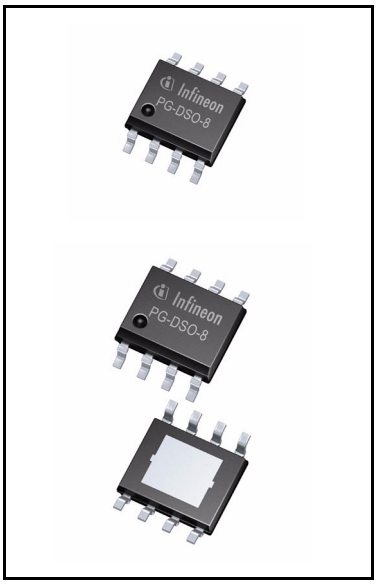
OPTIREG™ linear TLF4949

5 V low dropout linear voltage regulator with reset and sense

AEC Qualified

RoHS



Features

- Operating DC supply voltage range 5 V to 28 V
- Transient supply voltage up to 40 V
- Extremely low quiescent current in standby mode
- High precision standby output voltage 5 V ± 1%
- Output current capability up to 100 mA
- Very low dropout voltage less than 0.5 V
- Reset circuit sensing the output voltage
- Programmable reset pulse delay with external capacitor
- Voltage sense comparator
- Thermal shutdown and short-circuit protections
- Green Product (RoHS-compliant)

Potential applications

- General automotive applications
- Supply for microcontroller controlled systems

Product validation

Qualified for automotive applications. Product validation according to AEC-Q100.

Description

The TLF4949 is a monolithic integrated 5 V voltage regulator with a very low dropout output and additional functions such as undervoltage reset with power-on reset delay and input voltage sensing. It is designed to supply microcontroller controlled systems especially in automotive applications.

Type	Package	Marking
TLF4949SJ	PG-DSO-8	TLF4949S
TLF4949EJ	PG-DSO-8 exposed pad	TLF4949E

Table of contents

1 Block diagram

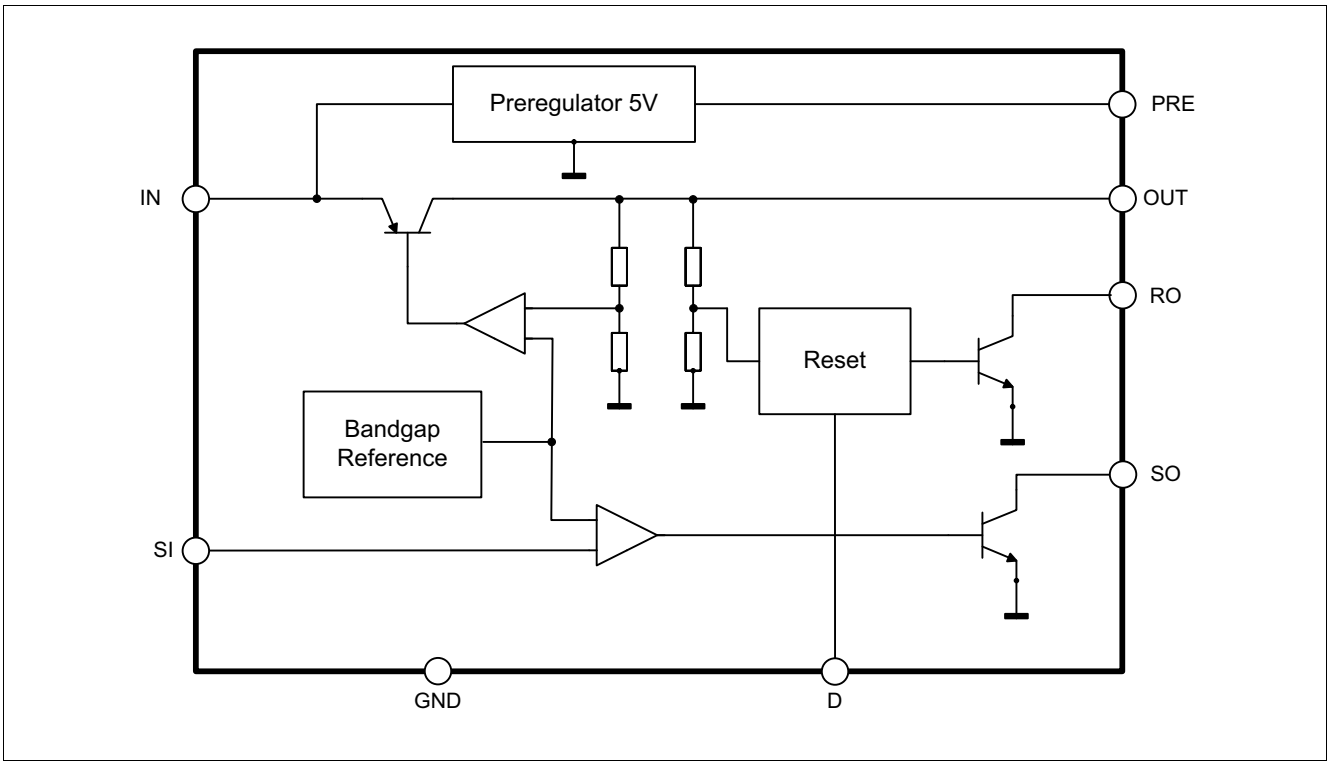


Figure 1 Block diagram

2 Pin configuration

2.1 Pin assignment PG-DSO-8

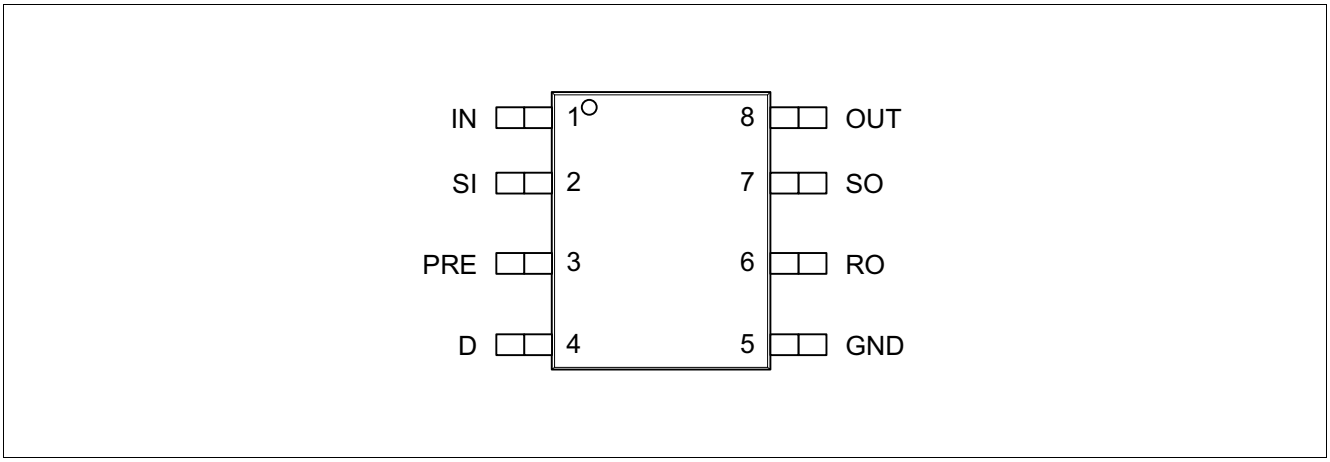


Figure 2 Pin configuration PG-DSO-8

2.2 Pin definitions and functions PG-DSO-8

Table 1 Pin definitions and functions

Pin	Symbol	Function
1	IN	**Input** Block to GND directly at the IC with a ceramic capacitor
2	SI	**Sense input** If not needed connect to OUT
3	PRE	**Preregulator output**
4	D	**Reset delay** To select delay time, connect to GND via capacitor
5	GND	**Ground**
6	RO	**Reset output** Open-collector output. Keep open, if not needed
7	SO	**Sense output** Open-collector output. Keep open, if not needed
8	OUT	**5 V output** [1) 2)] Connect to GND with a capacitor ≥ 4.7 µF, ESR < 10 Ω

1) For the usage of capacitors with very low ESR-values it is recommended to use a small 1 Ω resistor in series.
2) Measured at f = 10 kHz.

