | Typ. | Max. |      |  |
| <b>Package Versions PG-TO263-3</b> |                                   |            |              |      |      |      |  |
| 4.3.1                              | Junction to Case <sup>1)</sup>    | $R_{thJC}$ | –            | 4    | –    | K/W  | –  |
| 4.3.2                              | Junction to Ambient <sup>1)</sup> | $R_{thJA}$ | –            | 22   | –    | K/W  | <sup>2)</sup>  |
| 4.3.3                              |                                   |            | –            | 65   | –    | K/W  | footprint only <sup>3)</sup>                           |
| 4.3.4                              |                                   |            | –            | 39   | –    | K/W  | 300 mm <sup>2</sup> heatsink area on PCB <sup>3)</sup> |
| 4.3.5                              |                                   |            | –            | 33   | –    | K/W  | 600 mm <sup>2</sup> heatsink area on PCB <sup>3)</sup> |

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 x 114.3 x 1.5 mm<sup>3</sup> board with 2 inner copper layers (2 x 70μm Cu, 2 x 35μm Cu). Where applicable a thermal via array under the exposed pad contacted the first inner copper layer.

3) Specified  $R_{thJA}$  value is according to JEDEC JESD 51-3 at natural convection on FR4 1s0p board; The Product (Chip+Package) was simulated on a 76.2 x 114.3 x 1.5 mm<sup>3</sup> board with 1 copper layer (1 x 70μm Cu).

## 5 Block Description and Electrical Characteristics

### 5.1 Voltage Regulation

The output voltage  $V_Q$  is divided by a resistor network. This fractional voltage is compared to an internal voltage reference and drives the pass transistor accordingly.

The control loop stability depends on the output capacitor  $C_Q$ , the load current, the chip temperature and the internal circuit design. To ensure stable operation, the output capacitor's capacitance and its equivalent series resistor ESR requirements given in [Table 4.2 "Functional Range" on Page 6](#) must be maintained. For details see the typical performance graph "[Stability Region: Equivalent Serial Resistor ESR versus Output Current IQ](#)" on [Page 12](#). Since the output capacitor is used to buffer load steps, it should be sized according to the application's needs.

An input capacitor  $C_I$  is not required for stability, but is recommended to compensate line fluctuations. An additional reverse polarity protection diode and a combination of several capacitors for filtering should be used. Connect the capacitors close to the regulator terminals.

Whenever the load current exceeds the specified limit, e.g. in case of a short circuit, the output current is limited and the output voltage decreases.

The overtemperature shutdown circuit prevents the IC from immediate destruction under fault conditions (e.g. output continuously short-circuited) by switching off the power stage. After the chip has cooled, the regulator restarts. This oscillatory thermal behaviour causes the junction temperature to exceed the 150° C maximum and significantly reducing the IC's life.

