# TLE42664

Low Dropout Fixed Voltage Regulator

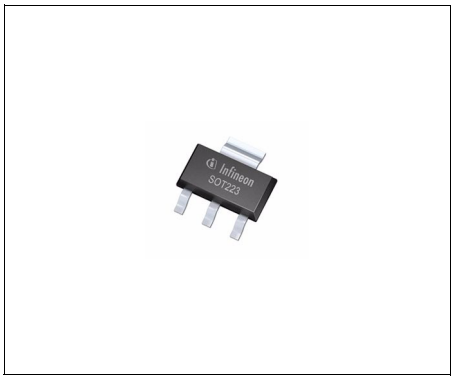
TLE42664G

## Data Sheet

Rev. 1.1, 2014-07-03

## Automotive Power

# 1 Overview



PG-SOT223-4

### Features

- Output Voltage 5 V ± 2 % up to Output Currents of 50 mA
- Output Voltage 5 V ± 3 % up to Output Currents 100 mA
- Very Low Dropout Voltage
- Very Low Current Consumption: typ. 40 µA
- Enable Input
- Output Current Limitation
- Reverse Polarity Protection
- Overtemperature Shutdown
- Wide Temperature Range From -40 °C up to 150 °C
- Suitable for Use in Automotive Electronics
- Green Product (RoHS compliant)
- AEC Qualified

### Description

The TLE42664 is a monolithic integrated low dropout fixed voltage regulator for load currents up to 100 mA. It is the 1-to-1 replacement product for the TLE4266-2. It is functional compatible to the TLE4266, but has a reduced quiescent current of typ. 40 µA. The TLE42664 is especially designed for applications requiring very low standby currents, e.g. with a permanent connection to the car's battery. It can be disabled/enabled by the integrated EN pin. The device is available in the small surface mounted PG-SOT223-4 package and is pin compatible to the TLE4266-2 and the TLE4266. The device is designed for the harsh environment of automotive applications. Therefore it is protected against overload, short circuit and overtemperature conditions by the implemented output current limitation and the overtemperature shutdown circuit. The TLE42664 can be also used in all other applications requiring a stabilized 5 V voltage.

An input voltage up to 45 V is regulated to $V_{Q,nom}$ = 5 V with a precision of ±3 %. An accuracy of ±2 % is kept for load currents up to 50 mA. A logical "HIGH" at the ENABLE pin enables the device.

