

P-Channel Enhancement Mode MOSFET

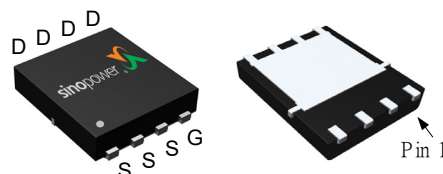
Features

- 60V/-56A
 $R_{DS(ON)} = 15.4m\Omega(max.) @ V_{GS} = -10V$
- 100% UIS + R_g Tested
- Reliable and Rugged
- Lead Free and Green Devices Available
 (RoHS Compliant)
- Moisture Sensitivity Level MSL1
 (per JEDEC J-STD-020D)

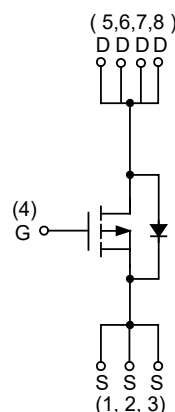
Applications

- DC/DC Converter.
- Power Management.
- Load Switch.
- Portable Equipment and Battery Powered Systems.

Pin Description



DFN5x6A-8_EP



P-Channel MOSFET

Ordering and Marking Information

SM6013PS - Assembly Material Handling Code Temperature Range Package Code	Package Code KP : DFN5x6A-8_EP Operating Junction Temperature Range C : -55 to 150 °C Handling Code TR : Tape & Reel Assembly Material G : Halogen and Lead Free Device
SM6013PS KP :	 XXXXX - 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).

Absolute Maximum Ratings ($T_A=25^{\circ}\text{C}$ Unless Otherwise Noted)

Symbol	Parameter		Rating	Unit
Common Ratings				
V _{DSS}	Drain-Source Voltage		-60	V
V _{GSS}	Gate-Source Voltage		±25	
T _J	Maximum Junction Temperature		150	°C
T _{STG}	Storage Temperature Range		-55 to 150	
I _S	Diode Continuous Forward Current	T _C =25°C	-28	A
I _D	Continuous Drain Current	T _C =25°C	-56	A
		T _C =100°C	-36	
I _{DM}	Pulsed Drain Current	T _C =25°C	-224 ^a	
P _D	Maximum Power Dissipation	T _C =25°C	89.3	W
		T _C =100°C	35.7	
R _{θJC}	Thermal Resistance-Junction to Case	Steady State	1.4	°C/W
I _D	Continuous Drain Current	T _A =25°C	-9	A
		T _A =70°C	-7	
P _D	Maximum Power Dissipation	T _A =25°C	2.27	W
		T _A =70°C	1.45	
R _{θJA}	Thermal Resistance-Junction to Ambient	Steady State	55	°C/W
I _{AS} ^b	Avalanche Current, Single pulse	L=0.5mH	-28	A
E _{AS} ^b	Avalanche Energy, Single pulse	L=0.5mH	196	mJ

Note a : Pulse width limited by maximum junction temperature.

Note b : 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)

