

60V P-Channel Mode MOSFET

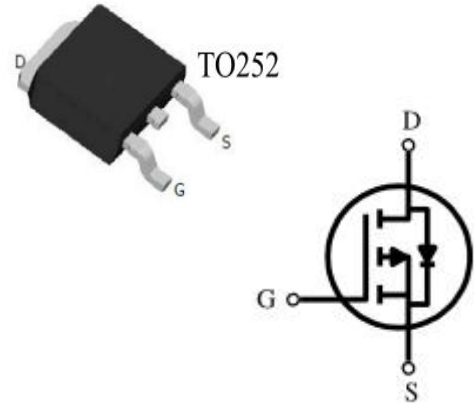
Features

- $V_{DS} = -60V$ $I_D = -13A$
- $R_{DS(ON)} = 90m\Omega(\text{max.}) @ V_{GS} = -10V$
- Low On-Resistance
- Low Input Capacitance
- Super Low Gate Charge
- Low Input / Output Leakage

Applications

- Lithium-Ion Secondary Batteries
- Load Switch
- DC-DC converters and Off-line UPS

PIN DESCRIPTION



Part Number	Package	Marking	ROHS Status	Packing
SI6113D	TO-252	D6113	Halogen-Free	Tape&Reel

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

Symbol	Parameter	Ratings	Unit	
V_{DS}	Drain-Source Voltage	-60	V	
V_{GS}	Gate-Source Voltage	± 20	V	
I_D	Continuous Drain Current	$T_C = 25^\circ C$	-13	A
		$T_C = 100^\circ C$	-8.5	A
I_{DM}	Pulsed Drain Current Tested	-26	A	
I_{AS}	Avalanche Current	$L = 0.1 \text{ mH}$	-24	A
E_{AS}	Avalanche Energy	$L = 0.1 \text{ mH}$	29	mJ
P_D	Total Power Dissipation	$T_A = 25^\circ C$	2	W
		$T_C = 25^\circ C$	31	W
T_J, T_{stg}	Operating Junction and Storage Temperature Range	-55 to 150	$^\circ C$	

THERMAL RESISTANCE RATINGS

Symbol	Parameter	Typical	Max	Unit
$R_{\theta JA}$	Maximum Junction-to-Ambient	Steady State	-	$^\circ C/W$
$R_{\theta JC}$	Maximum Junction-to-Case	Steady State	-	

Electrical Characteristics (T_J=25°C unless otherwise Ratings)

Symbol	Parameter	Test Conditions	Min.	TYP.	Max.	Unit
Static Characteristics						
V _{(BR)DSS}	Drain-source breakdown voltage	V _{GS} =0V, I _D = -250uA	-60	-	-	V
V _{GS(th)}	Gate threshold voltage	V _{DS} =V _{GS} , I _D = -250uA	-1.2	-	-2.5	V
I _{DSS}	Drain-Source Leakage Current	V _{DS} = -48V, V _{GS} =0V	-	-	-1	uA
I _{GSS}	Gate-source leakage current	V _{GS} =±20V, V _{DS} =0V	-	-	±100	nA
R _{DS(on)}	Drain-source on-state resistance	V _{GS} =-10V, I _D =-10A	-	-	90	mΩ
		V _{GS} = -4.5V, I _D =-5A	-	-	117	mΩ
DYNAMIC CHARACTERISTICS						
g _{fs}	Forward Transconductance	V _{DS} =-5V, I _D =- 4A	-	8.5	-	S
R _g	Gate Resistance	V _{DS} =0V, V _{GS} =0V, f=1MHz	-	15	-	Ω
C _{iss}	Input Capacitance	V _{DS} =-15V, V _{GS} =0V, f=1MHz	-	1100	-	PF
C _{oss}	Output Capacitance		-	78	-	PF
C _{rss}	Reverse Transfer Capacitance		-	49	-	PF
Dynamic Characteristic						
Q _g	Total Gate Charge	V _{DS} =-12V, V _{GS} =-4.5V, I _D =-6A	-	12	-	nC
Q _{gs}	Gate-Source Charge		-	2	-	nC
Q _{gd}	Gate-Drain Charge		-	6.8	-	nC
T _{d(on)}	Turn-on delay time	I _D =-1A, V _{GS} =-10V, V _{DS} =-15V, R _{GEM} =3.3Ω	-	9	-	nS
T _r	Rise time		-	20	-	nS
T _{d(off)}	Turn-off delay time		-	48	-	nS
T _f	Fall time		-	10	-	nS
Source-Drain Diode						
V _{SD}	Diode Forward Voltage	V _{GS} =0V, I _S =-1A	-	-	-1	V
I _S	Continuous Source Current	V _G =V _D =0V , Force Current	-	-	-13	A
I _{SM}	Pulsed Source Current		-	-	-26	A

