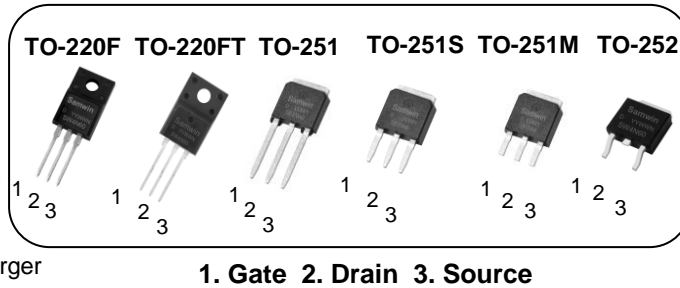


## N-channel Enhancement mode TO-220F/TO-220FT/TO-251/S/M/TO-252 MOSFET

### Features

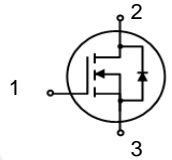
- High ruggedness
- Low  $R_{DS(ON)}$  (Typ 1.9Ω)  
@ $V_{GS}=10V$
- Low Gate Charge (Typ 18nC)
- Improved dv/dt Capability
- 100% Avalanche Tested
- Application: Adapter, LED, Charger



$BV_{DSS} : 600V$

$I_D : 4A$

$R_{DS(ON)} : 1.9\Omega$



### General Description

This power MOSFET is produced with advanced technology of SAMWIN.

This technology enable power MOSFET to have better characteristics, such as fast switching time, low on resistance, low gate charge and especially excellent avalanche characteristics.

### Order Codes

Item	Sales Type	Marking	Package	Packaging
1	SW F 4N60D	SW4N60D	TO-220F	TUBE
2	SW Y 4N60D	SW4N60D	TO-220FT	TUBE
3	SW I 4N60D	SW4N60D	TO-251	TUBE
4	SW SI 4N60D	SW4N60D	TO-251S	TUBE
5	SW MI 4N60D	SW4N60D	TO-251M	TUBE
6	SW D 4N60D	SW4N60D	TO-252	REEL



### Absolute maximum ratings

Symbol	Parameter	Value			Unit
		TO-220F/TO-220FT	TO-251*	TO-252	
$V_{DSS}$	Drain to Source Voltage	600			V
$I_D$	Continuous Drain Current (@ $T_C=25^\circ C$ )	4*			A
	Continuous Drain Current (@ $T_C=100^\circ C$ )	2.5*			A
$I_{DM}$	Drain current pulsed (note 1)	16			A
$V_{GS}$	Gate to Source Voltage	$\pm 30$			V
$E_{AS}$	Single pulsed Avalanche Energy (note 2)	184			mJ
$E_{AR}$	Repetitive Avalanche Energy (note 1)	55			mJ
dv/dt	Peak diode Recovery dv/dt (note 3)	5			V/ns
$P_D$	Total power dissipation (@ $T_C=25^\circ C$ )	23.5	152.6	141.0	W
	Derating Factor above 25°C	0.19	1.22	1.13	W/°C
$T_{STG}, T_J$	Operating Junction Temperature & Storage Temperature	-55 ~ + 150			°C
$T_L$	Maximum Lead Temperature for soldering purpose, 1/8 from Case for 5 seconds.	300			°C

\*. Drain current is limited by junction temperature.

### Thermal characteristics

Symbol	Parameter	Value			Unit
		TO-220F/TO-220FT	TO-251*	TO-252	
$R_{thjc}$	Thermal resistance, Junction to case	5.31	0.82	0.89	°C/W
$R_{thja}$	Thermal resistance, Junction to ambient	47.1	83.5	79.0	°C/W

Electrical characteristic (  $T_C = 25^\circ\text{C}$  unless otherwise specified )

