Advanced Power MOSFET

SSR/U1N60A

FEATURES

- ■ Avalanche Rugged Technology
- ■ Rugged Gate Oxide Technology
- ■ Lower Input Capacitance
- ■ Improved Gate Charge
- ■ Extended Safe Operating Area
- ■ Lower Leakage Current : 25 μA (Max.) @ V_{DS} = 600V
- ■ Low $R_{DS(ON)}$: 9.390 Ω (Typ.)

BV_{DSS} = 600 V

$R_{DS(on)}$ = 12 Ω

I_D = 0.9 A

D-PAK   I-PAK

1. Gate 2. Drain 3. Source

Absolute Maximum Ratings

Symbol	Characteristic		Value	Units
V_{DSS}	Drain-to-Source Voltage		600	V
I_D	Continuous Drain Current (T_C=25°C)		0.9	A
	Continuous Drain Current (T_C=100°C)		0.57	
I_{DM}	Drain Current-Pulsed	①	3	A
V_{GS}	Gate-to-Source Voltage		± 30	V
E_{AS}	Single Pulsed Avalanche Energy	②	66	mJ
I_{AR}	Avalanche Current	①	0.9	A
E_{AR}	Repetitive Avalanche Energy	①	2.8	mJ
dv/dt	Peak Diode Recovery dv/dt	③	3.0	V/ns
P_D	Total Power Dissipation (T_A=25°C)*		2.5	W
	Total Power Dissipation (T_C=25°C)		28	W
	Linear Derating Factor		0.22	W/°C
T_J , T_{STG}	Operating Junction and Storage Temperature Range		- 55 to +150	°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	--	4.53	°C/W
$R_{\theta JA}$	Junction-to-Ambient *	--	50	
$R_{\theta JA}$	Junction-to-Ambient	--	110	

* When mounted on the minimum pad size recommended (PCB Mount).

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ELECTRONICS

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

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Condition
BV_{DSS}	Drain-Source Breakdown Voltage	600	--	--	V	V_{GS}=0V,I_D=250 µA
$\Delta BV/\Delta T_J$	Breakdown Voltage Temp. Coeff.	--	0.74	--	V/°C	I_D=250 µA *See Fig 7*
$V_{GS(th)}$	Gate Threshold Voltage	2.0	--	4.0	V	V_{DS}=5V,I_D=250 µA
I_{GSS}	Gate-Source Leakage , Forward	--	--	100	nA	V_{GS}=30V
	Gate-Source Leakage , Reverse	--	--	-100		V_{GS}=-30V
I_{DSS}	Drain-to-Source Leakage Current	--	--	25	µA	V_{DS}=600V
		--	--	250		V_{DS}=480V,T_C=125°C
$R_{DS(on)}$	Static Drain-Source On-State Resistance	--	--	12	Ω	V_{GS}=10V,I_D=0.45A ④
g_{fs}	Forward Transconductance	--	0.70	--	℧	V_{DS}=50V,I_D=0.45A ④
C_{iss}	Input Capacitance	--	145	190	pF	V_{GS}=0V,V_{DS}=25V,f =1MHz *See Fig 5*
C_{oss}	Output Capacitance	--	20	24		
C_{rss}	Reverse Transfer Capacitance	--	7	9		
$t_{d(on)}$	Turn-On Delay Time	--	10	30	ns	V_{DD}=300V,I_D=1A, R_G=24 Ω *See Fig 13* ④⑤
t_r	Rise Time	--	13	35		
$t_{d(off)}$	Turn-Off Delay Time	--	28	65		
t_f	Fall Time	--	13	35		
Q_g	Total Gate Charge	--	7.5	11	nC	V_{DS}=480V,V_{GS}=10V, I_D=1A *See Fig 6 & Fig 12* ④⑤
Q_{gs}	Gate-Source Charge	--	1.2	--		
Q_{gd}	Gate-Drain("Miller") Charge	--	4	--		

