

## Dual Low Drop Voltage Regulator

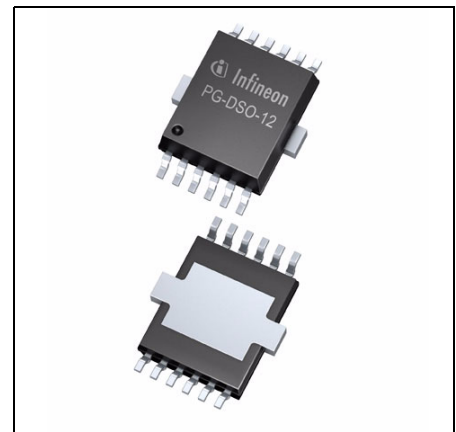
TLE 4473 GV53

TLE 4473 GV52



### Features

- Output 1: 300 mA, 3.3 V ( $\pm 3\%$ ) or 2.6 V ( $\pm 3\%$ )
- Output 2: 180 mA, 5 V ( $\pm 2\%$ )
- Low quiescent current consumption
- Disable function separately for both outputs
- Wide operation range: up to 42 V
- Very low dropout voltage
- 2 independent reset circuits
- Watchdog
- Output protected against short circuit
- Wide temperature range:  $-40\text{ }^{\circ}\text{C}$  to  $150\text{ }^{\circ}\text{C}$
- Overtemperature protection
- Overload protection