2.3 Pin assignment PG-DSO-8 exposed pad

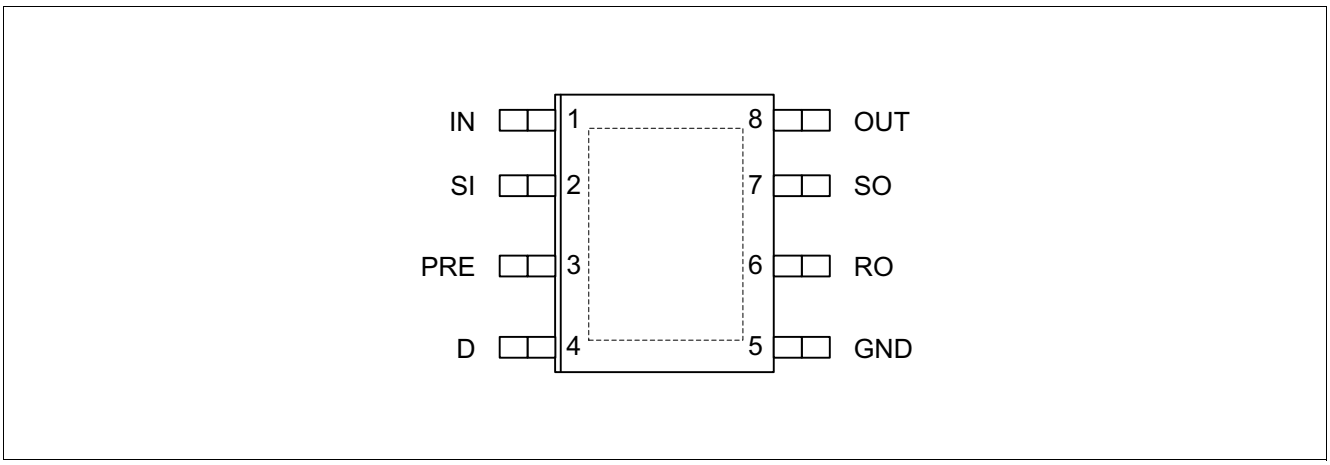


Figure 3 Pin configuration PG-DSO-8 exposed pad

2.4 Pin definitions and functions PG-DSO-8 exposed pad

Table 2 Pin definitions and functions

Pin	Symbol	Function
1	IN	**Input** Block to GND directly at the IC with a ceramic capacitor
2	SI	**Sense input** If not needed connect to OUT
3	PRE	**Preregulator output**
4	D	**Reset delay** To select delay time, connect to GND via capacitor
5	GND	**Ground**
6	RO	**Reset output** Open-collector output. Keep open, if not needed
7	SO	**Sense output** Open-collector output. Keep open, if not needed
8	OUT	**5 V output** [1) 2)] Connect to GND with a capacitor ≥ 4.7 µF, ESR < 10 Ω
Exposed pad	EP	**Heat sink** Connect to PCB heat sink area and GND

1) For the usage of capacitors with very low ESR-values it is recommended to use a small 1 Ω resistor in series.
2) Measured at f = 10 kHz.

3 General product characteristics

3.1 Absolute maximum ratings

Table 3 Absolute maximum ratings [1)]

T_j = -40°C to +125°C; all voltages with respect to ground, direction of current as shown in **Figure 4** (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Voltage rating							
DC operating supply	V_{IN}	-0.3	–	28	V	–	P_4.1.1
Transient supply voltage	V_{IN_TR}	–	–	45	V	[2)]	P_4.1.2
Preregulator output	V_{PRE}	–	–	7	V	–	P_4.1.3
Voltage regulator output	V_{OUT}	-0.3	–	20	V	–	P_4.1.4
Reset output	V_{RO}	-0.3	–	20	V	–	P_4.1.5
Sense input	V_{SI}	-30	–	40	V	–	P_4.1.6
Sense output voltage	V_{SO}	-0.3	–	20	V	–	P_4.1.7
Reset delay	V_D	-0.3	–	7	V	–	P_4.1.8
Current rating							
Preregulator output	I_{PRE}	–	–	5	mA	–	P_4.1.9
Reset out	I_{RO}	–	–	5	mA	–	P_4.1.10
Sense out	I_{SO}	–	–	5	mA	–	P_4.1.11
Temperatures							
Junction temperature	T_j	-40	–	150	°C	–	P_4.1.12
Storage temperature	T_{stg}	-50	–	150	°C	–	P_4.1.13
ESD susceptibility							
ESD resistivity to GND	V_{ESD}	-4	–	4	kV	[3)] Human body model (HBM)	P_4.1.14
ESD resistivity to GND	V_{ESD}	-1	–	1	kV	[4)] Charged device model (CDM)	P_4.1.15

1) Not subject to production test, specified by design.
2) For transient durations of t_{TR} < 1 s.
3) ESD susceptibility, human body model (HBM) according to ANSI/ESDA/JEDEC JS-001 (1.5 kΩ, 100 pF).
4) ESD susceptibility, charged device model (CDM) ESDA STM5.3.1 or ANSI/ESD S.5.3.1.

Note:

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 datasheet. Fault conditions are considered as "outside" normal operating range. Protection functions are not designed for continuous repetitive operation.*

3.2 Functional range

Table 4 Functional range

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Input voltage range for normal operation	V_{IN}	5.5	–	28	V	–	P_4.2.1
Extended input voltage range	V_{IN}	3.5	–	40	V	1) 2)	P_4.2.2

1) The output voltage will follow the input voltage for input voltages below $V_{OUT} + V_{DR}$, that is, device is in tracking mode until $V_{OUT} + V_{DR}$ is reached.
2) Input voltages ranging from > 28 V up to 40 V may only be applied for transient periods $t_{TR} < 1$ s.

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.

3.3 Thermal resistance

Table 5 Thermal resistance 1)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
TLF4949SJ (PG-DSO-8)							
Junction to soldering point	R_{thJSP}	–	71	–	K/W		P_4.3.1
Junction to ambient	R_{thJA}	–	116	–	K/W	2)	P_4.3.2
Junction to ambient	R_{thJA}	–	172	–	K/W	3) Footprint only	P_4.3.3
Junction to ambient	R_{thJA}	–	145	–	K/W	3) 300 mm² heatsink area on PCB	P_4.3.4
Junction to ambient	R_{thJA}	–	139	–	K/W	3) 600 mm² heatsink area on PCB	P_4.3.5
TLF4949EJ (PG-DSO-8 exposed pad)							
Junction to case	R_{thJC}	–	19	–	K/W	–	P_4.3.6
Junction to ambient	R_{thJA}	–	52	–	K/W	4)	P_4.3.7
Junction to ambient	R_{thJA}	–	167	–	K/W	3) Footprint only	P_4.3.8
Junction to ambient	R_{thJA}	–	78	–	K/W	3) 300 mm² heatsink area on PCB	P_4.3.9
Junction to ambient	R_{thJA}	–	66	–	K/W	3) 600 mm² heatsink area on PCB	P_4.3.10
Thermal shutdown							
Junction temperature	T_{JSD}	–	165	–	°C	–	P_4.3.11

1) Not subject to production test.
2) The specified R_{thJA} value is according to JEDEC JESD51-2,-7 at natural convection on FR4 2s2p board. The product (chip and package) was simulated on a 76.2 × 114.3 × 1.5 mm board with 2 inner copper layers (2 × 70 µm Cu, 2 × 35 µm Cu).
3) The specified R_{thJA} value is according to JEDEC JESD 51-3 at natural convection on an FR4 1s0p board. The product (chip and package) was simulated on a 76.2 × 114.3 × 1.5 mm³ board with 1 copper layer (1 × 70 µm Cu).
4) The specified R_{thJA} value is according to JEDEC JESD51-2,-5,-7 at natural convection on an FR4 2s2p board. The product (chip and package) was simulated on a 76.2 × 114.3 × 1.5 mm board with 2 inner copper layers (2 × 70 µm Cu, 2 × 35 µm Cu). Where applicable a thermal via array under the exposed pad contacted the first inner copper layer.