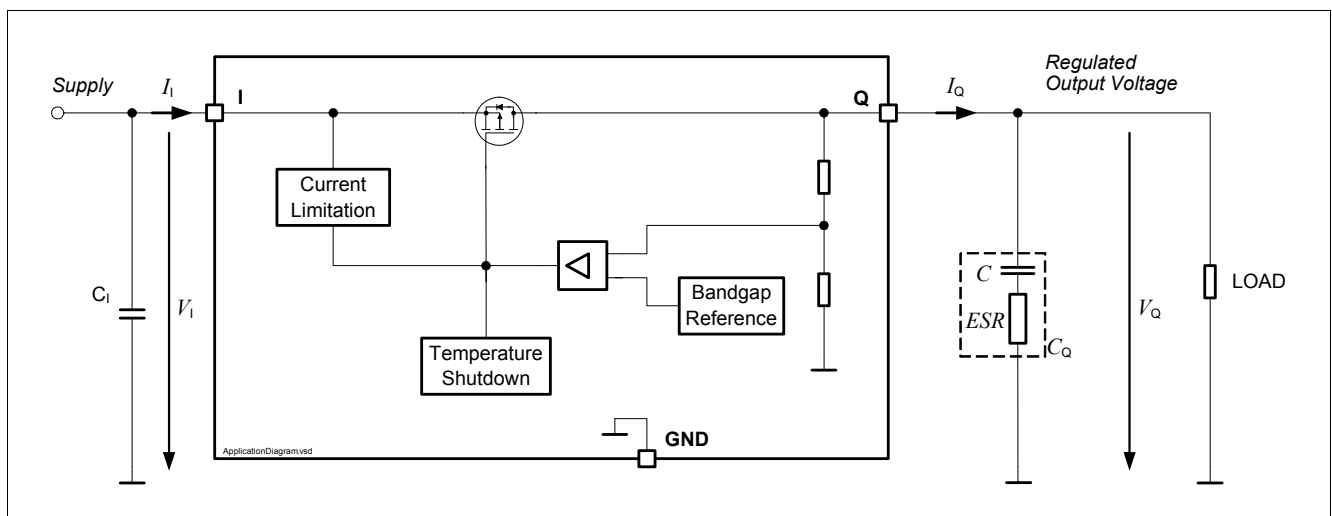


Figure 3 Block Diagram Voltage Regulation

## Block Description and Electrical Characteristics

**Electrical Characteristics Voltage Regulator 5 V version**

$V_I = 13.5\text{ V}$ ,  $-40\text{ °C} \leq T_j \leq 150\text{ °C}$ , all voltages with respect to ground, positive current flowing into pin (unless otherwise specified)

| Pos.  | Parameter   | Symbol                | Limit Values |      |      | Unit | Conditions   |
|-------|---|-----------------------|--------------|------|------|------|--|
|       |   |                       | Min.         | Typ. | Max. |      |  |
| 5.1.1 | Output Voltage Precision                              | $V_Q$                 | 4.9          | 5.0  | 5.1  | V    | $0.05\text{ mA} < I_Q < 400\text{ mA}$<br>$6\text{ V} < V_I < 28\text{ V}$   |
| 5.1.2 | Output Voltage Precision                              | $V_Q$                 | 4.9          | 5.0  | 5.1  | V    | $0.05\text{ mA} < I_Q < 200\text{ mA}$<br>$5.5\text{ V} < V_I < 40\text{ V}$ |
| 5.1.3 | Output Current Limitation                             | $I_{Q,max}$           | 401          | 600  | 900  | mA   | $0\text{ V} < V_Q < 4.8\text{ V}$  |
| 5.1.4 | Load Regulation steady-state                          | $ \Delta V_{Q,load} $ | –            | 20   | 50   | mV   | $I_Q = 0.05\text{ mA}$ to $400\text{ mA}$<br>$V_I = 6\text{ V}$              |
| 5.1.5 | Line Regulation steady-state                          | $ \Delta V_{Q,line} $ | –            | 10   | 30   | mV   | $V_I = 8\text{ V}$ to $32\text{ V}$<br>$I_Q = 5\text{ mA}$                   |
| 5.1.6 | Dropout Voltage <sup>1)</sup><br>$V_{dr} = V_I - V_Q$ | $V_{dr}$              | –            | 250  | 500  | mV   | $I_Q = 250\text{ mA}$  |
|       |   |                       | –            | 100  | 200  | mV   | $I_Q = 100\text{ mA}$  |
| 5.1.7 | Power Supply Ripple Rejection <sup>2)</sup>           | $PSRR$                | –            | 55   | –    | dB   | $f_{ripple} = 100\text{ Hz}$<br>$V_{ripple} = 0.5\text{ Vpp}$                |
| 5.1.8 | Overtemperature Shutdown Threshold                    | $T_{j,sd}$            | 151          | 175  | 200  | °C   | $T_j$ increasing <sup>2)</sup>   |
| 5.1.9 | Overtemperature Shutdown Threshold Hysteresis         | $T_{j,sdh}$           | –            | 15   | –    | K    | $T_j$ decreasing <sup>2)</sup>   |

