

Single N-Channel Enhancement Mode MOSFET  
with Schottky Diode

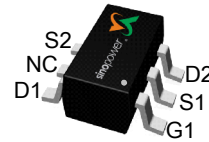
## Features

- Channel 1 (NMOS)**  
 60V/0.26A,  
 $R_{DS(ON)} = 2.2\Omega(\text{max.}) @ V_{GS}=10V$   
 $R_{DS(ON)} = 2.6\Omega(\text{max.}) @ V_{GS}=4.5V$
- Channel 2 (Schottky Diode)**  
 40V/0.35A,  
 $V_f = 0.4V(\text{max.}) @ I_F=0.02A$   
 $V_f = 0.6V(\text{max.}) @ I_F=0.2A$
- Reliable and Rugged
- Lead Free and Green Devices Available (RoHS Compliant)
- NMOS With Gate ESD Protection

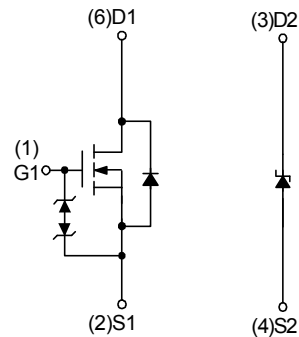
## Applications

- Load switch.
- High-speed line driver.
- Switching circuits.

## Pin Description



Top View of SOT-363



N-MOSFET Schottky Diode

## Ordering and Marking Information

<p>SM1691OS □□□-□□ □</p> <div style="margin-left: 20px;"> <p>└─ Assembly Material</p> <p>└─ Handling Code</p> <p>└─ Temperature Range</p> <p>└─ Package Code</p> </div>	<p>Package Code CS : SOT-363</p> <p>Operating Junction Temperature Range C : -55 to 150 °C</p> <p>Handling Code TR : Tape &amp; Reel</p> <p>Assembly Material G : Halogen and Lead Free Device</p>
<p>SM1691OS CS : <span style="border: 1px solid black; padding: 2px;">● M91X</span></p>	<p>X - Lot Code</p>

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)

- Channel 1

Symbol	Parameter	Rating	Unit
<b>Common Ratings</b>			
$V_{DSS}$	Drain-Source Voltage	60	V
$V_{GSS}$	Gate-Source Voltage	$\pm 20$	
$T_J$	Maximum Junction Temperature	150	$^\circ\text{C}$
$T_{STG}$	Storage Temperature Range	-55 to 150	
$I_S$	Diode Continuous Forward Current	$T_A=25^\circ\text{C}$ 0.1	A
$I_D$	Continuous Drain Current	$T_A=25^\circ\text{C}$ 0.26	A
		$T_A=70^\circ\text{C}$ 0.21	
$I_{DM}^a$	Pulsed Drain Current	$T_A=25^\circ\text{C}$ 1	A
$P_D$	Maximum Power Dissipation	$T_A=25^\circ\text{C}$ 0.25	W
		$T_A=70^\circ\text{C}$ 0.16	
$R_{\theta JA}^b$	Thermal Resistance-Junction to Ambient	Steady State 500	$^\circ\text{C/W}$

- Channel 2

Symbol	Parameter	Rating	Unit
<b>Common Ratings</b>			
$V_{RRM}$	Peak Repetitive Reverse Voltage	40	V
$V_{RWM}$	Working Peak Reverse Voltage	40	
$V_R$	DC Reverse Voltage	40	V
$V_{RMS}$	RMS Reverse Voltage	28	V
$I_S$	Diode Continuous Forward Current	$T_A=25^\circ\text{C}$ 0.35	A
$I_{SM}^a$	Non-Repetitive Peak Forward Current	$T_A=25^\circ\text{C}$ 1.5	A
$P_D$	Maximum Power Dissipation	$T_A=25^\circ\text{C}$ 0.25	W
		$T_A=70^\circ\text{C}$ 0.16	
$R_{\theta JA}^b$	Thermal Resistance-Junction to Ambient	500	$^\circ\text{C/W}$

Note a : Pulse width limited by max. junction temperature.

Note b : Surface Mounted on  $1\text{in}^2$  pad area.