| Type | Package | Marking |
|---|---|---|
| TLE42664G | PG-SOT223-4 | 42664 |

# 2 Block Diagram

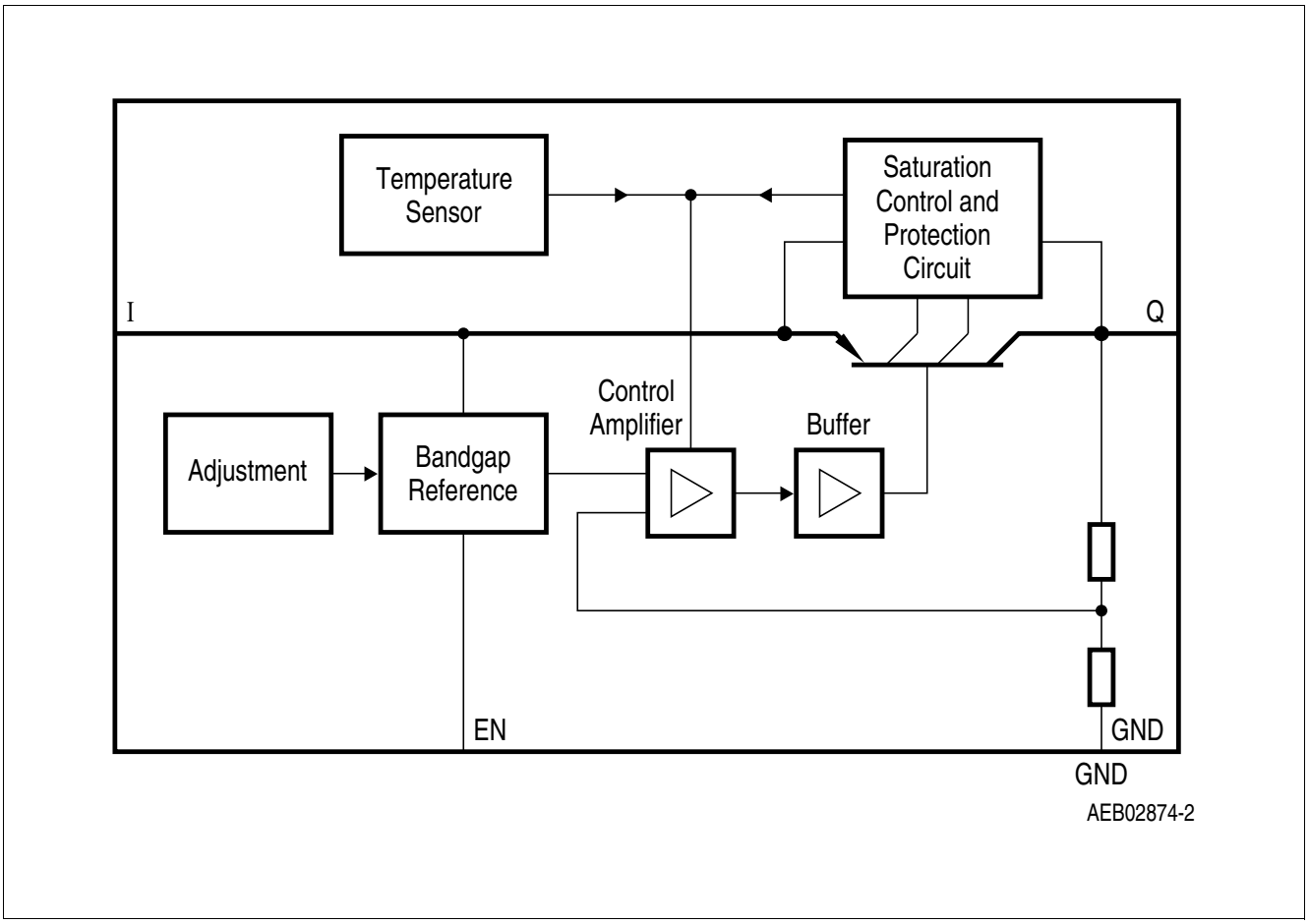



**Figure 1 Block Diagram**

# 3 Pin Configuration

## 3.1 Pin Assignment PG-SOT223-4

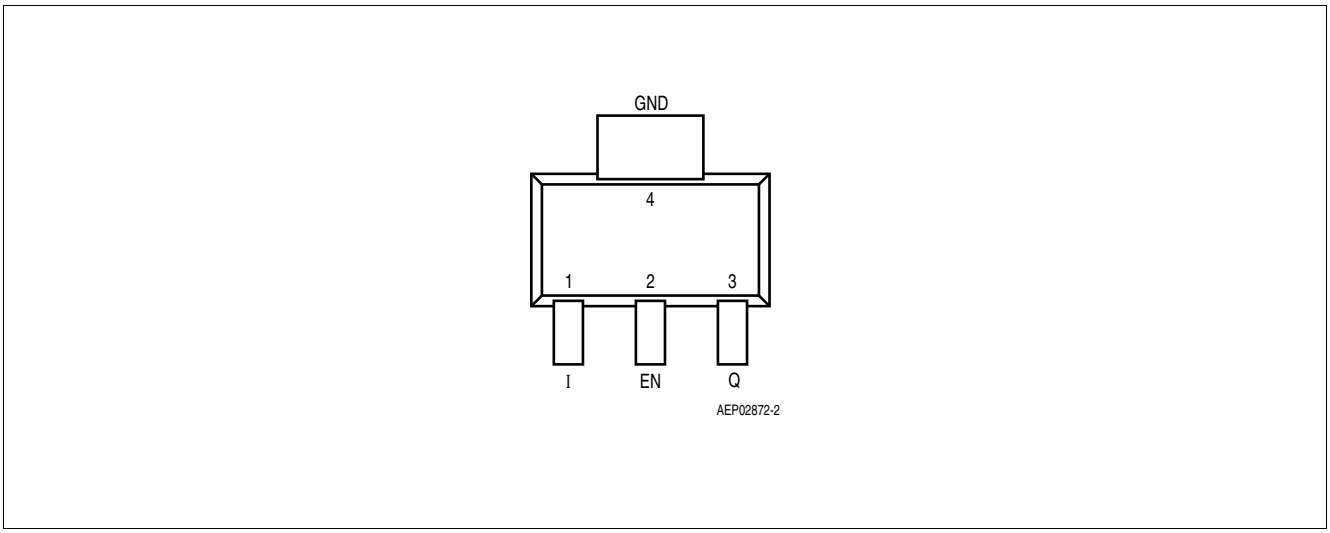



**Figure 2 Pin Configuration (top view)**

## 3.2 Pin Definitions and Functions PG-SOT223-4

| Pin No. | Symbol | Function |
|---|---|---|
| 1 | I | **Input**<br>block to ground directly at the IC with a ceramic capacitor |
| 2 | EN | **Enable Input**<br>high level enables the device;<br>low level disables the device;<br>integrated pull-down resistor |
| 3 | Q | **Output**<br>block to ground with a capacitor close to the IC terminals, respecting the values given for its capacitance and ESR in **“Functional Range” on Page 5** |
| 4 / Heat Slug | GND | **Ground / Heat Slug**<br>internally connected to leadframe and GND;<br>connect to GND and heatsink area |

# 4 General Product Characteristics

## 4.1 Absolute Maximum Ratings

**Table 1 Absolute Maximum Ratings[1)]**

$T_j$ = -40 °C to 150 °C; all voltages with respect to ground, (unless otherwise specified)

| Parameter | Symbol | Values | | | Unit | Note / Test Condition | Number |
|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | | |
| **Input I, Enable EN** | | | | | | | |
| Voltage | $V_I$, $V_{EN}$ | -30 | – | 45 | V | – | P_4.1.1 |
| **Output Q** | | | | | | | |
| Voltage | $V_Q$ | -0.3 | – | 32 | V | – | P_4.1.2 |
| **Temperature** | | | | | | | |
| Junction temperature | $T_j$ | -40 | – | 150 | °C | – | P_4.1.3 |
| Storage temperature | $T_{stg}$ | -50 | – | 150 | °C | – | P_4.1.4 |
| **ESD Susceptibility** | | | | | | | |
| ESD Absorption | $V_{ESD,HBM}$ | -3 | – | 3 | kV | Human Body Model (HBM)[2)] | P_4.1.5 |
| ESD Absorption | $V_{ESD,CDM}$ | -1500 | – | 1500 | V | Charge Device Model (CDM)[3)] at all pins | P_4.1.6 |