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

2) Not subject to production test, specified by design



## 5.2 Current Consumption

### Electrical Characteristics Current Consumption

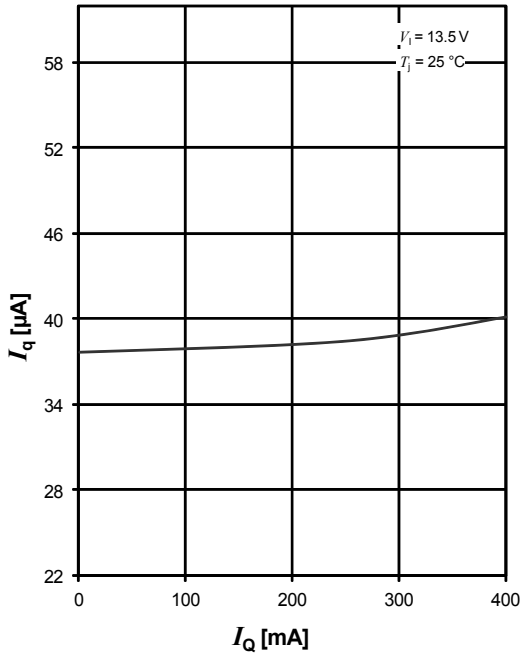
$V_I = 13.5\text{ V}$ ,  $-40\text{ °C} \leq T_j \leq 150\text{ °C}$ , positive current flowing into pin  
(unless otherwise specified)

| Pos.  | Parameter                                | Symbol | Limit Values |      |      | Unit          | Conditions  |
|-------|--|--------|--------------|------|------|---------------|---|
|       |  |        | Min.         | Typ. | Max. |               |   |
| 5.2.1 | Current Consumption<br>$I_q = I_I - I_Q$ | $I_q$  | –            | 38   | 46   | $\mu\text{A}$ | $I_Q = 0.05\text{ mA}$<br>$T_j < 25\text{ °C}$      |
| 5.2.2 |  |        | –            | –    | 75   | $\mu\text{A}$ | $I_Q = 0.05\text{ mA}$<br>$T_j < 125\text{ °C}$     |
| 5.2.3 |  |        | –            | 67   | 80   | $\mu\text{A}$ | $I_Q = 400\text{ mA}$<br>$T_j < 125\text{ °C}^{1)}$ |

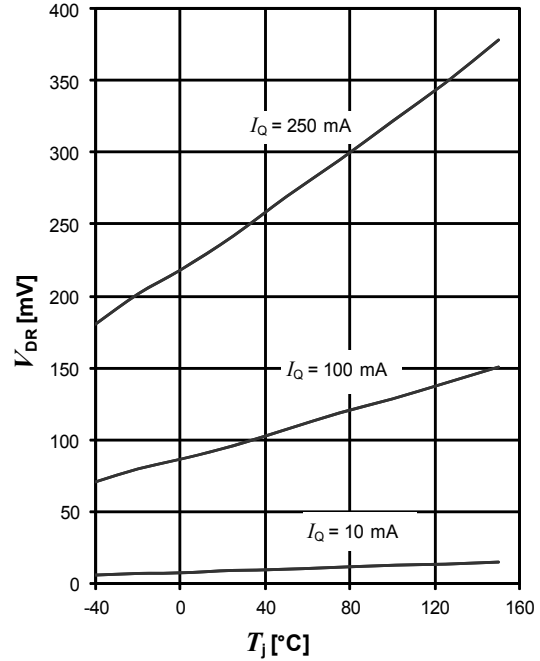
1) Not subject to production test, specified by design.

