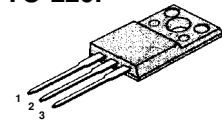


**FEATURES**

- v Avalanche Rugged Technology
- v Rugged Gate Oxide Technology
- v Lower Input Capacitance
- v Improved Gate Charge
- v 175°C Operating Temperature
- v Extended Safe Operating Area
- v Lower Leakage Current : 10 µA (Max.) @  $V_{DS} = -60V$
- v Low  $R_{DS(ON)}$  : 0.106 Ω (Typ.)

$BV_{DSS} = -60 V$   
 $R_{DS(on)} = 0.14 \Omega$   
 $I_D = -12 A$

**TO-220F**



1.Gate 2. Drain 3. Source

**Absolute Maximum Ratings**

Symbol	Characteristic	Value	Units
$V_{DSS}$	Drain-to-Source Voltage	-60	V
$I_D$	Continuous Drain Current ( $T_C=25^\circ C$ )	-12	A
	Continuous Drain Current ( $T_C=100^\circ C$ )	-8.4	
$I_{DM}$	Drain Current-Pulsed ①	-48	A
$V_{GS}$	Gate-to-Source Voltage	$\pm 30$	V
$E_{AS}$	Single Pulsed Avalanche Energy ②	555	mJ
$I_{AR}$	Avalanche Current ①	-12	A
$E_{AR}$	Repetitive Avalanche Energy ①	3.6	mJ
dv/dt	Peak Diode Recovery dv/dt ③	-5.5	V/ns
$P_D$	Total Power Dissipation ( $T_C=25^\circ C$ )	36	W
	Linear Derating Factor	0.24	
$T_J, T_{STG}$	Operating Junction and Storage Temperature Range	- 55 to +175	°C
$T_L$	Maximum Lead Temp. for Soldering Purposes, 1/8" from case for 5-seconds	300	

**Thermal Resistance**

Symbol	Characteristic	Typ.	Max.	Units
$R_{\theta JC}$	Junction-to-Case	--	4.17	°C/W
$R_{\theta JA}$	Junction-to-Ambient	--	62.5	

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

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Condition
$BV_{DSS}$	Drain-Source Breakdown Voltage	-60	--	--	V	$V_{GS}=0V, I_D=-250\mu A$
$\Delta BV/\Delta T_J$	Breakdown Voltage Temp. Coeff.	--	-0.05	--	$V/^\circ\text{C}$	$I_D=-250\mu A$ <b>See Fig 7</b>
$V_{GS(th)}$	Gate Threshold Voltage	-2.0	--	-4.0	V	$V_{DS}=-5V, I_D=-250\mu A$
$I_{GSS}$	Gate-Source Leakage , Forward	--	--	-100	nA	$V_{GS}=-20V$
	Gate-Source Leakage , Reverse	--	--	100		$V_{GS}=20V$
$I_{DSS}$	Drain-to-Source Leakage Current	--	--	-10	$\mu A$	$V_{DS}=-60V$
		--	--	-100		$V_{DS}=-48V, T_C=150^\circ\text{C}$
$R_{DS(on)}$	Static Drain-Source On-State Resistance	--	--	0.14	$\Omega$	$V_{GS}=-10V, I_D=-6.0A$ ④
$g_{fs}$	Forward Transconductance	--	7.9	--	S	$V_{DS}=-30V, I_D=-6.0A$ ④
$C_{iss}$	Input Capacitance	--	890	1155	pF	$V_{GS}=0V, V_{DS}=-25V, f=1\text{MHz}$ <b>See Fig 5</b>
$C_{oss}$	Output Capacitance	--	265	400		
$C_{rss}$	Reverse Transfer Capacitance	--	84	125		
$t_{d(on)}$	Turn-On Delay Time	--	14	40	ns	$V_{DD}=-30V, I_D=-18A,$ $R_G=12\Omega$ <b>See Fig 13</b> ④⑤
$t_r$	Rise Time	--	24	60		
$t_{d(off)}$	Turn-Off Delay Time	--	43	95		
$t_f$	Fall Time	--	28	65		
$Q_g$	Total Gate Charge	--	30	38	nC	$V_{DS}=-48V, V_{GS}=-10V,$ $I_D=-18A$ <b>See Fig 6 &amp; Fig 12</b> ④⑤
$Q_{gs}$	Gate-Source Charge	--	5.3	--		
$Q_{gd}$	Gate-Drain("Miller") Charge	--	12	--		

