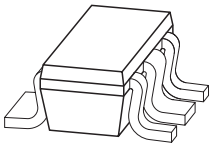
# Low Drop Voltage Regulator

# TLE 4296-2

## Features

- Two versions: 3.3 V, 5.0 V
- Output voltage tolerance ≤ ±4%
- Very low drop voltage
- Output current: 30 mA
- Inhibit input
- Low quiescent current consumption
- Wide operation range: up to 45 V
- Wide temperature range: -40 °C ≤ $T_j$ ≤ 150 °C
- Output protected against short circuit
- Overtemperature protection
- Reverse polarity proof
- Very small SMD-Package P-SCT595-5



SCT 595

## Functional Description

The **TLE 4296-2 G** is a monolithic integrated low-drop voltage regulator in the very small SMD package P-SCT595-5. It is designed to supply e.g. microprocessor systems under the severe conditions of automotive applications. Therefore the device is equipped with additional protection functions against overload, short circuit and reverse polarity. At overtemperature the regulator is automatically turned off by the integrated thermal protection circuit.

Input voltages up to 40 V are regulated to $V_{Q,nom}$ = 3.3 V (V33 version) or 5.0 V (V50 version). The output is able to drive a load of more than 30 mA while it regulates the output voltage within a 4% accuracy. To save energy the device can be switched in stand-by mode via an inhibit input which causes the current consumption to drop below 5 µA.

| Type | Ordering Code | Package |
|---|---|---|
| TLE 4296-2 GV33 | Q67006-A9608 | P-SCT595-5 |
| TLE 4296-2 GV50 | Q67006-A9609 | P-SCT595-5 |

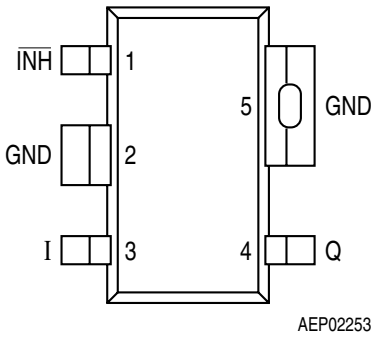



**Figure 1** **Pin Configuration** (top view)

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

| Pin No. | Symbol | Function |
|---|---|---|
| 1 | $\overline{\text{INH}}$ | **Inhibit input;** high level to turn IC on |
| 2 | GND | **Ground;** connected to pin 5 |
| 3 | I | **Input voltage** |
| 4 | Q | **Output voltage;** must be blocked with a ceramic capacitor $C_Q \geq 3.3\ \mu F$, ESR $\leq 2\ \Omega$ |
| 5 | GND | **Ground;** connected to pin 2 |