### 5.3 Typical Performance Characteristics Voltage Regulator

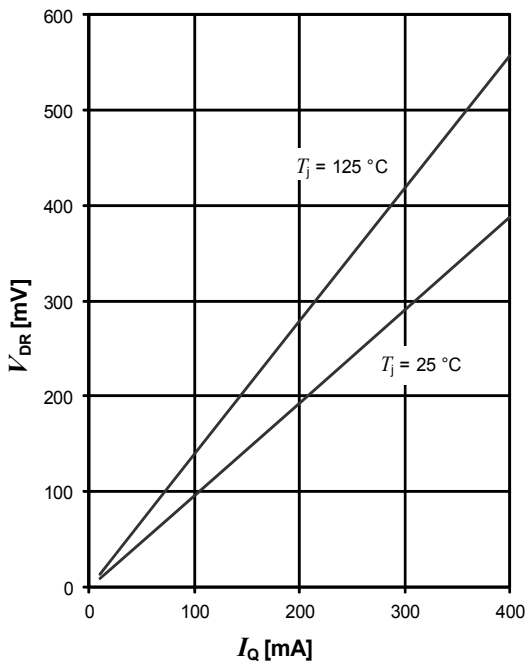
**Current Consumption  $I_q$  versus Output Current  $I_Q$**



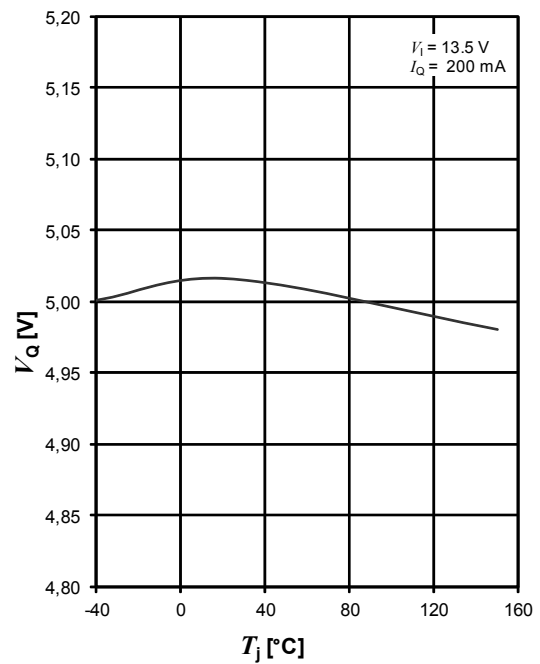
**Dropout Voltage  $V_{dr}$  versus Junction Temperature  $T_j$**



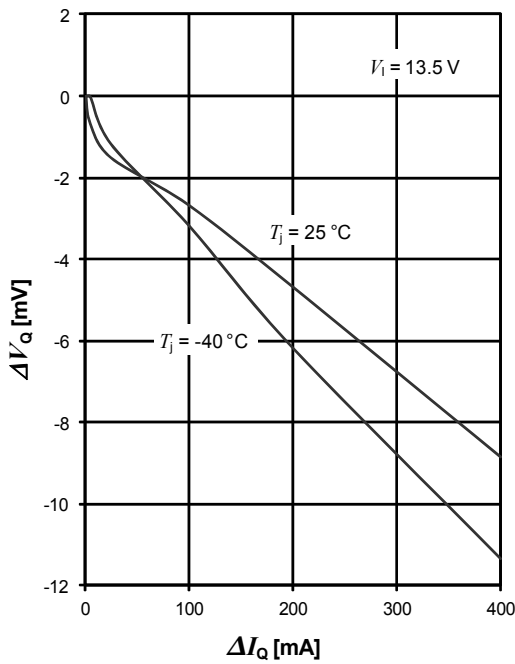
**Dropout Voltage  $V_{dr}$  versus Output Current  $I_Q$**