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
<b>Off characteristics</b>						
$BV_{DSS}$	Drain to source breakdown voltage	$V_{GS}=0V, I_D=250\mu A$	600			V
$\Delta BV_{DSS} / \Delta T_J$	Breakdown voltage temperature coefficient	$I_D=250\mu A$ , referenced to $25^\circ\text{C}$		0.47		$V/^\circ\text{C}$
$I_{DSS}$	Drain to source leakage current	$V_{DS}=600V, V_{GS}=0V$			1	$\mu A$
		$V_{DS}=480V, T_C=125^\circ\text{C}$			50	$\mu A$
$I_{GSS}$	Gate to source leakage current, forward	$V_{GS}=30V, V_{DS}=0V$			100	nA
	Gate to source leakage current, reverse	$V_{GS}=-30V, V_{DS}=0V$			-100	nA
<b>On characteristics</b>						
$V_{GS(TH)}$	Gate threshold voltage	$V_{DS}=V_{GS}, I_D=250\mu A$	2.5		4.5	V
$R_{DS(ON)}$	Drain to source on state resistance	$V_{GS}=10V, I_D=2A$		1.9	2.2	$\Omega$
$G_{fs}$	Forward Transconductance	$V_{DS}=30V, I_D=2A$		3.5		S
<b>Dynamic characteristics</b>						
$C_{iss}$	Input capacitance	$V_{GS}=0V, V_{DS}=25V, f=1\text{MHz}$		651		pF
$C_{oss}$	Output capacitance			70		
$C_{rss}$	Reverse transfer capacitance			8.4		
$t_{d(on)}$	Turn on delay time	$V_{DS}=300V, I_D=4A, R_G=25\Omega$ (note 4,5)		10		ns
$t_r$	Rising time			25		
$t_{d(off)}$	Turn off delay time			37		
$t_f$	Fall time			25		
$Q_g$	Total gate charge	$V_{DS}=480V, V_{GS}=10V, I_D=4A$ (note 4,5)		18		nC
$Q_{gs}$	Gate-source charge			3		
$Q_{gd}$	Gate-drain charge			9		
$R_g$	Gate resistance	$V_{DS}=0V$ , Scan F mode		3.1		$\Omega$

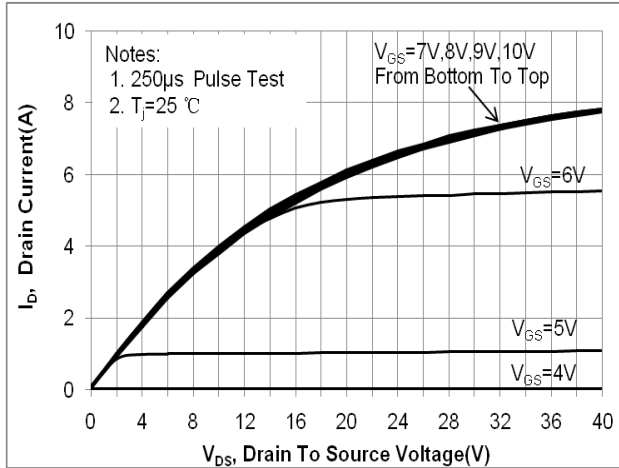
### Source to drain diode ratings characteristics

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$I_S$	Continuous source current	Integral reverse p-n Junction diode in the MOSFET			4	A
$I_{SM}$	Pulsed source current				16	A
$V_{SD}$	Diode forward voltage drop.	$I_S=4A, V_{GS}=0V$			1.4	V
$T_{rr}$	Reverse recovery time	$I_S=4A, V_{GS}=0V,$ $di_f/dt=100A/\mu s$		409		ns
$Q_{rr}$	Reverse recovery Charge				2.3	$\mu C$

