

P-Channel Enhancement Mode MOSFET

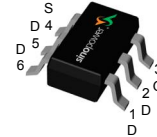
Features

- 20V/-5.6A ,
 $R_{DS(ON)} = 45m\Omega$ (Max.) @ $V_{GS} = -4.5V$
 $R_{DS(ON)} = 66m\Omega$ (Max.) @ $V_{GS} = -2.5V$
 $R_{DS(ON)} = 104m\Omega$ (Max.) @ $V_{GS} = -1.8V$
- 100% UIS + R_g Tested
- Reliable and Rugged
- Lead Free and Green Devices Available
(RoHS Compliant)

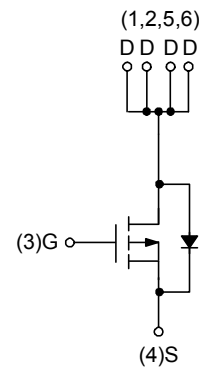
Applications

- Power Management in Notebook Computer, Portable Equipment and Battery Powered Systems.

Pin Description

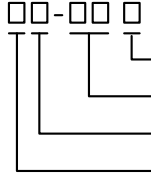


Top View of TSOT-23-6



P-Channel MOSFET

Ordering and Marking Information

SM2613PS □□-□□□  Assembly Material Handling Code Temperature Range Package Code	Package Code C : TSOT-23-6 Operating Junction Temperature Range C : -55 to 150 °C Handling Code TR : Tape & Reel Assembly Material G : Halogen and Lead Free Device
SM2613PS C : D13XX	XX - Lot Code

Note : SINOPOWER lead-free products contain molding compounds/die attach materials and 100% matte tin plate termination finish; which are fully compliant with RoHS. SINOPOWER lead-free products meet or exceed the lead-free requirements of IPC/JEDEC J-STD-020D for MSL classification at lead-free peak reflow temperature. SINOPOWER defines "Green" to mean lead-free (RoHS compliant) and halogen free (Br or Cl does not exceed 900ppm by weight in homogeneous material and total of Br and Cl does not exceed 1500ppm by weight).

SINOPOWER reserves the right to make changes to improve reliability or manufacturability without notice, and advise customers to obtain the latest version of relevant information to verify before placing orders.

Absolute Maximum Ratings ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter		Rating	Unit
V _{DSS}	Drain-Source Voltage		-20	V
V _{GSS}	Gate-Source Voltage		±12	
I _D [*]	Continuous Drain Current	T _A =25°C	-5.6	A
		T _A =70°C	-4.4	
I _{DM} [*]	Pulsed Drain Current	T _A =25°C	-22.2	
		T _A =70°C	-17.8	
I _S [*]	Diode Continuous Forward Current		-1	
T _J	Maximum Junction Temperature		150	°C
T _{STG}	Storage Temperature Range		-55 to 150	
P _D [*]	Maximum Power Dissipation	T _A =25°C	2.1	W
		T _A =70°C	1.3	
R _{θJA} [*]	Thermal Resistance-Junction to Ambient	t ≤ 10s	60	°C/W
		Steady state	100	
I _{AS} ^{**}	Avalanche Current, Single pulse	L=0.1mH	15	A
E _{AS} ^{**}	Avalanche Energy, Single pulse	L=0.1mH	11.25	mJ

Note *: Surface Mounted on 1in^2 pad area, $t \leq 10\text{sec}$.

Note **: UIS tested and pulse width limited by maximum junction temperature (initial temperature $T_J = 25^\circ\text{C}$).

Electrical Characteristics ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Static Characteristics						
BV_{DSS}	Drain-Source Breakdown Voltage	$V_{GS} = 0\text{V}$, $I_{DS} = -250\mu\text{A}$	-20	-	-	V
I_{DSS}	Zero Gate Voltage Drain Current	$V_{DS} = -16\text{V}$, $V_{GS} = 0\text{V}$	-	-	-1	μA
		$T_J = 85^\circ\text{C}$	-	-	-30	
$V_{GS(th)}$	Gate Threshold Voltage	$V_{DS} = V_{GS}$, $I_{DS} = -250\mu\text{A}$	-0.5	-0.7	-1	V
I_{GSS}	Gate Leakage Current	$V_{GS} = \pm 12\text{V}$, $V_{DS} = 0\text{V}$	-	-	± 100	nA
$R_{DS(ON)}^a$	Drain-Source On-State Resistance	$V_{GS} = -4.5\text{V}$, $I_{DS} = -5.6\text{A}$	-	36	45	m Ω
		$V_{GS} = -2.5\text{V}$, $I_{DS} = -3.5\text{A}$	-	49	66	
		$V_{GS} = -1.8\text{V}$, $I_{DS} = -1.5\text{A}$	-	72	104	
V_{SD}^a	Diode Forward Voltage	$I_{SD} = -1\text{A}$, $V_{GS} = 0\text{V}$	-	-0.7	-1	V
Gate Charge Characteristics^b						
Q_g	Total Gate Charge	$V_{DS} = -10\text{V}$, $V_{GS} = -4.5\text{V}$, $I_{DS} = -5.6\text{A}$	-	6.8	-	nC
Q_{gs}	Gate-Source Charge		-	0.8	-	
Q_{gd}	Gate-Drain Charge		-	2.5	-	

