

$V_{DSS}$	600V
$R_{DS(on)}$ (Max.)	0.196Ω
$I_D$	20A
$P_D$	120W

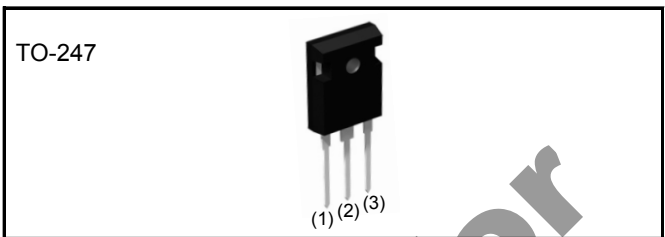
#### ●Features

- 1) Low on-resistance.
- 2) Fast switching speed.
- 3) Gate-source voltage ( $V_{GSS}$ ) guaranteed to be  $\pm 20V$ .
- 4) Drive circuits can be simple.
- 5) Parallel use is easy.
- 6) Pb-free lead plating ; RoHS compliant

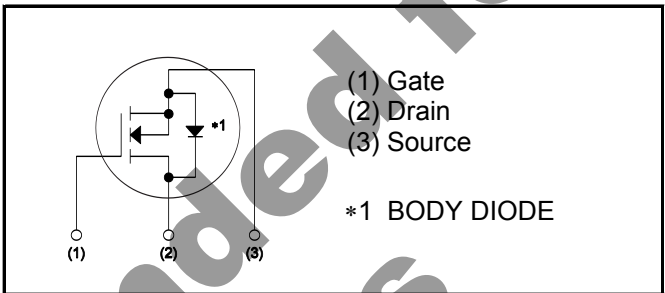
#### ●Application

Switching Power Supply

#### ●Outline



#### ●Inner circuit



#### ●Packaging specifications

Type	Packaging	Tube
	Reel size (mm)	-
	Tape width (mm)	-
	Basic ordering unit (pcs)	450
	Taping code	C9
	Marking	R6020ENZ1

#### ●Absolute maximum ratings ( $T_a = 25^\circ C$ )

Parameter	Symbol	Value	Unit
Drain - Source voltage	$V_{DSS}$	600	V
Continuous drain current	$I_D$ *1	$\pm 20$	A
	$I_D$ *1	$\pm 10.9$	A
Pulsed drain current	$I_{D,pulse}$ *2	$\pm 60$	A
Gate - Source voltage	$V_{GSS}$	$\pm 20$	V
Avalanche energy, single pulse	$E_{AS}$ *3	418	mJ
Avalanche energy, repetitive	$E_{AR}$ *3	0.63	mJ
Avalanche current, repetitive	$I_{AR}$	3.4	A
Power dissipation ( $T_c = 25^\circ C$ )	$P_D$	120	W
Junction temperature	$T_j$	150	$^\circ C$
Range of storage temperature	$T_{stg}$	-55 to +150	$^\circ C$
Reverse diode dv/dt	dv/dt *4	15	V/ns

### ●Absolute maximum ratings

Parameter	Symbol	Conditions	Values	Unit
Drain - Source voltage slope	dv/dt	$V_{DS} = 480V$ $T_j = 25^\circ C$	50	V/ns

### ●Thermal resistance

Parameter	Symbol	Values			Unit
		Min.	Typ.	Max.	
Thermal resistance, junction - case	$R_{thJC}$	-	-	1.04	$^\circ C/W$
Thermal resistance, junction - ambient	$R_{thJA}$	-	-	30	$^\circ C/W$
Soldering temperature, wavesoldering for 10s	$T_{sold}$	-	-	265	$^\circ C$

### ●Electrical characteristics ( $T_a = 25^\circ C$ )

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Drain - Source breakdown voltage	$V_{(BR)DSS}$	$V_{GS} = 0V, I_D = 1mA$	600	-	-	V
Zero gate voltage drain current	$I_{DSS}$	$V_{DS} = 600V, V_{GS} = 0V$ $T_j = 25^\circ C$	-	0.1	100	$\mu A$
		$T_j = 125^\circ C$	-	-	1000	
Gate - Source leakage current	$I_{GSS}$	$V_{GS} = \pm 20V, V_{DS} = 0V$	-	-	$\pm 100$	nA
Gate threshold voltage	$V_{GS(th)}$	$V_{DS} = 10V, I_D = 1mA$	2	-	4	V
Static drain - source on - state resistance	$R_{DS(on)}^{*5}$	$V_{GS} = 10V, I_D = 9.5A$ $T_j = 25^\circ C$	-	0.170	0.196	$\Omega$
		$T_j = 125^\circ C$	-	0.360	-	
Gate input resistance	$R_G$	$f = 1MHz, \text{open drain}$	-	5.8	-	$\Omega$

**●Electrical characteristics (T<sub>a</sub> = 25°C)**

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Transconductance	$g_{fs}^{*5}$	$V_{DS} = 10V, I_D = 10A$	5	10	-	S
Input capacitance	$C_{iss}$	$V_{GS} = 0V$	-	1400	-	pF
Output capacitance	$C_{oss}$	$V_{DS} = 25V$	-	1200	-	
Reverse transfer capacitance	$C_{rss}$	$f = 1MHz$	-	130	-	
Effective output capacitance, energy related	$C_{o(er)}$	$V_{GS} = 0V$ $V_{DS} = 0V \text{ to } 480V$	-	56	-	pF
Effective output capacitance, time related	$C_{o(tr)}$		-	266	-	
Turn - on delay time	$t_{d(on)}^{*5}$	$V_{DD} \approx 480V, V_{GS} = 10V$	-	35	-	ns
Rise time	$t_r^{*5}$	$I_D = 10A$	-	53	-	
Turn - off delay time	$t_{d(off)}^{*5}$	$R_L = 47.5\Omega$	-	150	-	
Fall time	$t_f^{*5}$	$R_G = 10\Omega$	-	67	-	

**●Gate Charge characteristics (T<sub>a</sub> = 25°C)**

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Total gate charge	$Q_g^{*5}$	$V_{DD} \approx 480V$	-	60	-	nC
Gate - Source charge	$Q_{gs}^{*5}$	$I_D = 20A$	-	8	-	
Gate - Drain charge	$Q_{gd}^{*5}$	$V_{GS} = 10V$	-	33	-	
Gate plateau voltage	$V_{(plateau)}$	$V_{DD} \approx 480V, I_D = 20A$	-	6.9	-	V

\*1 Limited only by maximum temperature allowed.