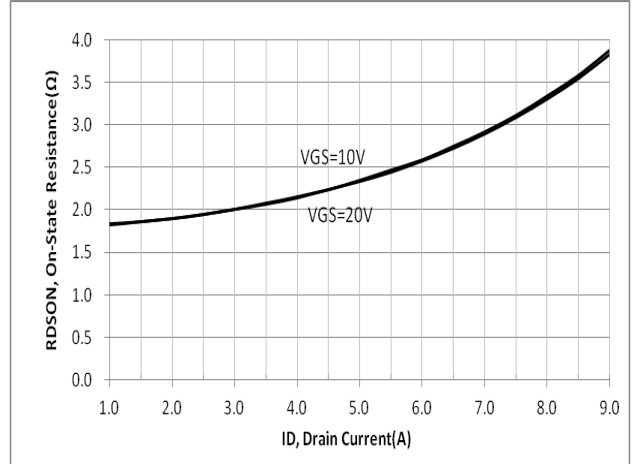
#### ※. Notes

1. Repetitive rating : pulse width limited by junction temperature.
2.  $L = 22.8\text{mH}, I_{AS} = 4A, V_{DD} = 50V, R_G=25\Omega$ , Starting  $T_J = 25^\circ\text{C}$
3.  $I_{SD} \leq 4A, di/dt = 100A/\mu s, V_{DD} \leq BV_{DSS}$ , Starting  $T_J = 25^\circ\text{C}$
4. Pulse Test : Pulse Width  $\leq 300\mu s$ , duty cycle  $\leq 2\%$ .
5. Essentially independent of operating temperature.

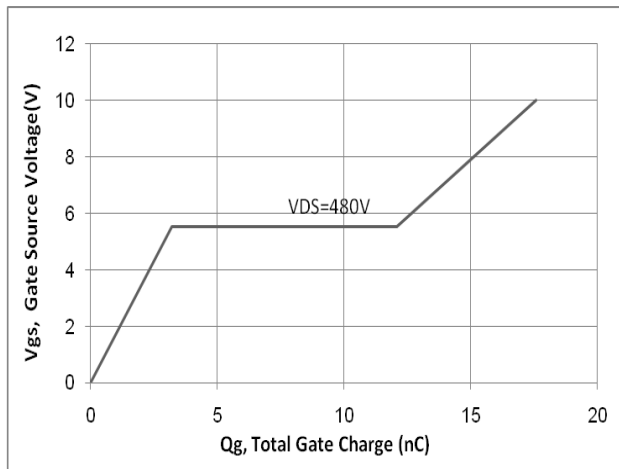
**Fig. 1. On-state characteristics**



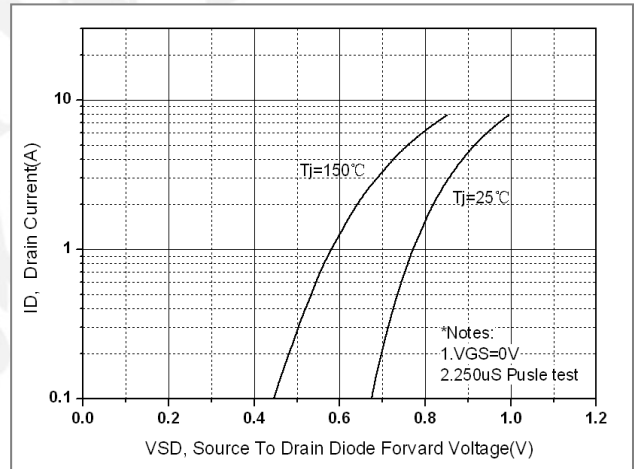
**Fig. 2. On-resistance variation vs. drain current and gate voltage**