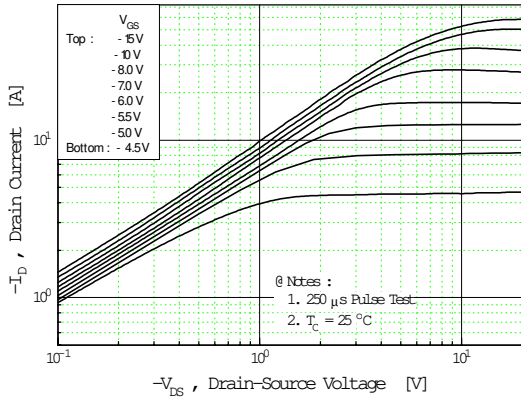
### Source-Drain Diode Ratings and Characteristics

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Condition
$I_S$	Continuous Source Current	--	--	-12	A	Integral reverse pn-diode in the MOSFET
$I_{SM}$	Pulsed-Source Current ①	--	--	-48		
$V_{SD}$	Diode Forward Voltage ④	--	--	-3.9	V	$T_J=25^\circ\text{C}, I_S=-12A, V_{GS}=0V$
$t_{rr}$	Reverse Recovery Time	--	85	--	ns	$T_J=25^\circ\text{C}, I_F=-18A$
$Q_{rr}$	Reverse Recovery Charge	--	0.25	--	$\mu\text{C}$	$di_F/dt=100A/\mu\text{s}$ ④

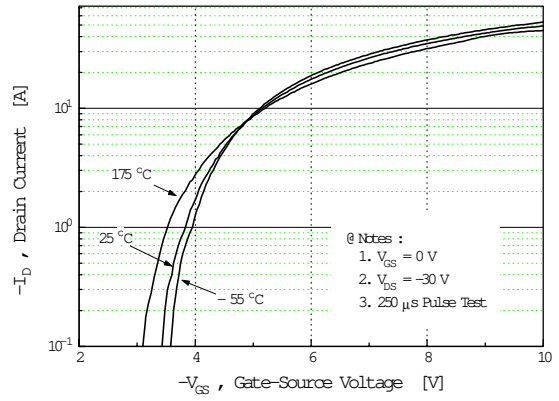
#### Notes ;

- ① Repetitive Rating : Pulse Width Limited by Maximum Junction Temperature
- ②  $L=4.5\text{mH}, I_{AS}=-12A, V_{DD}=-25V, R_G=27\Omega^*,$  Starting  $T_J=25^\circ\text{C}$
- ③  $I_{SD}\leq -18A, di/dt \leq 300A/\mu\text{s}, V_{DD} \leq BV_{DSS},$  Starting  $T_J=25^\circ\text{C}$
- ④ Pulse Test : Pulse Width =  $250\mu\text{s},$  Duty Cycle  $\leq 2\%$
- ⑤ Essentially Independent of Operating Temperature

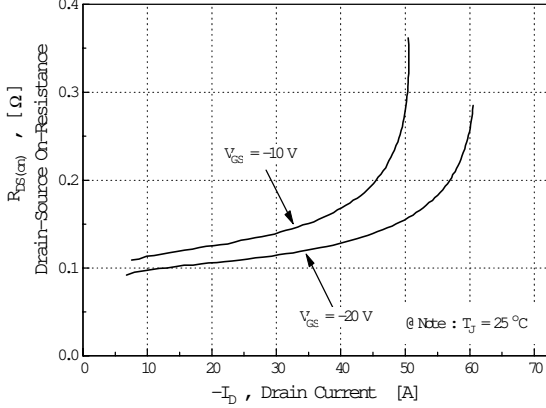
**Fig 1. Output Characteristics**



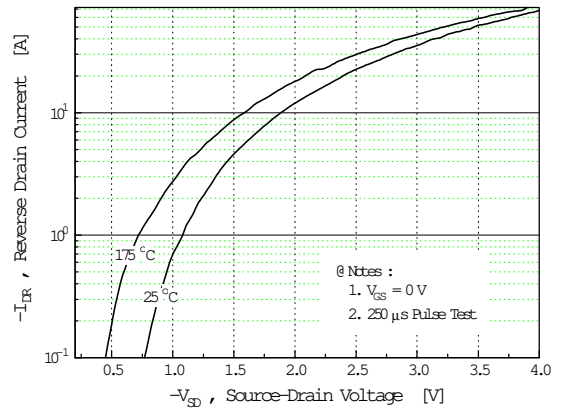
**Fig 2. Transfer Characteristics**



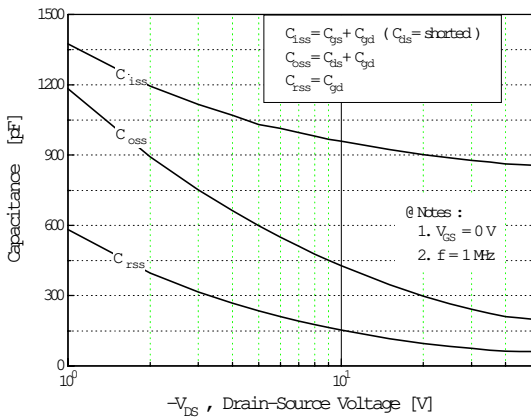
**Fig 3. On-Resistance vs. Drain Current**