Source-Drain Diode Ratings and Characteristics

Symbol	Characteristic	Min.	Typ.	Max.	Units	Test Condition
I_S	Continuous Source Current	--	--	0.9	A	Integral reverse pn-diode in the MOSFET
I_{SM}	Pulsed-Source Current ①	--	--	3		
V_{SD}	Diode Forward Voltage ④	--	--	1.2	V	T_J=25°C,I_S=0.9A,V_{GS}=0V
t_{rr}	Reverse Recovery Time	--	190	--	ns	T_J=25°C,I_F=1A
Q_{rr}	Reverse Recovery Charge	--	0.44	--	µC	di_F/dt=100A/µs ④

Notes ;
① Repetitive Rating : Pulse Width Limited by Maximum Junction Temperature
② L=150mH, I_{AS}=0.9A, V_{DD}=50V, R_G=27Ω, Starting T_J=25°C
③ I_{SD} ≤1A, di/dt ≤60A/µs, V_{DD} ≤BV_{DSS}, Starting T_J=25°C
④ Pulse Test : Pulse Width = 250µs, Duty Cycle ≤ 2%
⑤ Essentially Independent of Operating Temperature

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Fig 1. Output Characteristics

V_{GS}
Top : 15 V
10 V
8.0 V
7.0 V
6.0 V
5.5 V
5.0 V
Bottom : 4.5 V

I_D , Drain Current [A]

@ Notes :
1. 250 μs Pulse Test
2. T_C = 25 °C

V_{DS} , Drain-Source Voltage [V]
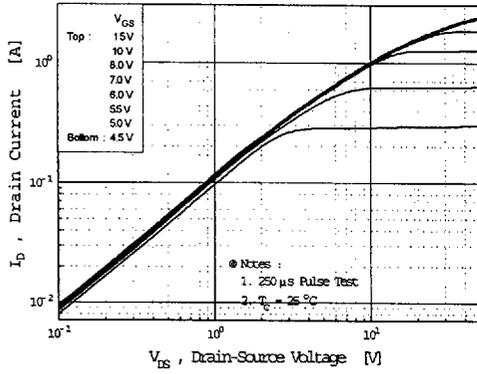
Fig 2. Transfer Characteristics

I_D , Drain Current [A]

150 °C
25 °C
- 55 °C

@ Notes :
1. V_{GS} = 0 V
2. V_{DS} = 50 V
3. 250 μs Pulse Test

V_{GS} , Gate-Source Voltage [V]
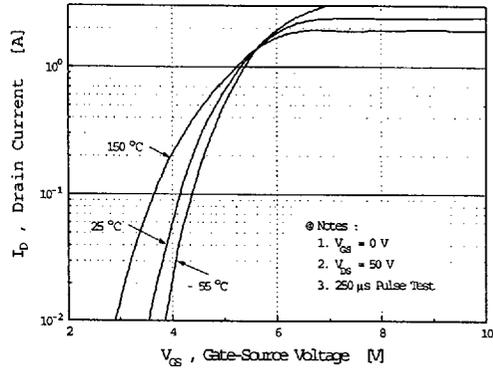
Fig 3. On-Resistance vs. Drain Current

$R_{DS(on)}$, [Ω]
Drain-Source On-Resistance

V_{GS} = 10 V
V_{GS} = 20 V

@ Note : T_J = 25 °C

I_D , Drain Current [A]
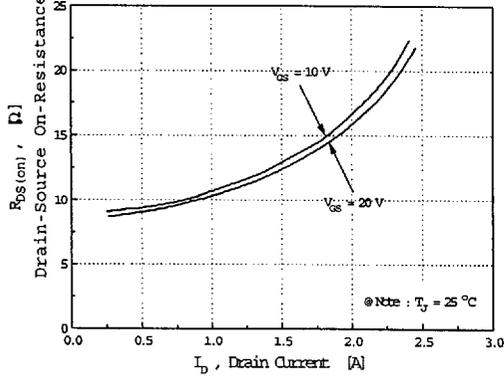
Fig 4. Source-Drain Diode Forward Voltage