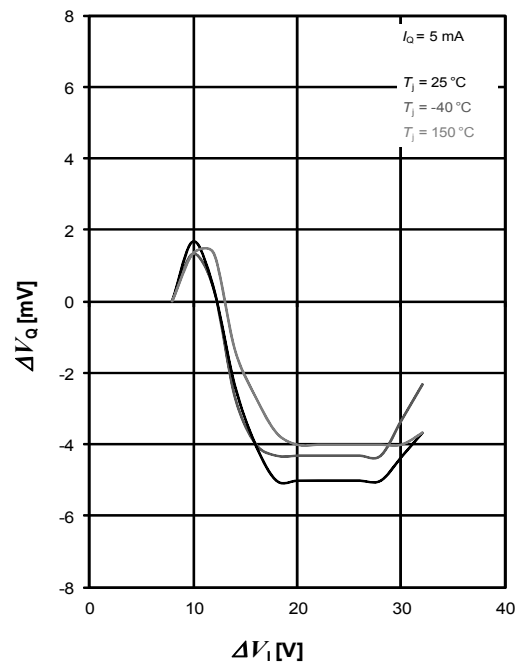
**Output Voltage  $V_Q$  versus Junction Temperature  $T_j$**



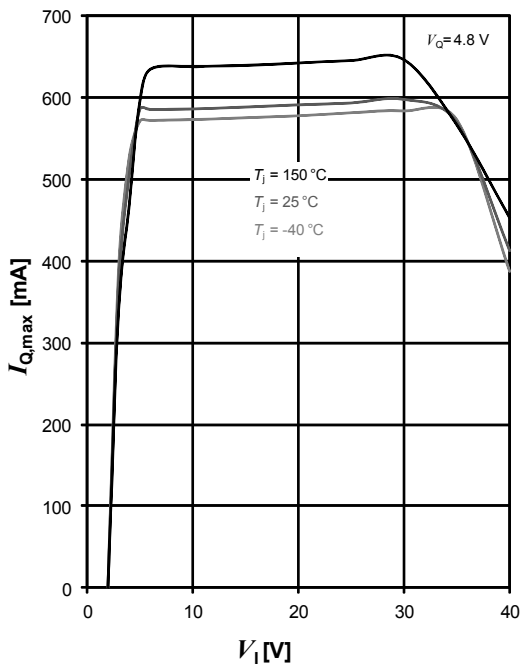
Output Voltage  $\Delta V_Q$  versus Output Current  $\Delta I_Q$



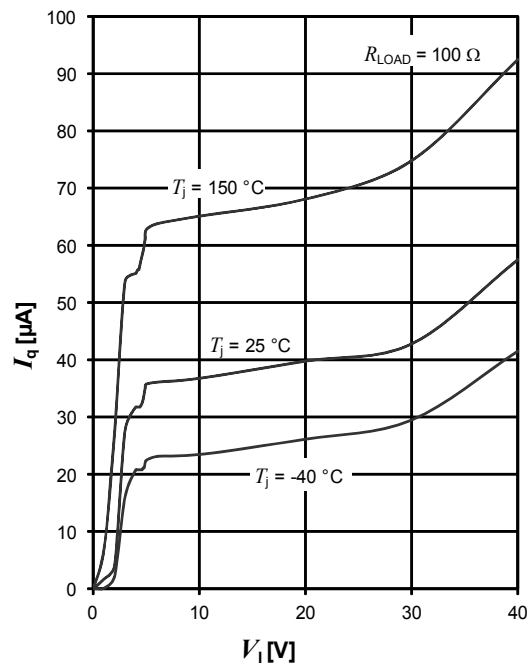
Output Voltage  $\Delta V_Q$  versus Input Voltage  $\Delta V_I$



