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# Ultra Low Quiescent Current Linear Voltage Regulator

## TLS810D1

TLS810D1EJV50  
TLS810D1LDV50

### Linear Voltage Regulator

### Data Sheet

Rev. 1.1, 2015-11-02

Automotive Power

## TLS810D1

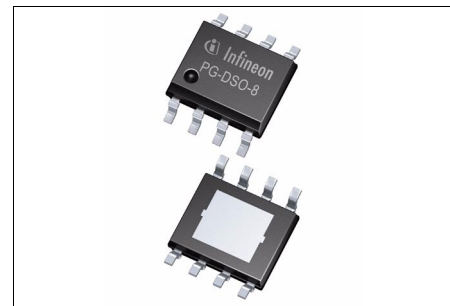
## TLS810D1EJ/LDV50



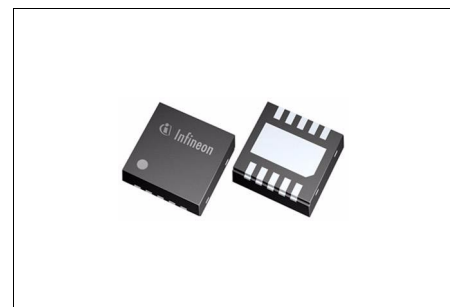
### 1 Overview

#### Features

- Ultra Low Quiescent Current of 9  $\mu$ A
- Wide Input Voltage Range of 2.75 V to 42 V
- Output Current Capacity up to 100 mA
- Off Mode Current Less than 1  $\mu$ A
- Low Drop Out Voltage of typ. 200 mV @ 100 mA
- Output Current Limit Protection
- Overtemperature Shutdown
- Enable
- Reset
- Available in PG-DSO-8 EP Package
- Available in PG-TSON-10 Package
- Wide Temperature Range
- Green Product (RoHS Compliant)
- AEC Qualified



**Figure 1 PG-DSO-8 EP**



**Figure 2 PG-TSON-10**

Type	Package	Marking
TLS810D1EJV50	PG-DSO-8 EP	810D1V50
TLS810D1LDV50	PG-TSON-10	810D1V50

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**Overview**

**Description**

The TLS810D1 is a linear voltage regulator featuring wide input voltage range, low drop out voltage and ultra low quiescent current.

With an input voltage range of 2.75 V to 42 V and ultra low quiescent of only 9  $\mu$ A, the regulator is perfectly suitable for automotive or any other supply systems connected permanently to the battery.

The TLS810D1EJ/LDV50 is the fixed 5 V output version with an accuracy of 2 % and output current capability up to 100 mA.

The new regulation concept implemented in TLS810D1 combines fast regulation and very good stability while requiring only a small ceramic capacitor of 1  $\mu$ F at the output.

The tracking region starts already at input voltages of 2.75 V (extended operating range). This makes the TLS810D1 also suitable to supply automotive systems that need to operate during cranking condition.

Internal protection features like output current limitation and overtemperature shutdown are implemented to protect the device against immediate damage due to failures like output short circuit to GND, over-current and over-temperature.

The device can be switched on and off by the Enable feature. When the device is switched off, the current consumption is typically less than 1  $\mu$ A.

The output voltage is supervised by the Reset feature, including undervoltage reset and delayed reset release at power-on.

**Choosing External Components**

An input capacitor  $C_I$  is recommended to compensate line influences. The output capacitor  $C_O$  is necessary for the stability of the regulating circuit. Stability is guaranteed at values  $C_O \geq 1 \mu$ F and an  $ESR \leq 100 \Omega$  within the whole operating range.

