Dual Enhancement Mode MOSFET (N-and P-Channel)

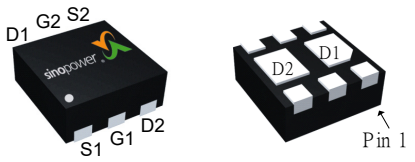
Features

- N Channel : 30V/3.7A,
  $R_{DS(ON)}$=40mΩ(max.)@V_{GS}=10V
  $R_{DS(ON)}$=65mΩ(max.)@V_{GS}=4.5V
- P Channel : -30V/-3.2A,
  $R_{DS(ON)}$=58mΩ(max.)@V_{GS}=-10V
  $R_{DS(ON)}$=90mΩ(max.)@V_{GS}=-4.5V
- 100% UIS + R_g Tested
- ESD Protection
- Reliable and Rugged
- Lead Free and Green Devices Available (RoHS Compliant)

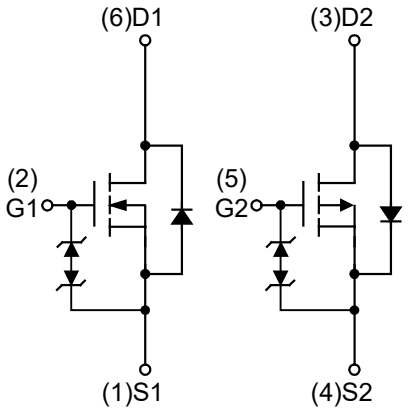
Applications

- Synchronous Rectification.
- Motor Control.
- High Current, High Speed Switching.
- Protable equipment application.

Pin Description



DFN2x2C-6_EP2



N-Channel MOSFET P-Channel MOSFET

Ordering and Marking Information

SM2216CS □□□-□□□ Assembly Material Handling Code Temperature Range Package Code	Package Code QG : DFN2x2C-6_EP2 Operating Junction Temperature Range C : -55 to 150 °C Handling Code TR : Tape & Reel Assembly Material G : Halogen and Lead Free Device
SM2216CS QG : 2216J XXXXX	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).

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°C Unless Otherwise Noted)

Symbol	Parameter		N Channel	P Channel	Unit
Common Ratings					
V_{DSS}	Drain-Source Voltage		30	-30	V
V_{GSS}	Gate-Source Voltage		±20	±20	
T_J	Maximum Junction Temperature		150		°C
T_{STG}	Storage Temperature Range		-55 to 150		
I_S	Diode Continuous Forward Current	T_A=25°C	0.8	-0.8	A
I_D	Continuous Drain Current	T_A=25°C	3.7	-3.2	A
		T_A=70°C	3	-2.6	
I_{DM}[a]	Pulse Drain Current Tested	T_A=25°C	15	-13	A
P_D	Maximum Power Dissipation	T_A=25°C	0.93	0.93	W
		T_A=70°C	0.6	0.6	
$R_{\theta JA}$[b]	Thermal Resistance-Junction to Ambient	Steady State	135	135	°C/W
I_{AS}[c]	Avalanche Current, Single pulse	L=0.1mH	7.2	11	A
E_{AS}[c]	Avalanche Energy, Single pulse	L=0.1mH	2.6	6.1	mJ

Note a : Pulse width is limited by maximum junction temperature.
Note b : Surface Mounted on $1in^2$ pad area.
Note c : UIS tested and pulse width limited by maximum junction temperature (initial temperature T_j=25°C).

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N Channel Electrical Characteristics (T_A = 25°C unless otherwise noted)

Symbol	Parameter	Test Conditions	N Channel			Unit
			Min.	Typ.	Max.	
Static Characteristics						
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS}=0V, I_{DS}=250μA	30	-	-	V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS}=24V, V_{GS}=0V	-	-	1	μA
		T_J=85°C	-	-	30	
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS}=V_{GS}, I_{DS}=250μA	1.3	1.8	2.3	V
I_{GSS}	Gate Leakage Current	V_{GS}=±20V, V_{DS}=0V	-	-	±10	μA
$R_{DS(ON)}$[d]	Drain-Source On-state Resistance	V_{GS}=10V, I_{DS}=4.5A	-	33	40	mΩ
		V_{GS}=4.5V, I_{DS}=2.5A	-	50	65	
Diode Characteristics						
V_{SD}[d]	Diode Forward Voltage	I_{SD}=2A, V_{GS}=0V	-	0.8	1.1	V
t_{rr}	Reverse Recovery Time	I_{SD}=4.5A, dI_{SD}/dt=100A/μs	-	9.2	-	ns
Q_{rr}	Reverse Recovery Charge		-	4	-	nC
Dynamic Characteristics[e]						
R_G	Gate Resistance	V_{GS}=0V,V_{DS}=0V,F=1MHz	-	2.5	-	Ω
C_{iss}	Input Capacitance	V_{GS}=0V, V_{DS}=15V, Frequency=1.0MHz	-	210	273	pF
C_{oss}	Output Capacitance		-	40	-	
C_{rss}	Reverse Transfer Capacitance		-	35	-	
$t_{d(ON)}$	Turn-on Delay Time	V_{DD}=15V, R_L=15Ω, I_{DS}=1A, V_{GEN}=10V, R_G=6Ω	-	5	9	ns
t_r	Turn-on Rise Time		-	11	20	
$t_{d(OFF)}$	Turn-off Delay Time		-	11	20	
t_f	Turn-off Fall Time		-	3	6	
Gate Charge Characteristics[e]						
Q_g	Total Gate Charge	V_{DS}=15V, V_{GS}=4.5V, I_{DS}=4.5A	-	2.3	-	nC
Q_g	Total Gate Charge	V_{DS}=15V, V_{GS}=10V, I_{DS}=4.5A	-	4.4	6.2	
Q_{gs}	Gate-Source Charge		-	0.6	-	
Q_{gd}	Gate-Drain Charge		-	1.2	-	

Note d : Pulse test ; pulse width≤300μs, duty cycle≤2%.
Note e : Guaranteed by design, not subject to production testing.