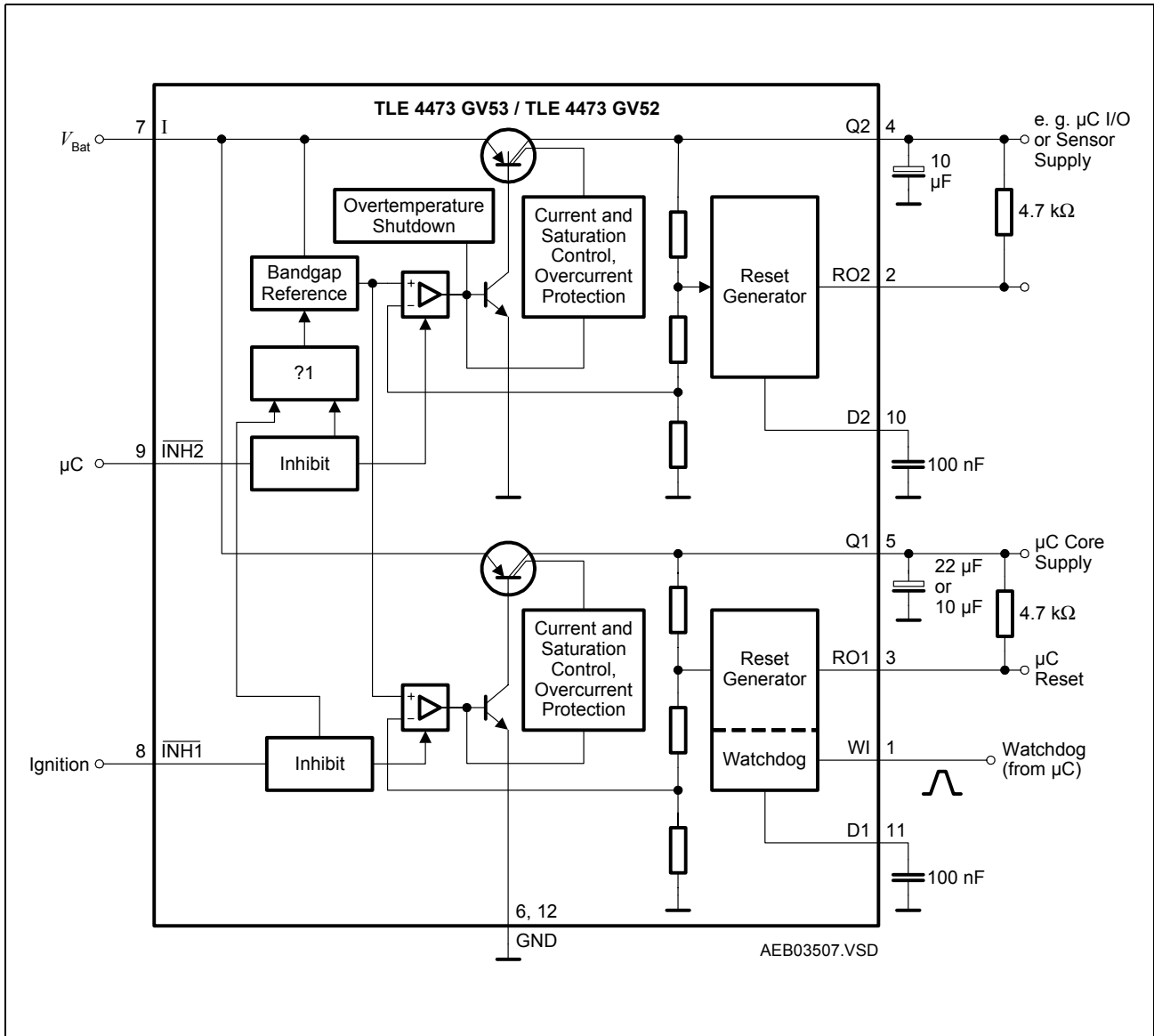
### Functional Description

The TLE 4473 is a monolithic integrated voltage regulator with two very low-drop outputs, Q1 for loads up to 300 mA and Q2 providing a maximum of 180 mA. An input voltage in the range of  $5.6\text{ V} \leq V_I \leq 45\text{ V}$  is transformed to  $V_{Q2} = 5.0\text{ V} (\pm 2\%)$  and  $V_{Q1} = 3.3\text{ V} \pm 3\%$  (TLE 4473 GV53) or  $V_{Q1} = 2.6\text{ V} \pm 3\%$  (TLE 4473 GV52). The device is also available with dual 5 V output voltage, please refer to the TLE 4473 GV55 data sheet. Two inhibit pins allow a flexible power management. Both outputs can independently be enabled or disabled. Thus the current consumption of the application can be reduced to a minimum. The quiescent current of the TLE 4473 with both outputs disabled is  $< 1\text{ }\mu\text{A}$ . The TLE 4473 is designed to supply microprocessor systems and sensors under the severe conditions of automotive applications and is therefore equipped with additional protection functions against overload, short circuit and overtemperature.

The device operates in the wide junction temperature range of  $-40\text{ }^{\circ}\text{C}$  to  $150\text{ }^{\circ}\text{C}$ .

Type	Package
TLE 4473 GV53	PG-DSO-12
TLE 4473 GV52	PG-DSO-12

The low drop regulator features a reset with adjustable power on delay for each of the outputs. In addition the output for the microcontroller supply comes up with a watchdog in order to supervise a microcontroller.



**Figure 1 Block Diagram with Typical External Components**

### Reset and Watchdog Behaviour:

The reset output RO1 is in high-state if the voltage on the delay capacitor  $C_{D1}$  is greater or equal  $V_{DL1}$ . The delay capacitor  $C_{D1}$  is charged with the current  $I_{DC1}$  for output voltages greater than the reset threshold  $V_{RT1}$ . If the output voltage drops below  $V_{RT1}$  ("reset condition"), the delay capacitor  $C_{D1}$  will be discharged rapidly. If  $V_{D1}$  reaches  $V_{DL1}$ , the reset output RO1 is set to low.

At power-on, the charging process of  $C_{D1}$  starts from 0 V, which leads to the equation

$$t_{D, on} = \frac{C_{D1} \times V_{DU1}}{I_{DC1}} \quad (1)$$

for the power-on reset delay time.

When the voltage at the delay capacitor has reached  $V_{DU1}$  and RO1 was set to high, the watchdog circuit is enabled and discharges  $C_{D1}$  with the constant current  $I_{DD1}$ .

