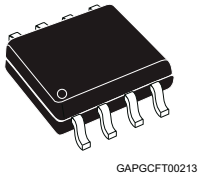
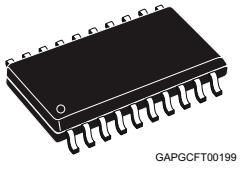
L4979D, L4979MD

Automotive Low drop voltage regulator

Datasheet - production data



SO-8



SO-20

Features

- AEC-Q100 qualified
- Operating DC supply voltage range 5.6 V to 31 31 V
- Low quiescent current (6 µA typ. @ 25 °C with enable low)
- High precision output voltage (2%)
- Low dropout voltage less than 0.5 V
- Reset circuit sensing the output voltage down to 1V
- Programmable reset pulse delay with external capacitor
- Watchdog
- Programmable watchdog timer with external capacitor
- Thermal shutdown and short circuit protection)
- Automotive temperature range (T_j = -40 °C to 150 °C)
- Enable input for enabling/disabling the voltage regulator output

Description

L4979D and L4979MD are low dropout linear regulators with microprocessor control functions such as low voltage reset, watchdog, on/off control. Typical quiescent current is 100 µA in very low output current mode and enabled regulator. The devices drop to 6 µA with not enabled regulators.

On chip trimming results in high output voltage accuracy (2%). Accuracy is kept over wide temperature range, line and load variation.

The maximum input voltage is 40 V. The max output current is internally limited. Internal temperature protection disables the voltage regulator output.

Table 1. Device summary

Package	Order codes	
	Tube	Tape & reel
SO-8	-	L4979DTR-E
SO-20	L4979MD	L4979MD013TR

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1 Block diagram and pin descriptions