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P Channel Electrical Characteristics (T_A = 25°C unless otherwise noted)

Symbol	Parameter	Test Conditions	P Channel			Unit
			Min.	Typ.	Max.	
Static Characteristics						
BV_{DSS}	Drain-Source Breakdown Voltage	V_{GS}=0V, I_{DS}=-250μA	-30	-	-	V
I_{DSS}	Zero Gate Voltage Drain Current	V_{DS}=-24V, V_{GS}=0V	-	-	-1	μA
		T_J=85°C	-	-	-30	
$V_{GS(th)}$	Gate Threshold Voltage	V_{DS}=V_{GS}, I_{DS}=250μA	-1.3	-1.8	-2.3	V
I_{GSS}	Gate Leakage Current	V_{GS}=±20V, V_{DS}=0V	-	-	±10	μA
$R_{DS(ON)}$ [d]	Drain-Source On-state Resistance	V_{GS}=-10V, I_{DS}=-2A	-	48	58	mΩ
		V_{GS}=-4.5V, I_{DS}=-1.2A	-	69	90	
Diode Characteristics						
V_{SD} [d]	Diode Forward Voltage	I_{SD}=-1A, V_{GS}=0V	-	-0.8	-1.1	V
t_{rr}	Reverse Recovery Time	I_{SD}=-2A, dI_{SD}/dt=100A/μs	-	12	-	ns
Q_{rr}	Reverse Recovery Charge		-	5.4	-	nC
Dynamic Characteristics [e]						
R_G	Gate Resistance	V_{GS}=0V,V_{DS}=0V,F=1MHz	-	10.5	-	Ω
C_{iss}	Input Capacitance	V_{GS}=0V, V_{DS}=-15V, Frequency=1.0MHz	-	395	514	pF
C_{oss}	Output Capacitance		-	65	-	
C_{rss}	Reverse Transfer Capacitance		-	55	-	
$t_{d(ON)}$	Turn-on Delay Time	V_{DD}=-15V, R_L=-15Ω, I_{DS}=-1A, V_{GEN}=-10V, R_G=6Ω	-	8	14	ns
t_r	Turn-on Rise Time		-	11	20	
$t_{d(OFF)}$	Turn-off Delay Time		-	27	49	
t_f	Turn-off Fall Time		-	24	44	
Gate Charge Characteristics [e]						
Q_g	Total Gate Charge	V_{DS}=-15V, V_{GS}=-4.5V, I_{DS}=-2A	-	4.3	-	nC
Q_g	Total Gate Charge	V_{DS}=-15V, V_{GS}=-10V, I_{DS}=-2A	-	8.4	11.8	
Q_{gs}	Gate-Source Charge		-	1	-	
Q_{gd}	Gate-Drain Charge		-	2	-	

Note d : Pulse test ; pulse width≤300μs, duty cycle≤2%.
Note e : Guaranteed by design, not subject to production testing.

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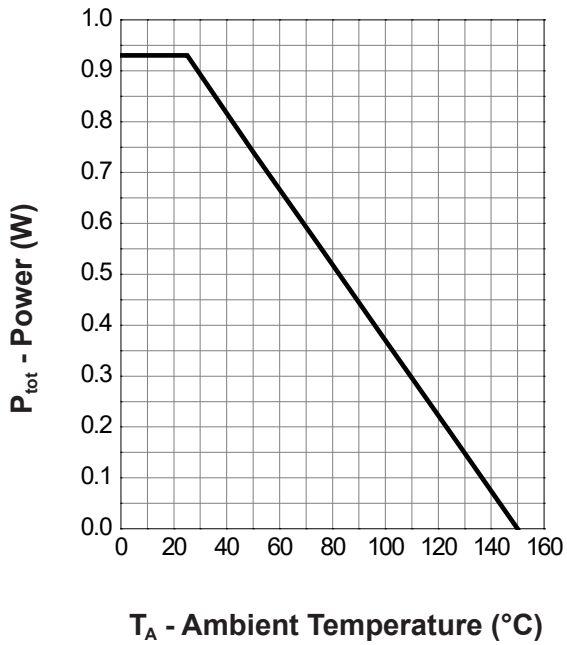
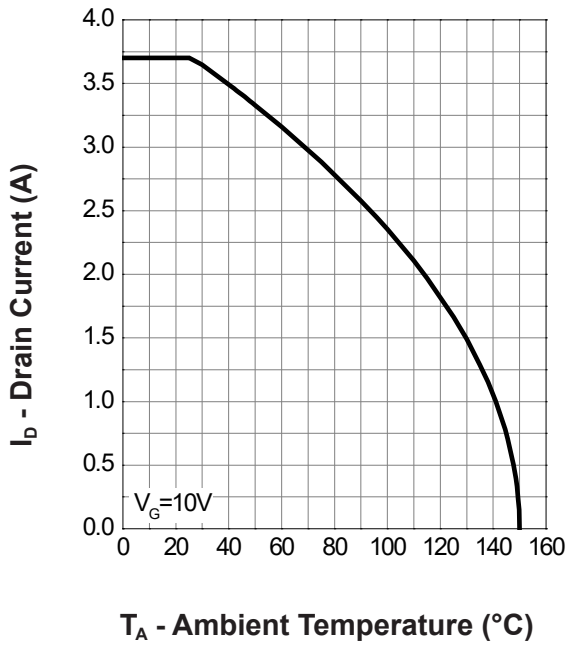
N Channel Typical Operating Characteristics