Block Diagram

## 2 Block Diagram

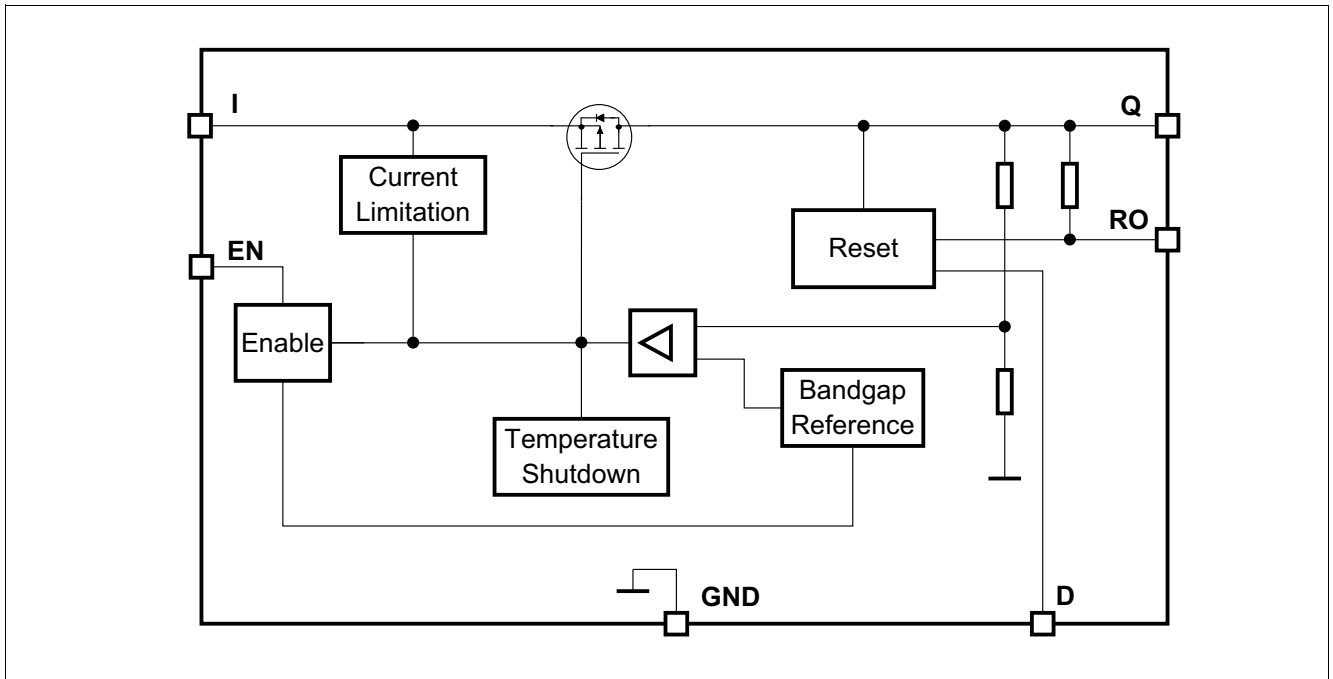


Figure 3 Block Diagram TLS810D1

Pin Configuration

### 3 Pin Configuration

#### 3.1 Pin Assignment in PG-DSO-8 EP Package

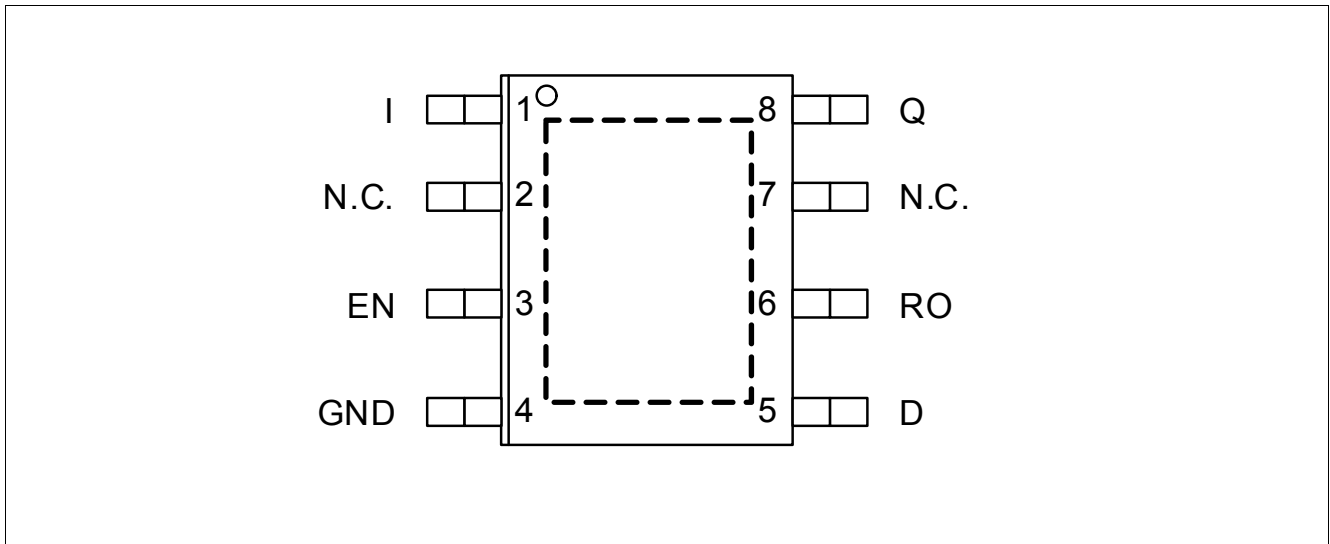


Figure 4 Pin Configuration TLS810D1 in PG-DSO-8 EP package

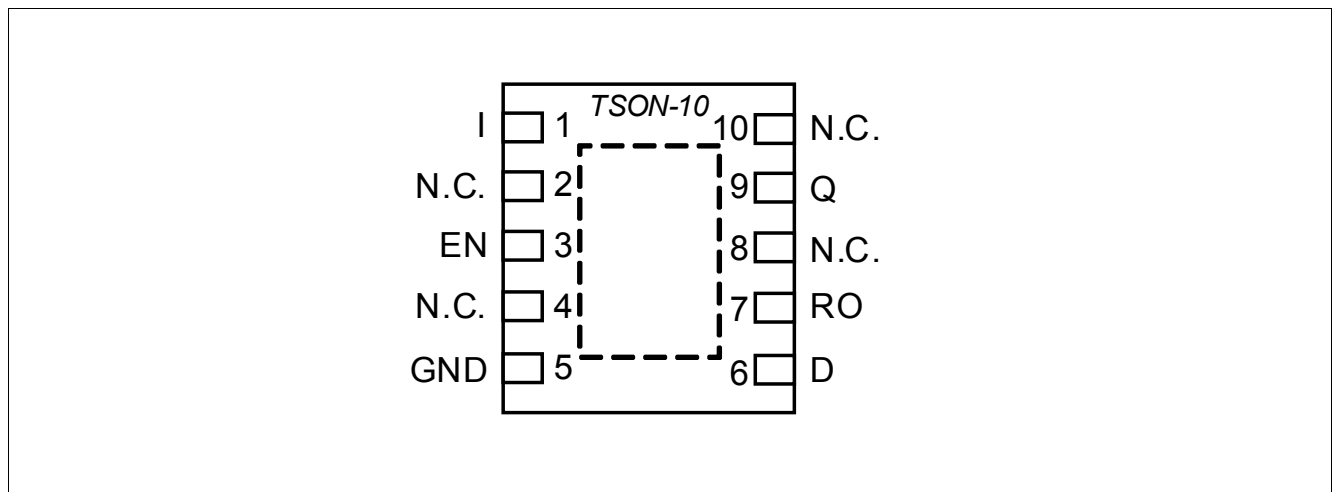
#### 3.2 Pin Definitions and Functions in PG-DSO-8 EP Package

Pin	Symbol	Function
1	I	<b>Input</b> It is recommended to place a small ceramic capacitor (e.g. 100 nF) to GND, close to the IC terminals, in order to compensate line influences.
2	N.C.	<b>Not connected</b>
3	EN	<b>Enable</b> Integrated pull-down resistor. Enable the IC with high level input signal. Disable the IC with low level input signal.
4	GND	<b>Ground</b>
5	D	<b>Reset Delay Timing</b> Connect a ceramic capacitor to GND for adjusting the reset delay time. Leave open if the reset function is not needed.
6	RO	<b>Reset Output</b> Integrated pull-up resistor. Open collector output. Leave open if the reset function is not needed.
7	N.C.	<b>Not connected</b>

**Pin Configuration**

Pin	Symbol	Function
8	Q	<b>Output</b> Connect an output capacitor $C_Q$ to GND close to the IC's terminals, respecting the values specified for its capacitance and ESR in <a href="#">Table 2 "Functional Range" on Page 9</a> .
Pad	-	<b>Exposed Pad</b> Connect to heatsink area. Connect to GND.

**3.3 Pin Assignment in PG-TSON-10 Package**



**Figure 5 Pin Configuration TLS810D1 in PG-TSON-10 package**

**3.4 Pin Definitions and Functions in PG-TSON-10 Package**

Pin	Symbol	Function
1	I	<b>Input</b> It is recommended to place a small ceramic capacitor (e.g. 100 nF) to GND, close to the IC terminals, in order to compensate line influences.
2	N.C.	<b>Not connected</b>
3	EN	<b>Enable</b> Integrated pull-down resistor. Enable the IC with high level input signal. Disable the IC with low level input signal.
4	N.C.	<b>Not connected</b>
5	GND	<b>Ground</b>

**Pin Configuration**

Pin	Symbol	Function
6	D	<b>Reset Delay Timing</b> Connect a ceramic capacitor to GND for adjusting the reset delay time. Leave open if the reset function is not needed.
7	RO	<b>Reset Output</b> Integrated pull-up resistor. Open collector output. Leave open if the reset function is not needed.
8	N.C.	<b>Not connected</b>
9	Q	<b>Output</b> Connect an output capacitor $C_Q$ to GND close to the IC's terminals, respecting the values specified for its capacitance and ESR in <a href="#">Table 2 "Functional Range" on Page 9</a> .
10	N.C.	<b>Not connected</b>
Pad	-	<b>Exposed Pad</b> Connect to heatsink area. Connect to GND.



General Product Characteristics

## 4 General Product Characteristics

### 4.1 Absolute Maximum Ratings

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

$T_j = -40\text{ °C}$  to  $+150\text{ °C}$ ; all voltages with respect to ground (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
<b>Voltage Input I, Enable EN</b>							
Voltage	$V_I, V_{EN}$	-0.3	-	45	V	-	P_4.1.1
<b>Voltage Output Q</b>							
Voltage	$V_Q$	-0.3	-	7	V	-	P_4.1.2
<b>Reset Output RO, Reset Delay D</b>							
Voltage	$V_{RO}, V_D$	-0.3	-	7	V	-	P_4.1.3
<b>Temperatures</b>							
Junction Temperature	$T_j$	-40	-	150	°C	-	P_4.1.4
Storage Temperature	$T_{stg}$	-55	-	150	°C	-	P_4.1.5
<b>ESD Absorption</b>							
ESD Susceptibility to GND	$V_{ESD,HBM}$	-2	-	2	kV	HBM <sup>2)</sup>	P_4.1.6
ESD Susceptibility to GND	$V_{ESD,CDM}$	-750	-	750	V	CDM <sup>3)</sup> at all pins	P_4.1.7

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

2) ESD susceptibility, HBM according to ANSI/ESDA/JEDEC JS001 (1.5 kΩ, 100 pF)

3) ESD susceptibility, Charged Device Model “CDM” according JEDEC JESD22-C101

#### 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.

General Product Characteristics

4.2 Functional Range

Table 2 Functional Range

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Input Voltage Range	$V_I$	$V_{Q,nom} + V_{dr}$	–	42	V	– <sup>1)</sup>	P_4.2.1
Extended Input Voltage Range	$V_{I,ext}$	2.75	–	42	V	– <sup>2)</sup>	P_4.2.2
Output Capacitor	$C_Q$	1	–	–	μF	– <sup>3)4)</sup>	P_4.2.3
Output Capacitor's ESR	ESR( $C_Q$ )	–	–	100	Ω	– <sup>4)</sup>	P_4.2.4
Junction temperature	$T_j$	-40	–	150	°C	–	P_4.2.5

- 1) Output current is limited internally and depends on the input voltage, see Electrical Characteristics for more details.
- 2) When  $V_I$  is between  $V_{I,ext,min}$  and  $V_{Q,nom} + V_{dr}$ ,  $V_Q = V_I - V_{dr}$ . When  $V_I$  is below  $V_{I,ext,min}$ ,  $V_Q$  can drop down to 0 V.
- 3) The minimum output capacitance requirement is applicable for a worst case capacitance tolerance of 30%.
- 4) Not subject to production testing, specified by design.