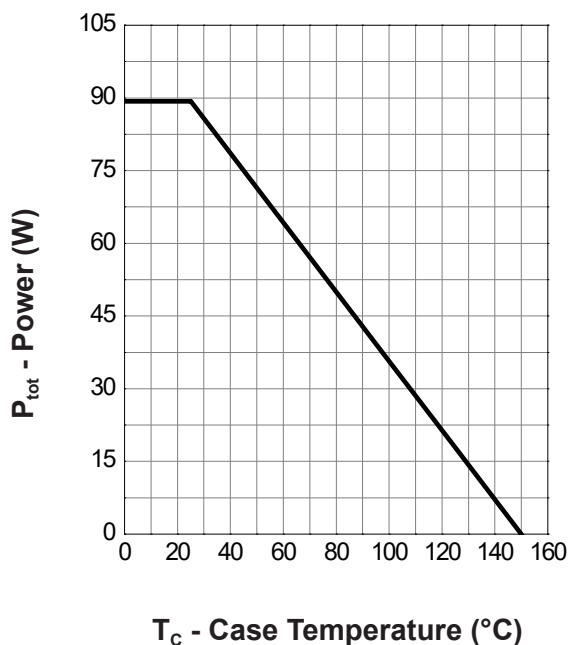
Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
Static Characteristics						
BV _{DSS}	Drain-Source Breakdown Voltage	V _{GS} =0V, I _{DS} =-250μA	-60	-	-	V
I _{DSS}	Zero Gate Voltage Drain Current	V _{DS} =-48V, V _{GS} =0V T _J =85°C	-	-	-1	μA
			-	-	-30	
V _{GS(th)}	Gate Threshold Voltage	V _{DS} =V _{GS} , I _{DS} =-250μA	-2	-2.5	-3	V
I _{GSS}	Gate Leakage Current	V _{GS} =±25V, V _{DS} =0V	-	-	±100	nA
R _{DS(ON)} ^c	Drain-Source On-state Resistance	V _{GS} =-10V, I _{DS} =-25A	-	12.3	15.4	mΩ
Diode Characteristics						
V _{SD} ^c	Diode Forward Voltage	I _{SD} =-12A, V _{GS} =0V	-	-0.8	-1.1	V
t _{rr}	Reverse Recovery Time	I _{SD} =-25A, dI _{SD} /dt=100A/μs	-	39	-	ns
Q _{rr}	Reverse Recovery Charge		-	62	-	nC
Dynamic Characteristics ^d						
R _G	Gate Resistance	V _{GS} =0V, V _{DS} =0V, F=1MHz	-	2	-	Ω
C _{iss}	Input Capacitance	V _{GS} =0V, V _{DS} =-30V, Frequency=1.0MHz	-	4800	6240	pF
C _{oss}	Output Capacitance		-	350	-	
C _{rss}	Reverse Transfer Capacitance		-	185	-	
t _{d(ON)}	Turn-on Delay Time	V _{DD} =-30V, R _L =30Ω, I _{DS} =-1A, V _{GEN} =-10V, R _G =6Ω	-	23	41	ns
t _r	Turn-on Rise Time		-	18	32	
t _{d(OFF)}	Turn-off Delay Time		-	115	207	
t _f	Turn-off Fall Time		-	47	85	
Gate Charge Characteristics ^d						
Q _g	Total Gate Charge	V _{DS} =-30V, V _{GS} =-10V, I _{DS} =-25A	-	90	126	nC
Q _{gs}	Gate-Source Charge		-	19	-	
Q _{gd}	Gate-Drain Charge		-	24	-	

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

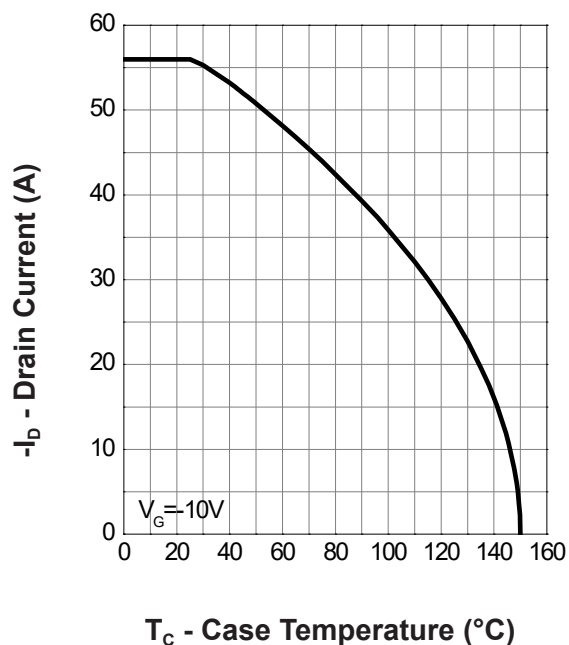
Note d : Guaranteed by design, not subject to production testing.