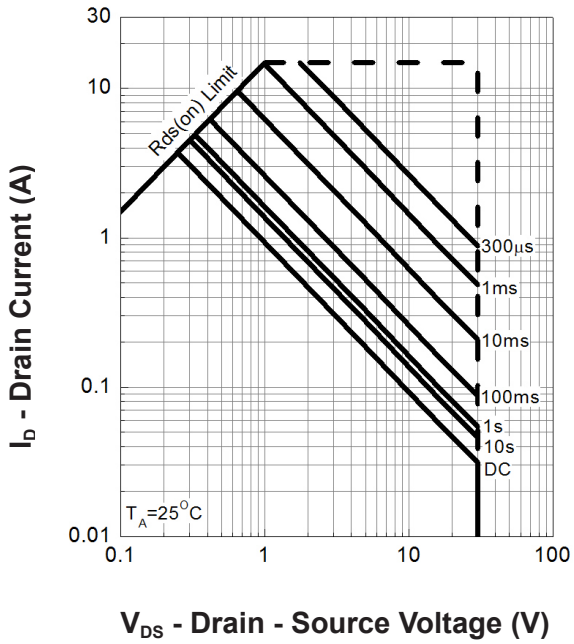
Power Dissipation



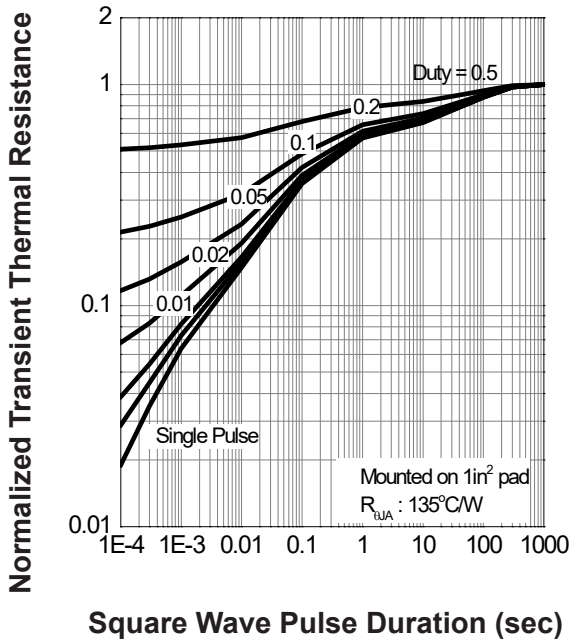
Drain Current



Safe Operation Area

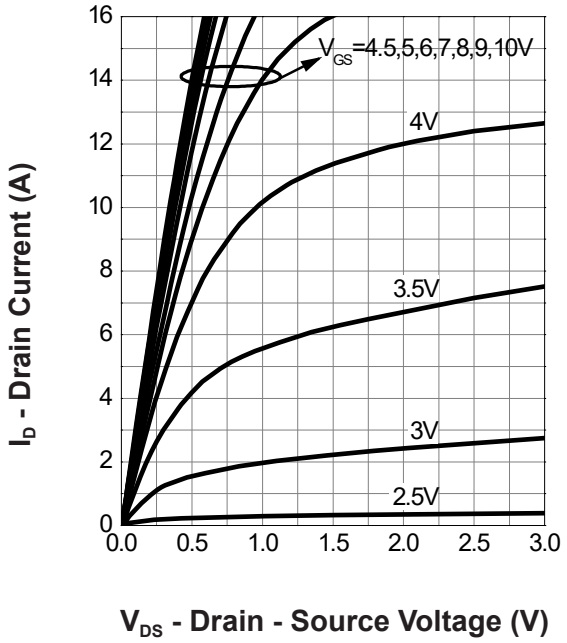


Thermal Transient Impedance

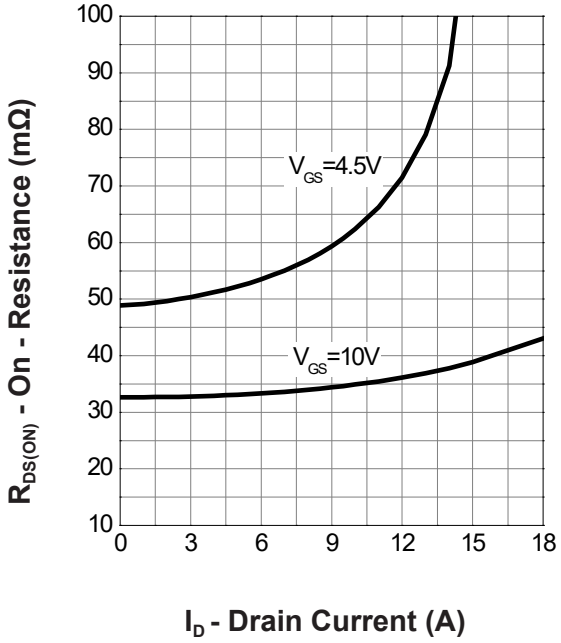


N Channel Typical Operating Characteristics(Cont.)