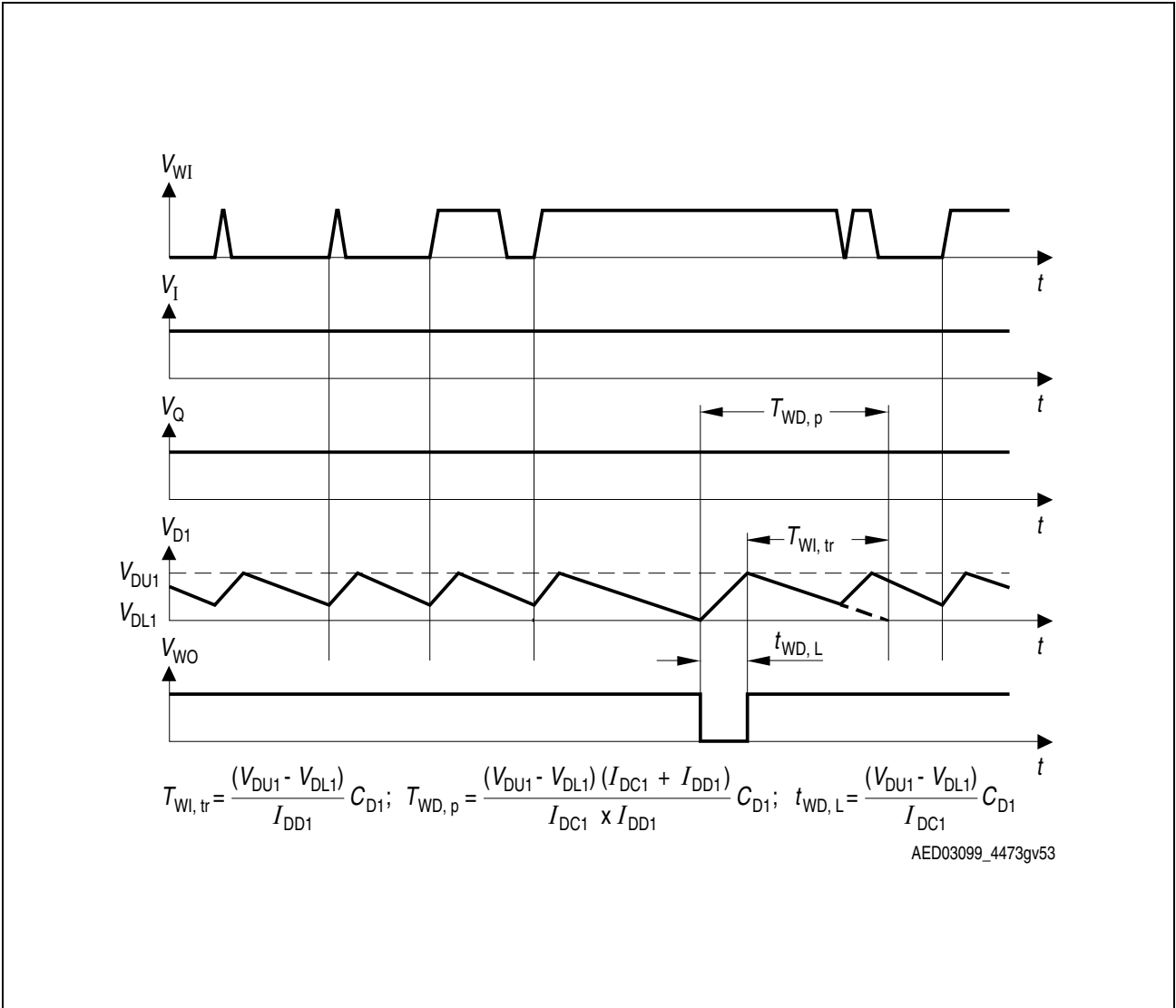
If there is no rising edge observed at the watchdog input,  $C_{D1}$  will be discharged down to  $V_{DL1}$ , where the reset output RO1 will be set to low and  $C_{D1}$  will be charged again with the current  $I_{DC1}$  until  $V_{D1}$  reaches  $V_{DU1}$  and reset will be set high again.

If a watchdog pulse (rising edge at watchdog input WI) occurs during the discharge period,  $C_{D1}$  is charged again and the reset output stays high. After  $V_{D1}$  has reached  $V_{DU1}$ , the periodical cycle starts again.

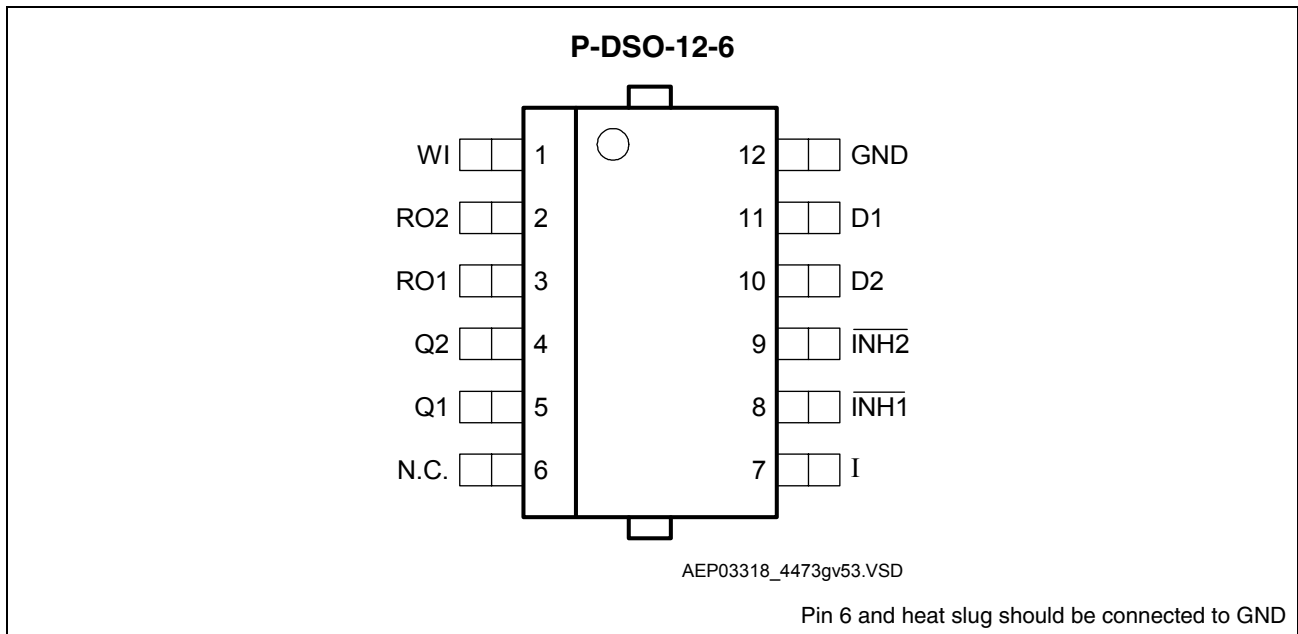
The watchdog timing is shown in **Figure 2**. The maximum duration between two watchdog pulses corresponds to the minimum watchdog trigger time  $T_{WI, tr}$ . Higher capacitances on pin D1 result in larger watchdog trigger time:

$$T_{WI, tr}|_{max} = 0.42 \text{ ms/nF} \times C_{D1} \quad (2)$$

If the output voltage Q2 decreases below  $V_{RT2}$ , the external capacitor  $C_{D2}$  is discharged. When the voltage at this capacitor drops below  $V_{DL2}$ , a reset signal is generated at pin 11 (RO2), i.e. the reset output is set to low-level. If the output voltage rises above the reset threshold,  $C_{D2}$  will be charged with the constant current  $I_{DC2}$ . After the power-on-reset time, the voltage at the capacitor reaches  $V_{DU2}$  and the reset output will be set to high again. The value of the power-on-reset time can be set within a wide range depending of the capacitance of  $C_{D2}$  using **Equation (1)** analogous for Q2.



**Figure 2 Watchdog Timing Schedule**



**Figure 3 Pin Configuration TLE 4473 GV53, TLE 4473 GV52 (top view)**

**Table 1 Pin Definitions and Functions (TLE 4473 GV53, TLE 4473 GV52)**

Pin No.	Symbol	Function
1	WI	<b>Watchdog input;</b> input for watchdog pulses, positive edge triggered
2	RO2	<b>Reset output for Q2;</b> open collector output
3	RO1	<b>Reset and watchdog output for Q1;</b> open collector output
4	Q2	<b>Output voltage 2 (5 V);</b> block to GND with a capacitor $C_{Q2} \geq 22 \mu\text{F}$ , $\text{ESR} < 5 \Omega$ at 10 kHz or $C_{Q2} \geq 10 \mu\text{F}$ , $\text{ESR} < 4 \Omega$ at 10 kHz
5	Q1	<b>Output voltage 1 (3.3 V/2.6 V);</b> block to GND with a capacitor $C_{Q1} \geq 10 \mu\text{F}$ , $\text{ESR} < 5 \Omega$ at 10 kHz
6	N.C.	<b>Not connected;</b> connect to GND
7	I	<b>Input voltage;</b> block to GND directly at the IC with a ceramic capacitor.
8	$\overline{\text{INH1}}$	<b>Inhibit input 1;</b> low level at $\overline{\text{INH2}}$ and $\overline{\text{INH1}}$ disables Q2 and Q1
9	$\overline{\text{INH2}}$	<b>Inhibit input 2;</b> low level disables Q2
10	D2	<b>Reset Delay 2;</b> connect a capacitor to set reset delay for Q2
11	D1	<b>Reset Delay 1;</b> connect a capacitor to GND to set reset delay and watchdog timing for Q1
12	GND	<b>Ground</b>
Heatsink	N. C.	<b>Not connected;</b> connect to GND

**Table 2 Absolute Maximum Ratings**

$-40\text{ °C} < T_j < 150\text{ °C}$

Parameter	Symbol	Limit Values		Unit	Remarks
		Min.	Max.		
<b>Input I</b>					
Voltage	$V_I$	-42	45	V	–
Current	$I_I$	–	–	mA	Internally limited
<b>Stand-by Output Q2</b>					
Voltage	$V_{Q2}$	-0.3	18	V	–
Current	$I_{Q2}$	–	–	mA	Internally limited
<b>Main Output Q1</b>					
Voltage	$V_{Q1}$	-0.3	18	V	–
Current	$I_{Q1}$	–	–	mA	Internally limited
<b>Inhibit Input <math>\overline{\text{INH1}}</math></b>					
Voltage	$V_{\overline{\text{INH1}}}$	-42	45	V	–
Current	$I_{\overline{\text{INH1}}}$	-2	2	mA	–
<b>Inhibit Input <math>\overline{\text{INH2}}</math></b>					
Voltage	$V_{\overline{\text{INH2}}}$	-42	45	V	–
Current	$I_{\overline{\text{INH2}}}$	-2	2	mA	–
<b>Reset Output RO1</b>					
Voltage	$V_{RO1}$	-0.3	18	V	–
Current	$I_{RO1}$	–	–	mA	Internally limited
<b>Reset Output RO2</b>					
Voltage	$V_{RO2}$	-0.3	18	V	–
Current	$I_{RO2}$	–	–	mA	Internally limited
<b>Reset Delay D1</b>					
Voltage	$V_{D1}$	-0.3	7	V	–
Current	$I_{D1}$	-5	5	mA	–
<b>Reset Delay D2</b>					
Voltage	$V_D$	-0.3	7	V	–
Current	$I_D$	-5	5	mA	–