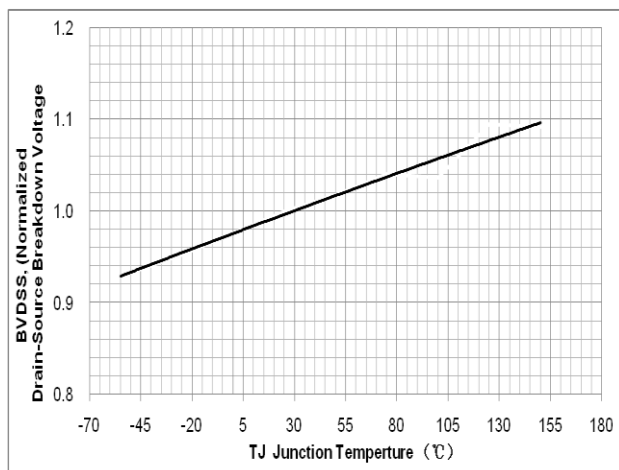
**Fig. 3. Gate charge characteristics**



**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**

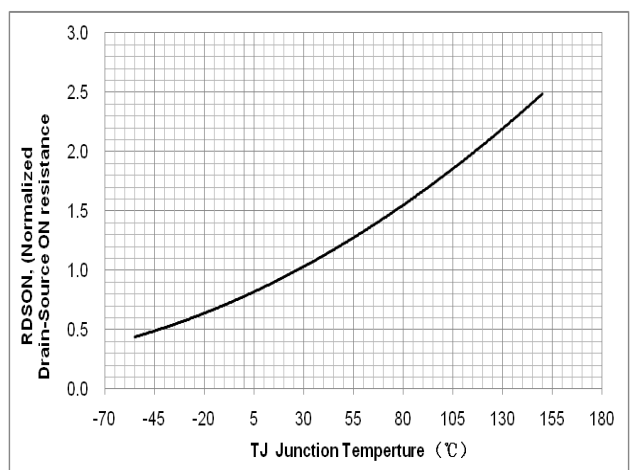


Fig. 7. Maximum safe operating area (TO-220F&TO220FT)

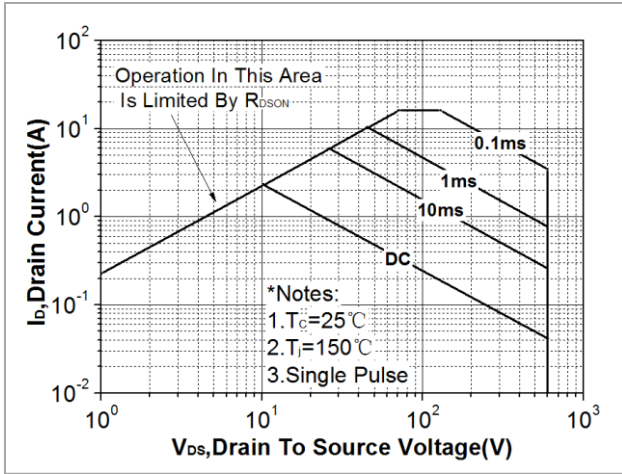


Fig. 8. Maximum safe operating area (TO-251\*)

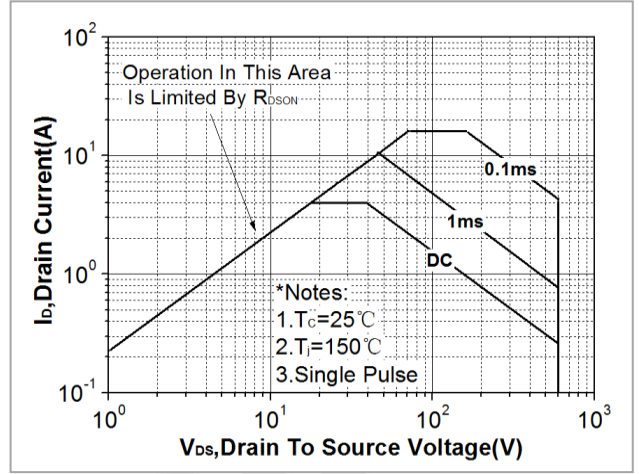


Fig. 9. Maximum safe operating area (TO-252)