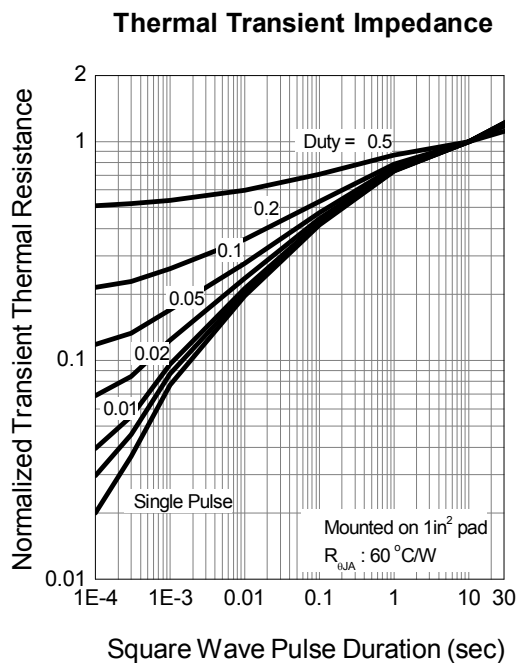
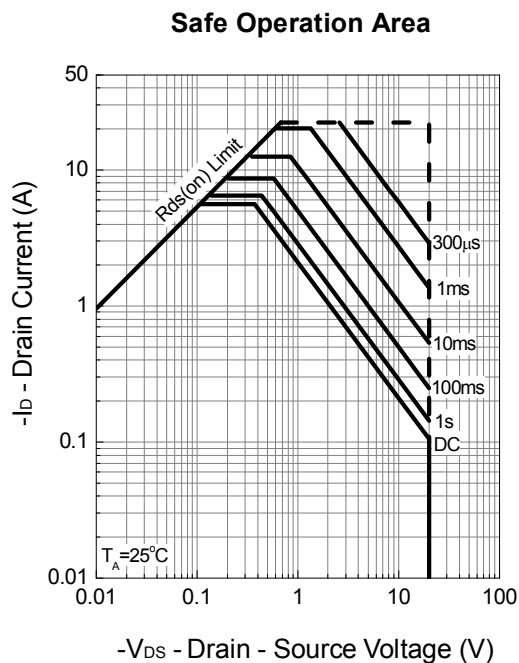
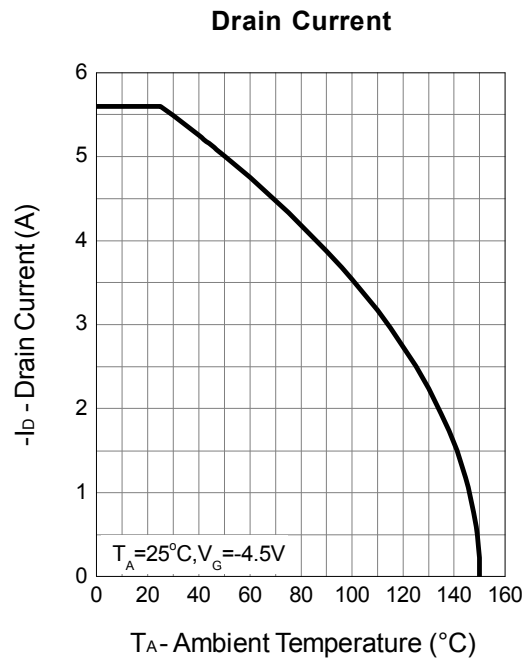
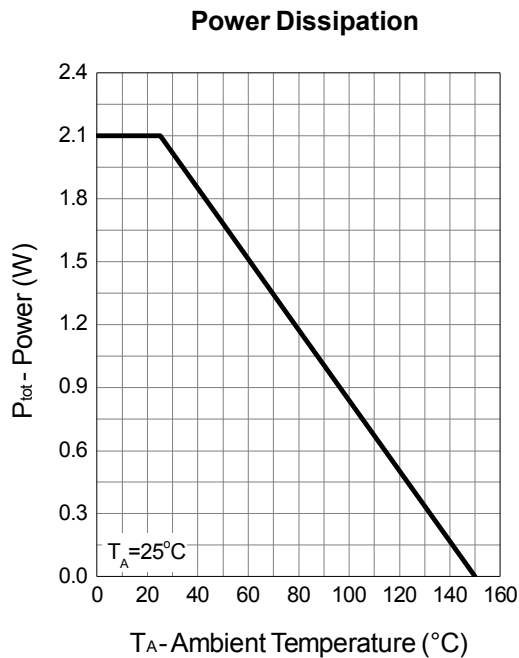
Electrical Characteristics (Cont.) ($T_A = 25^\circ\text{C}$ unless otherwise noted)