I_{DR} , Reverse Drain Current [A]

150 °C
25 °C

@ Notes :
1. V_{GS} = 0 V
2. 250 μs Pulse Test

V_{SD} , Source-Drain Voltage [V]
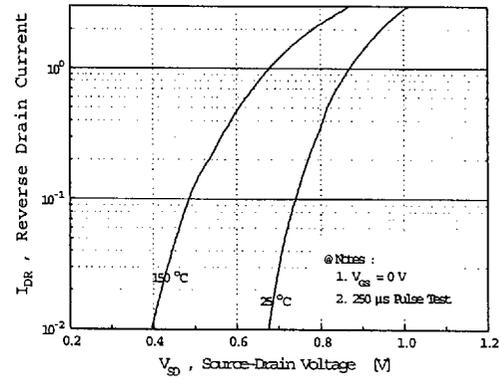
Fig 5. Capacitance vs. Drain-Source Voltage

Capacitance [pF]

$C_{iss} = C_{gs} + C_{gd}$ (C_{ds} = shorted)
$C_{oss} = C_{ds} + C_{gd}$
$C_{rss} = C_{gd}$

C_{iss}
C_{oss}
C_{rss}

@ Notes :
1. V_{GS} = 0 V
2. f = 1 MHz

V_{DS} , Drain-Source Voltage [V]
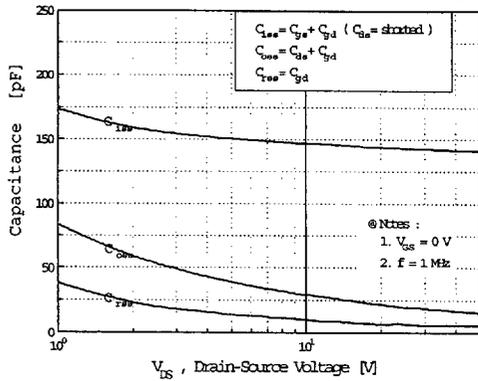
Fig 6. Gate Charge vs. Gate-Source Voltage

V_{GS} , Gate-Source Voltage [V]

V_{DS} = 120 V
V_{DS} = 300 V
V_{DS} = 480 V

@ Notes : I_D = 1.0 A

Q_G , Total Gate Charge [nC]