Typical Operating Characteristics

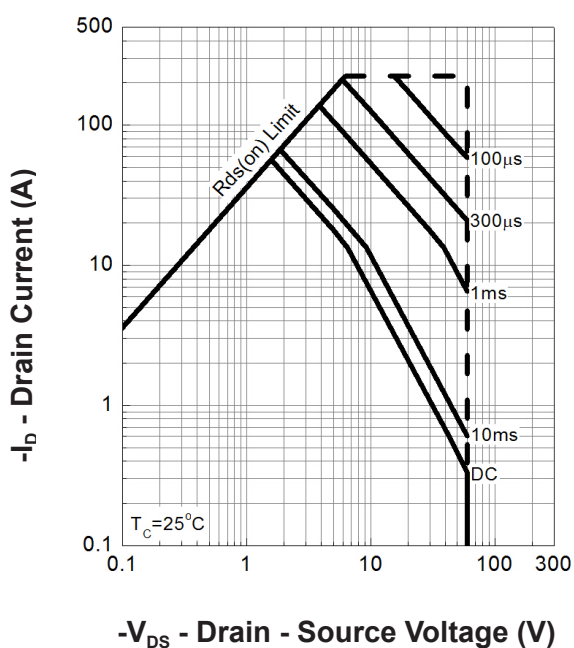
Power Dissipation



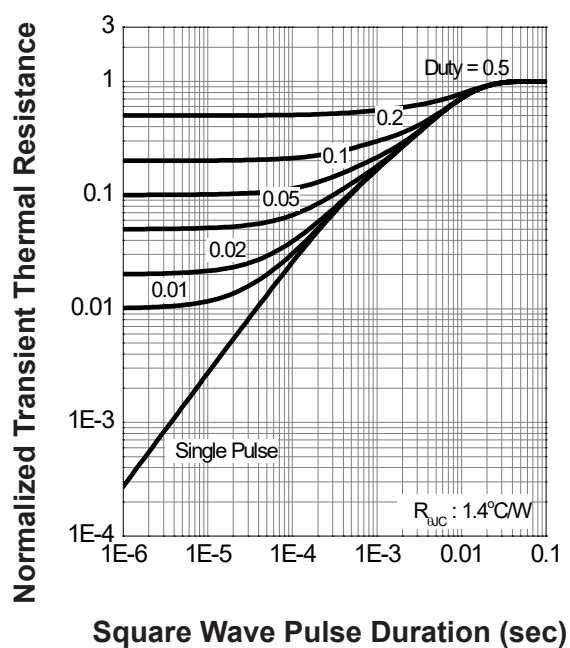
Drain Current



Safe Operation Area

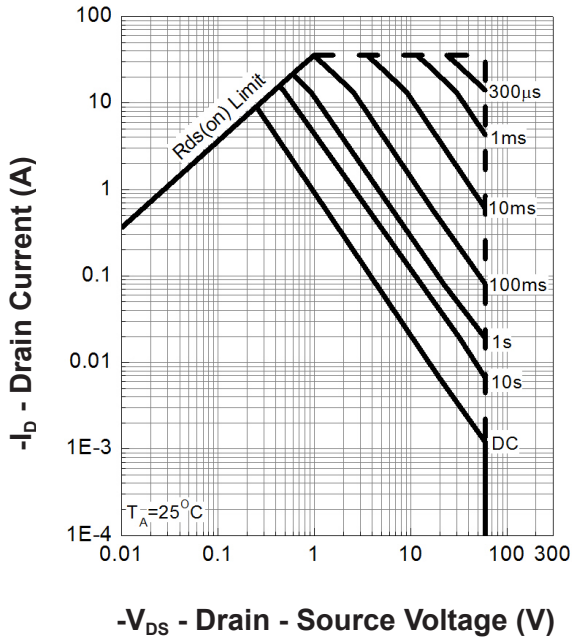


Thermal Transient Impedance

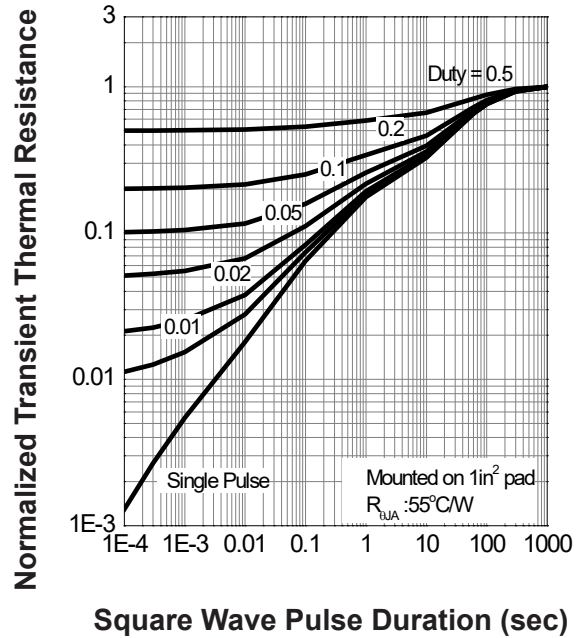


Typical Operating Characteristics(Cont.)

