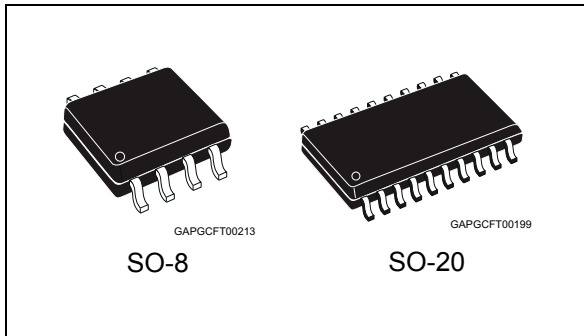


## Automotive low dropout voltage regulator

Datasheet - production data



very low output current mode and enabled regulator. The devices drop to 6  $\mu\text{A}$  with not enabled regulators.

On chip trimming results in high output voltage accuracy ( $\pm 2\%$ ). 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.

### Features



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

Table 1. Device summary

Package	Order codes	
	Tube	Tape and reel
SO-8	L4979D	L4979D013TR
SO-20	L4979MD	L4979MD013TR

### 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  $\mu\text{A}$  in

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# 1 Block diagram and pin descriptions

Figure 1. Block diagram

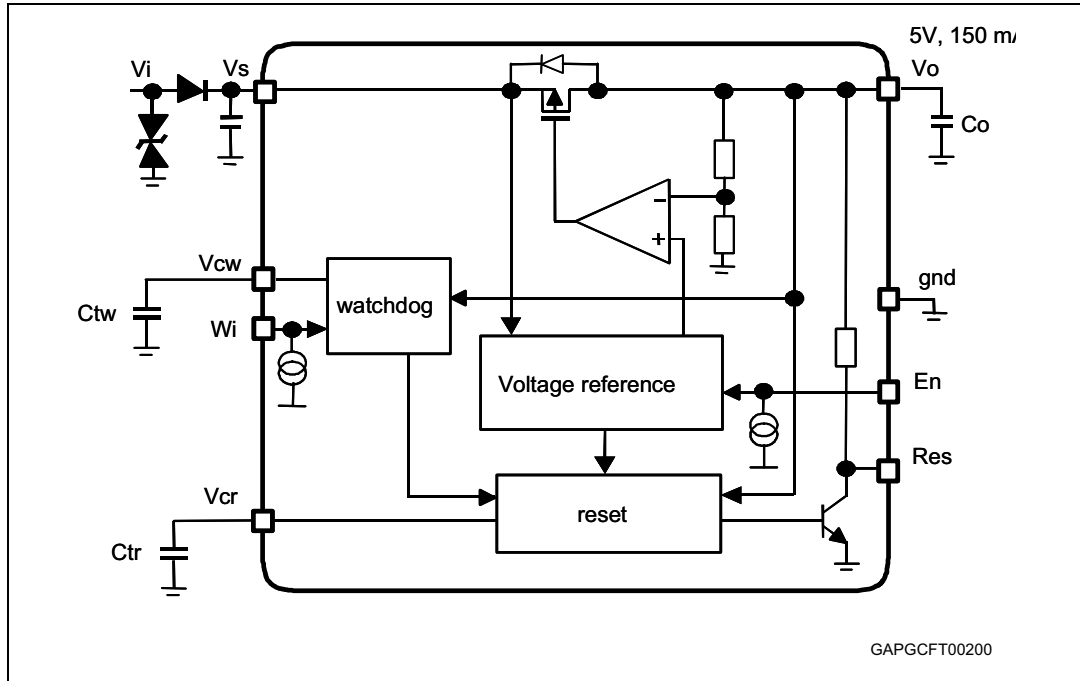


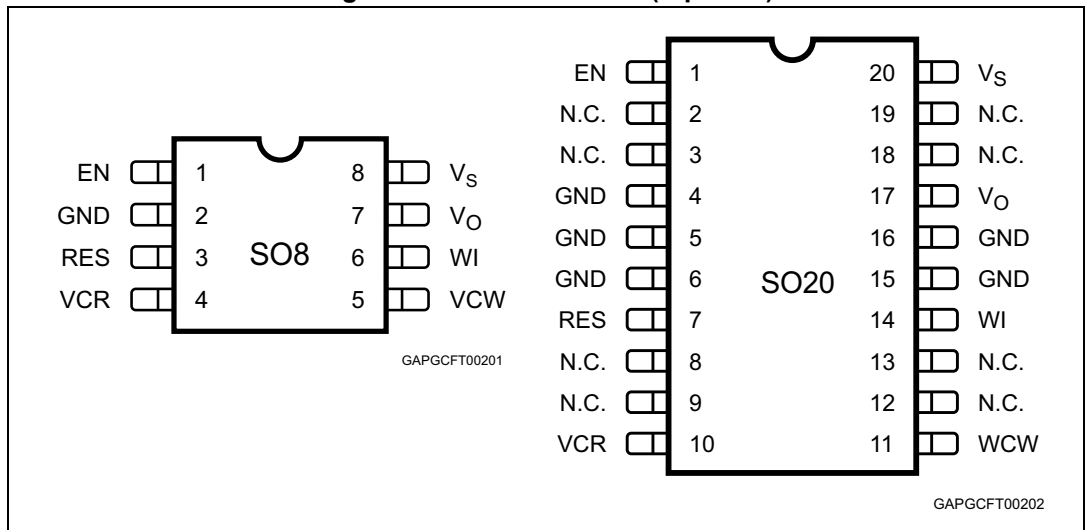
Table 2. Pin function

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 ratings listed in [Table 3](#) 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 reported in this section for extended periods may affect device reliability. Refer also to the STMicroelectronics SURE program and other relevant quality documents.