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

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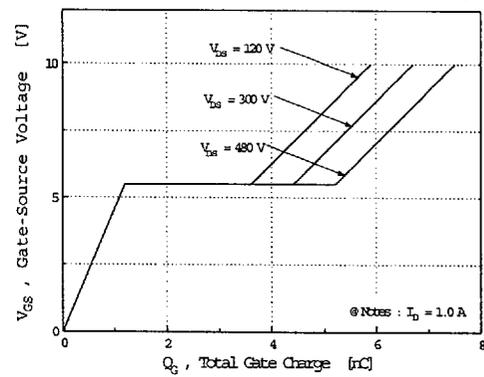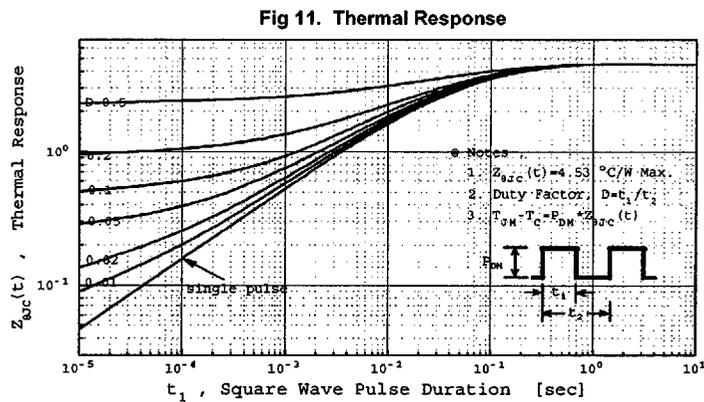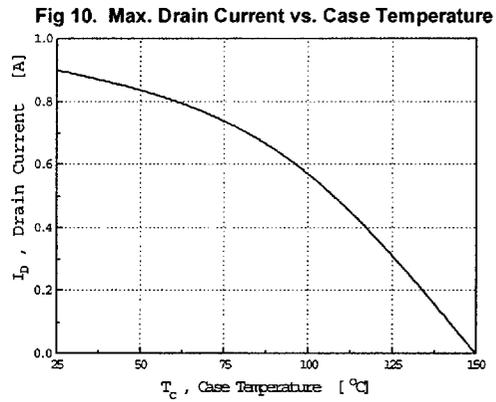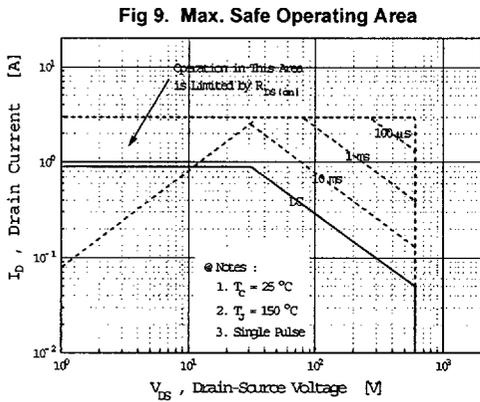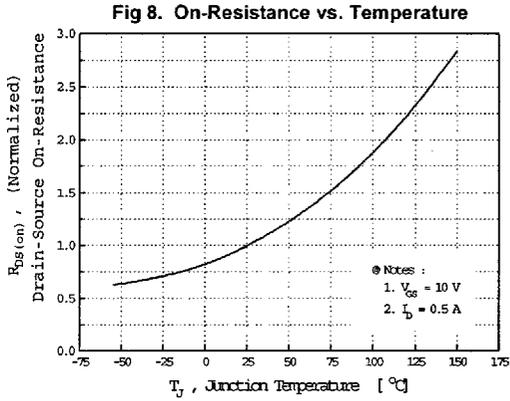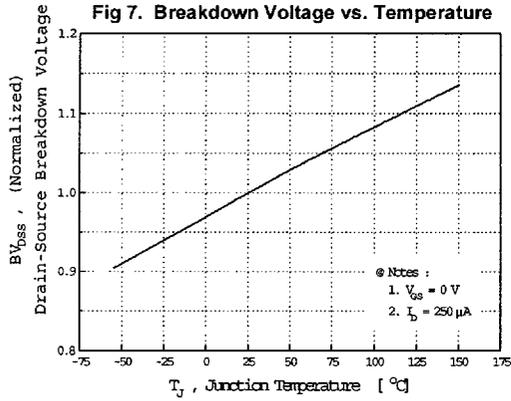
Fig 12. Gate Charge Test Circuit & Waveform
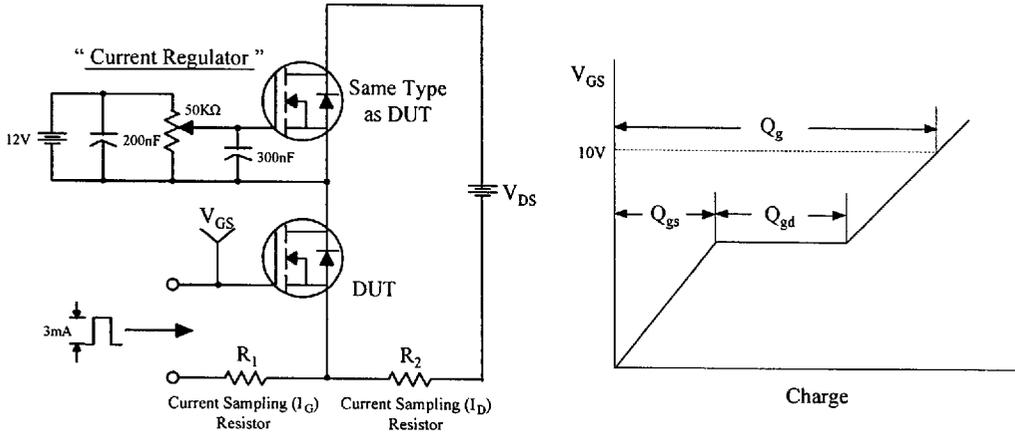
### Fig 13. Resistive Switching Test Circuit & Waveforms
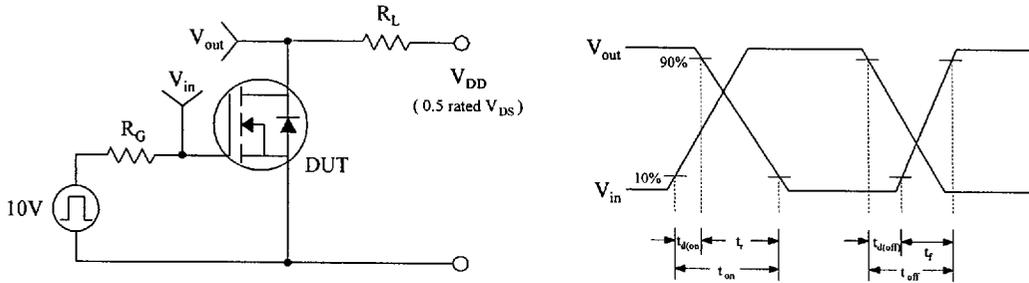
Fig 14. Unclamped Inductive Switching Test Circuit & Waveforms