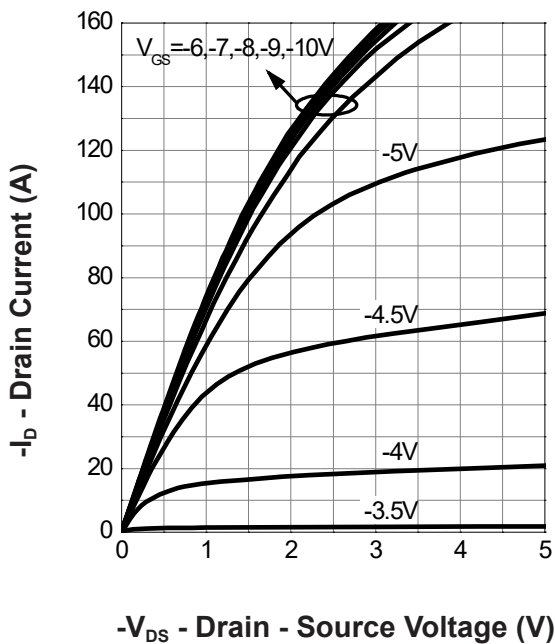
Safe Operation Area



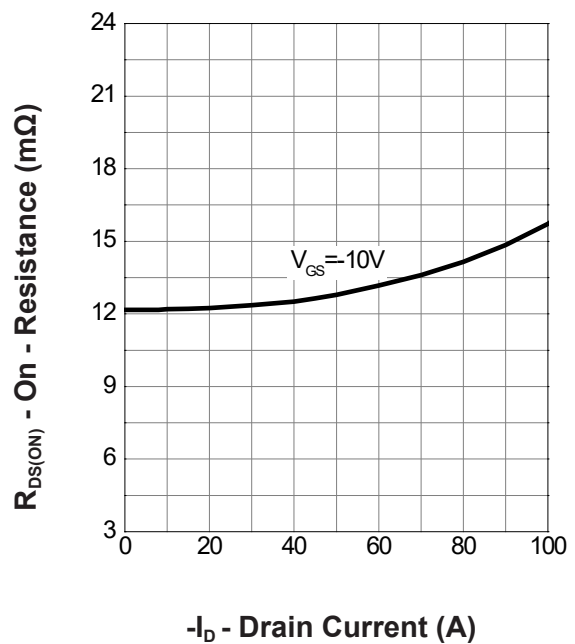
Thermal Transient Impedance



Output Characteristics

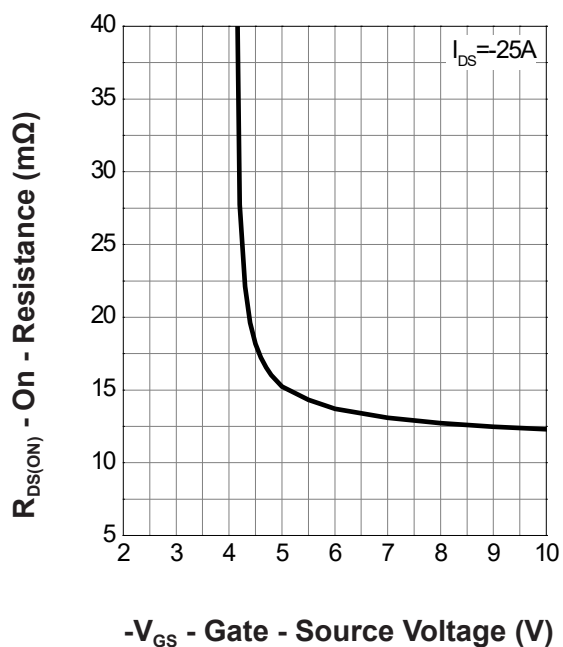


Drain-Source On Resistance

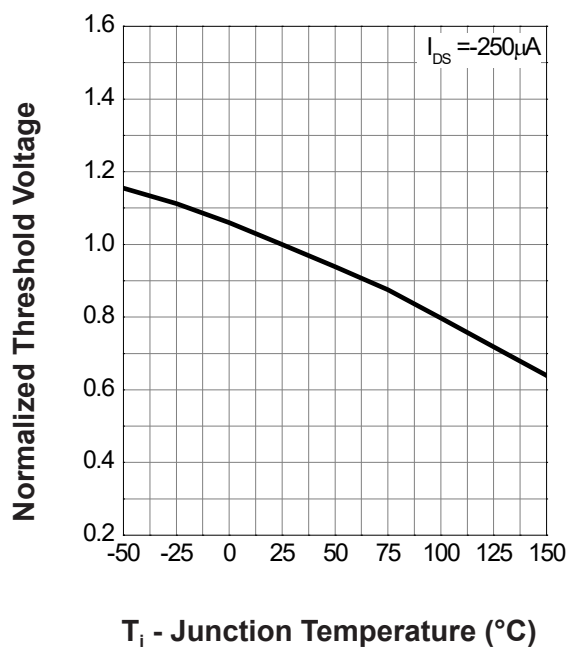


Typical Operating Characteristics(Cont.)