Figure 1. Block diagram

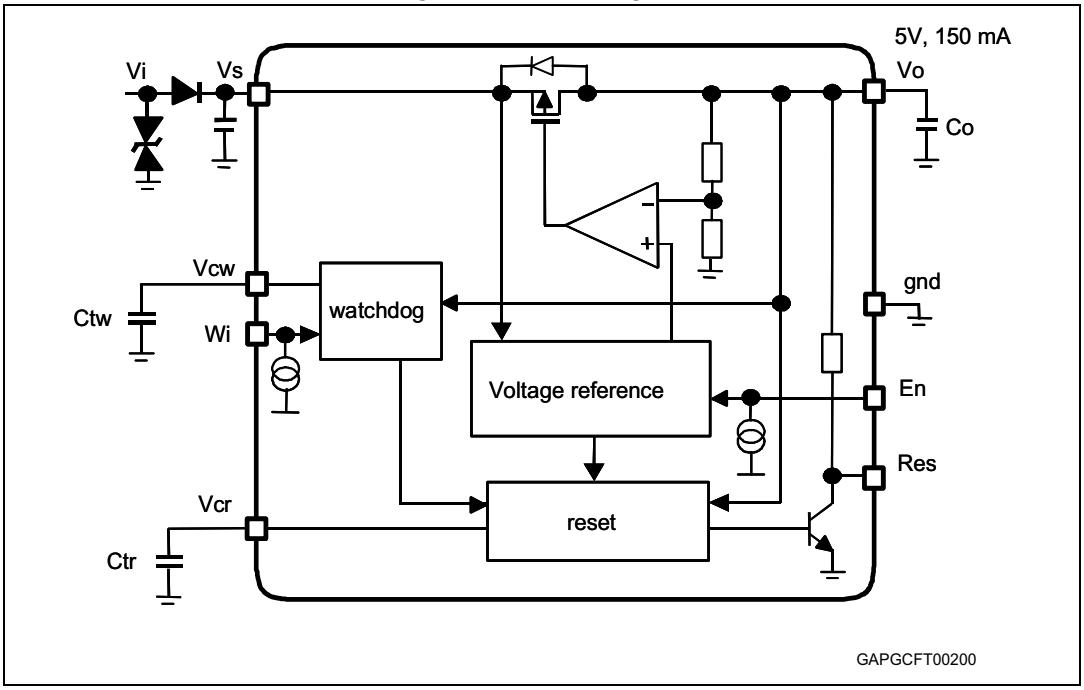


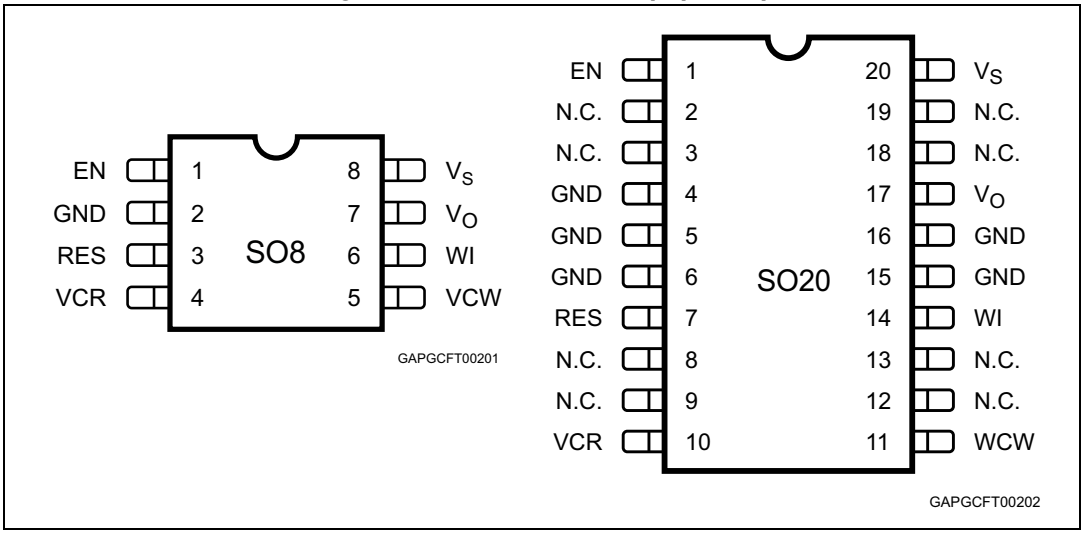
Table 2. Pin function

SO8 pin number	SO20 pin number	Pin name	Function
1	1	En	Enable input If high, regulator, watchdog and reset are operating. If low, regulator, watchdog and reset are shut down.
2	4	gnd	Ground reference
	5,6,15,16	gnd	Ground These pins are to be connected to a heat spreader electrically grounded
3	7	Res	Reset output. It is pulled down when output voltage drops below V_{o_th} or frequency at W_i is too low.
4	10	Vcr	Reset timing adjust A capacitor between Vcr pin and gnd sets the reset delay time (t_{rd})
5	11	Vcw	Watchdog timer adjust A capacitor between V_{cw} pin and gnd sets the time response of the watchdog monitor.
6	14	Wi	Watchdog input. If the frequency at this input pin is too low, the Reset output is activated.
7	17	Vo	Voltage regulator output Output capacitor >100 nF is needed for regulator stability

Table 2. Pin function (continued)

SO8 pin number	SO20 pin number	Pin name	Function
8	20	Vs	Supply voltage Supply capacitor (e.g. 200 nF) is needed for regulator stability.
	2, 3, 8, 9, 12, 13, 18, 19	N. C.	Not connected

Figure 2. Pins connection (top view)



2 Electrical specifications

2.1 Absolute maximum ratings

Stressing the device above the rating listed in *Table 3: Absolute maximum ratings* may cause permanent damage to the device. These are stress ratings only and operation of the device at these or any other conditions above those indicated in the Operating sections of this specification is not implied. Exposure to the conditions in the table below for extended periods may affect device reliability.

Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{vsdc}	DC supply voltage	-0.3 to 40	V
I_{vsdc}	Input current	Internally limited	
V_{vo}	DC output voltage	-0.3 to 6 (1)	V
I_{vo}	DC output current	Internally limited	
V_{wi}	Watchdog input voltage	-0.3 to V_{vo} +0.3	V
V_{od}	Open drain output voltage (RES)	-0.3 to V_{vo} +0.3	V
I_{od}	Open drain output current (RES)	Internally limited	
V_{cr}	Reset delay voltage	-0.3 to V_{vo} +0.3	V
V_{cw}	Watchdog delay voltage	-0.3 to V_{vo} +0.3	V
V_{en}	Enable input voltage	-0.3 to 40	V
T_j	Junction temperature	-40 to 150	°C
V_{ESD}	ESD voltage level (HBM-MIL STD 883C)	±2	kV

1. Using the typical application schematic with Cout= 10 µF and Iout=0 A, when the regulator is switched-on, an overshoot exceeding 6 V could occur.This behavior does not impact the reliability of the regulator.

Table 4. Thermal data

Symbol	Parameter	SO8	SO16+2+2	Unit
$R_{th\ j\text{-}amb}$	Thermal resistance junction to ambient	130 to 180	50 to 80	°C/W

2.2 Electrical characteristics

V_S = 5.6 V to 31 V; T_j = -40 °C to 150 °C, unless otherwise specified.

Table 5. General

Pin	Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_S, V_o	I_q	Quiescent current	V_S = 13.5 V, I_o = 150 mA, enable high all I/O currents = 0		1.5	3	mA
V_S, V_o	I_q	Quiescent current	V_S = 13.5 V, I_o = 0 mA, enable high all I/O currents = 0		100	200	µA
V_S, V_o	I_q	Quiescent current	V_S = 13.5 V, I_o = 0 mA, enable low all I/O currents = 0		6	20	µA
	T_w	Thermal protection temperature		150		190	°C
	T_{w_hy}	Thermal protection temperature hysteresis			10		°C

Table 6. Voltage regulator

Pin	Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
V_o	V_{o_ref}	Output voltage	V_S = 5.6 to 31 V; I_o = 1 to 150 mA	4.90	5.00	5.10	V
V_o	I_{short}	Output short circuit current(1)	V_S = 13.5 V	150	280	400	mA
V_o	I_{lim}	Output current limitation(1)	V_S = 13.5 V	150	320	500	mA
V_S, V_o	V_{line}	Line regulation voltage	V_S = 5.6 to 31 V I_o = 1 to 150 mA			25	mV
V_o	V_{load}	Load regulation voltage	I_o = 1 to 150 mA			25	mV
V_S, V_o	V_{dp}	Drop voltage	I_o = 150 mA		200	400	mV
V_S, V_o	SVR	Ripple rejection(2)	f_r = 100 Hz	55			dB

1. See *Figure 3: Behavior of output current versus regulated voltage V_o*.
2. Guaranteed by design.

Table 7. Reset

Pin	Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
R_{es}	V_{res_l}	Reset output low voltage	R_{ext} = 5 kΩ to V_o; V_o > 1 V			0.4	V
R_{es}	I_{res_h}	Reset output high leakage current	V_{res} = 5 V			1	µA
R_{es}	$R_{\_p\_u}$	Internal pull-up resistance	With respect to V_o	12	25	50	kΩ

Table 7. Reset (continued)

Pin	Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
R_{es}	V_{o_th}	Reset threshold voltage	V_s = 5.6 to 31 V I_o = 1 to 150 mA	6% below V_{o_ref}	8% below V_{o_ref}	10% below V_{o_ref}	
V_{cr}	V_{rhth}	Reset timing high threshold	V_s = 13.5 V	44% V_{o_ref}	47% V_{o_ref}	50% V_{o_ref}	
V_{cr}	V_{rlth}	Reset timing low threshold	V_s = 13.5 V	10% V_{o_ref}	13% V_{o_ref}	16% V_{o_ref}	
V_{cr}	I_{cr}	Charge current	V_s = 13.5 V	8	17	30	µA
V_{cr}	I_{dr}	Discharge current	V_s = 13.5 V	8	17	30	µA
R_{es}	t_{rr_2}	Reset delay time(1)	$V_o = V_{o\_th}$ - 100 mV	100	250	700	µs
R_{es}	t_{rd}	Reset pulse delay	V_s = 13.5 V; C_{tr} = 1 nF	65		150	ms

1. When V_o becomes lower than 4 V, the reset reaction time decreases down to 2 µs assuring a faster reset condition in this particular case.

