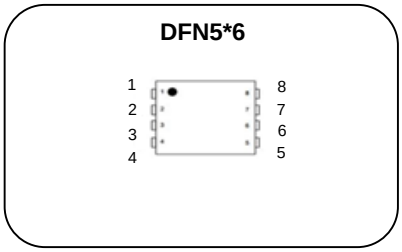
*N-channel Enhanced mode DFN5*6 MOSFET*

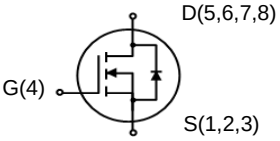
Features

- High ruggedness
- Low $R_{DS(ON)}$ (Typ 2.9mΩ)@V_{GS}=4.5V
  (Typ 2.3mΩ)@V_{GS}=10V
- Low Gate Charge (Typ 127nC)
- Improved dv/dt Capability
- 100% Avalanche Tested
- Application:DC-DC Converter, Inverter, Synchronous Rectification



4.Gate 5,6,7,8.Drain 1,2,3.Source

BV_{DSS} : 40V
I_D : 60A
$R_{DS(ON)}$: 2.9mΩ@V_{GS}=4.5V
2.3mΩ@V_{GS}=10V



General Description

This power MOSFET is produced with advanced technology of SAMWIN.
This technology enable the power MOSFET to have better characteristics, including fast switching time, low on resistance, low gate charge and especially excellent avalanche characteristics.

Order Codes

Item	Sales Type	Marking	Package	Packaging
1	SW HA 60N04V	SW60N04V	DFN5*6	REEL

Absolute maximum ratings

Symbol	Parameter		Value	Unit
V_{DSS}	Drain to source voltage		40	V
I_D	Continuous drain current (@T_C=25°C)		60*	A
	Continuous drain current (@T_C=100°C)		38*	A
I_{DM}	Drain current pulsed	(note 1)	240	A
V_{GS}	Gate to source voltage		±20	V
E_{AS}	Single pulsed avalanche energy	(note 2)	792	mJ
E_{AR}	Repetitive avalanche energy	(note 1)	18	mJ
dv/dt	Peak diode recovery dv/dt	(note 3)	5	V/ns
P_D	Total power dissipation (@Ta=25°C)		3.2	W
	Derating factor above 25°C		0.03	W/°C
T_{STG}, T_J	Operating junction temperature & storage temperature		-55 ~ + 150	°C

*. Drain current is limited by junction temperature.

Thermal characteristics

Symbol	Parameter	Value	Unit
R_{thja}	Thermal resistance, Junction to ambient	39	°C/W

Note: R_{thja} is the sum of the junction-to-case and case-to-ambient thermal resistance where the case thermal reference is defined as the solder mounting surface of the drain pins. R_{thjc} is guaranteed by design while R_{thca} is determined by the user's board design. 39°C/W on a 1 in^2 pad of 2oz copper.

Electrical characteristic (T_C = 25°C unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
Off characteristics						
BV_{DSS}	Drain to source breakdown voltage	V_{GS}=0V, I_D=250uA	40			V
ΔBV_{DSS} / ΔT_J	Breakdown voltage temperature coefficient	I_D=250uA, referenced to 25°C		0.03		V/°C
I_{DSS}	Drain to source leakage current	V_{DS}=40V, V_{GS}=0V			1	uA
		V_{DS}=32V, T_C=125°C			50	uA
I_{GSS}	Gate to source leakage current, forward	V_{GS}=20V, V_{DS}=0V			100	nA
	Gate to source leakage current, reverse	V_{GS}=-20V, V_{DS}=0V			-100	nA
On characteristics						
$V_{GS(TH)}$	Gate threshold voltage	V_{DS}=V_{GS}, I_D=250uA	1		3	V
$R_{DS(ON)}$	Drain to source on state resistance	V_{GS}=4.5V, I_D=30A		2.9	3.6	mΩ
		V_{GS}=10V, I_D=30A		2.3	2.9	mΩ
		V_{GS}=10V, I_D=60A		2.4	3.0	mΩ
G_{fs}	Forward transconductance	V_{DS}=5V, I_D=30A		108		S
Dynamic characteristics						
C_{iss}	Input capacitance	V_{GS}=0V, V_{DS}=20V, f=1MHz		5890		pF
C_{oss}	Output capacitance			715		
C_{rss}	Reverse transfer capacitance			683		
$t_{d(on)}$	Turn on delay time	V_{DS}=20V, I_D=30A, R_G=25Ω, V_{GS}=10V (note 4,5)		35		ns
t_r	Rising time			145		
$t_{d(off)}$	Turn off delay time			388		
t_f	Fall time			229		
Q_g	Total gate charge	V_{DS}=32V, V_{GS}=10V, I_D=30A (note 4,5)		127		nC
Q_{gs}	Gate-source charge			16		
Q_{gd}	Gate-drain charge			37		