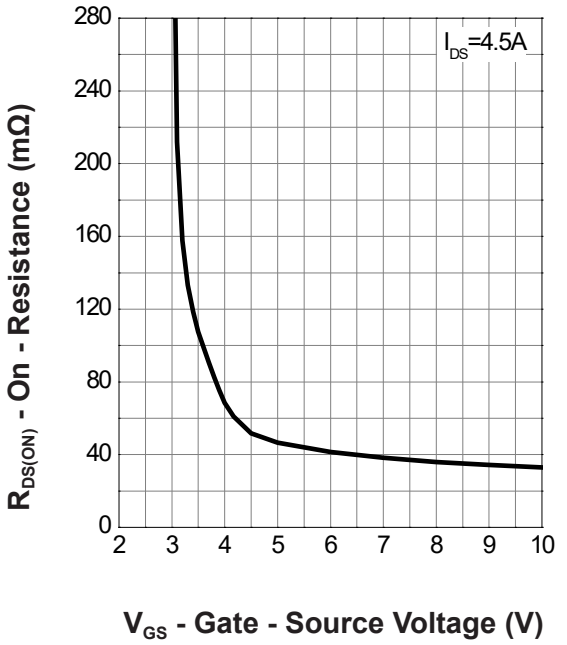
Output Characteristics



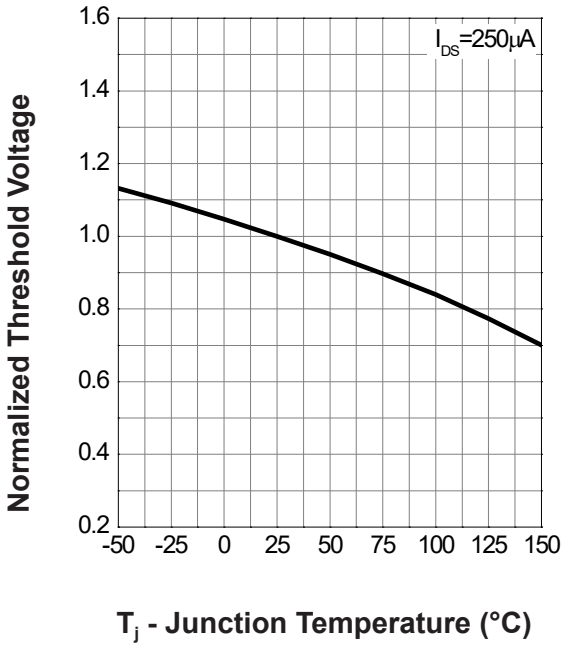
Drain-Source On Resistance



Gate-Source On Resistance



Gate Threshold Voltage



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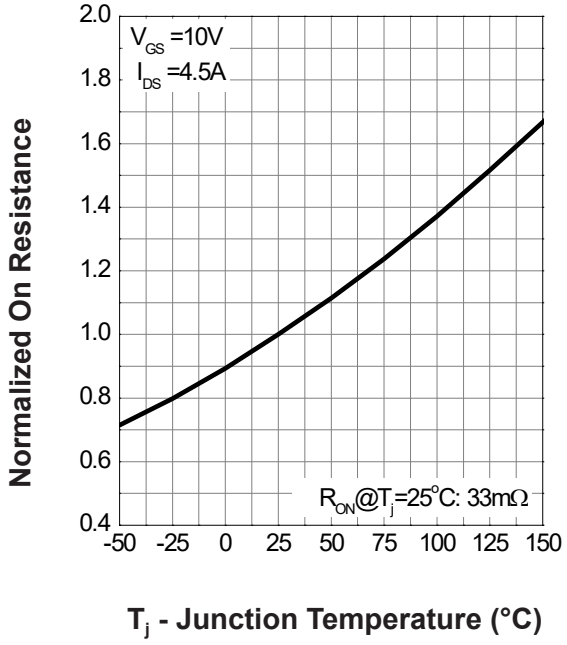
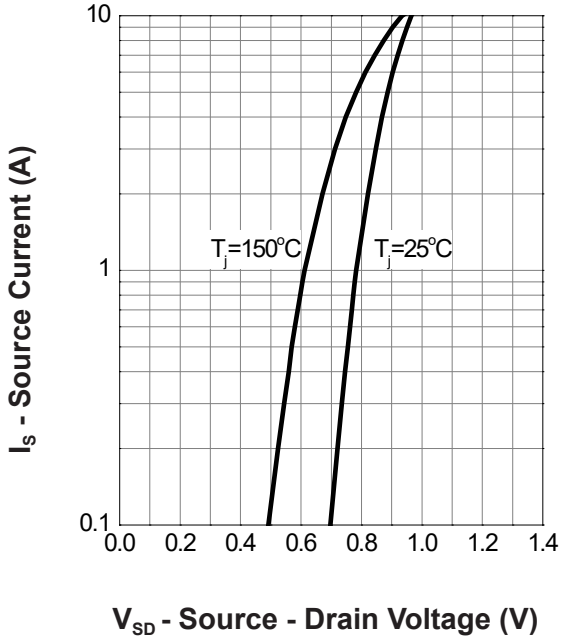
N Channel Typical Operating Characteristics(Cont.)

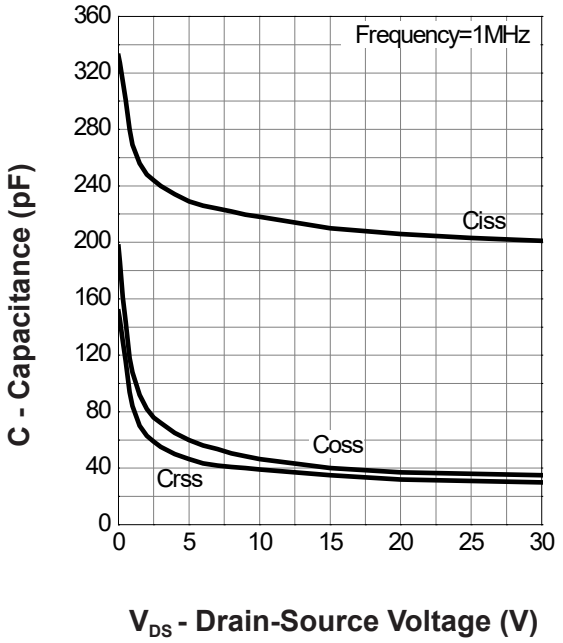
Drain-Source On Resistance



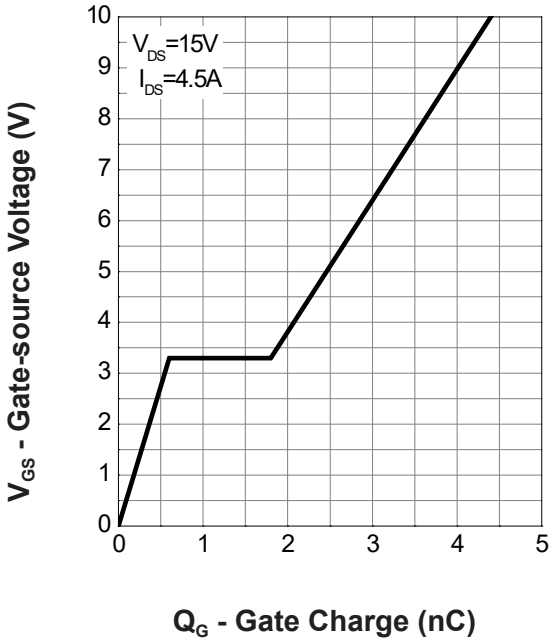
Source-Drain Diode Forward



Capacitance



Gate Charge



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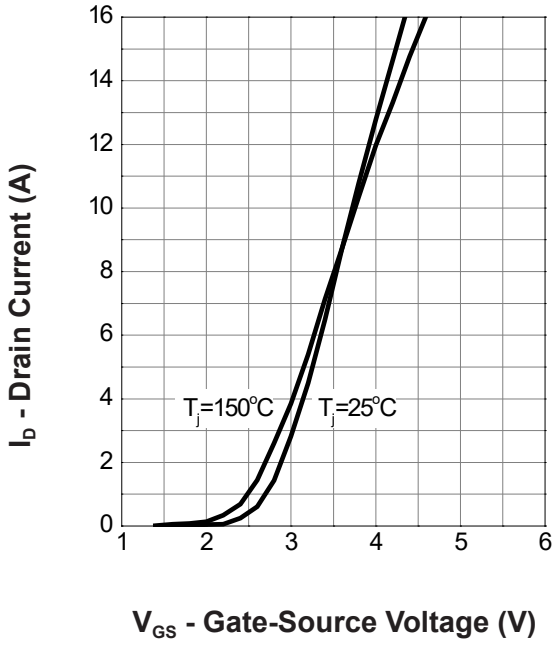
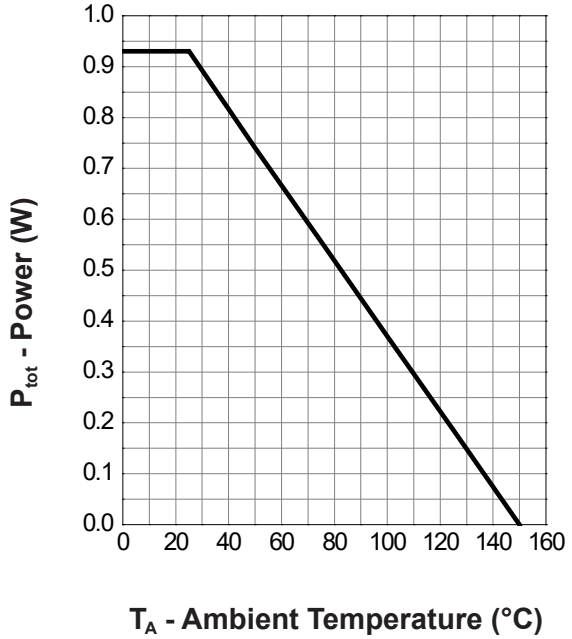
N Channel Typical Operating Characteristics(Cont.)