1) not subject to production test, specified by design

2) ESD susceptibility Human Body Model “HBM” according to AEC-Q100-002 - JESD22-A114

3) ESD susceptibility Charged Device Model “CDM” according to ESDA STM5.3.1

**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 2 Functional Range**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition | Number |
|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | | |
| Input voltage | $V_I$ | 5.5 | – | 40 | V | | P_4.2.1 |
| Output Capacitor’s Requirements for Stability | $C_Q$ | 10 | – | – | µF | – | P_4.2.2 |

**Table 2 Functional Range** (cont'd)

| Parameter | Symbol | Values | | | Unit | Note / Test Condition | Number |
|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | | |
| Output Capacitor's Requirements for Stability | $ESR(C_Q)$ | – | – | 2 | Ω | 1) | P_4.2.3 |
| Junction temperature | $T_j$ | -40 | – | 150 | °C | – | P_4.2.4 |

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

*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**.*

**Table 3 Thermal Resistance**

| Parameter | Symbol | Values | | | Unit | Note / Test Condition | Number |
|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | | |
| **TLE42664G (PG-SOT223-4)** | | | | | | | |
| Junction to Case[1)] | $R_{thJC}$ | – | 17 | – | K/W | measured to heat slug | P_4.3.1 |
| Junction to Ambient[1)] | $R_{thJA}$ | – | 54 | – | K/W | FR4 2s2p board[2)] | P_4.3.2 |
| Junction to Ambient[1)] | $R_{thJA}$ | – | 139 | – | K/W | FR4 1s0p board, footprint only[3)] | P_4.3.3 |
| Junction to Ambient[1)] | $R_{thJA}$ | – | 73 | – | K/W | FR4 1s0p board, 300 mm² heatsink area[3)] | P_4.3.4 |
| Junction to Ambient[1)] | $R_{thJA}$ | – | 64 | – | K/W | FR4 1s0p board, 600 mm² heatsink area[3)] | P_4.3.5 |

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 mm³ 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 × 114.3 × 1.5 mm$^3$ board with 1 copper layer (1 x 70µm Cu).