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.

General Product Characteristics

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 3 Thermal Resistance TLS810D1 in PG-DSO-8 EP Package**

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
<b>Package Version</b>							
Junction to Case <sup>1)</sup>	$R_{thJC}$	–	19	–	K/W	–	P_4.3.1
Junction to Ambient	$R_{thJA}$	–	51	–	K/W	2s2p board <sup>2)</sup>	P_4.3.2
Junction to Ambient	$R_{thJA}$	–	167	–	K/W	1s0p board, footprint only <sup>3)</sup>	P_4.3.3
Junction to Ambient	$R_{thJA}$	–	71	–	K/W	1s0p board, 300 mm <sup>2</sup> heatsink area on PCB <sup>3)</sup>	P_4.3.4
Junction to Ambient	$R_{thJA}$	–	60	–	K/W	1s0p board, 600 mm <sup>2</sup> heatsink area on PCB <sup>3)</sup>	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 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).

**Table 4 Thermal Resistance TLS810D1 in PG-TSON-10 Package**

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
<b>Package Version</b>							
Junction to Case <sup>1)</sup>	$R_{thJC}$	–	13	–	K/W	–	P_4.3.6
Junction to Ambient	$R_{thJA}$	–	60	–	K/W	2s2p board <sup>2)</sup>	P_4.3.7
Junction to Ambient	$R_{thJA}$	–	184	–	K/W	1s0p board, footprint only <sup>3)</sup>	P_4.3.8
Junction to Ambient	$R_{thJA}$	–	75	–	K/W	1s0p board, 300 mm <sup>2</sup> heatsink area on PCB <sup>3)</sup>	P_4.3.9
Junction to Ambient	$R_{thJA}$	–	64	–	K/W	1s0p board, 600 mm <sup>2</sup> heatsink area on PCB <sup>3)</sup>	P_4.3.10

- 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).

Block Description and Electrical Characteristics

## 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 the pass transistor is driven accordingly.

The control loop stability depends on the output capacitor  $C_Q$ , the load current, the chip temperature and the internal circuit structure. To ensure stable operation, the output capacitor's capacitance and its equivalent series resistor ESR requirements given in "Functional Range" on Page 9 have to be maintained. For details see the typical performance graph **Output Capacitor Series Resistor ESR( $C_Q$ ) versus Output Current  $I_Q$** . 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, in case the input is connected directly to the battery line. Connect the capacitors close to the regulator terminals.

In order to prevent overshoots during start-up, a smooth ramping up function is implemented. This ensures almost no overshoots during start-up, mostly independent from load and output capacitance.

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-circuit) by switching off the power stage. After the chip has cooled down, the regulator restarts. This oscillatory thermal behaviour causes the junction temperature to exceed the maximum rating of 150°C and can significantly reduce the IC's lifetime.

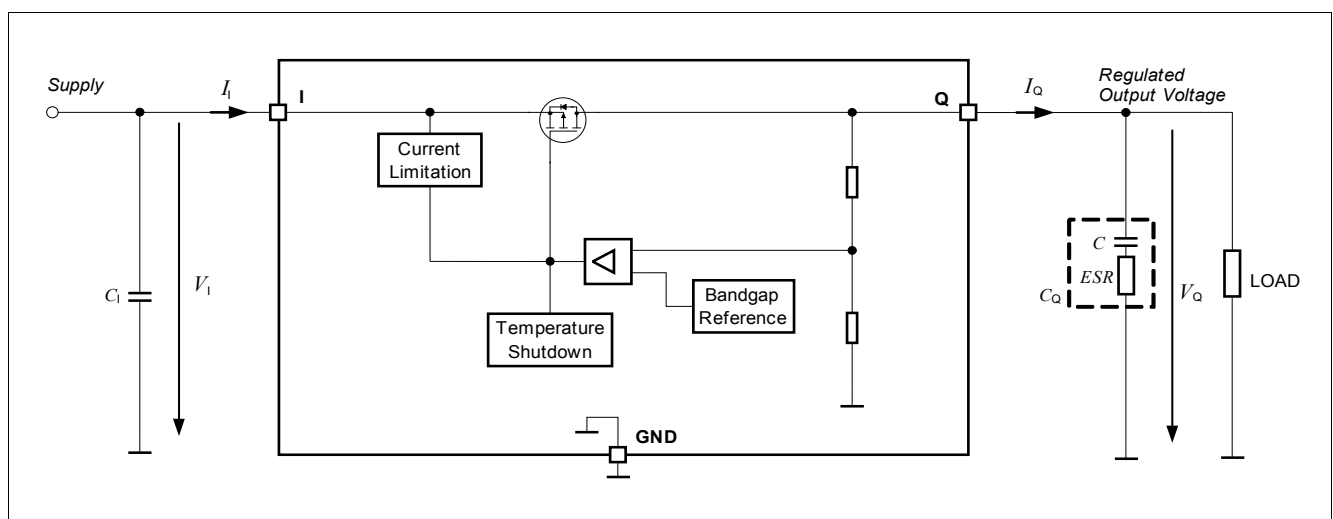


Figure 6 Block Diagram Voltage Regulation

**Block Description and Electrical Characteristics**

**Table 5 Electrical Characteristics**

$T_j = -40\text{ °C}$  to  $+150\text{ °C}$ ,  $V_I = 13.5\text{ V}$ , all voltages with respect to ground (unless otherwise specified).

Typical values are given at  $T_j = 25\text{ °C}$ ,  $V_I = 13.5\text{ V}$ .

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Output Voltage Precision	$V_Q$	4.90	5.00	5.10	V	$50\text{ }\mu\text{A} \leq I_Q \leq 100\text{ mA}$ , $5.7\text{ V} \leq V_I \leq 28\text{ V}$	P_5.1.1
Output Voltage Precision	$V_Q$	4.90	5.00	5.10	V	$50\text{ }\mu\text{A} \leq I_Q \leq 50\text{ mA}$ , $5.7\text{ V} \leq V_I \leq 42\text{ V}$	P_5.1.2
Output Current Limitation	$I_{Q,lim}$	110	190	260	mA	$0\text{ V} \leq V_Q \leq V_{Q,nom} - 0.1\text{ V}$	P_5.1.3
Line Regulation steady-state	$\Delta V_{Q,line}$	-	1	20	mV	$I_Q = 1\text{ mA}$ , $6\text{ V} \leq V_I \leq 32\text{ V}$	P_5.1.4
Load Regulation steady-state	$\Delta V_{Q,load}$	-20	-1	-	mV	$V_I = 6\text{ V}$ , $50\text{ }\mu\text{A} \leq I_Q \leq 100\text{ mA}$	P_5.1.5
Dropout Voltage <sup>1)</sup> $V_{dr} = V_I - V_Q$	$V_{dr}$	-	200	550	mV	$I_Q = 100\text{ mA}$	P_5.1.6
Ripple Rejection <sup>2)</sup>	$PSRR$	-	55	-	dB	$I_Q = 50\text{ mA}$ , $f_{ripple} = 100\text{ Hz}$ , $V_{ripple} = 0.5\text{ V}_{p-p}$	P_5.1.7
Overtemperature Shutdown Threshold	$T_{j,sd}$	151	175	-	°C	$T_j$ increasing	P_5.1.8
Overtemperature Shutdown Threshold Hysteresis	$T_{j,sdh}$	-	10	-	K	$T_j$ decreasing	P_5.1.9