*Note: This thermal data was generated in accordance with JEDEC JESD51 standards. For more information, go to **www.jedec.org**.*

4 Electrical characteristics

4.1 Voltage regulator

Table 6 Electrical characteristics: Regulator

V_{IN} = 14 V, T_j = -40°C to +125°C, all voltages with respect to ground, direction of current as shown in **Figure 4** (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Output voltage	V_{OUT}	4.95	5	5.05	V	T_j = 25°C; I_{OUT} = 1 mA	P_4.4.1
Output voltage	V_{OUT}	4.90	5	5.10	V	6 V ≤ V_{IN} ≤ 28 V; 1 mA ≤ I_{OUT} ≤ 50 mA	P_4.4.2
Output voltage	V_{OUT}	4.85	–	5.15	V	[1] V_{IN} = 40 V; 5 mA ≤ I_{OUT} ≤ 100 mA	P_4.4.3
Output voltage	V_{OUT}	4.85	5	5.15	V	6 V ≤ V_{IN} ≤ 28 V; 0 mA ≤ I_{OUT} ≤ 100 mA	P_4.4.4
Dropout voltage $V_{DR} = V_{IN} - V_{OUT}$	V_{DR}	–	0.1 0.2 0.3	0.25 0.4 0.5	V V V	I_{OUT} = 10 mA I_{OUT} = 50 mA I_{OUT} = 100 mA	P_4.4.5
Input to output voltage difference in undervoltage condition	V_{IO}	–	0.17	0.4	V	V_{IN} = 3.5 V; I_{OUT} = 35 mA	P_4.4.6
Current sink capability from output to GND	I_{outh}	-30	-55	–	µA	[2] V_{IN} = 25 V; V_{OUT} = 5.5 V	P_4.4.7
Line regulation	$\Delta V_{OUT,line}$	–	1	15	mV	6 V < V_{IN} < 28 V; I_{OUT} = 1 mA	P_4.4.8
Load regulation	$\Delta V_{OUT,load}$	–	4	20	mV	1 mA ≤ I_{OUT} ≤ 100 mA	P_4.4.9
Current limit	$I_{OUT,lim}$	120	240 180	400	mA mA	[3] V_{OUT} = 4.5 V V_{OUT} = 0 V	P_4.4.10
Quiescent current	I_{QSE}	–	180	300	µA	I_{OUT} = 0.3 mA	P_4.4.11
Quiescent current	I_Q	–	–	3.6	mA	I_{OUT} = 100 mA	P_4.4.12

1) V_{IN} = 40 V may be only applied as transient supply voltage to the device for maximum period of t_{TR} < 1 s. Please note that also for such transient conditions, especially under higher load conditions, the absolute maximum rating of T_j must be respected at any time. If transient conditions up to V_{IN} = 40 V and elevated load currents are expected in the application a sufficient cooling must be provided to meet the power dissipation. Testing this parameter for the maximum allowed period of t = 1 s is for thermal reasons not subject to production test but guaranteed by design.

2) The test of this parameter ensures that the output voltage will not exceed 5.5 V in a corresponding “no load current”-condition. A sufficiently high value for I_{outh} will allow the output to react in a fast manner in case of a sudden decrease of load current (for example, if load is switching to standby or powerdown mode).

3) Foldback characteristic.

4.2 Reset

Table 7 Electrical characteristics: Reset

V_{IN} = 14 V, T_j = -40°C to +125°C, all voltages with respect to ground, direction of current as shown in **Figure 4** (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Reset threshold voltage	V_{RT}	4.25	4.5	4.75	V	–	P_4.4.13
Reset threshold hysteresis	V_{RTH}	50	100	200	mV	–	P_4.4.14
Reset pulse delay	t_{RD}	55	100	180	ms	Calculated value: C_D = 100 nF; $t_R \geq$ 100 µs	P_4.4.15
Reset output low voltage	V_{RL}	–	–	0.4	V	[1] $R_{RES} \geq$ 10 kΩ to V_{OUT}; $V_{IN} \geq$ 0 V and $V_{OUT} \geq$ 1 V	P_4.4.16
Reset output high leakage current	I_{RH}	–	–	1	µA	V_{RES} = 5 V	P_4.4.17
Delay comparator threshold	$V_{D,th}$	–	2	–	V	–	P_4.4.18
Delay comparator threshold hysteresis	$V_{D,th, hy}$	–	100	–	mV	–	P_4.4.19
Delay capacitor charge current	$I_{D,chg}$	–	2	–	µA	V_D = 1 V; current flowing out of D pin	P_4.4.20
Delay capacitor discharge current	$I_{D,dchg}$	–	9	–	mA	V_D = 1 V; current flowing into D pin	P_4.4.21

1) Device entering this condition by decreasing V_{IN} from powered up and fully initialized operation state.

4.3 Sense

Table 8 Electrical characteristics: Sense

V_{IN} = 14 V, T_j = -40°C to +125°C, all voltages with respect to ground, direction of current as shown in **Figure 4** (unless otherwise specified)

Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Sense							
Sense low threshold	V_{ST}	1.16	1.23	1.35	V	–	P_4.4.22
Sense threshold hysteresis	V_{STH}	20	100	200	mV	–	P_4.4.23
Sense output low voltage	V_{SL}	–	–	0.4	V	$V_{SI} \leq$ 1.16 V; $V_{IN} \geq$ 3.5 V; $R_{SO} \geq$ 10 kΩ to V_{OUT}	P_4.4.24
Sense output leakage	I_{SH}	–	–	1	µA	V_{SO} = 5 V; $V_{SI} \geq$ 1.5 V	P_4.4.25
Sense input current	I_{SI}	-5	-1.5	0	µA	V_{SI} = 0 V	P_4.4.26

4.4 Preregulator

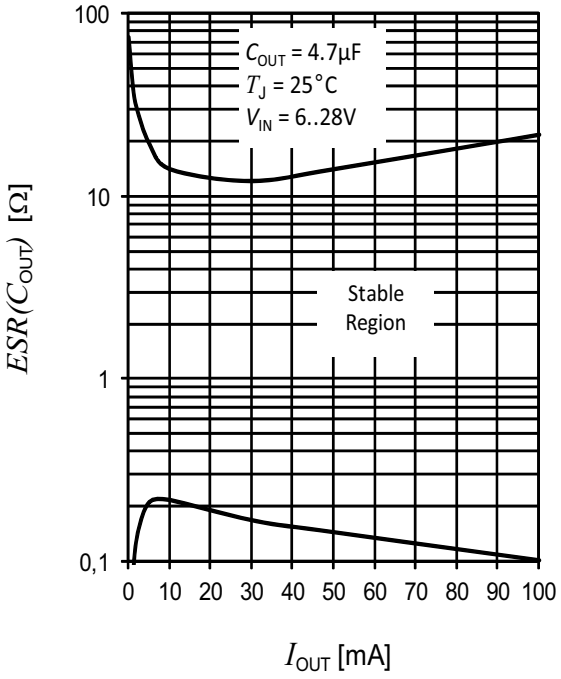
Table 9 Electrical characteristics: Preregulator

V_{IN} = 14 V, T_j = -40°C to +125°C, all voltages with respect to ground, direction of current as shown in **Figure 4** (unless otherwise specified)