\*2  $P_W \leq 10\mu s$ , Duty cycle  $\leq 1\%$

\*3  $I_D = 3.4A, V_{DD} = 50V$

\*4 Reference measurement circuits Fig.5-1.

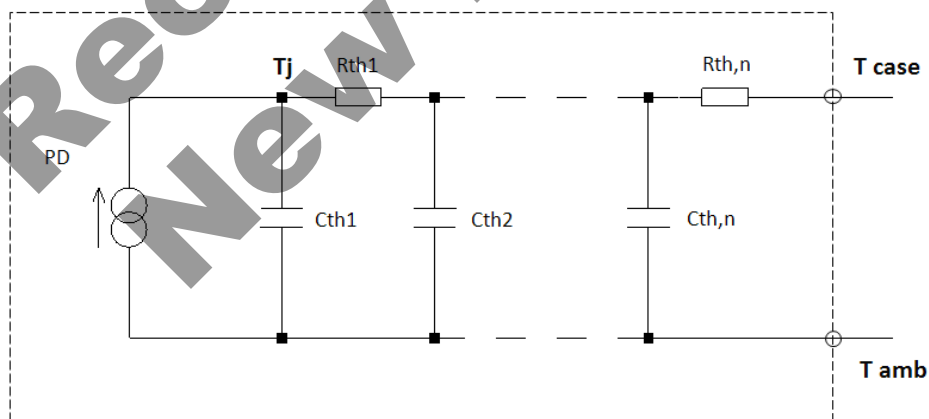
\*5 Pulsed

**●Body diode electrical characteristics (Source-Drain) ( $T_a = 25^\circ\text{C}$ )**

Parameter	Symbol	Conditions	Values			Unit
			Min.	Typ.	Max.	
Inverse diode continuous, forward current	$I_S^{*1}$	$T_c = 25^\circ\text{C}$	-	-	20	A
Inverse diode direct current, pulsed	$I_{SM}^{*2}$		-	-	60	A
Forward voltage	$V_{SD}^{*5}$	$V_{GS} = 0\text{V}, I_S = 20\text{A}$	-	-	1.5	V
Reverse recovery time	$t_{rr}^{*5}$	$I_S = 20\text{A}$ $di/dt = 100\text{A}/\mu\text{s}$	-	550	-	ns
Reverse recovery charge	$Q_{rr}^{*5}$		-	10.4	-	$\mu\text{C}$
Peak reverse recovery current	$I_{rrm}^{*5}$		-	38	-	A

**●Typical Transient Thermal Characteristics**

Symbol	Value	Unit	Symbol	Value	Unit
$R_{th1}$	0.283	K/W	$C_{th1}$	0.00969	Ws/K
$R_{th2}$	0.430		$C_{th2}$	0.226	
$R_{th3}$	0.250		$C_{th3}$	13.8	