Notes:

1. The data tested by surface mounted on a 1 inch 2 FR-4 board with 2OZ copper.
2. The data tested by pulsed , pulse width \leq 300us , duty cycle \leq 2%
3. The E_{AS} data shows Max. rating . The test condition is V_{DD}=-25V, V_{GS}=-10V, L=0.1mH, I_{AS}=-24.4A
4. The power dissipation is limited by 150 °C junction temperature
5. The data is theoretically the same as I_D and I_{DM} , in real applications , should be limited by total power dissipation.

Typical Performance Characteristics

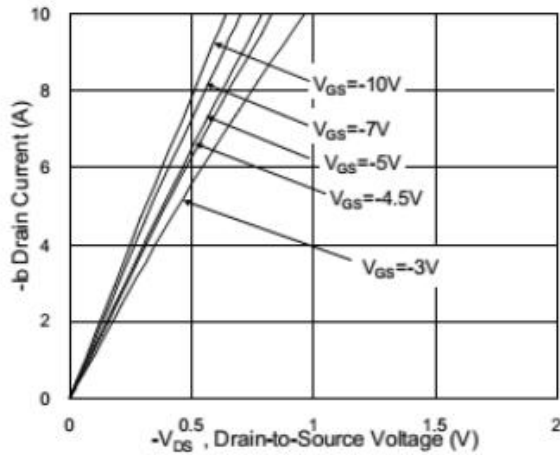


Fig.1 Typical Output Characteristics

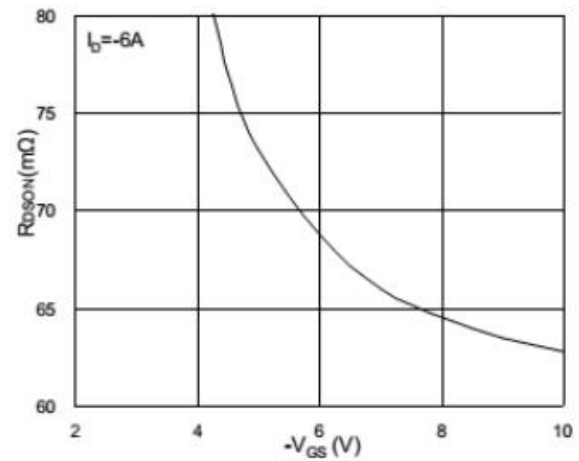


Fig.2 On-Resistance v.s Gate-Source

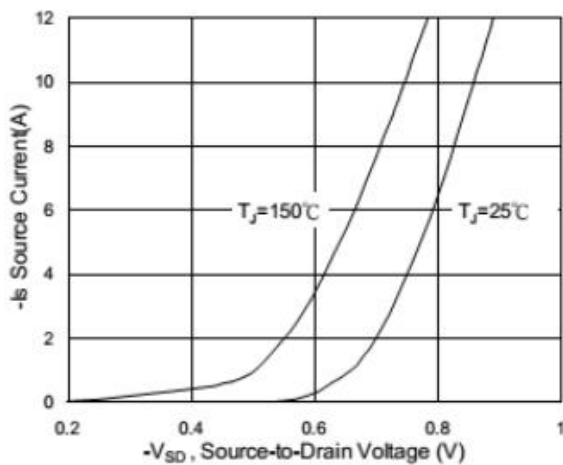


Fig.3 Forward Characteristics of Reverse

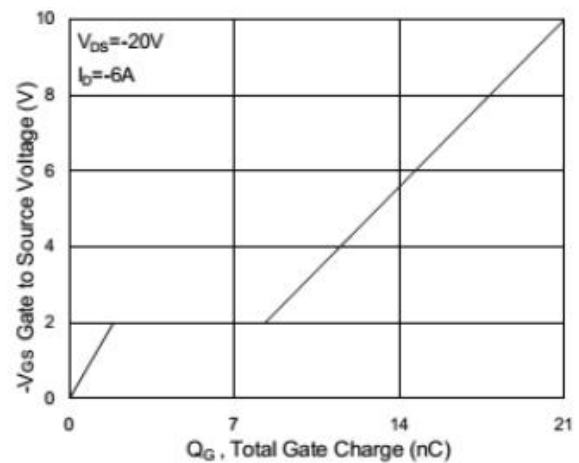


Fig.4 Gate-Charge Characteristics

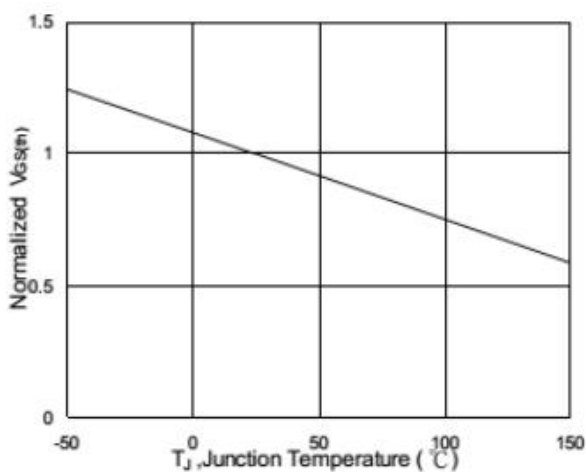


Fig.5 Normalized $V_{GS(th)}$ v.s T_J

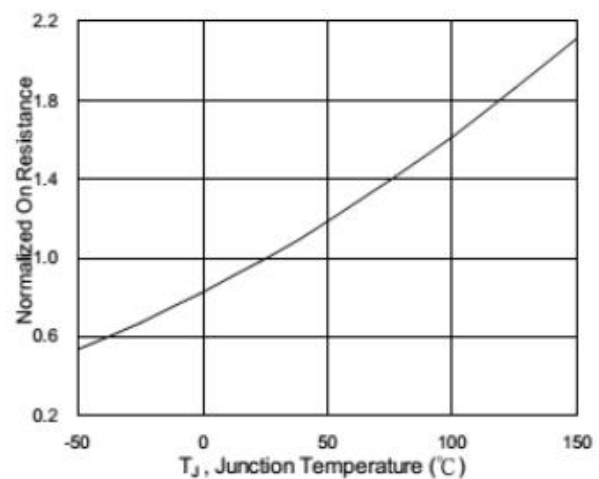


Fig.6 Normalized $R_{DS(on)}$ v.s T_J

Typical Performance Characteristics (Cont.)