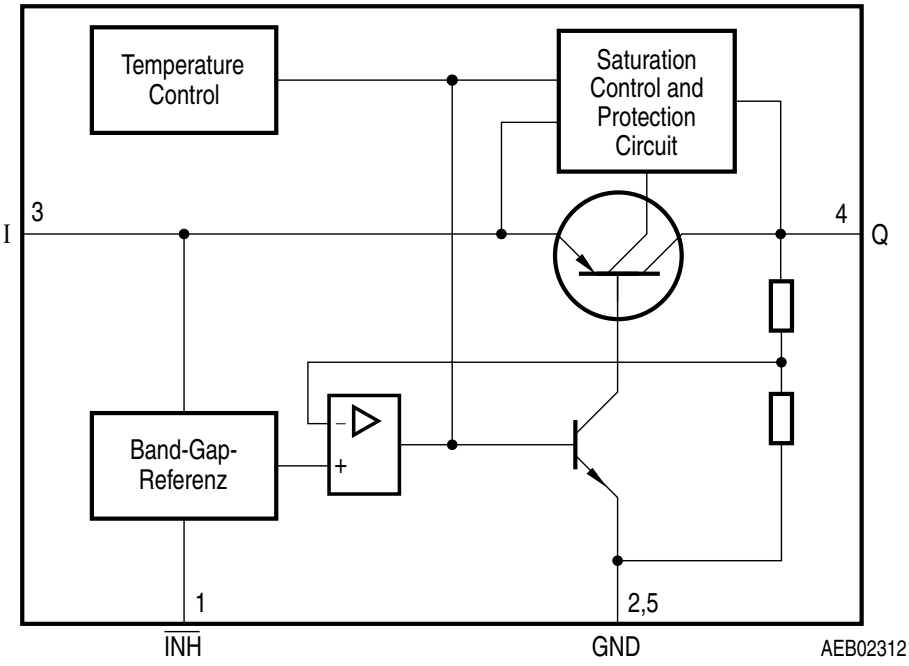



**Figure 2 Block Diagram**

**Table 2 Absolute Maximum Ratings**

-40 °C < $T_j$ < 150 °C

| Parameter | Symbol | Limit Values | | Unit | Remarks |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| **Input** | | | | | |
| Voltage | $V_I$ | -42 | 45 | V | – |
| Current | $I_I$ | – | – | mA | internally limited |
| **Output** | | | | | |
| Voltage | $V_Q$ | -0.3 | 30 | V | – |
| Current | $I_Q$ | – | – | mA | internally limited |
| **Inhibit** | | | | | |
| Voltage | $V_{INH}$ | -42 | 45 | V | – |
| Current | $I_{INH}$ | -500 | * | µA | * internally limited |
| Current | $I_{INH}$ | -5 | 5 | mA | -0.3 V < $V_I$ < 45 V; $t_p$ < 1 ms |
| **Temperatures** | | | | | |
| Junction temperature | $T_j$ | -40 | 150 | °C | – |
| Storage temperature | $T_{stg}$ | -50 | 150 | °C | – |
| **Thermal Resistances** | | | | | |
| Junction pin | $R_{thj\text{-}pin}$ | – | 30 | K/W | measured to pin 5 |
| Junction ambient[1)] | $R_{thja}$ | – | 179 | K/W | zero airflow<br>zero heat sink area |

1) Worst case regarding peak temperature.

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

**Table 3 Operating Range**

| Parameter | Symbol | Limit Values | | Unit | Remarks |
|---|---|---|---|---|---|
| | | Min. | Max. | | |
| Input voltage | $V_I$ | 4.0 | 45 | V | TLE 4296-2 GV33 |
| | $V_I$ | 5.5 | 45 | V | TLE 4296-2 GV50 |
| Inhibit voltage | $V_{\overline{INH}}$ | -0.3 | 40 | V | – |
| Junction temperature | $T_j$ | -40 | 150 | °C | – |

## Table 4 Electrical Characteristics

$V_I$ = 13.5 V; $V_{\overline{INH}}$ > +2.5 $V_Q$; -40 °C < $T_j$ < 150 °C; unless otherwise specified

| Parameter | Symbol | Limit Values | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Output voltage V33 version | $V_Q$ | 3.17 | 3.30 | 3.43 | V | 1 mA < $I_Q$ < 30 mA<br>$V_I$ = 13.5 V |
| | | 3.17 | 3.30 | 3.43 | V | $I_Q$ = 10 mA<br>4.3 V < $V_I$ < 40 V |
| Output voltage V50 version | $V_Q$ | 4.80 | 5.00 | 5.20 | V | 1 mA < $I_Q$ < 30 mA<br>$V_I$ = 13.5 V |
| | | 4.80 | 5.00 | 5.20 | V | $I_Q$ = 10 mA<br>6 V < $V_I$ < 40 V |
| Output current limitation | $I_Q$ | 30 | – | – | mA | 1) |
| Drop voltage | $V_{dr}$ | – | 0.25 | 0.30 | V | $I_Q$ = 20 mA 1) |
| Output capacitor | $C_Q$ | 3.3 | – | – | µF | ESR ≤ 2 Ω<br>at 10 kHz |
| Current consumption<br>$I_q = I_I - I_Q$ | $I_q$ | – | 2 | 5.2 | mA | $I_Q$ < 30 mA |
| Current consumption<br>$I_q = I_I - I_Q$ | $I_q$ | – | 130 | 170 | µA | $I_Q$ < 0.1 mA;<br>$T_j$ < 85 °C |
| Quiescent current (stand-by)<br>$I_q = I_I - I_Q$ | $I_q$ | – | 0 | 1 | µA | $V_{\overline{INH}}$ = 0.4 V;<br>$T_j$ < 85 °C |
| Quiescent current (stand-by)<br>$I_q = I_I - I_Q$ | $I_q$ | – | 0 | 5 | µA | $V_{\overline{INH}}$ = 0.4 V |