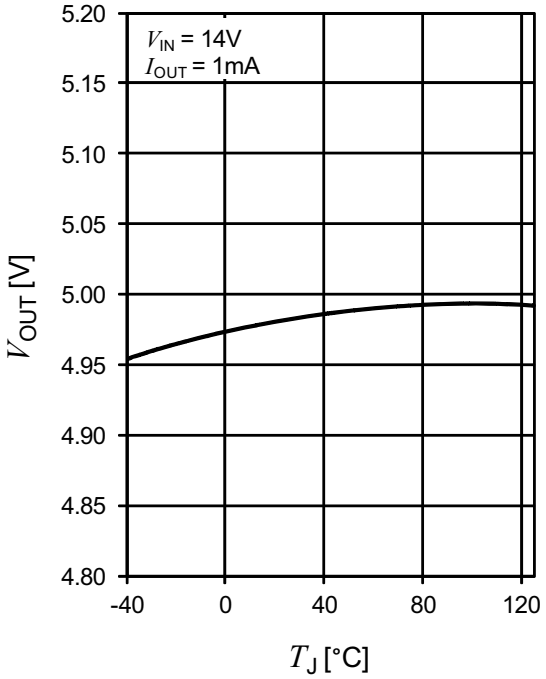
Parameter	Symbol	Values			Unit	Note or Test Condition	Number
		Min.	Typ.	Max.			
Preregulator							
Preregulator output voltage	V_{PRE}	4.5	5	6	V	I_{PRE} = 10 µA	P_4.4.27
Preregulator output current	I_{PRE}	–	–	10	µA	–	P_4.4.28

4.5 Typical performance characteristics

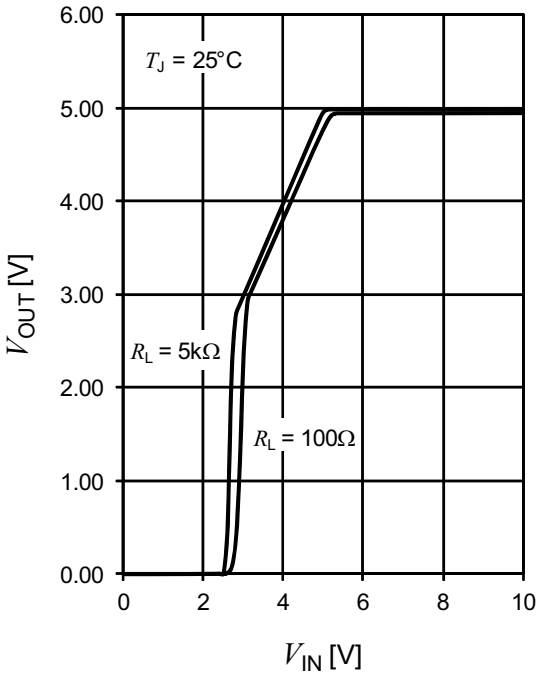
Equivalent series resistance *ESR(C_{OUT})* versus output current I_{OUT}



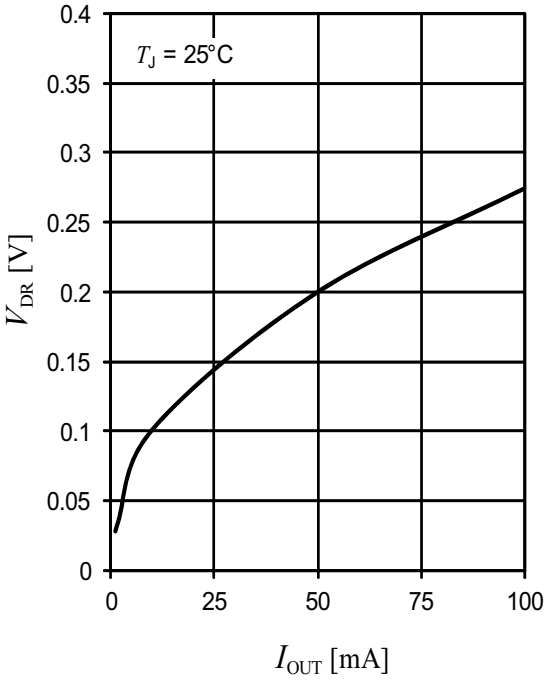
Output voltage V_{OUT} versus junction temperature T_j



Output voltage V_{OUT} versus input voltage V_{IN}

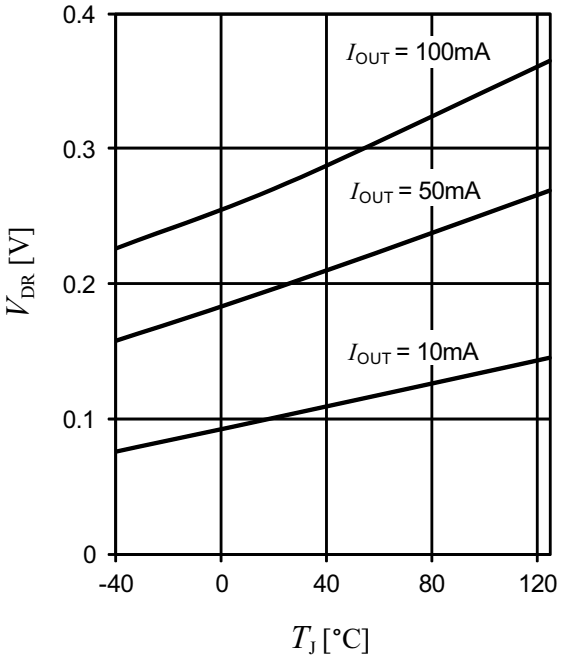


Dropout voltage V_{DR} versus output current I_{OUT}

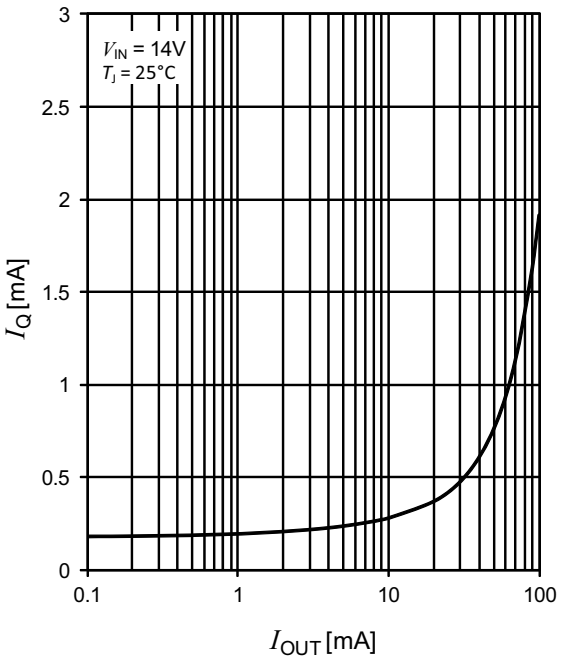


Electrical characteristics

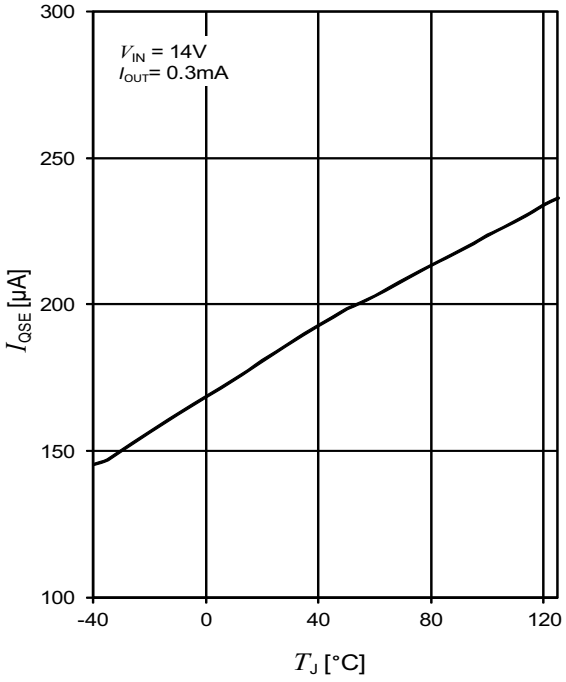
Dropout voltage V_{DR} versus junction temperature T_j