## Electrical Characteristics (T<sub>A</sub> = 25°C unless otherwise noted)

- Channel 1

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
<b>Static Characteristics</b>						
BV <sub>DSS</sub>	Drain-Source Breakdown Voltage	V <sub>GS</sub> =0V, I <sub>DS</sub> =250μA	60	-	-	V
I <sub>DSS</sub>	Zero Gate Voltage Drain Current	V <sub>DS</sub> =48V, V <sub>GS</sub> =0V	-	-	1	μA
		T <sub>J</sub> =85°C	-	-	30	
V <sub>GS(th)</sub>	Gate Threshold Voltage	V <sub>DS</sub> =V <sub>GS</sub> , I <sub>DS</sub> =250μA	1	2	2.5	V
I <sub>GSS</sub>	Gate Leakage Current	V <sub>GS</sub> =±20V, V <sub>DS</sub> =0V	-	-	±10	μA
R <sub>DS(ON)</sub> <sup>d</sup>	Drain-Source On-state Resistance	V <sub>GS</sub> =10V, I <sub>DS</sub> =100mA	-	1.8	2.2	Ω
		V <sub>GS</sub> =4.5V, I <sub>DS</sub> =50mA	-	2	2.6	Ω
<b>Diode Characteristics</b>						
V <sub>SD</sub> <sup>c</sup>	Diode Forward Voltage	I <sub>SD</sub> =100mA, V <sub>GS</sub> =0V	-	0.8	1.3	V
t <sub>rr</sub>	Reverse Recovery Time	I <sub>SD</sub> =1A, dI <sub>SD</sub> /dt=100A/μs	-	13	-	ns
Q <sub>rr</sub>	Reverse Recovery Charge		-	8	-	nC
<b>Dynamic Characteristics<sup>c</sup></b>						
C <sub>iss</sub>	Input Capacitance	V <sub>GS</sub> =0V, V <sub>DS</sub> =30V, Frequency=1.0MHz	-	24	32	pF
C <sub>oss</sub>	Output Capacitance		-	5.5	-	
C <sub>rss</sub>	Reverse Transfer Capacitance		-	2.5	-	
t <sub>d(ON)</sub>	Turn-on Delay Time	V <sub>DD</sub> =30V, R <sub>L</sub> =300Ω, I <sub>DS</sub> =0.1A, V <sub>GEN</sub> =10V, R <sub>G</sub> =6Ω	-	3	6	ns
t <sub>r</sub>	Turn-on Rise Time		-	7	13	
t <sub>d(OFF)</sub>	Turn-off Delay Time		-	10	18	
t <sub>f</sub>	Turn-off Fall Time		-	12	22	
<b>Gate Charge Characteristics<sup>d</sup></b>						
Q <sub>g</sub>	Total Gate Charge	V <sub>DS</sub> =30V, V <sub>GS</sub> =10V, I <sub>DS</sub> =1A	-	1.6	2.3	nC
Q <sub>gs</sub>	Gate-Source Charge		-	0.6	-	
Q <sub>gd</sub>	Gate-Drain Charge		-	0.1	-	