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Dynamic Characteristics^b						
R_G	Gate Resistance	$V_{GS}=0V, V_{DS}=0V, F=1\text{MHz}$	-	3.6	-	Ω
C_{iss}	Input Capacitance	$V_{GS}=0V,$ $V_{DS}=-10V,$ Frequency=1.0MHz	-	590	-	pF
C_{oss}	Output Capacitance		-	122	-	
C_{rss}	Reverse Transfer Capacitance		-	92	-	
$t_{d(ON)}$	Turn-on Delay Time	$V_{DD}=-10V, R_L=10\Omega,$ $I_{DS}=-1A, V_{GEN}=-4.5V,$ $R_G=6\Omega$	-	7.2	-	ns
t_r	Turn-on Rise Time		-	13.4	-	
$t_{d(OFF)}$	Turn-off Delay Time		-	26	-	
t_f	Turn-off Fall Time		-	17	-	
t_{rr}	Reverse Recovery Time	$I_{SD}=-5.6A, di_{SD}/dt = 100A/\mu s$	-	18	-	ns
Q_{rr}	Reverse Recovery Charge		-	7	-	nC

Note a : Pulse test ; pulse width $\leq 300\mu s$, duty cycle $\leq 2\%$.

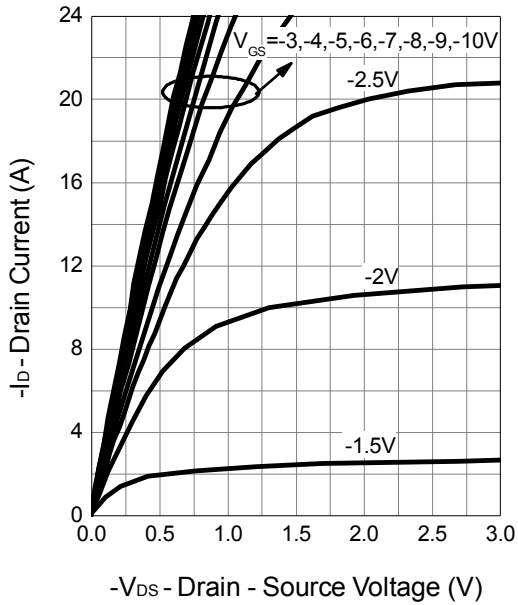
Note b : Guaranteed by design, not subject to production testing.

Typical Operating Characteristics

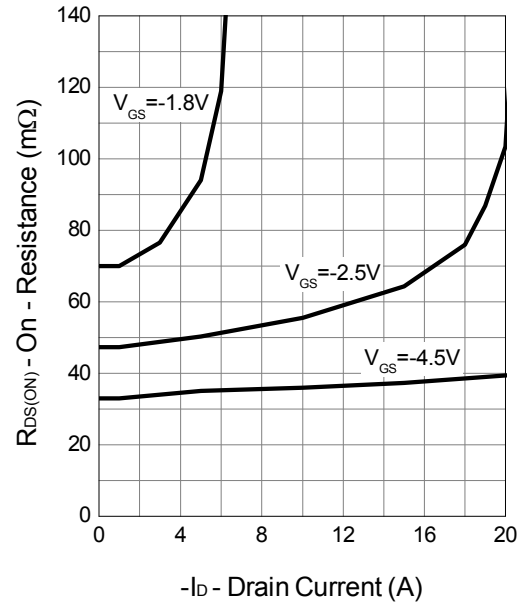


Typical Operating Characteristics (Cont.)