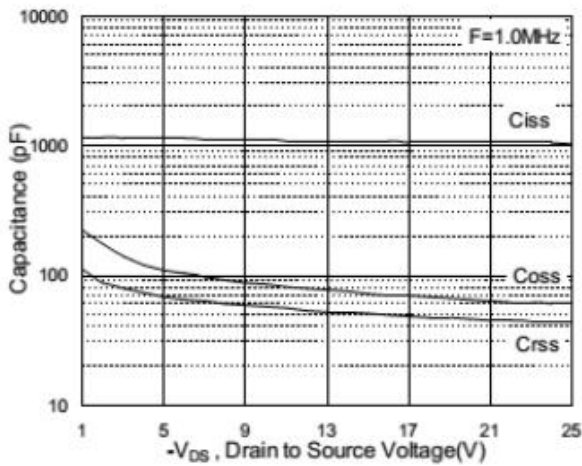


Fig.7 Capacitance

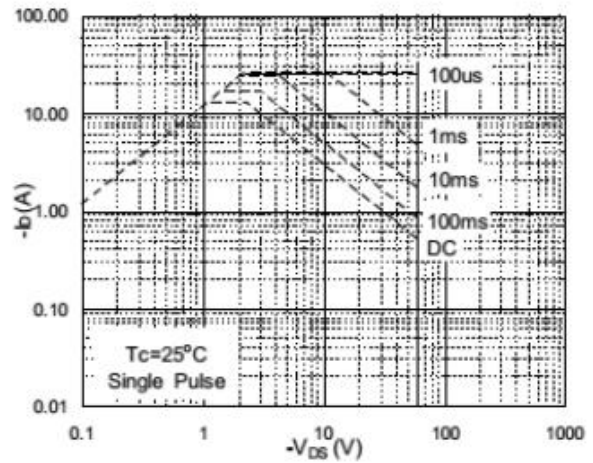


Fig.8 Safe Operating Area

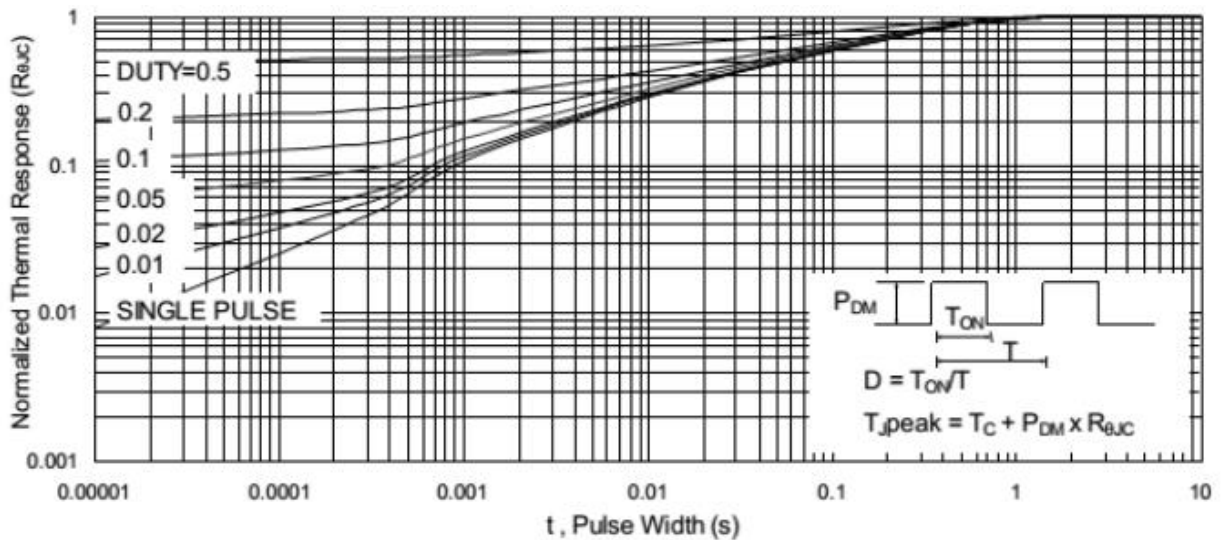