Table 8. Watchdog

Pin	Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
W_i	V_{ih}	Input high voltage	V_s = 13.5 V	3.5			V
W_i	V_{il}	Input low voltage	V_s = 13.5 V			1.5	V
W_i	V_{ih}	Input hysteresis	V_s = 13.5 V		300		mV
W_i	I_i	Pull down current	V_s = 13.5 V		10	20	µA
V_{cw}	V_{whth}	High threshold	V_s = 13.5 V	2.20	2.35	2.50	V
V_{cw}	V_{wlth}	Low threshold	V_s = 13.5 V	0.50	0.65	0.80	V
V_{cw}	I_{cwc}	Charge current	V_s = 13.5 V; V_{cw} = 0.1 V	4	7.5	14	µA
V_{cw}	I_{cwd}	Discharge current	V_s = 13.5 V; V_{cw} = 2.5 V	1.0	2.4	4.5	µA
V_{cw}	T_{wop}	Watchdog period	V_s = 13.5 V; C_{tw} = 47 nF	25	50	90	ms
R_{es}	t_{wol}	Watchdog output low time	V_s = 13.5 V; C_{tw} = 47 nF	6	10	22	ms

Table 9. Enable

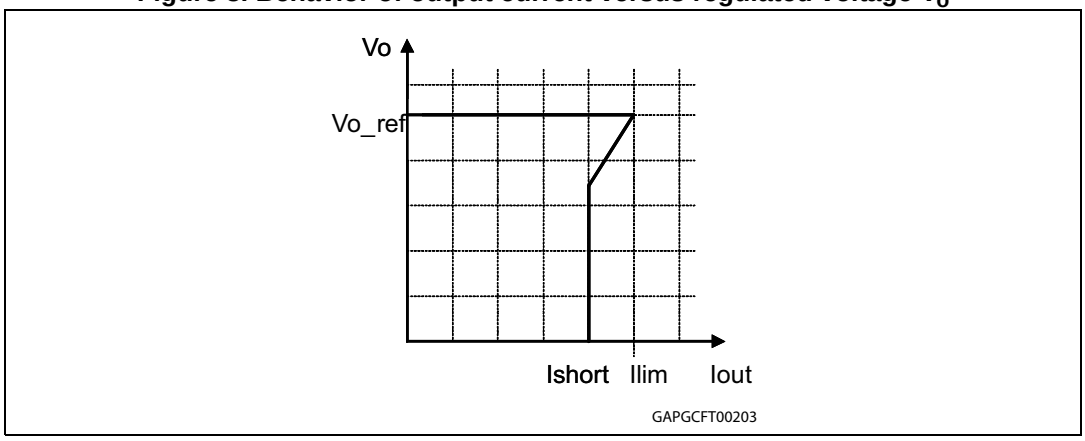
Pin	Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
E_n	V_{en_l}	Enable input low voltage				1	V
E_n	V_{en_h}	Enable input high voltage		3			V
E_n	V_{en_hy}	Enable input hysteresis		700	1000	1100	mV
E_n	$I_{\_leak}$	Pull down current	E_n = 5 V	2	10	20	µA

3 Application information

3.1 Voltage regulator

The voltage regulator uses a p-channel MOS transistor as a regulating element. With this structure a low dropout voltage at current up to 150 mA is achieved. The output voltage is regulated up to transient input supply voltage of 40 V. No functional interruption due to over-voltage pulses is generated. The high precision of the output voltage is obtained with a pre-trimmed reference voltage. A short circuit protection to GND is provided.

Figure 3. Behavior of output current versus regulated voltage V_o



3.2 Reset

The reset circuit monitors the output voltage V_o. If the output voltage drops below V_{o_th} then R_{es} becomes low with a delay time t_{rr}. Real t_{rr} value changes as a non-linear function of delta ($V_{o\text{-}th}$ - V_o). The reset low signal is guaranteed for an output voltage V_o greater than 1 V.

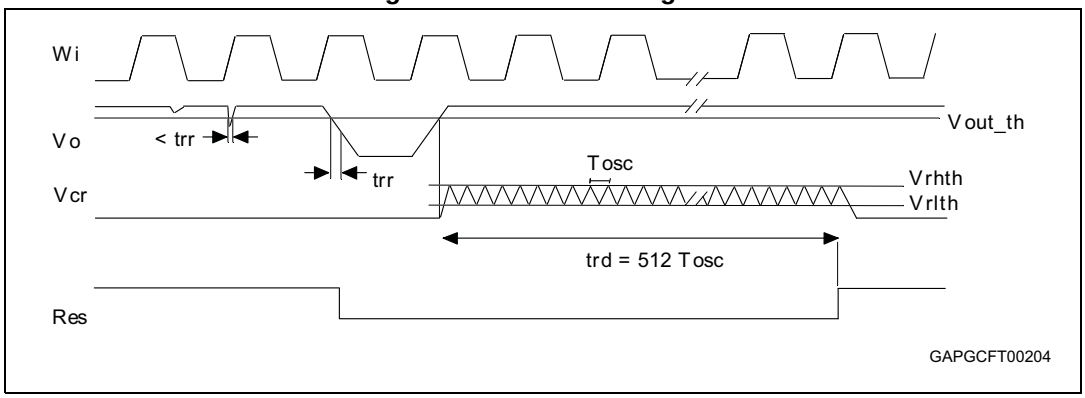
When the output voltage becomes higher than V_{o_th} then R_{es} goes high with a delay t_{rd}. This delay is obtained by 512 periods of an oscillator (see *Figure 4*). The oscillator period is given by:

$$T_{OSC} = \frac{[(V_{rhth} - V_{rlth}) \cdot C_{tr}]}{I_{cr}} + \frac{[(V_{rhth} - V_{rlth}) \cdot C_{tr}]}{I_{dr}}$$

and reset pulse delay t_{rd} is given by:

$$t_{rd} = 512 \times T_{OSC}$$

Figure 4. Reset time diagram



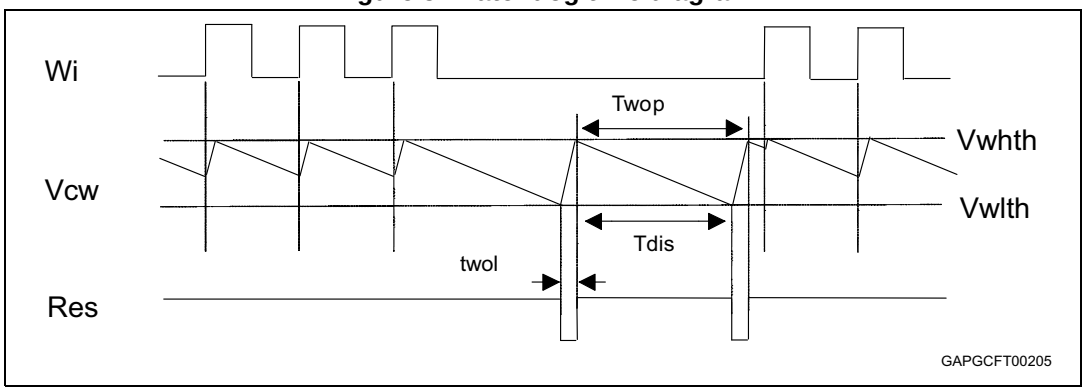
3.3 Watchdog

The watchdog input W_i monitors a connected microcontroller. If pulses are missing, the reset output R_{es} is set to low. The pulse sequence time can be set within a wide range through the external capacitor C_{tw}. The watchdog circuit discharges the capacitor C_{tw} with the constant current I_{cwd}. If the lower threshold V_{wlth} is reached, a watchdog reset is generated. To prevent this reset, the microcontroller must generate a positive edge during the discharge of the capacitor before the voltage has reached the threshold V_{wlth}. In order to calculate the minimum time T_{dis} during which the microcontroller must generate the positive edge, the following equation can be used:

$$(V_{whth} - V_{wlth}) \times C_{tw} = I_{cwd} \times T_{dis}$$

Each W_i positive edge switches the current source from discharging to charging; the same happens when the lower V_{wlth} threshold is reached. When the voltage reaches the upper threshold V_{whth} the current switches from charging to discharging. The result is a saw tooth voltage at the watchdog timer capacitor C_{tw}.

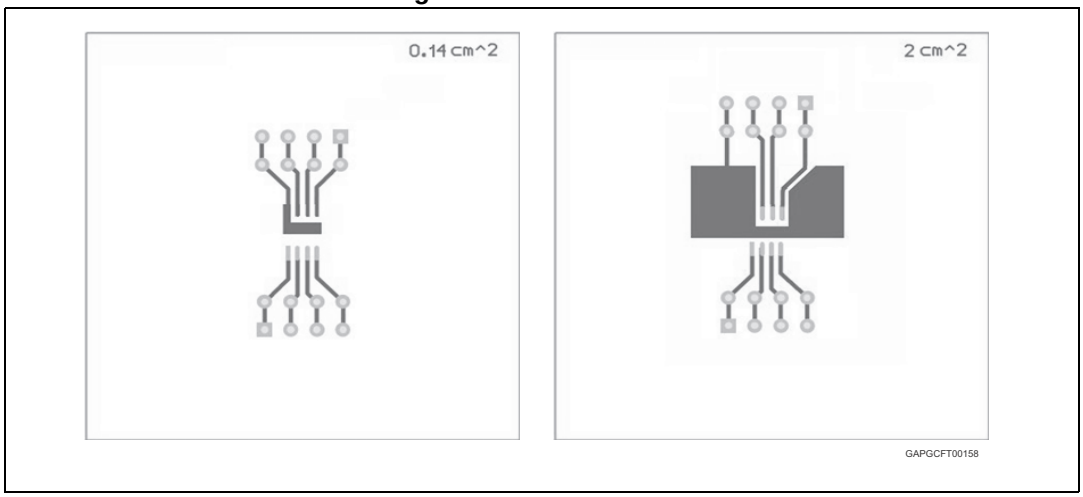
Figure 5. Watchdog time diagram



4 Package and PCB thermal data

4.1 SO-8 thermal data

Figure 6. SO-8 PC board



1. Layout condition of R_{th} and Z_{th} measurements (PCB: FR4 area = 58 mm x 58 mm, PCB thickness = 2 mm, Cu thickness = 35 mm, Copper areas: from minimum pad lay-out to 2 cm^2).