**Table 2 Absolute Maximum Ratings (cont'd)**

$-40\text{ }^{\circ}\text{C} < T_j < 150\text{ }^{\circ}\text{C}$

Parameter	Symbol	Limit Values		Unit	Remarks
		Min.	Max.		
<b>Watchdog Input WI</b>					
Voltage	$V_{\text{RADJ}}$	-0.3	7	V	–
Current	$I_{\text{RADJ}}$	-5	5	mA	–
<b>Temperatures</b>					
Junction temperature	$T_j$	-40	150	$^{\circ}\text{C}$	–
Storage temperature	$T_{\text{stg}}$	-50	150	$^{\circ}\text{C}$	–
<b>ESD Protection</b>					
Electrostatic Discharge Voltage	$V_{\text{ESD}}$	-2	2	kV	Human Body Model

*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	$V_I$	5.6	42	V	Q1 & Q2
		4.5	42	V	only Q1 regulating
Junction temperature	$T_j$	-40	150	°C	–

**Thermal Resistances PG-DSO-12**

Junction pin	$R_{thj-pin}$	–	3	K/W	–
Junction ambient	$R_{thj-a}$	–	115	K/W	PCB Heat Sink Area 0 mm <sup>2</sup> 1)
Junction ambient	$R_{thj-a}$	–	100	K/W	PCB Heat Sink Area 100 mm <sup>2</sup> 1)
Junction ambient	$R_{thj-a}$	–	60	K/W	PCB Heat Sink Area 300 mm <sup>2</sup> 1)
Junction ambient	$R_{thj-a}$	–	48	K/W	PCB Heat Sink Area 600 mm <sup>2</sup> 1)

1) Package mounted on PCB 80 × 80 × 1.5 mm<sup>3</sup>; 35 μ Cu; 5 μ Sn; zero airflow.

*Note: In the operating range the functions given in the circuit description are fulfilled. Integrated protection functions are designed to prevent IC destruction under fault conditions. Protection functions are not designed for repetitive operation.*



**Electrical Characteristics**
 $V_{I1} = 13.5 \text{ V}; V_{INH1} = V_{INH2} = 5 \text{ V}; -40 \text{ }^\circ\text{C} < T_j < 150 \text{ }^\circ\text{C};$  unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		

**REGULATOR 2:**
**Output Q2**

Output voltage	$V_{Q2}$	4.90	5.0	5.10	V	$1 \text{ mA} < I_{Q2} < 180 \text{ mA};$ $6 \text{ V} < V_1 < 28 \text{ V}$
Output current limitation	$I_{Q2}$	200	300	600	mA	$V_{Q2} = 4.5 \text{ V}$
Output drop voltage; $V_{DRQ2} = V_{I2} - V_{Q2}$	$V_{DRQ2}$	–	300	600	mV	$I_{Q2} = 100 \text{ mA};$ <sup>1)</sup>
Load regulation	$\Delta V_{Q2,Lo}$	–	15	50	mV	$1 \text{ mA} < I_{Q2} < 200 \text{ mA};$
Line regulation	$\Delta V_{Q2,Li}$	–	5	20	mV	$I_{Q2} = 1 \text{ mA};$ $6 \text{ V} < V_1 < 28 \text{ V}$
Power supply ripple rejection	$PSRR$	–	65	–	dB	$f_r = 100 \text{ Hz};$ $V_r = 1 \text{ V}_{pp}$

**Current Consumption**

Quiescent current; stand-by $I_q = I_1 - I_{Q2}$	$I_q$	–		165	$\mu\text{A}$	TLE 4473 GV52; $I_{Q2} = 500 \mu\text{A}; T_j = 25 \text{ }^\circ\text{C};$ $V_{INH1} < V_{INH1 \text{ OFF}} \text{ (Q1 off)}$
		–		205	$\mu\text{A}$	TLE 4473 GV52; $I_{Q2} = 500 \mu\text{A}; T_j = 85 \text{ }^\circ\text{C};$ $V_{INH1} < V_{INH1 \text{ OFF}} \text{ (Q1 off)}$
		–		180	$\mu\text{A}$	TLE 4473 GV53; $I_{Q2} = 500 \mu\text{A}; T_j = 25 \text{ }^\circ\text{C};$ $V_{INH1} < V_{INH1 \text{ OFF}} \text{ (Q1 off)}$
		–		210	$\mu\text{A}$	TLE 4473 GV53; $I_{Q2} = 500 \mu\text{A}; T_j = 85 \text{ }^\circ\text{C};$ $V_{INH1} < V_{INH1 \text{ OFF}} \text{ (Q1 off)}$
		–		235	$\mu\text{A}$	$I_{Q2} = 500 \mu\text{A};$ $V_{INH1} < V_{INH1 \text{ OFF}} \text{ (Q1 off)}$