## Electrical Characteristics (Cont.)

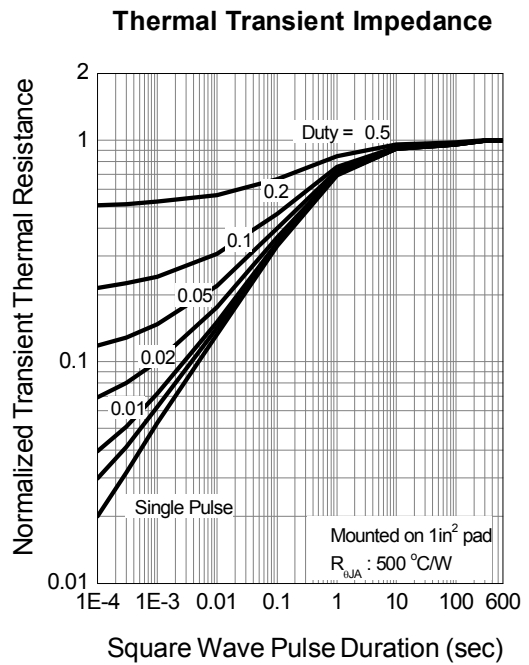
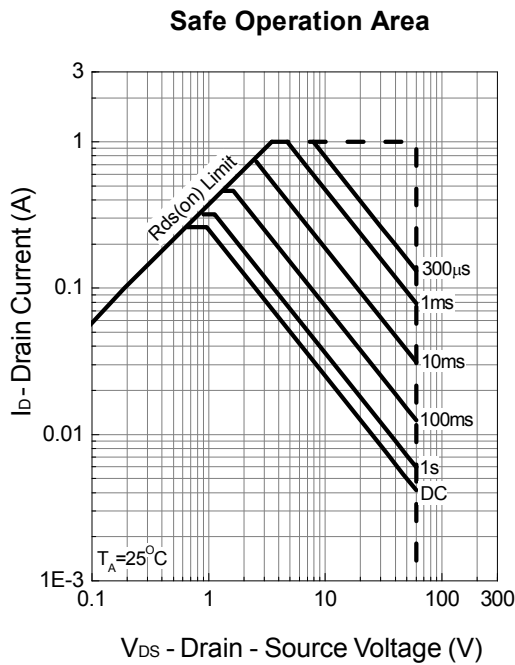
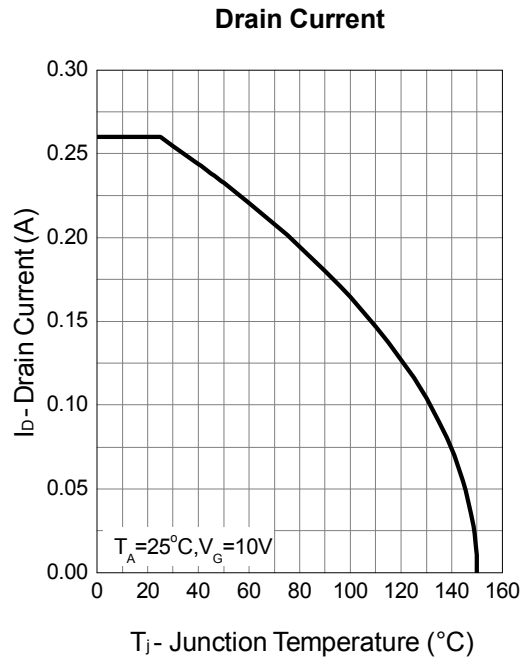
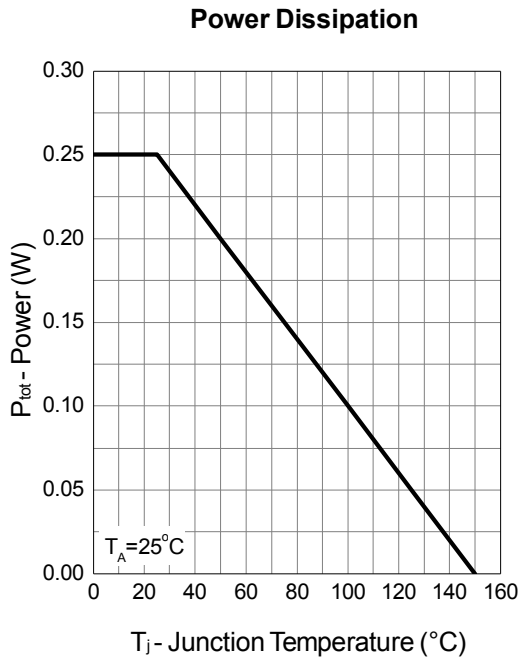
- Channel 2

Symbol	Parameter	Test Conditions	Min.	Typ.	Max.	Unit
<b>Diode Characteristics</b>						
$V_{BR}$	Reverse Breakdown Voltage	$I_{BR}=250\mu A$	40	-	-	V
$V_F^c$	Diode Forward Voltage	$I_F=0.02A$	-	-	0.4	V
		$I_F=0.2A$	-	-	0.6	V
$I_R$	Reverse Current	$V_{BR}=32V$	-	-	5	$\mu A$
$C_T$	Total Capacitance	$V_{BR}=20V$ , Frequency=1.0MHz	-	4.6	-	pF
$t_{rr}$	Reverse Recovery Time	$I_F=1A$ , $dI_F/dt=100A/\mu s$ ,	-	4.1	-	ns
$Q_{rr}$	Reverse Recovery Charge	$V_{BR}=25V$	-	1	-	nC