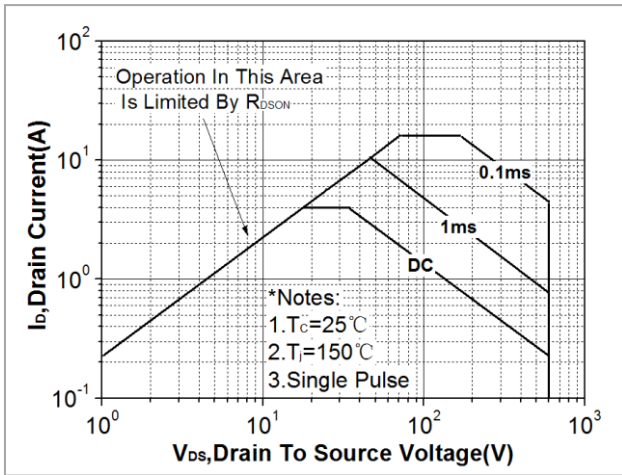


Fig. 10. Capacitance Characteristics

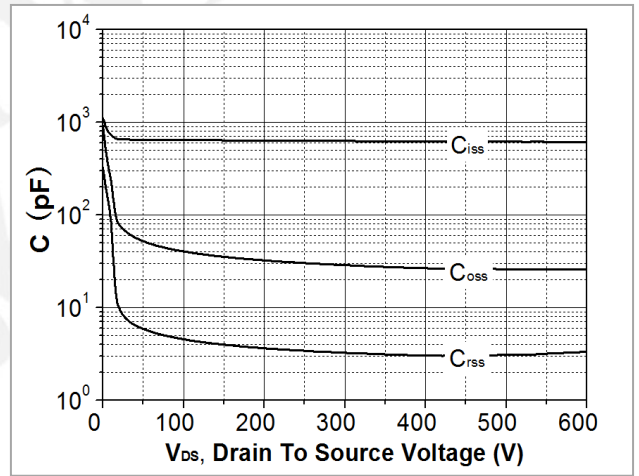


Fig. 11. Transient thermal response curve (TO-220F&TO-220FT)

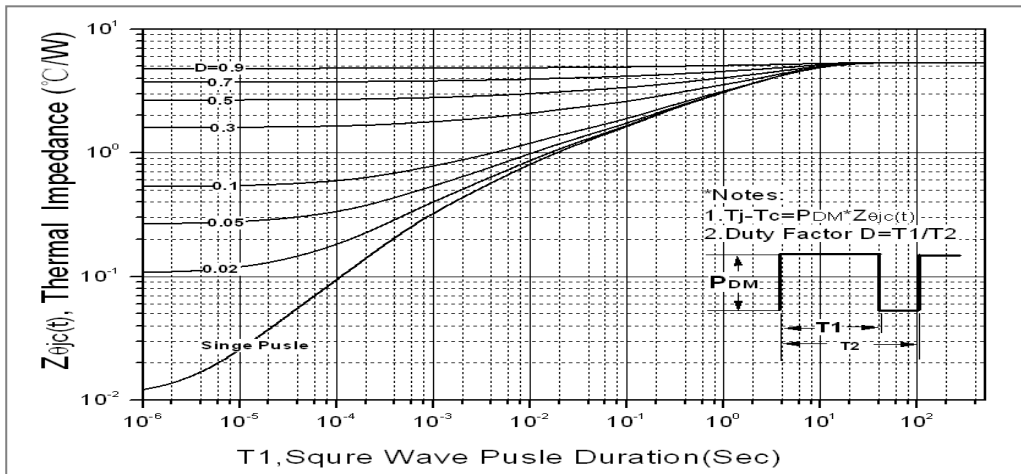


Fig. 12. Transient thermal response curve (TO-251\*)

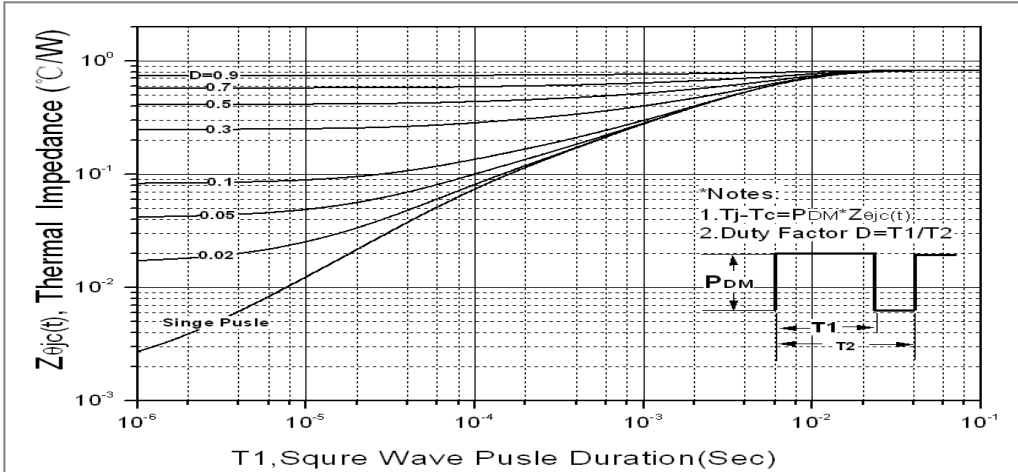


Fig. 13. Transient thermal response curve (TO-252)