Fig.9 Normalized Maximum Transient Thermal Impedance

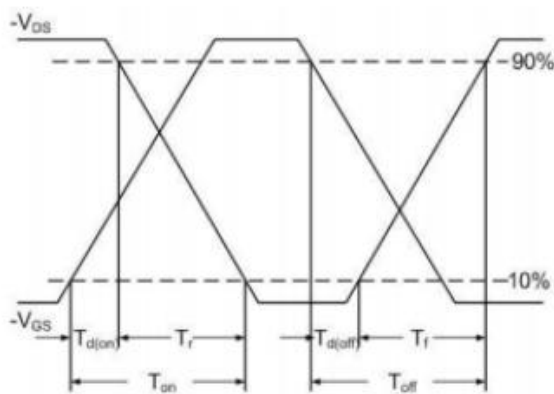


Fig.10 Switching Time Waveform

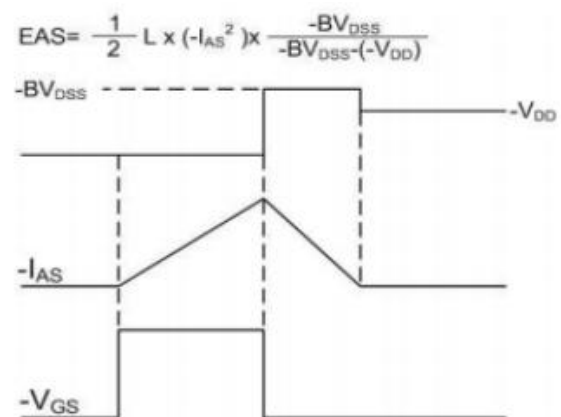
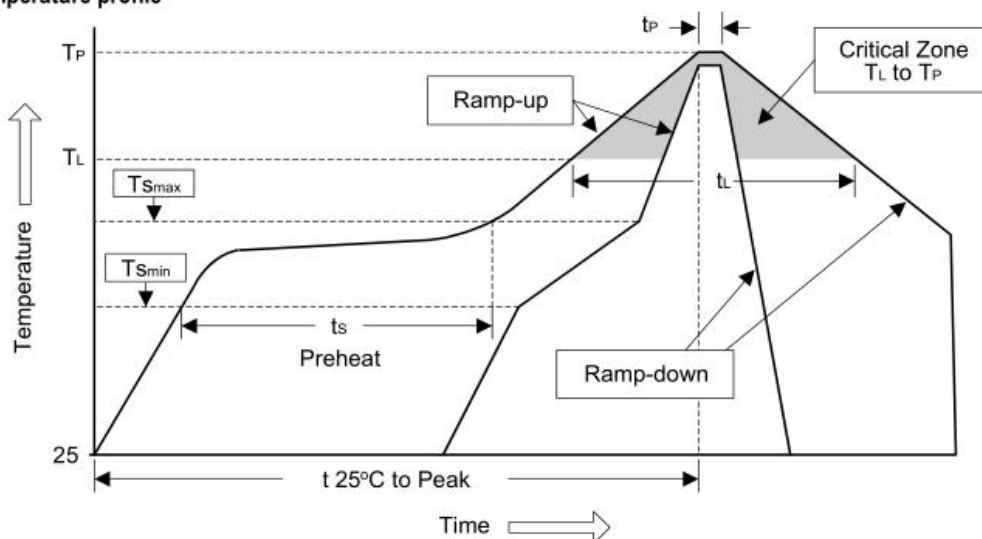