**Table 4 Electrical Characteristics** (cont'd)

$V_I$ = 13.5 V; $V_{\overline{INH}}$ > +2.5 $V_Q$; -40 °C < $T_j$ < 150 °C; unless otherwise specified

| Parameter | Symbol | Limit Values | | | Unit | Test Condition |
|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | | |
| Load regulation | $\Delta V_Q$ | – | 17 | 50 | mV | 1 mA < $I_Q$ < 25 mA; $T_j$ = 25 °C TLE 4296-2 GV50 |
| | | – | 14 | 40 | mV | 1 mA < $I_Q$ < 25 mA; $T_j$ = 25 °C TLE 4296-2 GV33 |
| Line regulation | $\Delta V_Q$ | – | 10 | 25 | mV | $V_I$ = ($V_{Q,nom}$ + 0.5 V) to 36 V $I_Q$ = 5 mA; $T_j$ = 25 °C |
| Power Supply Ripple Rejection | $PSRR$ | – | 60 | – | dB | $f_r$ = 100 Hz; $V_r$ = 0.5 Vpp |
| **Logic Inhibit Input** | | | | | | |
| Inhibit, Turn-on voltage | $V_{\overline{INH},\,high}$ | – | – | 2.2 | V | $V_Q$ > 0.95 $V_{Q,nom}$ |
| Inhibit, Turn-off voltage | $V_{\overline{INH},\,low}$ | 0.4 | – | – | V | $V_Q$ > 0.1 V |
| H-input current | $I_{\overline{INH},\,high}$ | – | 8 | 12 | µA | $V_{\overline{INH}}$ = 5 V |
| L-input current | $I_{\overline{INH},\,low}$ | -2 | – | 2 | µA | $V_{\overline{INH}}$ = 0 V |

1) Measured when the output voltage $V_Q$ has dropped 100 mV from the nominal value.