# 5 Electrical Characteristics

## 5.1 Electrical Characteristics Voltage Regulator

**Table 4 Electrical Characteristics**

$V_I$ = 13.5 V; $T_j$ = -40 °C to 150 °C; all voltages with respect to ground (unless otherwise specified)

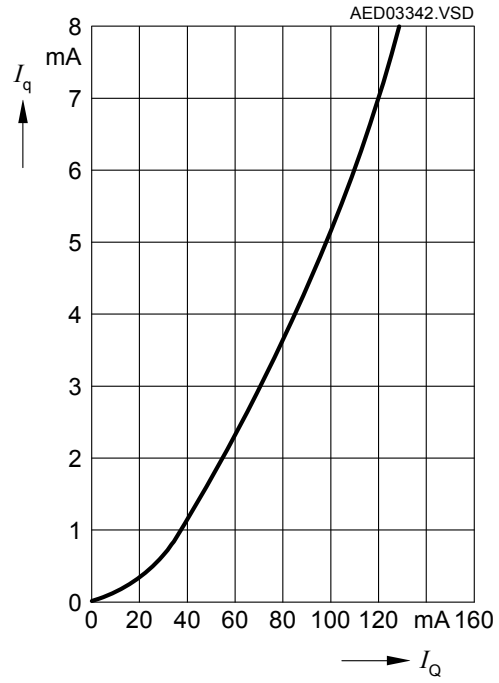
| Parameter | Symbol | Values | | | Unit | Note / Test Condition | Number |
|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | | |
| **Output Q** | | | | | | | |
| Output Voltage | $V_Q$ | 4.9 | 5.0 | 5.1 | V | 5 mA < $I_Q$< 50 mA<br>6 V < $V_I$ < 16 V | P_5.1.1 |
| Output Voltage | $V_Q$ | 4.85 | 5.0 | 5.15 | V | 5 mA < $I_Q$<100 mA<br>6 V < $V_I$ < 21 V | P_5.1.2 |
| Output Voltage At Low Output Currents | $V_Q$ | 4.80 | 5.0 | 5.20 | V | 100 µA < $I_Q$<5 mA<br>6 V < $V_I$ < 21 V | P_5.1.3 |
| Dropout Voltage | $V_{dr}$ | – | 250 | 500 | mV | $I_Q$ = 100 mA<br>$V_{dr}$ = $V_I$ – $V_Q$ [1] | P_5.1.4 |
| Load Regulation | $\Delta V_{Q,\,lo}$ | – | 50 | 90 | mV | $I_Q$ = 1 mA to 100 mA<br>$V_I$ = 13.5 V | P_5.1.5 |
| Line Regulation | $\Delta V_{Q,\,li}$ | – | 5 | 30 | mV | $V_I$ = 6 V to 28 V$I_Q$ = 1 mA | P_5.1.6 |
| Output Current Limitation | $I_Q$ | 150 | 200 | 500 | mA | [1] | P_5.1.7 |
| Power Supply Ripple Rejection[2] | $PSRR$ | – | 68 | – | dB | $f_r$ = 100 Hz; $V_r$ = 0.5 Vpp | P_5.1.8 |
| Overtemperature Shutdown Threshold | $T_{j,sd}$ | 151 | – | 200 | °C | $T_j$ increasing | P_5.1.9 |
| Overtemperature Shutdown Threshold Hysteresis | $T_{j,sdh}$ | – | 25 | – | °C | $T_j$ decreasing | P_5.1.10 |
| **Current Consumption** | | | | | | | |
| Current Consumption Device Disabled | $I_{q,OFF}$ | – | 0 | 1 | µA | $V_{EN}$ = 0 V; $T_j$ < 100 °C | P_5.1.11 |
| Quiescent Current $I_q = I_I - I_Q$ | $I_q$ | – | 40 | 60 | µA | $I_Q$ = 100 µA, $T_j$ < 85 °C | P_5.1.12 |
| Quiescent Current $I_q = I_I - I_Q$ | $I_q$ | – | 40 | 70 | µA | $I_Q$ = 100 µA | P_5.1.13 |
| Current Consumption $I_q = I_I - I_Q$ | $I_q$ | – | 1.7 | 4 | mA | $I_Q$ = 50 mA | P_5.1.14 |
| **Enable Input** | | | | | | | |
| High Level Input Voltage | $V_{EN,ON}$ | 3.5 | – | – | V | – | P_5.1.15 |
| Low Level Input Voltage | $V_{EN,OFF}$ | – | – | 0.8 | V | – | P_5.1.16 |
| Enable Input Current | $I_{EN,ON}$ | – | 4 | 8 | µA | $V_{EN}$ = 5 V | P_5.1.17 |
| Pull-down Resistor | $R_{EN}$ | – | 1.0 | – | MΩ | – | P_5.1.18 |