Figure 7. $R_{thj\text{-}amb}$ vs PCB copper area in open box free air condition

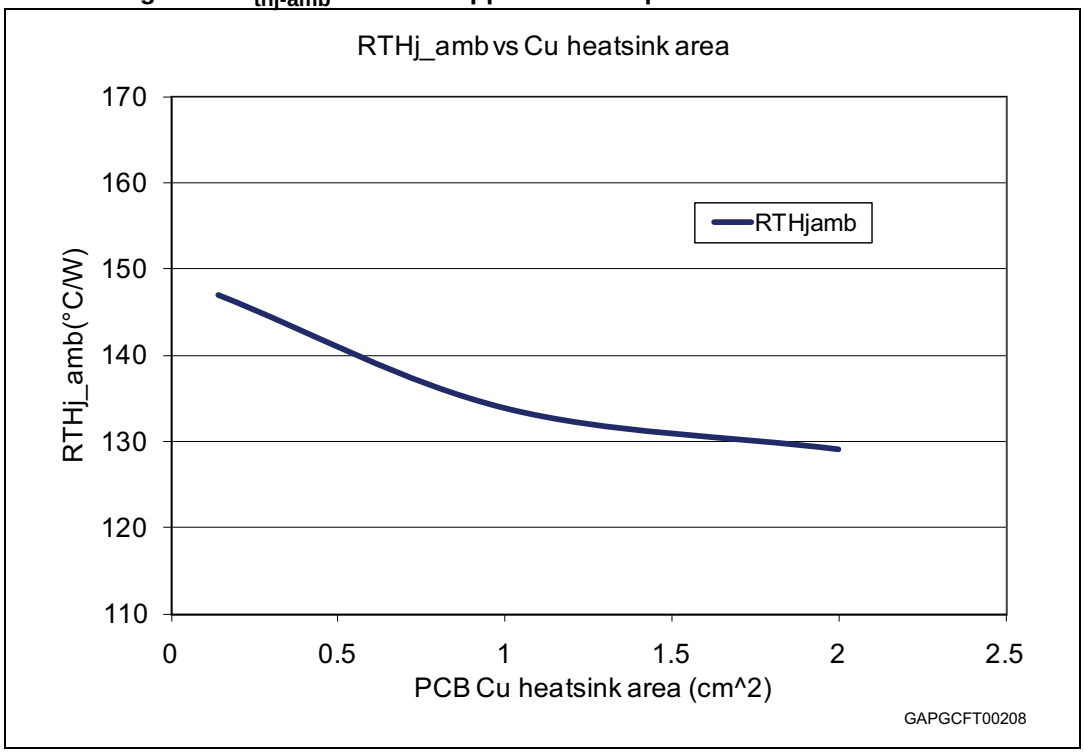
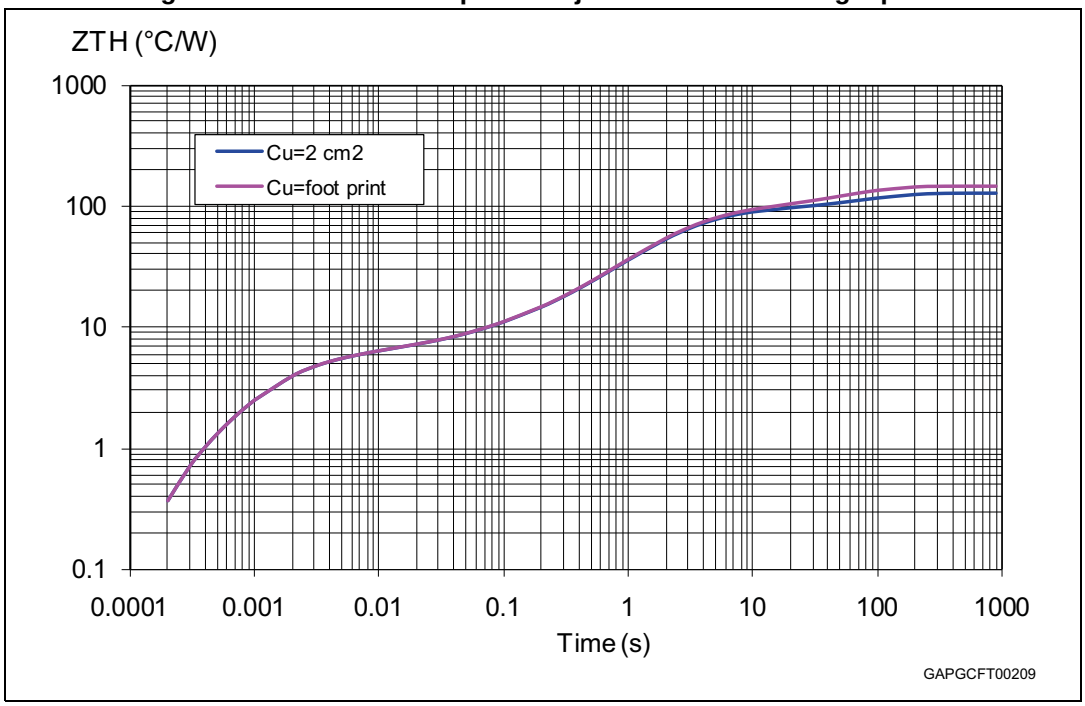


Figure 8. SO-8 thermal impedance junction ambient single pulse



Equation 1: pulse calculation formula

$$Z_{TH\delta} = R_{TH} \cdot \delta + Z_{THtp}(1-\delta)$$

where $\delta = t_P/T$

Figure 9. Thermal fitting model of V_{reg} in SO-8

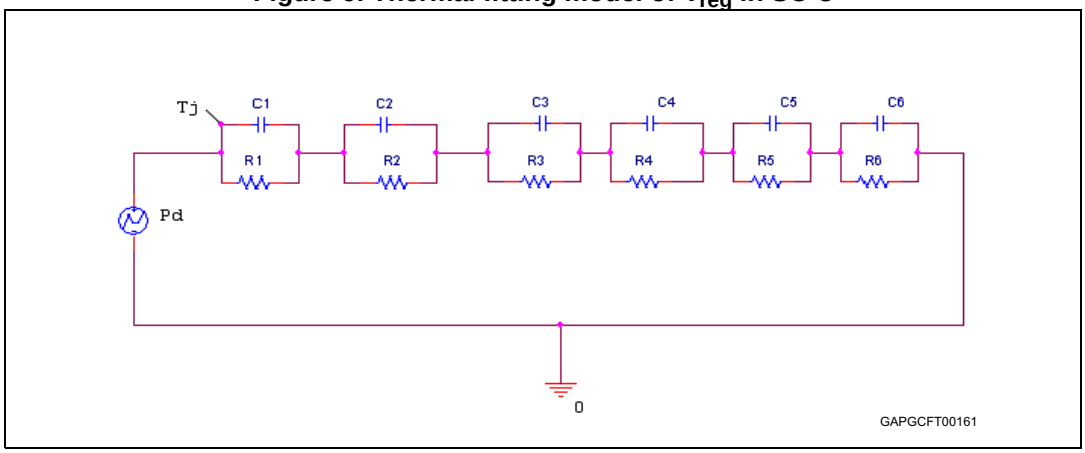
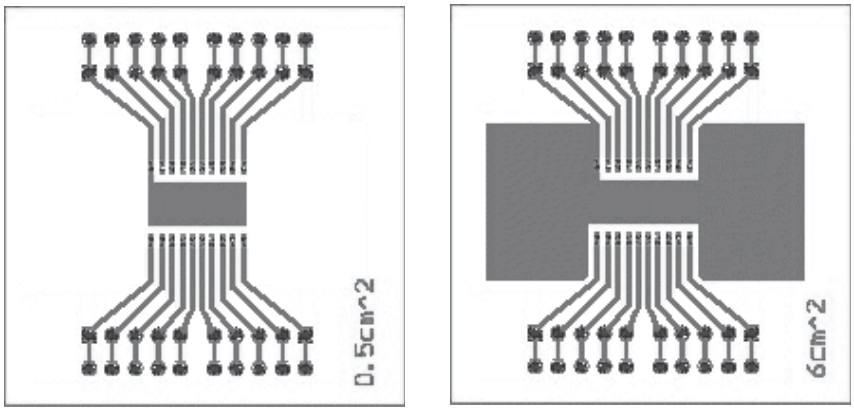