**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 <sup>(1)</sup>	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  $C_{out} = 10 \mu F$  and  $I_{out} = 0 A$ , 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
$R_{th j-amb}$	Thermal resistance junction to ambient	130 to 180	50 to 80	°C/W

## 2.2 Electrical characteristics

$V_s = 5.6 \text{ V to } 31 \text{ V}$ ;  $T_j = -40 \text{ }^\circ\text{C to } 150 \text{ }^\circ\text{C}$ , unless otherwise specified.

**Table 5. General**

Pin	Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$V_s, V_o$	$I_q$	Quiescent current	$V_s = 13.5 \text{ V}$ , $I_o = 150 \text{ mA}$ , enable high all I/O currents = 0		1.5	3	mA
$V_s, V_o$	$I_q$	Quiescent current	$V_s = 13.5 \text{ V}$ , $I_o = 0 \text{ mA}$ , enable high all I/O currents = 0		100	200	$\mu\text{A}$
$V_s, V_o$	$I_q$	Quiescent current	$V_s = 13.5 \text{ V}$ , $I_o = 0 \text{ mA}$ , enable low all I/O currents = 0		6	20	$\mu\text{A}$
	$T_w$	Thermal protection temperature		150		190	$^\circ\text{C}$
	$T_{w\_hy}$	Thermal protection temperature hysteresis			10		$^\circ\text{C}$

**Table 6. Voltage regulator**

Pin	Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$V_o$	$V_{o\_ref}$	Output voltage	$V_s = 5.6 \text{ to } 31 \text{ V}$ ; $I_o = 1 \text{ to } 150 \text{ mA}$	4.90	5.00	5.10	V
$V_o$	$I_{short}$	Output short circuit current <sup>(1)</sup>	$V_s = 13.5 \text{ V}$	150	280	400	mA
$V_o$	$I_{lim}$	Output current limitation <sup>(1)</sup>	$V_s = 13.5 \text{ V}$	150	320	500	mA
$V_s, V_o$	$V_{line}$	Line regulation voltage	$V_s = 5.6 \text{ to } 31 \text{ V}$ $I_o = 1 \text{ to } 150 \text{ mA}$			25	mV
$V_o$	$V_{load}$	Load regulation voltage	$I_o = 1 \text{ to } 150 \text{ mA}$			25	mV
$V_s, V_o$	$V_{dp}$	Drop voltage	$I_o = 150 \text{ mA}$		200	400	mV
$V_s, V_o$	SVR	Ripple rejection <sup>(2)</sup>	$f_r = 100 \text{ Hz}$	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	$R_{ext} = 5 \text{ k}\Omega$ to $V_o$ ; $V_o > 1 \text{ V}$			0.4	V
$R_{es}$	$I_{res\_h}$	Reset output high leakage current	$V_{res} = 5 \text{ V}$			1	$\mu\text{A}$



Table 7. Reset (continued)

Pin	Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
R <sub>es</sub>	R <sub>p_u</sub>	Internal pull-up resistance	With respect to V <sub>o</sub>	12	25	50	kΩ
R <sub>es</sub>	V <sub>o_th</sub>	Reset threshold voltage	V <sub>s</sub> = 5.6 to 31 V I <sub>o</sub> = 1 to 150 mA	6% below V <sub>o_ref</sub>	8% below V <sub>o_ref</sub>	10% below V <sub>o_ref</sub>	
V <sub>cr</sub>	V <sub>rhth</sub>	Reset timing high threshold	V <sub>s</sub> = 13.5 V	44% V <sub>o_ref</sub>	47% V <sub>o_ref</sub>	50% V <sub>o_ref</sub>	
V <sub>cr</sub>	V <sub>rlth</sub>	Reset timing low threshold	V <sub>s</sub> = 13.5 V	10% V <sub>o_ref</sub>	13% V <sub>o_ref</sub>	16% V <sub>o_ref</sub>	
V <sub>cr</sub>	I <sub>cr</sub>	Charge current	V <sub>s</sub> = 13.5 V	8	17	30	μA
V <sub>cr</sub>	I <sub>dr</sub>	Discharge current	V <sub>s</sub> = 13.5 V	8	17	30	μA
R <sub>es</sub>	t <sub>rr_2</sub>	Reset delay time <sup>(1)</sup>	V <sub>o</sub> = V <sub>o_th</sub> - 100 mV	100	250	700	μs
R <sub>es</sub>	t <sub>rd</sub>	Reset pulse delay	V <sub>s</sub> = 13.5 V; C <sub>tr</sub> = 1 nF	65		150	ms