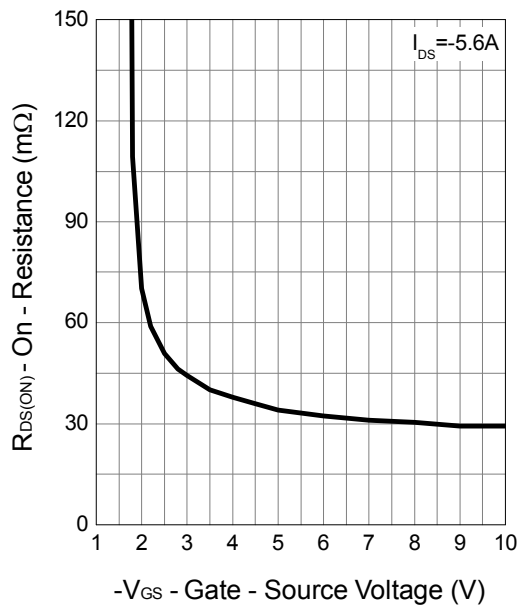
Output Characteristics



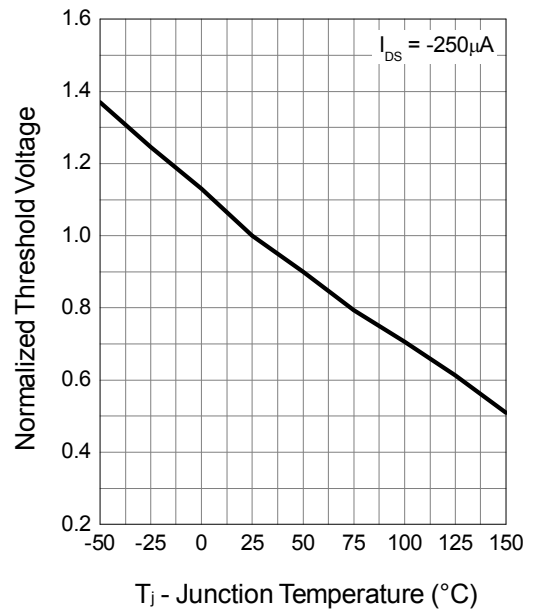
Drain-Source On Resistance



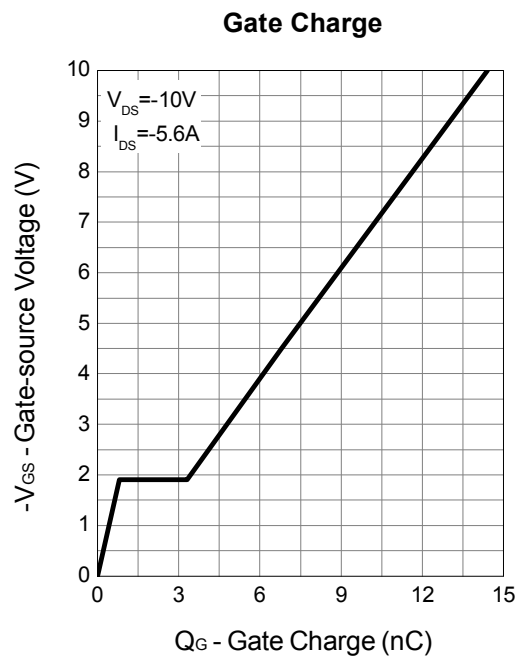
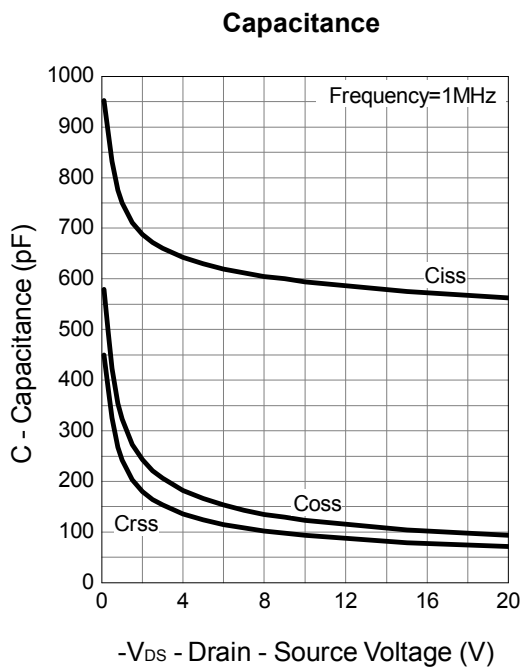
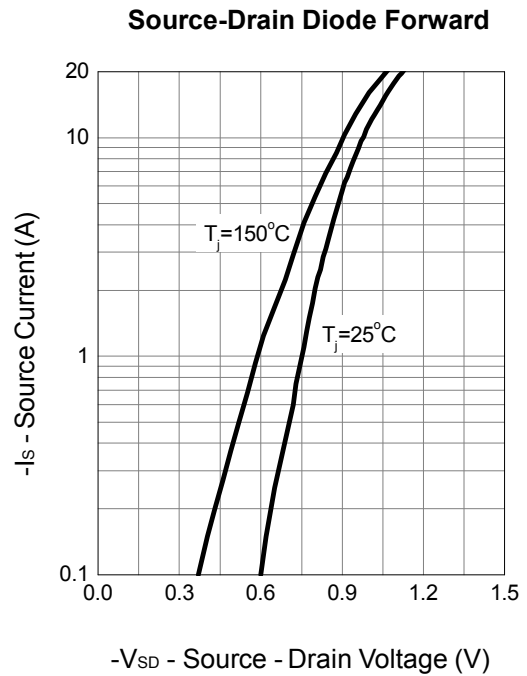
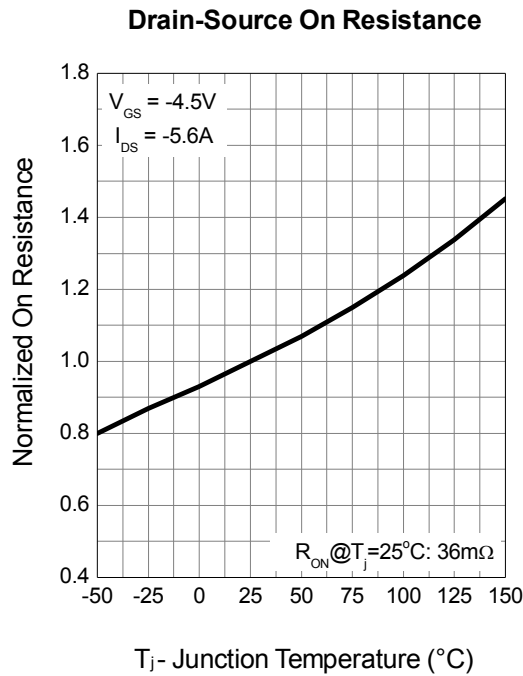