**Electrical Characteristics (cont'd)**
 $V_{I1} = 13.5 \text{ V}; V_{INH1} = V_{INH2} = 5 \text{ V}; -40 \text{ }^\circ\text{C} < T_j < 150 \text{ }^\circ\text{C};$  unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		

**Current Consumption (cont'd)**

Quiescent current; stand-by $I_q = I_1 - I_{Q2}$	$I_q$			5	mA	$I_{Q2} = 100 \text{ mA};$ $V_{INH1} < V_{INH1 \text{ OFF}} (Q1 \text{ off})$
Quiescent current; inhibited	$I_q$	–	–	1	$\mu\text{A}$	$V_{INH1} = V_{INH2} = 0 \text{ V};$ $T_j < 85^\circ\text{C}$

**Inhibit Input  $\overline{\text{INH2}}$** 

Turn-on Voltage	$V_{\overline{\text{INH2}} \text{ ON}}$	–	–	2.3	V	$V_{Q2} \text{ on}$
Turn-off Voltage	$V_{\overline{\text{INH2}} \text{ OFF}}$	0.8	–	–	V	$V_{Q2} \text{ off}$
H-input current	$I_{\overline{\text{INH2}} \text{ ON}}$	– 1	0.5	3	$\mu\text{A}$	$V_{\overline{\text{INH2}}} = 5 \text{ V}$
L-input current	$I_{\overline{\text{INH2}} \text{ OFF}}$	– 1	0.1	1	$\mu\text{A}$	$0 \text{ V} < V_{\overline{\text{INH2}}} < 0.8 \text{ V}$

**Reset Timing D2**

Charge current	$I_{DC2}$	5.0	9.0	13.0	$\mu\text{A}$	$V_{D2} = 0.7 \text{ V}$
Upper timing threshold	$V_{DU2}$	1.6	1.8	2.2	V	–
Lower timing threshold	$V_{DL2}$	0.3	0.45	0.6	V	–
Saturation Voltage	$V_{D2, \text{SAT}}$			100	mV	$V_{Q2} < V_{RT2}$
Reset delay time	$T_{RD2}$	12	20	28	ms	$C_{D2} = 100 \text{ nF}$
Reset reaction time	$T_{rr}$	–		10	$\mu\text{s}$	$C_{D2} = 100 \text{ nF}$

**Electrical Characteristics** (cont'd)

 $V_{I1} = 13.5 \text{ V}; V_{INH1} = V_{INH2} = 5 \text{ V}; -40 \text{ }^\circ\text{C} < T_j < 150 \text{ }^\circ\text{C};$  unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		

**Reset Output RO2**

Reset switching threshold	$V_{RT2}$	4.5	4.65	4.8	V	–
Reset output current	$I_{RO2}$	–	–	1.4	mA	Collector current of RO1, power good, reset still delayed. $V_{Q2} = 5 \text{ V}, V_{D2} = 0 \text{ V}, V_{RO2} = 0.3 \text{ V}$
Reset output low voltage	$V_{RO2L}$	–	0.15	0.3	V	$V_{Q2} \geq 1 \text{ V}, V_{D2} = 0 \text{ V}, I_{RO2} = 0.5 \text{ mA}$
Reset high voltage	$V_{RO2H}$	4.5	–	–	V	$R_{RO2,ext} = 4.7 \text{ k}\Omega$

**REGULATOR 1:**
**Output Q1**

Output voltage	$V_{Q12}$	3.20	3.3	3.40	V	TLE 4473 GV53 $1 \text{ mA} < I_{Q1} < 300 \text{ mA};$ $4.5 \text{ V} < V_I < 28 \text{ V}$
Output voltage	$V_{Q12}$	2.52	2.60	2.68	V	TLE 4473 GV52 $1 \text{ mA} < I_{Q1} < 300 \text{ mA};$ $4.5 \text{ V} < V_I < 28 \text{ V}$
Output current limitation	$I_{Q1}$	350	500	600	mA	$V_{Q1} = 3.0 \text{ V}$ (TLE 4473 GV53); $V_{Q1} = 2.3 \text{ V}$ (TLE 4473 GV52)
Load regulation	$\Delta V_{Q1,Lo}$	–	5	50	mV	$5 \text{ mA} < I_{Q1} < 300 \text{ mA};$
Line regulation	$\Delta V_{Q1,Li}$	–	5	20	mV	$I_{Q1} = 5 \text{ mA};$ $6 \text{ V} < V_I < 28 \text{ V}$
Power-Supply-Ripple-Rejection	$PSRR$	–	65	–	dB	$f_r = 100 \text{ Hz};$ $V_r = 1 \text{ V}_{pp}$