1. When V<sub>o</sub> 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 <sub>i</sub>	V <sub>ih</sub>	Input high voltage	V <sub>s</sub> = 13.5 V	3.5			V
W <sub>i</sub>	V <sub>il</sub>	Input low voltage	V <sub>s</sub> = 13.5 V			1.5	V
W <sub>i</sub>	V <sub>ih</sub>	Input hysteresis	V <sub>s</sub> = 13.5 V		300		mV
W <sub>i</sub>	I <sub>i</sub>	Pull down current	V <sub>s</sub> = 13.5 V		10	20	μA
V <sub>cw</sub>	V <sub>whth</sub>	High threshold	V <sub>s</sub> = 13.5 V	2.20	2.35	2.50	V
V <sub>cw</sub>	V <sub>wlth</sub>	Low threshold	V <sub>s</sub> = 13.5 V	0.50	0.65	0.80	V
V <sub>cw</sub>	I <sub>cwc</sub>	Charge current	V <sub>s</sub> = 13.5 V; V <sub>cw</sub> = 0.1 V	4	7.5	14	μA
V <sub>cw</sub>	I <sub>cwd</sub>	Discharge current	V <sub>s</sub> = 13.5 V; V <sub>cw</sub> = 2.5 V	1.0	2.4	4.5	μA
V <sub>cw</sub>	T <sub>wop</sub>	Watchdog period	V <sub>s</sub> = 13.5 V; C <sub>tw</sub> = 47 nF	25	50	90	ms
R <sub>es</sub>	t <sub>wol</sub>	Watchdog output low time	V <sub>s</sub> = 13.5 V; C <sub>tw</sub> = 47 nF	6	10	22	ms

Table 9. Enable

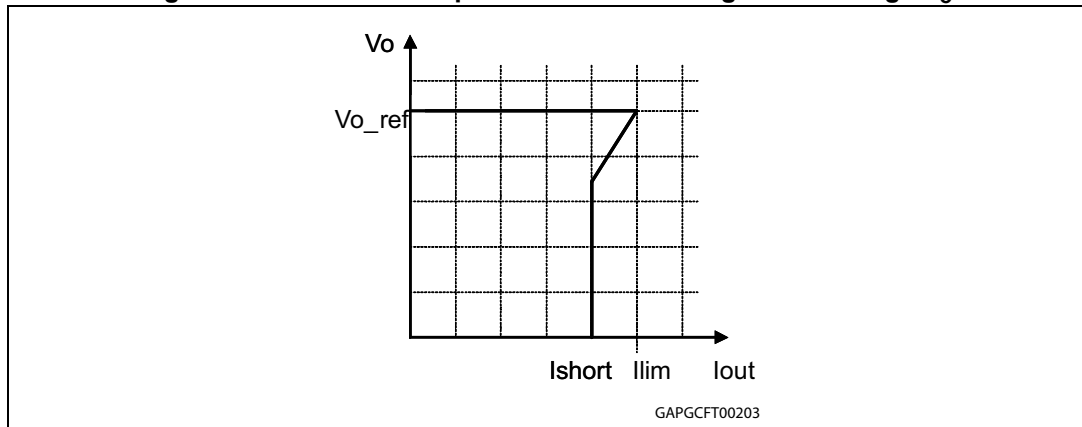
Pin	Symbol	Parameter	Test condition	Min.	Typ.	Max.	Unit
$E_n$	$V_{en\_l}$	Enable input low voltage				1	V
$E_n$	$V_{en\_h}$	Enable input high voltage		3			V
$E_n$	$V_{en\_hy}$	Enable input hysteresis		700	1000	1100	mV
$E_n$	$I_{leak}$	Pull down current	$E_n = 5\text{ V}$	2	10	20	$\mu\text{A}$

## 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 ( $V_{o\_th} - V_o$ ). The reset low signal is guaranteed for an output voltage  $V_o$  greater than 1 V.

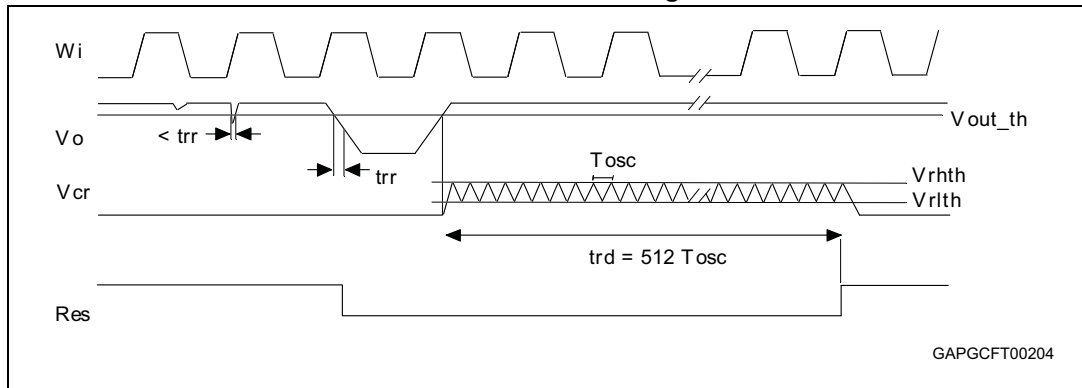
When the output voltage becomes higher than  $V_{o\_th}$  then  $R_{es}$  goes high with a delay  $t_{rd}$ . This delay is obtained by 512 periods of an oscillator (see fig. 5). The oscillator period is given by:

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

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

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

Table 10. Reset time diagram



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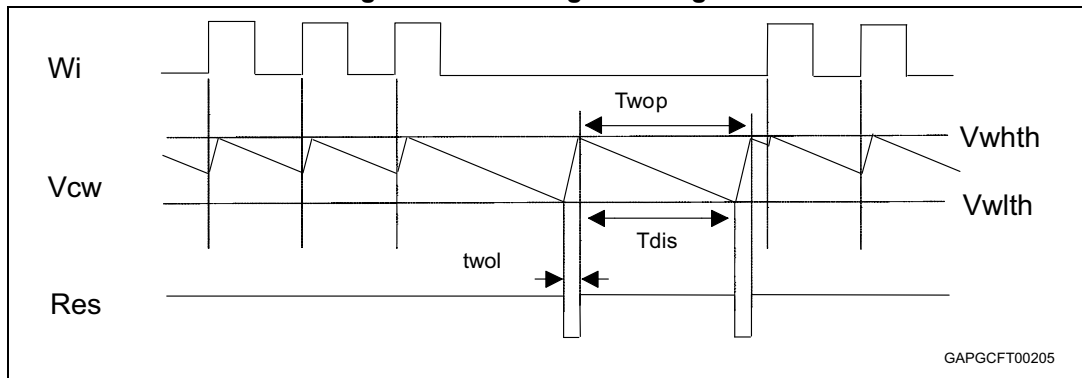
### 3.3 Watchdog

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 4. Watchdog time diagram

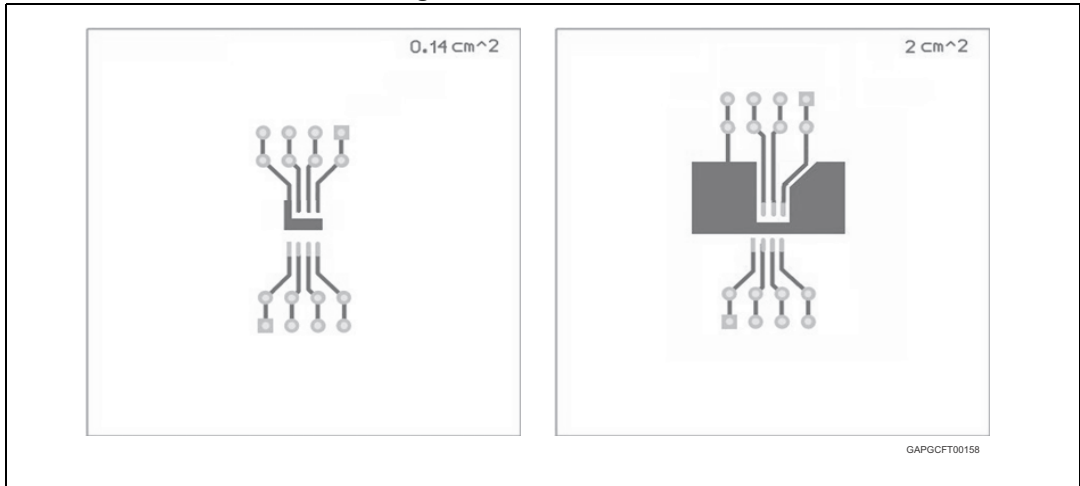


GAPGCF00205

## 4 Package and PCB thermal data

### 4.1 SO-8 thermal data

Figure 5. 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 2cm<sup>2</sup>).