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

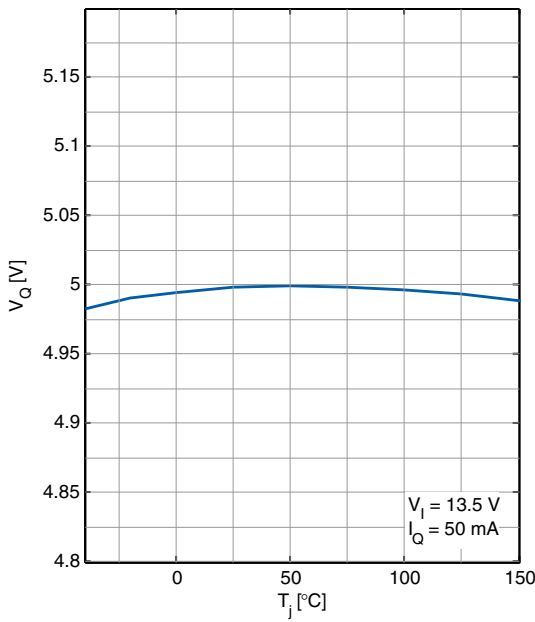
2) Not subject to production test, specified by design

Block Description and Electrical Characteristics

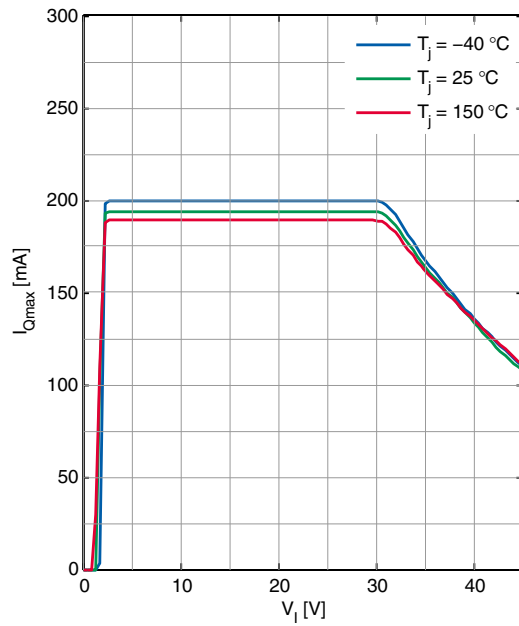
5.2 Typical Performance Characteristics Voltage Regulation

Typical Performance Characteristics

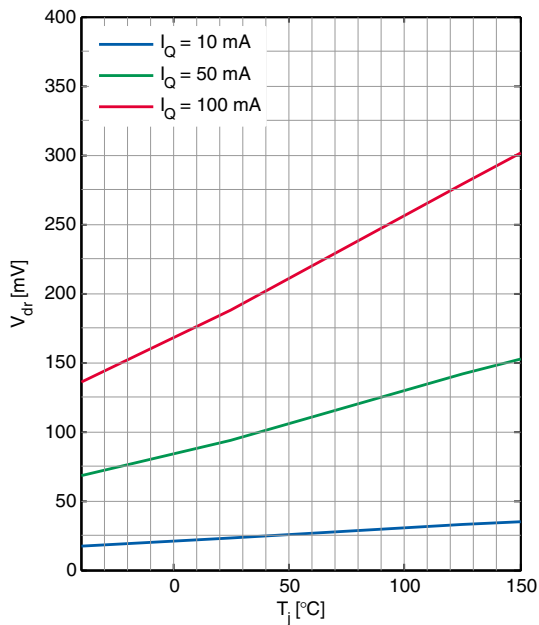
Output Voltage  $V_Q$  versus Junction Temperature  $T_j$



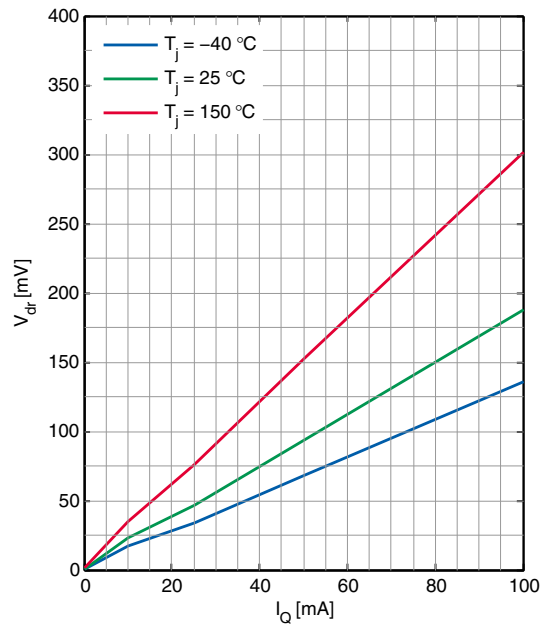
Output Current  $I_Q$  versus Input Voltage  $V_I$