**Electrical Characteristics** (cont'd)

 $V_{I1} = 13.5 \text{ V}; V_{INH1} = V_{INH2} = 5 \text{ V}; -40 \text{ }^\circ\text{C} < T_j < 150 \text{ }^\circ\text{C};$  unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		

**Current Consumption**

Quiescent current; $I_q = I_1 - I_{Q1} - I_{Q2}$	$I_q$	–	200	265	$\mu\text{A}$	TLE 4473 GV52; $I_{Q1} = 500 \mu\text{A};$ Q1 on; Q2 off; $T_j < 85^\circ\text{C}$
		–	210	280	$\mu\text{A}$	TLE 4473 GV53; $I_{Q1} = 500 \mu\text{A};$ Q1 on; Q2 off; $T_j < 85^\circ\text{C}$
		–	7	20	$\text{mA}$	$I_{Q1} = 300 \text{ mA}$ $I_{Q2} = 500 \mu\text{A},$ $V_{Q1} \text{ \& } V_{Q2} \text{ on}$
		–	250	500	$\mu\text{A}$	$I_{Q2} = I_{Q1} = 500 \mu\text{A};$ $V_{Q1} \text{ \& } V_{Q2} \text{ on}$

**Inhibit Input  $\overline{\text{INH1}}$** 

Turn-on Voltage	$V_{\overline{\text{INH1}} \text{ ON}}$	–	–	2.3	V	$V_{Q1} \text{ on}$
Turn-off Voltage	$V_{\overline{\text{INH1}} \text{ OFF}}$	0.8	–	–	V	$V_{Q1} \text{ off}$
H-input current	$I_{\overline{\text{INH1}} \text{ ON}}$	– 1	0.5	3	$\mu\text{A}$	$V_{\overline{\text{INH1}}} = 5 \text{ V}$
L-input current	$I_{\overline{\text{INH1}} \text{ OFF}}$	– 1	0.1	1	$\mu\text{A}$	$0 \text{ V} < V_{\overline{\text{INH1}}} < 0.8 \text{ V}$

**Watchdog and Reset Timing D1**

Charge current	$I_{\text{DC1}}$	3.0	7.0	11.0	$\mu\text{A}$	$V_{\text{D1}} = 0.7 \text{ V}$
Discharge current	$I_{\text{DD1}}$	1.1	1.5	3.7	$\mu\text{A}$	$V_{\text{D1}} = 0.7 \text{ V}$
Upper timing threshold	$V_{\text{DU1}}$	0.7	1.1	1.6	V	–
Lower timing threshold	$V_{\text{DL1}}$	0.2	0.35	0.6	V	–

**Electrical Characteristics (cont'd)**
 $V_{I1} = 13.5 \text{ V}; V_{INH1} = V_{INH2} = 5 \text{ V}; -40 \text{ }^\circ\text{C} < T_j < 150 \text{ }^\circ\text{C};$  unless otherwise specified

Parameter	Symbol	Limit Values			Unit	Test Condition
		min.	typ.	max.		