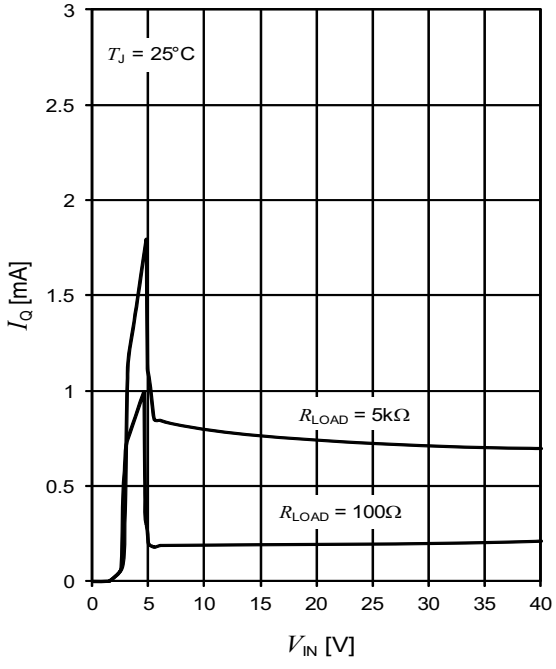
Quiescent current I_Q versus output current I_{OUT}



Quiescent current I_{QSE} versus junction temperature T_j

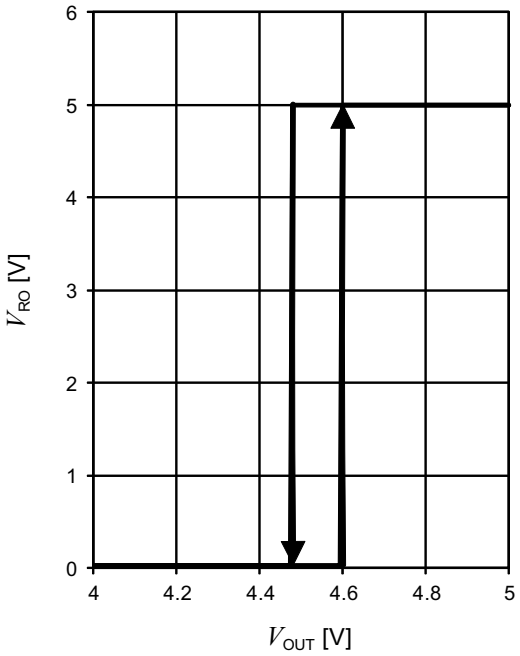


Quiescent current I_Q versus input voltage V_{IN}

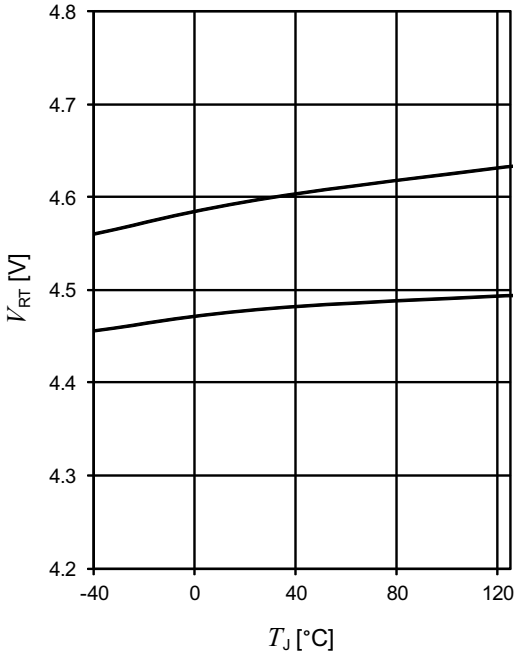


Electrical characteristics

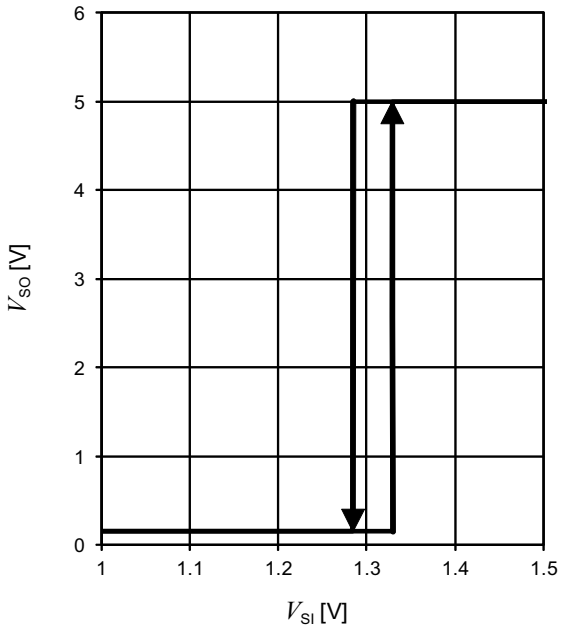
Reset output voltage V_{RO} versus regulator output voltage V_{OUT}



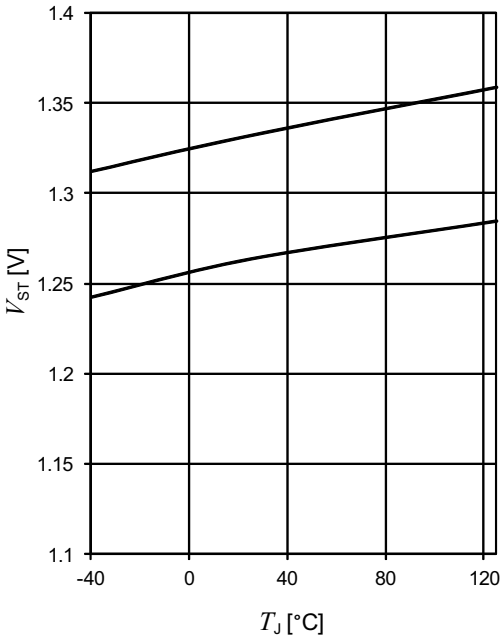
Reset thresholds V_{RT} versus junction temperature T_j



Sense output voltage V_{SO} versus sense input voltage V_{SI}



Sense thresholds V_{ST} versus junction temperature T_j



5 Application information

Note: The following information is given as a hint for the implementation of the device only and should not be regarded as a description or warranty of a certain functionality, condition or quality of the device.