Figure 6.  $R_{thj-amb}$  vs PCB copper area in open box free air condition

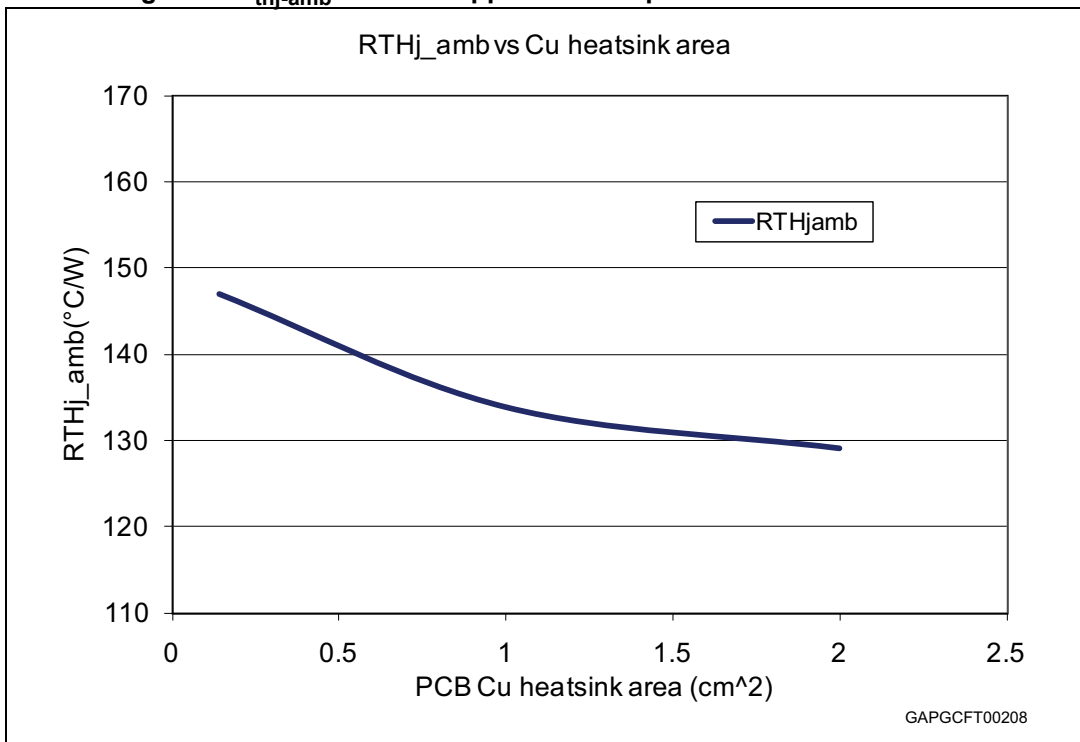
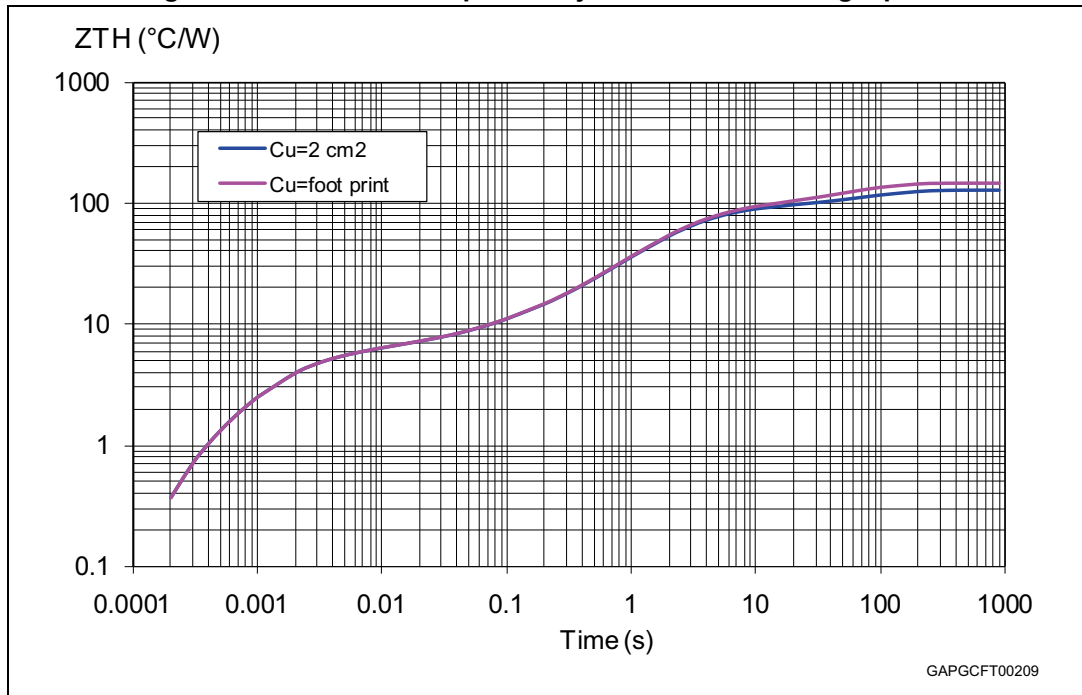


Figure 7. SO-8 thermal impedance junction ambient single pulse



Equation 1: pulse calculation formula

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

where  $\delta = t_p/T$

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

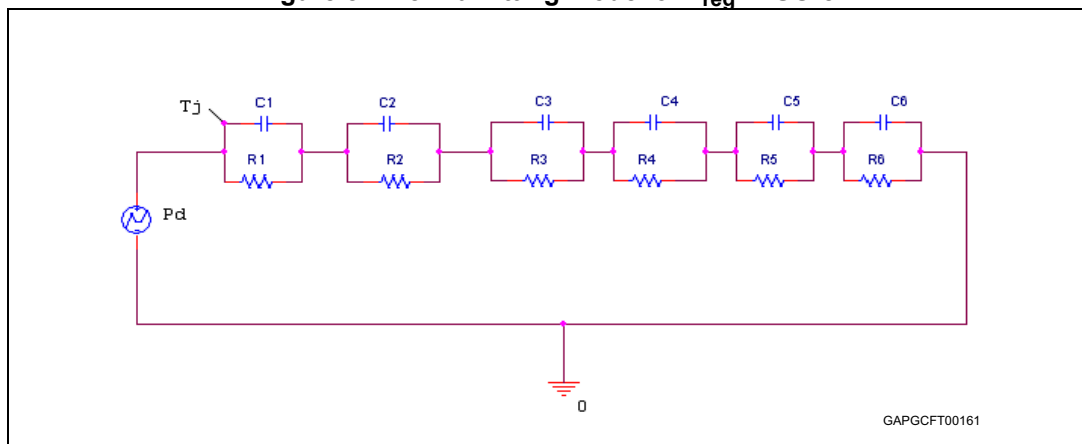
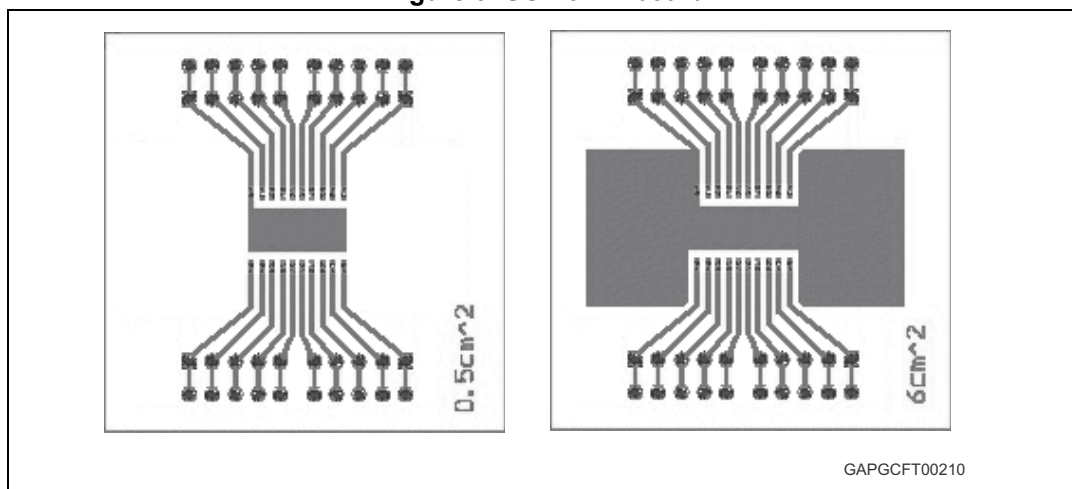