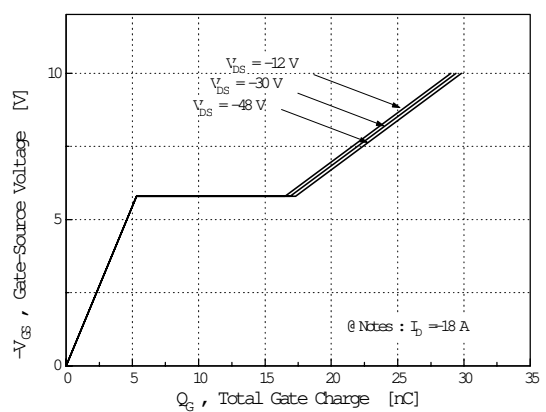
**Fig 4. Source-Drain Diode Forward Voltage**



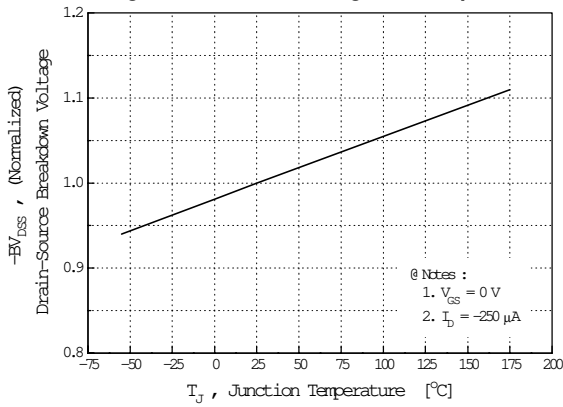
**Fig 5. Capacitance vs. Drain-Source Voltage**



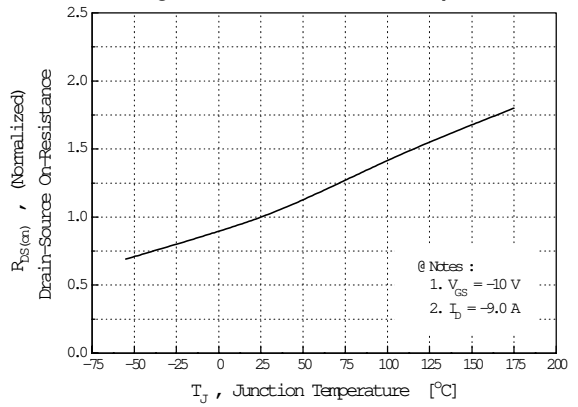
**Fig 6. Gate Charge vs. Gate-Source Voltage**



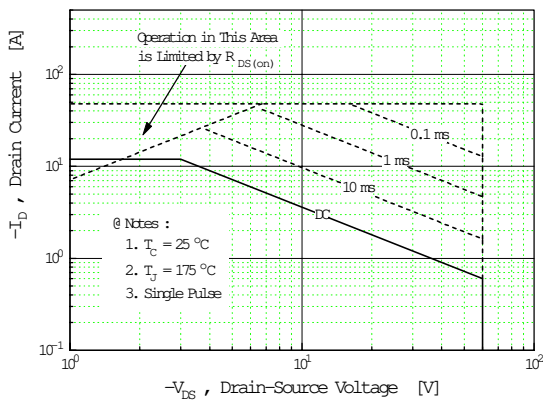
**Fig 7. Breakdown Voltage vs. Temperature**



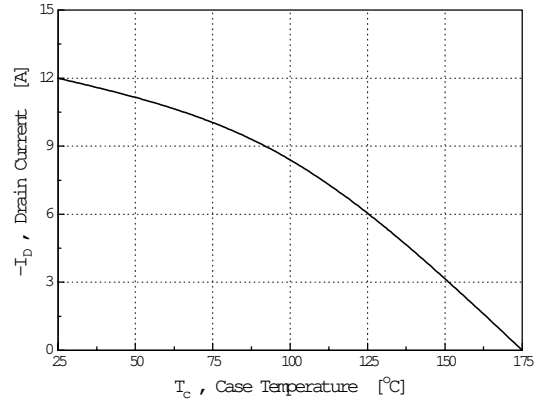
**Fig 8. On-Resistance vs. Temperature**