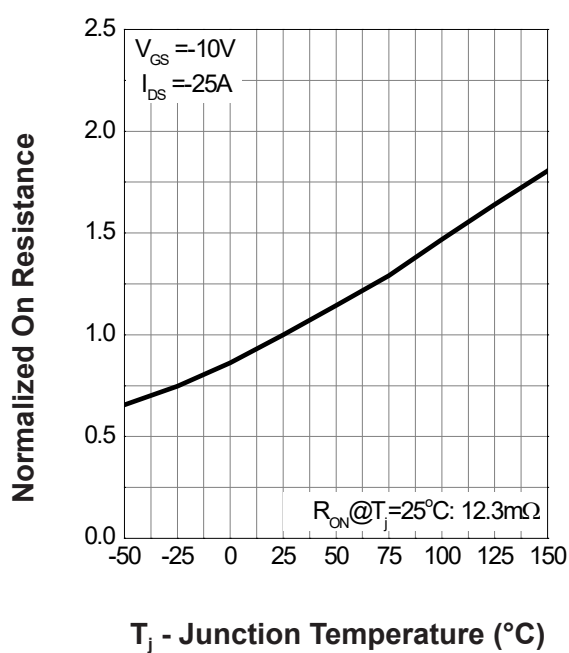
Gate-Source On Resistance



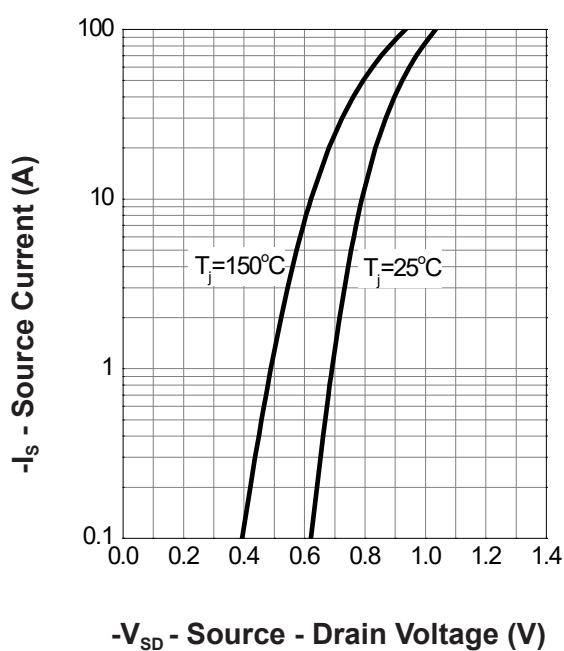
Gate Threshold Voltage



Drain-Source On Resistance