Source to drain diode ratings characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_S	Continuous source current	Integral reverse p-n Junction diode in the MOSFET			60	A
I_{SM}	Pulsed source current				240	A
V_{SD}	Diode forward voltage drop.	I_S=60A, V_{GS}=0V			1.4	V
t_{rr}	Reverse recovery time	I_S=30A, V_{GS}=0V, dI_F/dt=100A/us		29		ns
Q_{rr}	Reverse recovery charge			10		nC

※. Notes
1. Repeatitive rating : pulse width limited by junction temperature.
2. L =1.76mH, I_{AS} =30A, V_{DD}=30V, R_G=25Ω, Starting T_J = 25°C
3. I_{SD} ≤ 30A, di/dt = 100A/us, V_{DD} ≤ BV_{DSS}, Staring T_J =25°C
4. Pulse Test : Pulse Width ≤ 300us, duty cycle ≤ 2%.
5. Essentially independent of operating temperature.

Fig. 1. On-state characteristics

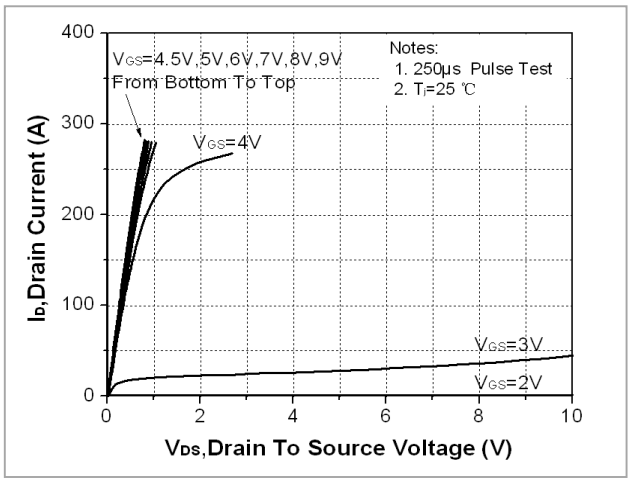


Fig. 2. On-resistance variation vs. drain current and gate voltage

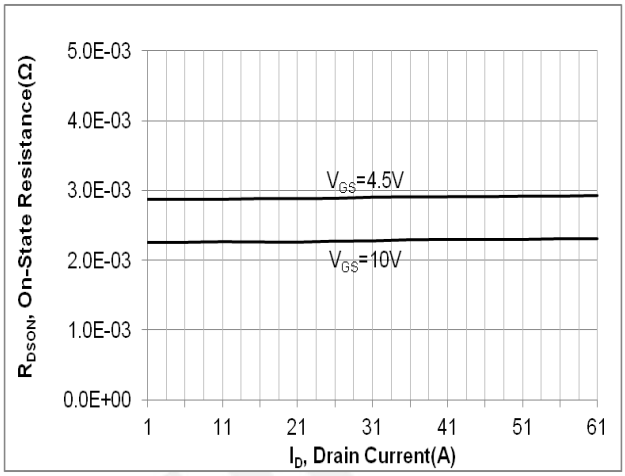


Fig. 3. Gate charge characteristics