●Electrical characteristic curves

Fig.1 Power Dissipation Derating Curve

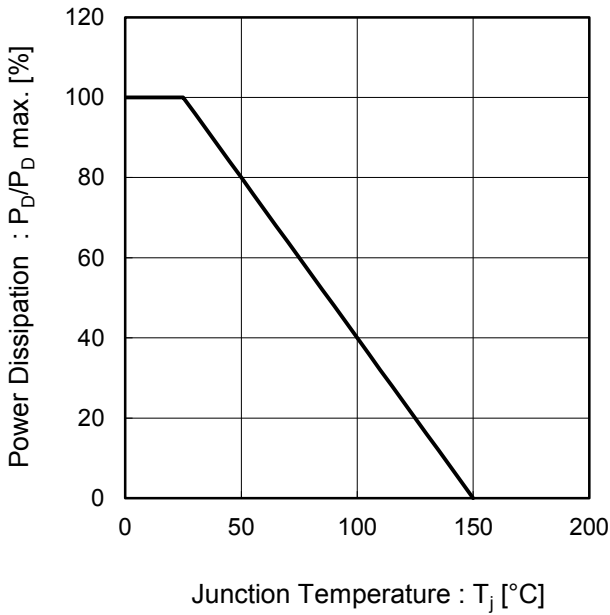


Fig.2 Maximum Safe Operating Area

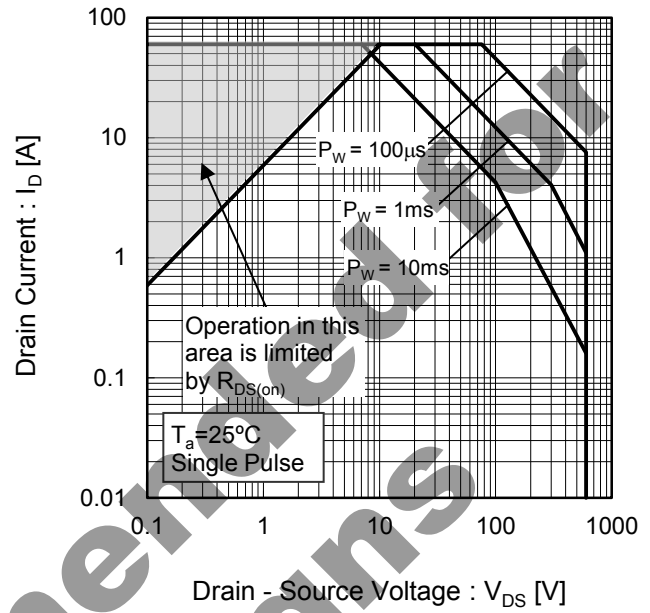


Fig.3 Normalized Transient Thermal Resistance vs. Pulse Width

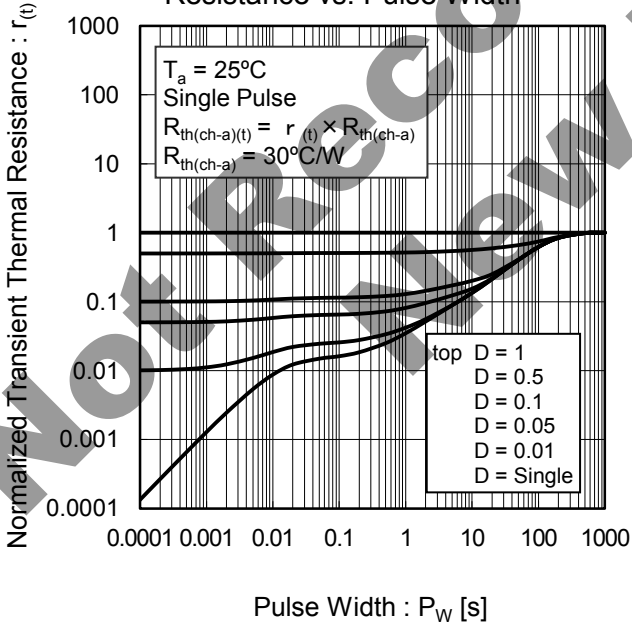
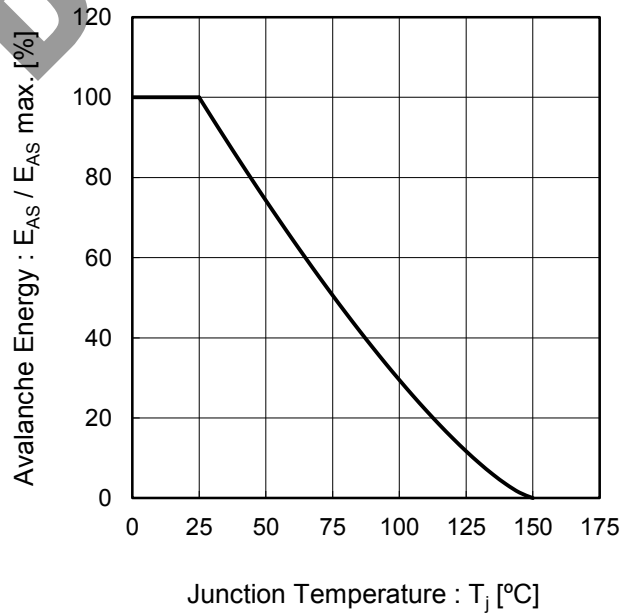


Fig.4 Avalanche Energy Derating Curve vs Junction Temperature



●Electrical characteristic curves

Fig.5 Typical Output Characteristics(I)

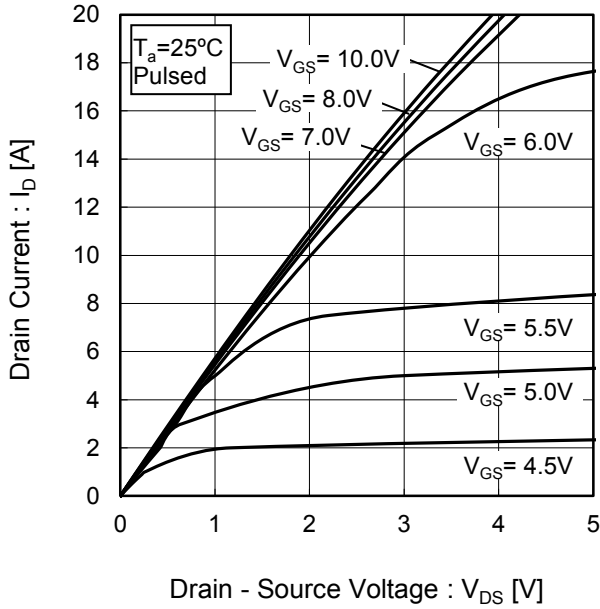


Fig.6 Typical Output Characteristics(II)

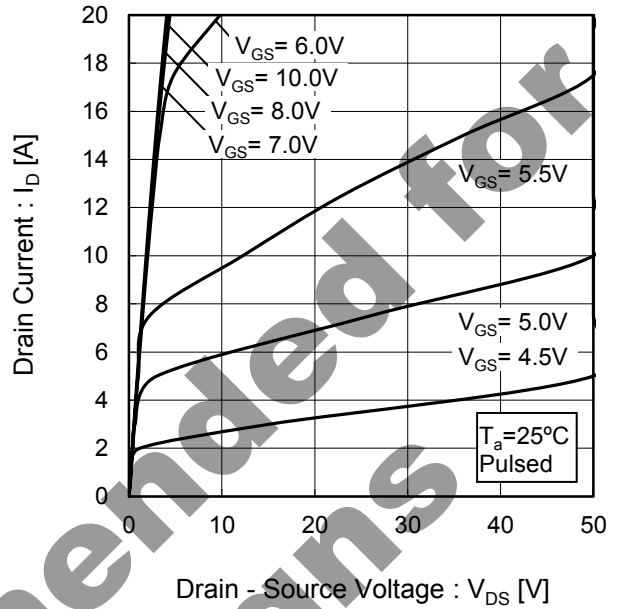


Fig.7  $T_j = 150^\circ\text{C}$  Typical Output Characteristics(I)