Table 11. SO-8 thermal parameter

Area (cm <sup>2</sup> )	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 9. 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 6cm<sup>2</sup>).

Figure 10.  $R_{thj-amb}$  vs PCB copper area in open box free air condition

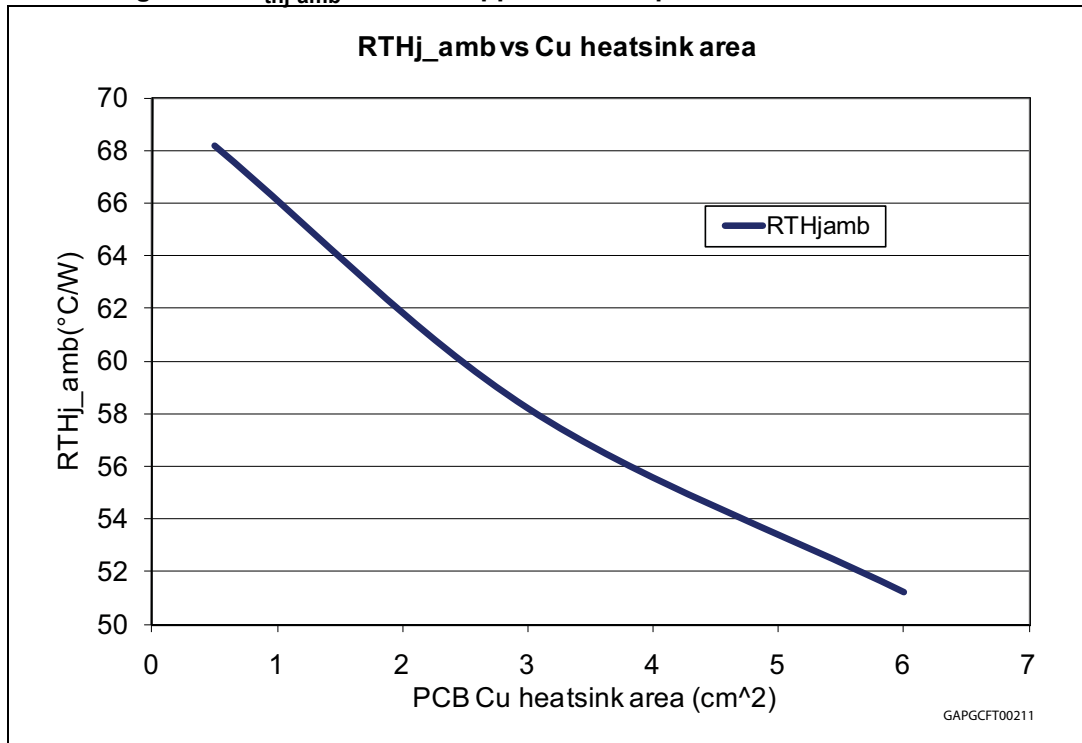
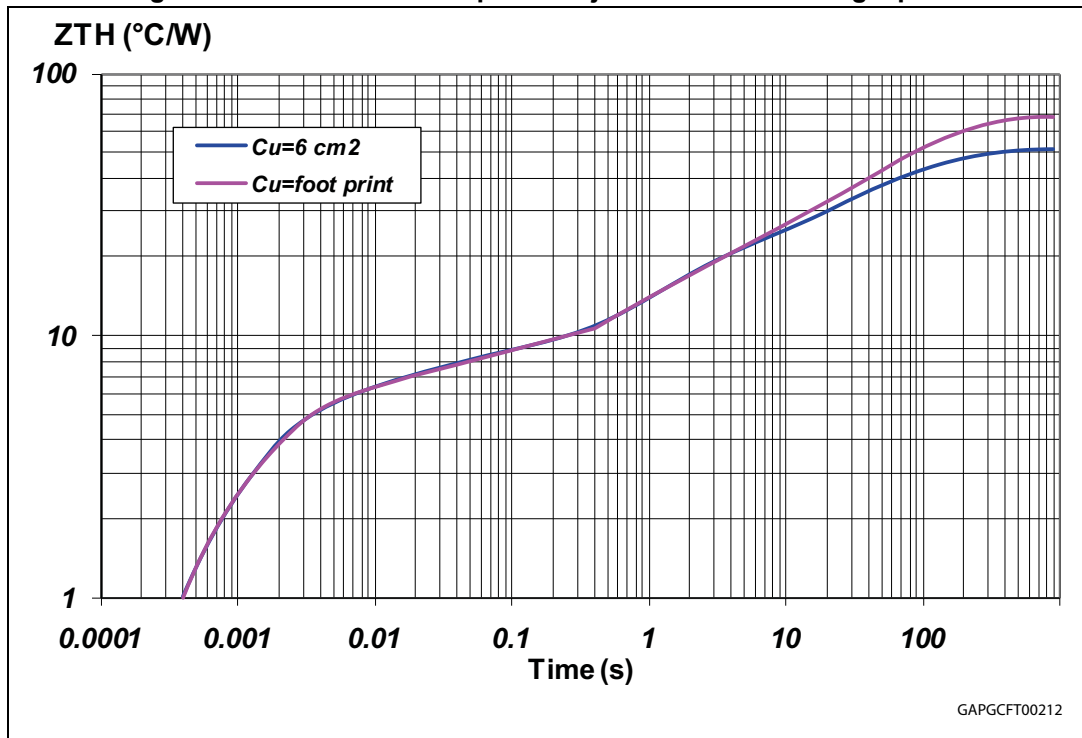