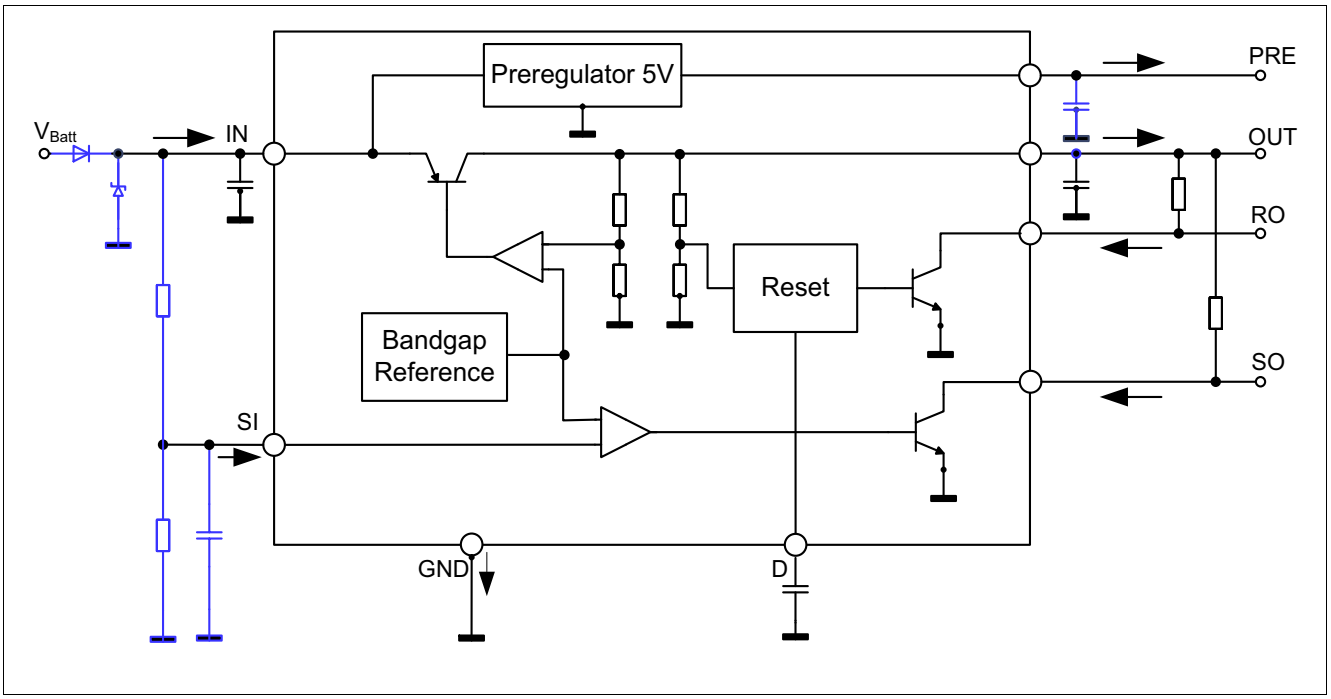


Figure 4 Application diagram

Note: This is a very simplified example of an application circuit. The function must be verified in the real application.

5.1 Supply voltage transients

For many other voltage regulators fast supply voltage transients can often be the cause of unwanted reset output signal perturbations. In contrast the TLF4949 shows a very high immunity of its reset output against such supply voltage transients. Already starting from input voltages as low as 5.5 V the TLF4949 shows an immunity of the reset output against supply transients of more than 100 V/µs even without an additional external capacitor at the PRE pin [1) 2)].

5.2 Functional description

The TLF4949 is a monolithic integrated low dropout voltage regulator. Several outstanding features and auxiliary functions are implemented to meet the requirements of supplying microprocessor systems in automotive applications. Nevertheless, it is also suitable in other applications where the present functions are required. The modular approach of this device allows to easily get other features and functions when required.

1) Please note that also for the case of such input transients the absolute maximum ratings must not be violated.
2) The PRE pin of the TLF4949 offers the possibility to connect a bypass capacitor to GND to stabilize PRE output and to optimize the transient behavior. See also section **Preregulator**.

Application information

Voltage regulator

The voltage regulator uses a PNP transistor as a regulation element. With this structure a very low dropout voltage at currents of up to 100 mA is obtained.

The dropout operation of the standby regulator is maintained down to 3.5 V input supply voltage. The output voltage is regulated up to a transient input supply voltage of 40 V. With this feature no functional interruption due to over voltage pulses is generated. The typical curve showing the standby output voltage as a function of the input supply voltage V_S is shown in **Figure 5**.Typical values of the current consumption of this device at small loads (quiescent current) are less than 200 µA.

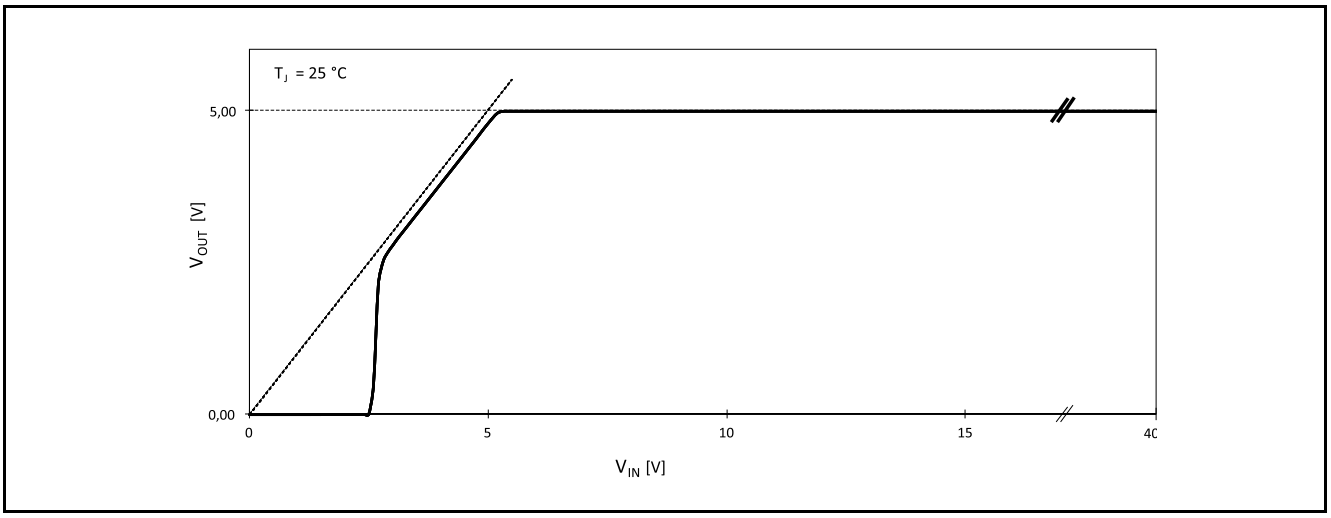


Figure 5 Output voltage V_{OUT} versus input voltage V_{IN}

To reduce the quiescent current peak in the undervoltage region and to improve the transient response in this region, the dropout voltage is controlled. The quiescent current as a function of the supply input voltage is shown for two different load conditions in **Figure 6**.

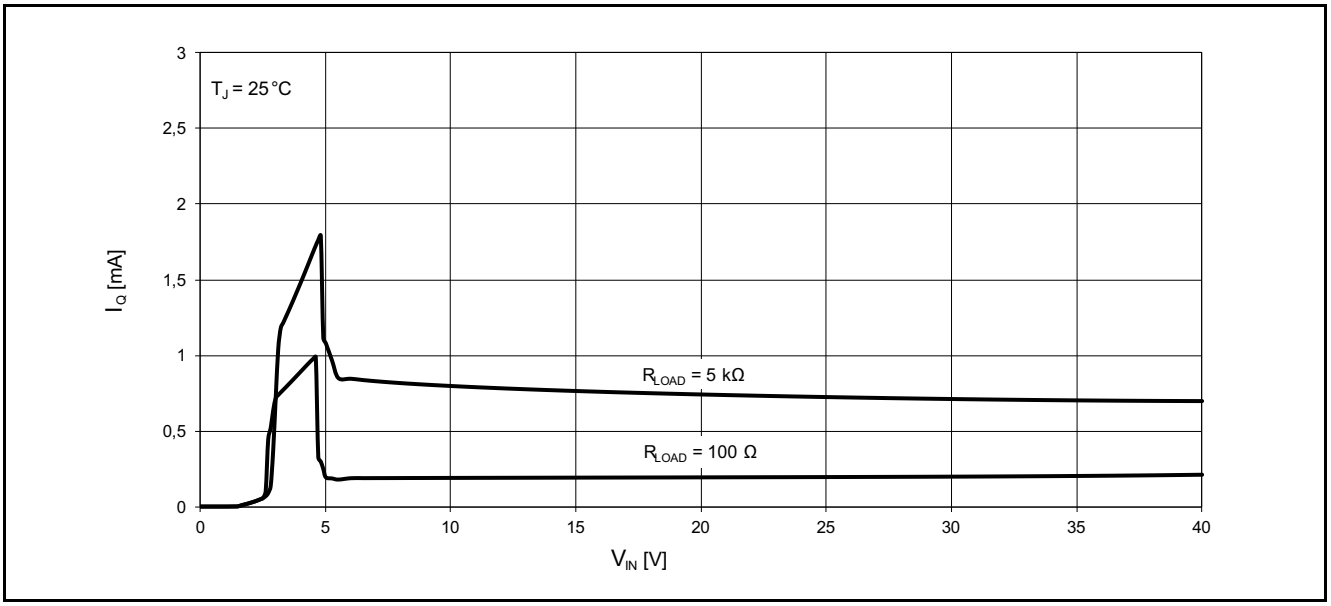


Figure 6 Quiescent current I_Q versus supply voltage V_{IN}

Application information

Short circuit protection

The maximum output current of the device is internally limited. In case of short circuit, the output current is foldback limited as described in **Figure 7**.