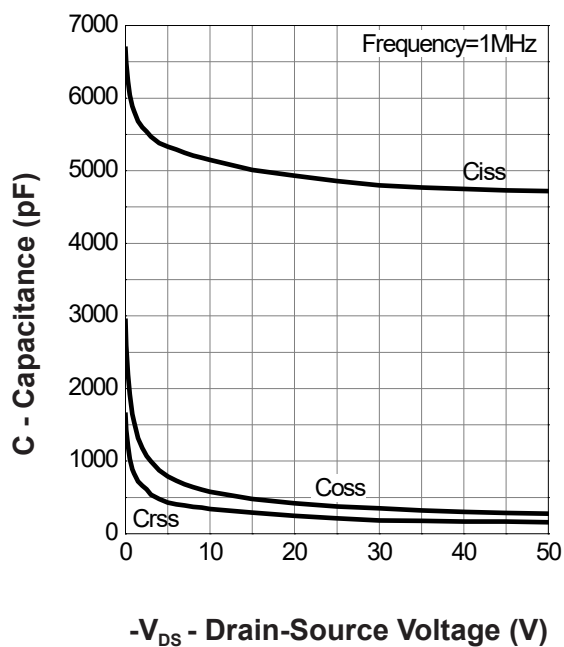


Source-Drain Diode Forward

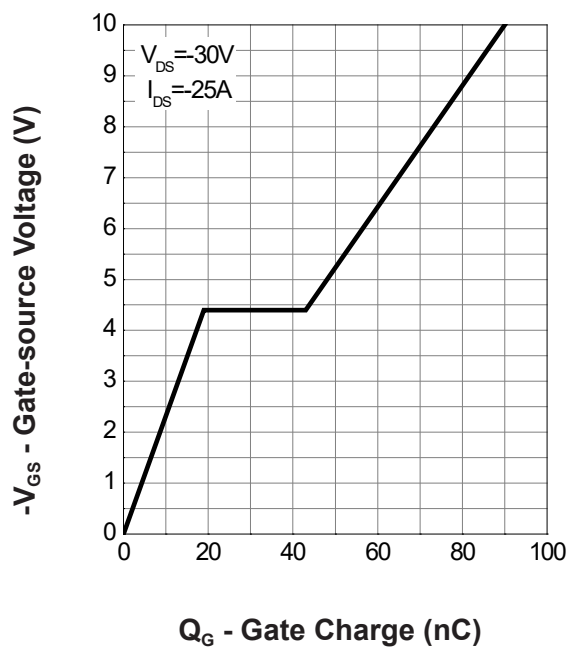


Typical Operating Characteristics(Cont.)