Figure 11. SO-20 thermal impedance junction ambient single pulse





Equation 2: pulse calculation formula

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

where  $\delta = t_p/T$

Figure 12. Thermal fitting model of  $V_{reg}$  in SO-20

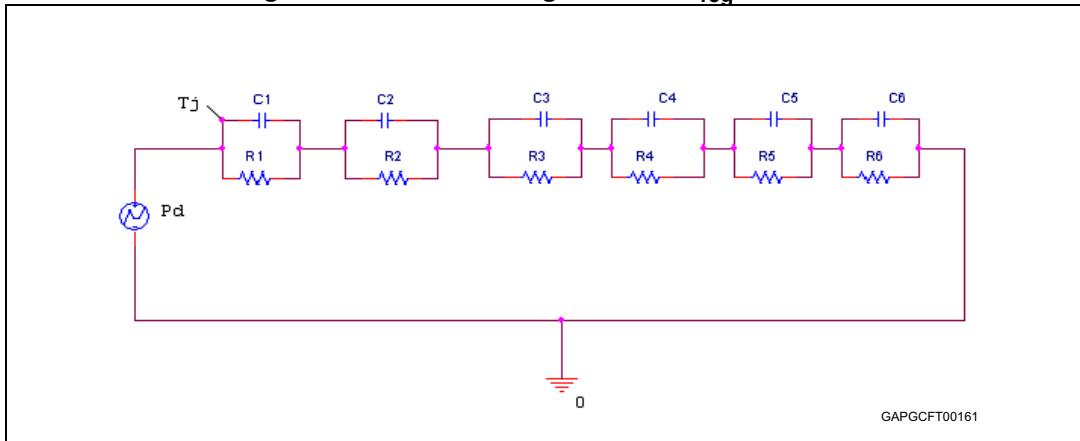


Table 12. SO-20 thermal parameter

Area (cm <sup>2</sup> )	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](http://www.st.com). ECOPACK® is an ST trademark.