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

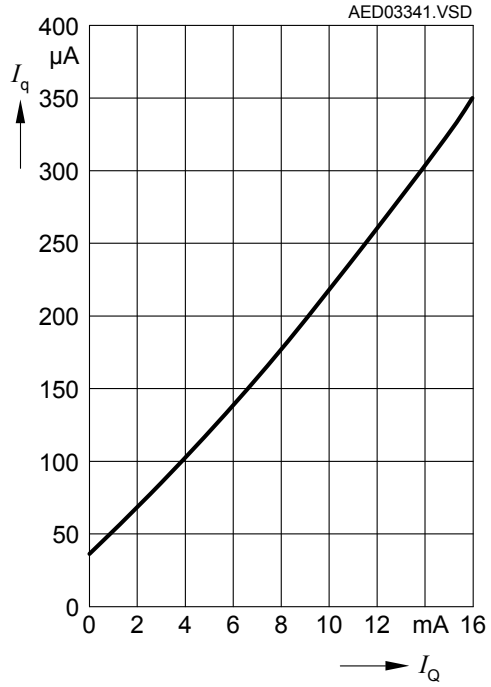
2) not subject to production test, specified by design

## 5.2 Typical Performance Characteristics Voltage Regulator

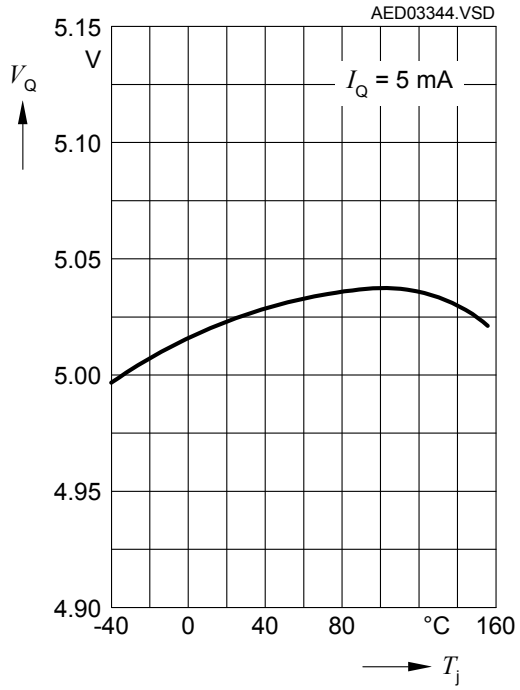
**Current Consumption $I_q$ versus Output Current $I_Q$**