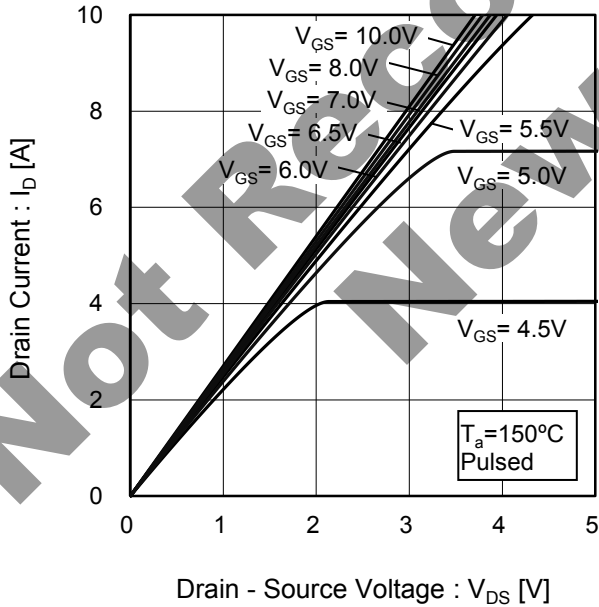
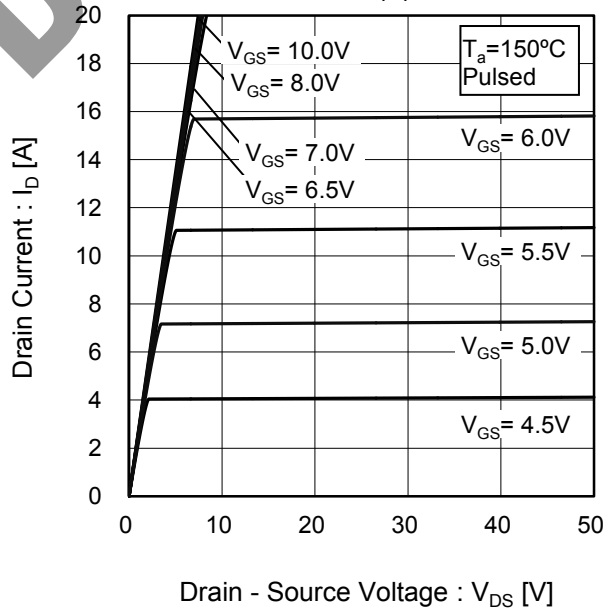


Fig.8  $T_j = 150^\circ\text{C}$  Typical Output Characteristics(II)



●Electrical characteristic curves

Fig.9 Breakdown Voltage vs. Junction Temperature

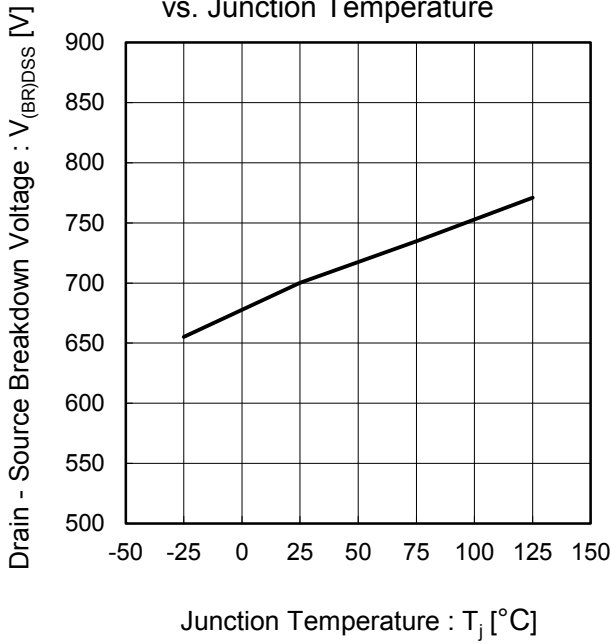


Fig.10 Typical Transfer Characteristics

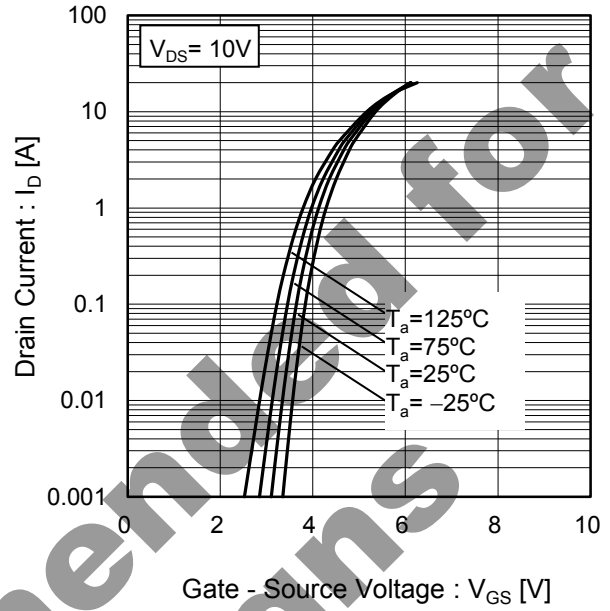


Fig.11 Gate Threshold Voltage vs. Junction Temperature

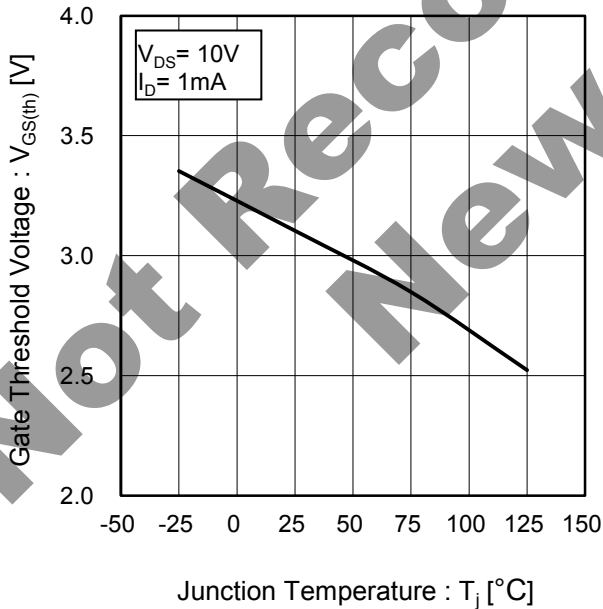
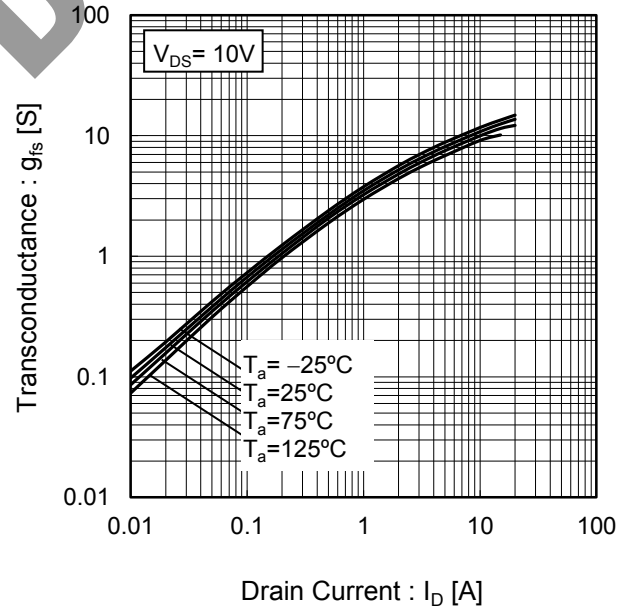