### 5.2 SO-8 package information

Figure 13. SO-8 package dimensions

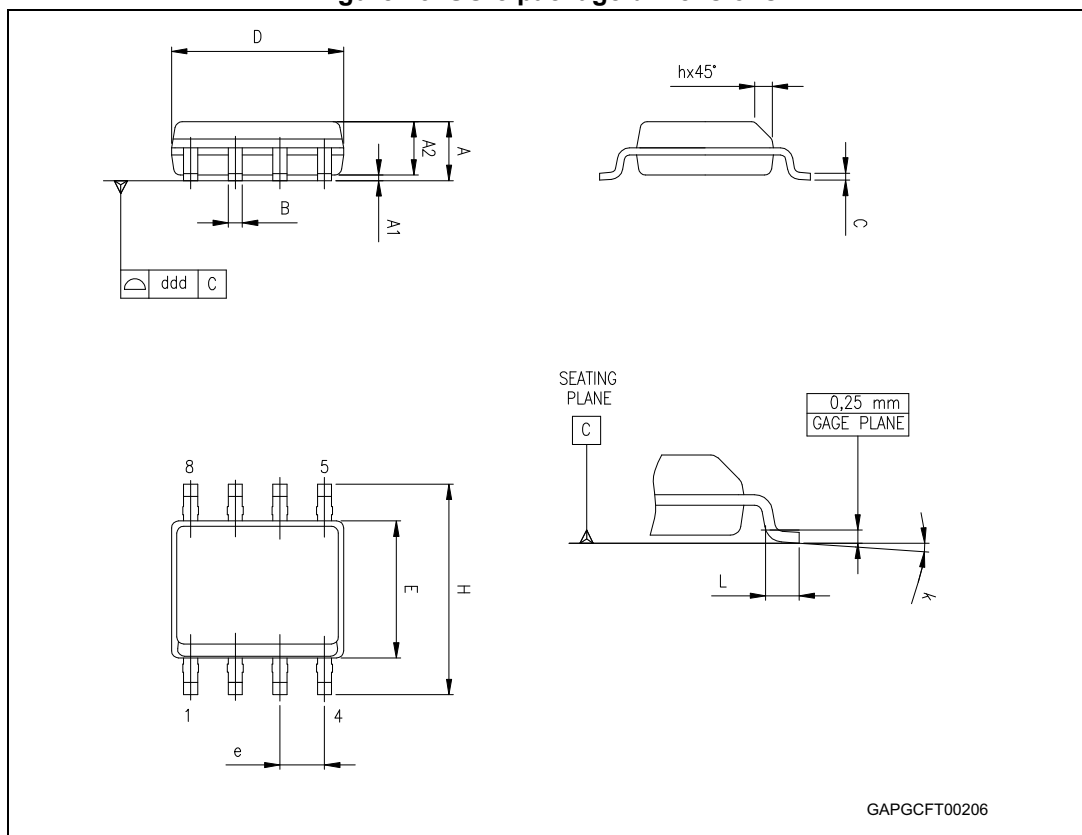


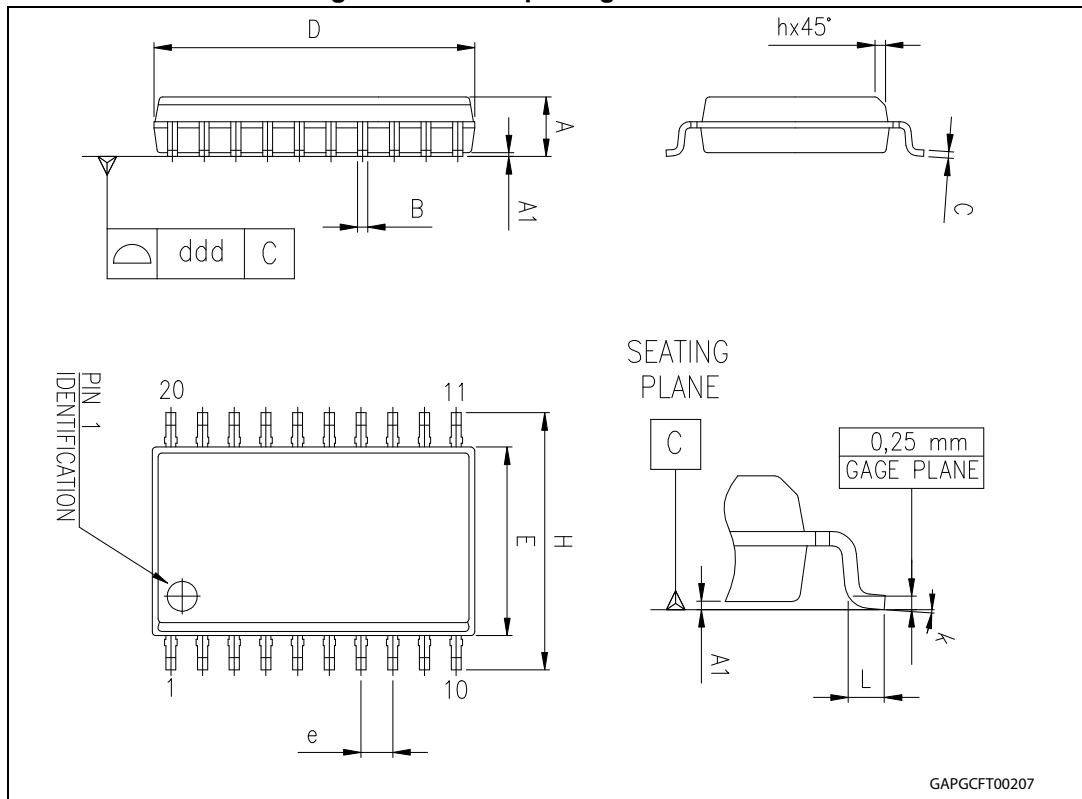
Table 13. SO-8 mechanical data

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 <sup>(1)</sup>	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 14. SO-20 package dimensions



GAPGCF00207

Table 14. 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 <sup>(1)</sup>	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 15. 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 <a href="#">Chapter 4: Package and PCB thermal data</a>
27-Mar-2012	8	Update <a href="#">Table 3: Absolute maximum ratings</a>
19-Sep-2013	9	Updated Disclaimer.
23-Feb-2018	10	Updated template. Removed the tube version on the SO-8 package on the <a href="#">Table 1: Device summary</a> . Updated <a href="#">Section 2.1: Absolute maximum ratings</a>
20-Sep-2018	11	Added the feature "AEC-Q100 qualified" in cover page with the logo automotive.

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