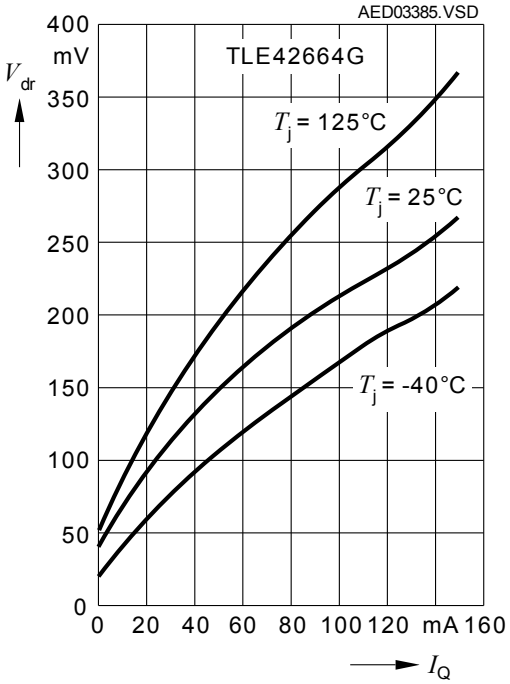

**Current Consumption $I_q$ versus Low Output Current $I_Q$**



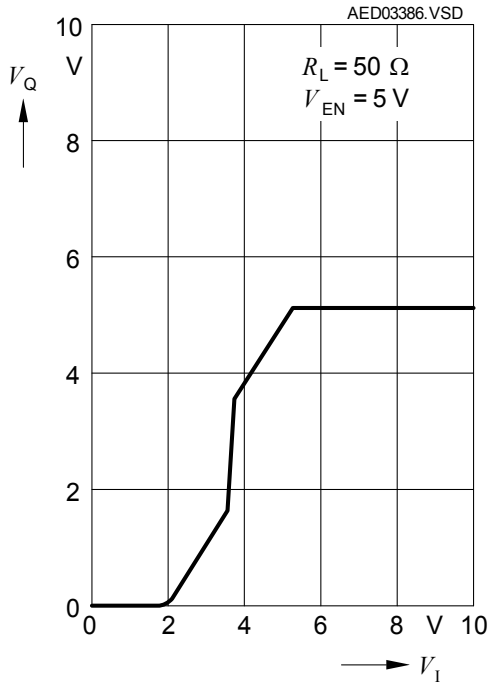

**Output Voltage Variation $\Delta V_Q$ versus Junction Temperature $T_J$**



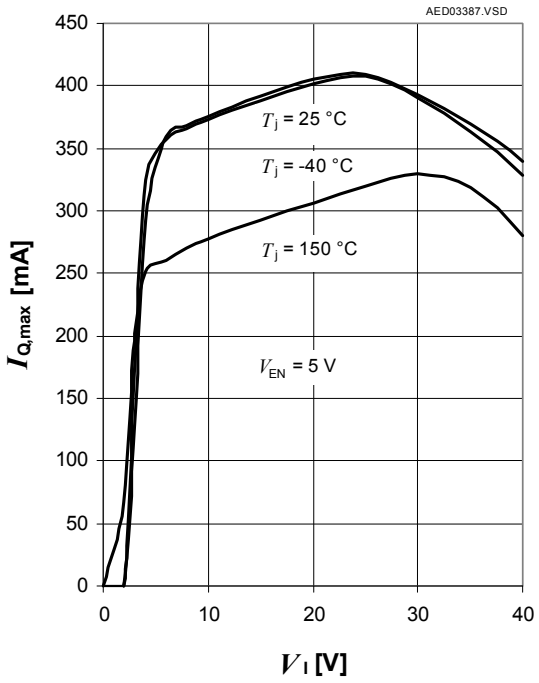

**Dropout Voltage $V_{dr}$ versus Output Current $I_Q$**



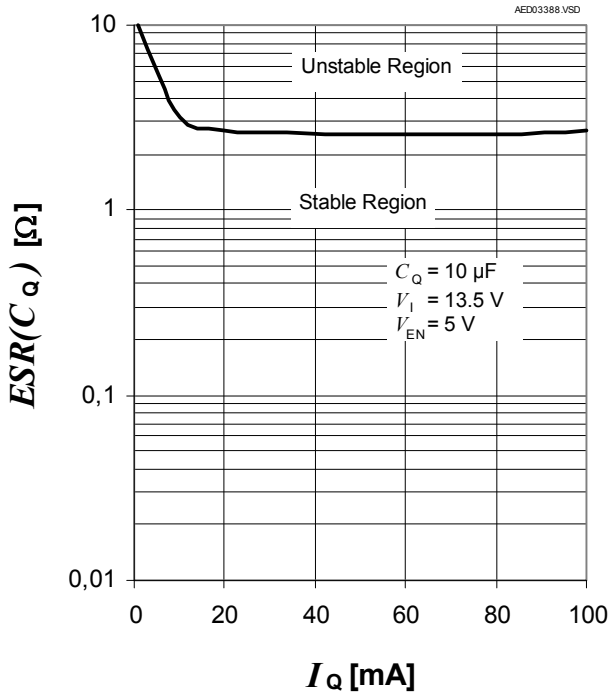
**Output Voltage $V_Q$ versus Input Voltage $V_I$**