Table 10. SO-8 thermal parameter

Area (cm^2)	Footprint	2
R1 (°C/W)	4	
R2 (°C/W)	2	
R3 (°C/W)	2	
R4 (°C/W)	41	
R5 (°C/W)	40	
R6 (°C/W)	58	40
C1 (W.s/°C)	0.0003	
C2 (W.s/°C)	0.0025	
C3 (W.s/°C)	0.03	
C4 (W.s/°C)	0.04	
C5 (W.s/°C)	0.1	
C6 (W.s/°C)	1.05	2

4.2 SO-20 thermal data

Figure 10. SO-20 PC board



1. Layout condition of R_{th} and Z_{th} measurements (PCB: FR4 area = 58 mm x 58 mm, PCB thickness = 2 mm, Cu thickness = 35 mm, Copper areas: from minimum pad lay-out to 6 cm^2).

Figure 11. $R_{thj\text{-}amb}$ vs PCB copper area in open box free air condition

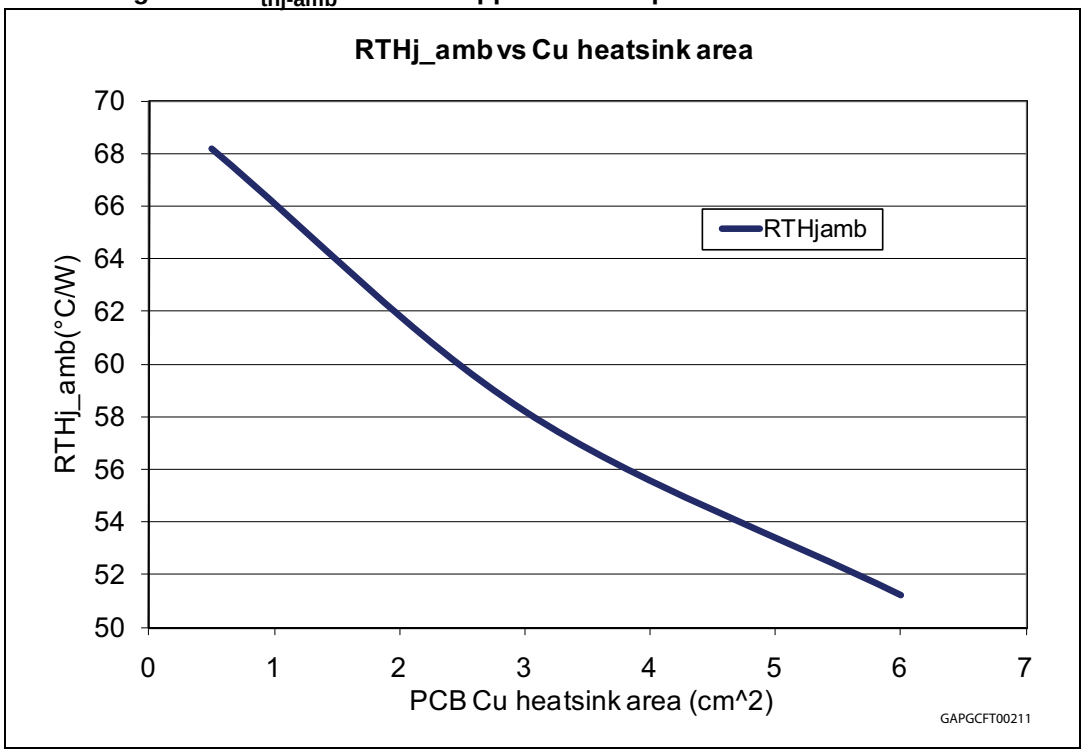
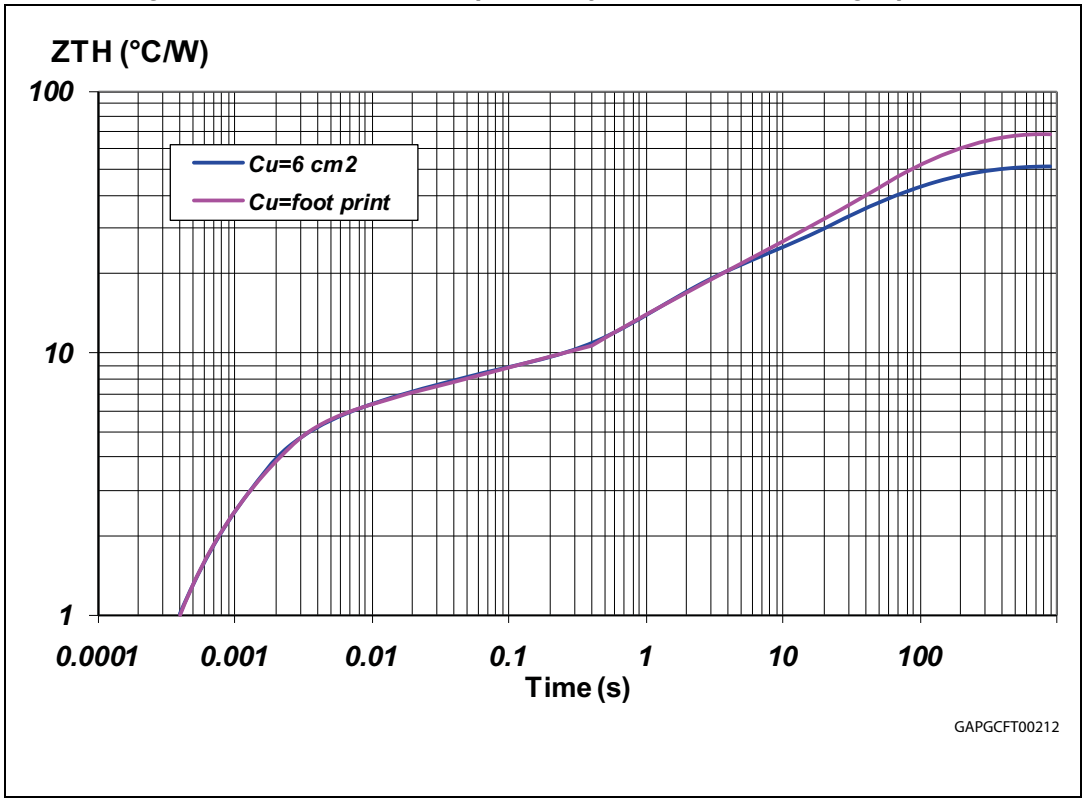