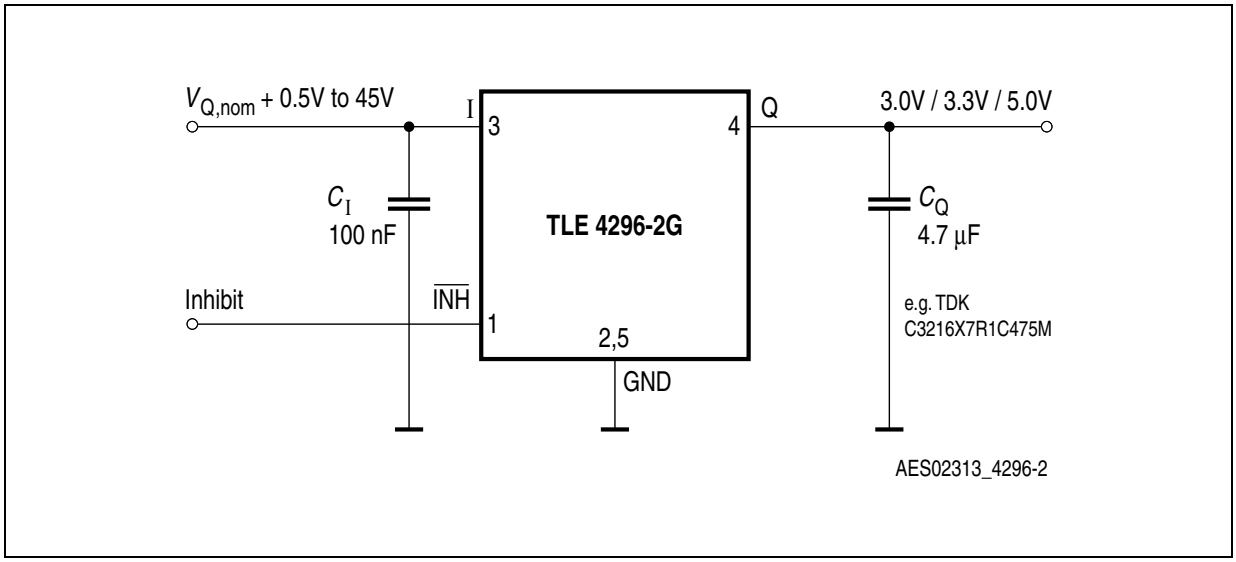



**Figure 3 Application Circuit**

## Application Information

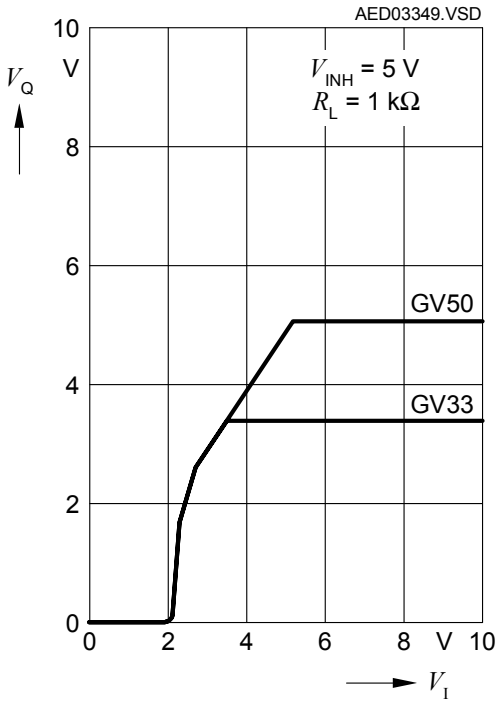
In the TLE 4296-2 G the output voltage is divided and compared to an internal reference of 2.5 V typical. The regulation loop controls the output to achieve a stabilized output voltage.

**Figure 3** shows a typical application circuit. In order to maintain the stability of the control loop the TLE 4296-2 G output requires an output capacitor $C_Q$ of at least 3.3 µF with a maximum permissible ESR of 2 Ω. It is recommended to use a multi layer ceramic capacitor for $C_Q$, e.g. the TDK C3216X7R1C475M with a nominal capacitance of 4.7 µF. Aluminum electrolytic as well as tantalum capacitors do not cover the required ESR range over the full operating temperature range of -40 °C to 150 °C.

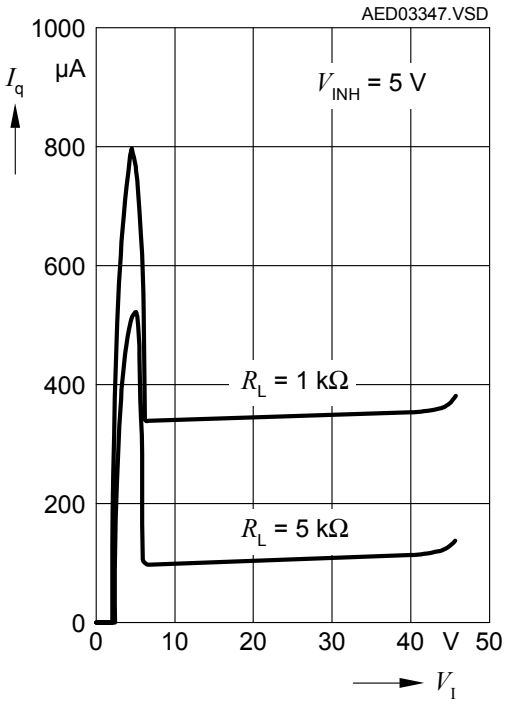
At the input of the regulator an input capacitor is necessary for compensating line influences (100 nF ceramic capacitor recommended). A resistor of approx. 1 Ω in series with $C_I$, can damp any oscillation occurring due the input inductivity and the input capacitor. If the regulator is sourced via long input lines of several meters it is recommended to place an additional electrolytic capacitor ≥ 47 µF at the input.