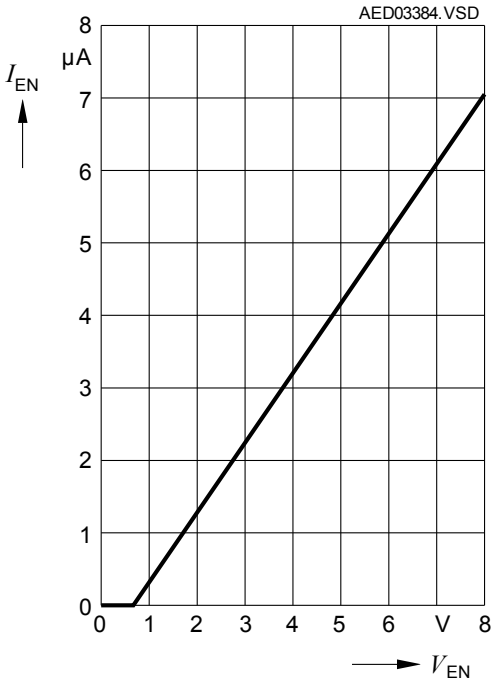

**Maximum Output Current $I_Q$ versus Input Voltage $V_I$**




**Region Of Stability: Output Capacitor's ESR $ESR(C_Q)$ versus Output Current $I_Q$**




**Enable Input Current $I_{EN}$ versus Enable Input Voltage $V_{EN}$**



# 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.*

## 6.1 Application Diagram

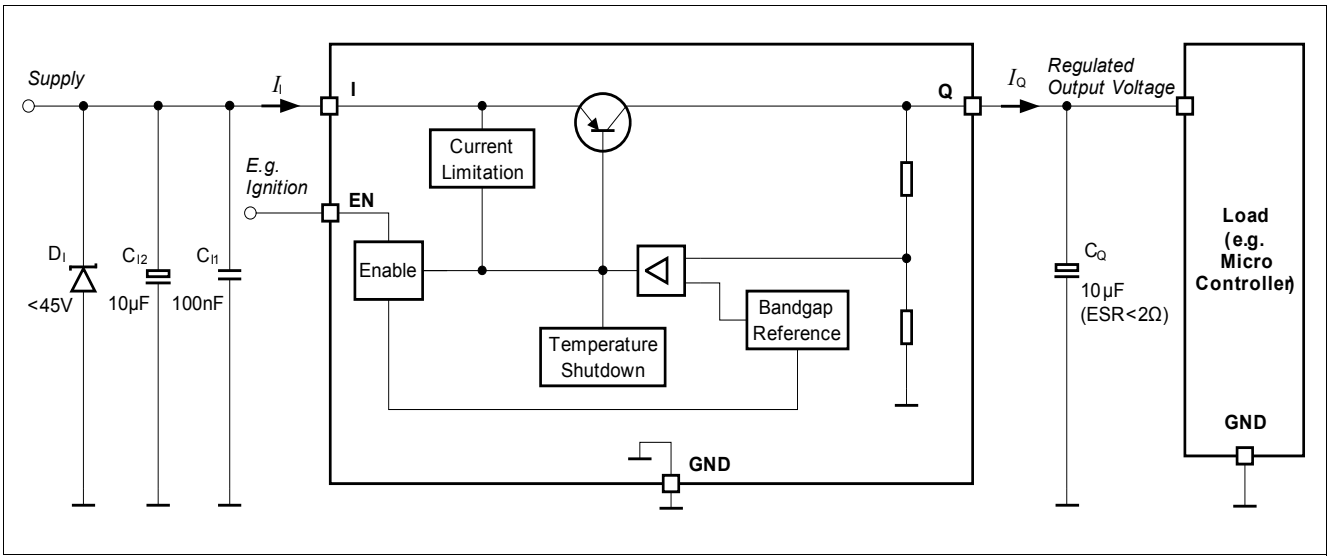



**Figure 3 Application Diagram**

## 6.2 Selection of External Components

### 6.2.1 Input Pin

The typical input circuitry for a linear voltage regulator is shown in the application diagram above.

A ceramic capacitor at the input, in the range of 100 nF to 470 nF, is recommended to filter out the high frequency disturbances imposed by the line e.g. ISO pulses 3a/b. This capacitor must be placed very close to the input pin of the linear voltage regulator on the PCB.

An aluminum electrolytic capacitor in the range of 10 µF to 470 µF is recommended as an input buffer to smooth out high energy pulses, such as ISO pulse 2a. This capacitor should be placed close to the input pin of the linear voltage regulator on the PCB.

An overvoltage suppressor diode can be used to further suppress any high voltage beyond the maximum rating of the linear voltage regulator and protect the device against any damage due to over-voltage.

The external components at the input are not mandatory for the operation of the voltage regulator, but they are recommended in case of possible external disturbances.

### 6.2.2 Output Pin

An output capacitor is mandatory for the stability of linear voltage regulators.

The requirement to the output capacitor is given in **"Functional Range" on Page 5**. The graph **"Region Of Stability: Output Capacitor's ESR $ESR(C_Q)$ versus Output Current $I_Q$" on Page 9** shows the stable operation range of the device.

TLE42664 is designed to be stable with extremely low ESR capacitors. According to the automotive environment, ceramic capacitors with X5R or X7R dielectrics are recommended.

The output capacitor should be placed as close as possible to the regulator's output and GND pins and on the same side of the PCB as the regulator itself.

In case of rapid transients of input voltage or load current, the capacitance should be dimensioned in accordance and verified in the real application that the output stability requirements are fulfilled.