Figure 12. SO-20 thermal impedance junction ambient single pulse



Equation 2: pulse calculation formula

$$Z_{TH\delta} = R_{TH} \cdot \delta + Z_{THtp}(1 - \delta)$$

where $\delta = t_P/T$

Figure 13. Thermal fitting model of V_{reg} in SO-20

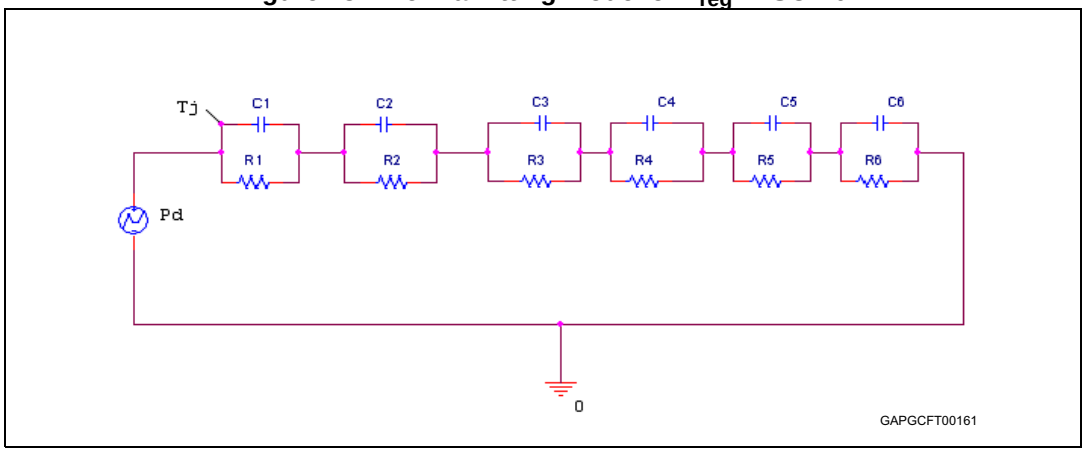


Table 11. SO-20 thermal parameter

Area (cm^2)	Footprint	2
R1 (°C/W)	4	
R2 (°C/W)	2	
R3 (°C/W)	2.2	
R4 (°C/W)	10	
R5 (°C/W)	15	
R6 (°C/W)	35	18
C1 (W.s/°C)	0.0003	
C2 (W.s/°C)	0.0025	
C3 (W.s/°C)	0.015	
C4 (W.s/°C)	0.15	
C5 (W.s/°C)	1.5	
C6 (W.s/°C)	4	7

5 Package information

5.1 ECOPACK®

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: *www.st.com*. ECOPACK® is an ST trademark.