Gate-Source On Resistance



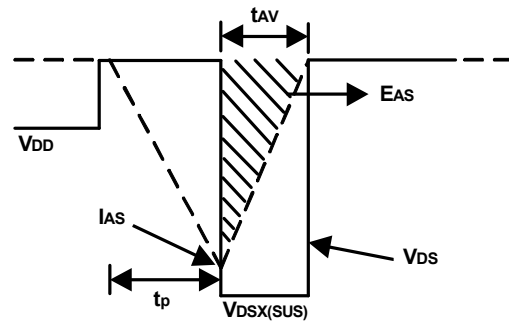
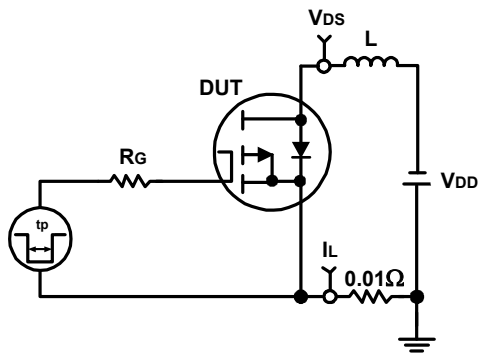
Gate Threshold Voltage



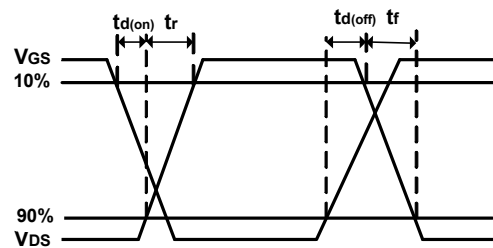
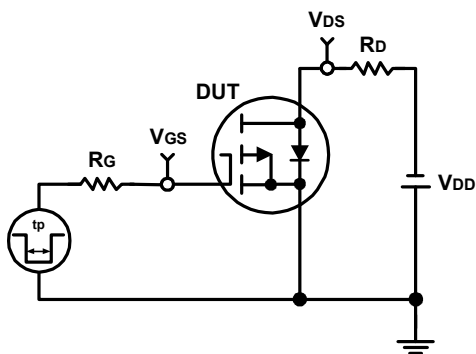
Typical Operating Characteristics (Cont.)