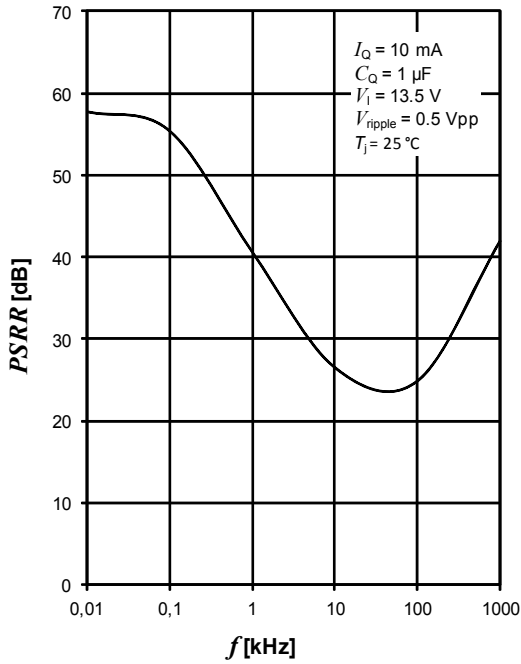
Maximum Output Current  $I_{Q,max}$  versus Input Voltage  $V_I$



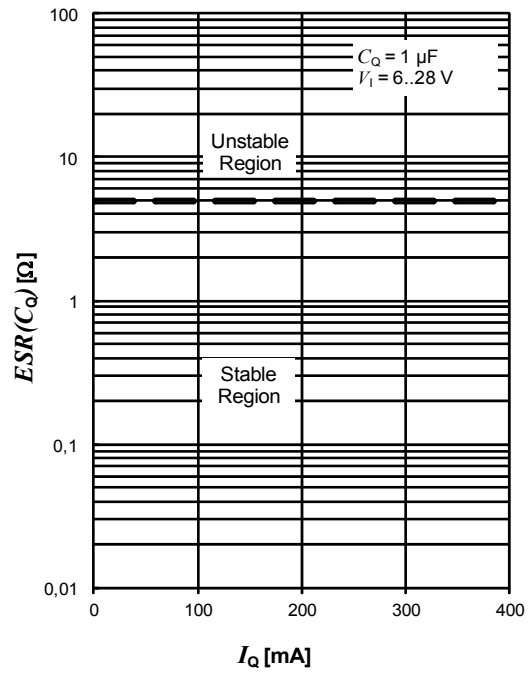
Current Consumption  $I_Q$  versus Input Voltage  $V_I$



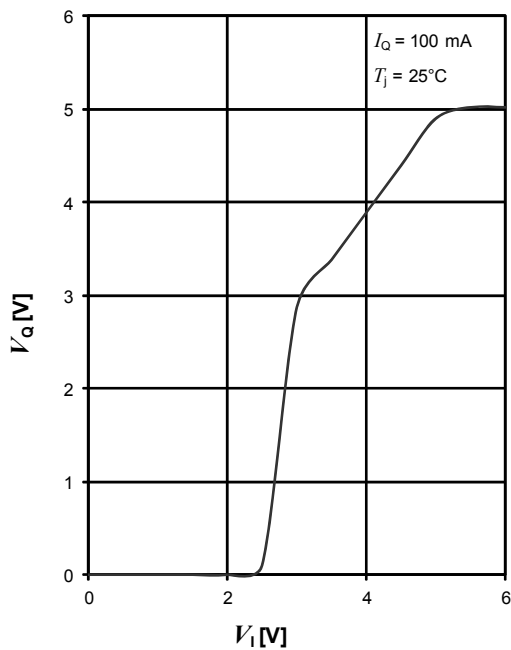
**Power Supply Ripple Rejection versus Frequency**