Transfer Characteristics

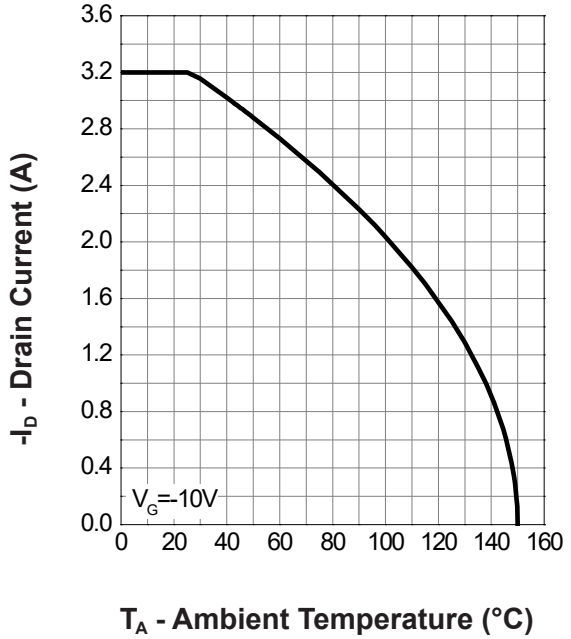


P Channel Typical Operating Characteristics

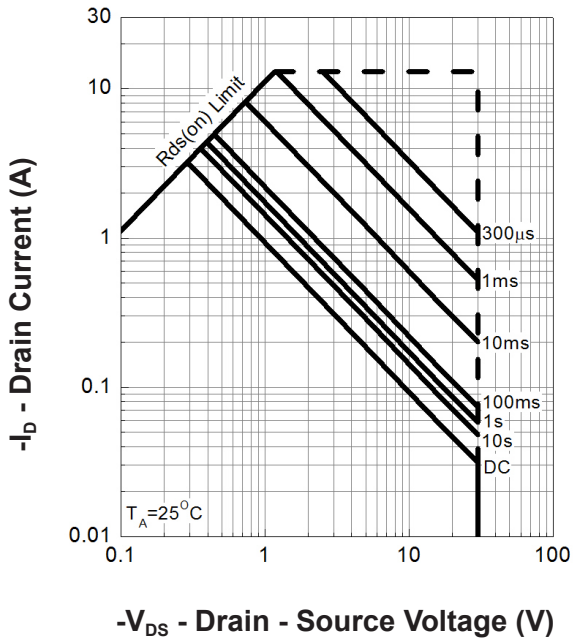
Power Dissipation



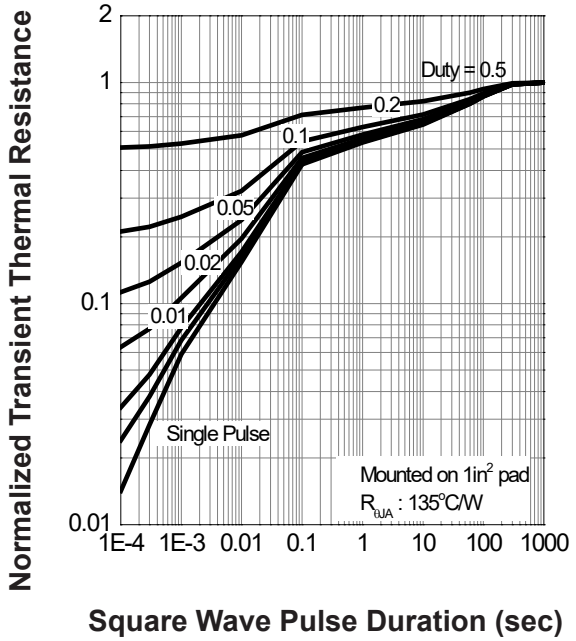
Drain Current



Safe Operation Area

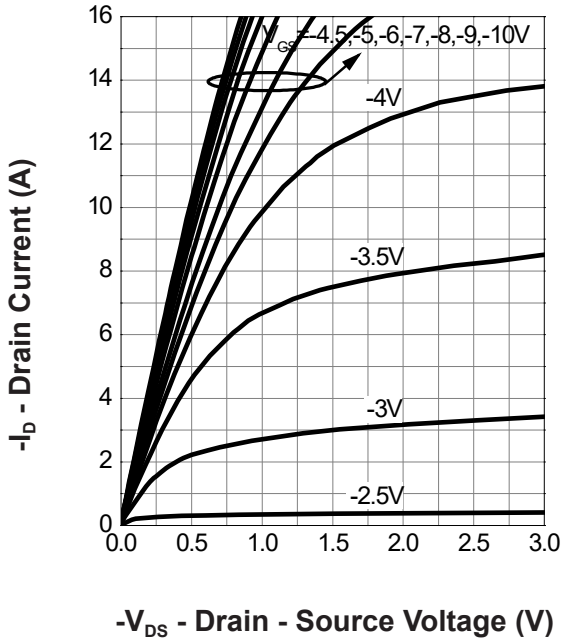


Thermal Transient Impedance

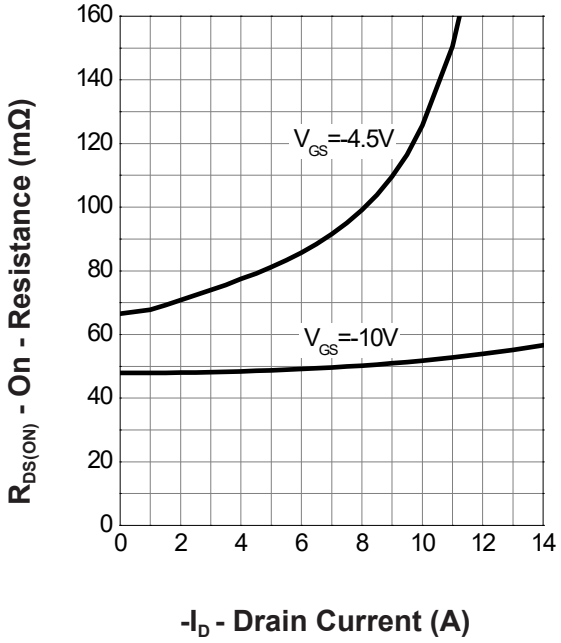


P Channel Typical Operating Characteristics(Cont.)