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

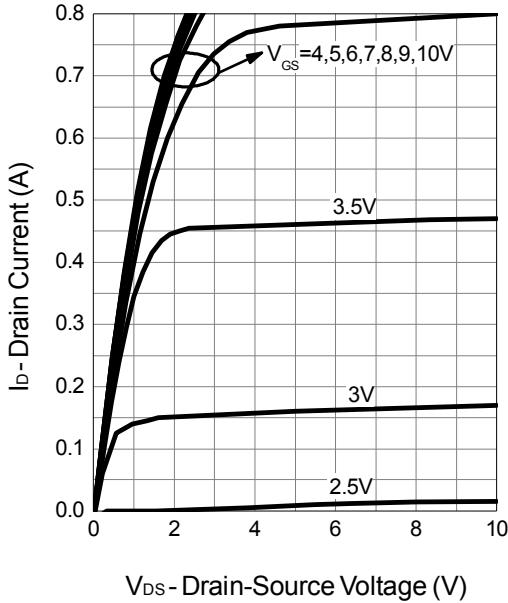
Note d : Guaranteed by design, not subject to production testing.

## Channel 1 Typical Operating Characteristics

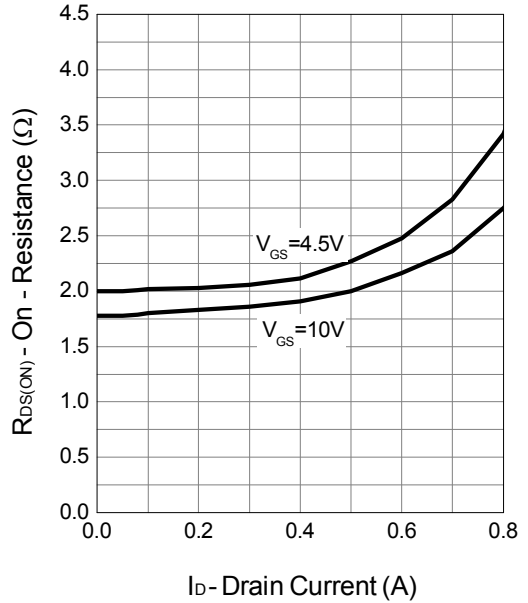


Channel 1 Typical Operating Characteristics (Cont.)