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

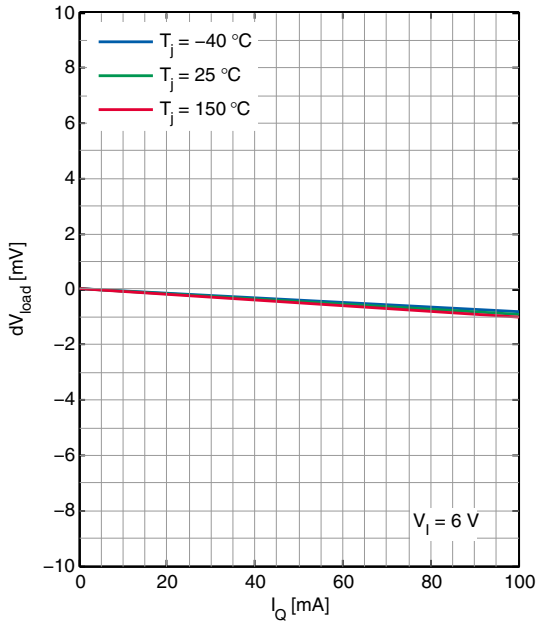


Dropout Voltage  $V_{dr}$  versus Output Current  $I_Q$

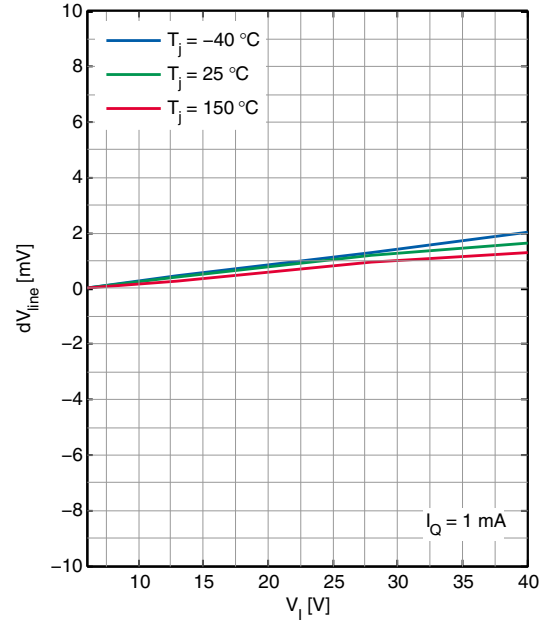


Block Description and Electrical Characteristics

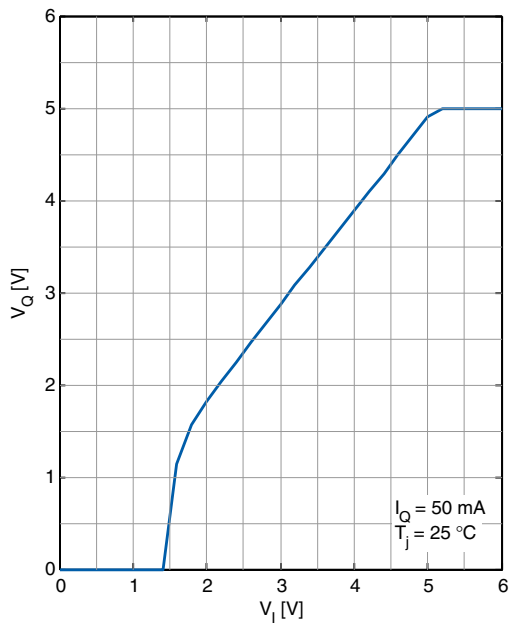
**Load Regulation  $\Delta V_{Q,load}$  versus Output Current  $I_Q$**



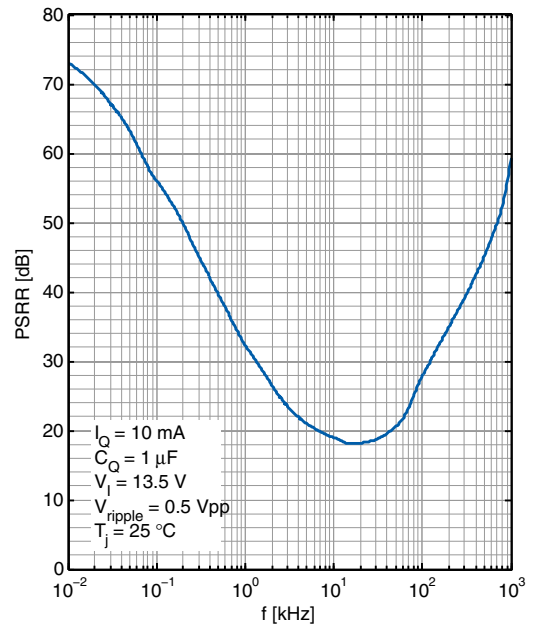
**Line Regulation  $\Delta V_{Q,line}$  versus Input Voltage  $V_I$**



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

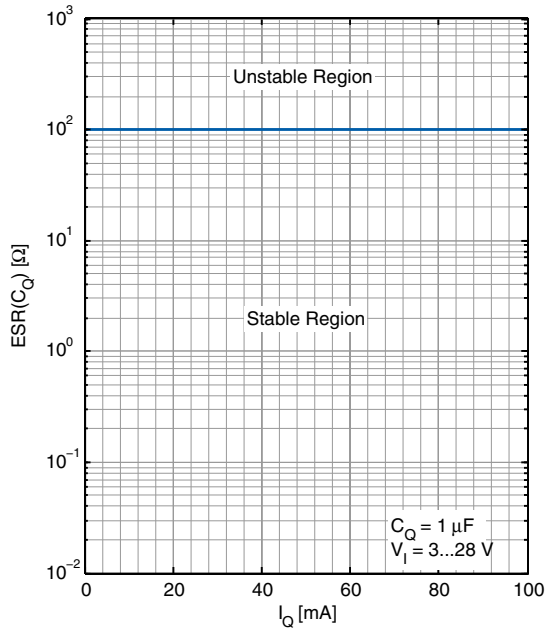


**Power Supply Ripple Rejection  $PSRR$  versus Ripple Frequency  $f_r$**



Block Description and Electrical Characteristics

Output Capacitor Series Resistor  $ESR(C_Q)$  versus Output Current  $I_Q$





Block Description and Electrical Characteristics

5.3 Current Consumption

**Table 6 Electrical Characteristics Current Consumption**

$T_j = -40\text{ °C}$  to  $+150\text{ °C}$ ,  $V_I = 13.5\text{ V}$  (unless otherwise specified).

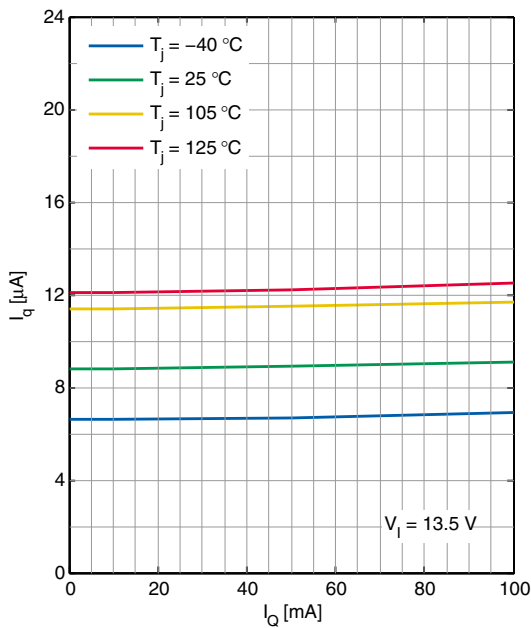
Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Current Consumption $I_q = I_I$	$I_{q,off}$	–	–	1	$\mu\text{A}$	$V_{EN} \leq 0.4\text{ V}$ , $T_j < 105\text{ °C}$	P_5.3.1
Current Consumption $I_q = I_I - I_Q$	$I_q$	–	9	11.5	$\mu\text{A}$	$I_Q = 50\ \mu\text{A}$ , $T_j = 25\text{ °C}$	P_5.3.2
Current Consumption $I_q = I_I - I_Q$	$I_q$	–	11.5	14.5	$\mu\text{A}$	$I_Q = 50\ \mu\text{A}$ , $T_j < 105\text{ °C}$	P_5.3.3
Current Consumption $I_q = I_I - I_Q$	$I_q$	–	12	16	$\mu\text{A}$	$I_Q = 50\ \mu\text{A}$ , $T_j < 125\text{ °C}$	P_5.3.4
Current Consumption $I_q = I_I - I_Q$	$I_q$	–	12	16	$\mu\text{A}$	$I_Q = 100\ \text{mA}$ , $T_j < 125\text{ °C}$	P_5.3.5

Block Description and Electrical Characteristics

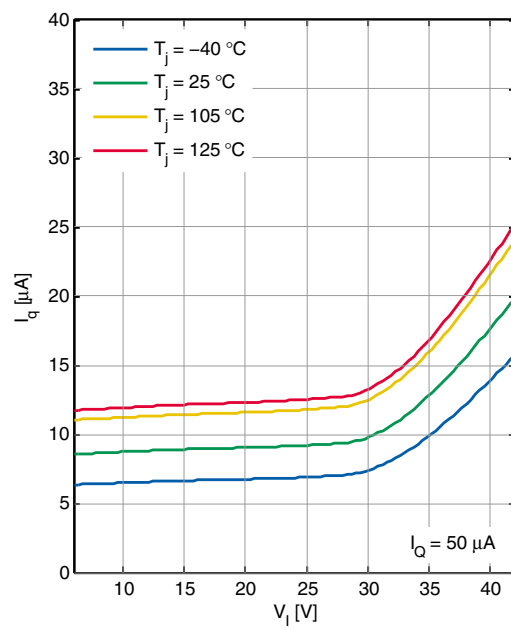
5.4 Typical Performance Characteristics Current Consumption