**Watchdog and Reset Timing D1 (cont'd)**

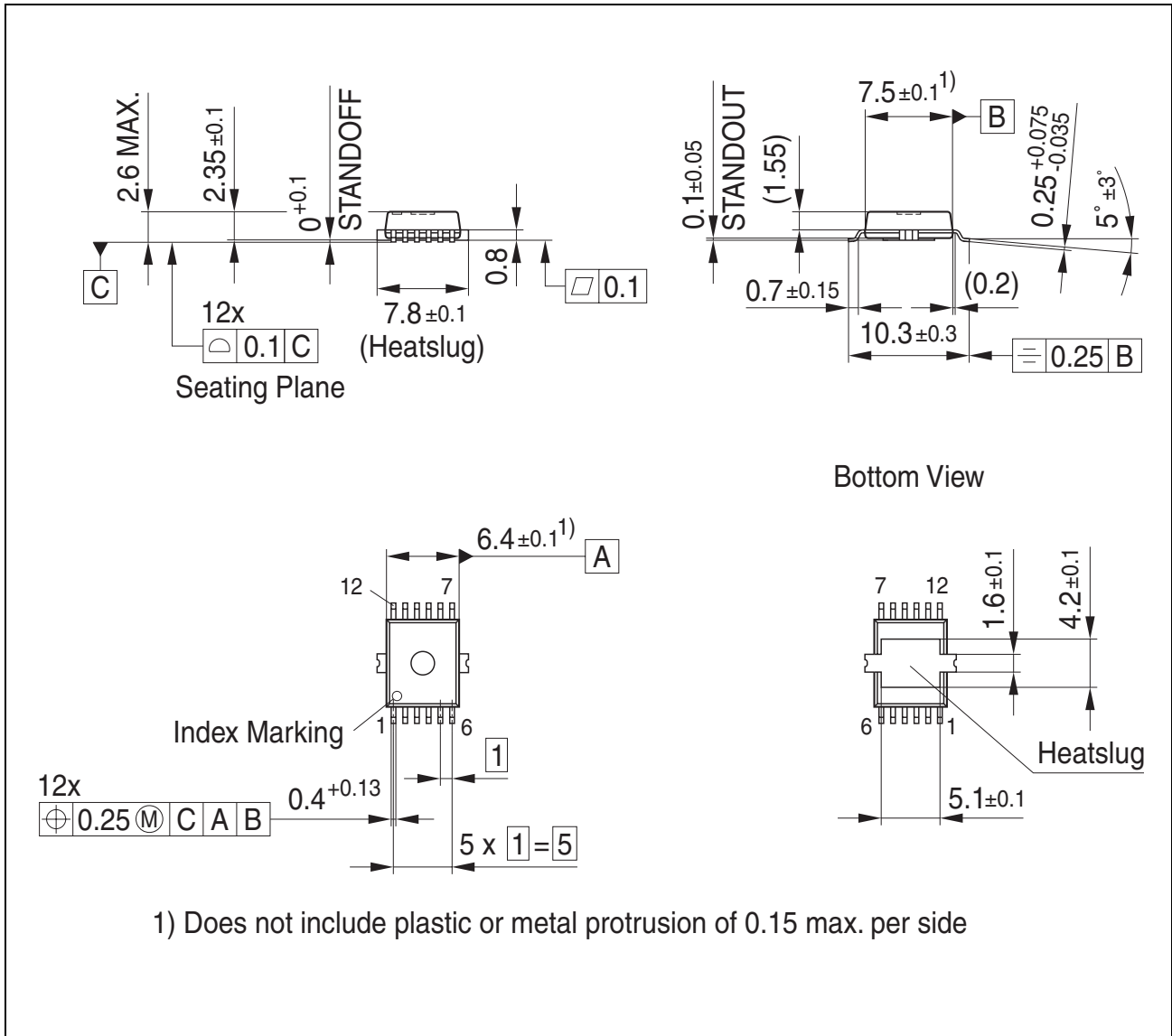
Saturation Voltage	$V_{D1,SAT}$			100	mV	$V_{Q1} < V_{RT2}$
Watchdog trigger time	$T_{Wl,tr}$	24	32	40	ms	$C_{D1} = 100 \text{ nF}$
Reset delay time	$T_{RD1}$	11	17	23	ms	$C_{D1} = 100 \text{ nF}$
Reset reaction time	$T_{rr}$	–		5.0	$\mu\text{s}$	$C_{D1} = 100 \text{ nF}$

**Reset Output RO1**

Reset switching threshold	$V_{RT1}$	2.97	3.08	3.18	V	TLE 4473 GV53
		2.34	2.42	2.50	V	TLE 4473 GV52
Reset threshold headroom	$V_{R1HEAD}$	100	–	–	mV	TLE 4473 GV53
Reset threshold headroom	$V_{R1HEAD}$	80	–	–	mV	TLE 4473 GV52
Reset output current	$I_{RO1}$	–	–	1.4	mA	Collector current of RO1, power good, reset still delayed. $V_{Q1} = 3.30 \text{ V}$ (TLE 4473 GV53), $V_{Q1} = 2.60 \text{ V}$ (TLE 4473 GV52); $V_{Q2} = 5.0 \text{ V};$ $V_{D1} = 0 \text{ V}, V_{RO1} = 0.3 \text{ V}$
Reset output low voltage	$V_{RO1L}$	–	0.1	0.3	V	$V_{Q1} \geq 1 \text{ V}, V_{D1} = 0 \text{ V},$ $I_{RO1} = 0.5 \text{ mA}$
Reset output high voltage	$V_{RO1H}$	2.45	–	–	V	$R_{RO1,ext} = 4.7 \text{ k}\Omega$ connected to Q1; TLE 4473 GV52
Reset output high voltage	$V_{RO1H}$	3.15	–	–	V	$R_{RO1,ext} = 4.7 \text{ k}\Omega$ connected to Q1; TLE 4473 GV53

1) Drop voltage =  $V_i - V_o$  (measured when the output voltage has dropped 100 mV from the nominal value obtained at 13.5 V input)

### Package Outlines



**Figure 4 PG-DSO-12 (Plastic Dual Small Outline)**

### 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).

## Revision History

Version	Date	Changes
Rev. 1.1	2008-19-09	Initial version of RoHS-compliant derivate of TLE 4473 GV53 <b>Page 1</b> : AEC certified statement added <b>Page 1</b> and <b>Page 14</b> : RoHS compliance statement and Green product feature added <b>Page 1</b> and <b>Page 14</b> : Package changed to RoHS compliant version Legal Disclaimer updated
Rev. 1.0	2004-07-14	Initial version

You can find all of our packages, sorts of packing and others in our Infineon Internet Page "Products": <http://www.infineon.com/products>.

SMD = Surface Mounted Device

Dimensions in mm

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