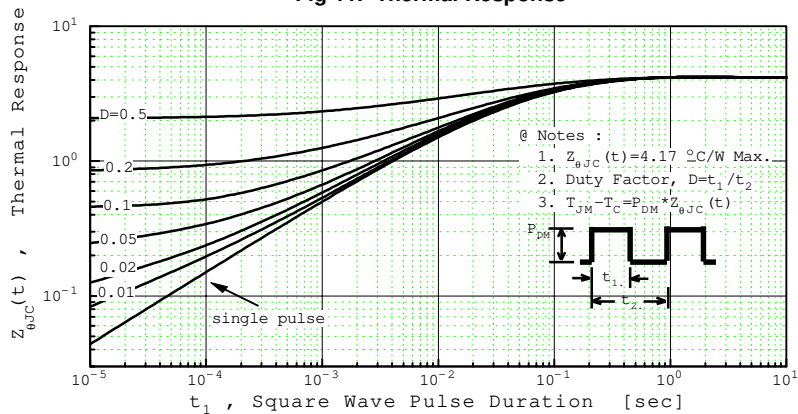
**Fig 9. Max. Safe Operating Area**



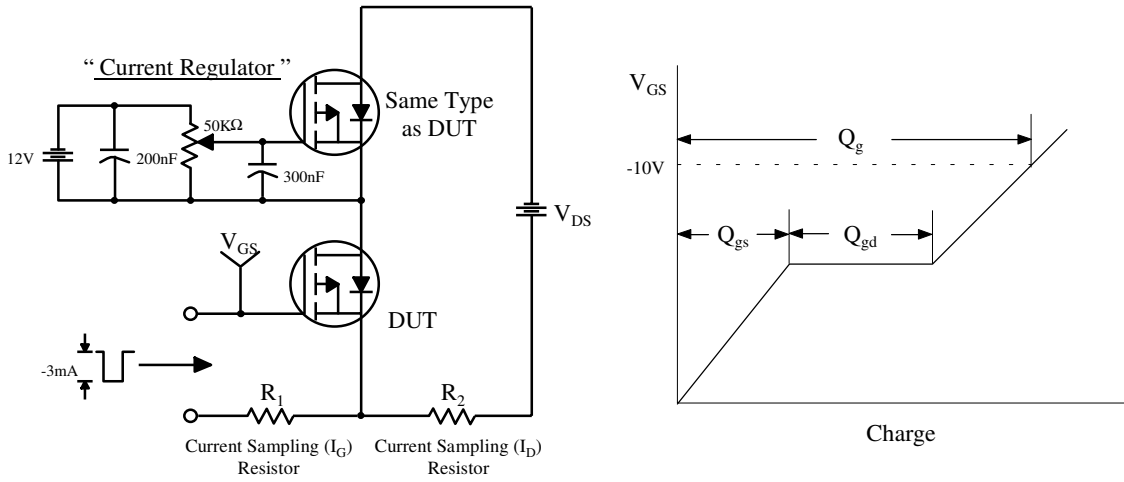
**Fig 10. Max. Drain Current vs. Case Temperature**