Typical Performance Characteristics

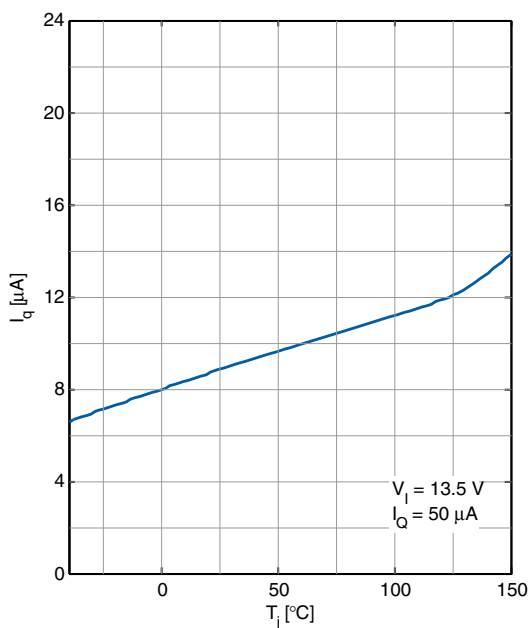
Current Consumption  $I_q$  versus Output Current  $I_Q$



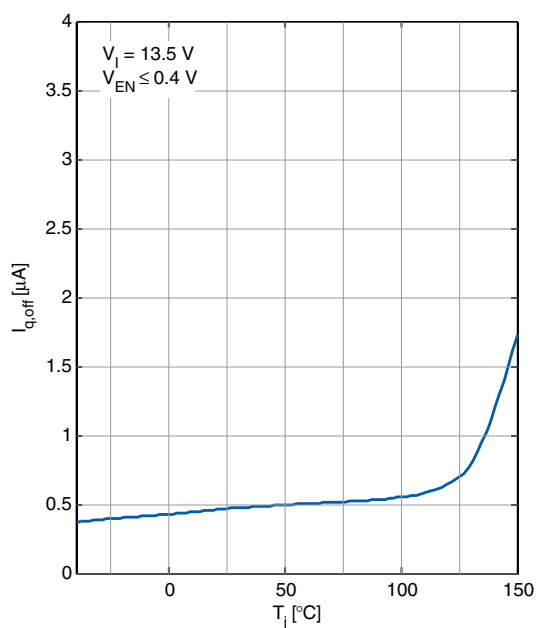
Current Consumption  $I_q$  versus Input Voltage  $V_I$



Current Consumption  $I_q$  versus Junction Temperature  $T_j$



Current Consumption in OFF mode  $I_{q,off}$  versus Junction Temperature  $T_j$



**Block Description and Electrical Characteristics**

**5.5 Enable**

The device can be switched on and off by the Enable feature. Connect a HIGH level as specified below (e.g. the battery voltage) to pin EN to enable the device; connect a LOW level as specified below (e.g. GND) to switch it off. The Enable function has a build-in hysteresis to avoid toggling between ON/OFF state, if signals with slow slopes are applied to the EN input.

**Table 7 Electrical Characteristics Enable**

$T_j = -40\text{ °C}$  to  $+150\text{ °C}$ ,  $V_I = 13.5\text{ V}$ , all voltages with respect to ground (unless otherwise specified). Typical values are given at  $T_j = 25\text{ °C}$ ,  $V_I = 13.5\text{ V}$ .

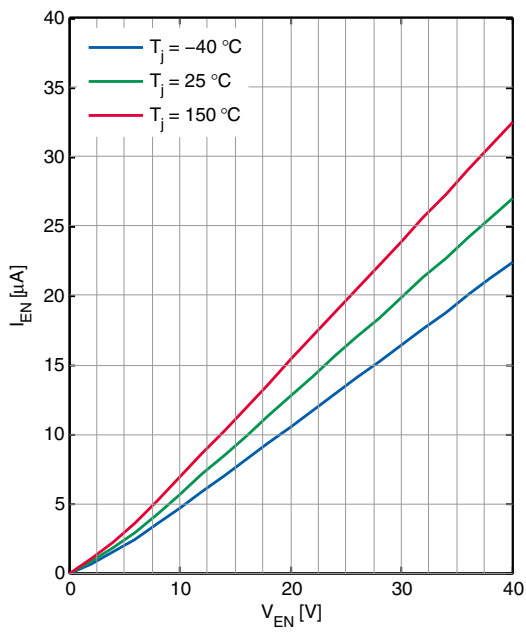
Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Enable High Level Input Voltage	$V_{EN,H}$	2	–	–	V	$V_Q$ settled	P_5.5.1
Enable Low Level Input Voltage	$V_{EN,L}$	–	–	0.8	V	$V_Q \leq 0.1\text{ V}$	P_5.5.2
Enable High Level Input Current	$I_{EN,H}$	–	–	4	$\mu\text{A}$	$V_{EN} = 5\text{ V}$	P_5.5.3
Enable Internal Pull-down Resistor	$R_{EN}$	1.25	2	3.5	$\text{M}\Omega$	–	P_5.5.4

Block Description and Electrical Characteristics

5.6 Typical Performance Characteristics Enable

Typical Performance Characteristics

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



## Block Description and Electrical Characteristics

### 5.7 Reset Function

The reset function provides several features:

#### Output Undervoltage Reset

An output undervoltage condition is indicated by setting the Reset Output RO to “low”. This signal may be used to reset a microcontroller during low supply voltage.

#### Power-On Reset Delay Time

The power-on reset delay time  $t_{rd}$  allows microcontroller and oscillator to start up. This delay time is the time frame from exceeding the reset switching threshold  $V_{RT}$  until the reset is released by switching the reset output “RO” from “low” to “high”. The power-on reset delay time  $t_{rd}$  is defined by an external delay capacitor  $C_D$  connected to pin D charged by the delay capacitor charge current  $I_{D,ch}$  starting from  $V_D = 0$  V.

If the application needs a power-on reset delay time  $t_{rd}$  different from the value given in [Table 8](#), the delay capacitor’s value can be derived from the specified value and the desired power-on delay time:

$$C_D = \frac{t_{rd,new}}{t_{rd}} \cdot 100 \text{ nF} \tag{5.1}$$

with

- $C_D$ : capacitance of the delay capacitor to be chosen
- $t_{rd,new}$ : desired power-on reset delay time
- $t_{rd}$ : power-on reset delay time specified in this datasheet

For a precise calculation also take the delay capacitor’s tolerance into consideration.

#### Reset Reaction Time

The reset reaction time  $t_{rr}$  considers the internal reaction time  $t_{rr,int}$  and the discharge time  $t_{rr,d}$  defined by the external delay capacitor  $C_D$  (see typical performance graph for details). Hence, the total reset reaction time becomes:

$$t_{rr} = t_{rr,int} + t_{rr,d} \tag{5.2}$$

with

- $t_{rr}$ : reset reaction time
- $t_{rr,int}$ : internal reset reaction time
- $t_{rr,d}$ : reset discharge

#### Optional Reset Output Pull-Up Resistor $R_{RO,ext}$

The Reset Output RO is an open collector output with an integrated pull-up resistor. If needed, an external pull-up resistor to the output Q can be added. In [Table 8](#) a minimum value for the external resistor  $R_{RO,ext}$  is given.