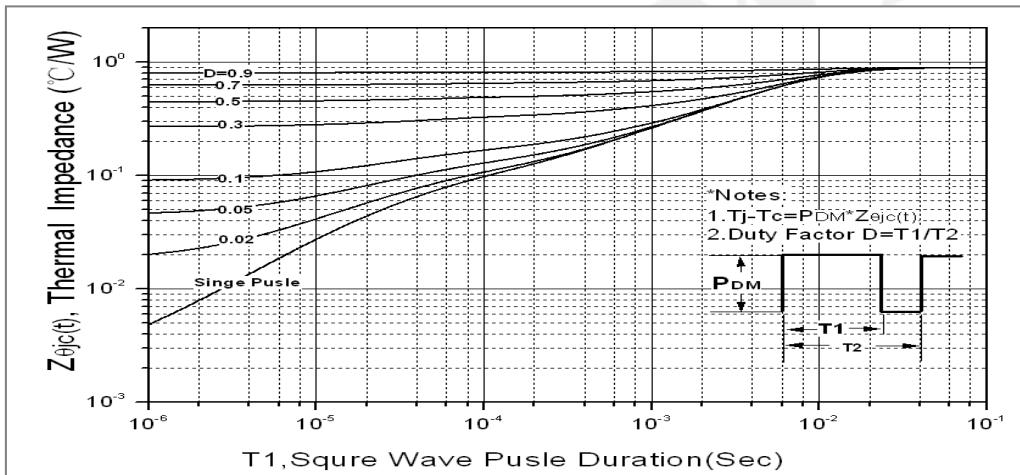


Fig. 14. Gate charge test circuit & waveform

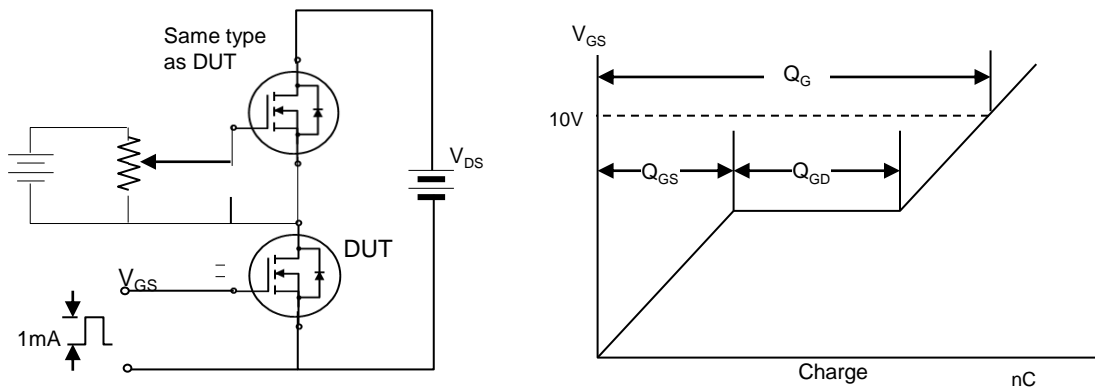


Fig. 15. Switching time test circuit & waveform

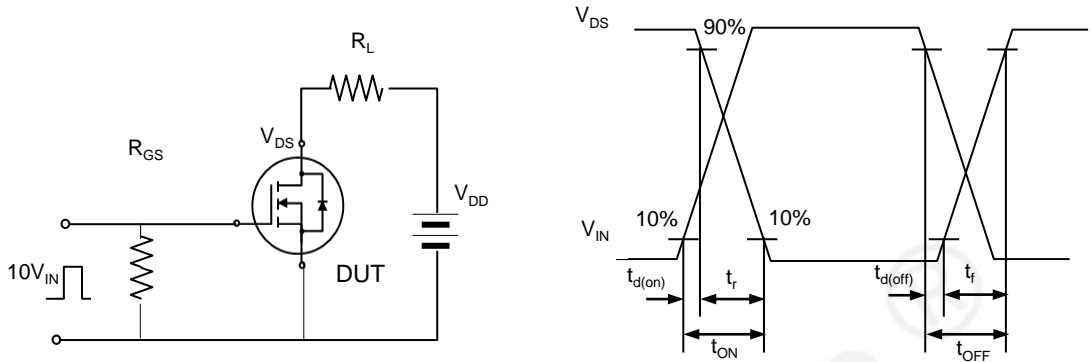


Fig. 16. Unclamped Inductive switching test circuit & waveform

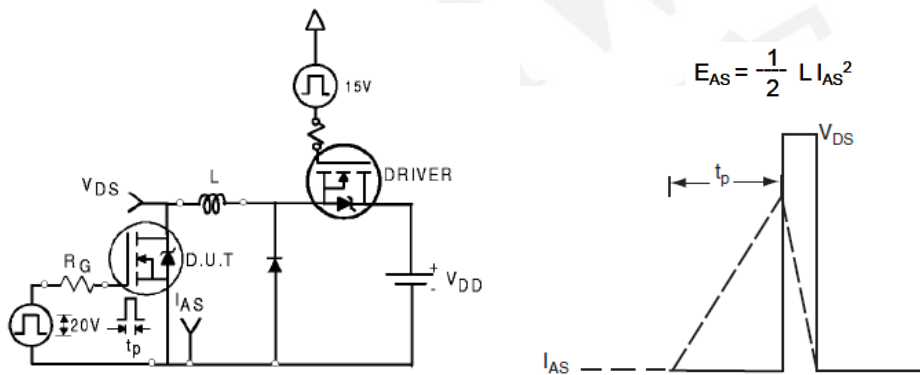
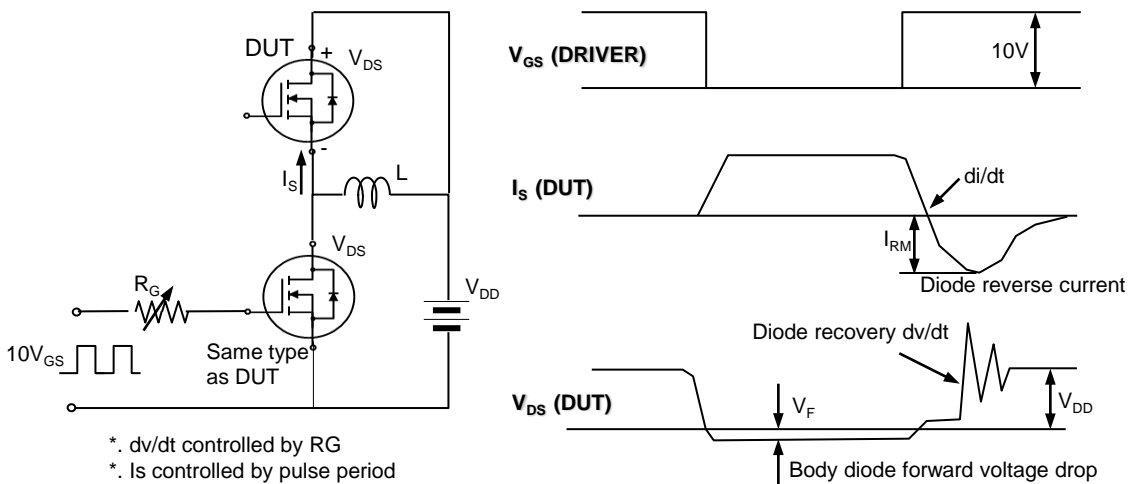



Fig. 17. Peak diode recovery dv/dt test circuit & waveform



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### DISCLAIRATION:

- \* All the data&curve within this document was tested in 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>) 
- \* Any advice, please send your proposal to [samwin@samwinsemi.com](mailto:samwin@samwinsemi.com)

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