**Stability Region: Equivalent Serial Resistor  $ESR$  versus Output Current  $I_Q$**



**Output Voltage  $V_Q$  versus Input Voltage  $V_I$**



## 6 Package Outlines

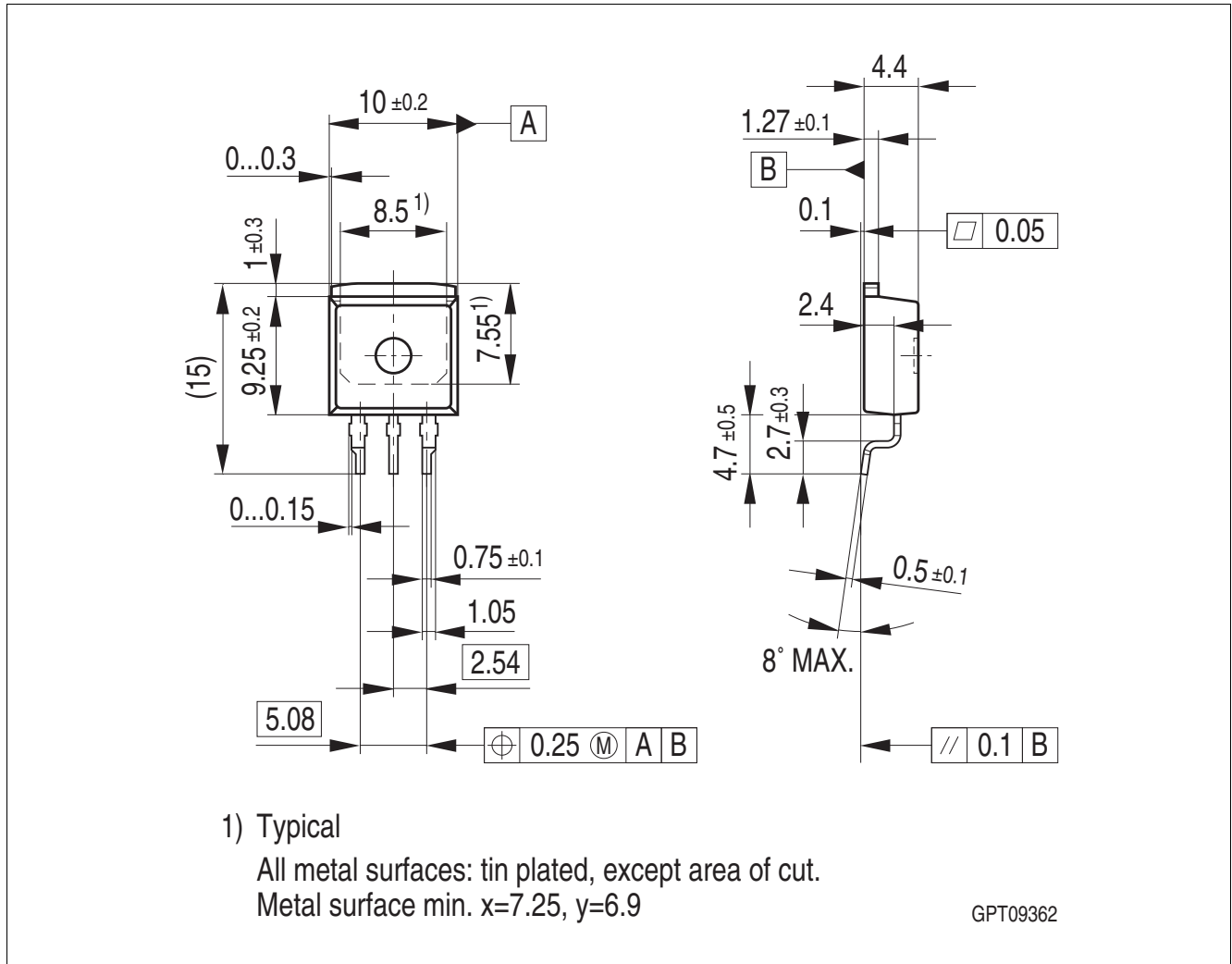


Figure 4 PG-TO263-3

## 7 Revision History

| Revision | Date       | Changes   |
|----------|------------|---|
| 1.01     | 2016-06-21 | Editorial change: corrected page number<br>Updated disclaimer |
| 1.0      | 2012-06-15 | Data Sheet - Initial Version                                  |

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