Block Description and Electrical Characteristics

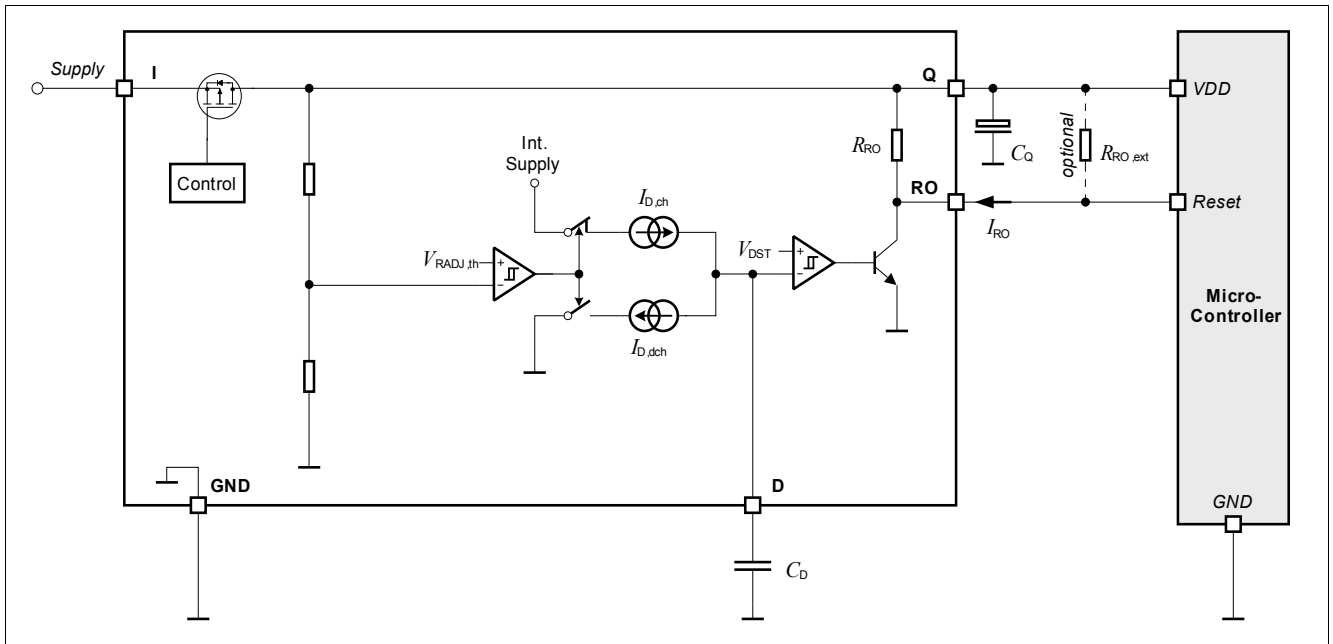


Figure 7 Block Diagram Reset Function

Block Description and Electrical Characteristics

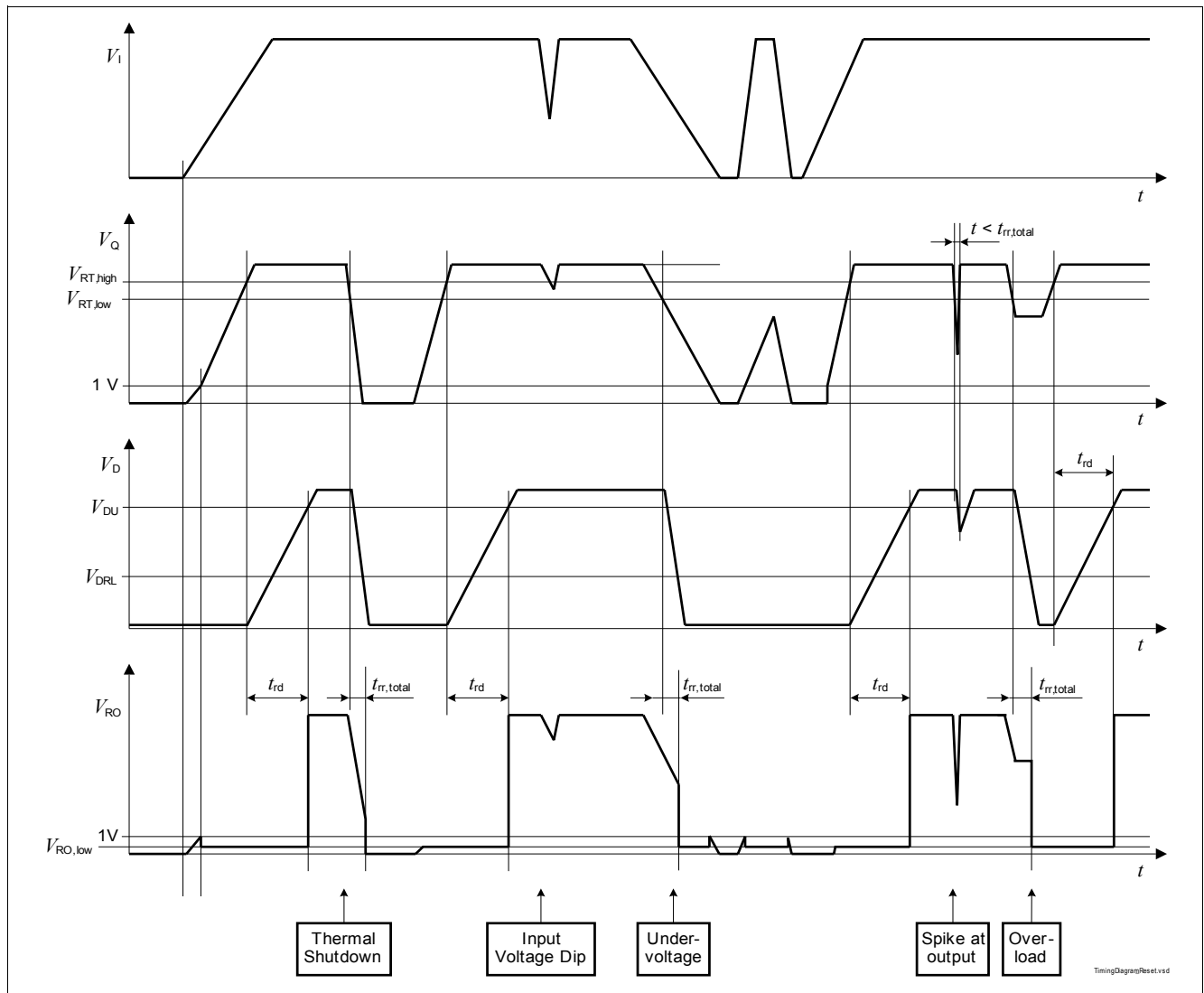


Figure 8 Timing Diagram Reset

Table 8 Electrical Characteristics Reset

$T_j = -40\text{ °C to }+150\text{ °C}$ ,  $V_i = 13.5\text{ V}$ , all voltages with respect to ground (unless otherwise specified). Typical values are given at  $T_j = 25\text{ °C}$ ,  $V_i = 13.5\text{ V}$ .

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
<b>Output Undervoltage Reset</b>							
Output Undervoltage Reset Upper Switching Threshold	$V_{RT,high}$	4.6	4.7	4.8	V	$V_Q$ increasing, $V_{EN} \geq 2.0\text{ V}$	P_5.7.1
Output Undervoltage Reset Lower Switching Threshold	$V_{RT,low}$	4.5	4.6	4.7	V	$V_Q$ decreasing, $V_{EN} \geq 2.0\text{ V}$	P_5.7.2
<b>Reset Output RO</b>							

**Block Description and Electrical Characteristics**

**Table 8 Electrical Characteristics Reset (cont'd)**

$T_j = -40\text{ °C}$  to  $+150\text{ °C}$ ,  $V_I = 13.5\text{ V}$ , all voltages with respect to ground (unless otherwise specified).  
 Typical values are given at  $T_j = 25\text{ °C}$ ,  $V_I = 13.5\text{ V}$ .