Fig.12 Transconductance vs. Drain Current



●Electrical characteristic curves

Fig.13 Static Drain - Source On - State Resistance vs. Gate Source Voltage

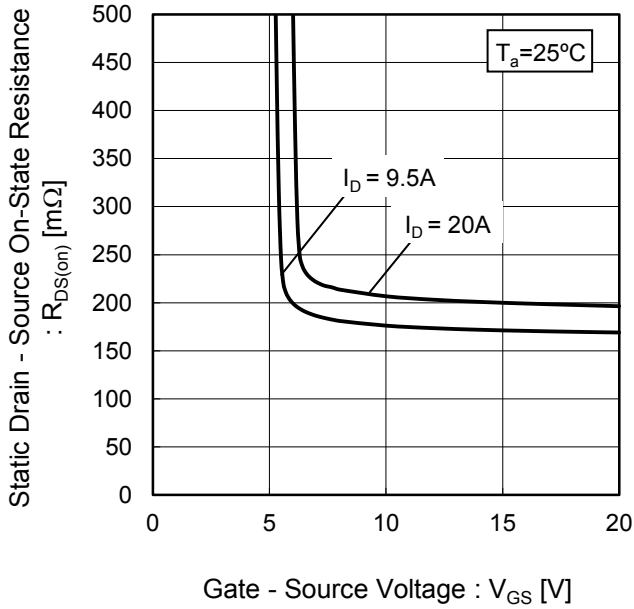


Fig.14 Static Drain - Source On - State Resistance vs. Junction Temperature

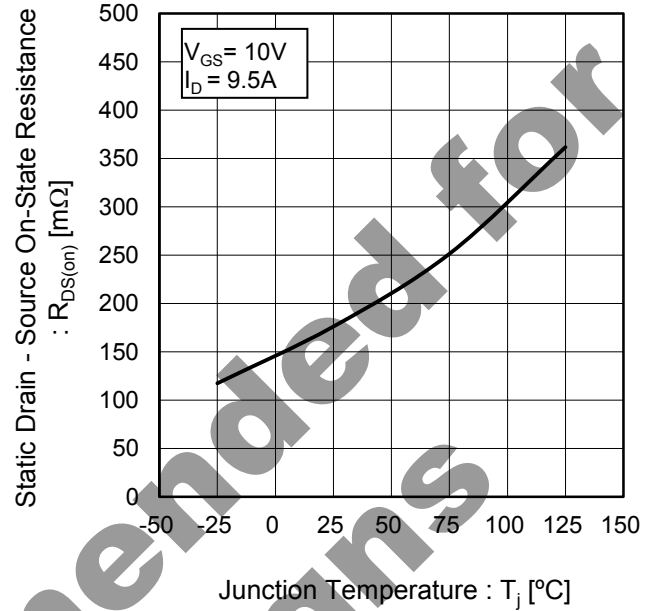


Fig.15 Static Drain - Source On - State Resistance vs. Drain Current

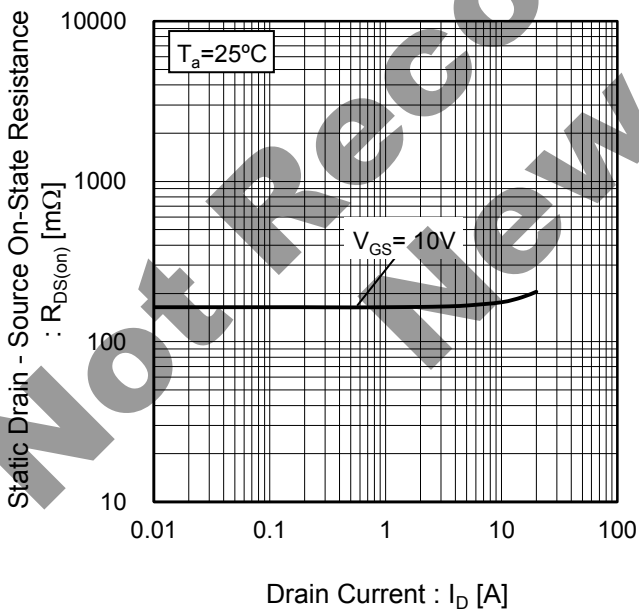
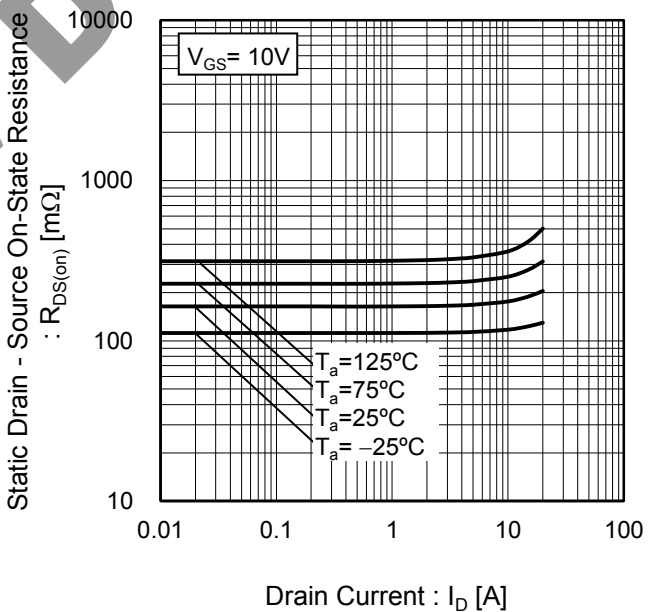