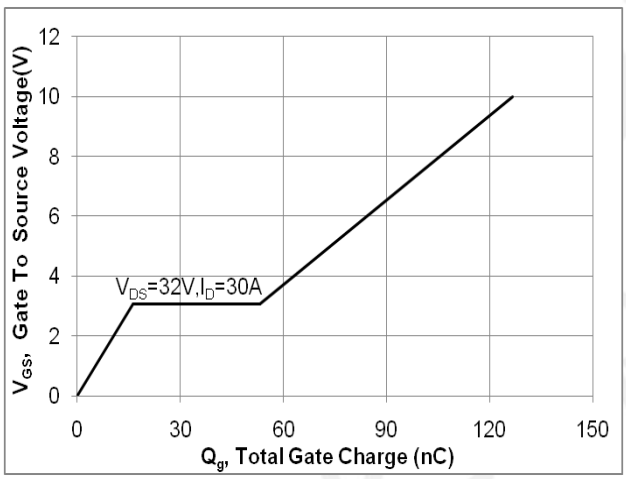


Fig. 4. On-state current vs. diode forward voltage

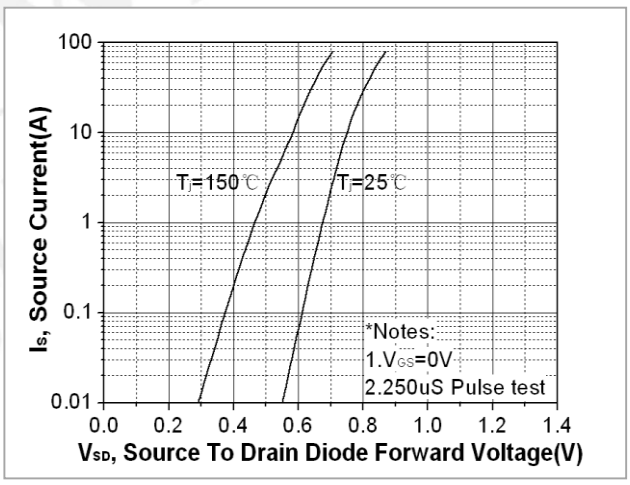


Fig 5. Breakdown voltage variation vs. junction temperature

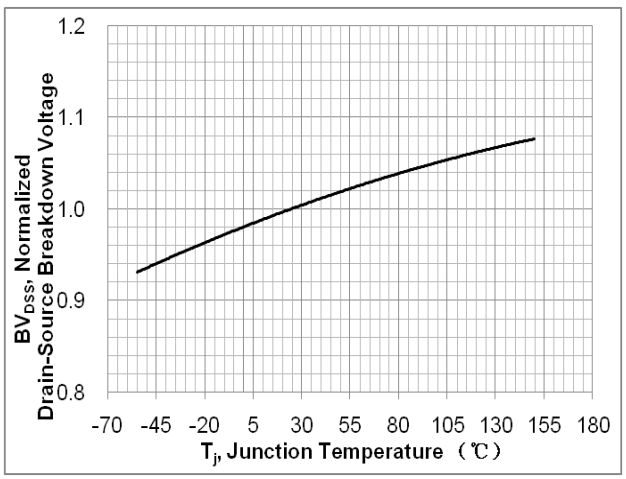


Fig. 6. On-resistance variation vs. junction temperature

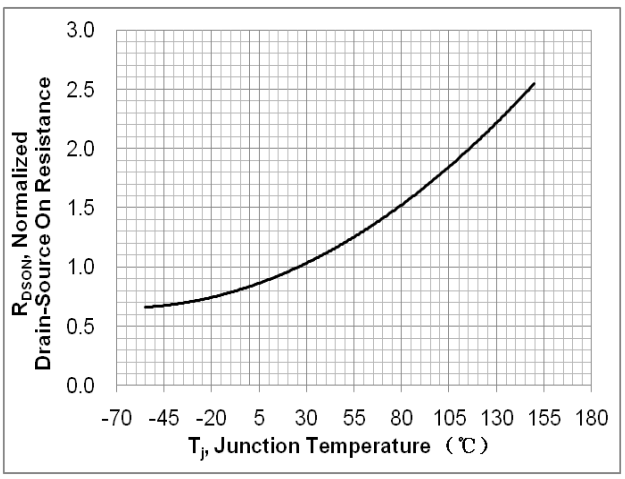


Fig. 7. Maximum safe operating area

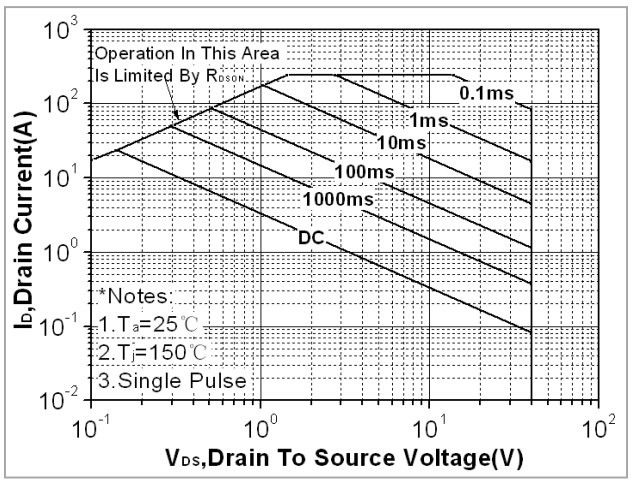


Fig. 8. Capacitance Characteristics

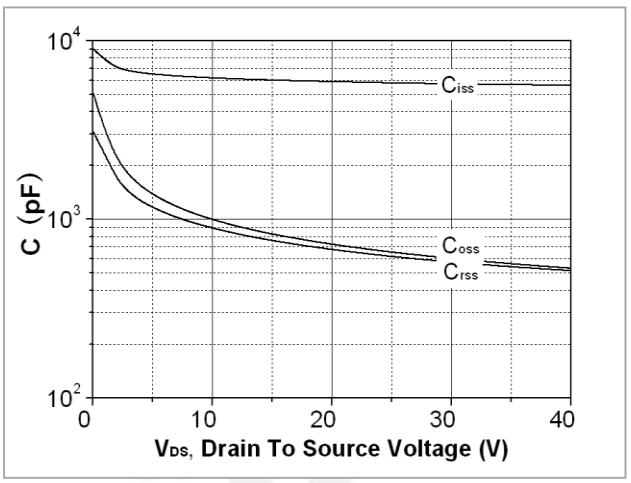