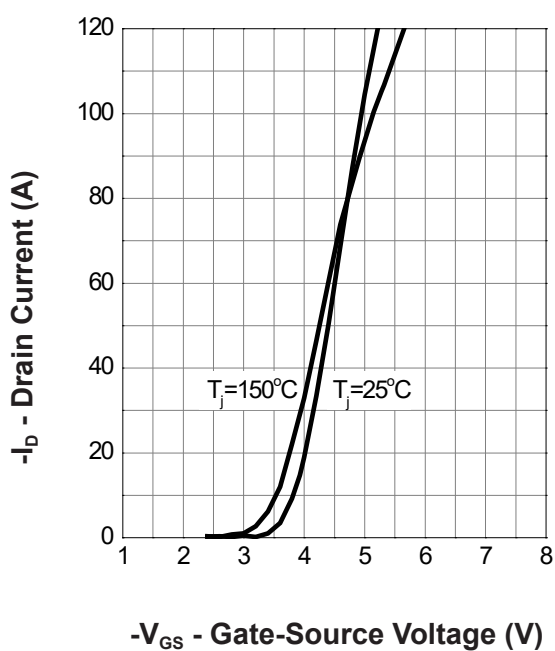
Capacitance



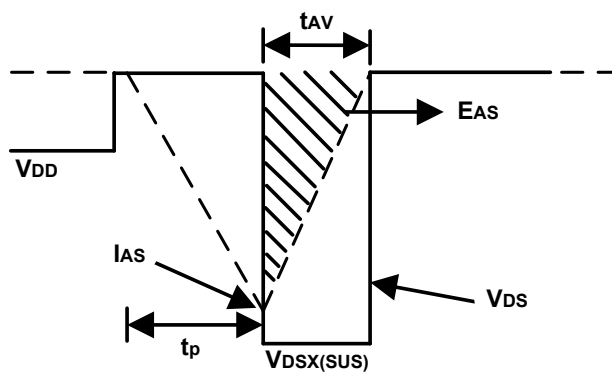
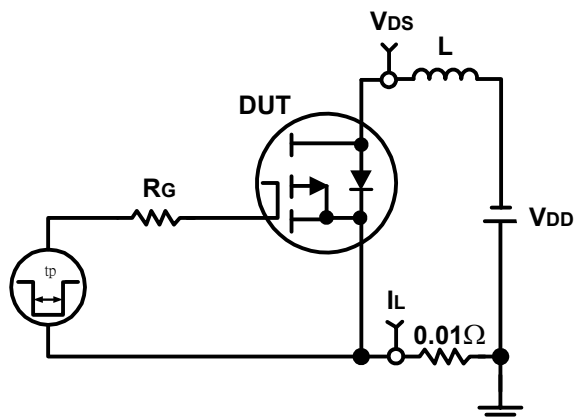
Gate Charge



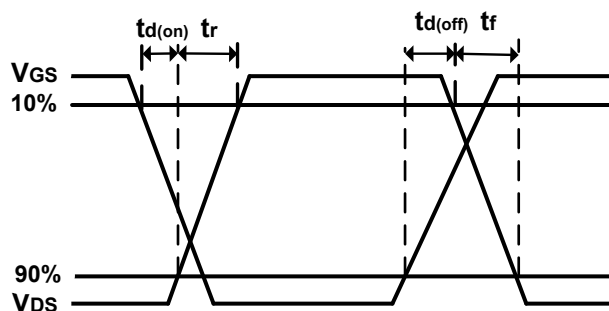
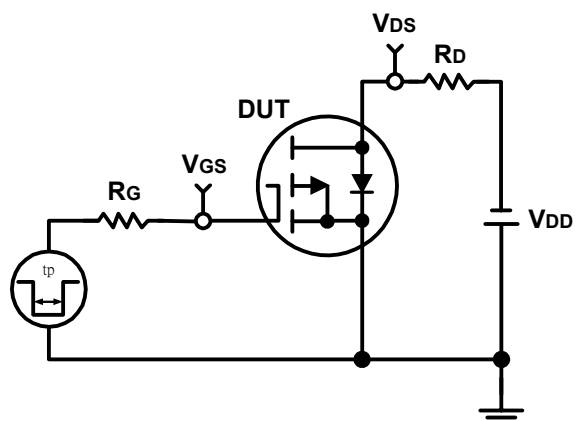
Transfer Characteristics