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Reset Output Low Voltage	$V_{RO,low}$	0	0.2	0.4	V	$1\text{ V} \leq V_Q \leq V_{RT}$ ; $R_{RO} > 4.7\text{ k}\Omega$	P_5.7.3
Reset Output Internal Pull-Up Resistor	$R_{RO,int}$	13	20	36	k $\Omega$	Internally connected to Q	P_5.7.4
Reset Output External Pull-up Resistor to $V_Q$	$R_{RO,ext}$	4.7	–	–	k $\Omega$	$1\text{ V} \leq V_Q \leq V_{RT}$ ; $V_{RO} \leq 0.4\text{ V}$	P_5.7.5

**Reset Delay Timing**

Power On Reset Delay Time	$t_{rd}$	17	25	37	ms	$C_D = 100\text{ nF}$ Calculated vaule	P_5.7.6
Upper Delay Switching Threshold	$V_{DU}$	–	0.9	–	V	–	P_5.7.7
Lower Delay Switching Threshold	$V_{DL}$	–	0.6	–	V	–	P_5.7.8
Delay Capacitor Charge Current	$I_{D,ch}$	–	3.6	–	$\mu\text{A}$	$V_D = 1\text{ V}$	P_5.7.9
Delay Capacitor Discharge Current	$I_{D,dch}$	–	250	–	mA	$V_D = 1\text{ V}$	P_5.7.10
Delay Capacitor Discharge Time	$t_{rr,d}$	–	2	4	$\mu\text{s}$	$C_D = 100\text{ nF}$ Calculated value	P_5.7.11
Internal Reset Reaction Time <sup>1)</sup>	$t_{rr,int}$	–	8	14	$\mu\text{s}$	$C_D = 0\text{ nF}$	P_5.7.12
Reset Reaction Time	$t_{rr,total}$	–	10	18	$\mu\text{s}$	$C_D = 100\text{ nF}$ Calculated value	P_5.7.13

1) Parameter not subject to production test; specified by design.

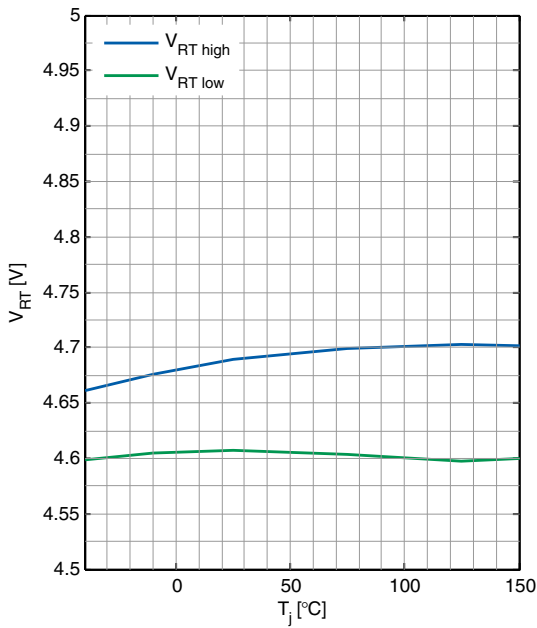


Block Description and Electrical Characteristics

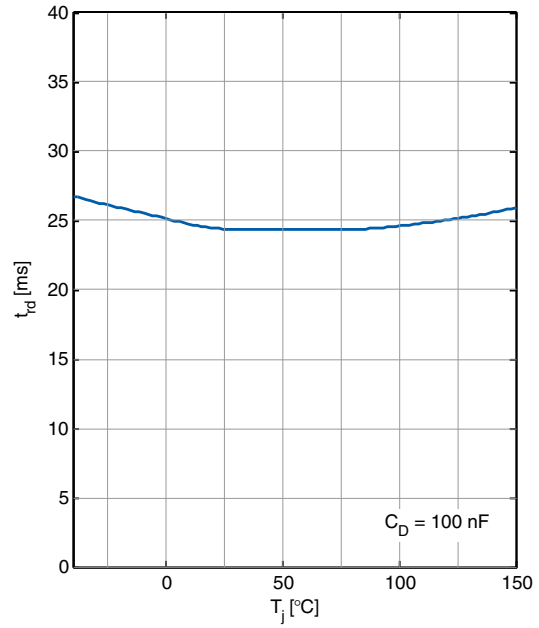
5.8 Typical Performance Characteristics Reset

Typical Performance Characteristics

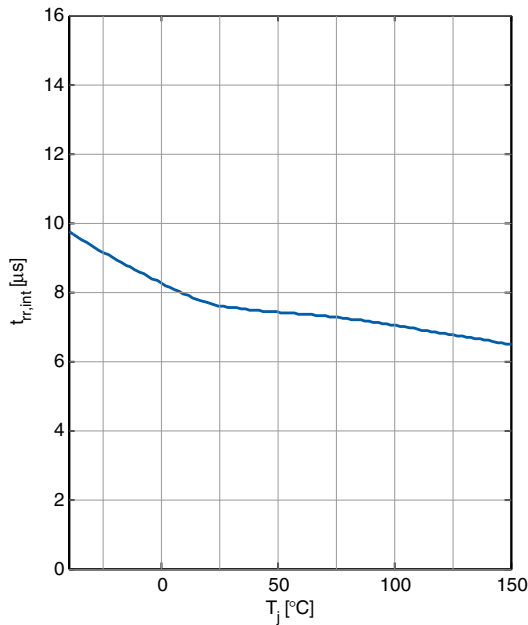
Undervoltage Reset Threshold  $V_{RT}$  versus Junction Temperature  $T_j$



Power On Reset Delay Time  $t_{rd}$  versus Junction Temperature  $T_j$



Internal Reset Reaction Time  $t_{rr,int}$  versus Junction Temperature  $T_j$



Application Information

## 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

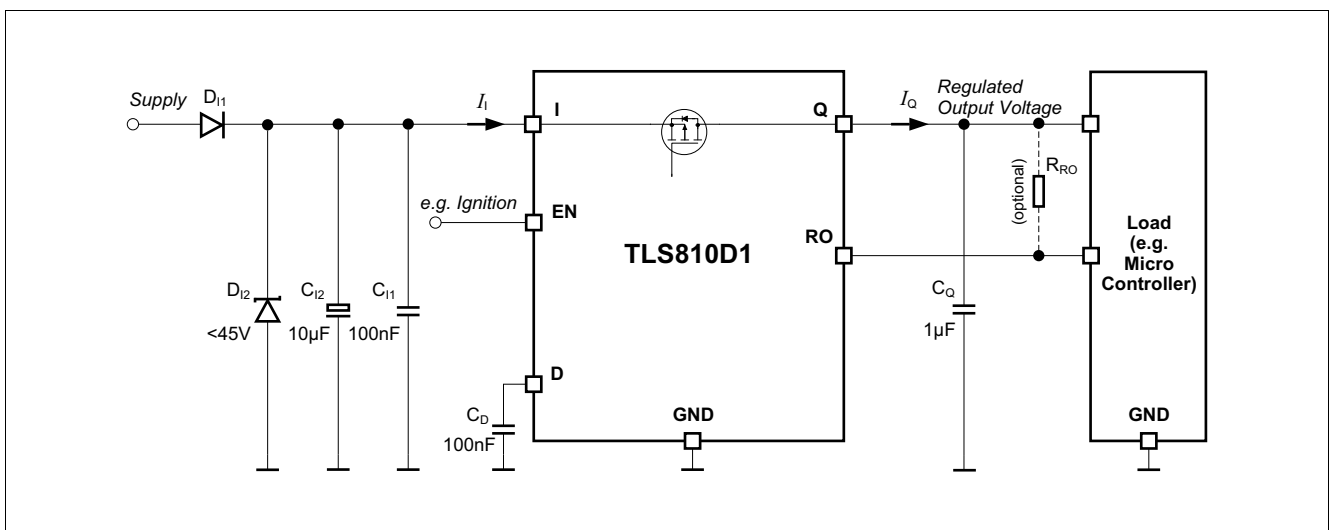


Figure 9 Application Diagram

### 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.