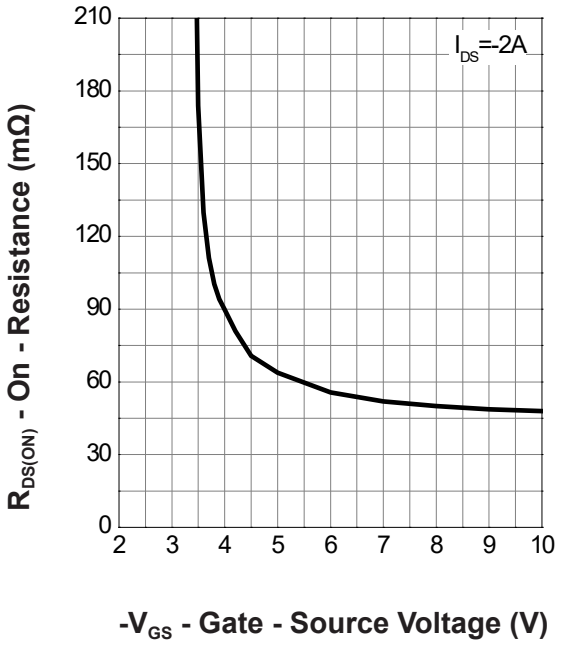
Output Characteristics



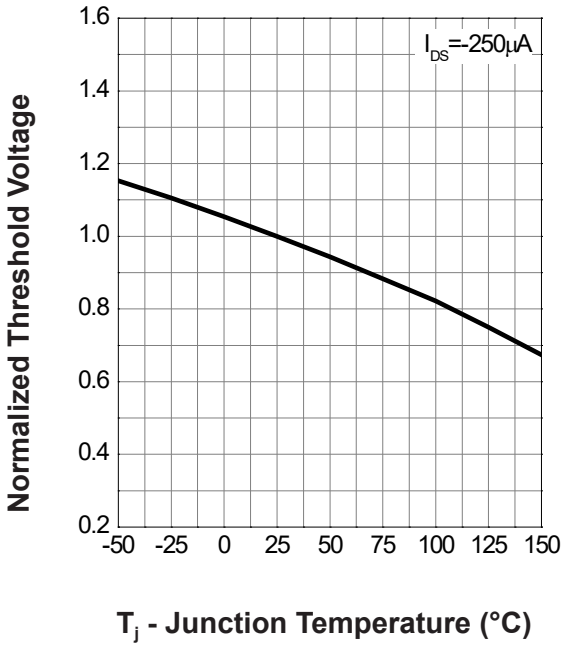
Drain-Source On Resistance



Gate-Source On Resistance



Gate Threshold Voltage



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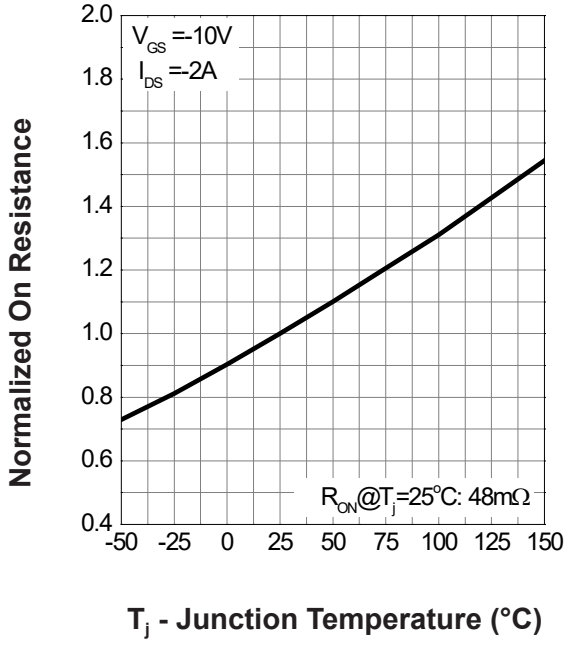
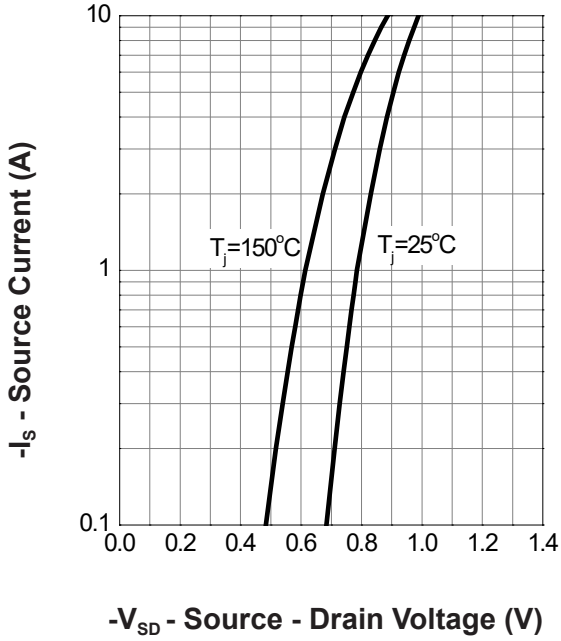
P Channel Typical Operating Characteristics(Cont.)