$$E_{AS} = \frac{1}{2} L_L I_{AS}^2 \frac{BV_{DSS}}{BV_{DSS} - V_{DD}}$$

7964142 0040465 376
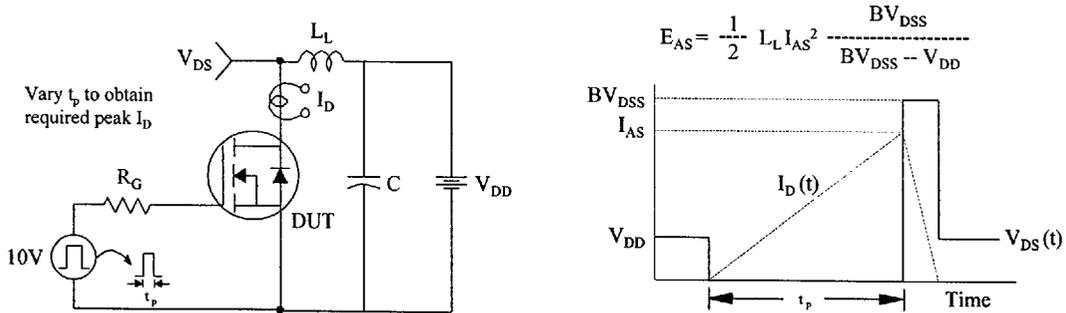
Fig 15. Peak Diode Recovery dv/dt Test Circuit & Waveforms

DUT

V_{DS}

I_S

L

V_{GS}

Driver

R_G

Same Type
as DUT

V_{DD}

V_{GS}

• dv/dt controlled by "R_G"
• I_S controlled by Duty Factor "D"

V_{GS}
(Driver)

$D = \dfrac{\text{Gate Pulse Width}}{\text{Gate Pulse Period}}$

10V

I_S
(DUT)

I_{FM}, Body Diode Forward Current

di/dt

I_{RM}

Body Diode Reverse Current

V_{DS}
(DUT)

Body Diode Recovery dv/dt

V_f

V_{DD}

Body Diode
Forward Voltage Drop

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