Fig.11 Unclamped Inductive Switching Waveform

Soldering Methods for Products

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp -up rate(TL to TP)	<3°C/sec	<3°C/sec
Preheat -Temperature Min(Ts min) -Temperature Max(Ts max) -Time(min to max)(ts)	- 100°C 150°C 60 to 120 sec	- 150°C 200°C 60 to 180 sec
Ts max to TL - ramp-up rate	<3°C/sec	<3°C/sec
Time maintained above: -Temperature(TL) -Time(TL)	183°C 60 to 150 sec	217°C 60 to 150 sec
Peak Temperature(TP)	240°C+0/-5°C	250°C+0/-5°C
Time within 5°C of actual Peak Temperature	10 to 30 sec	20 to 40 sec
Ramp-down Rate	<6°C/sec	<6°C/sec
Time 25 °C to Peak Temperature	<6 minutes	<8 minutes

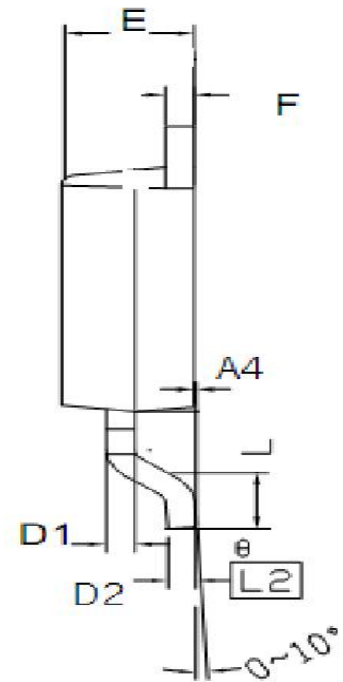
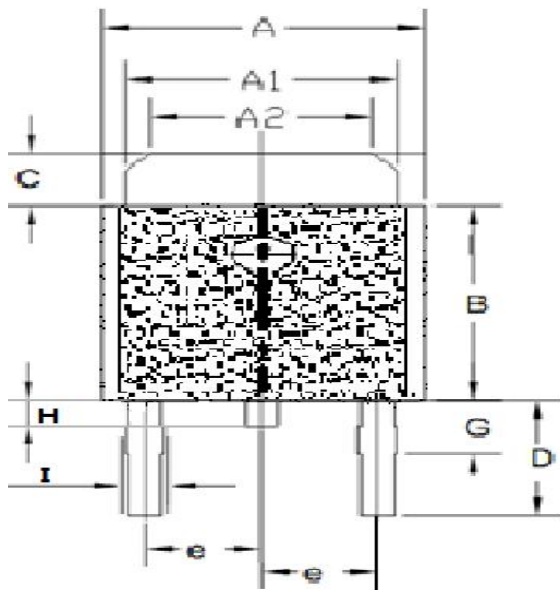
Figure 1: Temperature profile



- Note :**
- 1.Storage environment: Temperature=10°C to 35@Humidity=45%±15%
 - 2.Reflow soldering of surface-mount devices
 - 3.Flow(wave) soldering(solder dipping)

Products	Peak Temperature	Dipping Time
Pb devices	245°C±5°C	5sec±1sec
Pb-free devices	250°C+0/-5°C	5sec±1sec

Package Outline



unit: mm					
Symbol	Min	Max	Symbol	Min	Max
A	6.40	6.60	D	2.90	3.10
A1	5.20	5.40	D1	0.45	0.55
A2	4.40	4.60	D2	0.45	0.55
A3	4.40	4.60	e	2.3BSC	
A4	0.00	0.15	E	2.20	2.40
A5	4.65	4.95	F	0.49	0.59
B	6.00	6.20	G	1.7BSC	
B1	1.57	1.77	L	1.40	1.60
C	0.90	0.96	θ (度)	0.00	10.00
I	0.80	0.85	H	0.49	0.52

■ Important Notice

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