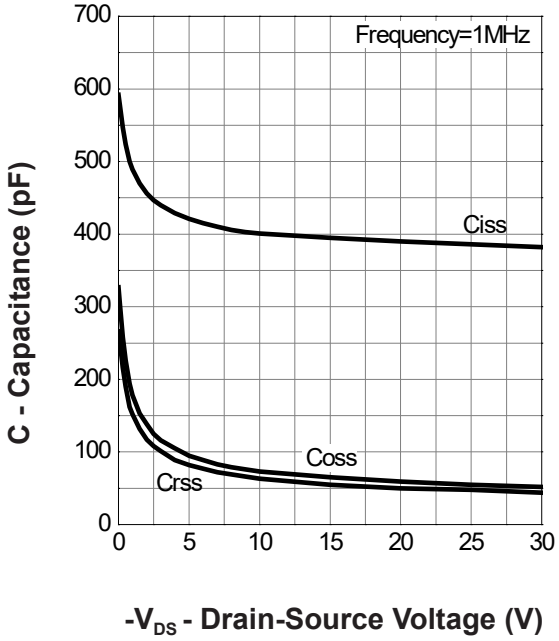
Drain-Source On Resistance



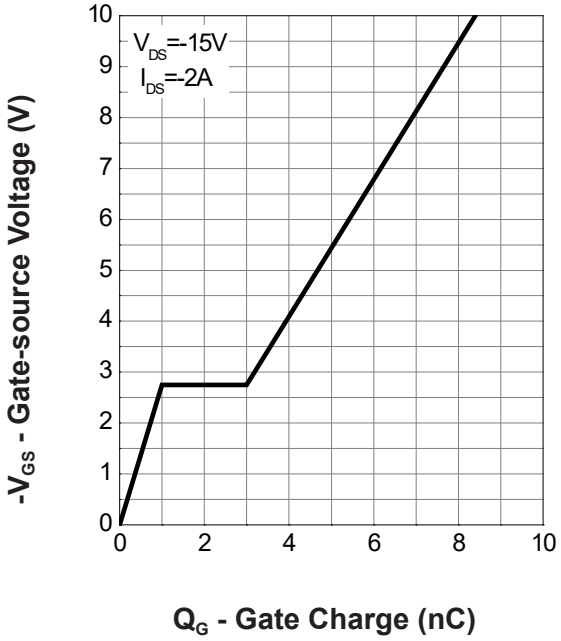
Source-Drain Diode Forward



Capacitance



Gate Charge



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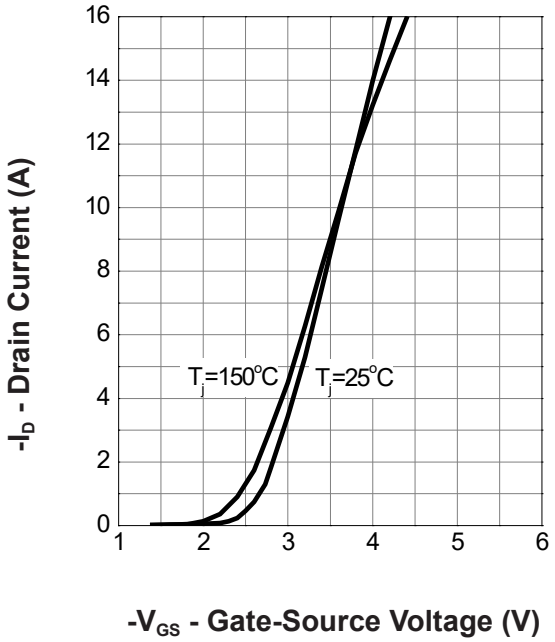
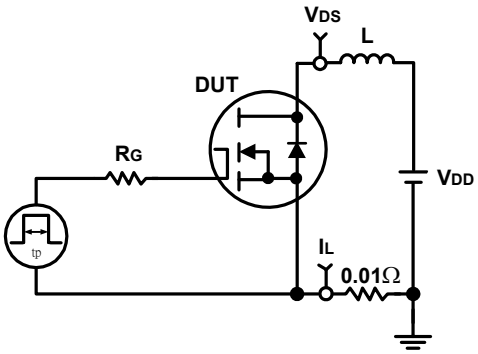
P Channel Typical Operating Characteristics(Cont.)