Avalanche Test Circuit and Waveforms



Switching Time Test Circuit and Waveforms



Disclaimer

Sinopower Semiconductor Inc. (hereinafter “Sinopower”) has been making great efforts to develop high quality and better performance products to satisfy all customers’ needs. However, a product may fail to meet customer’s expectation or malfunction for various situations.

All information which is shown in the datasheet is based on Sinopower’s research and development result, therefore, Sinopower shall reserve the right to adjust the content and monitor the production.

In order to unify the quality and performance, Sinopower has been following JEDEC while defines assembly rule. Notwithstanding all the suppliers basically follow the rule for each product, different processes may cause slightly different results.

The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the products. Sinopower does not grant customers explicitly or implicitly, any license to use or exercise intellectual property or other rights held by Sinopower and other parties. Sinopower shall bear no responsible whatsoever for any dispute arising from the use of such technical information.

The products are not designed or manufactured to be used with any equipment, device or system which requires an extremely high level of reliability, such as the failure or malfunction of which any may result in a direct threat to human life or a risk of human injury. Sinopower shall bear no responsibility in any way for use of any of the products for the above special purposes. If a product is intended to use for any such special purpose, such as vehicle, military, or medical controller relevant applications, please contact Sinopower sales representative before purchasing.

Figure 1 illustrates the temperature profile of a typical heat pump. The main graph plots Temperature (Y-axis) against Time (X-axis). The Y-axis includes markers for 25, T_L , T_p , and $T_c - 5^\circ\text{C}$. The X-axis includes markers for Time 25°C to Peak and t . The profile shows a preheat phase (Preheat Area) between T_{smin} and T_{smax} , followed by a heating phase reaching a peak at T_p . The peak duration is t_p . The graph also indicates the maximum ramp up rate (3°C/s) and maximum ramp down rate (6°C/s).

Two inset graphs show the temperature profiles for the Supplier and User. The Supplier inset shows a peak at $T_p \geq T_c$ with duration t_p . The User inset shows a peak at $T_p \leq T_c$ with duration t_p . Both insets show a horizontal line at $T_c - 5^\circ\text{C}$.

Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak		
Temperature min (T_{smin})	100 °C	150 °C
Temperature max (T_{smax})	150 °C	200 °C
Time (T_{smin} to T_{smax}) (t_s)	60-120 seconds	60-120 seconds
Average ramp-up rate (T_{smax} to T_p)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L)	183 °C	217 °C
Time at liquidous (t_L)	60-150 seconds	60-150 seconds
Peak package body Temperature (T_p)*	See Classification Temp in table 1	See Classification Temp in table 2
Time (t_p)** within 5°C of the specified classification temperature (T_c)	20** seconds	30** seconds
Average ramp-down rate (T_p to T_{smax})	6 °C/second max.	6 °C/second max.
Time 25°C to peak temperature	6 minutes max.	8 minutes max.
* Tolerance for peak profile Temperature (T_p) is defined as a supplier minimum and a user maximum.		
** Tolerance for time at peak profile temperature (t_p) is defined as a supplier minimum and a user maximum.		

Table 1. SnPb Eutectic Process – Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ ≥350
<2.5 mm	235 °C	220 °C
≥2.5 mm	220 °C	220 °C

Table 2. Pb-free Process – Classification Temperatures (T_c)

Package Thickness	Volume mm ³ <350	Volume mm ³ 350-2000	Volume mm ³ >2000
<1.6 mm	260 °C	260 °C	260 °C
1.6 mm – 2.5 mm	260 °C	250 °C	245 °C
≥2.5 mm	250 °C	245 °C	245 °C

Customer Service

Sinopower Semiconductor Inc.

5F, No. 6, Dusing 1St Rd., Hsinchu Science Park,

Hsinchu, 300096, Taiwan

TEL: 886-3-5635818 Fax: 886-3-5635080