5.2 SO-8 package information

Figure 14. SO-8 package dimensions

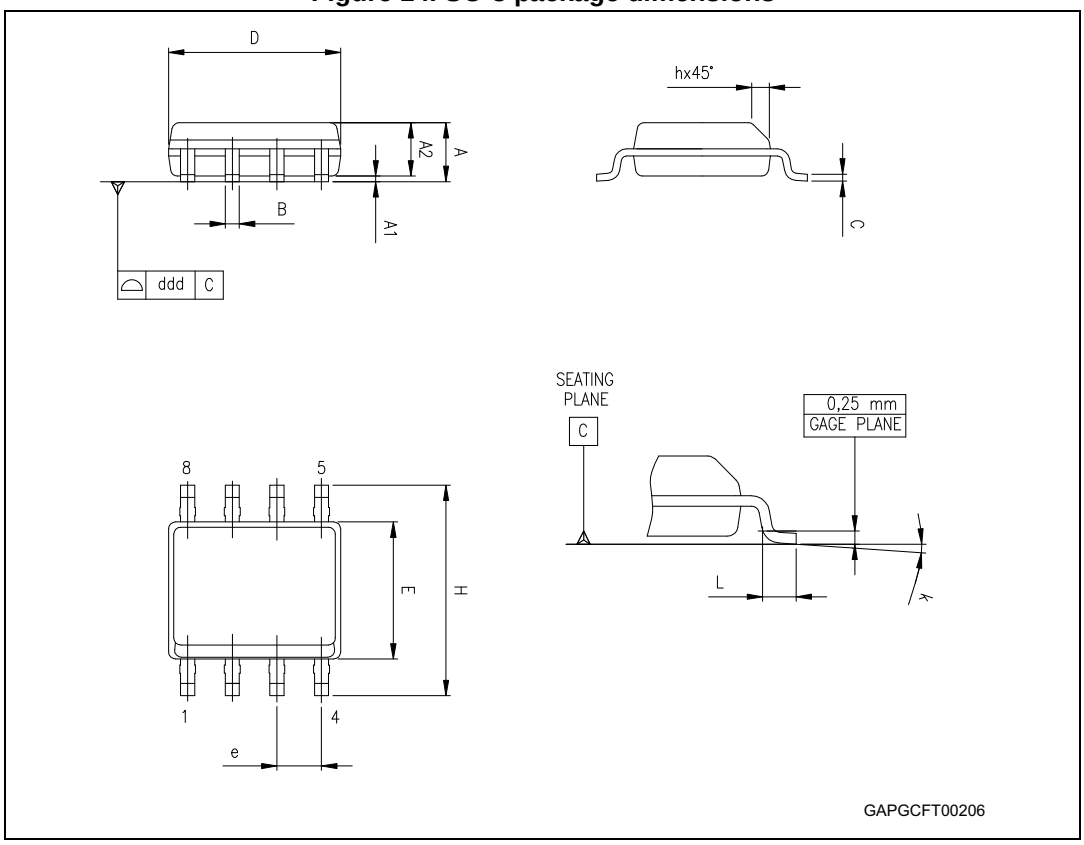


Table 12. SO-8 mechanical data

Symbol	mm			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D(1)	4.80		5.00	0.189		0.197
E	3.80		4.00	0.15		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	0°		8°	0°		8°
ddd			0.10			0.004

1. Dimensions D does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15 mm (0.006 inch) in total (both side).

5.3 SO-20 package information

Figure 15. SO-20 package dimensions

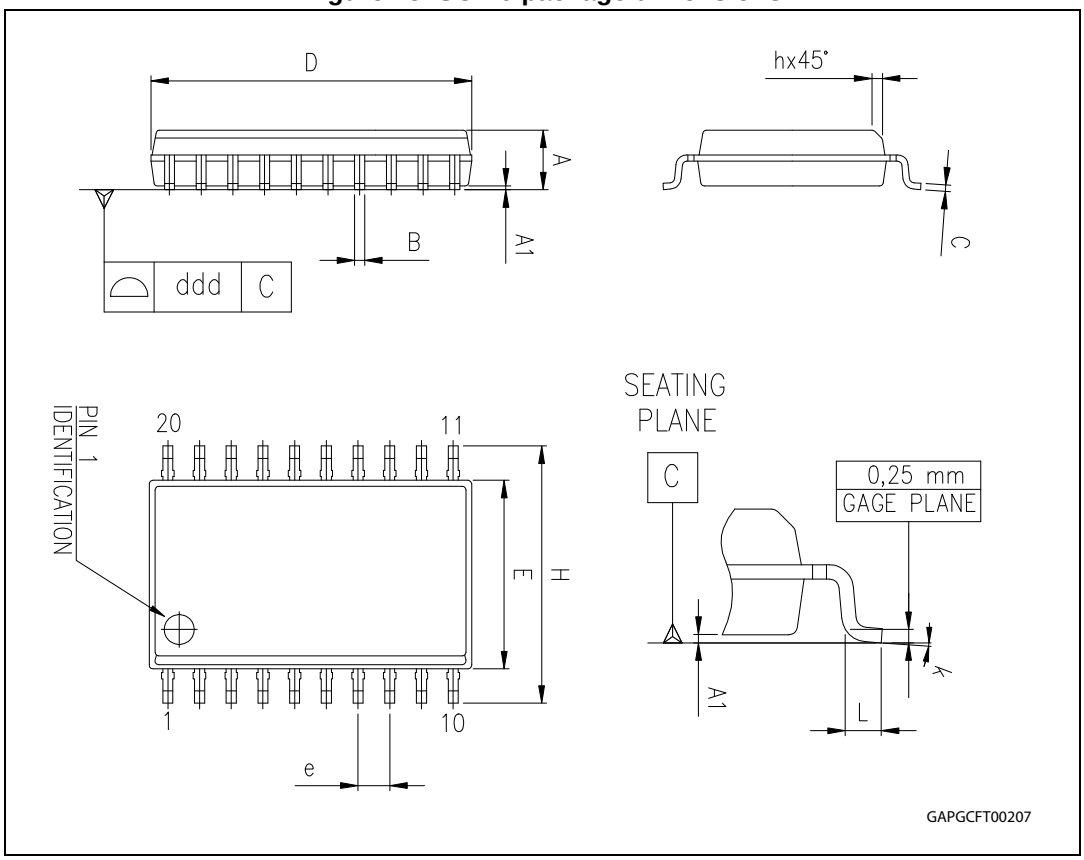


Table 13. SO-20 mechanical data

Dim.	mm			inch		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.35		2.65	0.093		0.104
A1	0.10		0.30	0.004		0.012
B	0.33		0.51	0.013		0.200
C	0.23		0.32	0.009		0.013
D(1)	12.60		13.00	0.496		0.512
E	7.40		7.60	0.291		0.299
e		1.27			0.050	
H	10.0		10.65	0.394		0.419
h	0.25		0.75	0.010		0.030
L	0.40		1.27	0.016		0.050
k	0° (min.), 8° (max.)					
ddd			0.10			0.004

1. “D” dimension does not include mold flash, protrusions or gate burrs. Mold flash, protrusions or gate burrs shall not exceed 0.15 mm per side.

6 Revision history

Table 14. Document revision history

Date	Revision	Changes
01-Jun-2004	3	Changed the values of the parameter “Reset timing high/low threshold.
01-Jul-2004	4	Pin Connection SO-20 changed. Changed some textes in the Features and table 2. Changed some values in the tables 3, 4 and 5. Changed some textes in the sections 2, 3 and 4.
01-Oct-2004	5	Changed from Product Preview to final datasheet.
01-Feb-2006	6	Modified the orderable part numbers for Tape & Reel.
04-Apr-2011	7	Changed document template. Added *Chapter 4: Package and PCB thermal data*
27-Mar-2012	8	Update *Table 3: Absolute maximum ratings*
19-Sep-2013	9	Updated Disclaimer.
23-Feb-2018	10	Updated template. Removed the tube version on the SO-8 package on the *Table 1: Device summary*. Updated *Section 2.1: Absolute maximum ratings*