## Typical Performance Characteristics

### Output Voltage $V_Q$ versus Input Voltage $V_I$




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



## Package Outlines

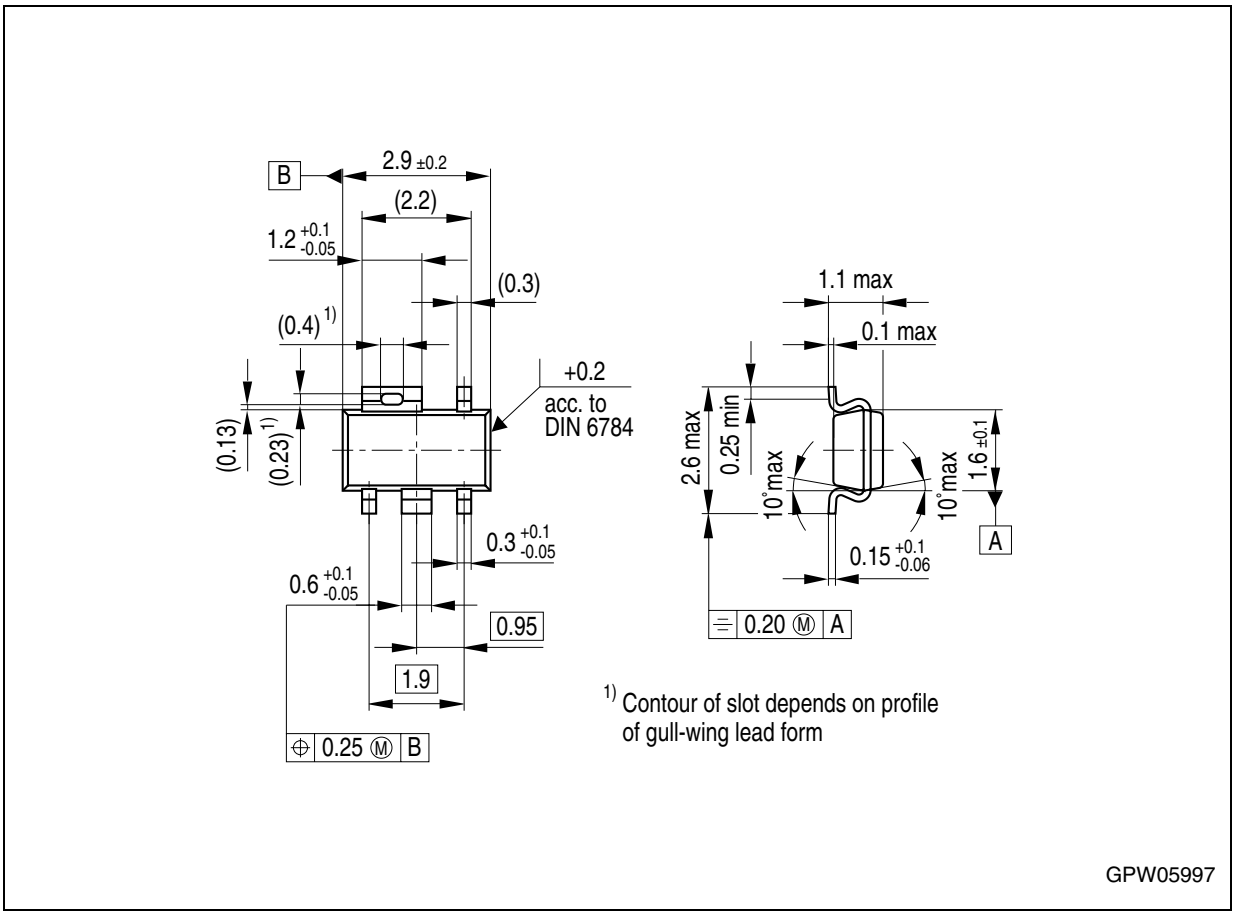



**Figure 4** **P-SCT595-5** (Plastic Small Outline)

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SMD = Surface Mounted Device

Dimensions in mm

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