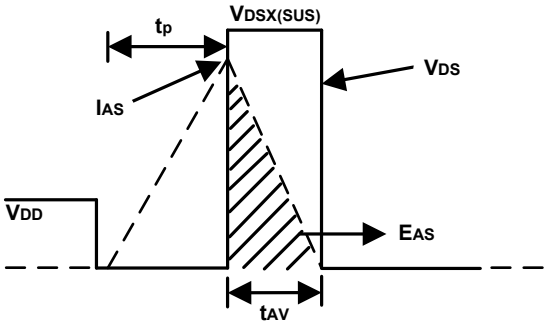
Transfer Characteristics



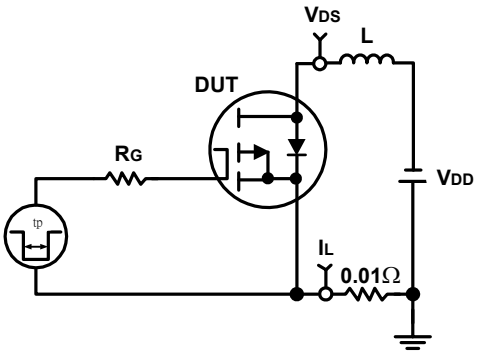
Avalanche Test Circuit and Waveforms

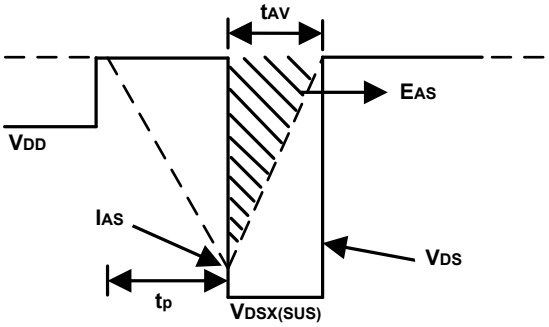
N Channel





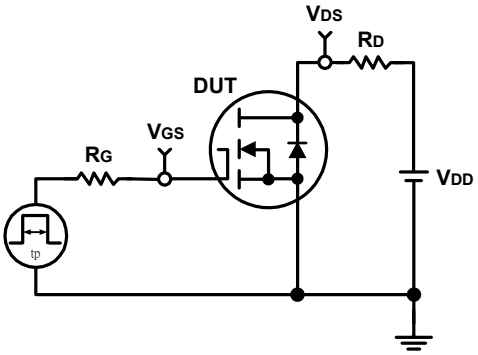
P Channel

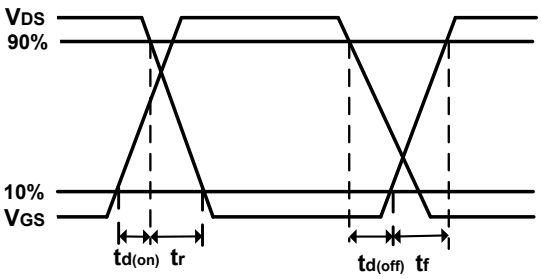




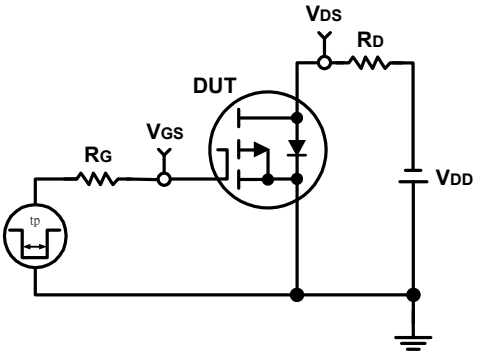
Switching Time Test Circuit and Waveforms

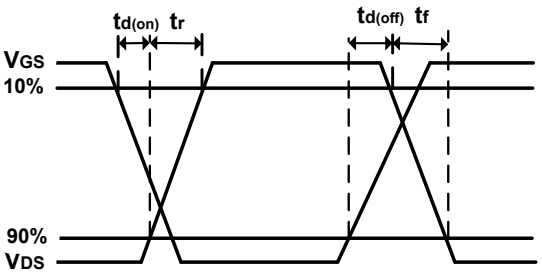
N Channel





P Channel





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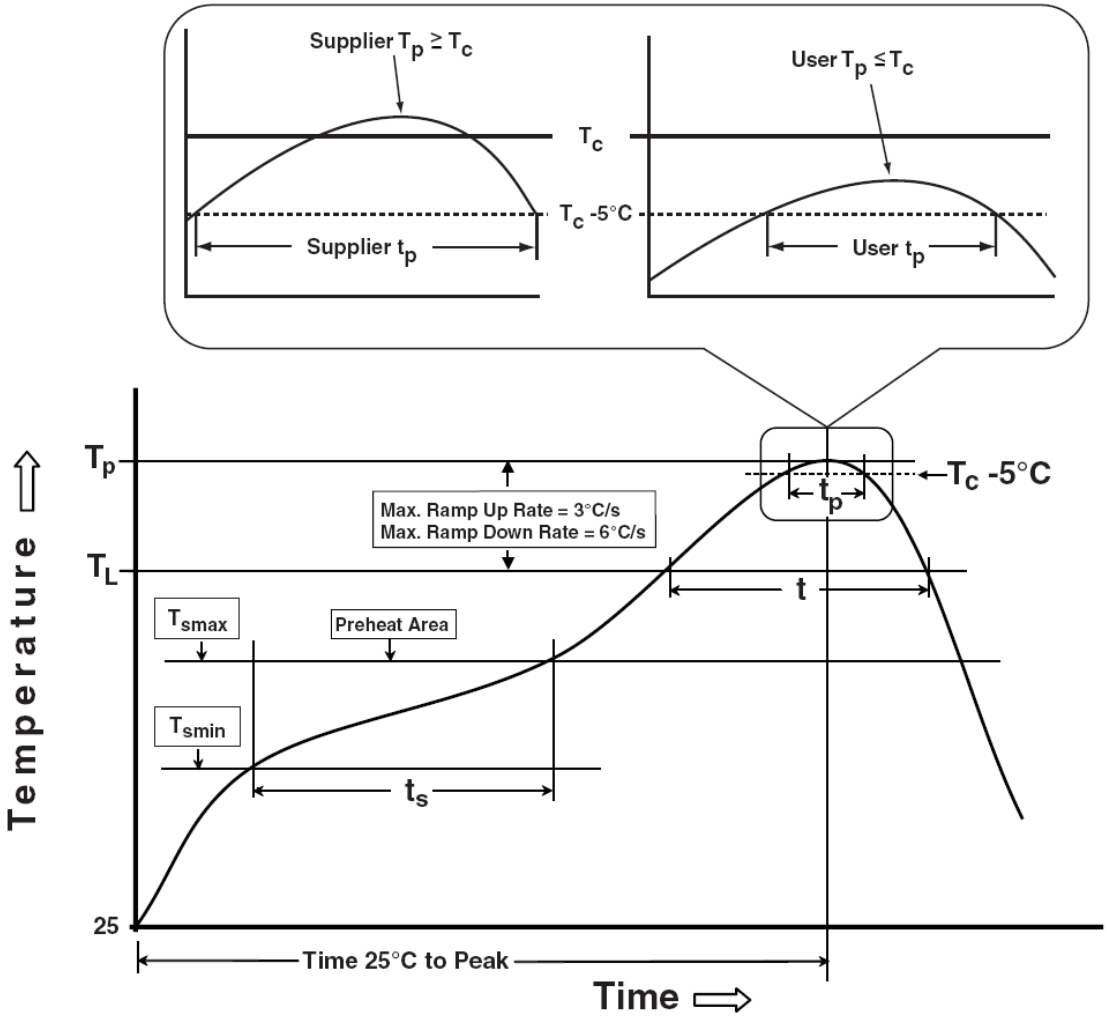
Classification Profile



Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Preheat & Soak Temperature min (T_{smin}) Temperature max (T_{smax}) Time (T_{smin} to T_{smax}) (t_s)	100 °C 150 °C 60-120 seconds	150 °C 200 °C 60-120 seconds
Average ramp-up rate (T_{smax} to T_P)	3 °C/second max.	3°C/second max.
Liquidous temperature (T_L) Time at liquidous (t_L)	183 °C 60-150 seconds	217 °C 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 (Tc)

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 (Tc)

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 @ Tjmax
HTGB	JESD-22, A108	1000 Hrs, 100% of VGS max @ Tjmax
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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