## 6.3 Thermal Considerations

Knowing the input voltage, the output voltage and the load profile of the application, the total power dissipation can be calculated:

(1)

$$P_D = (V_I - V_Q) \times I_Q + V_I \times I_q$$

with

- $P_D$: continuous power dissipation
- $V_I$: input voltage
- $V_Q$: output voltage
- $I_Q$: output current
- $I_q$: quiescent current

The maximum acceptable thermal resistance $R_{thJA}$ can then be calculated:

(2)

$$R_{thJA,\,max} = \frac{T_{j,\,max} - T_a}{P_D}$$

with

- $T_{j,max}$: maximum allowed junction temperature
- $T_a$: ambient temperature

Based on the above calculation the proper PCB type and the necessary heat sink area can be determined with reference to the specification in **"Thermal Resistance" on Page 6**.

**Example**

Application conditions:

$V_I$ = 13.5 V

$V_Q$ = 5 V

$I_Q$ = 50 mA

$T_a$ = 105 °C

Calculation of $R_{thJA,max}$:

$P_D = (V_I - V_Q) \cdot I_Q + V_I \cdot I_q$

= (13.5 V – 5 V) • 50 mA + 13.5 V • 4 mA

= 0.425 W + 0.054 W

= 0.479 W

$R_{thJA,max}$ = ($T_{j,max}$ – $T_a$) / $P_D$
= (150 °C – 105 °C) / 0.479 W
= 93.9 K/W

As a result, the PCB design must ensure a thermal resistance $R_{thJA}$ lower than 93.9 K/W. By considering TLE42664G (PG-SOT223-4 package) and according to **“Thermal Resistance” on Page 6**, at least 300 mm² heatsink area is needed on the FR4 1s0p PCB, or the FR4 2s2p board can be used.

## 6.4 Reverse Polarity Protection

TLE42664 is self protected against reverse polarity faults and allows negative supply voltage. External reverse polarity diode is not needed. However, the absolute maximum ratings of the device as specified in **“Absolute Maximum Ratings” on Page 5** must be kept.

The reverse voltage causes several small currents to flow into the IC hence increasing its junction temperature. As the thermal shut down circuitry does not work in the reverse polarity condition, designers have to consider this in their thermal design.

# 7 Package Outlines

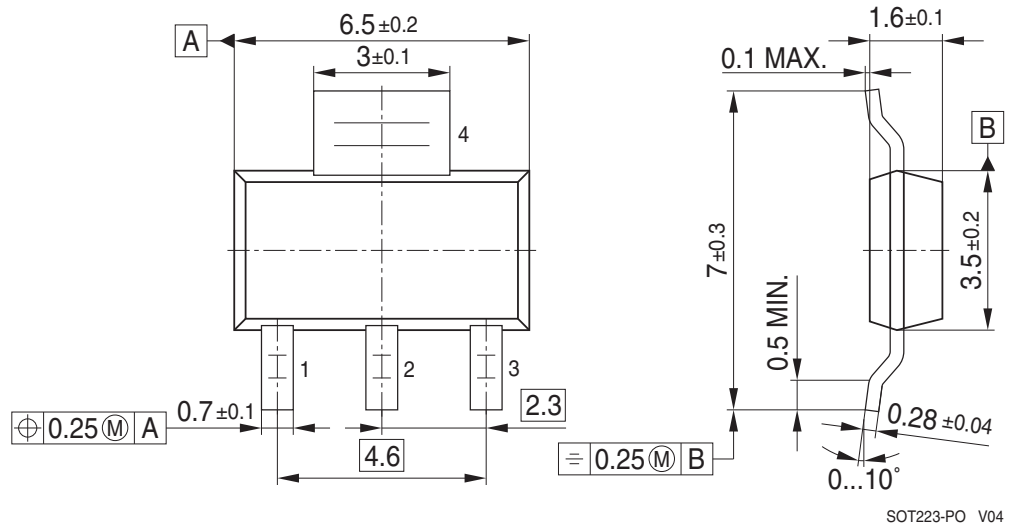



**Figure 4 PG-SOT223-4**

### 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).

For further information on alternative packages, please visit our website:
**http://www.infineon.com/packages**.

Dimensions in mm

# 8 Revision History

| Revision | Date | Changes |
|---|---|---|
| 1.0 | 2009-06-26 | initial version data sheet |
| 1.01 | 2009-09-30 | updated version data sheet; typing error corrected in **Table 1 “Absolute Maximum Ratings” on Page 5**: In **Voltage** min. value corrected from “-42V” to “-30V” |
| 1.1 | 2014-07-03 | Application information added |

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