Fig.16 Static Drain - Source On - State Resistance vs. Drain Current





●Electrical characteristic curves

Fig.17 Typical Capacitance vs. Drain - Source Voltage

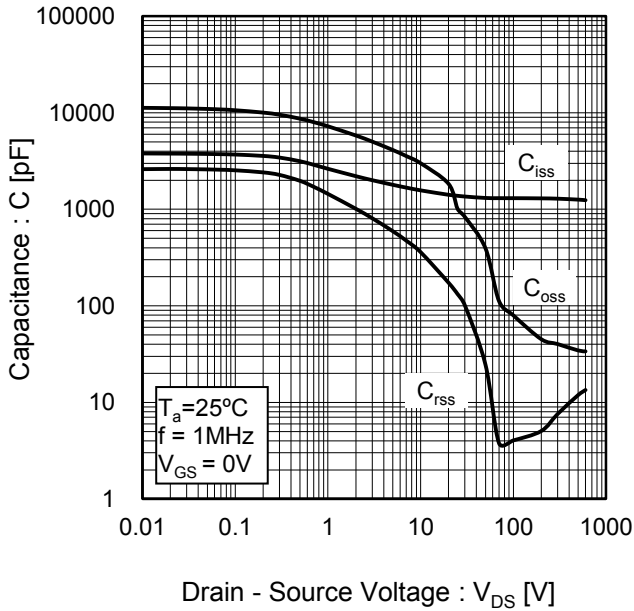


Fig.18 Coss Stored Energy

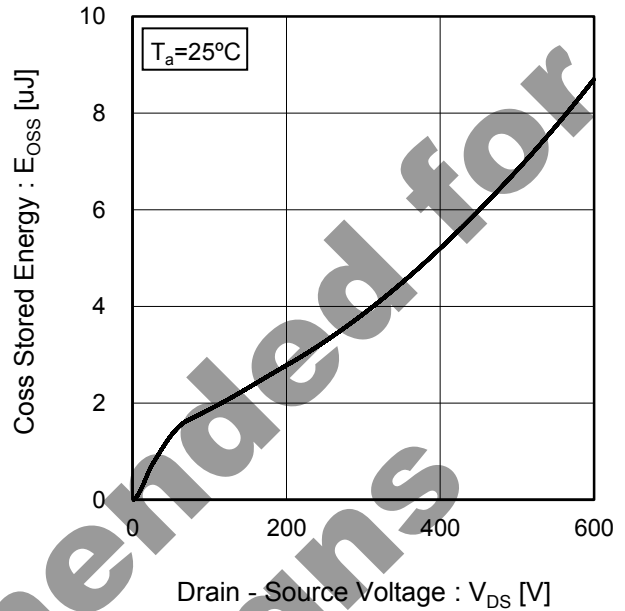


Fig.19 Switching Characteristics

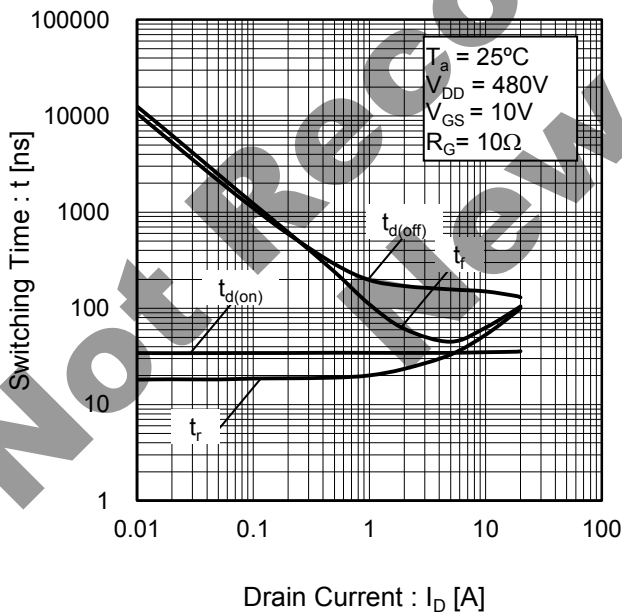
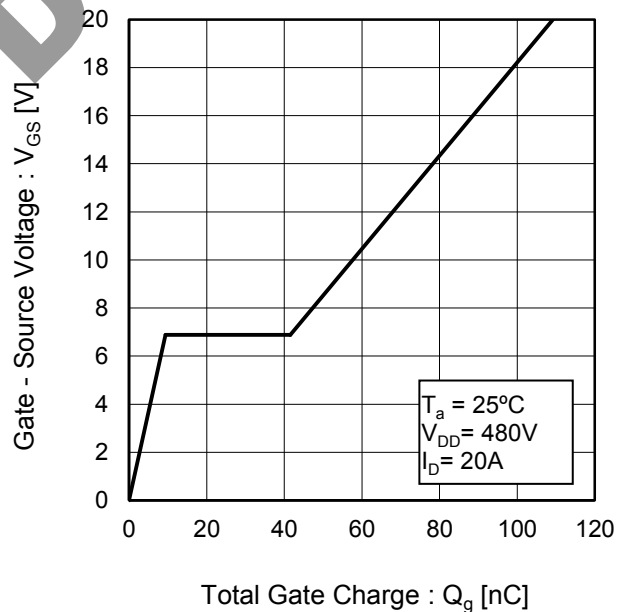