Avalanche Test Circuit and Waveforms



Switching Time Test Circuit and Waveforms



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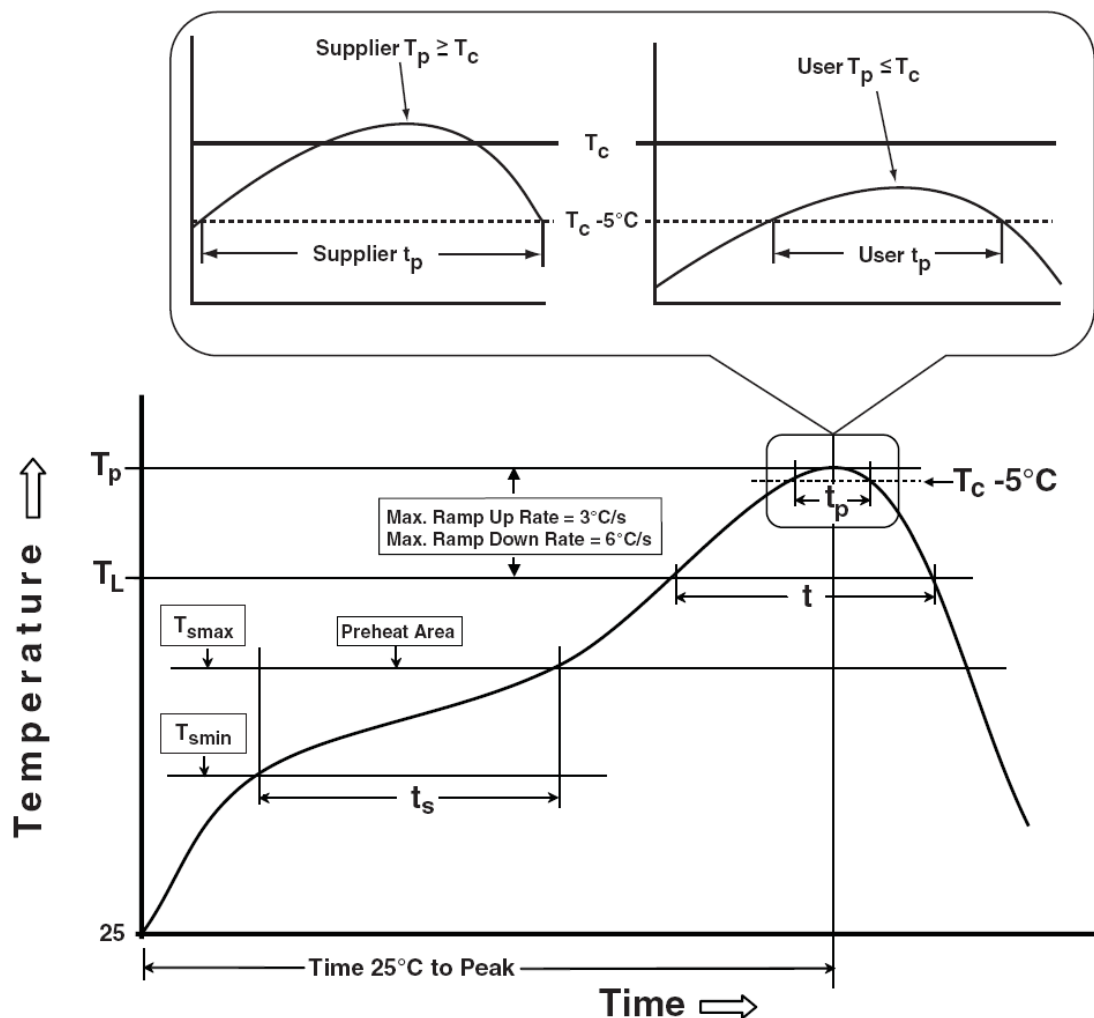
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Classification Profile



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

Reliability Test Program

Test item	Method	Description
SOLDERABILITY	JESD-22, B102	5 Sec, 245°C
HTRB	JESD-22, A108	1000 Hrs, 80% of VDS max @ T_{jmax}
HTGB	JESD-22, A108	1000 Hrs, 100% of VGS max @ T_{jmax}
PCT	JESD-22, A102	168 Hrs, 100%RH, 2atm, 121°C
TCT	JESD-22, A104	500 Cycles, -65°C~150°C

Customer Service

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