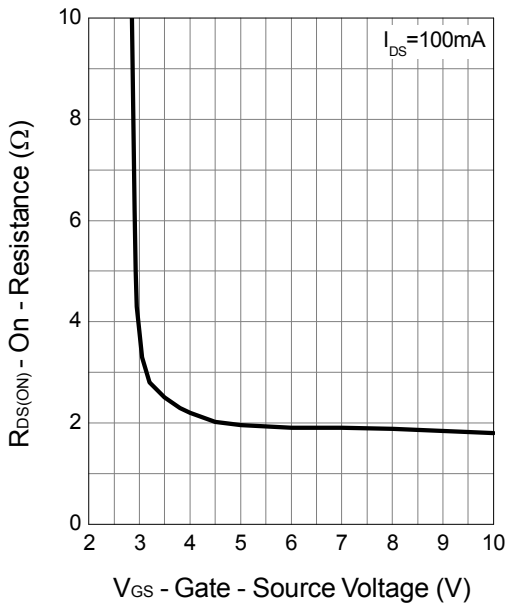
Output Characteristics



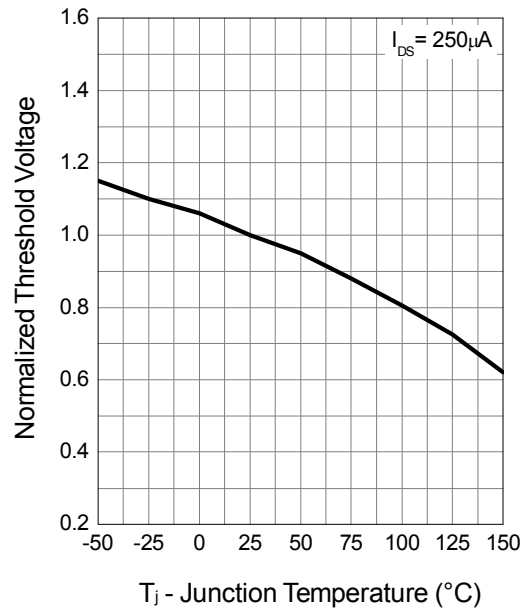
Drain-Source On Resistance



Gate-Source On Resistance

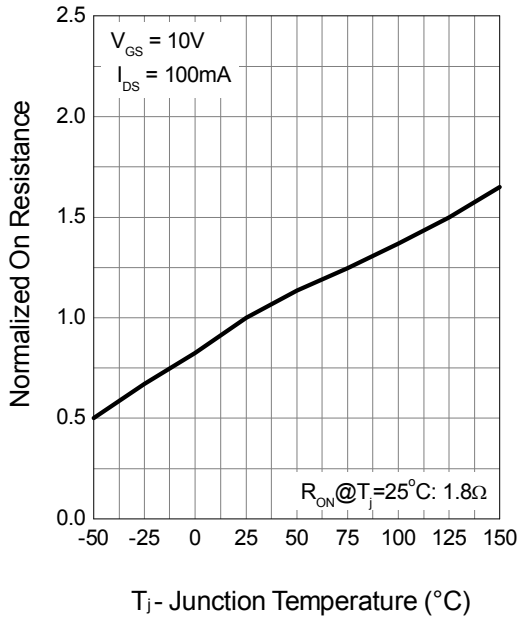


Gate Threshold Voltage

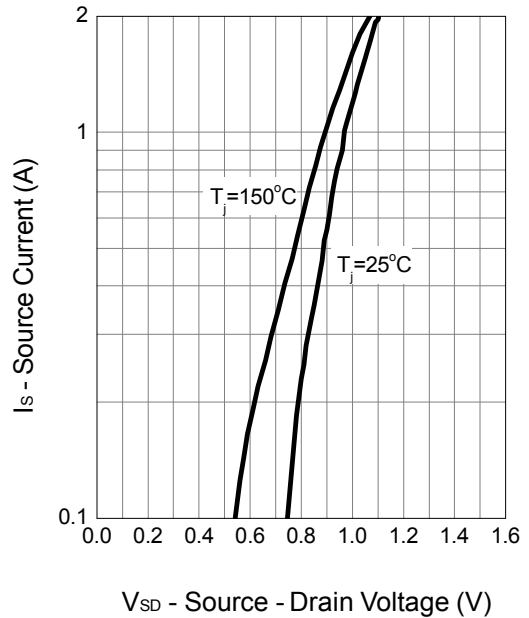


Channel 1 Typical Operating Characteristics (Cont.)