Fig.20 Dynamic Input Characteristics



●Electrical characteristic curves

Fig.21 Inverse Diode Forward Current vs. Source - Drain Voltage

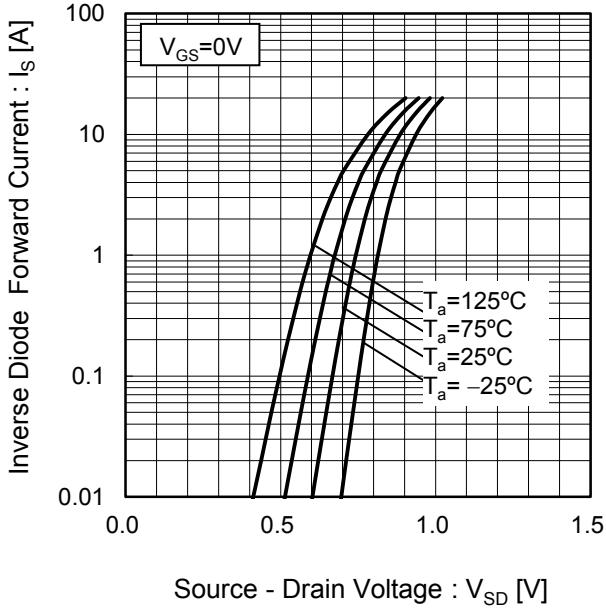
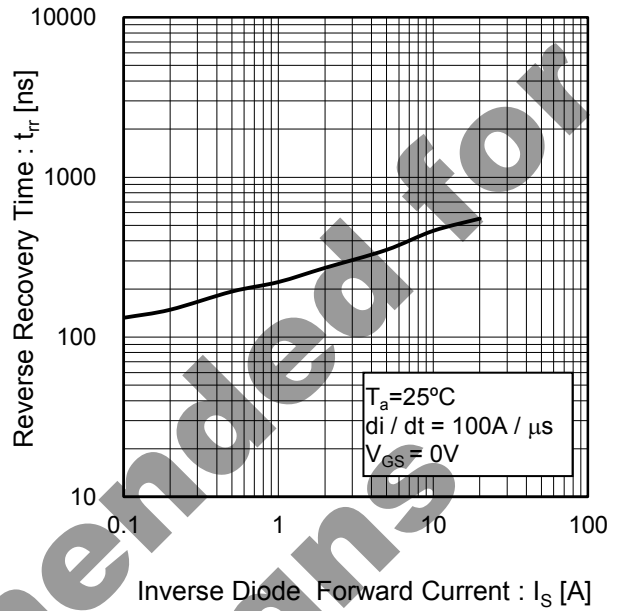