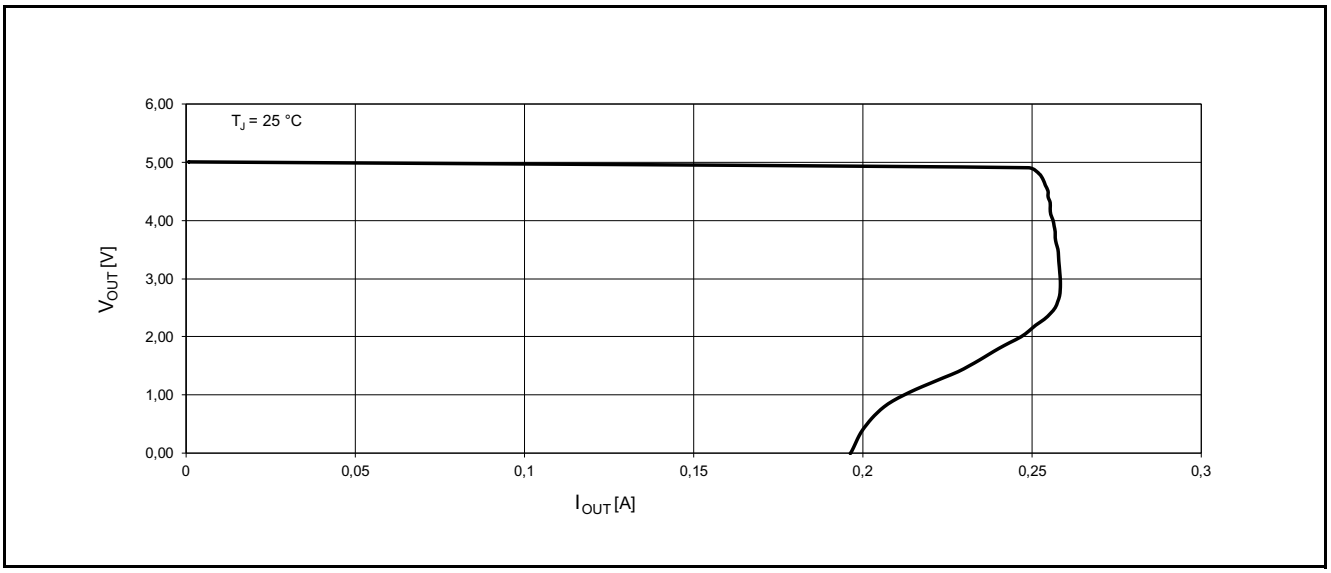


Figure 7 Foldback characteristics of V_{OUT}

Preregulator

To improve the transient immunity a preregulator stabilizes the internal supply voltage to 5 V. This internal voltage is also present at the PRE pin (Pin 3). This voltage should not be used as an output because the output capability is very small (≤ 10 µA).

This output at the PRE pin may be used as an option when an improved transient behavior for supply voltages less than 8 V is desired. In this case a capacitor (between 100 nF and 1 µF) can be connected between the PRE pin and GND. At the same time the usage of such a bypass capacitor is suitable to reduce output noise at the OUT pin. If this feature is not used the PRE pin must be left open.

Reset circuit

The block circuit diagram of the reset circuit is shown in **Figure 8**. The reset circuit supervises the output voltage. The reset threshold of 4.5 V is defined by the internal reference voltage and standby output divider. The reset pulse delay time t_{RD}, is defined by the charge time of an external capacitor $C_{D:}$

$$t_{RD} = \frac{C_D \times 2.0\ V}{2.0\ \mu A}$$

The reaction time of the reset circuit originates from the discharge time limitation of the reset capacitor C_D and is proportional to the value of C_D.

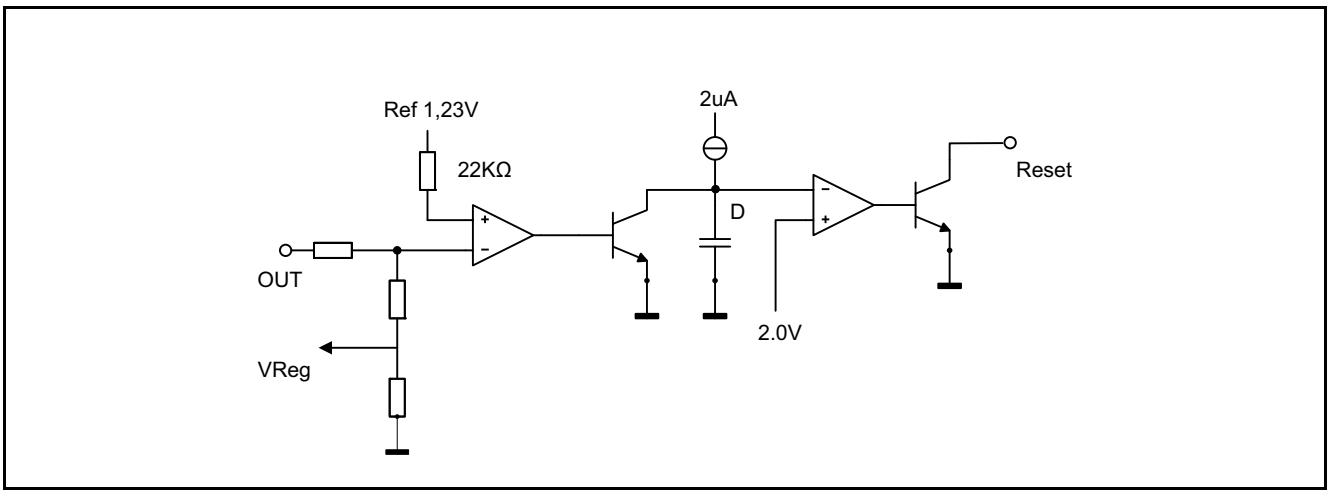


Figure 8 Reset circuit

The reaction time of the reset circuit corresponds to its noise immunity. Standby output voltage drops below the reset threshold that are only marginally longer than the reaction time will result in a shorter reset delay times.

The nominal reset delay time will be generated for standby output voltage drops longer than approximately 50 µs.

The typical reset output waveforms are shown in **Figure 9**.