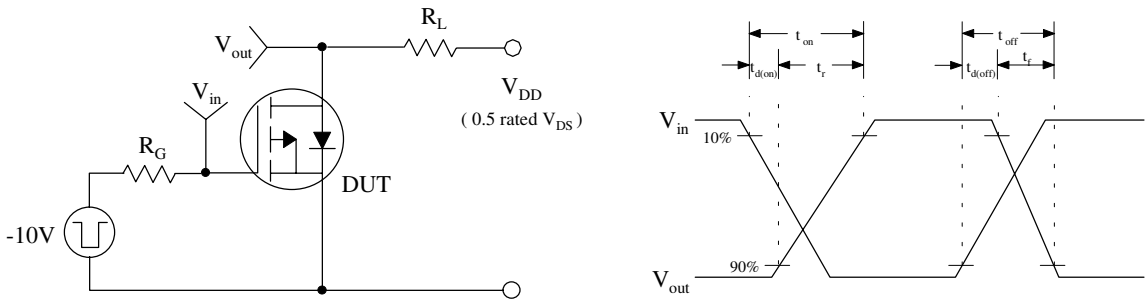
**Fig 11. Thermal Response**



**Fig 12. Gate Charge Test Circuit & Waveform**



**Fig 13. Resistive Switching Test Circuit & Waveforms**



**Fig 14. Unclamped Inductive Switching Test Circuit & Waveforms**

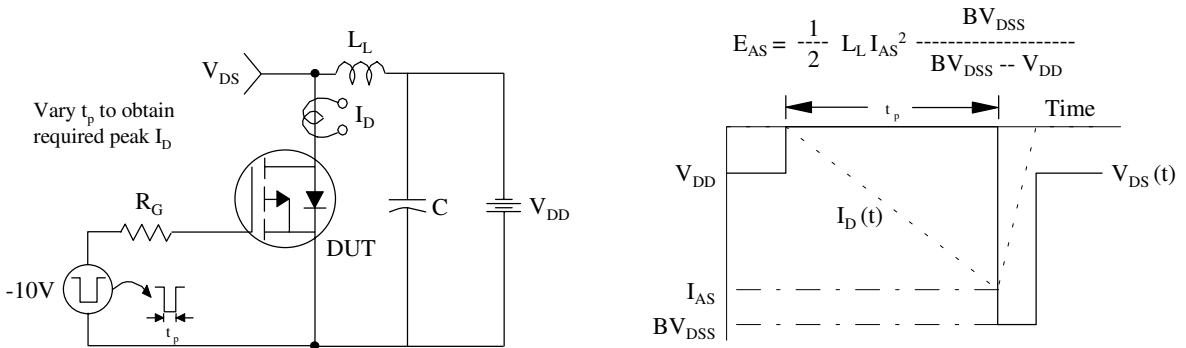
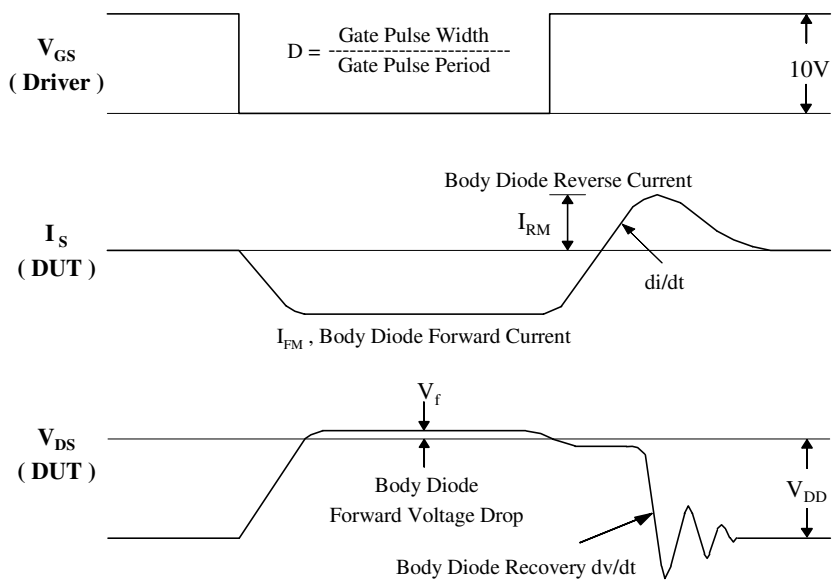
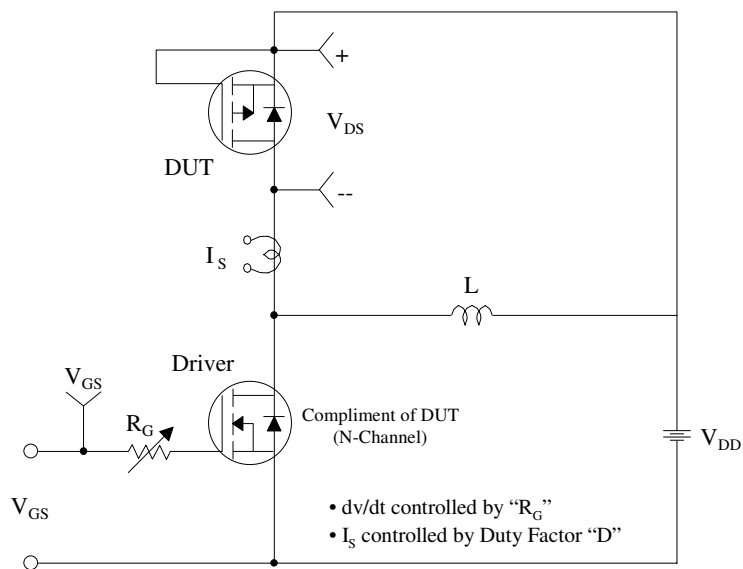


Fig 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms



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EnSigna™	µC™	OCX™	RapidConfigure™	UHC™
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