Fig.22 Reverse Recovery Time vs. Inverse Diode Forward Current



Not Recommended for New Designing

● Measurement circuits

Fig.1-1 Switching Time Measurement Circuit

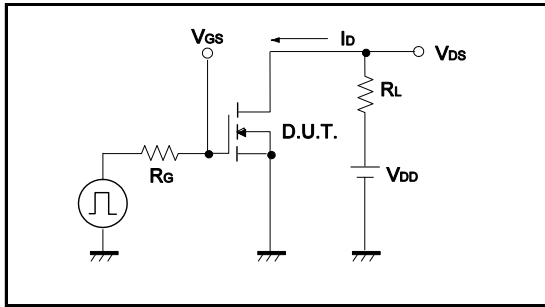


Fig.1-2 Switching Waveforms

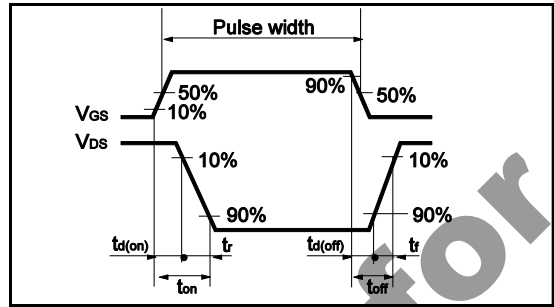


Fig.2-1 Gate Charge Measurement Circuit

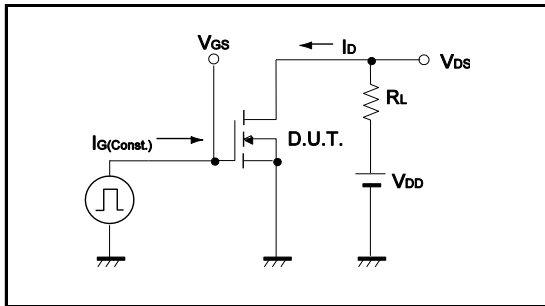


Fig.2-2 Gate Charge Waveform

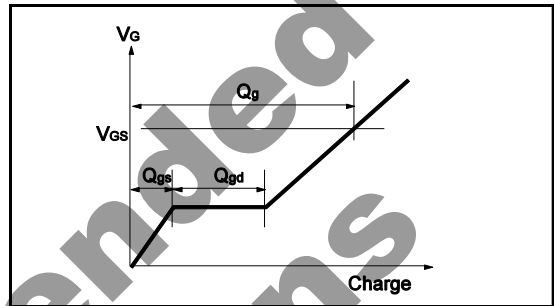


Fig.3-1 Avalanche Measurement Circuit

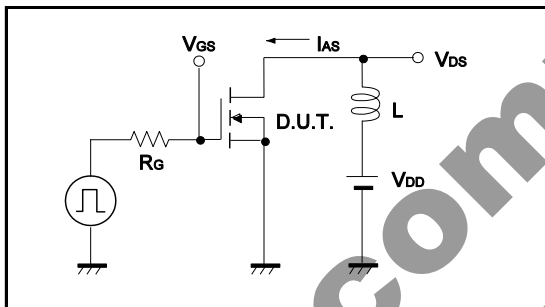


Fig.3-2 Avalanche Waveform

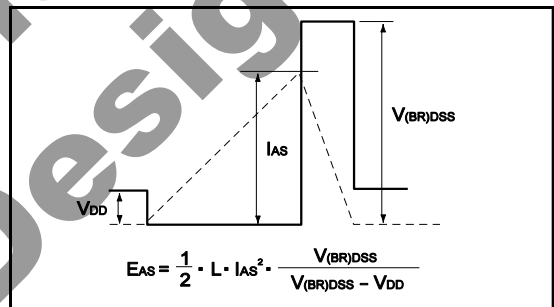


Fig.4-1 dv/dt Measurement Circuit

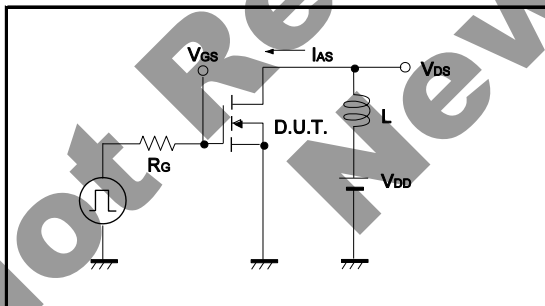


Fig.4-2 dv/dt Waveform

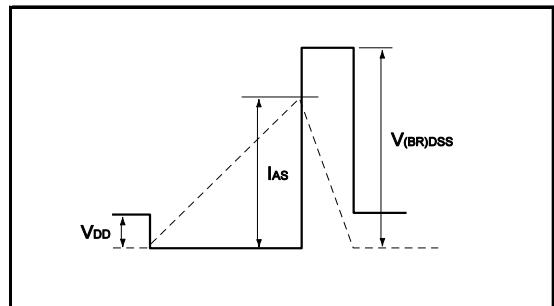


Fig.5-1 di/dt Measurement Circuit

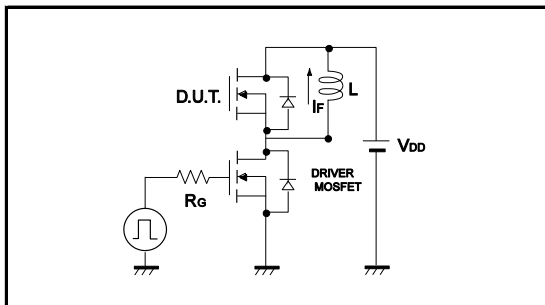
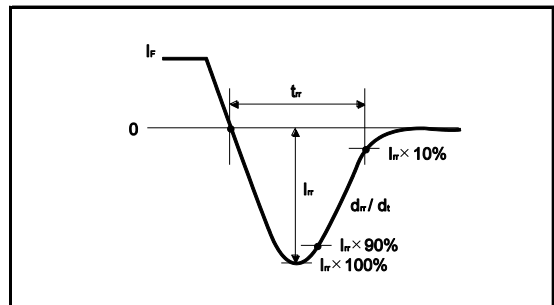
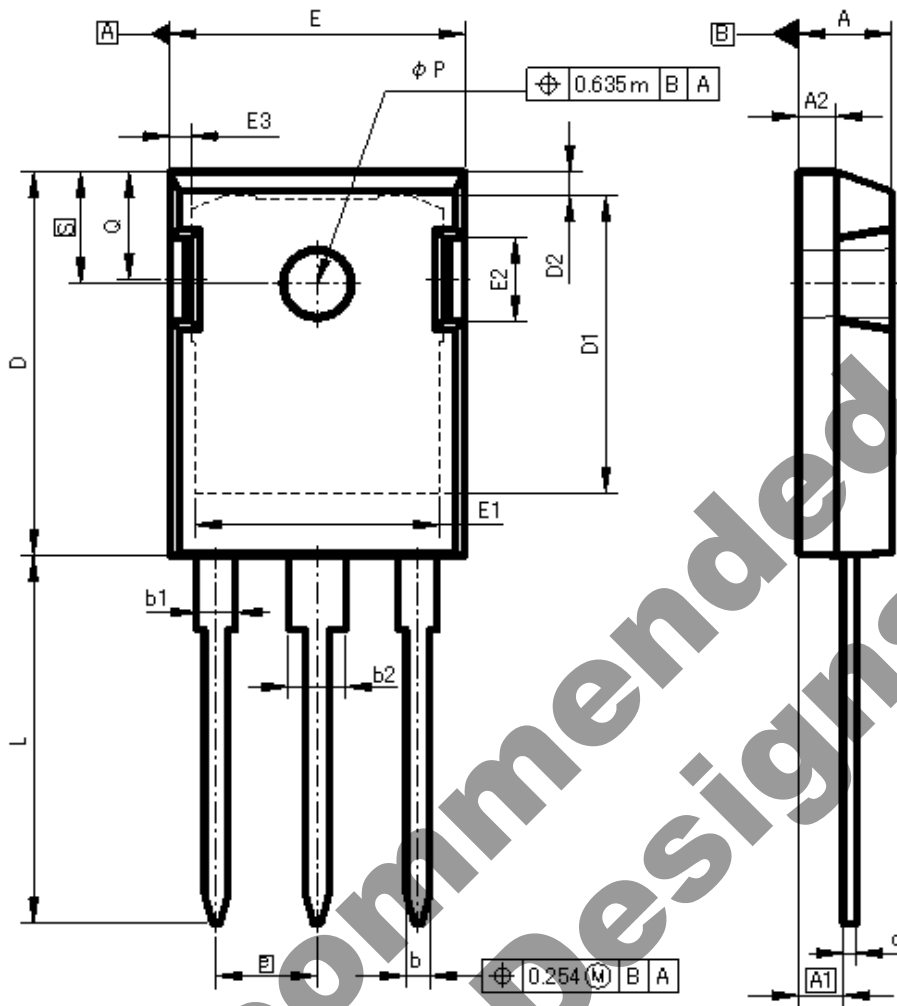


Fig.5-2 di/dt Waveform



●Dimensions (Unit : mm)

TO-247



DIM	MILIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	4.83	5.21	0.190	0.205
A1	2.29	2.54	0.090	0.100
A2	1.91	2.16	0.075	0.085
b	1.14	1.40	0.045	0.055
b1	1.91	2.20	0.075	0.087
b2	2.92	3.20	0.115	0.126
c	0.61	0.80	0.024	0.031
D	20.80	21.34	0.819	0.840
D1	17.43	17.83	0.686	0.702
E	15.75	16.13	0.620	0.635
e	5.45		0.215	
N	3.00		3.000	
L	19.81	20.57	0.780	0.810
L1	3.81	4.32	0.150	0.170
$\Phi P$	3.55	3.65	0.140	0.144
Q	5.59	6.20	0.220	0.244
S	6.15		0.240	

Dimension in mm / inches

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