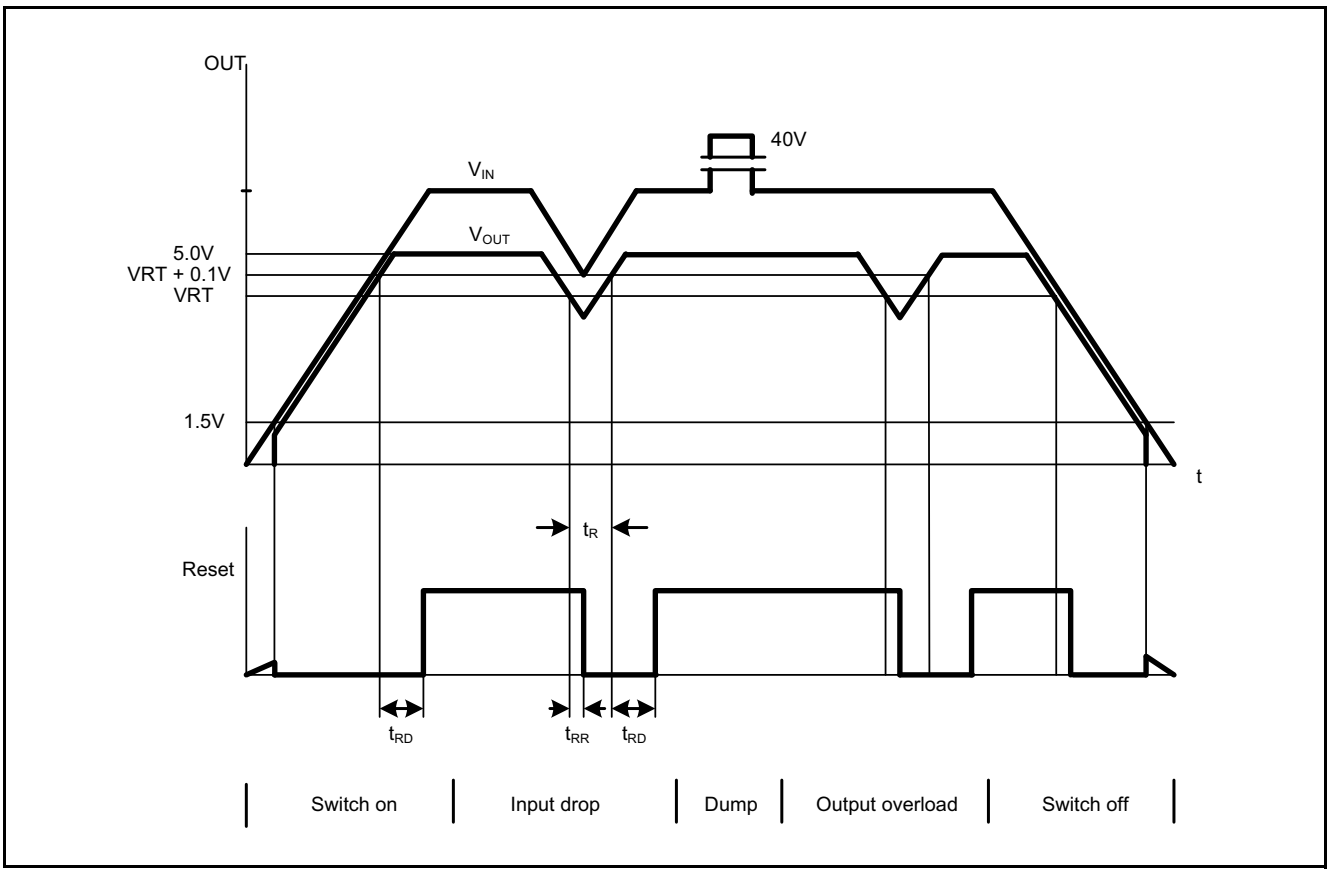


Figure 9 Typical reset output waveforms

Sense comparator

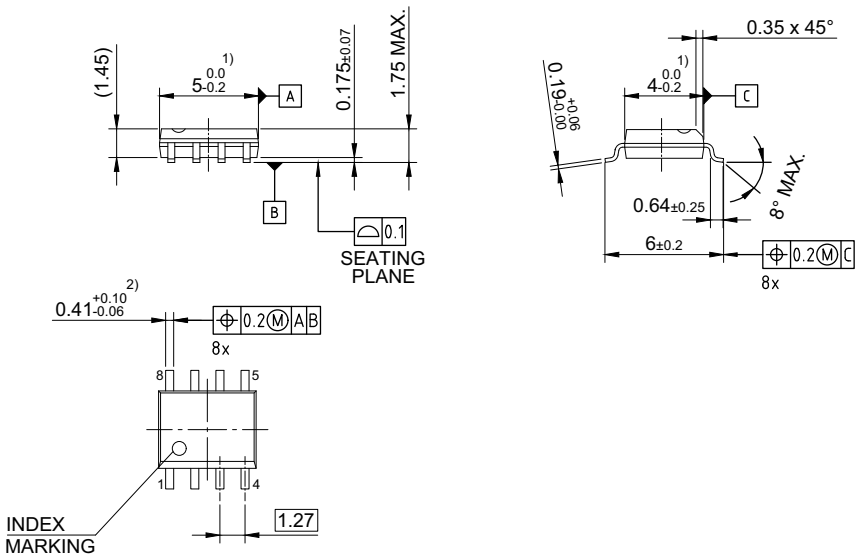
The sense comparator compares an input signal with the internal voltage reference of typical 1.23 V. The use of an external voltage divider makes this comparator very flexible in the application.

It can be used to supervise the input voltage either before or after a protection diode and to give additional informations to the microprocessor like low voltage warnings.

5.3 Further application information

For further information you may contact **https://www.infineon.com**.

6 Package information



1) Does not include plastic or metal protrusion of 0.15 max. per side
2) Lead width can be 0.61 max. in dambar area
All dimensions are in units mm
The drawing is in compliance with ISO 128-30, Projection Method 1 [ ]

Figure 10 PG-DSO-8

Package information

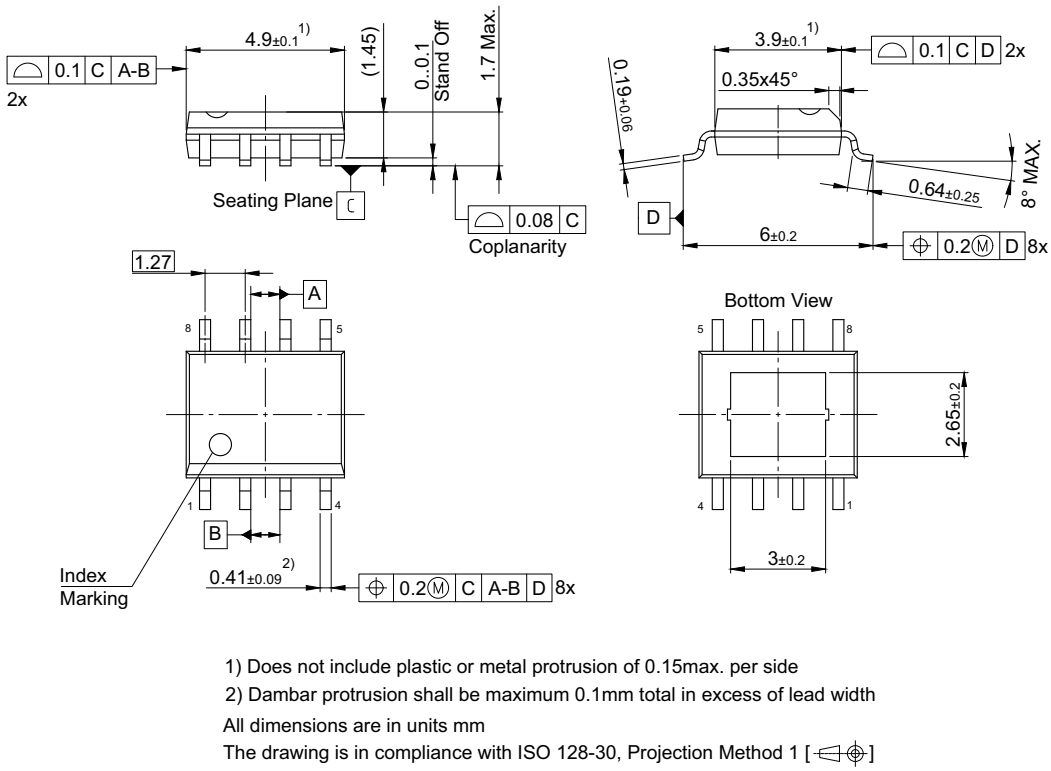


Figure 11 PG-DSO-8 exposed pad

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 (Pb-free finish on leads and suitable for Pb-free soldering according to IPC/JEDEC J-STD-020).

Further information on packages

https://www.infineon.com/packages

7 Revision history

Revision	Date	Changes
1.10	2024-10-11	Template update and editorial changes P-number assignment corrected to ensure singular assignment only (P_4.3.1 - P_4.3.11)
1.00	2012-05-07	Datasheet – initial release

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