Fig. 9. Transient thermal response curve

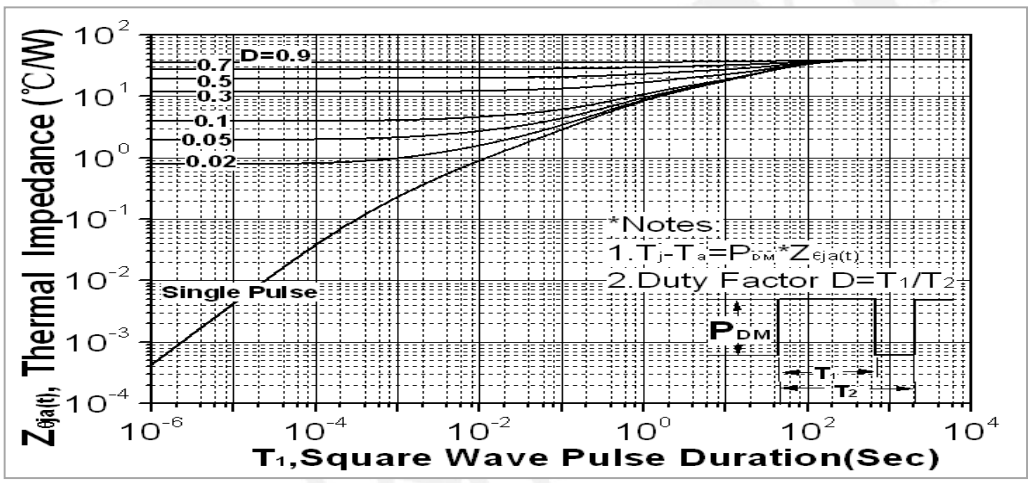


Fig. 10. Gate charge test circuit & waveform

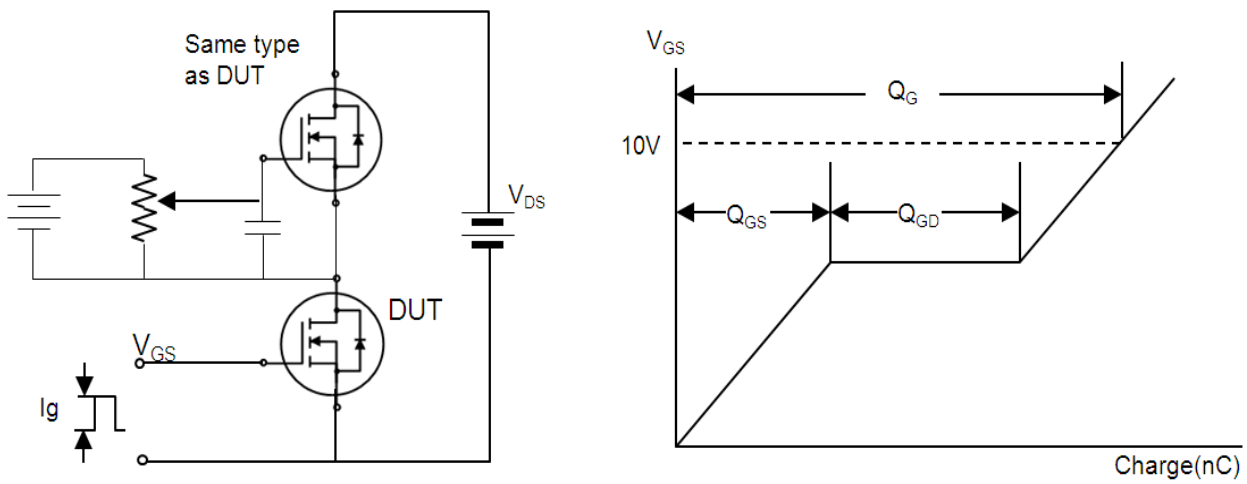


Fig. 11. Switching time test circuit & waveform

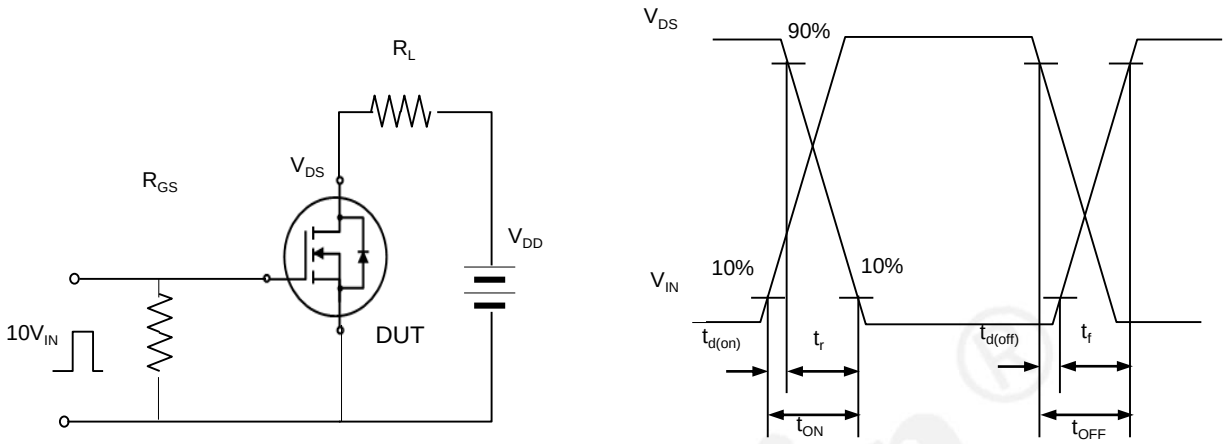


Fig. 12. Unclamped Inductive switching test circuit & waveform

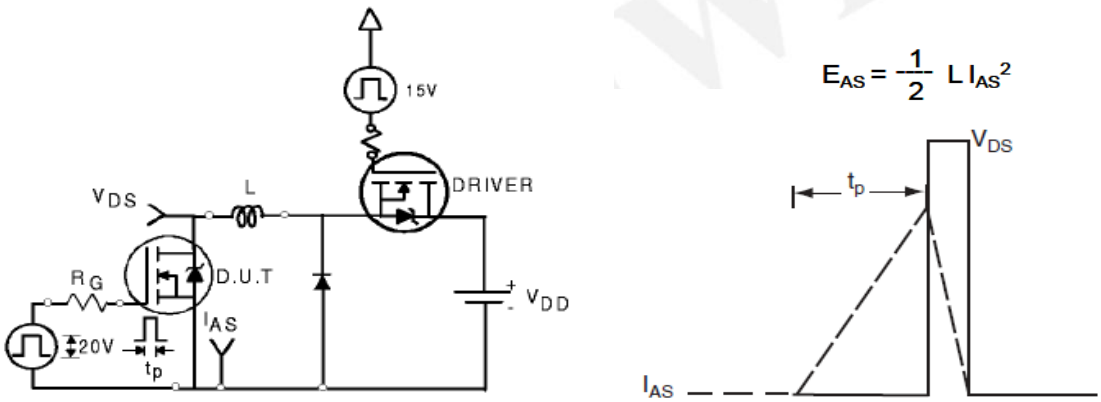
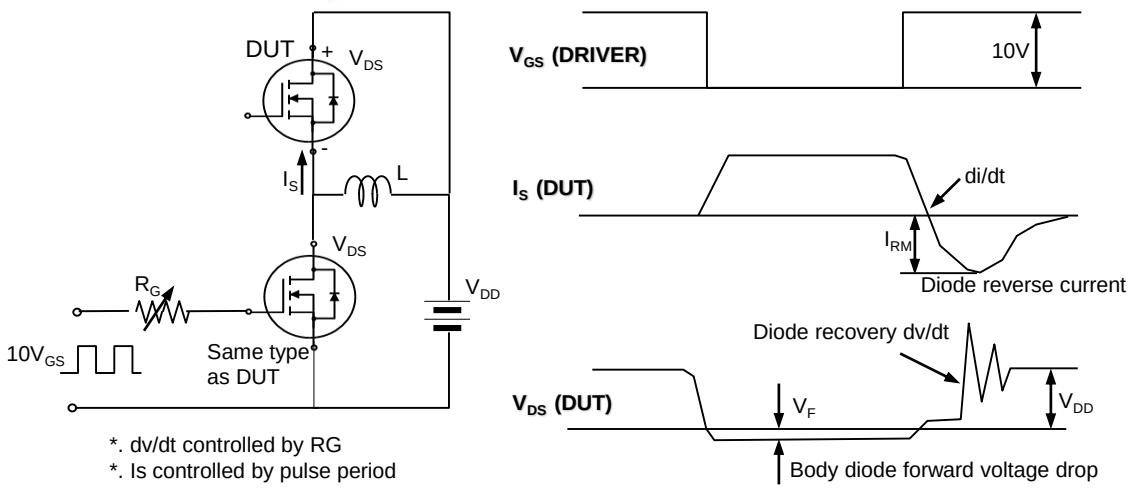


Fig. 13. Peak diode recovery dv/dt test circuit & waveform



*. dv/dt controlled by RG
*. Is controlled by pulse period

DISCLAIMER

* All the data & curve in this document was tested in XI'AN SEMIPOWER TESTING & APPLICATION CENTER.
* This product has passed the PCT,TC,HTRB,HTGB,HAST,PC and Solderdunk reliability testing.
* Qualification standards can also be found on the Web site (**http://www.semipower.com.cn**)
* Suggestions for improvement are appreciated, Please send your suggestions to **samwin@samwinsemi.com**