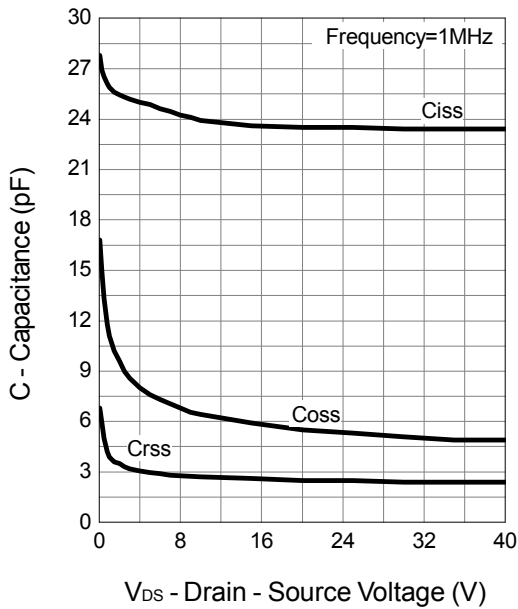
Drain-Source On Resistance



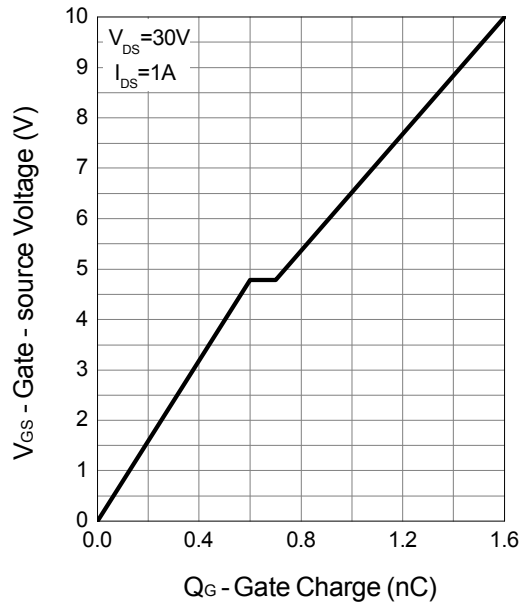
Source-Drain Diode Forward



Capacitance

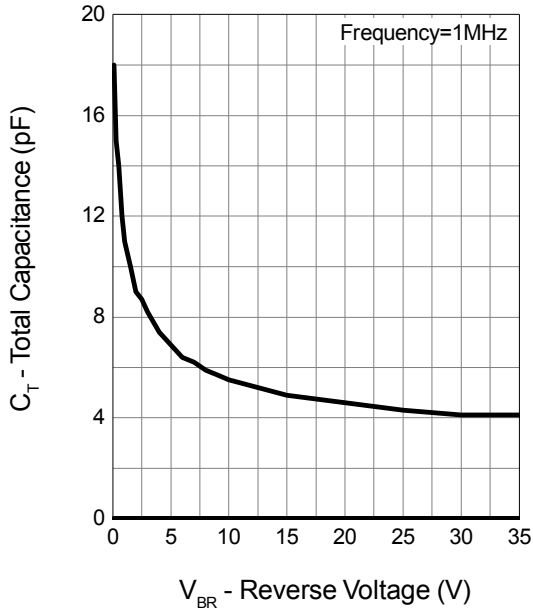


Gate Charge

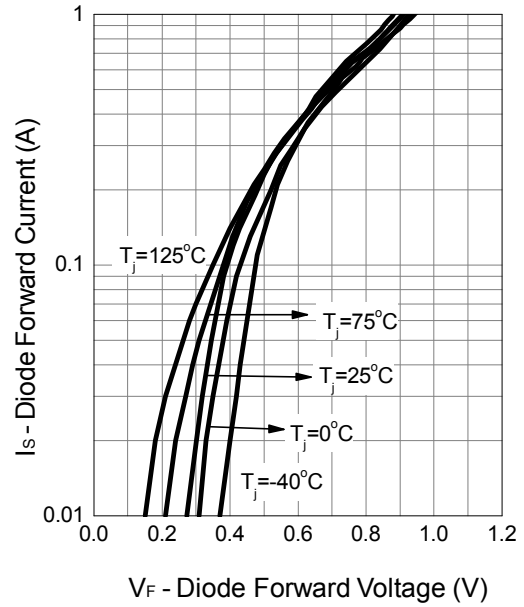


## Channel 2 Typical Operating Characteristics

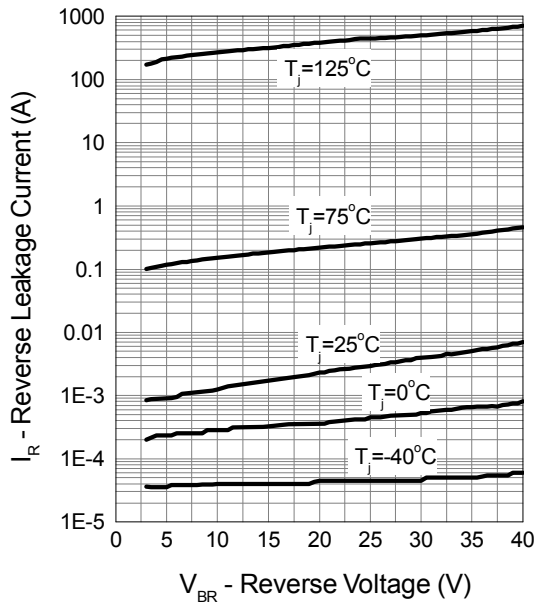
Capacitance



Source-Drain Diode Forward

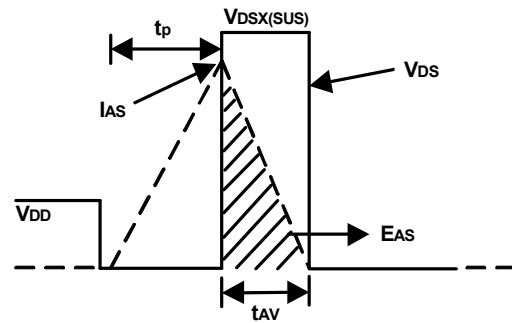
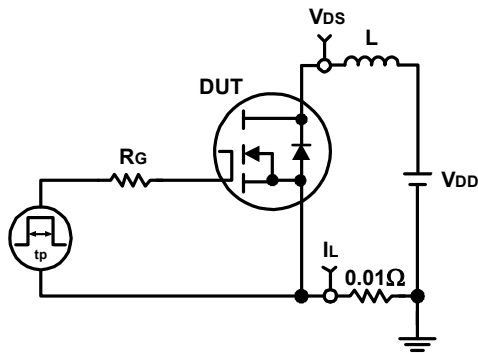


Body Diode Reverse Leakage Current

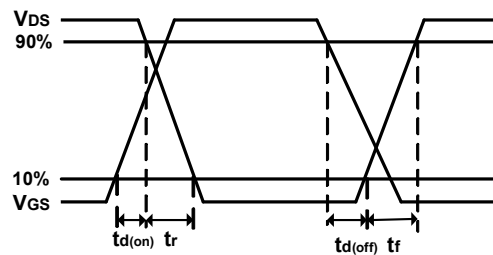
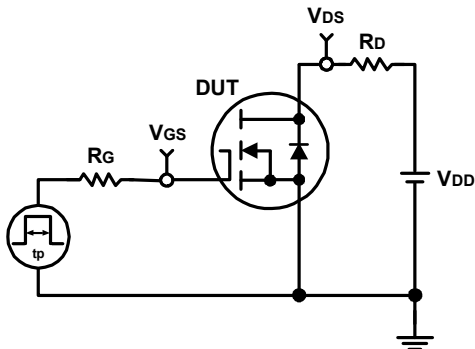




## Avalanche Test Circuit and Waveforms



## Switching Time Test Circuit and Waveforms



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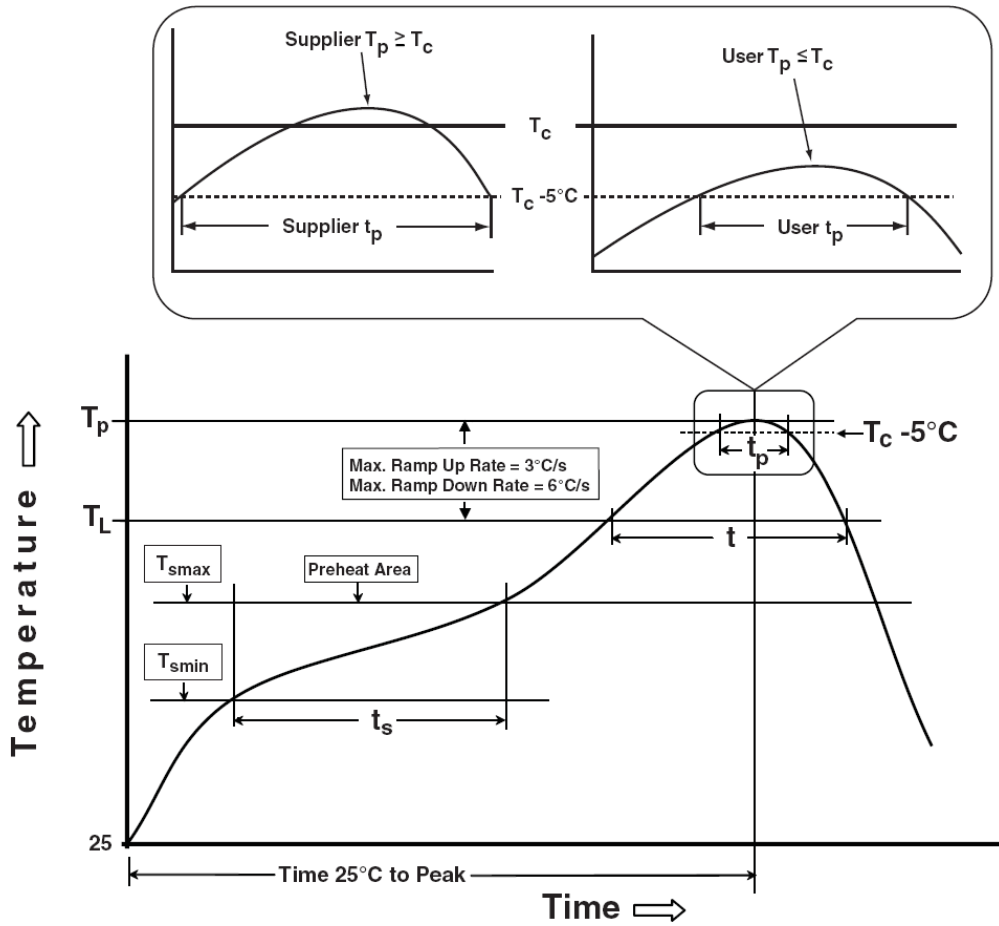
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Classification Profile



## Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
<b>Preheat &amp; Soak</b>		
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 <sup>3</sup> <350	Volume mm <sup>3</sup> ≥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 <sup>3</sup> <350	Volume mm <sup>3</sup> 350-2000	Volume mm <sup>3</sup> >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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